

**THE ART OF MAKING RAIN AND FAIR WEATHER:
THE LIFE AND WORLD SYSTEM OF
LOUIS-BERTRAND CASTEL, SJ (1688-1757)**

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ABSTRACT

This dissertation explores the natural philosophy of the polymath Louis-Bertrand Castel (1688-1757), one of the most prolific and colorful Jesuit thinkers of early modern France. It approaches Castel's writings as part of a coherent and insightful enterprise and shows the importance of avoiding facile categorizations of his world system as "Aristotelian," "Cartesian" or "Anti-Newtonian" in favor of a sensitive biographical and historical contextualization of his oeuvre. Castel believed that God invested human beings with the duty and power to shape the earth, and he developed an all-embracing philosophy upon this notion. He argued that human activity occasioned rains, storms, and natural disasters; perpetuated the existence of plants and animals; caused mountains to rise and fall, rivers to flow, and fire to burn beneath the crust; in short, it ensured the circulation, the organization, and the revitalization of the world machine. Castel's lifelong, syncretic endeavor aimed to reconcile the mechanical philosophy of his forebears with the tenets of his faith, at a time when he felt a growing number of "moderns" were eroding the dignity and free will of man.

Although scholarship has long marginalized his work, Castel's oeuvre emerges here at the center of eighteenth-century intellectual life. By studying the development of his theories about "the action of man upon nature" in a variety of disciplinary contexts — theology, physics, political economy, geometry, meteorology, and history — this work allows one to better understand the relationship between these disciplines and the evolution of the early modern quest for universal knowledge. This work also participates in the reassessment of the role that the Society of Jesus played in France in the development of

early modern science. Castel's intellectual endeavor helps shift one's understanding of the scientific revolution and its aftermath, as it features Jesuits as full participants, colleagues and even precursors to better known figures of the canon. It suggests new ways of understanding how science and religion – far from being in conflict – worked together at one point to foster Enlightenment practices and ideologies.

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INTRODUCTION

A Twist of Smoke and Spirit

Our life is but an epigram, of which death is the point.
— Louis-Bertrand Castel¹

On 11 January 1757, Reverend Father Louis-Bertrand Castel of the Society of Jesus, one of the fieriest spirits of his generation, drew his last breath at the infirmary of Louis-le-Grand College in Paris. He was sixty-eight years old.

Burning with a passion for study, Castel had traded health for insight, wearing his body out with long hours of reading and writing by candlelight. To alleviate the weight of years and soothe his growing ailments, he surrounded himself with young pupils to whom he taught geometry; in return, they attended to his needs and kept him company in his quarters on rue Saint-Jacques. Determined to drop dead only in the midst of his labors, the Archimedes of Paris refused to lie in bed during his final illness and insisted on sitting in an armchair with his clothes on even after his transfer to the college's sick house. There, one of his students continued to look after him to the end — an end that his brethren described as worthy of a Christian sage. Castel's last recorded words were exclamations of wonder at the spectacle offered by his extreme unction: "How beautiful! How well instituted!" He was referring to the orderliness of the rite, a glimpse, perhaps, into a better world to come.²

¹ Louis-Bertrand Castel, *Esprit, saillies et singularités du Père Castel*, ed. Abbé Joseph de Laporte [?] (Amsterdam and Paris: Vincent, 1763), 393 : "Notre vie n'est qu'une épigramme, dont la mort est la pointe."

² Claude-Nicolas Le Cat, "Eloge du Père Castel Jesuite [...]," C21, Archives de l'Académie de Rouen, Bibliothèque municipale François Villon, Rouen. (Henceforth "Eloge")

News of Castel's demise spread quickly in the Parisian gazettes and elicited mixed responses from the public.³ By October 1758, word of it had reached missionaries in China.⁴ Formal eulogies were written too, but they were few in number and not altogether laudatory. One of them was Claude-Nicolas Le Cat's "Éloge du Père Castel," read belatedly on 5 August 1761 at the public assembly of the Académie des Sciences, Belles-lettres et Arts of Rouen.⁵ As the perpetual secretary of this society, it was Le Cat's responsibility to compose biographies of deceased academicians and analyses of their works. Castel had been an associate member of the Rouen academy since 1748 and was famous enough to deserve a formal farewell.⁶ Accordingly, Le Cat heaped praise on the Jesuit's industry and inventive genius while giving careful consideration to his main works. The result, however, was no panegyric. Highlighting Castel's failures as much as his successes, it aimed for a balanced assessment of his reputation, his character, and his style.

[Père Castel's] fiery genius made him enthusiastic, despite himself, about all the things he was busy with; his application to work was not an ardor so much as a blaze. From this resulted a crowd of ideas whose impetuous course rarely submitted to the empire of sound judgement (*jugement sévère*), which made his work seem like learned frenzy (*délires*). The

³ *Gazette de France*, no. 3 (15 January 1757): 12; Friedrich Melchior Grimm et al., *Correspondance littéraire*, vol. 4 (Ferney-Voltaire: Centre international d'étude du XVIIIe siècle, 2010), 41-42 [February 1st 1757].

⁴ Antoine Gaubil, *Correspondance de Pékin 1722-1759*, ed. René Simon (Genève: Librairie Droz, 1970), 856-857.

⁵ See note 2, above. Three copies of the *éloge* survived, including an early draft and a revised version in two copies. I cite the most polished one. A truncated version later appeared in the *Précis analytique des travaux de l'Académie des Sciences, Belles-lettres et Arts de Rouen*, vol. 3 (Rouen: P. Periaux, 1817), 236-240. For a succinct overview of Claude Nicolas Le Cat's life and work, see Théodore Vetter, "Claude-Nicolas Le Cat, chirurgien de Province au XVIII siècle," *Annales médicales de Nancy* 8 (1969): 433-445.

⁶ Castel was elected on 29 November 1748. Le Cat recalled the Jesuit's gratefulness, as well as his (unfulfilled) promise to communicate essays on his optical and acoustic inventions to the academy. Le Cat, "Eloge," 4v. Inserted within the *éloge* is a letter written by Castel, who thanks Le Cat and the members of the academy for the honor of membership and proceeds to describe all the projects he had yet to produce to the public, and for which he probably hoped to find support in Rouen.

same rapidity, the same abundance in the expressions he piled up made his diction comparable to an overflowing torrent that carries pell-mell both sand and gold, diamond and rock.⁷

Sharp-tongued, but right on target, the Rouennais surgeon wielded his pen like a scalpel.

To piece together his *éloge*, Le Cat had sent letters to potential informants in Paris and in the provinces.⁸ His main source, Père Berthier, SJ, was privy to the details of Castel's last hours, although probably not as a first-hand witness. Berthier was himself the author of a better-known obituary published in April 1757 in the *Mémoires de Trévoux*.⁹ Less detailed but more widely-read than Le Cat's, this homage set the tone for nearly all subsequent sketches of Castel's life.¹⁰ Ambivalent about his colleague's philosophical merit, Berthier admired his intellectual breadth, his spirited style and his religious zeal, but disapproved of his excessive imagination.¹¹ Accordingly, neither he nor those who followed his lead felt they could fully endorse Castel's intellectual legacy.

⁷ Le Cat, "Eloge," 12r: "Son genie plein de feu le rendoit, malgrez lui, Anthousiaste de tous les objets dont il s'occupoit; son application n'estoit pas une ardeur, mais un embrasement; La foule des idées qui en resultoit, leur cours impetueux rarement soumis à l'Empire d'un jugement severe, ont fait un peu ressembler ses ouvrages à de sçavans délire. La mesme rapidité, la mesme abondance dans les expressions qu'il accumule les unes sur les autres, rendent sa diction comparable à un torrent débordé qui entraîne pêle mêle le sable et l'or, le diamant et le caillou."

⁸ Le Cat cites P. Berthier as his main source in one of his *éloge*'s footnotes. The Académie de Rouen archives also hold a letter dated 6 August 1760 whose author, a certain Bernoy, perpetual secretary of the Académie de Montauban, responds to Le Cat's request. Bernoy's own source seem to have been the rector of the Jesuit College of Montauban (C24, Archives de l'Académie de Rouen, Bibliothèque municipale François Villon, Rouen).

⁹ Guillaume-François Berthier, "Eloge historique du Père Castel," *Mémoires de Trévoux* (April 1757): 1100-1118 (henceforth, "Eloge historique"). The *Mémoires de Trévoux* was a Jesuit-run periodical of European repute, of which Berthier assumed the directorship between 1745 and 1762, and to which Castel had contributed assiduously between 1720 and 1750. On Père Berthier (1704-1784), consult John N. Pappas, *Berthier's Mémoires de Trévoux and the Philosophes* (Genève: Institut et Musée Voltaire, 1957). On the Jesuit journal, see chapter one, below.

¹⁰ To Le Cat's *éloge*, one could add the introduction to *Esprit, saillies et singularités*, v-xxxii, a compilation of excerpts from Castel's works attributed to the Abbé Laporte. The Jesuit Aimé-Henri Paulian also adapted Berthier's piece in the first volume of his *Dictionnaire de physique* (Avignon: Louis Chambeau, 1761), 316-318. Most eighteenth- and nineteenth-century encyclopedic entries on Castel freely borrowed or plagiarized these early biographical sketches and multiplied factual errors in the process.

¹¹ Berthier, "Eloge historique," 1104-1105: "Mais cette imagination est une infidèle; elle a ses moments de séduction; elle trompe alors les plus sages." The two Jesuits had a falling out after Berthier had

A controversial figure by all accounts, Castel had made headlines in his prime, acquiring fame across Europe by the 1730s thanks to a breathless presence in print and a profusion of original ideas.¹² Feeling comfortable writing treatises, textbooks, open letters, dialogues, and polemical pamphlets, he explored all these genres and often pushed their boundaries. Theology, geometry, physics, astronomy, geography, history, politics, morals, tactics, music, aesthetics, and the mechanical arts: all fell within his ambit. Over the years, his omnivorous interests, combined with a tendency to quarrel, led him to tread over all sorts of ground, and to step on all sizes of toes. His position as a book reviewer for the influential Jesuit periodical the *Mémoires de Trévoux* placed him in the midst of contemporary scientific debates, where he rubbed shoulders with nearly all the major figures of the early Enlightenment.

Castel made himself known in his early thirties by taking on the challenge of explaining gravity, an object of heated debate in the public arena at the turn of the eighteenth century. The fruit of his labor was contained in his two-volume *Traité de physique de la pesanteur universelle des corps* (1724), as well as in a number of subsequent *éclaircissements*.¹³ Over the years, he developed a remarkable system of natural philosophy proposing at once a conjectural journey through the celestial spheres, a synthesis of an-

taken over the direction of the Jesuit periodical in 1745 and changed its editorial line in such a way as to marginalize Castel's influence on the editorial board and force his early retirement by the late 1740s. Grievances against Berthier's leadership can be found in several of Castel's manuscripts and letters; see for instance a letter from Castel to Montesquieu [circa 1750], Ms. 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux.

¹² Castel's biographers estimated that he had contributed some three hundred articles and reviews to the *Mémoires de Trévoux*, and several dozen pieces to the *Mercur* and other French periodicals. Considering that several of these writings were printed in multiple installments, the complete number is certainly higher and totals several thousand pages. Unfortunately, most of them were unsigned and their attribution is uncertain.

¹³ Louis-Bertrand Castel, *Traité de physique sur la pesanteur universelle des corps*, 2 vol. (Paris: André Cailleau, 1724). (Henceforth *Traité de la pesanteur*.) See chapter 2, below, for a discussion of this and other related works.)

cient and modern physics, and a reconciliation of mechanical philosophy with free will. In a series of related endeavors, he also sought to organize the arts and the sciences — mathematics in particular — within a universal curriculum, so as to bring them all within the reach of a lay audience and facilitate their teaching.¹⁴ His greatest claim to fame, however, was and remains his “ocular harpsichord,” a musical instrument he imagined in 1725 and that he subsequently endeavored to construct for the enjoyment of the hearing and the deaf.¹⁵

This fascinating project originated in Castel’s assumptions about the analogous nature of light and sound. As such, it grew out of a natural philosophical tradition established by the seventeenth-century polymath Athanasius Kircher, SJ, his model and main source of inspiration. Castel’s insight was that it might be possible to create a new kind of music based on the harmony of colors instead of audible tones. Over the years, the idea evolved into a sophisticated physico-aesthetic theory, which Castel put to the test by designing a model harpsichord or organ capable of simultaneously playing sounds and displaying colors in movement. Shunning contrived experiments, he placed his trust in the

¹⁴ Louis-Bertrand Castel, *Mathématique universelle abrégée à la portée et à l’usage de tout le monde, principalement des jeunes Seigneurs, Ingénieurs, Physiciens, Artistes &c. où l’on donne une notion générale de toutes les Sciences Mathématiques & une connoissance particuliere des Sciences Géométriques, au nombre de cinquante-cinq Traités* (Paris: Pierre Simon, 1728). (Henceforth, *Mathématique universelle*)

¹⁵ Castel first described this project in an essay entitled “Clavecin pour les yeux, avec l’art de peindre les sons, et toutes sortes de pièces de musique. Lettre écrite de Paris le 20 février 1725 par le R. P. Castel, jésuite, à M. Decourt à Amiens,” *Mercur de France* (November 1725): 2552-2577. In this letter, he explained that he had been inspired by a passage from Athanasius Kircher’s *Musurgia Universalis* and that his friend Rameau had encouraged him to develop his insight further. See also his “Nouvelles expériences d’optique et d’acoustique, adressées à M. le président de Montesquieu” which appeared in six installments in the *Mémoires de Trévoux* between August and December 1735; his *Optique des couleurs, fondée sur les simples observations, et tournée sur-tout à la pratique de la peinture, de la teinture et des autres arts coloristes* (Paris: Briasson, 1740), as well the *Vrai système de physique générale de M. Isaac Newton, exposé et analysé en parallèle avec celui de Descartes, à la portée du commun des physiciens* (Paris: Sébastien Jorry, 1743). Only the last divisions of this work concerned Castel’s optics, but this is where he enunciates most clearly his reasons for rejecting Newton’s prismatic theory of colors.

work of artists and craftsmen, whose hands-on expertise he tried to elevate into a universal art or science. This led him to experiment with dyes and pigments, lanterns and mirrors, silk ribbons and metal springs, and to imagine ever grander versions of his invention.¹⁶ In spite of considerable investments of time and money, the ocular harpsichord never fully materialized. Instead, it took pride of place in the Jesuit's oeuvre as a metaphor for nature (God's art) and a symbol of universal harmony.¹⁷

Like fireworks, Castel's ideas made noise and captivated the public for more than three decades; but now that their author lay silent, they lingered on like smoke in the sky.¹⁸ Within a few years, Père Castel's fame had faded, his detractors outnumbering his friends in the Republic of Letters. Those willing to celebrate his memory recalled his wit and his "singularities," but no longer grasped the spirit of his oeuvre, scattered as it was across hundreds of journal articles, several books, and a mountain of manuscripts.¹⁹ Of the last, many were lost, some destroyed. The rest sat for a while in the Jesuit College's library until its contents were seized and auctioned by the Crown in 1763, and the Society

¹⁶ Castel conceived of his instrument as a kind of wondrous organ capable of producing an opera of light and music. He also envisioned something similar could be achieved with dance or with the harmonization of senses other than sight and hearing, such as smell or taste. He also considered the possibility of weaving tapestries according to famous musical scores.

¹⁷ For Castel's retrospective account of his invention, see his "Journal historique et démonstratif de la pratique et exécution du clavecin des couleurs, et des découvertes et machines nouvelles qui l'ont fait et perfectionné depuis 27 ans" [c. 1753] which can be found in Ms. 15746, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels (henceforth, "Journal du clavecin"). For a short presentation and analysis of this complex, multi-genre work, see Karine Van Hercke, "Le journal du clavecin oculaire: démonstration philosophique, esthétique, apologétique ou poétique?" in *Autour du Père Castel et du clavecin oculaire: Études sur le XVIIIe siècle, vol. XXIII*, ed. Hervé Hasquin and Roland Mortier (Bruxelles: Université de Bruxelles, 1995), 17-21.

¹⁸ Castel saw fireworks as a potential way to demonstrate his chromatic music; see "Lettre D[u] P. C[astel] J[ésuite] à M. L[e] P[résident] D[e] M[ontesquieu] sur un feu d'artifice où les couleurs bien diversifiées feraient un vrai clavecin oculaire," *Mémoires de Trévoux* (August 1739): 1675-1678.

¹⁹ See for instance *Esprit, saillies, et singularités*, which provides a rich sample of Castel's curiosities without a clear organizing principle.

of Jesus expelled from the Kingdom of France.²⁰ For a long time afterwards, Castel's work was *opera non grata*, along with his order's intellectual legacy.²¹

The Forging of Castel's Reputation

It did not help, in retrospect, that Castel sided with the “losing side” in most of his philosophical disputes, most notably against the disciples of Newton. His lack of enthusiasm for mathematical physics and experimental philosophy made him unfashionable to a younger generation of natural philosophers, and his opposition on moral and religious grounds to Enlightenment figureheads like Voltaire and Rousseau branded him as reactionary. But most of all, Castel's reputation suffered from contemporary and posthumous insinuations that he was a lunatic.

One of the earliest indications that the public thought Castel “a little off” took the form of an unpublished rhyme (written probably around 1726) documenting skeptical responses to the “invention” of the ocular harpsichord. Entitled “P. C.'s color harpsichord transported into the world of the moon,” it features Castel as a black-horned wizard (a reference to his Jesuit hat) swearing by Hecate (the Greek goddess of witchcraft) and

²⁰ Castel's papers were purchased by the Dutch printer and bibliophile Gerhard Meerman (1722-1771). The Meerman library was in turn auctioned in 1824, at which point another collector, Charles van Hulthem (1764-1832), took possession of a large bundle of Castel's manuscripts. The travels of Castel's manuscripts would end in 1837, when the newly founded Royal Library of Belgium acquired the Van Hulthem collection. See Manuel Couvreur, “Aperçus d'un naufrage: les ouvrages perdus ou inédits du père Castel,” in *Autour du Père Castel et du clavecin oculaire: Études sur le XVIIIe siècle*, vol. XXIII, ed. Hervé Hasquin and Roland Mortier (Bruxelles: Université de Bruxelles, 1995), 107-127, esp. 107-108 (henceforth, “Aperçus d'un naufrage”); The majority of Castel's surviving papers can still be found in Ms. 15743-15757, Ms. 20753-20756, and Ms. 20758, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

²¹ Echoes of Castel's color-music theory endured after his death in German and in Romantic circles. Little of it remained attached to his name, however, and his influence on nineteenth-century theorists is indirect. See Marten Franssen, “The Ocular Harpsichord of Louis-Bertrand Castel: The Science and Aesthetics of an Eighteenth-Century *Cause Célèbre*,” *Tractrix* 3 (1991): 15-77; Alain Montanon, “Castel en Allemagne: Synesthésies et correspondances dans le romantisme allemand,” in *Autour du Père Castel et du clavecin oculaire: Études sur le XVIIIe siècle*, vol. XXIII, ed. Hervé Hasquin and Roland Mortier (Bruxelles: Université de Bruxelles, 1995), 95-106.

pouring over his grimoires in the hope of achieving extraordinary feats. The Jesuit's determination to demonstrate his "music for the eyes" was such, we are told, that on the night of 19 October 1726, his harpsichord was magically transported into the sky, thus accounting for an uncanny aurora borealis observed as far south as Paris.²²

Variations on the themes of extravagance, madness, and foolish pride found numerous echoes in subsequent portrayals of Castel by such well-known authors as Voltaire, Montesquieu, Fontenelle, Diderot, Rousseau, and Condillac.²³ In his *Lettre à Rameau*, Voltaire famously calls him "the Don Quixote of mathematics," with the qualifying note that, unlike the ingenious hidalgo "who always thought he was fighting giants," Castel actually "thinks he himself is a giant." More benignly, Montesquieu supposedly dubbed him the "Harlequin of philosophy," in reference perhaps to his wit and colorful character, while the others all agreed that Castel offered a curious spectacle of madness and reason. While some of them regarded his ideas as "beautiful chimeras," less benevolent critics berated them as the conceits of an enthusiast.²⁴ It would be ill-advised to take

²² MS. 1552, Wellcome Library, London. The identity of the author is uncertain. The poem features at the end of a manuscript translation of Charles François de Charleval SJ's Latin poetry into French. The translator, who may also be the author of the rhyme, signs M. D. L. R. which possibly stands for Monsieur [Antoine] de la Roque, editor of the *Mercure de France* between 1724 and 1744.

²³ Voltaire, François-Marie Arouet, "Lettre à Rameau," in *Œuvres complètes de Voltaire*, vol. 18c, ed. Theodore Besterman et al. (Oxford: Voltaire Foundation, 2008), 15-23, esp. 22-23; Montesquieu, quoted in L.-S. Auger, *Vie de Montesquieu* ([Paris]: [Lefèvre], [1816].), xli; Jean-Jacques Rousseau, *Œuvres complètes, vol. I. Les Confessions, autres textes autobiographiques* (Paris: Gallimard, 1959), 288-289; Denis Diderot, *Les Bijoux indiscrets*, in *Œuvres complètes*, ed. Jean Macary and Aram Vartanion, vol. 3 (Paris: Hermann, 1978), 276 ff; Fontenelle, quoted in Nicolas-Charles-François Trublet, "Suite [du mémoire] sur M. de Fontenelle," *Mercure de France* (June 1757), 65, note 1; Étienne Bonnot de Condillac, *Traité des systèmes* (Paris: Fayard, 1991), 30-32.

²⁴ Another great example can be found in a short pamphlet attributed to Pierre-Louis d'Aquin de Chateau-Lyon entitled *Idée du siècle littéraire présent, réduit à six vrais Auteurs* (s. l.: s. n., s. d [1754]). This work, also attributed to J. Blanchet (cf. Grimm et al., *Correspondence Littéraire, philosophique et critique*, vol 2 (Paris: Garnier, 1877): 165-166) offers a series of satirical portraits of writers deemed representative of the time, namely Gresset, Crébillon, Trublet, Fontenelle, Montesquieu, and an unnamed one whose identity the reader is meant to guess: "Supposons qu'il tombe sans péril d'une Planette sur la terre un homme d'une imagination extrêmemement vive, d'un orgueil infini, d'un esprit peu juste, & d'une vaste

these portrayals at face value: the *philosophes* were fond of epithets like ‘*fou*’ and ‘*chimérique*’ and applied them to almost every project that did not line up with their own (and sometimes to *their own* as well). Yet it is significant that the only surviving portrait of Castel is a caricature representing him as an old man playing a farcical version of his harpsichord.²⁵ Indeed, to contemporary labels of lunacy more than anything else does he owe his marginalization from the history of science. Few modern scholars ever read his works, while many encounter his name only through the critiques of better-known authors.

While more receptive to Castel’s ideas than their predecessors of the eighteenth century, nineteenth-century commentators seldom understood them historically. Whether they read him in the original or through biographical dictionary entries, authors of the Romantic and post-Romantic eras tended precisely to admire him for his vivid imagination, his visionary “dreams,” and his opposition to what, by then, was often regarded as the cold rationalism of the Enlightenment.²⁶ In one instance, it was the anticipatory nature of his insights into nature that had the greatest appeal, as if Castel’s cosmology heralded the discoveries of nineteenth-century physicists and astronomers.²⁷ Later commentators related to his ideas with more sympathy but even less understanding.

science en genre de Mathématique et de Physique [...]” (21). His style, his academic and religious affiliation, his color music, and most of all, his theory of the action of man, according to which the whole universe can bend to his megalomaniac will, make it unmistakably a caricature of Castel. A partial microfiched version of this rare document is found in Paris, at the Bibliothèque Nationale de France (henceforth BnF), Mic. zz-4284.

²⁵ James H. Johnson, “Musical Culture,” in *The Saint-Aubin Livre de caricatures: Drawing Satire in Eighteenth-Century Paris*, ed. Colin Jones, Juliet Carey, and Emily Richardson (Oxford: Oxford University Press, 2012), 215-232, 227, fig. 9.5 (See Figure 1, below).

²⁶ See for instance Joseph Bertrand, *Un rêve de savant au XVIIIe siècle: Le Père Castel* (Paris: Charles Douniol, 1868).

²⁷ Émile Duboux, *La physique de Descartes* (Lausanne: Georges Bridel, 1881), 35-38.

Further contributing to Castel's discredit is the enduring tendency on the part of more recent interpreters to cast him as the entrenched survivor of a foregone age. For Manuel Couvreur, Castel's resistance in the face of adversity "imposes respect," but also elicits pity, especially if one agrees with the claim that, by the 1750s, Castel's scientific ideas were "completely obsolete."²⁸ Disillusionment and melancholy find even stronger expressions in Donald S. Schier's biography, in which the Jesuit ends his days in full awareness of his intellectual isolation.²⁹ While this last image finds some support in the historical record, for the most part it derives from passages cited out of context.³⁰

Castel was undoubtedly saddened by the turn of events of the 1750s, both on a personal and on a "world-historical" level. It was not grief that killed him, however, but

²⁸ Couvreur, "Aperçus d'un naufrage," 122: "Comment ne pas éprouver de la pitié pour cet homme que l'on force à écrire sans cesse, et qui sait qu'on lui refusera l'imprimatur. Castel, aigri et malade, n'était pas la dupe des propos soi-disant bienveillants de ses supérieurs."

²⁹ Donald S. Schier, *Louis Bertrand Castel, Anti-Newtonian Scientist* (Cedar Rapids, Iowa: The Torch Press, 1941). Although Schier justifies his monograph by presenting Castel as representative of eighteenth-century thought, he nonetheless regards him as a man lagging behind his time, dogmatically attached to traditional ideas, fighting a war he could not win against history itself. Schier's Castel is a sympathetic study in failure, written in the late 1930s, when positivist historians prevailed in the history of science.

³⁰ Castel, "Journal du clavecin," 53 (also cited in Schier, *Louis Bertrand Castel*, 57): "La nature des choses est diminuée, affaiblie, énervée, infirmée. Tout le jeu de l'univers comme celui de l'arc en ciel et de la musique est monté dans le mineur [...], en violet, en noir, ou demi-noir. Toute la nature, tous nos arts, tous nos organes, tous nos sens, toutes nos facultés portent le deuil de leur première perfection. Tout est maudit entre nos mains et autour de nous, tout est en discorde et en dissonance. / Il me semble que voilà la clef de la musique, de toute science et de tout art, et que si l'on veut, on pourra désormais faire de vrais systèmes, de vrais arts, de vraies découvertes, en le prenant toujours sur le mineur, sur le diminutif, sur le ton le plus bas." Scholars are wont to read this passage from Castel's "Journal du clavecin oculaire" as a sign he was sinking into melancholic reflections on the decline of the times, while in fact he is describing the post-lapsarian state of the world, arguing that it now "plays out" on a minor key, as opposed to the major key of earthly paradise, and that, accordingly, all human endeavors aiming too high are bound to be frustrated. A similar case could be made about his last publication, *L'Homme moral opposé à l'homme physique de Rousseau* (1756), occasionally interpreted as containing a recantation of his youthful ideals regarding the diffusion of philosophical knowledge. Castel, *L'Homme moral opposé à l'homme physique de Monsieur R***. Lettres philosophiques, où l'on réfute le Déisme du jour* (Toulouse: s.n., 1756). More probant evidence of Castel's frustration can be found in his correspondence. Cf. Letter from Castel to Montesquieu [c. 1750], Ms 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux; Castel, "Lettre à la Comtesse de Maillebois," in *Autour du Père Castel et du clavecin oculaire: Études sur le XVIIIe siècle*, vol. XXIII, ed. Hervé Hasquin and Roland Mortier (Bruxelles: Université de Bruxelles, 1995), 187-190. The original letter is found in Ms. 20753-20756 (28r-29v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

overwork and old age.³¹ In the face of adversity, Castel continued to philosophize and found solace in his faith, if not in the support of his brethren. Emphasizing the pathos of Castel's autumn years, therefore, colors his entire life with a misplaced sense of loss that neither renders justice to his oeuvre, nor to the intellectual traditions to which it contributed. Indeed, insisting that Castel's theories were outdated by the 1750s (which is not obvious) and that he was fighting for a lost cause (which is historically fallacious) overlooks the optimistic spirit that animated him in his prime and downplays his historical significance.

Castel's Oeuvre and its Place in Enlightenment Thought

Once a key protagonist of the Republic of Letters, today Castel is remembered, if at all, as an intellectual curiosity.³² Insofar as conceptual blinkers like "*philosophe*" and "the Enlightenment" continue to obscure our understanding of eighteenth-century science, one might say this fate was overdetermined. Despite recent and not so recent correctives, the Jesuits of that era are still commonly represented as reactionaries in decline, black robes losing a war against *philosophes* in white togas.³³ This chiaroscuro, owed in

³¹ In *Les bijoux indiscrets*, Diderot had "anticipated" Castel's demise, claiming that the inventor of the color harpsichord had "died of grief" because his fellow Jesuits had frustrated his efforts. Diderot, *Œuvres complètes*, vol. 3, 276-277.

³² Thus even as fine a book as Caroline M. Northeast's *The Parisian Jesuits and the Enlightenment* (Oxford: Voltaire Foundation, 1991) occasionally lapses into facile characterization when she cites Castel's natural philosophy as a good example of the "vagaries of eighteenth-century imagination" (93).

³³ Correctives include, for French Jesuits, Northeast, *The Parisian Jesuits*; Sébastien Brodeur-Girard, "Influence et représentation des Jésuites dans l'Encyclopédie de Diderot et d'Alembert" (Ph.D. diss., Université de Montréal, 2004); Robert R. Palmer, "The French Jesuits in the Age of Enlightenment: A Statistical Study of the *Journal de Trévoux*," *The American Historical Review* 45, no. 1 (Oct. 1939): 44-58. For German Jesuits, see Marcus Hellyer, *Catholic Physics: Jesuit Natural Philosophy in Early Modern Germany* (Notre Dame: Notre Dame University Press, 2005). See also Mordechai Feingold (ed.), *Jesuit Science and the Republic of Letters* (Cambridge, MA: MIT Press, 2002), which surveys different aspects of the Jesuits' intellectual contribution to seventeenth-century science and letters.

part to the monuments erected by nineteenth-century historians to celebrate the “triumph of Reason” over *ancien régime* institutions, leaves little room for Castel’s philosophical contributions. The term *philosophe* remains monopolized by secular and secularist intellectuals, most of them encyclopedists, deists, antimonarchists, advocates of cosmopolitanism and religious tolerance, and revolutionaries. The same is often true of “the Enlightenment,” a historical category still too easily connoting the emancipation of the modern world from the double yoke of the Church and divine-right Monarchy.³⁴ This interpretation ignores the plurality of meanings that *les lumières* had in the early eighteenth century. Most importantly, it extends the influence of a minority group backwards in time and clouds the preoccupations of the previous generations by assuming that they either planted the seeds of later political revolutions or sought to nip them in the bud.³⁵

Several of Castel’s ideas stood at odds with an “Enlightenment” thus understood. He cautiously avoided taking a stance on Copernicanism, he elaborated a theory of the world in which Scripture figured among his sources, and he preferred thought experiments and analogies to laboratory experiments and mathematical formulas. He was also an adamant supporter of the French monarchy and a zealous apologist for the Catholic Church. Yet, at the same time, he advocated for the public diffusion of knowledge through encyclopedic works, journals, and academic societies, the usefulness of the mechanical arts, and his own version of a “science of man” — all of which are hallmarks of

³⁴ This is the conception popularized by classic surveys of Enlightenment thought, such as Peter Gay’s *The Enlightenment: An Interpretation*, 2 vol. (New York: Knopf, 1966-1969) or Jonathan Israel’s *The Radical Enlightenment: Philosophy and the Making of Modernity 1650-1750* (Oxford: Oxford University Press, 2002).

³⁵ For an insightful and recent historiographical discussion problematizing the Enlightenment, see Jeremy L. Caradonna, *The Enlightenment in Practice: Academic Prize Contests and Intellectual Culture in France, 1670-1794* (Ithaca: Cornell University Press, 2012), 8-13.

the so-called “Age of Reason.” Throughout his career, he befriended and influenced many *philosophes* even as he alienated others. This suggests that he belonged to neither camp; indeed, for the better part of his life, there were no such “camps” to side with.³⁶ He felt, in other words, perfectly at home in his time.

Attempting to measure Castel against a particular view of the Enlightenment is therefore misleading.³⁷ It is more profitable to approach him on his own terms, as a philosopher, a mathematician, a priest — as a person as complex as any other — and to situate him in his historical context rather than in the subsequent historiography. Confronted with questions about the natural world, Castel looked for answers that satisfied both his faith and his standards of natural philosophy. Some of his answers sound foreign to the modern ear, while others feel eerily familiar. Our task is to attune ourselves to his worldview, so that we may achieve a better understanding of the man himself, and through him, a clearer perspective on his epoch. Castel was indeed a uniquely positioned witness to early eighteenth-century science and an important actor in the shaping of its history.

Just as misleading are hasty categorizations of Castel’s work into either one of the great philosophical schools of his day, notably those of Aristotle, Descartes, and Newton,

³⁶ Jin Lu, “*Qu'est-ce qu'un philosophe?*”: éléments d'une enquête sur l'usage d'un mot au Siècle des lumières (Québec: Presses de l'Université Laval, 2005). Lu’s book contains a whole section on the *Mémoires de Trévoux*’s use of the term *philosophe*. Although she describes the Jesuit journal as “collective writing,” one should keep in mind that most articles she cites were actually written by Castel.

³⁷ J. B. Shank, “A French Jesuit in the Royal Society of London: Father Louis-Bertrand de Castel, S.J. and Enlightenment Mathematics, 1720-1735,” *Journal of Early Modern Studies* 1, no. 1 (2012): 151-198. For Shank, Castel belongs to the Enlightenment not because of his particular stances with respect to Cartesianism, Newtonianism, and any other “-isms” of the time, but because of the critical spirit with which he made his name within the new “mediasphere” of newspapers, periodicals, and academic journals addressing the educated public. While I agree with Shank’s overall conclusions, my approach differs from his in that I am interested in defining Castel’s system on its own terms, as a coherent contribution to an older tradition of natural philosophy.

or to a vague and unqualified “Jesuit eclecticism.” A number of studies have been published on Castel since the nineteenth century, but few have approached his oeuvre — that is, the sum of his work — as an internally coherent, cohesive, and self-motivated enterprise.³⁸ To this day, his most comprehensive biography remains Schier’s 1941 *Louis Bertrand Castel, Anti-Newtonian Scientist*, a book whose lasting usefulness as a reference work is offset by its interpretive shortcomings and its dated historical sensitivity.³⁹ Like Berthier and Le Cat, Schier divides Castel’s intellectual output into “systems,” which he treats more or less independently.⁴⁰ Aware of the interconnectedness of these systems, he places them under the umbrella of anti-Newtonianism instead of approaching them on their own terms. Several in-depth inquiries have since enriched our understanding of the various aspects of Castel’s philosophy, but a synthesis of their findings, and more broadly, their integration into the history of eighteenth-century science, has yet to be undertaken.⁴¹

³⁸ Notable exceptions include Bernard Barthelet, *Science, histoire et thématiques ésotériques chez les Jésuites en France (1680-1764)* (Bordeaux: Presses Universitaires de Bordeaux, 2012), 149-165 and Jean Ehrard, *L’idée de la nature en France*, 2 vol. (Paris: S.E.V.P.E.N., 1963), esp. 66-71, both of which provide succinct but perspicacious overviews of Castel’s oeuvre.

³⁹ In Schier’s defence, this book was originally written as a philosophy dissertation, at a time when few scholars were inclined to consider Jesuit thinkers seriously.

⁴⁰ Berthier divides Castel’s work into “ses trois grands systèmes; celui de la pesanteur universelle; celui du développement des Mathématiques; celui de la Musique en couleurs ou du Clavecin pour les yeux.” Berthier, “Éloge historique,” 1102-1103. Le Cat organizes his own *éloge* around Castel’s four main books: the *Traité de la pesanteur*, the *Mathématique universelle*, the *Nouvelles expériences d’optique et d’acoustique* (ocular harpischord), and the *Vrai système de physique générale de M. Isaac Newton*. Schier’s biography regroups all his journalistic works into one broad survey of his life and proceeds with chapters on Castel’s “three main systems” — his work on *pesanteur*, his ideal of public education (with a focus on mathematics), and his ocular harpischord — arguing they were motivated by his anti-Newtonian stance.

⁴¹ Important steps in this direction have been taken by Northeast and Shank in their respective, previously cited works, the former providing a useful overview of eighteenth-century Parisian Jesuit intellectual life, the latter a narrative within which to frame Castel’s contribution to the early Enlightenment. Other more specialized studies include Albert Wellek, “Farbenharmonie und Farbenklavier. Ihre Entstehungs-geschichte im 18. Jahrhundert,” *Archiv für die gesamte Psychologie* 94 (1935): 347-375; George R. Healy, “Mechanistic Science and the French Jesuits: A Study of the Responses of the Journal de Trévoux (1701-1762) to Descartes and Newton” (Ph.D. diss., University of Minnesota, 1956); Anne-Marie

In theory, historians should have an advantage over Castel's contemporaries and successors when grappling with his intellectual contribution. Distance offers an opportunity to embrace his writings as a whole, rather than to make sense of them piece-meal. Yet it is also distance that makes it difficult for modern readers to appreciate the integrity of Castel's thought and the reasons why he wrote what he did, and how he did.

We have forgotten what it means to be a polymath and a living encyclopedia. Trained in the spirit of seventeenth-century Jesuit natural philosophy, Castel aspired to universal knowledge. His lack of specialization, which today makes him look like a dilettante, was for him just as for many of his contemporaries, the mark of superior genius (*génie*). Genius, for Castel, was a natural disposition or talent that manifests itself when one grasps in a single glance (or expresses in a luminous and effortless way) the general principles underlying a complex reality.⁴² Adopting novel perspectives and uncovering

Chouillet-Roche, "Le Clavecin oculaire du Père Castel," *Dix-huitième Siècle* 8 (1976): 141-166; Franssen's previously cited "Ocular Harpischord"; several studies contained in Hervé Hasquin and Roland Mortier (eds.), *Autour du Père Castel et du clavecin oculaire: Etudes sur le XVIIIe siècle XXIII* (Bruxelles: Université de Bruxelles, 1995); Thomas L. Hankins and Robert J. Silverman, "The Ocular Harpsichord of Louis-Bertrand Castel; The Instrument that Wasn't," in *Instruments and the Imagination* (Princeton: Princeton University Press, 1995), 72-85; Lyndia Roveda, "Le Père Castel et l'éthos du mathématicien," *Rhetorica* 25, no. 2 (Spring 2007): 159-182; Corinna Gepner, *Le Père Castel et le clavecin oculaire: Carrefour de l'esthétique et des savoirs dans la première moitié du XVIIIe siècle* (Paris: Honoré Champion, 2014). In addition, a few colleagues are independently and complementarily working on Castel. A glimpse into their work can be found online: Marco Caccavo "La correspondance du Père Castel avec Montesquieu," *Société Française d'Étude du Dix-Huitième siècle*, available online: <http://sfeds.ish-lyon.cnrs.fr/publications/docSjc/Sjc2012/Caccavo%20Castel.pdf>; Rosalind Holmes Dufy, "La dispute d'Orphée Rameau avec Euclide Castel," *Projet ANR Agon*, 2012, accessed December 2015, <http://www.agon.paris-sorbonne.fr/fr/ressources-en-ligne/comptes-rendus/lunch-seminar-4-la-dispute-d-orphee-rameau-avec-euclide-castel>.

⁴² The eighteenth-century concept of "genius" is hard to define. Castel wrote about it in several contexts, ascribing it to great military commanders (Alexander, Cesar, Turenne), great philosophers (Descartes), great mathematicians (Archimedes, Newton), and great artists (Homer). Castel, *Esprit, saillies et singularité*, 19-26: "Le grand génie, ou en général le génie, a deux qualités qui le caractérisent: il est inventif & philosophe. C'est la vivacité qui le rend inventif, c'est la maturité qui le rend philosophe [...]. Le génie en général est une grand facilité de penser, de concevoir, de raisonner, d'apprendre, d'imaginer, &c.[...] Les grands hommes sont quelques fois sujets à précipiter les démarches; les démonstrations, les preuves sont souvent pour eux des formalités insipides, à quoi ils ne daignent point s'arrêter; leur génie tient lieu de tout ça."

insightful analogies between seemingly unrelated facets of reality was his way of cultivating and expressing his genius; doing so required familiarity with a variety of domains. If the consolidation of modern scientific disciplines was already underway in the eighteenth century, for generalists like Castel, their boundaries remained permeable.

Just as blunt is our understanding of what it meant to be a system-builder in the eighteenth century. Rather than assuming that Castel worked in the footsteps of Descartes — the quintessential early modern ‘system-builder’ in the current historiography — it is far more interesting to ask how it was possible for him to elaborate his system, in an age reputed to have been highly critical of this kind of endeavor. Perhaps the most interesting lesson one may take away from a careful study of Castelian philosophy is that we need to better historicize the concept of “system.”⁴³ The coherence of his enterprise was not that of Descartes (that is, the typical caricature of Descartes the rationalist): it was organic, it grew over time, adjusting to the demands of his readers, to his own learning experience, as well as to his gradual professional shift from geometry and physics toward mechanics, history, morals, and even poetry. Seeing that the form a system took cannot be separated from the ideas, the method, and the life of their authors, one must approach Castel’s “system building” as a dynamic process rather than as a rational edifice.

Thesis, Method, and Outline

Taken as a whole, the Castelian corpus is vast and labyrinthine, full of analogies, poetic jumps, mirror games, and self-reflexive allusions. At times, it feels as though it

⁴³ See Donald R. Kelley, “Between History and System,” in Gianna Pomata and Nancy G. Siraisi, ed., *Historia: Empiricism and Erudition in Early Modern Europe* (Cambridge: MIT Press, 2005), 224-234; Julie Candler Hayes. *Reading the French Enlightenment: System and Subversion* (Cambridge: Cambridge University Press, 1999), 22-57.

goes in circles, or folds in upon itself; at other times it twists and turns in seemingly random directions. Yet a number of threads run through Castel's thought that help make sense of his intellectual maze. This study follows two of them as they intertwine throughout his writings.

The first is his recurring use of the concept of circulation. Castel derived this notion partly from Cartesian physics, according to which the natural, rectilinear trajectories of moving bodies are bent or curved at every instant by their surrounding medium, partly from the Harveyan theory of blood circulation.⁴⁴ With characteristic ease, he applied the concept to all manners of movement and change taking place not only in the physical, but also in the moral and intellectual realms. For him, drawing analogies between different facets of reality was the key to scientific discovery.⁴⁵ By following the progress of his analogical reasoning, his world system can be seen to unfold over time.

Castel's prime motivation for writing provides a second thread with which to make sense of his oeuvre. This motivation, I maintain, was his unrelenting concern for the dignity of mankind. From his perspective, a disquieting number of contemporaries worked towards undermining humanity's privileged position in creation, either by downplaying its achievements or by raising doubts about its physical, moral, and intellectual potential. Whether it took the form of determinism, fatalism, skepticism, or materialism,

⁴⁴ René Descartes, *Traité du monde et de la lumière* (bilingual edition), trans. Michael Sean Mahoney (New York: Abaris Books, 1979), 28 and 70 [corresponding to pp. 419 and 440 in the Clairselier ed. of 1677]; William Harvey, *Exercitatio anatomica de motu cordis et sanguinis in animalibus* [facsimile of the 1628 Francofurti edition, with translation] (Birmingham: The Classics of Medicine Library, 1978).

⁴⁵ Louis-Bertrand Castel, "Réflexion sur la nature et la source du sublime dans le discours: sur le vrai philosophique du discours poétique, et sur l'analogie qui est la clef des découvertes," *Mercure de France* (June 1733): 1309-1322 and *Mémoires de Trévoux* (Oct. 1733): 1747-1762.

this corrosive philosophical wave had to be broken, lest it erode the very foundations of civilization.

In contrast, Castel's natural philosophy endeavored to make humans aware of the extraordinary impact they have on the world as embodied "spirits" endowed with free will. Ultimately, he hoped this awareness, combined with the cultivation of the arts and the sciences, would allow mankind to take control of nature to a degree hitherto unimagined. This translated into a "system of the action of man upon nature," which manifested itself at the juncture point of the two threads. This theory, an early modern analogue of modern notions of climate change and the anthropocene (as the period where human intervention in the biosphere reaches a geological scale), was closely connected to that of circulation because circulation at its most fundamental was a bending of the common course of nature occasioned by human beings. As such, it spoke directly to Enlightenment debates over the place of man in nature.

This study follows the threads of circulation and human dignity to show the coherence and cohesiveness of Castel's philosophy. My approach is not meant to be reductive: indeed, it would be madness to look for a single path or a premediated argument in the Jesuit's system. The work of a lifetime cannot be coherent in *that* way. Rather, my objective is to come to a more historical and synthetic understanding of Castel himself, of his method, and of the natural philosophical landscapes he proposed. I believe there is intrinsic value in exploring the existential motivations of an individual, particularly one so deeply invested in the intellectual struggles of his time. My interpretation aims to overturn the lingering tendency to treat Castel as an anachronism and shift the attention away from his over-celebrated ocular harpischord toward the lesser-known but more fun-

damental facets of his work. This is not to say that the harpsichord was unimportant in his life. Rather, I believe that understanding this instrument requires understanding the broader enterprise that gave it rise.

If the coherence and originality of Castellian philosophy invites serious biographical inquiry, his unique perspective on early eighteenth-century natural philosophy begs a thorough historical and contextual treatment. As a polymath, Castel constitutes an ideal nexus from which to explore the boundaries and dynamics of scientific disciplines in the early modern world. As a self-proclaimed historian of the arts and sciences and as a journalist for the *Mémoires de Trévoux*, he is both a witness and a candid critic of his age who forces us to consider eighteenth-century natural philosophy in a different light. As an eminent member of the Society of Jesus, he offers invaluable insight into how men of the cloth found harmony between the laws of nature and their faith in early Enlightenment France. In short, Castel has an important story to tell.

From a philosophical standpoint, this story participates in the eternal debate opposing determinism and free will, law and liberty, order and chaos, or as Castel would have put it, Spinoza and Epicurus. The spin he gave to this debate, however, was undeniably a product of the late-seventeenth and early-eighteenth centuries. His physics, his mathematics, his politics, his morals, his aesthetics, and most of all his theology and his history were all steered by his desire to strike an Aristotelian middle course between extreme positions and to reconcile past and present systems. This places him between mechanists and vitalists, Cartesians and Newtonians, naturalists and supernaturalists, ancients and moderns — a position that not only explains why he fell through the historiographical cracks, but also makes him a particularly rich subject for the history of ideas.

Analyzing Castel's oeuvre into a sequence of discrete chapters without compromising its integrity proves challenging. A roughly chronological organization seemed the best course, even though the result somewhat flattens Castel's turn of mind, and in any case cannot be sustained throughout. The publication dates of his major books, for instance, do not reflect the date of their inception, nor the fact that the "germs" from which they arose matured together, forming a tangle rather than the neat rows of parallel enterprises.

Chapter 1, "Seeds of Discovery," establishes the methodological, biographical, and metaphysical foundations of Castel's natural philosophy. It begins with a preamble introducing his conception of discovery as a slow process of maturation combining repeated observations of nature with perspicacious analogical reasoning. I argue that to see past the idiosyncracies of his approach and appreciate his contribution to philosophy on his own terms, one must keep in mind the *kind* of contribution he was aiming for as a would-be "man of genius." With these preliminary remarks in mind, I proceed with a brief overview of his youth, in which I show how his family background, his Jesuit formation in Toulouse, and the early stages of his journalistic career in Paris prepared the ground for his subsequent achievements. Then, through an analysis of his earliest natural philosophical conjectures, and in particular of the research program he outlined in his "Lettre à M. C.," I lay out his main assumptions about nature, God, and man, and explain how they announced the development of his world system.⁴⁶ My overarching claim is that Castel's intellectual background gave him insight into the role of man in the mechanism of the world, and thus serves as an entry point into early Enlightenment debates.

⁴⁶ Louis-Bertrand Castel, "Lettre à M. C. par le P. C. J.," *Mémoires de Trévoux* (Dec. 1722): 2072-2097.

Castel's "seeds" soon developed into a full-blown system of natural philosophy. Chapter 2, "Weight and Lightness," is devoted entirely to Castel's first major treatise, the *Traité de physique de la pesanteur universelle des corps*, published in 1724. The aim of this treatise was to demonstrate the two-fold nature of the universe, which Castel regarded as part mechanical, part spiritual. The first half of this chapter focuses on the mechanical side of Castel's system, which reduced all physical phenomena to the blind action of universal gravity (*pesanteur*). I argue that the middle course that Castel struck between his Cartesian and Newtonian theories on this question was an original contribution to early eighteenth-century *physique*, and that this contribution helps us refine our understanding of the shift from seventeenth-century mechanical philosophy to eighteenth-century vitalistic and sensiblist doctrines. The second part of chapter two contextualizes the spiritual half of Castel's system, which was his theologically-informed response to both the shortcomings of the mechanical worldview and the pitfalls of seventeenth-century metaphysical systems. To counterweigh the blind action of universal *pesanteur*, and thereby account for the lasting complexity of movement and life in the world, he proposed the existence of an "active principle." Unlike most contemporaries who recognized its necessity, Castel identified this active principle as the free, spiritual action of God's stewards on earth — men — as opposed to a natural or miraculous cause. In this, one finds the most eloquent expression of Castel's "circulation" and "action of man" theories, both of which he embedded in a "system of universal lightness" or "liberty" meant to promote the dignity of man in a world he believed was increasingly dominated by deterministic interpretations of nature.

Castel's two-fold system of universal *pesanteur* and universal lightness had ramifications throughout the rest of his life. Chapter 3, "Circulation and Physico-Politics" focuses on one of these. Written in 1725, the "Lettre sur la politique" illustrates how Castel expanded his physical insight into a wider system reaching into the political and the moral realms.⁴⁷ To demonstrate the practical utility of his natural philosophy, he outlined a physico-political program of circulation meant to empower a "prince" over nature and improve the well-being of his subjects. This preliminary project ought to be understood as a contribution to the burgeoning 'science of man.'

Chapter 4, "Tree of Knowledge," argues that Castel's notion of circulation extended likewise into the intellectual realm. This idea appears in Castel's pedagogical works, in particular his 1728 *Mathématique universelle*, which he intended as a scaffolding from which to explore the interconnectedness of the arts and sciences. My interpretation of this work as a *mathesis universalis* (rather than as a mere geometry textbook) reveals that as a teacher, Castel likened the process by which one learns and discovers to the general principle that governs the earth, the human body, and the body politic. Rather than treating this work separately from the rest of his natural philosophy, I present it as its natural extension, as well as a forceful endorsement of man's capacity to know.

Chapter 5, "Wandering Stars Walking the Earth," discusses Castel's view of the earth in relation to the heavens through the exposition of a little-known quarrel that broke out in the mid-1730s after the publication of his *Lettre philosophique pour rassurer*

⁴⁷ Louis-Bertrand Castel, "Lettre sur la Politique adressée à Monsieur l'Abbé de Saint Pierre, par le Père Castel Jesuite. A Paris ce huitième de Février 1725," *Mémoires de Trévoux* (April 1725): 698-729.

l'univers.⁴⁸ Written in the aftermath of a violent windstorm, this entertaining and edifying piece refuted superstitious interpretations of meteorological anomalies as portents of the apocalypse. It also opposed deterministic interpretations of astro-meteorological influences (including the action of the sun and the moon on earth) by explaining weather irregularities as by-products of the central fire of the earth fuelled by erratic human activity on its surface. In other words, Castel used this quarrel to showcase his philosophical system which, by then, he did not hesitate to pitch as an alternative to his fashionable and potentially deleterious Cartesian and Newtonian rivals. This episode demonstrates how Castel's system continued to evolve after the publication of the *Traité de la pesanteur*. It also serves as a window onto the world of early Enlightenment critical journalism — a world to which Castel belonged and which forced him to adapt to the changing taste of the public.

Finally, chapter 6, “One Man's Dignity,” analyzes Castel's explicit thoughts on the dignity of man through his refutation of Jean-Jacques Rousseau's early writings, a refutation that I frame within Castel's latter-day project for an encyclopedic history of the arts and sciences against eighteenth-century deism. *L'Homme moral opposé à l'homme physique*, Castel's last publication and the culmination of various historical and theological works begun in the 1740s, sheds light on his mature views about civilization, the nature of man, and what constitutes “wholesome philosophy.” I approach this text as Castel's intellectual last will and testament and as a retrospective self-assessment of his oeuvre.

⁴⁸ Louis-Bertrand Castel, *Lettre philosophique pour rassurer l'univers contre les bruits populaires d'un dérangement dans le cours du Soleil; au sujet du vent furieux & de la chaleur extraordinaire qu'il fit le Samedi 20 Octobre dernier 1736* (Paris: Prault père, 1736).

Some major aspects of Castel's life must be set aside for the time being. It goes without saying that a study aiming to demonstrate the integrity of his oeuvre is incomplete without a consideration of his ocular harpischord, along with his related works on music, optics, and aesthetics. Just as glaring is the absence of a discussion of his keen interest in the science of military tactics. My intention is to integrate these "missing chapters" into a revised version of this work.



Figure 1: Charles-Germain de Saint-Aubin, *Livre de caricatures tant bonnes que mauvaises*, 'Que n'ont ils tous employés leurs tems à la même machine,' 1755? Watercolour, ink and graphite, 18.7 x 13.2 cm (675.302); reproduced in James H. Johnson, "Musical Culture," in *The Saint-Aubin Livre de caricatures*, 227.

CHAPTER 1

Seeds of Discoveries

For a discovery, a great discovery like that of a science or a new art, is a harvest.
— Louis-Bertrand Castel¹

Preamble

Approaching Père Castel on his own terms, as a significant actor on the eighteenth-century scientific stage, requires giving serious consideration to his concept of discovery, as well as to his related understanding of genius. Not only did he have insightful things to say on both counts, he also used these terms self-reflectively, with important implications for his system of natural philosophy. Recognizing the difference between modern and early modern expectations of what constitutes discovery, or what makes an inventor a genius, is essential for putting Castel's philosophical contribution into proper historical perspective.

While moderns tend to associate genius with originality and to value innovation over respect for tradition, Castel and many of his contemporaries saw things in a different light. From his viewpoint, “novelties” were to be held in check by the historical awareness of one's intellectual debts, and in certain matters — religion first among them — avoided altogether as potential pitfalls. Given these premises, it may seem paradoxical that he simultaneously boasted important discoveries, going so far as to claim credit for the invention of new arts and new sciences. The paradox resolves itself, however, once we realize that for Castel, great discoveries were the outcome of a long process of maturation made possible by the labor of many minds over several generations. Every stroke

¹ Castel, *Optique des couleurs*, 371: “Car une découverte, une grande découverte, celle d'une science, celle d'un art nouveau, est une récolte, une moisson.”

of genius, he claimed, was first prepared through extensive studies and grounded in the efforts of one's forefathers. Discovering was thus akin to harvesting, an inventor reaping glory in the same way one reaps a crop: in awareness of, and ideally with deference for, those who sowed.

Serendipity played a role in this harvesting process. One did not choose to be born at the propitious time and place to make a discovery, and Providence had its way of bringing about unexpected finds. But individual merit also had to be acknowledged, especially in philosophy, where hard work is as necessary for finding truths about nature as it is for convincing others of their well-foundedness. Castel characterized the inventive genius as a felicitous combination of "vivacity" and "philosophy," that is to say, of ebullient imagination and philosophical reflection. When properly balanced, these faculties disposed the mind to contemplate its object from multiple perspectives, comparing, combining, and synthesizing observations and experiences in new and fruitful ways.² As the *philosophe* Claude-Adrien Helvetius would later put it,

by the word 'discovery' one must therefore understand a new combination, a new rapport seen between certain objects or certain ideas. One earns the title of 'man of genius,' if the ideas that result from this rapport form a great whole, are pregnant with truths, and are of interest for humanity.³

In philosophy, examples of great geniuses included men like Descartes and Newton who were born at the right time and place with enough insight to both reap what was valuable

² Castel, "Du génie," in *Esprit, saillies et singularités*, 19-26, esp. 19.

³ Claude-Adrien Helvetius, *De L'esprit* (Paris: Fayard, 1988), 420. Helvetius's understanding of genius and invention is similar to Castel's insofar as both men seem to reduce the process of discovery to the normal process by which judgements are formed, that is, by association and combination of ideas. Helvetius differs from Castel (and Diderot after him) in placing emphasis on the role of randomness in the process of discovery. For an illuminating analysis of Helvetius and Diderot's take on genius, see Jean-Alexandre Perras, "L'invention associative: le génie à l'épreuve du sensualisme," *Revue des sciences humaines* 303 (July-Sept. 2011): 17-40. I suspect Castel exerted a quiet influence upon both *philosophes*, or at the very least participated in laying the ground for their theories of genius and discovery.

in the works of their predecessors and shed light on what the latter had grasped only obscurely. They not only developed more general, more fertile, and more useful systems than their predecessors, they also often achieved this through intuitive leaps. Indeed, geniuses see things so clearly from on high that they often neglect to provide their readers with step-by-step expositions of their reasoning process.⁴

This chapter argues that the young Castel aspired to become a “man of genius,” and that this ideal shaped the way he formulated philosophical conjectures. In conformity with the eighteenth-century understanding of the term, Castel crafted his arguments in such a way as to offer new perspectives on old problems, sketching out unsuspected connections between discrete facets of reality, and proposing unifying principles where others wallowed in minute details and calculations.⁵ Although he valued “geometrical” demonstrations as ways to confirm and establish discoveries once they were made and criticized men like Descartes and Newton for lacking in this respect, he took more pride in opening up new avenues for research than he did in following them through. In his *Traité de la pesanteur*, he writes that “[i]t is mostly by the totality of their system that original geniuses stand out from the common man (*le vulgaire*); the mind (*esprit*) of the common is a mind set on detail (*esprit de détail*).”⁶ He left to lesser minds the tedious task of working out the implications of his grand ideas.

⁴ Castel, *Traité de la pesanteur* II, 455-458.

⁵ For a discussion of the evolution of the concept of genius in the early modern era, from something one *has* to something one *is*, see Jean-Alexandre Perras, “Genius as Commonplace in Early Modern France,” *L’Esprit créateur* 55, no. 2 (Summer 2015): 20-33, esp. 25-27.

⁶ Castel, *Traité de la pesanteur* II, 458: “C’est sur-tout par le total du système, que les génies originaux se distinguent du vulgaire: l’esprit du vulgaire est un esprit de détail.”

One of the most striking features of Castel's philosophizing was his self-conscious reliance on metaphorical thinking.⁷ Undergirding his thought process was the geometrically-informed, methodological conviction that every scientific discovery has its origin in analogical reasoning, an analogy expressing with words what a rapport or proportion (a relation of equality between two ratios) expresses in mathematical terms (i.e., $a:b::c:d$).⁸ In order to discover a new rapport, or else deduce an unknown value on the basis of three known terms (a conceptual rule of third), inventors of genius kept an eye out for similarities in nature. Interestingly enough, Castel felt this task was facilitated by the work of poets, who by training were master-wielders of analogies.

For what poets and orators call metaphor, comparison, allegory, and figure of speech, a philosopher, a geometer avoiding the use of thorny language (*géomètre non hérissé*) calls analogy, proportion, rapport. All our discoveries are but relational truths (*vérités de rapport*). Hence, the figurative sense often descends into the literal, and the figure of speech into reality.⁹

Castel's oft-criticized "literalization" or reification of figurative language was a direct consequence of his belief that analogies say something true about the fabric of the world. Poets who intuitively caught glimpses of true rapports in nature indeed provided philosophers with precious starting points for discoveries.

⁷ The explicit use of metaphor was common in early modern philosophy (as opposed to modern science, where they are present but usually less obvious, and rarely used self-consciously). The use of imagery was part of the self-fashioning of the public image of the scientist at the time and is particularly frequent in the works of non-mathematical physicists. Shank makes a remark to this effect about Dortous de Mairan in *Newton Wars*, 103. But Castel is a special case, both in the frequency and in the self-reflectivity with which he used metaphors, and in the way he anticipates, and possibly influenced, some of Diderot's better known reflections on analogies.

⁸ Castel explicates the nature of analogy in terms of rapport, proportion, and in the final analysis, as a simple arithmetic operation in the *Mathématique universelle* I, 313-327.

⁹ Castel, "Réflexions sur la nature & la source du sublime dans le Discours," 1320: "Or c'est l'analogie qui rend ces traits poétiques féconds en découvertes. Car ce qu'on appelle chés les Poètes ou chés les Orateurs, métaphore, comparaison, allégorie, figure, un Philosophe, un Géomètre non hérissé l'appelle analogie, proportion, rapport. Toutes nos découvertes, toutes nos vérités scientifiques ne sont que des vérités de rapport. Et par là souvent le sens figuré dégénère en sens propre, & la figure en réalité."

Castel appealed to a vast array of metaphors not only when making conjectures about nature, but also when reflecting upon his own method of invention. By the turn of the eighteenth century, philosophers had inherited a vast repertoire of tropes to discuss this matter. The most common of these tropes was probably that of the exploratory voyage. Columbus's heroic venture, for instance, offered a model for natural philosophers desirous of breaking new ground. By extension, the "establishment" and diffusion of a discovery was compared to a colonizing enterprise. Another set of metaphors — one of Castel's favorites — drew from the mining industry. Like a prospector, an inventor was in the business of opening a mine or a quarry, while the process of working out the implications of a particular discovery was analogous to ore extraction or stone-cutting. The transition from dawn to daylight provided yet another image to talk about the gradual discovery of truth, as was the more active notion of "clearing up" a light source buried under rubble.¹⁰ Castel appealed to all of these metaphors at various points in his writings, mixing them shamelessly, as he felt they offered complementary perspectives on the same object.¹¹

But of all the metaphors Castel had at his disposal, that of the "seed" has pride of place, featuring most prominently in his reflections about the cumulative and organic nature of scientific progress. This preamble began by asserting that Castel believed discoveries to be the *outcome* of a process of maturation; in fact, it may be more accurate to say

¹⁰ He also contributed some of his own. For instance, he compared discoveries to microscopes, by which he meant that a true invention, like the optical instrument, makes visible a reality hitherto unseen or misunderstood in spite of having been there all along. See Castel, *Optique des couleurs*, 373.

¹¹ Some of these emphasized the active role that discoverers play in the extraction or retrieval of truth, conceived as a hidden, virtually infinite reservoir of God-given riches; others, more passive or impersonal, suggested a slow process of enlightenment or growth. None of them, it is worth pointing out, conceived of discovery as the "production" of knowledge — a modern conception alien to most if not all thinkers of that period.

that he conceived of discoveries *as* that process. This notion had theological underpinnings. The ancient sage was right to claim that there is nothing *truly* new under the sun, for, strictly speaking, there had only been a single act of creation.¹² Following Saint Augustine, Castel conceived of the primeval chaos that God had brought into existence as the “seed of the heavens and the earth,” by which he meant the fertile “principle” of all things to come — the “envelope” from which successive generations of beings unfolded in time, and over time.¹³ While there could only be one *creatio*, the world was so designed as to perpetuate itself by means of *generatio*, or in the case of animate beings, reproduction. Now for Castel, what was true of plants and animals was also true of ideas and philosophical systems; they made man’s genius shine, but none of them arose *ex nihilo*.¹⁴ Just as a seed contains within its folds the potential for future generations of plants, so could truths wrapped in vague, poetic expressions unfold and yield new truths, provided that they received enough attention: “Such is the true role of the philosopher: to understand what others can only feel, to turn instinct into thought, thought into reflection, reflection into reasoning.”¹⁵

¹² A reference to Ecclesiastes I echoed throughout Castel’s oeuvre. See for instance, Castel, *Traité de la pesanteur* II, 455: “Le génie le plus heureux à beau faire, il n’est point de vérité parfaitement neuve, & l’on ne passe point d’une extrémité à l’autre: *Nihil sub Sole novum* [...]. Ce n’est que l’ignorance où nous sommes de ce qui a précédé, qui nous fait regarder comme tout nouveau ce qui ne l’est qu’à demi. *Non est priorum memoria* [...] *nec quisquam valet dicere, ecce hoc recens est; jam enim praecessit in Saeculis, quae fuerunt ante nos.*” [Ecclesiastes I, 10-11]

¹³ *Ibid.*, 425-426: “Et quand il [St. Augustine] dit au ch. 3e. de son Ouvrage imparfait sur la Genèse expliqué à la Lettre, quand il dit, que la matière que Dieu créa d’abord, étoit la Semence du Ciel, et de la Terre, *Semen Caeli & Terrae*; il montre assez qu’il regardoit le Ciel et la Terre, comme enveloppés, & confondus dans ces commencemens; car à prendre les termes en rigueur, qui dit *semence*, dit des principes, & des élémens bien formés d’une chose, qui n’est point encore, mais qui doit prendre avec le tems en se développant sa forme sensible.” See also Castel, “[Review of Castel’s] *Traité de Physique de la Pesanteur Universelle des Corps*,” *Mémoires de Trévoux* (March 1724): 470-472.

¹⁴ That is, except insofar as everything did...

¹⁵ Castel, “Réflexions sur la nature & la source du sublime,” 1320: “Mais comme c’est toujours le vrai, toujours la Nature que le Poète peint, le Philosophe ne sauroit trop méditer le sens profond de tous les traits véritablement sublimes qui sont répandus chés les Poètes plus que chés aucune autre sorte d’Ecri-

A concrete example of what Castel meant by the “development” of poetic insight into philosophic reasoning was his appropriation of Athanasius Kircher’s allusion to the color of music in the *Musurgia Universalis*:

[S]omewhere in ... [the *Musurgia*] I found that, if during a beautiful concert we could see the air agitated with all the shivers that voices and instruments excite in it, we would be astonished to see it riddled with the most vivid and well-matched colors; here is one of those ideas I call seeds of discoveries.¹⁶

Like a seed, Kircher’s insight took root in Castel’s imagination and grew to become the latter’s most celebrated invention: the ocular harpischord. Castel designed his instrument not only to delight the public with a “new” music for the eyes, but also to assist the human mind in the discovery of additional rapports and proportions between lights, sounds, and the senses. Moreover, Castel used the *clavecin* to spread seeds of his own, hoping that they would take root in the imagination of potential patrons and inspire fellow inventors to walk in his footsteps. The same could be said for most of his early insights into the workings of nature.

In this chapter, I appropriate Castel’s seed metaphor in two ways. In Part I, the expression stands in for his social and intellectual background — the fertile “envelope” from which his early philosophical insight sprung. Proceeding from the assumption that the first thirty years of Castel’s life, though poorly documented, exerted a profound influence upon his subsequent career, I survey what is known and what can be inferred about

vains. C'est là le véritable emploi du Philosophe, de comprendre ce que les autres ne font que sentir, de tourner l'instinct en pensée, la pensée en réflexion, la réflexion en raisonnement. Je regarde tous ces grands traits qu'on admire dans les Poètes, comme autant de semences de découvertes.”

¹⁶ Castel, “Clavecin pour les yeux,” 2557-2558: “C’est encore à notre bon ami [Kircher], que je dois la naissance d’une si riante idée. Je lisois sa *Musurgie*, il y a deux ans: j’y trouvai quelque part, que si dans le temps d’une beau concert, nous pouvions voir l’air agité de tous les frémissemens divers que les voix & les instrumens y excitent, nous serions tout étonnés de le voir semé des couleurs les plus vives & les mieux assorties; voilà une de ces idées que j’appelle des semences de découvertes.” Kircher’s *Ars magna lucis et umbrae* (Rome: H. Scheuz, 1746) is also a likely source of inspiration.

his family, his education, and his Jesuit formation. In Part II, “seeds of discoveries” stands for Castel’s earliest publications, which appeared starting in 1720 in the form of book reviews and conjectural essays in the Jesuit periodical the *Mémoires de Trévoux*. My analysis lays bare some of the fundamental principles undergirding his natural philosophy. I grant particular attention to the inconspicuous yet important “Lettre à M[onsieur] C.,” an essay that sheds light on Castel’s assumptions about nature, God, and mankind.¹⁷ Containing the germs of his mature system, this work indeed shows evidence of an ambitious natural philosophical project premised upon what Castel considered his most important discovery at the time: the need to take into account the role of “free spirits” when studying the mechanism of nature.

PART I

Fertile Ground

Louis-Bertrand was born in Montpellier on 5 November 1688 and baptized a few days later in the parish of Notre-Dame-des-Tables.¹⁸ His father, Guillaume André Castel, was a well-to-do *perruquier* and master surgeon originating from Ausson, in the Béarn. His mother, Louise Du Buisson, was Guillaume’s first wife (m. 1679) and the daughter of Pierre Du Buisson, a book merchant. Present to sign the baptismal registry were his godfather, the physician Bertrand Besson, and his godmother, Anne Du Buisson, one of Louise’s step-sisters. Judging by the repeated use of honorifics like *Monsieur* and *Dam-*

¹⁷ Castel, “Lettre à M. C. par le P. C. J.,” *Mémoires de Trévoux* (Dec. 1722): 2072-2097.

¹⁸ Etat Civil 5 MI 1/41 – 49; 5 MI 1/40 – 257; 5 MI 1/42 – 70; 5 MI 1/ 43 – 21; 5 MI 1/43 – 113; 5 MI 1/44 – 45-46; 5 MI 1/44 – 56; 5 MI 1/45 – 79; 5 MI 1/45 – 129, Archives départementales, Hérault. Available online: <http://archives-pierresvives.herault.fr>.

oiselle in the records, the Castels must have been respectable bourgeois with some claim to the *noblesse de robe* on the Du Buisson's side of the family.

In 1690, Guillaume was elected 4th consul, a municipal office that made him *administrateur* of the Saint-Eloi Hospital. There he had made a reputation as a lithotomist, that is, as a surgeon specializing in the cutting and removal of bladder stones. According to Le Cat, it was Guillaume who first introduced this procedure in Montpellier, where his successful practice earned him a pension from the Province of Languedoc.¹⁹ His expertise was in fact recognized as far as Paris, where he was called on several occasions to operate.²⁰ It was during one such visit that he passed away in 1709. In his will, he left a *rente* for the “cutting room” of his hospital — a kind of endowment to insure the perpetuation of his legacy.²¹ Considering that he was survived by his (second) wife and several children, this donation suggests a certain prosperity.

Louis-Bertrand was the fourth child of the family. He had an older sister named Théodore (d. 1715), who married the merchant Paul Madière, and two older brothers, Jean-François (b. 1684-?), who became a merchant “interested in the affairs of the king,” and Charles-Thomas (1687-1750), of whom nothing is known.²² In 1693, Louise gave birth to a fifth child, Pierre, who died the following year. She herself must have passed

¹⁹ The pension of 600 *livres*, was granted by the Etat du Languedoc in exchange for having travelled throughout the province to offer his lithotomy services and perform the surgery free of charge for the poor. The first attribution was decided during the deliberation and plenary session of 9 January 1682 and was renewed again for the years 1683, 1689, 1690, 1691, 1692, and 1693. See C 7213 (51v-52r); C 7214 (58r-58v); C 7248 (138v-139r); C 7252 (36v); C 7255 (55v); C 7262 (58r); C 7269 (69r), *Registres des délibérations des Etats, Montpellier*. Available online: <http://etats-du-languedoc.univ-montp3.fr>. Accessed 4 September 2015.

²⁰ Le Cat, “Eloge,” 1r.

²¹ *Ibid.*, 1r. See also Louis Dulieu, *La Chirurgie à Montpellier de ses origines au début du XIXe siècle* (Avignon: Aubanel, 1975), 243-244.

²² Although see letter from Bernoy to Le Cat, dated 6 August 1760, at Montauban, C24, Archives de l'Académie de Rouen, Bibliothèque municipale François Villon, Rouen. This letter refers to one of Castel's brothers who used to be *contrôleur des actes des notaires* in Montpellier, without specifying his name.

away a couple years later, since Guillaume remarried in 1702 with a certain Damoiselle Anne Darles. Three children were born of this second union: another Jean-François, another Théodore, and Paul. Guillaume may not have been an inspired name-giver, but he “raised his children [...] with the care of a gentle friend,” showing more concern for their well-being and the development of their talents “than for his finances.” The Castel siblings apparently shared a preceptor and “all sorts of masters,” who early on recognized Louis-Bertrand’s potential.²³

When his father died, Castel grieved.²⁴ Yet nowhere before or after that point does he refer to his relatives in his writings, and none of his early correspondence survives to shed light on his childhood and teenage years. Later in life, he would occasionally allude to distant memories, such as the making of “music” by fitting sheets of paper into drafty window frames,²⁵ or the fever outbreaks that followed the harsh winter of 1709.²⁶ Indirect evidence can also be pieced together from book reviews he wrote in the *Mémoires de Trévoux*, showing some interest in medical and surgical topics (perhaps a nod in the direction of his father’s profession) as well as in the natural and artificial landscapes of Languedoc (ever a source of pride).²⁷ The great engineering projects that trans-

²³ Le Cat, “Eloge,” 1r.

²⁴ A letter addressed to him by his fellow Jesuit Durranc, dated 31 August 1710 in Cahors, reveals that he was still grieving the death of his father; see Ms 15751-15754 (7v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. Perhaps he severed contacts with his blood relatives afterward, his Jesuit brethren and superiors becoming his new family. It is tempting to speculate about the influence of Louis-Bertrand’s family background on his professional life, but with a few exceptions (see chapter 3, below), I will refrain from doing so until further evidence is unearthed.

²⁵ Castel, “Journal du clavecin,” 20v: “Est-ce que les bruits divers que fait le vent dans les rebords d’un chassis de papier sont impossibles à diapasoner? J’ai quelquefois par amusement étant enfant disposé des papier branlants dans les fenestres ou tel coup de vent produisoit au hazard des bouts de chanson.”

²⁶ Castel, *Traité de la pesanteur* I, 548.

²⁷ See for instance Castel’s “[Review of Gautier’s] Nouvelles conjectures physiques, concernant la disposition de tous les corps animés, [followed by] Nouvelles conjectures sur la peste. En deux lettres,

formed his native province at the turn of the eighteenth century undoubtedly made a strong impression on him, as did the political and religious upheavals in the decades following the Revocation of the Edict of Nantes (1685).²⁸ Until more documents surface to further substantiate these claims, one can assume that Castel's background provided him with the material comfort and the intellectual stimulation he needed to show enough promise, in his father's eyes, to justify a Jesuit education. If he had little to say, in retrospect, about his upbringing in Montpellier, it might be because he found a family to substitute his own in the Jesuit house of Toulouse.

Training Grounds

Guillaume decided to send his son to the esteemed Jesuit College of Toulouse, confident he would receive a first-rate education there. Showing an excellent disposition for studies, and in particular for Latin poetry, Louis-Bertrand was recruited by the Society of Jesus on 16 October 1703, after he had completed his year of Rhetoric.²⁹ He was not yet 15 years old. His exact course of study during his novitiate is uncertain, but a general outline can be inferred from what is known about Jesuit colleges in the early eighteenth century.

l'une de Mr. Gautier, l'autre de Mr. Baux," *Mémoires de Trévoux* (Feb. 1722): 332-345. The attribution is uncertain, but this article is cross-referenced in another review who was almost certainly written by Castel, namely, the "[Review of Gautier's] Nouvelles conjectures sur le Globe de la Terre où l'on fait voir de quelle maniere la Terre se detruit journellement pour pouvoir changer a l'avenir de figure," *Mémoires de Trévoux* (April 1722): 730-750. Other examples would include his "[Review of Sanctorius's] La Medecine statique, traduite en François par feu M. Le Breton, Medecin de la Faculté de Paris," *Mémoires de Trévoux* (March 1723): 436-442; "[Review of Michelotti's] De Separatione Fluidorum in corpore animali Dissertatio Physico-Mechanico-Medica [...]," *Mémoires de Trévoux* (July 1723): 1243-1258; as well as his possible involvement in the plagiarism quarrel between his friend the eye surgeon John Thomas Woolhouse (the plaintiff), and Heister, Saint-Yves, and Winslow (the accused). On this quarrel, see Schier, *Louis Bertrand Castel*, 9-10. For articles related to Languedoc, see chapter 3 of this dissertation.

²⁸ See chapter 3, below.

²⁹ Le Cat, "Eloge," 2r; Berthier, "Eloge historique," 1100.

The *Ratio Studiorum*, which provided official guidelines for the Jesuit curriculum, comprised two cycles, a minor and a major one. The minor cycle included grammar, humanities and rhetoric courses, usually completed over a period of three to four years. During that time, children and teenagers were also expected to participate in a number of public speaking exercises, including theater performances, verbal jousts, and oral examinations. The major cycle, for its part, traditionally consisted in the triennium — the three year-long course of philosophy that covered logic, physics, and metaphysics, and to a lesser extent mathematics (although only a minority of students studied anything beyond basic arithmetic and geometry). For students aspiring to priesthood, a four-year course in dogmatic, scholastic, and casuistic theology followed. This coursework usually spread over several years interspaced with teaching duties. Indeed, one of the hallmarks of Jesuit education was the built-in training of teachers during what was referred to as a period of *régentage*. Senior students were sent to other Jesuit schools in their province to instruct their younger peers, alternating periods of studies with classroom duties well into their twenties or thirties.³⁰ At the end of this process, fully committed novices who completed their theology training officially joined the ranks of the Society by confirming their vows, at Christly age thirty three.

The young Louis-Bertrand certainly went through a similar curriculum, but Le Cat's *éloge* suggests that, although he was at first entrusted a classroom, his superiors

³⁰ For useful discussions of the *Ratio Studiorum* and the Jesuit's curriculum, see Hellyer, *Catholic Physics*, 71-89 and Bernard Barthet, *Science, histoire et thématiques ésotériques*, 71-87. See also François de Dainville, SJ, *L'éducation des jésuites (XVI-XVIIIe siècles)* (Paris: Editions de Minuits, 1978) and Gustave Dupont-Ferrier, *Du Collège de Clermont au Lycée Louis-le-Grand (1563-1920)*, 3 vol. (Paris: Editions de Boccard, 1921-1925). Province here refers to Jesuit administrative subdivision, which did not overlay secular political entities. Within the "Assistancy" of France (*Assistentia Galliae*), there were five provinces: *provincia Franciae* (including New France), *Aquitaniae*, *Campaniae*, *Lugdunensis*, *Tolosanae*. Castel belonged to the last one, the Province of Toulouse.

recognized his talent in mathematics and natural philosophy and soon “dispensed him of his usual functions” so that he might focus on his studies.³¹ This may well be the case, for he was listed as *physicus* at the College of Toulouse in 1707, four years after his recruitment, without any records of teaching assignment. The dispensation would not last, however. In 1711, a 23-year-old Père Castel held the chair of humanities at the college of Clermont-Ferrand, where in 1712 he also taught rhetoric (with the title of *magister*). By 1714-1715, we find him at the college of Aubenas (in Ardèche), teaching rhetoric again. In 1716, strong from his pedagogical experience, he was appointed second in command (*minister*) of the school at Pamiers (in Ariège), where he cumulated the functions of catechism teacher, *consultor*, *admonitor*, and *confessor exterioris*. In 1719 he occupied the same functions at the College of Cahors (Prefecture du Lot, in the Midi Pyrénée). In his biography, Schier surmises that Castel’s superiors must have been favorably impressed by his teaching skills to entrust him with all these responsibilities.³²

Castel’s training in the Jesuit province of Toulouse was profoundly formative. During what amounted to nearly two decades of coursework, teaching, and administrative duties, Castel cultivated his passion for geometry and natural philosophy, devouring all the major ancient and modern treatises he could lay his hand upon in his spare time. “Geometry” here must be understood in the general sense of mathematics, but Castel actually showed a preference for the subdiscipline of geometry proper, which included not only Euclidian elements, but also the analysis and the practical execution of complex curves

³¹ Le Cat, “Eloge,” 2r.

³² Schier, *Louis Bertrand Castel*, 3-4. According to Castel’s biographer, the documents pertaining to this period of Castel’s life are preserved at the Lycée Saint-Stanilas in Toulouse. Unfortunately, these documents have since been lost, and the content of library scattered. For a description of the kind of administrative duties Castel was entrusted with, see Dupont-Ferrier, *Du Collège de Clermont*, 37-62, which describes the personel of the Parisian College.

and figures. He was also interested in infinitesimal geometry and calculus, though it is unclear to what degree he mastered the latter. His main model in this regard was Grégoire de Saint-Vincent (1584-1667), a Belgian-born Jesuit mathematician who, among other things, studied the properties and areas of conic sections, played a role in the emergence of modern calculus, and endeavored to square the circle. His work, sadly underappreciated in Castel's opinion, exemplified the process of mathematical invention: his findings were not always conclusive, but they yielded discoveries along the way.³³ Castel admired him as much as, if not more than, he admired Euclid, Pappus, Apollodorus, Archimedes, Descartes, and Newton.

It is also during his *régentage* that Castel managed to borrow a first edition of Newton's *Principia mathematica*, which he allegedly transcribed long-hand and read a hundred times prior to drafting what would later become a book-length refutation.³⁴ Though more properly called a work of physico-mathematics than "geometry," Newton's treatise belongs at the tail-end of Castel's mathematical readings because he considered the *Principia* was a geometrical *tour de force*, rather than a work of natural philosophy. Though incontestably brilliant, Newton failed to meet Castel's expectations as a *physicien*, that is, as a natural philosopher concerned with nature *as it actually is*, as opposed to *how it can be represented* through mathematical formalization. This is not to say Castel found no use for geometry in physics; quite the contrary, he thought physics was a part of mathematics broadly conceived, and that the geometrical method should be ap-

³³ See Louis-Bertrand Castel, "Mémoire pour l'histoire des découvertes qu'on a faites en mathématiques dans ces derniers siècles," *Mémoires de Trévoux* (June 1721), 998-1045, as well as his "Discours préliminaire" to Edmund Stone, *Analyse des infiniments petits*, trad. M. Rondet (Paris, Gaudoin et Giffard, 1735), iii-c.

³⁴ Castel, *Vrai système*, 14.

plied to the understanding of nature. What he rejected in Newton and like-minded physico-mathematicians was their tendency — or what he believed was their tendency — to equate nature itself with their mathematical abstractions. There is little doubt that Castel's training years were influential in developing this attitude.³⁵

The Jesuit curriculum indeed maintained the Aristotelian categorical distinction between geometry and physics; accordingly, teachers did not mix the two in the classroom.³⁶ Within their colleges, physics (or in Latin, *physica*) consisted in a year-long course grounded in Aristotelian natural philosophy, nestled between a year of logic and a year of metaphysics. Heirs to the scholastic tradition, the Jesuits considered “natural philosophy” as the systematic inquiry into the causes of observable phenomena. It covered concepts such as matter, form, and movement, that is, “characteristic common to all natural bodies” (*physica generalis*), but also sought to explain the particulars of nature (*physica particularis*), notably the structure of the cosmos, the elements and their combinations, atmospheric and terrestrial phenomena, the structure and parts of animals, as well as the nature of the soul.³⁷ From the thirteenth to the early eighteenth century, the works of Aristotle on each of these subjects — the so-called *libri naturales* — formed the core curriculum of natural philosophy throughout the colleges and universities of Europe. Castel's introduction to natural philosophy began with these texts, either in their Latin trans-

³⁵ Note that this was also the representative stance of Newton's critics in France since the publication of *Principia*. “[Review of Newton's] *Principia mathematica*,” *Journal des sçavans* (August 1688): 153-154 and for the second edition, *Journal des sçavans* (March 1715): 157-160.

³⁶ Hellyer, *Catholic Physics*, 115-122.

³⁷ *Ibid.*, 77.

lations, supplemented with Jesuit commentaries, or indirectly, through the digests prepared by his teachers.³⁸ In due time, he certainly read these texts very carefully.

By the late seventeenth century, students were aware of alternative natural philosophical traditions, and teachers increasingly apt to teach them.³⁹ Depending on their inclination and competence, Jesuit lecturers sprinkled the opinions of ancient and modern authors who disagreed with Aristotle throughout the philosophy course. These dissident voices served as foils for debate.⁴⁰ Only once the basic training was completed could curious and discerning minds like Castel become fully acquainted with the physico-mathematical works of Copernicans, Cartesians, and Newtonians circulating more or less freely within the circles of philosophers (in cases where these books were on the index of prohibited readings, one had to obtain a special authorization). Various Jesuit contributions to mathematics and natural philosophy, those for instance of Clavius, Scheiner, Grimaldi and Kircher would also have been available in the most important college libraries, and held in high esteem, as the Jesuits took pride in being part of a distinguished lineage of scholars. It should be also noted that as the eighteenth-century unfolded, colleges increasingly enriched the traditional physics course by making regular use of instruments and experimental demonstrations, as well as by providing separate training in mixed mathematics and “applied” sciences like geography, hydrography, and the military

³⁸ Ibid., 72-73 and 77.

³⁹ Originally, natural philosophy, and to a lesser extent mathematics, were taught, like the humanities course, by junior teachers during their *régentage*, who did not make a career out of it. Castel and other from his generation formed the exception rather than the rule, though the eighteenth century certainly witnessed the professionalization of these disciplines within the colleges.

⁴⁰ Hellyer, *Catholic Physics*, 89.

arts; a sign that the curriculum was adapting to the rise of experimental philosophy and the utilitarian demands of their clientele.⁴¹

Keeping abreast of recent and not so recent debates both in mathematics and natural philosophy, Castel was fully aware of the challenges that traditional disciplines were facing outside the scholastic enclave.⁴² In parallel to mathematical or experimental *physique*, and in contrast with traditional Aristotelian natural philosophy, Castel developed a conception of “salubrious” or “healthy” physics (*saine physique*) that had more in common with natural history and cosmography than with physico-mathematics, and that is quite representative of the Jesuit’s Thomistic empiricism. Consisting primarily in the description and analysis of the sensible (i.e., perceptible) world, it encouraged phenomenal over causal explanations. It was also grounded in observational and experiential “facts” rather than contrived experiments or speculations. One of its characteristics was its apparent “ease”: anybody with eyes and a capacity for attention could make discoveries in this field, and anybody with good literary taste could communicate their findings to educated readers, without the need for special jargon.

All the functions of our lives are experiences: our most ordinary glances (*moindres coups d’œil*) are observations; everywhere nature is an open

⁴¹ Ibid., 181-201.

⁴² Some of these challenges offered comprehensive alternatives to Aristotle. These fell under the category of “systematic physics,” rationalist and deductive endeavors exemplified by the works of Descartes, Gassendi and their followers. Under the influence of their “mechanical” philosophy, but also of the Galilean physico-mathematical tradition, *physique* in early eighteenth-century France was gradually taking on a more specialized meaning than the generic “study of nature” or “study of natural causes.” Under the leadership of the Académie Royale des Sciences, and indirectly, of Leibniz and Newton, “*physique*” increasingly referred to the mathematical study of forces (dynamics), or else fell in the category of experimental philosophy. Its advocates held mechanistic and reductionistic assumptions, but some were increasingly skeptical of systematic endeavors. Preferring circumscribed problems to lofty meditations, these *physiciens* avoided discussing the theological implications of their works, and as such, differed from English natural philosophers, whose natural philosophical works often overlapped with natural theology. Thus, while it is customary for historians of science to refer to early modern “*physique*” as “natural philosophy” — an interchangeable usage corroborated by eighteenth-century dictionaries — this translation is somewhat misleading.

book, everywhere she awakens curiosity and engages the least philosophical of minds in inquiries, in reflections, in learned thoughts. And if we pay close attention, in matter of physics one realizes that it is only by degree by that we differ from each other: everybody is a *physicien*, everybody thinks and reasons physically.⁴³

Physics's relative facility was, ironically, the main obstacle to its progress. Whereas it is easy to convince common folks they are mistaken in geometry — a science that appeals to pure reason, and about which few people entertain any preconceived ideas — the “systems” and “prejudices” that the very same people develop during their lives to make sense of the natural world around them require hard work to overturn.⁴⁴

Castel had several models in this respect: Aristotle, whose “naïve” insights about nature he esteemed, and regarded as a historical and necessary passage from the common apprehension of nature to the understanding of the *savant*; Descartes, whose method and intuitive cosmology he regarded as the mark of a great genius; Kircher, whose encyclopedic works and analogical approach to nature he found deeply inspiring; and last but not least, Fontenelle, who better than anyone else in France knew how to write about difficult matters with clarity of expression and style. In accordance with the Jesuit apologetic mission, the primary goal of this amalgamation of natural philosophical traditions was to foster a religious appreciation for the spectacle of nature, rather than speculations about its stage machinery. Castel was interested in the mechanical causes of things but not unlike Newton, he considered that prior to formulating hypotheses about the insensible world, a philosopher should gather and organize all the “historical facts” of nature through obser-

⁴³ Castel, *Traité de la pesanteur* II, 2-3: “Toutes les fonctions de notre vie sont des expériences: nos moindres coups d’œil sont des observations; la nature est partout un livre ouvert: par-tout elle réveille la curiosité & engage l’esprit le moins philosophe dans des recherches, dans des réflexions, dans des pensées sçavantes; & si l’on y prend garde, en fait de physique, ce n’est que du plus au moins qu’on diffère: tout le monde est physicien, tout le monde pense & raisonne physique”

⁴⁴ Ibid., 2-4.

vation. A discovery required a lot of preliminary work; too many contemporaries — especially so-called Cartesians — failed to prepare adequately, and wrote novels instead of writing history. Their Newtonian critics, however, fell into another extreme:

Nothing is more unfair or more fatal to physics [than to forbid hypotheses like they do]. For its essence it is conjectural and hypothetical, and to deprive it of the freedom of inventive reasoning, which is all conjectural and full of hypotheses, and even of a little imagination and poetic fiction.... it is to annihilate it.⁴⁵

Moreover, unlike Newton Castel did not think contrived experiments had their place in natural philosophy. Adapting the traditional objection to experimental philosophy according to which experiments obfuscate the regular course of nature, he felt that artificial constraints placed upon nature would disrupt its rapports and proportions, thus hindering the very process of discovery.

The development of a complex attitude vis-à-vis mathematics and physics does not exhaust, far from it, the extent to which Castel's Jesuit formation influenced his scientific career. Although drawn toward the study of nature, Castel did not turn his back to the humanities. The lessons he learned during his minor cycle and subsequently applied during his *régentage* served him throughout his life. His writings indeed demonstrate both a good command of his classics as well as an engaging, distinctively "naïve" (i.e. natural) style.⁴⁶ Castel's conviction was that all fields of studies ultimately depend upon

⁴⁵ "[Review of Musschenbroek's] *Essai de physique*," *Mémoires de Trévoux* (Oct. 1739): 2112-2151, esp. 2130: "Or rien n'est plus injuste ni plus fatal à la physique. Elle est essentiellement conjecturale & hypothétique; & c'est l'anéantir, que de lui ôter la liberté du raisonnement inventif, qui est tout conjectural & plein d'hypothèses, d'un peu d'imagination même & de fiction poétique, si l'on veut, en danger même de devenir romanesque: car toutes choses ont leurs écueils & leurs abus."

⁴⁶ Castel's style was praised by some, and disapproved by others. For an example of a favorable reception, see "[Review of Castel's] *Traité sur la pesanteur universelle des corps*," *Journal des Sçavans* (June 1724): 391-406, in particular 403-406, which contains exemplary excerpts from the work. Those who, on the contrary, castigated him for his style generally complained about his prolixity, his imaginative excesses, and his inappropriate lightness in the treatment of serious matters like mathematics. His alleged

one another. Good speech, for instance, must have a geometrical foundation, and geometry, like any dry and arcane science, needed an eloquent delivery in order to persuade.⁴⁷

Castel followed his own maxims and eventually developed his stylistic insights into full-blown essays on taste and the geometrical underpinnings the arts.⁴⁸ Moreover, as discussed in the preamble, Castel thought that an attention to language and metaphorical thinking served more than a rhetorical function: it was a key to discovery itself: “Books of poetry go a long way toward perfecting one’s inventive genius: poems, I mean those of Virgil, Homer, Tasso, and even Ariosto [...] are filled with germs of discoveries, that only need a certain kind of precise and scientific development”⁴⁹ To this list, one could add moralists like Gracián and Boileau, and dramatists like Racine and Molière, all of whom were sources of inspiration.

Yet one must recall that prior to being a geometer, a physicist, and a rhetorician, Castel was a priest-in-training, invested with a mission to convert and edify. Part of his

“provincial” turn of phrase, and the “jargon” he invented or borrowed during his Jesuit training were also the object of mockery (the anti-Jesuitic sentiment is obvious in these critiques). See for instance Ms. 15751-15754 (42r-51r), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels, for a long, admonitory “Avis” against Castel’s *Plan d’une Mathématique abrégée, à l’usage et à la portée de tout le monde, principalement des jeunes seigneurs, des officiers, des ingénieurs, des physiciens, des artistes* (Paris: Pierre Simon, 1727).

⁴⁷ Castel, “Discours préliminaire” in Stone, *Analyse des Infiniment petits*, x: “Car, si toutes les sciences se tiennent par la main, & ont besoin les unes des autres pour se perfectionner & se développer, la Géométrie plus que toute autre, est une science sèche & roide, qui ne se manie point elle-même, & ne sauroit se retourner sans le secours d’un peu de Litterature, de Logique, & même de Rhetorique, qui est une Logique ornée. Comment parler Géométrie, en effet, si on ne sçait pas parler? Et comment écrire sur quoi que ce soit, si on ne sçait pas écrire?”

⁴⁸ See for instance Castel, “Géométrie naturelle en dialogue” *Nouveaux amusements du coeur et de l’esprit* (Amsterdam: Zacharie Chastelain, 1738) vol. 1, 79-94 and 185-202, vol. 2, 197-214 and 214-225 and “Dissertation philosophique et littéraire” in *Amusements du coeur et de l’esprit* (Amsterdam: Henri du Sauzet, 1741), vol. 2, 7-63.

⁴⁹ Castel, *Mathématique universelle* I, 283: “Les Livres de Poësie perfectionnent beaucoup le Génie de l’Invention: les Poëmes, je dis ceux de Virgile, d’Homere, du Tasse, d’Arioste même, &c, sont pleins de Germes de Découvertes; qui n’ont besoin que d’un certain Développement scientifique & précis.” Castel also thought that that books about the arts (including technical crafts), as well as moral books, “ont aussi leur mérite à cet égard, & en particulier, si on peut s’aider de la Méchanique pour taiter la Morale et la Politique, on peut aussi transporter bien des vûës, de la Morale & de la Politique, dans la Méchanique & ailleurs.”

formation would have included positive and speculative theology, biblical exegesis, as well spiritual exercises, in which he was expected to cultivate his meditation skills. These spiritual retreats in particular would have disposed him to contemplate the world as the harmonious creation of God. Under the guidance of a director of conscience, he would also have been introduced to “discernment of spirit,” a method aiming to determine whether a given phenomenon or action had a natural or supernatural cause — a concern that set him apart from many non-Jesuit natural philosopher. Discernment of spirit indeed entailed learning “to determine from what spirit [good or bad] the impulses of the soul emanate,” and more generally, to see through appearances in order to determine whether a seemingly miraculous event actually emanated from the will of God or what in fact explicable by means of natural, secondary causes.⁵⁰ Although his career steered him away from the pulpit and the confessional, Castel’s training in moral philosophy and theology would remain fundamental to his thought. Already in his thirties he claimed that books of moral philosophy had inspired his study of nature more than the book of nature itself, and later in life, that his entire philosophy had really been but a long commentary on Scripture.⁵¹

Castel was sincere about his religion, and the beginning of the eighteenth century was an exciting time to become a man of the cloth. Castel’s training took place against a backdrop of religious polemics, at a time when the Society of Jesus, in spite of the recent setback in the Chinese Rite controversy, was still at its height in Europe. Conflicts between Protestant and Catholics, Ultramontanists and Gallicists (that is, between support-

⁵⁰ Paul Debuchy, *The Catholic Encyclopedia*, s.v. “Discernment of Spirits” (New York: Appleton Compagny, 1909), accessed December 2015, <http://www.newadvent.org/cathen/05028b.htm>.

⁵¹ Castel, “Journal du clavecin,” 49r.

ers of the Pope and supporters of the French crown on matters of religious authorities), and most of all, between the Jesuit themselves and their Jansenist enemies, no doubt instilled a sense of purpose in aspiring priests. Moreover, in the aftermath of seventeenth-century theological controversies over freewill, original sin, and grace, there arose the growing threat of scepticism, materialism, and atheism (real or imaginary). As the eighteenth century unfolded, Christian apologists from various horizons made it their duty to confute these views, and although the young Castel was not directly involved in religious polemics, he certainly saw his natural philosophical works as a contribution to his order's apologetic mission.⁵²

Another cause for enthusiasm was the Society's apostolic front. With the publication of the *Lettres édifiantes* beginning in 1703, missionary zeal witnessed a new surge in France.⁵³ Many young Jesuits aspired to travel to the West or the East Indies to join the heroic venture on which their Company had embarked from the time of its inception. This recruitment propaganda apparently kindled Castel's desire to travel to distant shores. In his *éloge*, Le Cat recounts that "China requested missionaries and [that] P. Castel, who had all the qualities required to take on these important functions, was actively soliciting a place [in the mission.]"⁵⁴ All the qualities but one: health. Long hours of studies had supposedly taken their toll, and Castel was deemed too fragile to survive the journey to

⁵² The good overview of this mission is given at length in Northeast, *Parisian Jesuits*. On Castel's early work and its place in the Jesuit apologetic effort, see in particular pp. 92-93.

⁵³ *Lettres édifiantes et curieuses, écrites des missions étrangères, par quelques missionnaires de la Compagnie de Jésus* (Paris: Nicolas Leclerc, 1703-1776).

⁵⁴ Le Cat, "Eloge," 3r: "La Chine demandait des missionnaires et le P. Castel, qui réunissait toutes les qualités nécessaires pour ces importantes fonctions, y sollicitait vivement une place." If this solicitation left any traces, they have yet to be found.

the Far East. Lest his talents go to waste, his superiors declined his request and sent his rival Père Gaubil instead.⁵⁵

Castel's interest in the Jesuit missions endured throughout his life. He kept abreast of the Jesuits' missionary activities in China and North America by reading and reviewing the astronomical, religious and natural historical reports of his colleagues. Resolved to a life of scholarship, he considered Chinese historical records as useful evidence in support of his geographical and antiquarian conjectures. Some of his correspondence with Jesuit missionaries in Canada also survives, in which he advocated for the role of missionaries in the exploration of the northwestern reaches of the continent.⁵⁶ But Castel never reiterated his request to be transferred oversea. For even as the road to China was closing, another prestigious career path was opening ahead of him.

“Transplantation” to Paris

Few people would have heard of Révérend Père Castel prior to 1720. Raised, schooled and trained in Languedoc, his heart was set on priesthood, his mind busy with mathematics, and his time consumed by teaching and administrative duties. Ahead of him lay the respectable but modest station of the provincial Jesuit natural philosopher. The

⁵⁵ On Père Gaubil (1689-1759), consult Paul Demiéville's preface to Antoine Gaubil, *Correspondance de Pékin 1722-1759*, ed. René Simon (Genève: Librairie Droz, 1970).

⁵⁶ Louis-Bertrand Castel, “Réflexions du P. C[astel] J[ésuite] sur la fameuse éclipse observée à la Chine l’an 31 de Jésus-Christ, et que plusieurs prétendent être l’éclipse de la passion,” *Mémoires de Trévoux* (Feb. 1733): 296-315; “[Review of Du Halde’s] Description Géographique, Historique, Politique, & Physique de l’Empire de la Chine & de la Tartarie Chinoise,” *Mémoires de Trévoux* (March 1736): 521-554, (June 1736): 1299-1338, (July 1736): 1362-1400 and (August 1736): 1859-1894; Louis-Bertrand Castel, *Lettre de Monsieur d’Anville, géographe ordinaire du Roy, au R. P. Castel, Jesuite, Au sujet des Pays de Kamtchatka et de Jeço, et Réponse du R. P. Castel* (s. l.: s.n., 1737); Louis-Bertrand Castel, *Papiers [...]* sur le passage de la mer d’ouest en Asie avec les lettres de missionnaires sur ce sujet, Ms. 13373, Manuscrits français, BnF, Paris. His correspondants in Canada were with the Jesuits Joseph Pierre de Bonnécamp (1707-1790) and Claude Godefroy Coquart (1706-1765).

great intellectual centers of Europe — Paris first among them — were out of reach, the constitution of the Society of Jesus forbidding the transfer of its members across Jesuit provinces.⁵⁷ His immediate superiors wanted him close to home, where his religious zeal and his teaching expertise would serve their local interest best.

Given these restrictions, Castel was probably surprised and delighted when news came of his imminent transfer to the prestigious Parisian College of Clermont (Louis-le-Grand). He had no doubt hoped to establish himself as an academic correspondent with some of his Parisian colleagues, but moving to the capital represented an unhoped-for opportunity. According to his obituaries, some of his manuscripts in circulation had fallen into the hands of Bernard Le Bovier de Fontenelle — the perpetual secretary of the Académie Royale des Sciences — and Père Tournemine, SJ — the chief editor of the *Mémoires de Trévoux* — both eminent patrons of the art and sciences who recognized Castel's potential and pulled a few strings to allow his relocation to the capital.⁵⁸ For Jean Ehrard,

this double sponsorship, which promised him a brilliant career, takes on a symbolic meaning. Patronized by both the Secretary of the Académie Royale des Sciences and by the former director of the *Mémoires de Trévoux*, P. Castel's oeuvre had to seek an agreement between the imperatives of the faith and the principles of mechanical philosophy.⁵⁹

Indeed, Castel would thenceforth repeatedly proclaim himself a “reconciler,” and regard his own system of physics — part mechanical, part spiritual — as one of his most funda-

⁵⁷ With the notable exception of missionaries, which were supervised by the Province of France, and thus in primarily tied to the *Maison Professe* of Paris.

⁵⁸ Le Cat, “Eloge,” 2r; Berthier, “Eloge historique,” 1102.

⁵⁹ Ehrard, *L'idée de nature*, 67: “À nos yeux, ce double parrainage, qui lui promettait une brillante carrière, prend une valeur symbolique. Patronnée à la fois par le Secrétaire de l'Académie Royale des Sciences et par l'ancien directeur des *Mémoires de Trévoux*, l'œuvre du P. Castel se devait de chercher un accord entre les impératifs de la foi et des principes du mécanisme.” Note however that the commitment to the reconciliation of faith with reason was part of the Thomistic tradition, and thus already a Jesuit concern.

mental achievements. But first and foremost, his appointment at the Jesuit College of Paris was a promotion that came with social benefits. For one, it opened up opportunities to tutor the sons of the high nobility, and through them, court some of the most powerful men of the kingdom. It also granted him access to the Parisian salons, where he befriended some of the foremost intellectuals of his day, including Montesquieu and the Abbé Saint-Pierre.

Unfortunately, the only surviving evidence of Fontenelle and Tournemine's involvement comes from Castel's obituaries, written forty years after the fact:

It was around the age of 30 that [Castel] made himself known by a few essays representative (*relatifs*) of his taste and genius. These sketches fell into the hands of Mr. de Fontenelle and Père de Tournemine, both declared protectors of emerging talents (*succès naissants*). They judged that Père Castel would not be moved to the capital [without their intervention], and they advised his superiors to have him transferred from Toulouse to Paris.⁶⁰

Le Cat simply echoed Père Berthier.⁶¹ While there is no reason to doubt the veracity of these accounts, one can only speculate about the nature and the specific circumstances of the two men's intervention. By the time their *protégé* was settling in Paris, the *Mémoires de Trévoux* had already published his "Physico-mathematical Principles of the Mechanism of Nature in the Refraction of Light," an essay that built upon Descartes's theory of light to argue that refraction and reflection are instances of the same mechanical princi-

⁶⁰ Berthier, "Eloge historique," 1102: "Ce fut aussi vers l'âge de 30 ans qu'il se fit connoître par quelques Essais relatifs à son goût & à son génie. Ces ébauches tomberent entre les mains de M. de Fontenelle & du Père de Tournemine, l'un & l'autre Protecteurs déclarés des succès naissants. Ils jugèrent que le P. Castel ne seroit point déplacé dans la Capitale, & ils conseillèrent à ses Supérieurs de le faire passer de Toulouse à Paris."

⁶¹ Le Cat, "Eloge," 2r-3r: "Fontenelle, notre grand Fontenelle, le Protecteur des talents, comme le Promoteur des sciences, sentît tout le merite du jeune Physicien de Province; Il s'unît au Pere Tournemine pour obtenir de ses superieurs qu'il fût apellé dans la Capitale. Cette transmigration estoit contre les regles de la Societé; La maison de Toulouse, dans le sistême de ces Religieux, n'est pas de la Province de France, et les changemens de Province n'y sont pas permis; Il falût donc tout le mérite du Pere Castel, et le credit de ses deux grands Protecteurs pour faire transgresser cette loi."

ple.⁶² Perhaps this was one the “sketches” that had brought Castel to the attention of Fontenelle and Tournemine in the first place. Castel’s arrival in Paris coincided with a period of crisis within the Jesuit periodical; Tournemine may have been on the look-out for potential recruits before the Society took official measures to reinvigorate the enterprise. (Tournemine had officially left the journal’s *agence* in 1719 to work at the *Maison Professe*, but he remained an *eminence grise* for several additional years).

Properly called *Mémoire pour l’histoire des sciences et des beaux-arts*, the *Journal* or *Mémoires de Trévoux* was the main scientific and literary organ of the Society of Jesus. Although printed in Trévoux (north of Lyon) from its foundation in 1701 until 1731,⁶³ its redactors were stationed in the capital. The journal’s official aim was to offer, on a monthly basis, scholarly book reviews and original articles for the educated public interested in the sciences and the arts, broadly conceived. Though not originally conceived as such, in practice it was also a platform for Christian apologetics and a forum for debate. For over sixty years it stood amongst the most widely read and most influential scholarly periodicals of Europe, its board of redactors comprising some of the finest *scriptores librorum* the Society could muster in France.⁶⁴ Although Castel did not enjoy this enviable title, in practice he sat among them for thirty years.

⁶² Louis-Bertrand Castel, “Principes physico-mathématiques du mécanisme de la nature dans la refraction de la lumière,” *Mémoires de Trévoux* (Mars 1720): 540-559.

⁶³ In 1731, the journal briefly moved to Lyon, and then to Paris (1734), where it remained in the hands of the Parisian Jesuits until 1762.

⁶⁴ There exists a considerable literature on the *Mémoires de Trévoux*, though unfortunately very little archival documents. For general studies, consult Emmy Allard, *Die Angriffe Gegen Descartes und Malebranche im Journal de Trévoux, 1701-1715* (Halle a. S.: M. Niemeyer, 1914); Gustave Dumas, *Histoire du Journal de Trévoux, depuis 1701 jusqu’en 1762* (Paris: Boivin & cie, 1936); Alfred Desautels, *Les Mémoires de Trévoux et le mouvement des idées au XVIIIe siècle (1701-1734)* (Rome: IHSI, 1956); Healy, “Mechanistic Science”; Pappas, *Berthier’s Mémoires de Trévoux*; J. Sgard and F. Weils, “Les anecdotes inédites des *Mémoires de Trévoux* (1720-1744),” *Dix-huitième siècle* 8 (1976): 193-204 (this whole issue is in fact devoted the *Mémoires de Trévoux*); Christian Albertan, “Les journalistes de Trévoux lecteurs de

Neither Fontenelle nor Tournemine seem to have been directly involved in Castel's appointment to the *Mémoire de Trévoux*, but their original sponsorship probably helped establish him as a good candidate. "In 1720," Castel reminisced in one of his manuscripts, "the Journal had fallen."⁶⁵ It was running six months late and running out of funds. Only the first five issues appeared that year — the first major interruption in two decades. According to Castel's account, in 1721 an assembly of Jesuit notables met at the Jesuit College to decide what needed to be done to salvage the wreck:

It was decided to spare no effort, and to even call for help, to redress this work. A proposal was made to summon P. Baltus expressly for this purpose, and to give to P[ère] C[astel], who had recently arrived [in Paris], the honor of using his services. P. Daniel, P. Gaillard and P. Paulon were those who proposed him.⁶⁶

Castel's candidacy made sense. His knowledge of advanced mathematics and predilection for natural philosophy made him stand out from his colleagues, who were for the most part more interested in religion, antiquities, and *belles-lettres* than science. Not everyone agreed with these nominations, but after some negotiation, "[i]t was concluded that P. Baltus would be left out, that P. C[astel] would be put to use since he was there, and

l'Encyclopédie," *Recherches sur Diderot et sur l'Encyclopédie* 13 (1992): 107-116; idem, "Entre foi et sciences: les *Mémoires de Trévoux* et le mouvement scientifique dans les années 50," *Dix-huitième siècle* 34 (2002): 91-97; Dinah Ribard, "Pratiques jésuites de l'écrit: le P. Tournemine, les *Mémoires de Trévoux* et Fénelon," *Dix-septième siècle* 3, no. 228 (2005): 513-526. More generally on the French press in the Enlightenment, consult Jack R. Censer, *The French Press in the Age of Enlightenment* (London: Routledge, 1994); James Basker, "Criticism and the Rise of Periodical Literature," in *The Cambridge History of Literary Criticism*, vol. 4, ed. H. B. Nisbet and Claude Rawson (Cambridge: Cambridge University Press, 1997), 316-332.

⁶⁵ Louis-Bertrand Castel, "Les anecdotes du Journal depuis 1720," Ms. 11 364, Nouvelles acquisitions françaises, BnF, Paris. One of two versions of Castel's brief history of the *Mémoires de Trévoux* has been edited by J. Sgard and F. Weils, "Les anecdotes," 193-204 (hereafter cited Castel, "Les anecdotes" with the modern edition page numbers). In this text, Castel gives a rare and precious insider's perspective on the Jesuit journal, recounting the main events that took place during his long tenureship and making suggestions on how to reform the structure of the agency. This manuscript was written before Castel would gradually withdraw from the editorial team between 1746 and 1750.

⁶⁶ Castel, "Les anecdotes," 195.

that PP. Brumoy and Rouiller would be called,” as was P. Bougeant soon afterward.⁶⁷

These four formed the core of the journal’s editorial “agency.” It was supplemented by a larger group of “freelancers” that included PP. Kervillars, Courbeville, Blainville, not to forget Buffier and de Fontenay. Supervising the team was the old Père Thoubeau, whose leadership Castel remembered fondly. “He was a good man, a knowledgeable man. All in all, no [agent] has ever done better than he.”⁶⁸

Castel thrived in his new work environment. Responsible for most of the mathematical and natural philosophical content of the journal, he suddenly found himself at the center of an international network of correspondents, including members of the Parisian, provincial, and foreign scientific academies. Prominent among his contacts were also Jesuit natural philosophers stationed across Europe and beyond, eager to communicate their findings or to get their writings reviewed. Supplied with more books than he could read, Castel’s work was as challenging as it was intellectually rewarding.

Several of Castel’s own writing projects predated his transplantation to Paris. Indeed, he had had time to develop some of his ideas while teaching in the provincial colleges. Yet his tempo accelerated during the first years of his tenure, and would remain high for the rest of his life. Nourished by a welter of readings and by frequent contact with the Parisian and European intelligentsia, he began to see more clearly the outline of an ambitious philosophical enterprise. Desirous of sounding out his ideas with the public, Castel planted what he called “seeds of discoveries” in the pages of the *Mémoires de Tré-*

⁶⁷ Ibid., 196.

⁶⁸ Ibid., 196. In their critical introduction, Sgard and Weil explain that the role of the agent (i.e. Thoubeau at that time) “was not so much to write excerpts than to obtain books, find correspondents and collaborators, revise and lay out the excerpts” (194). The monthly “Nouvelles littéraires” also fell under his purview.

voux. Within a few years, most intellectuals in Europe had heard of Louis-Bertrand Castel.

PART 2 Germination

The first two years of Castel's tenure as "science editor" for the *Mémoires de Trévoux* testified to the fertility of his mind and to the ferment of his new work environment. Besides writing several anonymous book reviews, he authored a series of articles aimed at giving readers a glimpse of the new system he was preparing for publication.⁶⁹ These articles included, besides the aforementioned essay on the mechanism of light refraction, a history of mathematical progress (June 1721); an *éloge historique* for Leibniz

⁶⁹ Reviews included, among others: "[Review of Keill's] *Introductio ad veram physicam, seu lectiones physicae habitae in Schola naturalis Philosophiae Academiae Oxoniensis*," *Mémoires de Trévoux* (April 1721): 644-665; "[Review of 'sGravesande's] *Physices elementa mathematica experimentis confirmata, sive Introductio ad Philosophiam Newtonianam*," *Mémoires de Trévoux* (May 1721): 823-885; (Oct. 1721): 1761-1796; "[Review of Desmaizeaux's] *Recueil de diverses pieces sur la Philosophie, la Religion naturelle, l'Histoire, les Mathématiques, &c. par Messieurs Leibnis, Carke, Newton, & autres auteurs celebres*," *Mémoires de Trévoux* (June 1721): 963-998 and (July 1721): 1230-1254; "[Review of Hermann's] *Exercitationum Francofurtensium*," *Mémoires de Trévoux* (Aug. 1721): 1325-1350 and (Nov. 1721) 1960-2001; "[Review of Crouzas's] *Commentaire sur l'analyse des infiniment petits*," *Mémoires de Trévoux* (July 1722): 1189-1215; "[Review of J. de Brye's] *L'art de tirer les armes: réduit en abrégé méthodique*," *Mémoires de Trévoux* (Fev. 1722): 275-297; "[Review of Gautier's] *Nouvelles conjectures sur le Globe de la Terre*," *Mémoires de Trévoux* (April 1722): 730-750; [Review of Fontenelle's] *Histoire de l'Académie Royale des Sciences de l'année 1718*," *Mémoires de Trévoux* (May 1722): 761-790 and (June 1722) 989-1031; "[Review of Gamache's] *Système du mouvement*," *Mémoires de Trévoux* (May 1722): 845-866; "[Review of Rameau's] *Traité de l'harmonie réduite à ses principes naturels*," *Mémoires de Trévoux* (Oct. 1722): 1713-1743 and (Nov. 1722): 1876-1910. In May 1722, the *Mémoires de Trévoux* announced that Castel's *Traité de la pesanteur* was in preparation: "This work is divided into three parts, the first two dealing with the phenomena of *pesanteur*, the last one with its causes. Nothing is more extensive (*étendu*) than these phenomena; this father undertakes to show that the system of *pesanteur* encompasses the entire system of the universe: as for the causes, nothing is simpler, one single principle answers all difficulties" (930-931). The *Traité de la pesanteur* passed the examination of the Jesuit censor board on 18 May 1723 and royal censorship on the 10 December of that same year. Of the three parts announced, only the first would be published; it would itself comprise two volumes. In addition to the work on *pesanteur*, the same issue of the journal announced Castel's *Traité sur les coquillage* (treatise on seashells) partly based on the work of Filippo Bonanni, SJ (1638-1723). This project, which was abandoned by 1731, contained a French translation of the natural historical section of Bonanni's *Ricreatione dell'occhio et della mente*, plus two original sections, presumably discussing their generation, their fossilized form, and their place in the system of the world. A detailed but incomplete outline of this work survived in Ms. 15744, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

(August 1721); an epistolary exchange over Bouillet's prize-winning 1720 *Dissertation sur la cause de la pesanteur* (December 1721); as well as a set of "physical conjectures" on the nature of viscous bodies (February 1722), the role of plowing in the generation of plants (March 1722), and the origin of fossils (June 1722).⁷⁰ Considering Castel was simultaneously teaching at Louis-le-Grand College, working on several book manuscripts, and busy getting introduced to the worldly circles of Paris, this output is impressive indeed.⁷¹

Since the content of most of these works also features in the *Traité de la pesanteur* (the subject of the next chapter), analyzing them in detail here is unnecessary. Although fascinating in their own right, his reviews of 'sGravesande's *Physices elementa mathematica*, Herman's *Exercitationum Francofursensium* and Bouillet's *Dissertation sur la cause de la pesanteur*, to name but three, can be summed up as critiques of the prevalent Newtonian, Leibnitzian and Malebranchian views of gravity, respectively, and thus as attempts on Castel's part to clear space for his own contribution. It is worth pointing out, however, that scattered throughout these reviews are a number of precepts that

⁷⁰ Castel, "Mémoire pour l'histoire des découvertes," *Mémoires de Trévoux* (June 1721): 998-1045; "Eloge historique de M. Leibniz," *Mémoires de Trévoux* (Aug. 1721): 72-76; "[Review of Bouillet's] Dissertation sur la cause de la pesanteur," *Mémoires de Trévoux* (Jan 1722): 109-136; "Conjectures sur la nature des corps visqueux," *Mémoires de Trévoux* (Feb. 1722): 223-248; "Conjectures de physique sur la raison qui fait qu'on laboure les terres, sur leur fertilité, sur la génération des plantes, et autres corps organisés, et sur bien d'autres phénomènes qui en dépendent ou qui y ont du rapport," *Mémoires de Trévoux* (March 1722): 509-527; "Conjectures sur les pierres figurées qu'on trouve à Saint-Chaumont dans le Lyonnais et en mille autres endroits de la terre, aussi bien que sur les coquillages et les autres vestiges de la mer," *Mémoires de Trévoux* (June 1722): 1089-1102.

⁷¹ The convention of the time was for book reviewers to remain anonymous. Any attribution of authorship must therefore rely on extraneous cues and ultimately remain tentative. Fortunately, Castel had a distinctive style, a number of pet ideas, and a tendency toward self-promotion that facilitate the identification of his contributions. George R. Healy, in his study of the French Jesuits' response to early eighteenth-century scientific currents, makes a number of such attributions (without justifying them unfortunately), and he proposes that Castel was the primary scientific voice of the journal between 1720 and 1745; see Healy, "Mechanistic Science," esp. 119-120. As my bibliography attests, I agree with Healy and will indicate, whenever it seems necessary, the evidence supporting our attributions.

Castel would repeat and develop further in subsequent works. These include generic statements such as “physics is a history of nature,” “careful hypotheses have their place in natural philosophy,” “the truth of a system lies in the middle course between extremes,” and so forth. More idiosyncratic are his notions that the specific form of matter is more important than its quantity (density) when it comes to explaining gravity; or that gravity and light emission are really two sides of the same principle.⁷²

Even richer is the triptych of physical conjectures Castel published in 1722 on “la nature des corps visqueux,” “la raison qui fait qu’on laboure les terres,” and “les pierres figurées.” Like his reviews, these pieces announced some of the content of his *Traité de la pesanteur*. They offered original insight onto a series of long-standing problems of *physique* and showed that Castel was engaged in contemporary debates. Judging by their titles alone, his conjectures formed an eclectic set; upon closer inspection, however, their content cohered.⁷³ Insofar as they are illustrative of Castel’s style and suggestive of what he understood to be a good “system,” they deserve some consideration before we proceed with an in-depth analysis of the “Lettre à M. C.,” the most fecund of Castel’s early seeds of discovery.

⁷² See esp. Castel’s “[Review of ’sGravesande’s] *Physices elementa mathematica experimentis confirmata*,” *Mémoires de Trévoux* (May 1721): 850 and “[Review of Hermann’s] *Exercitationum Francofurtensium*,” *Mémoires de Trévoux* (Aug. 1721):1325-1337.

⁷³ Healy discusses the three “incredible articles” that Castel referred to as conjectures to illustrate the “unfortunate methodological combination” of his “Thomistic, Jesuit concern for sensory facts simply expressed” and his Cartesian “trust in intuitive ideas, deductions, and analogy” Healy, “Mechanistic Science,” 130. He also argues that Castel’s “unhappily all too characteristic” arguments were connected by his theory of “air pressure,” the power of the air being the cause of viscosity, of motive force being plant growth, and of the fuel of the central fire responsible for the circulation of the earth (123-128). While Healy’s effort to underscore the interconnectedness of Castel’s thought is commendable, it is marred by its occasional condescension and misinterpretations of the text (Strictly speaking, Castel does not think in terms of “air pressure,” but in terms of its “spring” and “elasticity;” he does not merely dismiss contemporary hypotheses to replace them gratuitously with his own; he articulates methodological problems with mechanical philosophy as practiced by certain Cartesians; he does not believe air is the main fuel of the central fire of the earth, but one of the elements which allows for its perpetuations, etc.).

Thoughts on a Viscous System

Castel's first conjecture was that the admixture of air in solid bodies, by virtue of this element's "spring" or "elasticity" (i.e., its natural tendency to expand and rarefy), accounts for "viscosity," a state of matter between solidity and fluidity whose main property is "to obey traction easily without losing unity."⁷⁴ This proposition, based on everyday observations and simple kitchen table experiments, was offered by some Cartesians as an alternative to the widespread hypothesizing about branched particles, or *ramuscules*, whose dendritic shape was held to account for the phenomenon. Castel rejected these putative particles as *ad hoc* suppositions, which he regarded as a misuse of analogy in philosophy. The problem with *ramuscules*, he argued, was that they were hypothetical, microscopic analogues to one, and only one, observable instance of viscosity (the interlocking of branches) rather than as a principle "proportional" to viscous phenomena in general. A more careful observation of nature would reveal other kinds of viscosity, each of them suggestive of a different metaphor. In focusing on twigs, one missed the trunk, that is, the common denominator that might avoid the multiplication of causes.

In common parlance, the term viscous applied to a rather small set of substances like oil, honey, clay, or bread dough. The latter two, incidentally, were probant examples for Castel of the role that air plays in the determination of their state (the effect of kneading being to integrate more air in their substance). But since nature does everything by degrees, viscosity could also be conceived of as a vast domain spreading between perfectly solid and perfectly fluid bodies:

⁷⁴ Castel, "Conjectures sur la nature des corps visqueux," 239.

Perhaps this question of the viscosity of bodies will not appear very important in physics; yet [...] it might be possible to propose on its basis a system of generation and organization of plants and animals, all based on the nature of viscous bodies and the spring of the air.⁷⁵

Accordingly, Castel's second conjecture on the physical effect of plowing built upon the concept of viscosity to explain vegetative growth, and by the same token, to undermine another widespread hypothesis: that of the "niter of the air."⁷⁶

The main physical reason for tilling the earth, Castel surmised, was to force air into the soil, thereby making it viscous.⁷⁷ Understood as a body's propensity to cede without breaking its unity, viscosity explained why the air entrapped beneath the earth got caught, by attempting to escape, in the fibrous cells or folds of the earth, and forced their expansion, their development, and their growth. Thus, "taken in the right way, [fe-

⁷⁵ Ibid., 247: "Peut-être que cette question de la viscosité des corps ne paroîtra pas fort importante dans la Physique' mais si le Public daigne y faire quelque attention & en juger favorablement, on pourra dans la suite proposer le système de la generation & de l'organisation des plantes & des animaux; système tout fondé sur la nature des corps visqueux & sur le ressort de l'air [...]" On the question of the "spring of the air," Castel was manifestly influenced by Boyle and his followers.

⁷⁶ Ibid., 247-248: "[D]epuis quelques années, on s'est avisé d'imaginer un esprit universel, un nitre aérien, qui fertilise les terres, fait vivre les animaux, anime la flamme, colore le sang, dilate le coeur, fait fermenter, croître, meurir toutes choses. N'est-ce point la passion secrete qu'on a pour le merveilleux, qui fait substituer un nitre ambigu, & aussi imaginaire que les ramuscules des corps visqueux, au ressort & aux proprietés les plus incontestables de l'air, qu'on ne perd sans doute de vûë dans tous ces phenomènes, que parce qu'il y saute trop sensiblement aux yeux, & qu'il est plus facile & plus naturel de l'y appercevoir." The reference is to a chemist like John Mayow (1641-179) as well as to English and French philosophers who adopted his ideas about combustions and respiration. On the origins of the aerial niter theory, see Allan Debus, "The Paracelsian Aerial Niter," *Isis* 55, no. 1 (March 1964): 43-61.

⁷⁷ Castel's conjecture was influenced, it would seem, by Borelli's *Tractatus de motu animalium* (Rome: Barnabo, 1680-81) and Astruc's *Tractatus de motus fermentativi causa* (Montpellier: Honoratum Pech, 1702), as noted by a certain Mr. Astier le Cadet in a *mémoire* read at the Académie Royale des Sciences et des lettres of Béziers in response to Castel's article. Astier proposed that etherial matter was the efficient cause of the fermentation that Castel attributed to the spring of the air, and thus adopted Jean Bouillet's theory published as *Dissertation sur la cause de la multiplication des ferments* (Bordeaux: R. Brun, 1719). Astier's views are summarized and quoted in Jean Bouillet, "Sur la cause de la fertilité des terres," *Recueil des lettres, mémoires, et autres pièces pour servir à l'histoire de l'Académie des Sciences & Belles Lettres de la Ville de Béziers* (Béziers: Veuve d'Estienne Barbut, 1736), 2-6. Castel seems to have maintained strong ties with the academicians of Béziers throughout his life, publicizing (and criticizing) their works in the *Mémoires de Trévoux*.

cundity] is but the earth disposed to swell and to somehow get out of itself.”⁷⁸ From this perspective, plants were the “froth of the earth” (*des pétilllements et des écumes de la terre*), a kind of vegetation taking place with and without seeds.⁷⁹ “For what is a seed, after all” if not “a pile of earth, water, salt, sulfur, and mostly air, as suggested by its viscosity and its capacity to rarefy [i.e., expand]”? In a seed, “these substances are mixed, combined and arranged with the air” to form “an infinity of artfully folded and entangled nets, such that the juice (*suc*) of the earth only has to penetrate these nets and their fabric to make them expand and develop” into a plant. But since the juice of the earth itself consists in a mixture of “earth, water, salts, sulfur, and mostly air,” disposed to form nets and threads as its various components force their way out according to their specific weight, Castel accepted that the air introduced into the earth by plowing could occasion a kind of spontaneous generation.⁸⁰

Pushing his conjecture further, Castel argued that the action of the air upon the the seminal or earthy envelope could lead to organization, that is, the formation of organic structures, channels through which the juices of a plant (and for that matter, those of an animal) might circulate, and therefore keep it alive and sound. He writes,

Surely one sees that I am not priding myself on multiplying phenomena, and that I embrace an infinity of them in a few words: the perpendicularity of stems, the rise of sap to the top of the highest trees, the development of

⁷⁸ Castel, “Conjectures de physique sur la raison qui fait qu'on laboure les terres, 516.

⁷⁹ Ibid., 518.

⁸⁰ Ibid., 521: “Qu’est-ce qu’une semence après tout? C’est un amas de terre, d’eau, de sel, de soufre, & sur tout d’air, témoin la viscosité qu’on y remarque & la raréfaction dont elle est capable; il est vrai que toutes ces substances sont mêlées, combinés & arrangées avec art dans cette semence, & y forment une infinité de filets repliez et entrelacez avec encore plus d’art, en sorte que le suc de la terre n’a plus qu’à pénétrer, à étendre, à développer ces filets et leur tissu. / Mais qu’est-ce que le suc de la terre? Nous l’avons déjà vû, c’est comme la semence, c’est un amas de terre, d’eau, de sels, de soufres, & surtout d’air; & du reste si ce suc n’est point formé en filet, il est au moins très disposé à s’y former. Que faut-il pour former des filets? Il faut une filiere & une action, un mouvement qui forme une matiere visqueuse à passer à travers les trous de cette filiere [...]”

seeds, the fermentation of juices, a thousand sorts of elaborations, even breathing, and circulation in animals as much as in plants, the heating, the rarefaction, the fermentation of the blood, heartbeats; in a word, the entire system of generation and of plant and animal life is obviously the immediate consequence of the spring of the air, and of the effort it makes to free itself from the other substances with which it is mixed, and which impede it.⁸¹

What some philosophers attributed to the properties of a universal vivifying agent, the mysterious “aerial niter,” Castel reduced to the mechanical interaction of air with the other elements. Unlike the invisible niter, the spring of the air was an observable, measurable property, and a “sufficient and efficacious cause.”⁸²

Castel’s third conjecture followed from the previous ones. Its main object was to explain the puzzling presence of fossilized plants and seashells in elevated regions, in particular those featuring species normally found on separate continents.⁸³ Castel proposed an alternative to the mainstream theories recently expounded by the naturalist Antoine de Jussieu (1686-1758) at the Académie Royale des Sciences, such as the rise and withdrawal of the sea over long periods of time (Castel called it the “system of wandering seas”), as well as an appeal to the universal flood.⁸⁴ Castel’s approach relied instead upon

⁸¹ Ibid., 526: “On voit bien que je ne me pique pas ici de multiplier les phénomènes, & que j’en embrasse une infinité en peu de mots: la perpendicularité des tiges, la montée de la seve à la cime des arbres les plus hauts, les developemens des semences, la fermentation des suc, mille sortes d’élaborations, la respiration mêmes, & la circulation tant dans les animaux que dans les plantes, l’échauffement, la rarefaction, la fermentation du sang, les battements du coeur; en un mot tout le système de la génération & de la vie des plantes et des animaux, sont évidemment suite immédiate du ressort de l’air, & des effort qu’il fait pour se dégager des autres substances avec quoi il est mêlé, & qui le gênent.”

⁸² Ibid., 527. This is interesting in light of the similar language was sometimes used in Jesuit debates against Jansenists to talk about moral causation.

⁸³ Castel, “Conjectures sur les pierres figurées,” 1089-1102.

⁸⁴ Ibid., 1089-1093, esp. 1093. Castel refers specifically to Antoine de Jussieu’s “Examen des causes des impressions des plantes marquées de certaines pierres des environs de Saint-Chaumont dans le Lionnais,” *Mémoires de l’Académie Royale des Science* (1719), 287-297, which is discussed in “[Review of Fontenelle’s] *Histoire de l’Académie Royale des Sciences pour l’année 1718. avec les Mémoires de Mathématique & de Physique pour la même année*,” *Mémoires de Trévoux* (June 1722): 1016-1020. On this and other early eighteenth-century geological debates, consult Rhoda Rappaport, *When Geologists Were*

the mechanical behavior of elemental mixtures, thereby projecting on a global scale his insight about the role of plowing in the fertilization of the ground. The organization and circulation resulting from the admixture of air into the soil found a parallel, he suggested, in the internal movement of elements within the planet. On this basis, he sketched out a theory of mechanical circulation accounting not only for the vegetative froth on the surface of the globe, but also for the rise and fall of water and earth from its periphery to its fiery core, and from its fiery core to its surface. Seen from afar, the earth might look like a living animal. Castel considered the mysterious transportation of fossils both as a consequence of circulation and as suggestive evidence of the existence of subterranean conduits.⁸⁵

There is something playfully “viscous” about these three conjectures. Not only do they cohere, in a manner of speaking, because of air; they are also connected in such a way that pulling any of their propositions out drags all of them along. This should serve as an indication that Castel’s thinking was more holistic than it was eclectic. He was not fashioning a patchwork so much as creating the conditions for the fermentation of ideas and the growth of his system. For him, a system consisted of the concatenation of propositions brought together by an underlying principle. Good systems were not only internally coherent, however, for they also derived from repeated observations. The best systems accounted for the widest array of phenomena. In contrast, bad systems, even if internally coherent, failed to explain the natural course of events without introducing new hypotheses to supplement an insufficiently fertile principle. In other words, they were made to fit

Historians, 1665-1750 (Ithaca: Cornell University Press, 1997), which refers to Castel’s theories on a few occasions.

⁸⁵ Castel, “Conjectures sur les pierres figurées,” 1097-1098.

observations *ex post facto*. Hypothesizing “branched particles” to account for viscosity or appealing to the “niter of the air” to explain fertility were examples of what Castel regarded as arbitrary hypotheses. Although Castel has been criticized by modern critics on the grounds that he jumped too quickly from observations to conclusions, he scrupulously avoided multiplying causes beyond necessity. Indeed, he was proposing new perspectives from which to judge inadequately envisioned natural philosophical problems. By juxtaposing viscosity, fertility, and fossils, he thought he had “discovered” a principle that reduced a multitude of phenomena into a systematic unity. In the process, he also suggested a number of new avenues of research, most notably his intriguing concept of terrestrial circulation. By his definition, this was *génie* at work.

“Lettre à M[onsieur] C.”: Discernment of Spirit with a Twist

Before the end of 1722, Castel experienced intellectual vertigo at the realization that he stood on the brink of another discovery. In December of that year, the *Mémoires de Trévoux* published a modestly titled but profoundly original letter the content of which would ripple throughout the rest of his career.⁸⁶ Introducing a recent flash of insight regarding the role that spirits ought to play in the mechanical philosophy, the “Lettre à M. C.” was not only the first public *coup d’envoi* of Castel’s system of the free action of men upon nature, but also the outline of an ambitious research program, a “quarry,” as he later described it, so vast that the prospect of exploiting it made him dizzy.⁸⁷ The “Lettre” deserves careful consideration for the light it sheds on Castel’s fundamental assumptions

⁸⁶ Castel, “Lettre à M. C.,” 2072-2097.

⁸⁷ The metaphorical allusion appears at the beginning of the fourth book of the *Traité de la pesanteur* I, 327-332, esp. 331, where Castel offers a retrospective account of his discovery. References to the discovery or opening of quarries and mines abound in his oeuvre.

about the relationship between nature, God, and mankind. Putting the assumptions into historical perspective will help us make sense of his project for *physics* specifically and clarify in what ways he considered his discovery an important contribution to natural philosophy more broadly.

The primary purpose of the letter was to address the need to carefully distinguish between the natural, the artificial, and (implicitly) the supernatural realms. Castel found ridiculous the conceit that “we have progressed much in physics,” when most of his contemporaries still treated the “mixture of natural and artificial actions” as a single object of study. The failure on the part of natural philosophers to discern these different kinds of actions “generated a continual illusion and threw a great veil of obscurity upon nature.”⁸⁸ Such category mistakes had to be avoided.

A good *physicien*, Castel believed, studied the teeming spectacle of the world in order to reveal its underlying unity. To succeed at the difficult task of reducing complex phenomena to simple principles (an act of synthesis), one first needed to identify what properly counted as “natural” (by means of analysis). Trained in the Jesuit art of spiritual discernment, Castel thought that beneath the plethora of observable phenomena, there lay different kinds of causes, some of which were mechanical and necessary, others spiritual and free. Acts of will, both divine and human, belonged to the latter. When God intervened in natural processes, the effects were properly called supernatural; when men intervened, the resulting phenomena belonged to the category of artifice.

⁸⁸ Castel, “Lettre à M. C.,” 2096-2097: “[...] on peut se flatter qu’on est fort avancé dans la Physique, où jusques-là on trouve un mélange d’actions naturelles, & artificielles; qui fait une continuelle illusion, & jeter, comme j’ai dit, un grand voile, qui obscurcit la nature.”

This tripartite division was a commonplace of scholastic ontology. Castel's delineation of each domain, however, was not. For one, he held a radically mechanistic conception of nature, reducing it to the blind action of universal *pesanteur* and its epiphenomena. "Nature" was subordinated to its Author who, on rare occasions, chose to display His power by miraculously suspending the laws He had decreed. Between these narrowly defined natural and supernatural realms, there lay a vast middle realm that Castel — following Aristotle — called "artificial." The artificial realm comprised "everything nature does such as it is determined by the free will of Man," and as such, extended far beyond what was normally understood by the term "artificial." It comprised, for example, projectile and violent motions of Aristotelian physics, as well as the consequences of these actions.⁸⁹ Castel argued that, as embodied spirits, human beings could physically and efficaciously interact with matter without being entirely bound by its laws, and that this interaction produced ripple effects. By continually bending the otherwise regular course of nature to their will, men effectively transformed the world into a giant artifice — a *second* nature.

Redefining the boundaries between nature and artifice served to clarify the task of the *physicien*, but also to grant a place to free will in natural philosophy — a central concern for the Jesuits.⁹⁰ Indeed, his discernment of natural, artificial and supernatural causes was not meant to restrict the scope of natural philosophy. Quite the contrary: the better one's understanding of man's action upon nature, the better one's comprehension of the

⁸⁹ Ibid., 2073.

⁹⁰ In the same way one might prefer to conduct free fall experiments in a vacuum, or an isolated environment. Dropping a feather under these conditions will reveal something about gravity that might not be obvious if the surrounding air constantly interferes with the result. For Castel, something analogous was going on when the disruptive "artificial" action of free spirits in the world were mistakenly folded in the physical explanation of *pesanteur*.

world as it actually is. But why define natural and divine action so narrowly in the first place? Part of the answer lies in Castel assumptions about Nature.

The Simplicity of Nature and the Complexity of the World

Few ideas in the history of science are as nebulous as that of “nature,” and few historical periods were more preoccupied with nature than the eighteenth century. Robert Boyle famously identified eight popular meanings of the term and rejected most of them as misleading or religiously dubious.⁹¹ Sixty years later, d’Alembert was still noting that some dictionaries held as many as fourteen entries for this term.⁹² In Castel’s lifetime, “nature” designated, among other things, the machine of the universe (what Descartes preferred to call the “world”), the sum and arrangement of all beings (God and all his creation, *natura naturans* and *natura naturata*), the specific essence of these beings, the usual chain or course of secondary causes, the occult causes of things, the laws of motions, and the temperament of individuals or animals. The definition extended yet further into moral and political philosophy (“state of nature”), as well as into aesthetics (*belle nature*). ‘Natural’ was also used in contradistinction to “artificial” and “miraculous.”⁹³ As is to be expected, Castel’s use of the term reflected this polysemy.

⁹¹ Robert Boyle, *Free Inquiry on the Vulgarly Received Notion of Nature*, ed. Edward B. Dacis and Michael Hunter (Cambridge: Cambridge University Press, 1996). In the Christian world, *Natura* had for a long time stood as a problematic intermediary between the Creator and his Creation. Formerly worshipped as a pagan Goddess, she had survived in some regions of early modern Europe among the peasantry, which made Boyle anxious to propose his own definition of nature, one less likely to lead Christians astray.

⁹² Jean le Rond d’Alembert, “Nature,” *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d’Alembert (University of Chicago: ARTFL Encyclopédie Project, 2013), accessed December 2015, <http://encyclopedie.uchicago.edu/>.

⁹³ Antoine Furetière, *Dictionnaire Universel*, s.v. “Nature” (La Haye: Leers, 1690). See also Eh-rard, *L’idée de nature*, 66-71.

When prompted to define his terms, however, Castel favored one meaning in particular.⁹⁴ Convinced that nature “properly is the expression of [God’s] wisdom,” Castel assumed, like many predecessors and contemporaries, that it was both simple in its principles and in its means of operation.⁹⁵ Scholastic maxims such as *entia non sunt multiplicanda praeter necessitatem* — which Castel rendered throughout his works in variations of “we must not multiply systems [beings] needlessly” — and the *lex parsimoniae naturae* [the principle of the economy of nature] — better known as Ockham’s razor — expressed the widespread ontological and methodological conviction that simplicity was God’s preferred mode of action, and thus the preferable mode of natural philosophical explanation.⁹⁶ Although no empirical evidence supported or contradicted these metaphysical assumptions, students of nature accepted them on religious and aesthetic grounds, as they still do to this day.

Castel, however, was willing to push the idea of simplicity to its limit. “Nothing is as simple as nature,” he wrote on one occasion:

⁹⁴ Some broad currents of thought can be identified in the first half of the eighteenth-century, and Castel situated with respect to them. The idea of nature stretched over a spectrum of infinite gradation. At one extremity stood the expression of God’s infinite wisdom — order, simplicity, stability, the external finality of the clock maintaining its regular course; at the other, the expression of His limitless creative powers — fertility, diversity, change, the internal finality of the animal striving to live and multiply. Stretched a little further on both sides, and God might indeed fall off the spectrum, leaving a self-sufficient nature to run its course, either as a perpetual machine or as an a living animal. In practice, eighteenth century thinkers tended to move back and forth along the spectrum, and to settle somewhere in the middle. Ehrard, in fact, found the first half of the eighteenth century particularly prone to seeking an equilibrium between these views, whether in the form of reconciliation attempts or in the serene denial of the tension. Ehrard, *L’idée de nature*, 151.

⁹⁵ Castel, *Esprit, saillies et singularités*, 5.

⁹⁶ This *specific* formulation “*entia non sunt multiplicanda praeter necessitatem*” originated in the logic textbook of the Irish scholastic theologian John Ponce (1603-1661), but it was found, in various forms in medieval authors. It is usually attributed to the Franciscan philosopher and theologian William of Ockham (c. 1287-1347). According to the *lex parsimoniae naturae* it is methodologically preferable to adopt the simplest explanation when attempting to determine the cause of a natural phenomenon. It was reformulated most famously in Newton’s *Principia*: “We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances. Therefore, to the same natural effects we must, so far as possible, assign the same causes” (first of his “Rules of Reasoning in Philosophy”).

It is like a center, from which radiates an infinity of all kinds of lines, or phenomena, that make it perceptible to us. To understand nature, it is necessary to find the intersection, or the prime and unique point of concurrence of all these rays; to explain only a detached phenomena is nothing. It is here that the maxim, *all or nothing*, applies: for nature is indivisible in its principles, however complex it may appear in its effects.⁹⁷

For Castel, simplicity amounted to unity, or better yet, to a kind of geometrical singularity.

This definition of nature, which has a Leibnizian flavor to it, followed from his understanding of God as the infinitely wise originator of the world.⁹⁸ It also drew from the dictates of mechanical philosophy, according to which all natural phenomena should be explained by appealing to material particles (found in a finite number of shapes and sizes) and motion alone. The measure of wisdom, from his perspective, was one's capacity and willingness to create complex, yet regular and lasting machines with the smallest number of parts possible. With a few wheels and springs, a wise clockmaker could assemble a timekeeping device requiring minimal external assistance or repair. God, being infinitely wiser than the wisest clockmaker, likewise only needed to create a finite amount of matter and imprint upon it a single principle of motion for the world to unfold, that is, to radiate from its primordial starting point.

Some important divergences of interpretation notwithstanding, scholastics and mechanical philosophers agreed that nature, on some level, is simple.⁹⁹ The notion was

⁹⁷ Castel, "Conjectures sur la nature des corps visqueux," 226, trans. by Healy, "Mechanistic Science," 122.

⁹⁸ Castel was heavily influenced by the Leibniz-Clark debate, which he reviewed and criticized in the *Mémoires de Trévoux* of June and July 1721. For remarks on this subject, see Carlo Borghero, *Les cartésiens face à Newton: Philosophie, science et religion dans la première moitié du XVIIIe siècle*, trans. Tomaso Berni Canani (Turnhout: Brepols, 2011), 93-101, esp. 98.

⁹⁹ Healy's remarks on this subject are insightful: "The unity of nature, for the scholastics, had been a metaphysical proposition. It encouraged science to look primarily for linkages between a natural things and the universal, divine principle informing and regulating its existence. It emphasized study of a thing essentially in its reference to God and to man and it de-emphasized — without, of course, denying — study of things as they were related to other things in a more or less autonomous nature. Descartes and his

also essential to the philosophy of the Jesuit encyclopedist and polymath Athanasius Kircher, one of Castel's main sources of inspiration. It was Kircher, Castel reckoned, who first had the sublime idea of a universal system where matter and spirits unite to form a universal harmony. In truth, Castel's metaphysical assumptions about nature were influenced by all these traditions. It is at their point of convergence, where God's infinite wisdom met Descartes's reductionist agenda, Newton's universal gravitation, and Kircher's vision of harmony, that Castel achieved originality.

Indeed, by cornering himself with an absurdly restrictive concept of nature, he discovered a way out. I use the word "absurdly" deliberately, to emphasize that Castel used his definition of nature as a *reductio ad absurdum*. That nature was radically simple was for him a metaphysical certainty. Yet it was just as manifest that the world constantly belied this ideal state. Philosophers had yet to provide a satisfying explanation for this contradiction. Holding on to the principle of unity in the face of empirical evidence of plurality made one vulnerable to powerful objections. For instance, if one believed that matter was, from the beginning of time, under the sole and determining influence of a universal principle of motion, and that elementary particles, by virtue of this principle, were distributed across the universe according to their properties, how could one explain that the world was full of compounds? How could one account for irregularities, for the

fellow thinkers secularized this notion, and stressed a real and natural unity of physical things considered quite apart from metaphysical compulsions or tendencies. This at once simplified, re-oriented, and gave a new impetus to scientific thought. It also encouraged followers — like Castel, who accused even Descartes as having needlessly multiplied causes — to carry the process of simplification even farther" ("Mechanistic Science," 123). Newton's case is more complicated. On the one hand, he did not consider himself a mechanical philosopher, and when pushed to speculate about the physical nature of universal gravitation, instead of a material medium he proposed the existence of a spiritual aether filled with God's active principles and responsible for renewing motion and holding the universe together (as his letters to Bentley testify). On the other hand, early eighteenth-century French interpretations of Newton folded his physico-mathematical description of universal gravitation within Cartesianian vortical physics, and as such, arguably made their interpretation of Newtonianism consistent with mechanical philosophy.

facts that mountains rose above the sea (earth above water), and that air was released from the bowels of the earth? How could we account for minerals, for plants, for animal life? Left on its own, the simple action of nature would lead to a stillness or chaos. Descartes, Newton, and their successors all had to reckon with this problem, which arose from the limitation of the mechanical worldview.

In the early eighteenth century, Fontenelle was perhaps the most eloquent exponent of the tension between mechanical philosophy, which *sought* simple laws, and the irreducible bountifulness of the natural world, which *begged* for different laws.¹⁰⁰ Castel, who began his Parisian career under Fontenelle's protection, envisioned his philosophy as a solution to this problem. Cartesians, he felt, had released some of this tension by hypothesizing corpuscles whose irregular shapes ensured that a general, uniform movement created by God would be inflected, resulting in a variety of effects. Newtonians, for their part, appealed both to God's *manus emendatrix* (the adjusting hand of God) to compensate for the loss of motion in the void and prevent the disruption of the celestial clockwork, and to aether in order to produce effects unaccounted for by gravitation. Castel was not convinced by these solutions. He believed that the principle of simplicity ought to make philosophers pause before arbitrarily formulating *ad hoc* hypotheses about the insensible world (*pace* Descartes). He also objected that God, on account of His infinite wisdom, could not conceivably have created a universe in constant need of adjustments (*pace* Newton). Instead of "multiplying systems" with Cartesians; instead of imagining, with Newton, that God must actively hold the parts of the world together; instead of adopting a more flexible definition of nature, as Fontenelle would have proposed, it oc-

¹⁰⁰ Leonard M. Marsak, "Bernard de Fontenelle: The Idea of Science in the French Enlightenment." *Transactions of the American Philosophical Society, New Series* 49, no. 7 (1759): 1-64.

curred to Castel that something might be wrong in the natural philosophers' conception of their object of study. As seen in the previous section, his solution was to redefine the boundaries between nature, artifice, and miracle so that the irreducible complexity of the world would no longer be confused with the simplicity of natural principles. Concretely, this meant that *physiciens* in the strict sense would be in possession of an object of study they could reduce, while natural philosophy broadly conceived would double in scope to include free causes.

Faire la pluie et le beau temps: *The Spirit of the "Lettre"*

The "Lettre à M. C." crystallized Castel's inchoate ideas about the impact of free will on the mechanism of nature.¹⁰¹ The letter opens by referencing a previous exchange, in which Castel had baffled a certain Monsieur C. with the claim that "there are few, perhaps no truly natural events in nature, in particular on the surface of the earth [where] the actions and the oddities of men throw a great veil upon the proper action of nature." Did Castel "seriously believe that men make the rain fall and the sun to shine?" asked the interlocutor.¹⁰² The answer was yes: the human spirit could and did, in fact, produce changes in the course of nature that nature itself could not effect — rainclouds and fair weather included.

¹⁰¹ The identity of this M. C. is unknown. For all we know, it could even be a fictive exchange with himself, a strategy he employed on occasion.

¹⁰² Castel, "Lettre à M. C.," 2074: "[...]dans la nature, & en particulier dans l'étenduë de la terre, il y a peu, & peut être point d'événement bien naturels, & que les actions & les bizarreries des hommes jettent un grand voile sur l'action propre de la nature, &c. Et là-dessus vous me demandez, si je crois bien sérieusement que les hommes fassent la pluye & le beau tems? &c." The original is italicized, signaling that Castel was citing or dramatizing a previous letter exchange. A more literal translation would read "making rain and fair weather."

In French, “*faire la pluie et le beau temps*” is a proverb meaning “to have all things at one’s command by means of one’s credit or influence.”¹⁰³ A better English rendering might be “ruling the roost,” “calling the shots,” or “being all-powerful,” but this shifts the emphasis away from the astrological and meteorological connotations of the expression toward the (admittedly not unrelated) sphere of politics or domestic economy.¹⁰⁴ Faithful in spirit, the translation betrays the letter; and here as elsewhere, the letter mattered to Castel. Common sayings, he thought, were receptacles of wisdom that could be analyzed to reveal deeper truths about the world. Much like poetic seeds, one could use them as rhetorical *loci* to explore ideas and make discoveries. “*Faire la pluie et le beau temps*,” would serve such a purpose throughout the Jesuit’s work. This particular proverb expressed man’s true power upon nature, though admittedly it did not demonstrate that this power exists. The “Lettre à M. C.” was not the place to provide such a demonstration, but it outlined the project and surveyed a number of proofs subsequently integrated into the *Traité de la pesanteur*.

Evidence of Castel’s theory of the action of man upon nature could be taken from history. Agriculture, he observed with his “Conjecture sur la raison qu’on laboure les terres” in mind, enriched the earth with a variety of plants, fruits and vegetables that would not exist otherwise. Through breeding, humans perpetuated a variety of animals

¹⁰³ Pierre-Marie Quitard, *Dictionnaire étymologique, historique et anecdotique des proverbes et des locutions proverbiales de la langue française. En rapport avec des proverbes et des locutions proverbiales des autres langues* (Paris: P. Bertrand, 1842), 602.

¹⁰⁴ The precise origin of the proverb is buried in time. In his *Essai sur les mœurs*, Voltaire surmises that it came from the popular misconception that astrologers were capable of commanding the weather rather than merely attempting to predict it. Although his claim is unsupported, it is true that in the early modern era, it was common for rulers and commoners alike to consult an astrologer to determine what day would be most propitious for important undertakings, and more generally, for agricultural purposes. While this was no longer the case in Castel’s time in France, horoscopes had indeed wielded considerable political influence in the previous centuries. Voltaire is cited in Noël Laurent Pissot, *Histoire des proverbes rédigée par le Traducteur de la Galerie Anglaise* [N. L. P.] (Paris: Durosiers, 1803), 66.

likewise incapable of surviving in the wilderness. To sustain farming and industry, past and present societies diverted and divided the course of rivers, drained marshes, dug harbors, and built canals. They had also opened mines and quarries in search of precious ore, gems, and building stones. The ancients — the Romans in particular — had mastered the art of shaping landscapes according to their needs. The moderns had little to envy their forbears: did the Canal du Midi and the fountains of Versailles not testify to their superior skills and ingenuity?

Importantly, Castel believed that these works of engineering had altered the local climate. The vast reservoirs of the Canal du Midi, for instance, seemed to have given rise to unprecedented storms and fogs in Languedoc; the blue sky of Versailles, for its part, was now cloudy. Similar phenomena had been observed elsewhere and in the distant past. On the premise that the earth was a closed system, made by God in number, weight and measure (another favorite saying of his from *Wisdom* 11:21), Castel also deduced that what was gained in a given place had to be taken away from another. Cases where no impact on local climate had been reported must have had an impact elsewhere on the globe. Ripples along the web of causation were inevitable.¹⁰⁵ The same reasoning applied for meteorological events.

Suggesting that man could exert an important impact upon his environment was not entirely new. It had been a conviction of Christian humanists since the Renaissance and one of the premises of the Baconian program in the seventeenth century. The influential geographer Bernhardus Varenius (1622-1650/51), whom Castel cited selectively, had even raised the possibility that most rivers (i.e., all those who were not there at Creation)

¹⁰⁵ Castel, "Lettre à M. C.," 2076-2078.

might in fact follow courses originally drawn and redrawn by men.¹⁰⁶ Closer to Castel were recent theories ascribing national characters and historical events to climatological influences or local impurities in the air, in conjunction with moral causes distinct from these physical influences.¹⁰⁷ These theories, in effect, proposed that mankind is subjected to deterministic natural causes while leaving some room to individual agency. As such, they provided a foil for Castel to expound his own Christian humanist conviction that man is capable, up to a point, of bending nature to his will.

Castel went further than his predecessors. Mankind was not merely a factor in the complex web of causation responsible for rain and sunshine; instead, human activity was ultimately the cause — efficient and occasional — of all meteorological phenomena (that is, all corruption and generation between the earth’s surface and the moon). The corollary, though only alluded to, was just as daring: because this activity originated in acts of free will rather than being determined by the laws of nature, Castel surmised that, in principle, men were capable of “calling the shots,” just as Adam had reportedly been able to do before the Fall.¹⁰⁸

Man’s alleged power over the weather barely scratched the surface of the issue. Castel believed, in addition, that God had entrusted mankind with a deeper and more fundamental role. By upsetting the natural equilibrium toward which the world tends, men

¹⁰⁶ Varenius Bernhardus, *Geographia generalis: In qua affectiones generales Telluris explicantur* (Amsterdam: 1671), ch. 16, prop. 8, 239-240. Not cited in this letter, but appears in his “Lettre sur la politique” and the first *Lettre philosophique pour rassurer l’univers*.

¹⁰⁷ These tended to maintain that government and mores either did or ought to conform to a particular climate of environment, which in effect is the reverse thesis. The beginning of the fifth book of Jean Bodin, *Les six livres de la république* (Paris: Fayard, 1986 [1576]) expressed such idea. More recent echoes included passages from the abbé Jean-Baptiste Dubos, *Réflexions critiques sur la poésie et sur la peinture*, 4th ed., 3 vol. (Paris: Pierre-Jean Mariette, 1740 [1719]), 148-153, 237-312. Montesquieu would famously develop some of these ideas in the third part of his *Esprit des lois*, esp. Books 14-17.

¹⁰⁸ Castel, “Lettre à M. C.,” 2095.

insured no less than the perpetuation of change, movement, and diversity of life on earth.

From these two activities alone, he conjectured, there results

all variety of mixed bodies, plants, animals, minerals; all kinds of meteors, fogs, winds, clouds, rains, snows, hails, flashes (*éclairs*), thunders, lightnings (*foudres*); and [...], all the various main arrangements and diverse mechanisms of the earth, both internal and external: mountains, plains, seas and continents, rivers and fountains; in a word, the organization and circulation of the whole globe.¹⁰⁹

Without claiming that human beings were *consciously* and *directly* causing all these phenomena, he believed that they, and only they, made them possible (with exception made for God, obviously, who had started it all and could end it all with a single command). Castel's idea of the action of man was more radical than that of any contemporary. Indeed, one is hard-pressed to find antecedents, except perhaps in the theurgic visions of such men as Cornelius Agrippa, the sixteenth-century magus who believed that the magical arts might lead to a kind of apotheosis, and by implication to mastery of nature. From a twenty-first century standpoint, Castel's claims also resonate with current ecological and environmental concerns. Yet, one must also recognize that Castel would have vehemently repudiated the first comparison — he was certainly no magus! — and been thoroughly perplexed by the second. For whereas climate change anxieties paint our impact on nature in a negative light and (should) urge us to reduce our ecological footprint, he thought of man's activities on earth as primarily restorative, necessary, and divinely sanctioned. Thus, what was arguably his most innovative idea was rooted in some of the most traditional religious ones.

¹⁰⁹ Ibid., 2080-2081.

Nowhere is the gap between our and Castel's conception of nature more obvious than in his discussions of life. Metaphysically speaking, the Jesuit argued, the perpetuation of our species belonged to the category of free actions and of artifice. Human procreation was not determined by natural laws (unlike the downward movement of a stone, for instance), but by acts of volition. The "occasional" cause of human reproduction — that which occasioned coitus to take place — was the same which made it possible for someone to create artificial devices: "Men are just as free to multiply clocks as they are to multiply themselves."¹¹⁰ Plants and animals, though they may not reproduce by acts of their own free will, ultimately do so thanks to humans when they occasion the circumstances that make their reproduction possible — for instance, by tilling the earth and making the environment propitious for the germination of seeds.

Life, then, was not strictly speaking "natural" for Castel. Humans ultimately must intervene in the course of nature to sustain themselves and other species; they must literally bend this course — induce violent, artificial motion into it — lest its downward pull drive all things to their death and quite literally bring them down into the earth.

It is obvious [...] that we are not part of nature's plans; that by herself, she tends directly at our destruction; that it is only by accident, against her intention, and by destroying the food that we ingest, that she cooperates with us to nourish us and to prolong our life, and that our death is more often her work than our birth, since it is only on account of a free, foreign and accidental determination that she makes us come to life and live, while she needs only herself to make us die.¹¹¹

¹¹⁰ Ibid., 2079. This reminds one of Diderot's playful remark about self-reproducing harpischords in his "Suite de l'entretien entre d'Alembert et Diderot," though the latter represents a change of paradigm, where matter is now believed capable of sentience and reproduction. Denis Diderot, *Œuvres complètes*, ed. Herbert Dieckmann et al., vol. 17 (Paris: Hermann, 1975), 103.

¹¹¹ Castel, "Lettre à M. C.," 2079.

Castel admitted that the action of nature played an essential role in the perpetuation of life: it was its primary weight, just like the weight of a mechanical clock. But nature “co-operated” reluctantly, as if ensnared or channeled away from its *terminus ad quem* by a superior power. The modern reader might find this odd. It is difficult to imagine, from our perspective, the generation of life as something distinct from nature. Whether we speak of nature in general — minerals, plants, and animals — or in the narrow, more technical sense of the set of laws governing the universe, we tend to regard life as an emergent property of the natural world. But for Castel, who held a mechanical understanding of nature, these modern allegations would have sounded dangerously close to pagan or Renaissance animism — the idea that the world, and perhaps matter itself, are imbued with life, sentience, and even thought, rather than being inherently passive, yet moved by spiritual causes.

Mixture, Rupture, Scripture

The “Lettre à M. C.” provides a point of entry into Castel’s ‘research program’ on the role of spiritual causes in the universe by raising at least two questions: how exactly, and to what end, do free spirits affect the natural world? Castel answers that the action of men upon nature can be reduced to two types — the production of *mixtures* and the interruption of natural *equilibrium* — and that the proper exercise of freedom in the otherwise determinate mechanism of the world is meant by God as a counterweight to nature, and thus as a means of making its movement perpetual.

Unlike nature, whose action Castel considered to be, in the final analysis, a principle of separation affecting all bodies down to the four elements, human beings constant-

ly create mixtures (*mélanges*).¹¹² Some, such as chemists, dyers, cooks, and brewers, do so deliberately. Most, however, do so unwittingly, unaware that their labor actually consists in aggregating all sorts of substances (farmers tilling and irrigating their fields, house-builders mixing stone, wood and iron), or that the products and by-products of their daily activities also are mixtures (notably natural and artificial wastes). Castel's reasoning applied to "all men who work, eat, digest, excrete, perspire — who live, in a word, break, disperse, combine, mix air, water and earth [together], and cause (*déterminent*) nature to make mixtures and more regular combinations."¹¹³ More loftily — and with a touch of self-derision — the Jesuit includes himself among mixture-makers by pointing out that "a visionary Author like [him], who perhaps overloads paper with his rêveries," makes a trade out of blending ink, paper, and ideas.¹¹⁴ The bottom line is that there is no such thing, in Castel's system, as a purely natural mixture.

Castel's notion of mixture encompassed a great variety of processes and substances ranging from the microscopic incorporation of food particles to the formation of subterranean caverns filled with air and water. The earth itself, from his viewpoint, consists in a mixture the heterogenous parts, which are themselves mixtures of elementary particles. This broad conception of mixture blurred the Aristotelian distinction between *mixtio* and *compositio*. For Aristotle's medieval and early modern followers, *mixtio* de-

¹¹² Indeed, while on a large scale the action of *pesanteur* might lead to the union of parts to their wholes, it is ultimately responsible for the sorting out of particles (parts) into discrete groups (wholes). Castel's matter theory was influenced by Aristotle, *On Generation and Corruption*, I, 10.

¹¹³ Castel, "Lettre à M. C.," 2082.

¹¹⁴ *Ibid.*, 2082: "[...] un visionnaire Auteur qui comme moi peut-être surcharge le papier de ses rêveries." The term visionary, denoting someone who has or claims to have visions (i.e., a crazy person) is here intended humourously as self-derision.

noted a combination of elements resulting in the production of a new substantial form.¹¹⁵ For instance, a plant, although originally made up of a certain proportion of earth, water, air and fire, actually possesses a specific essence that supersedes the essence of its elementary constituents. A mixture, in that sense, is more than the sum of its parts. *Compositio*, in contrast, referred to superficial compounds or aggregates whose parts were merely juxtaposed, i.e., mingled without change.¹¹⁶ The exhalations of the earth and the various transient “meteors” they produced in the sublunary realm fell into this category.

Castel reduced the qualitative distinction between *mixtio* and *compositio* to a matter of degree. Not unlike his Jesuit predecessor Niccolò Cabeo (1586–1650), he conceived of generation and corruption as the production and dissolution of mixtures, that is, as a process of union and separation of parts. Some mixtures were more perfect than others in the sense that their union was more subtle and more persistent, yet all remained susceptible to the analytic and sorting powers of nature.¹¹⁷ Given enough time, a chemical solution evaporates, precipitates, and “combobulates” into its various components; given enough time, a cavern collapses, forcing the air and water it contained toward the

¹¹⁵ The scholastic phrase to express this process was “combination of contraries with alteration.” See Aristotle, *Generation and Corruption* I, 10.

¹¹⁶ Meteorological treatises of the Renaissance and early modern period made use of this distinction to explain why the knowledge they sought about sublunary phenomena could not be demonstrative. Demonstrative knowledge usually required an exhaustive discussion of four causes. Due to their more or less fleeting nature, meteors did not lend themselves well to a discussion of their formal and final causes. As heterogenous and transitory compounds, they could best be explained by appealing to their material and efficient causes. Martin, *Renaissance Meteorology*, 26-27.

¹¹⁷ See Martin, “With Aristotelians Like These, Who Needs Anti-Aristotelians: Chemical Corpuscular Matter Theory in Niccolò Cabeo’s Meteorology,” *Early Science and Medicine* 11:2 (2006): 135-161. Martin argues that Cabeo’s *physica* rejected the notion of substantial form in favor of a chemical understanding of matter, which in many ways resembles Castel. His understanding of the purview of physics, his explanation for why mathematical equations fail to explain phenomena, and his use of chemical ideas in the elaboration of his physics all remind one of Castel’s own work (though they differed in substantial ways, notably in Cabeo rejection of mechanical philosophy). The influence of Cabeo on Castel would deserve further inquiry, and more generally, the connection between their conception of *physica* and matter theory. More broadly, Castel’s natural philosophy belonged to a Jesuit tradition of physical writings including Cabeo’s but also Kircher’s, Schott’s, Casati’s, etc.

surface, where they naturally belong; given enough time, an abandoned house turns into a pile of rubble. The example of the house illustrates how *pesanteur* pulls matter apart, but also how human artificial action (the building of the house in the first place) can force nature to produce, against its inclination, mixtures of its own (the pile of rubble being, ironically, a more perfect mixture than the original house). Castel accounted for the production of rain by appealing to the human production of mixtures and the ripple effects on the course of nature. One of “our main occupation[s],” Castel explains, “is to disperse and spread out the water naturally gathered in rivers all over the earth.”¹¹⁸ By dispersing water for irrigation purposes, humans make it easier for the sun to warm it up and rarefy it. The sun’s heat, however, would not suffice to mechanically pull watery particles out of their proper place and into the atmosphere (i.e., the water might dilate, but it would not mix with the air). For this, water needs to be combined with heavier, earthy particles, so as to be pushed out of its natural place by the separation action of *pesanteur*.¹¹⁹ The mechanism he imagined was quite straightforward and already implicit in his early conjectures. Assuming that the world is a *plenum*, the downward movement of heavier particles (dust, for instance) would push lighter particles (water) in the opposite direction, which offers the least resistance. In a rarefied state, some of these repulsed watery particles could, in turn, mix with the air to form vapors and clouds, and eventually be forced, by the same process, to return to their proper place in the form of rain. A purely homogeneous substance would not produce these effects because the action of *pesanteur* would be

¹¹⁸ Castel, “Lettre à M. C.,” 2083: “[N]otre principale occupation est de disperser, d’étendre sur la terre l’eau qui est naturellement ramassée dans les rivières.”

¹¹⁹ This is what takes place, Castel argues, when the addition of substance to an existing solution results in a sudden precipitate, or in an exhalation. He also refers to marshes as an examples of this process. Indeed, the turbid waters of a marsh are also the smelliest, which suggests that the mixture releases vapors.

distributed equally on all its parts. Without the upstream intervention of man, there would be no mixture, no evaporation, and, therefore, no rain.¹²⁰

The main by-product of human action — perspiration — could also account for rainfall. Castel observed that rainy periods of the year seemed to correspond to the most labor-intensive part of the agrarian work cycle (the tilling in the spring and harvesting in the fall). He also saw a connection between urban activities and the accumulation of vapors (smoke, haze, smells). Castel argued that sweat, by mixing with the air, could, when found in sufficient amount, condense to form rain under the effect of *pesanteur*. He supported his conjecture with a speculative estimate of the amount of rain he believed fell annually over France, and he found it inferior to his (just as conjectural) estimate of the amount of perspiration produced by the labor of his hardworking countrymen. Whether human perspiration sufficed to account for all precipitation in the world was something for men with more patience to calculate. He believed it sufficed for him to show the *possibility* of his system to make it a worthwhile discovery.¹²¹ Castel had an *esprit de système* rather than an *esprit de détails*.

Arithmetic of this kind was common in the eighteenth century. Indeed, similar attempts were made to calculate the total weight of the earth or the total population of the world.¹²² Interestingly, it seems that Castel vastly overestimated the latter, making his

¹²⁰ Castel, “Lettre à M. C.,” 2084-2085.

¹²¹ Ibid., 2085.

¹²² Several examples of this are provided in Gaston Bachelard, *La formation de l'esprit scientifique* (Paris: J. Vrin, 1938), 251-283. Bachelard treats this kind of arithmetic as an “epistemological obstacle” to scientific progress, but it contains some useful citations. One in particular is directly relevant to the present discussion: “Ainsi on peut lire dans l'*Encyclopédie* à l'article *Air* ces incroyables précisions: ‘Il est démontré que moins de 3.000 hommes placés dans l'étendue d'un arpent de terre, y formeraient de leur transpiration dans 34 jours une atmosphère d'environ 71 pieds de hauteur, laquelle n'étant point dissipée par les vents, deviendrait pestilentielle en un moment’ (257). This citation fits within the mid-eighteenth

theory seem all the more plausible from his standpoint.¹²³ Moreover, this example is one of many lending support to the impact of man's labor on the production of vapors, not all of which had to do with the circulation of water:

Did you notice [...] that several days after a land, a field has been tilled in October, there arises from it every morning, with sunrise, such a flow of fumes that sometimes an entire valley, a whole countryside is covered with fog? For my part, I have noticed this a long time ago, when I was not even thinking about this system yet.¹²⁴

These vapors were released thanks to the mixture of earth and air induced by the plough because ploughing opened the pores of the earth and facilitated the release of subterranean exhalations. Last but not least, Castel's theory had theological implications: it turned the Biblical curse of Genesis — men shall have to sweat in order to ripen the fruit of the earth — into an essential part of the mechanism of nature.

The free action of man also affects the earth by interrupting the natural equilibrium. Castel conceived of the equilibrium of nature as an ideal state of rest between bodies — ideal in the sense that it was never observed in reality. He believed that such a state was the *terminus ad quem* of nature and the logical consequence of the dissociating action of *pesanteur*. By treating all bodies as mixtures of fire, earth, water and air, and by assuming, by virtue of the simplicity of nature, that their union, no matter how perfect,

century preoccupation with the impurities of the air on the human body, but it also gives a sense of what Castel imagined billions of humans over six thousand years would be able to achieve.

¹²³ Castel, *Traité de la pesanteur* I, 523: “Or combien de millions d’hommes n’y a-t-il pas sur la Terre? il y en a bien tout au moins un million de million [...]” Castel proposes this hyperbolic number in a calculation exercise aiming to determine the quantity of mixture that humankind must produce in order to counter the “unmixing” action of nature upon the earth. He concludes that human activity is potentially and actually far superior to the minimum required for the earth not to deperish (he compares the planet to a giant animal that requires feeding to survive).

¹²⁴ Castel, “Lettre à M. C.,” 2087: “Avez vous remarqué que pendant plusieurs jours après qu’on a bêché une terre, un champ, au mois d’Octobre, il en sort tous les matins, à l’arrivée du Soleil, de si grands flots de fumées, que souvent tout un vallon, toute une campagne en est plongée dans les brouillards? Pour moi, j’ai remarqué il y a long-tems, lors même que je ne pensois point au système.”

was not immune to the sorting and separating action of *pesanteur*, Castel maintained that the world should gradually arrange itself according to the specific weight of its elements and, thus, eventually turn into a set of nested, concentric, and homogeneous elementary spheres. This process, unless counteracted, would soon deface God's beautiful arrangement of the universe, turning it into a static "chaos" resembling the schematized representation of the Aristotelian system.¹²⁵

Men served as the main counterweight to this natural tendency. Their action was a principle of liberty — a different kind of chaos — preventing absolute rest. By altering the weight distribution of matter on the surface (by displacing things, by "peeling" the skin of the earth, by mining it and transferring its heaviest ore from one site to others), they effectively relieved certain pillars of the earth from their burden and increased the pressure on others (Castel thought of the subterranean world as a vast structure of caverns supported by "columns" of stone). In the closed system of the earth he had in mind, the redistribution of weight led certain regions to collapse and others to rise. This process, in turn, opened passages for the circulation of air, water and fire within the core of the earth, thus setting the conditions right for terrestrial circulation. In Castel's words:

1° By overloading certain areas and unloading other areas, we force the air, water, and fire to return (*se réfléchir*) from the center toward the circumference [of the globe], and then 2° by scratching, so to speak, by dividing and softening almost everywhere the surface of the earth, we make it possible for all that to perspire, and to surge in the shape of mountains, volcanoes, fountains, winds, vapors and exhalations.¹²⁶

¹²⁵ See Aristotle, *Generation and Corruption* II, 10.

¹²⁶ Castel, "Lettre à M. C.," 2090: "1° En surchargeant certains endroits, déchargeant certains autres endroits, nous forçons l'air, l'eau, le feu, à se réfléchir du centre, vers la circonférence, & puis 2°. En gratant en quelque sorte, en divisant, en attendrissant la surface extérieure de la terre presque par tout, nous donnons lieu à tout ça de transpirer, & de jaillir en montagnes, en volcans, en fontaines, en vents, en vapeurs, en exhalaisons."

The free action of men upon nature thus assumed global proportions, and was both positive and necessary: “[...] it is our interruption of the equilibrium of nature that we can call the great spring of its main mechanism.”¹²⁷ For Castel, the earth’s dynamic state of change ensured by the activity of men is what made it beautiful, bountiful, and persistently alive; without this “spring,” God’s clockwork would stop as soon as its main weight had reached its destination.

While God could, in principle, serve as this “spring,” Castel believed such work was below His dignity. As mentioned above, he rejected Newton’s view of God’s direct involvement in the system of universal gravitation precisely for the reason that it suggested that He was shortsighted rather than supremely wise. Trained as a Thomist and a mechanist, Castel believed that the physical world should be explained, as much as possible, by means of secondary causes. Removing God from the mechanism of the world, in the early eighteenth century, was tricky. The Cartesian-Spinozist “error” of arguing a self-sustaining universe into existence was constantly on Castel’s mind. Showing that the world is a perfectly designed chain of causes and effects was the main staple of natural theologians, but the risk was to make God so distant (or so immanent) that He was either no longer Christian or no longer necessary. Jesuit apologetics required the acceptance of both miracles and “physical proofs” of the existence and attributes of God. Striking a middle course between two reefs, Castel sailed thus:

[In my system,] I first draw one of the strongest physical demonstrations of the existence of a God superior to nature, who disturbed the equilibrium from the beginning to enrich the earth with plants and animals; this first action was undeniably a miracle; but the perpetuation of this interruption

¹²⁷ Ibid., 2087-2088.

[of the action of nature], and the persistence (*durée*) of plants and animals — are these miraculous? No, yet they are not purely natural either, since nature is but a blind and mechanical weight, which always pulls towards, and sooner or later arrives at, its endpoint.¹²⁸

The first miracle in question, Castel explains, could not originate in man, nor could it originate, by definition, in nature. Mixtures and the disequilibrium of nature were not originally caused by human activity, but by God.¹²⁹ But the constant “miracle” of the world — its irregularity, diversity and intricate beauty — only required the intervention of artificial causes. God had not created a defective world mechanism — a clockwork inherently flawed requiring interventions to endure — nor was the world an uncreated perpetual machine. Instead, Castel argued that God’s creation was so sophisticated that *freedom itself* played a role in its mechanism, counteracting natural friction, so to speak, to the point of making the machine perpetual (for as long as God allowed it to be).¹³⁰ By locating this freedom in human beings, Castel avoided both unnecessary supernaturalism and dangerous materialism. Men were literally spirits in the machine, being both spiritual causes, free from the bounds of natural causality, yet capable, as embodied secondary causes, of inserting themselves within the course of nature.

¹²⁸ Ibid., 2093: “je tire d’abord une des plus fortes démonstrations Physiques de l’existence d’un Dieu supérieur à la nature, qui a dérangé cet équilibre dès le commencement, pour enrichir la terre de plantes, & d’animaux; cette première action étoit un miracle sans contredit; mais la perpétuité de cette interruption, & la durée de ces plantes, & de ces animaux, est-elle un miracle? Non, elle n’est pas non plus purement naturelle, puisque la nature n’est qu’un poids mécanique, & aveugle, qui tire toujours en embas, & arrive tôt ou tard à son terme.”

¹²⁹ This is necessarily the case, since humans are themselves elementary mixtures and their action would presumably not be strong enough to produce the globe in its current state of confusion. God, as is recounted in Genesis I, first had to create the plants and the animals with their seeds. The act of creation was miraculous since *pesanteur* on its own would not generate these forms. Then, God created man to tend to his garden and menagerie. Their task was not to create more plants and animals to make it possible for them to perpetuate themselves, and assume the role of stewards of God’s garden. Castel, “Lettre à M. C.,” 2091: “[...] c’est Dieu qui a d’abord produit les plantes, qui se perpétuent depuis ce tems-là par des semences, mais qui ne se perpétuent qu’autant que les hommes en occasionnent la perpétuité.”

¹³⁰ For Castel’s early views on perpetual motion, see “[Review of Hermann’s] *Exercitationum Francofurtensium*,” *Mémoires de Trévoux* (Nov. 1721): 1980 ff.

Lest some might think his system granted too much power to men and not enough to God, Castel insisted that men, though indeed more powerful than they suspect, do not wield divine power: insofar as the physical world is concerned, their action, though far-reaching and essential to God's plan, is merely one of conservation of movement. God gave his "spinning top" an initial push; men, since then, only keep it spinning.

This contribution needed not even be conscious — even if Castel thought it would be preferable if it were.¹³¹ Men's lack of wisdom, a consequence of the Fall, did not change the fact that they had power over nature. "[M]odern philosophers seem to me rather far from the bottom of things," Castel writes,

when by mockery more than by reasoning, they limit the powers and the dignity of men to almost nothing, while Scripture favors rather openly the system that I propose to you. For it is [Scripture] that teaches us that Man was made in the image of God, was constituted on earth as His lieutenant to preside over its entire mechanism, and to draw out this variety of plants and animals it is susceptible of, in spite of its infinite simplicity [...] *homo non erat qui operaretur terram*.¹³²

This volley was addressed to Augustinians, Jansenists, Calvinists, and Sceptical *esprits forts*, all of whom held a pessimistic outlook on human nature. Castel was more of an optimist — a term he in fact coined, though with a different connotation — and shared this outlook with many of his fellow Jesuits.¹³³ Although he believed that in their current postlapsarian state, men failed to understand their role in the mechanism of nature, he

¹³¹ Castel, "Lettre à M. C.," 2091. I will return to this issue in the following chapters. Since none of these human activities are concerted, excesses often take place that lead to catastrophic events. Convulsive motions such as earthquakes can indeed be envisioned in architectural and engineering terms, as if the earth were a cathedral whose structure humans were constantly and unwittingly meddling with. Such phenomena can take place in any region of the globe, even those that are not inhabited.

¹³² *Ibid.*, 2094-2095.

¹³³ Castel coined the term to translate Leibniz's notion of *optimum*. See his "[Review of Leibniz's] *Essais de théodicée*," *Mémoires de Trévoux* (Jan. 1737): 5-36; (Feb 1737): 197-241; (March 1737): 444-471; (June 1737): 953-991. In this particular context, optimism assumed a negative connotation, since Leibniz's theory seemed to imply a limitation of the powers of God (more on this in chapter 6, below).

nonetheless believed they could restore, by means of study and concerted effort, something like Adam's pre-lapsarian knowledge of cause and effect.¹³⁴ He believed, in other words, in the dignity of man.

The difference between the innocent and the sinful Man was enormous: before the Fall, Adam understood his role in nature and knew both the immediate and distant consequences of his actions. Since eating the forbidden fruit, men had regularly abused their power over nature by producing too many mixtures or digging too much out of the earth to satisfy their vanity, their gluttony, and their avarice. The result was that nature occasionally fought back:

For here again this system demonstrates that sin is the natural scourge of the sinner, and that the earth turns the weapon we lend to it against us, *pugnabit orbis terrarum contra insensatos* (the orb of the earth will fight against the foolish).¹³⁵

The violent reaction of nature being proportional to the violent action of men — in the Aristotelian sense of the term — Castel believed there was no cause to worry on the cosmic scale. The world was designed by God so as to take into account not only the normal actions of spirits, but also their excesses. From a human perspective, however, the price of ignorance could be very high indeed, which suggested the need to investigate the impact of their action more systematically.¹³⁶

¹³⁴ Though not quite the same state of nature; his later writings indeed suggest a more pessimistic outlook. Castel, "Journal du clavecin," 53v: "Une couche de noir après le Peché l'a precipité une octave plus bas, en le rapprochant des tenebres et du centre de la terre ou est l'enfer meme [...]. Tout est maudit entre nos mains et autour de nous. Tout est en discorde, et en dissonance." This pessimistic outlook had a silver lining, however: acknowledging that nature had been diminished was for Castel the key to restoring physics, all the sciences, and the arts within the modest bounds appropriate to the postlapsarian world (whereas aiming higher would be bound to fail).

¹³⁵ Castel, "Lettre à M. C.," 2095: "[C]ar voilà encore ce que nous démontre ce systême, que le peché est le fleau naturel du pecheur, & que la terre tourne contre nous, les armes que nous lui prêtons, *pugnabit orbis terrarum contra insensatos*." Castel is interpreting the *Wisdom of Solomon* 5:21.

¹³⁶ This will be explored in greater details in chapter three and chapter five.

Concluding Remarks

By discerning more carefully between natural, artificial, and supernatural causes, Castel believed that he had facilitated the task of *physiciens* by making their objects of study less confused, less irregular, and therefore easier to reduce to simple principles. By the same token, he also opened up a vast field of inquiry, endeavoring to examine the interaction of these simple principles of nature with free causes. His intervention, in other words, set favorable conditions for discovery in physics, while planting seeds for natural philosophical discoveries of a higher order.

In attempting to reconcile the mechanical simplicity of nature with the existence of a non-deterministic universe, Castel was contributing to more than natural philosophy: he was tackling a problem of Christian apologetics of particular significance to Jesuit theologians of the early eighteenth century. Proving the existence of spiritual causes without resorting to miracles was indeed a concern for the Jesuits, who neither wanted to appear philosophically unsophisticated in the eyes of lay philosophers nor wanted to be accused of impious naturalism by their pietist enemies. The admission of the existence and necessity of “freedom” and “spirit” within the mechanism of nature was Castel’s answer to this challenge, and a means of repairing the damage done to the dignity of man by the libertines, skeptics, and other *esprits forts* of his time. This answer, if not widely accepted, was ingenious.

It would be a mistake to belittle Castel’s early contributions to natural philosophy on the grounds that they were conjectural. When Castel used the term “discovery,” he did not mean a full-fledged theory, but a process. Like the travel to a new land or the opening

of a mine, it was a difficult, trying, and daring venture — an important step in a longer enterprise of exploration and exploitation. To be sure, finding a truth did not mean much until proofs were produced in its support and followed by a systematic demonstration. And for a demonstration to be of value in the long run, it had to be accepted by the scientific community and the wider public — in eighteenth-century parlance, it had to be *established*. The discovery process could only be called complete once its truth was so widely accepted from a generation to the next that it became, so to speak, “hereditary.”¹³⁷ As we will see, establishing his system was one of the tasks Castel set for himself in his subsequent works.

By surveying Castel’s background and early career, this chapter showed that his system of natural philosophy was both deeply influenced by his background and already contained within his first publications. Indeed, my exposition of his physical conjectures, as well as my detailed analysis of the “Lettre à M. C.” unpacked the main underlying principles of his philosophy, thus laying a foundation upon which to explore, in the following chapters, the development of his universal system. This is not to say that Castel had no new insight to offer afterwards, but that his first publications in the *Mémoires de Trévoux* carried within them the seeds of subsequent inventions.

My appropriation of Castel’s seed metaphor to describe his philosophizing style is not merely rhetorical. Castel thought about the discovery process through metaphors

¹³⁷ Castel, *Traité de la pesanteur* II, 331-332: “Dès là qu’une découverte est faite, elle n’est pas faite pour tout le monde; il faut bien du tems avant que chacun se l’approprie par son propre génie; Répétitions, Commentaires, rien n’y est inutile. Or jusqu’à ce que cette appropriation deviennent universelle, & comme héréditaire de siècle en siècle sans contestation ni opposition, celui qui en a rendu publics le droit et l’usage, est forcé de s’en tenir là.” That is, in spite of his desire and capacity to discover new things, he often must stop and hold his ground against detractors, and try to convince them of the well-foundedness of his discovery, before he may proceed further. Though referring primarily to the “copyists” of the Middle Ages, no doubt Castel anticipated that this might apply to his own work.

(seed-related or otherwise); he understood invention as the outcome of analogical reasoning. By making use of poetic insights and intuitive imagery to uncover new rapports and proportions in nature, he often befuddled his readers, both contemporary and modern; consequently, his work has often been mischaracterized as hopelessly naive or careless, both in its assessment of facts and in its conclusions. In truth, his style was a reflection of his conception of genius and a deliberate and rigorous attempt on his part to live up to an ideal. This ideal entailed memorizing a vast array of facts and ideas as drawn from extensive studies and observations; considering these facts and ideas from various angles, so as to put them in relation to one another; seeing, in a single glance, and expressing with natural ease simple principles accounting for the complexity of phenomena; and from there elaborating a general system that was both true to nature and useful to mankind.

Modern critics misunderstood what genius meant to Castel, and *a fortiori*, how his aspirations to it shaped his contribution to natural philosophy. In contrast, contemporary critics, for whom terminology was not an issue, questioned the soundness of this ideal or disagreed about whether Castel's work embodied it. The question of Castel's merit as a man of science need not detain us as historians. Instead, we ought to approach his works as meaningful attempts to contribute to particular traditions of natural philosophy. It is from this historically sensitive standpoint, then, that we now turn to his *Traité de la pesanteur*, the next development of his system.

CHAPTER 2: Weight and Lightness

According to Père Castel, the system of the Universe taken formally and in itself is but a mechanism of bodies (mécanisme de corps) and a pure system of weighing (pesanteur): but he does not stop there. To this weight (poids), he associates a counterweight, which is a kind of universal lightness introduced within bodies by the free action of spirits, such that the system of the Universe can be regarded as half material, half spiritual.
— *Mémoires de Trévoux*¹

With its implication of organic growth, the seed metaphor that Castel used to reflect upon his discoveries expressed both his indebtedness to previous generations of inventors and the fecundity of his own insights. His recognition of the necessary role of free causes in the mechanism of nature — his most important discovery up to that point — was indeed seminal. As detailed in the previous chapter, Castel realized that substantial progress could be achieved in natural philosophy only if 1) the proper object of physics were correctly delineated prior to attempting to reduce phenomena to purely mechanical principles, and 2) light were shed on the impact of man upon the course of nature — where “man” ought to be understood as a “free spirit” capable of introducing irregularities into the world. This chapter examines how Castel developed these two insights into a full-fledged system.

In 1724 Castel published his two-volume *Traité de physique de la pesanteur universelle des corps*. The first volume contained a 600-page articulation of the argument he had given piecemeal in the *Mémoires de Trévoux* starting in 1720. It comprised five

¹ Louis-Bertrand Castel, “[Review of Castel’s] *Traité de Physique sur la Pesanteur Universelle des Corps*,” *Mémoires de Trévoux* (April 1724): 618-619: “Selon le Pere Castel, le système de l’Univers formellement pris en lui-même, n’est qu’un mécanisme de corps & un pur système de pesanteur: mais il ne s’y borne pas. A ce poids, il associe un contrepoids, qui est une espece de legereté universelle, introduite dans les corps par l’action libre des esprits; en sorte que le système de l’Univers est comme mi-parti de *Materialisme* & de *Spiritualisme*.”

“books,” three of which expounded his purely “mechanical system of universal weighing” (*pesanteur*), and the remaining two, his “system of universal lightness or liberty,” which comprised his theories of terrestrial circulation and of the free action of man. The second, equally ponderous tome contained four additional “books” recounting the history of the progress of natural philosophy through the lens of *pesanteur*, a conclusion including both a review of the most recent developments on this question and a series of objections to some Newtonians propositions, as well as a systematic table of contents recapping the entire argument.²

Several scholars have summarized this argument, but few have been attentive to its internal structure, to the context in which it was written, or to its actual and intended contributions to natural philosophy. Written in the hayday of positivist historiography, Donald Schier’s biography set the tone for the next generations of critics when stating that a “point by point criticism of the *Traité de la pesanteur* [...] would reveal little that would be new, for Castel’s system had at least this virtue, that its faults are obvious.”³ Although more recent inquiries have shown more sensitivity to Castel’s enterprise, many still echo Schier’s characterization of the treatise as “an attempt to harmonize philosophy, scientific curiosity, and religious dogma by means of rationalism.”⁴ While eschewing ex-

² The second, historical volume stands among the most neglected parts of the Castelian corpus. This is unfortunate because it is also one of its most original. Since it deserves more space than this chapter can grant it, I relegate its discussion to chapter six, where its reflections on history and progress will resonate with Castel’s retrospective assessments of his oeuvre.

³ Schier, *Louis Bertrand Castel*, 88. For Schier, Castel’s main virtue was the clarity with which he erred methodologically: “In essence, the quarrel between Newtonians and Cartesians was a quarrel of method, and some of Castel’s work, because of its exaggerations, as well as his frankness in explaining his procedure, offers an excellent example of the results of the rationalistic, as opposed to the scientific method, and it is here that for us the interest of Castel’s absurd system may be said to lie.”

⁴ *Ibid.*, 201. George R. Healy provides a more nuanced reading than Schier’s and corrects some of his mistakes, yet he too occasionally condescends to Castel’s system. Healy, “Mechanistic Science,” 117-154. Shorter but more sensitive and better contextualized readings can be found in Ehrard’s *L’idée de la*

plicit value judgements, most categorize Castel as an anti-Newtonian seeking to revive Cartesian and Aristotelian ideas within a Christian apologetic framework, or as an idiosyncratic Jesuit who excited public interest, but hardly converted anyone to his cause. Historicizing Castel's claims rectifies this picture by allowing his contribution to emerge in its fullness at the center rather than on the margins of the history of eighteenth-century science.

On the one hand, I maintain that despite its idiosyncrasies, Castel's work fits squarely into the natural philosophical landscape of early Enlightenment France. I am not the first to point this out: in *Newton Wars*, J. B. Shank argues that Castel's philosophical style was typical of the urbane, French Jesuit culture, and that he stood at the vanguard of a new kind of critical journalism that catalyzed and polarized natural philosophy between Cartesians and Newtonians. As a polemicist, Castel indeed "became a major player in the French public sphere after 1720."⁵ But instead of focusing, as Shank does, on Castel's *persona* and "particular brand of Jesuit philosophy," I prefer to emphasize the *content* of his system.⁶ My main objective is to show that his struggle with the deterministic implications of seventeenth-century mechanical philosophies, and the solution he proposed to resolve this struggle, make him emblematic of his time.⁷

nature, 116-121; Barthes's *science, histoire et thématiques ésooteriques*, 149-165; and Northeast, *Parisian Jesuits*, 89-93.

⁵ Shank, *Newton Wars*, 163. See also pp. 379-380, 403, and 466 for similar appraisals.

⁶ *Ibid.*, 163.

⁷ By calling Castel "emblematic" rather than "representative," I also wish to distance my interpretation from Schier's, for whom Castel "with his prejudices, his patriotism, his loyalty to the throne and the altar, his superstitions, and his likes and dislikes, was certainly closer than the *philosophes* to the educated middle class from which he came, and for which he wrote." Schier was not wrong to claim that "Castel represents a side of the eighteenth century which is often forgotten," but he overstates his case when he contrasts the "brilliance" of the *philosophe* with "the welter of confusions, contradictions, and survivals" that "find expression in [Castel's] work." Schier, *Louis Bertrand Castel*, 202.

On the other hand, I also maintain that one cannot categorize Castel's effort as Scholastic, Cartesian, or anti-Newtonian. Indeed, his system is best construed as a *personal* and *original* attempt to reconcile his predecessors' legacies and crown their achievements by rendering them compatible with the teachings of the Roman Catholic Church, and with Jesuit theology more specifically. One may qualify his work as "eclectic" or "syncretic," but these terms ought to be used with discretion, lest they become place-holders for unexamined content.⁸

This chapter proceeds in two parts. Part I contextualizes the mechanical system featured in the first three books of Castel's *Traité*. It shows that by analyzing and reducing a vast array of phenomena into a sensible (perceptible) principle of universal weighing and by refraining from hypothesizing about the underlying cause of this principle, Castel was simultaneously distancing himself from the Cartesian tradition of synthetic physics and emulating certain aspects of Newton's approach to natural philosophy. Indeed, even though he rejected the Englishman's theory of gravitational attraction in a vacuum, Castel provided his readers with a phenomenal explanation of *pesanteur* that was as comprehensive as Newton's system. Like him, Castel also claimed to follow the

⁸ Castel's oeuvre was neither a patchwork of sources, nor a naïve indiscriminate reconciliation effort, but something like a middle course between the two. Most importantly, it was no dogmatic adherence to any one particular system or school of thought. On the subject of Jesuit anti-systemism and philosophical eclecticism, see Marcus Hellyer, *Catholic Physics*, 178; Stephen Gaukroger, *The Collapse of Mechanism and the Rise of Sensibility: Science and the Shaping of Modernity, 1680-1760* (Oxford: Clarendon Press, 2010), 244-245, and Healy, "Mechanistic science," 90-115. See also Denis Diderot, "Syncretistes, Hénétiques, ou Conciliateurs" in the *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d'Alembert. University of Chicago: ARTFL Encyclopédie Project (Spring 2013 Edition), Robert Morrissey, ed., accessed December 2015, <http://encyclopedie.uchicago.edu/>: "Il ne faut pas confondre les *Syncretistes* avec les *Eclectiques*: ceux-ci, sans s'attacher à personne, ramenant les opinions à la discussion la plus rigoureuse, ne recevoient d'un système que les propositions qui leur sembloient reductibles à des notions évidentes par elles-mêmes. Les *Syncretistes* au contraire ne discutoient rien en soi-même; ils ne cherchoient point à découvrir si une assertion étoit vraie ou fausse; mais ils s'occupoient seulement des moyens de concilier des assertions diverses, sans aucun égard ou à leur fausseté, ou à leur vérité."

method of analysis prior to synthesizing his findings. Yet by grounding universal *pesanteur* in qualitative and analogical inferences taken from the “history of nature” (rather than from contrived experiments or quantified observations), he also offered what he considered a properly *physical* counterpoint to Newton’s physico-mathematical abstractions.⁹

While Castel’s mechanical system was rooted in specific natural philosophical debates, its spiritual flipside sprang from of a more diffuse metaphysical and theological context. Part II of this chapter shows that by highlighting the inherent limits of his *pesanteur* mechanics, Castel threw into sharp relief the necessity of a free and undetermined cause — an active principle of universal lightness or liberty. This principle found its clearest expression in the second half of the treatise, which contrasts the state of a hypothetical “primitive earth” governed by the sole action of universal *pesanteur* with the *actual* state of the earth, explained as the interaction of nature with human free will. The result of this interaction was a fecund and perpetual circulatory movement, as well as a confirmation of mankind’s stewardship of the earth. Castel was not the only one to express the need for a “counterweight” to *pesanteur* — subtle matter, aether, vegetative spirits, fire, monads, God, and other active principles were variously called upon by pre-

⁹ See Schier, *Louis Bertrand Castel*, vii, who maintains that “although Castel tried once or twice to obliterate [the battle line], and to take a stand midway between the Cartesians and the Newtonians, the bent of his mind was such that he was always fundamentally in accord with conservative opinion, although he occasionally disagreed with it in matters of detail.” Instead of finding the “unity” of his work in anti-Newtonian views (which he certainly held), I locate it in the sincere and pervasive conciliatory or syncretic spirit that animates his different writings, the *Traité* first among them. This is not to say that Castel was a model of irenicism. In practice, his journalistic work often rhymed with controversy; as Shank puts it, “Castel rarely entered a discussion without enflaming it,” thus making “the Jesuit journal a much more partisan and openly polemical voice on question of philosophy and science than it ever was before.” Shank, *Newton Wars*, 163. But that Castel often threw oil on the fire does mean he did not seek, in principle, a philosophical harmony between systems. For him, honest criticism was a path to the unity of truth — much to the chagrin of those he disagreed with.

cursors and contemporaries for this purpose. His originality lies in having associated lightness to the moral and theological concept of human liberty. For Castel, this was the only way to secure both a rigorous mechanical philosophy and the tenets of his faith.

PART I **System of *Pesanteur Universelle***

When Pierre-Simon Laplace published his *Exposition du système du monde* in 1796, he unwittingly paid tribute to Père Castel by substituting “*pesanteur universelle*” for the Newtonian concept of “*gravitation universelle*.”¹⁰ This substitution was unproblematic, since both terms had been used more or less interchangeably since the mid-eighteenth century to denote the reciprocal action that bodies exert toward one another and that presides over celestial and terrestrial mechanics.¹¹ The situation was different in the 1720s, however, when Castel coined the expression and used it in the title of his physics treatise.¹² Back then, *pesanteur* harkened to the Cartesian tradition that sought to elucidate terrestrial heaviness synthetically, that is, in the fashion of a Euclidean proof, and mechanically, in terms of contact action between microcorpuscles. The idea of universalizing *pesanteur*, in contrast, invoked the rival Newtonian physico-mathematical theory of gravitational attraction that eschewed any mechanical explanation but used mathemati-

¹⁰ Pierre-Simon Laplace, *Exposition du système du monde*, vol. 4-5 (Paris: Imprimerie du Cercle Social, 1796).

¹¹ Note, however, that the *Dictionnaire de Physique*, s. v. “gravitation universelle,” edited by Monge, Gaspard, Jean-Dominique Cassini, Pierre Bertholon, J.H. Hassenfratz and Charles Joseph Panckoucke (Paris: [Panckoucke], 1793-1822), pointed out the recent substitution, explaining it was used “to distinguish the general from the particular action of gravitation.” The author of the entry also recommends that the original designation be maintained and that the term “gravity” be used instead to designate the general action of gravitation.

¹² Indeed, I have not found any precedent to Castel’s use of the compound “*pesanteur universelle*” in the seventeenth and the eighteenth century. Castel never claimed to have coined it, but there is little doubt that he intended the compound to sound both familiar and new.

cal analysis, inferential reasoning, and experimentation to generalize the phenomenon of gravity to all matter. While pledging allegiance to neither of these traditions, Castel's *pesanteur universelle* in effect positioned his work as a contribution to both.

The significance of Castel's neologism does not lie in lexical "priority claims," however, but in how it framed an original system of natural philosophy. The mechanics of universal *pesanteur* filling the first three books of the *Traité* both drew and departed from the Cartesian and the Newtonian traditions (among others). The result was a unique work whose method, structure, and content resist facile categorization, and yet demonstrably belong to the natural philosophical debates of its time. In addition to providing correctives to common misreadings of the works, the following discussion is the necessary springboard for the analysis of Castel's system of universal lightness in Part II.

Contextualizing Castel's Mechanical System

Making sense of Castel's contribution to mechanics requires framing his *Traité* within the early modern debate over the nature and cause of *pesanteur*. This can be done only by taking into consideration the rise of Cartesian mechanical philosophy in the seventeenth century, the introduction of Newtonian ideas in France at the turn of the eighteenth, and the complex negotiations and confrontations that animated partisans of both worldviews in subsequent decades. Fortunately, several scholarly accounts of these historical moments exist, leaving us with the more manageable task of integrating Castel's

contribution into the grand narrative and asking how his inclusion requires certain “re-touches” to our overall historical picture.¹³

What did Castel’s predecessors and contemporaries mean by *pesanteur*? One may rely upon late seventeenth- and early eighteenth-century dictionary definitions as reflections of well-established usage. The primary definition of *pesanteur* in Furetière’s *Dictionnaire Universel*, for instance, is representative of its widespread conception as a strictly earthbound phenomena: “*Pesanteur* is the quality that makes bodies heavy (*grave*), and by which they tend downward.” This definition still had purchase in the mid-eighteenth century.¹⁴ In the *Encyclopédie*, Formey (following Emilie du Châtelet, who in turn followed Rohault) defines *pesanteur* as “this property by virtue of which all known bodies fall and approach the center of the earth when they are not withheld (*soutenus*).” D’Alembert, for his part, distinguishes *pesanteur* from *gravité* on two counts: *pesanteur*, unlike gravity, is sometimes used to denote the varying weight of specific bodies, whereas gravity is used in the Newtonian system to describe a general phenomena that is not limited to the Earth.¹⁵ The *encyclopédistes* advocated the use of the Newtonian concepts

¹³ Useful background readings include Pierre Brunet, *L’introduction des théories de Newton en France au XVIIIe siècle* (Paris: A. Blanchard, 1931); Healy, “Mechanistic Science;” Henry Guerlac, *Newton on the Continent* (Ithaca: Cornell University Press, 1958); E. J. Aiton, *The Vortex Theory of Planetary Motion* (New York: American Elsevier, 1972); Michel Blay, *La naissance de la mécanique analytique: La science du mouvement au tournant des XVIIe et XVIIIe siècles* (Paris: Presses Universitaires de France, 1992); Mordechai Feingold, *The Newtonian Moment: Newtonian Science and the Making of Modern Culture* (Oxford: Oxford University Press, 2004); Gaugkroger, *Collapse of Mechanism*; and especially Shank, *Newton Wars*.

¹⁴ Antoine Furetière, *Dictionnaire Universel*, s.v. “Pesanteur” (La Haye: Leers, 1690). A host of secondary definitions follow, covering other physical and moral denotations. The authors of the *Dictionnaire de Trévoux*, for their part, based their definition on Furetière in the 1704, 1721, and 1732 editions.

¹⁵ See Formey, “Pesanteur [physique],” D’Alembert, “gravité [physique, mécanique]” and Jaucourt, “Pesanteur, Poids, Gravité, [synonymes],” in *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d’Alembert, University of Chicago: ARTFL Encyclopédie Project (Spring 2013), ed. Robert Morrissey, Accessed December 2015, <http://encyclopedie.uchicago.edu/>. Jaucourt provides useful terminological distinctions: la *pesanteur* est dans le corps une qualité qu’on sent & qu’on distingue par elle-même. Le *poids* est la mesure ou le degré de

of gravitation and attraction as the best way of interpreting the phenomena on a universal scale, and as a result, these concepts gained ascendancy in France to the point of replacing or Newtonizing the original meaning of *pesanteur* (as exemplified by Laplace's work). This transformation, of course, was already begun decades before its enshrinement as the French disciples of Newton blurred lexical distinctions by translating "gravitate" and "gravitation" with the familiar and technically neutral "*peser*" and "*pesanteur*" (although conceptually no equivocation was possible).¹⁶ Before the 1730s, however, the use of *pesanteur* in France generally excluded, or even precluded, Newtonian interpretations.

Translating *pesanteur* into modern English is notoriously difficult and, perhaps, best avoided. Although "gravity," "weight," and terrestrial "heaviness" have variously been used for this purpose, each has its shortcomings. Gravity has too many Newtonian connotations to a modern ear to be useful.¹⁷ "Weight" more accurately translates "*poids*" (a measurement that varies from body to body, although as d'Alembert pointed out, *pesanteur* could mean that in certain contexts). "Heaviness," as opposed to "lightness," comes closest to capturing *pesanteur*, but a more accurate translation might be "weighing" — as in, the weighing of bodies toward their center. Conceived as such, *pesanteur* not only reveals conceptual ties to the Aristotelian-Scholastic distinction between

cette qualité, on ne le connoît que par comparaison. La *gravité* désigne une certaine mesure générale & indéfinie de *pesanteur*."

¹⁶ *Peser* was a standard French rendition of the Latin *tendere*, that both Cartesians and Newtonians used to describe the downward action of bodies, irrespective of their philosophical standpoints. That is, whether one conceived of the downward tendency of bodies toward their center as an impulsion caused by the mechanical contact of particles in vortical motion or as an attraction the cause of which is unknown but the effect of which can be expressed with mathematical accuracy by the inversed squared relation, a body could still be said to tend (*peser*) downward. Newton, for instance, defines the centripetal force as "the force by which bodies are drawn from all sides, are impelled, or in any way tend, towards some point as to a centre." Isaac Newton, *The Principia: Mathematical Principles of Natural Philosophy*, trans. and ed. I. Bernard Cohen, Anne Whitman, and Julia Budenz (Berkeley: University of California Press, 1999), 405.

¹⁷ Already in the 1721 edition of the *Dictionnaire de Trévoux*, "gravité" is assimilated to the concept of "centripetal force" and with Newtonian mechanics.

heavy and light elements, but also suggests an active force rather than a passive, inherent quality of specific bodies. This is important in light of the conceptual transformation of the term under the influence of the mechanical philosophy.

Aristotelian physics taught that heaviness and lightness are properties of sublunary bodies, the natures of which determine the downward or upward “appetite,” that is, whether they strive downward or upward with respect to the center of the Earth. Bodies made up primarily of earth or water were called heavy, while those made up primarily of air and fire were called light. Whether one held these qualities as absolute or relative depended upon one’s interpretation of the Aristotelian corpus, as well as on one’s stance vis-à-vis seventeenth-century experimental philosophy.¹⁸ Importantly, the Aristotelian-Scholastic tradition also maintained that heavenly bodies moved around the earth along circular paths without weighing upon it or upon each other. Instead, planets were carried around by the rotation of nested spheres made up, like the planets, of weightless aether. Thus, within the enclave of the colleges and universities, *pesanteur* was only meaningful with reference to the four elements.

Over the course of the seventeenth century, the scholastic divide between sublunary and superlunary physics was challenged by a new generation of astronomers and natural philosophers — people like Galileo, Kepler, Gassendi, and Descartes — who re-

¹⁸ There are ambiguities within the Aristotelian corpus on this issue that allow for a variety of interpretations. A simplified interpretation made earth and water absolutely heavy, and air and fire absolutely light, but more discerning readers made earth and fire absolute in their category, while water and air were relative. Belonging to a more liberal group of exegetes, Castel interpreted passages from Aristotle’s *De Caelo* to support the view that all elements are weighing, including fire (which incidentally he considered the heaviest of element due to its observed preservation beneath the crust of the earth and its manifest absence in the farther reaches of the atmosphere. See Castel, *Traité de la pesanteur* II, 108-109. Experiments also suggested that all elements had weight. Barometric measurements taken with “Torricellian tubes” indeed provided proofs of the *pesanteur* of the air, while chemical experiments involving the calcination of metals yielded suggestive, but contested, evidence of the *pesanteur* of fire.

conceptualized and broadened the scope of *pesanteur*. For one, the scholastic appeal to inherent, “occult” qualities like heaviness and lightness was rejected on the grounds that it begged the question instead of providing an “intelligible” cause for the phenomenon of weighing and rising.¹⁹ Some of these *novatores*, the so-called mechanical philosophers, proposed to replace the Scholastic worldview with another that grounded traditional mechanics in a reductionist matter theory. According to the mechanical philosophy, the sensible world can be explained as the result of contact action between microscopic corpuscles of various sizes, shapes, speeds, and situations. By interacting with one another according to a finite set of mechanical laws (determined by God at Creation), corpuscles generate macroscopic phenomena, including “secondary qualities” such as color, heat, and bitterness, which depend upon the sensory apparatus of a perceiver. While the microscopic “primary qualities” of matter could not be observed with a naked eye, they could be inferred by analogy with large-scale objects.²⁰ Used as hypothetical principles, these inferences served to deduce the sensible features of the world, and thus “second-guess” the system of nature.

Several theories were proposed to account for *pesanteur* in mechanical terms. Although they differed in their specifics, all agreed that falling and rising bodies had to be explained by an extrinsic cause rather than by an inherent downward or upward appe-

¹⁹ The rise of mechanical philosophy played an important role in the stigmatization of the term “occult” by associating it with obscurity and sophistry. Intelligibility, in contrast, was a term used to describe clear and distinct causes that the imagination could represent to the understanding. Gaukroger suggests “picturability” as a good translation. Gaukroger, *Collapse of Mechanism*, 248.

²⁰ For instance, I explained in chapter 1 how some philosophers accounted for viscosity by hypothesizing the existence of *ramuscules*, or particles shaped like twigs and easily conceived to form “viscous” entanglements. My understanding of mechanism is indebted to Gaukroger’s interpretation. *Ibid.*, 58.

tite of bodies.²¹ The most famous and most influential of these theories was that formulated by Descartes in his *Principia Philosophiae* (1644).²² For Descartes, matter was reduced to extension — a passive, three-dimensional and homogeneous *plenum*, which by definition left no room (so to speak) for empty space. Thanks to the rotational movement that God had imparted to countless arbitrarily chosen “centers,” extension had been broken up and pulverized into three elements of varying sizes, shapes, and velocities. Some of these were larger, clunkier, and more oddly shaped than others — the gross particles that made up the stuff of the earth (including the traditional elements), and possibly of the other planets. A more subtle kind of particle, which Descartes called “globular,” pervaded the interstices of the grosser type and filled up the heavens. The sun and stars, for their part, were concentrations of even finer and more volatile particles, the dust resulting from the grinding that had given globular particles their shape, and which filled up *their* interstices. Descartes referred to these as third, second, and first elements respectively.²³

To explain the motion of these elements in a *plenum*, Descartes resorted to analogies with the behavior of whirling fluids. On a cosmic scale, he proposed that planets were carried around the sun in a state of hydrostatic equilibrium, like floating corks carried by a vortex made up of the first and second elements.²⁴ Descartes suggested that

²¹ Rohault explains that the term “appetite” either implies that inanimate objects like rocks have a kind of volition (which he thought absurd) or that it simply stands for an indeterminate cause, in which case it begs the question. Jacques Rohault, *Traité de physique*, vol. 2 (Paris: Veuve Charles Savreux, 1671), 129-130.

²² René Descartes, *Principia philosophiae* (Amsterdam: Ludovicum Elzevirium, 1644). For citation purposes, I am relying primarily on a re-edition of the abbé Picot’s French translation: *Principes de la philosophie, écrits en Latin [...] et traduit en François par un de ses amis* (Paris: Compagnie des Libraires, 1723).

²³ Descartes had provided a similar account in *Traité du monde et de la lumière*, written around 1632-33, but only published in 1664. Descartes, *Le Monde*, 34-58 [422-434].

²⁴ Descartes posited that in a *plenum*, the only movement possible would be one of circulation. Once set in motion by God, this circulation would continue. His followers conceived of the celestial equi-

there were many interlocked vortices in the universe, thus conjuring the image of a liquid clockwork. It was one such embedded vortex — the one surrounding the earth and possibly causing its diurnal rotation — that accounted for the fall of heavy objects on its surface. Descartes conjectured that *pesanteur* resulted from the excessive movement of subtle particles compared to that of gross matter. By moving at high speed around and away from the earth (by what would later be called the centrifugal force), the subtle matter of the earth's vortex, including that which permeated the pores of the third element, resisted the ascent of the latter, pressing upon it and compelling it to fill up the space it left vacant.²⁵

Descartes's causal explanation of *pesanteur* satisfied the basic requirements of the mechanical philosophy, but it was not without serious difficulties. Vortical mechanics predicted, for instance, the fall of earthly bodies toward the *axis* of the earth, rather than toward its center— a problem that Christiaan Huygens and others after him tried to solve by hypothesizing a multidirectional “agitation” of subtle matter instead of a single rectilinear centrifugal movement.²⁶ Another problem arose from the explanation of *pesanteur* as the pressure of subtle particles upon the bodies it supposedly permeated. How did bod-

librium that resulted in the stable rotation of planetary bodies as a balance between a *centrifugal* force (resulting from the rotation of bodies) and the opposed pressure of the whirling medium. In contrast, Newton's approach consisted in treating the orbit of planets as a combination of a *centripetal* force with the planet's inertial movement along a tangent. In the first case, an equilibrium results from opposed forces more or less cancelling each other out; in the second case, there is no such equilibrium, which in light of the reciprocal action of matter affecting every planet in its course, makes it seem like the heavens hold precariously together. See Gaugroker, *Collapse of Mechanism*, 69.

²⁵ Descartes, *Principes de la philosophie*, 325-332. Descartes saw *pesanteur* as one of several effects of subtle matter on earth, including the transparency of certain liquids where it abounds (319-321), the purification and separation of liquids (221-223), the formation of drops and celestial globes (323-325) and heat (334-335). As we will see, Castel treated these and other phenomena as instances of *pesanteur*, as opposed to several distinct phenomena resulting from the same hypothetical subtle matter. There are many accounts of Descartes's theory of *pesanteur* in the secondary literature; see, for instance, Aiton, *Vortex Theory*, 55-58.

²⁶ Christiaan Huygens, *Traité de la lumière [...] avec un Discours sur la cause de la pesanteur* (Leyde: Pierre Vander, 1690); Aiton, *Vortex Theory*, 75-85.

ies with wider surfaces of contact undergo the same accelerated fall as objects presenting a narrower surface? This question invited speculation about the porous properties of matter. Comets, likewise, presented a major challenge to Cartesian cosmology because of the overwhelming resistance they would presumably have to face as they cut across the whirling medium of the planets. Finally, philosophers who accepted Kepler's astronomical laws and Newton's discovery of the inverse square relationship acknowledged important discrepancies with the predictions of vortical dynamics. Precise astronomical (and later, geodesic) measurements posed a similar problem. This required weighing Descartes' intuitive but imprecise causal explanation of the physical phenomena against Newton's more rigorous, but physically objectionable, mathematical approach.²⁷

Many attempts were made in the second half of the seventeenth century to rectify Descartes's system. The debates on *pesanteur* that took place at the Académie Royale des Sciences in 1669 testify to the existence of a wide range of competing explanations, several of which rejected Cartesian mechanical impulsion altogether.²⁸ Some philosophers still held *pesanteur* as an intrinsic quality of bodies, whereas others speculated about the existence of a reciprocal, perhaps magnetic, attraction between bodies. Yet, a majority of

²⁷ For a good summary of the "difficulties" raised against Descartes's system, see Shank, *Newton Wars*, 55 ff.

²⁸ This debate is reviewed by Aiton in *Vortex Theory*, 75-85, and very accessibly summarized in Blay, "Pesanteur des corps de Descartes à Newton," *Pour la science* 38 (Jan-April 2003): 12-17. One of the most interesting participants in this debate was Gilles Personne de Roberval (1602-1675), whose theory of *pesanteur* shows striking similarities with the Jesuit's view: "Roberval definit d'abord la pesanteur d'un corps comme 'ce qui porte ce corps à descendre vers un centre par la nature seule et sans artifice.' Cela étant, 'on pourra considérer une pesanteur terrestre, une lunaire, une solaire, une joviale, etc.' Chaque planète possède donc une pesanteur propre et dont il s'agit de rendre raison: 'Il n'est pas nécessaire d'attribuer une vertu particulière à ce centre, qui n'est qu'un point; mais il suffit d'entendre que toutes les parties du corps sont portées à 'sunir ensemble pour ne faire qu'un seul corps; car de là, il en résulte un centre de gravité vers lequel toutes ces parties seront dirigées, avec plus ou moins de force, suivant leur propre nature: Et c'est cette force en quoy consiste la pesanteur.'" Blay, "Pesanteur," 13. On Roberval's life and work, consult Léon Auger, *Un savant méconnu, Gilles Personne de Roberval (1602-1675); son activité intellectuelle dans les domaines mathématique, physique, mécanique et philosophique* (Paris: Librairie scientifique A. Blanchard, 1962).

French philosophers innovated within the broad parameters laid down by Descartes in his *Principia*. These included such works as Huygens's *Discours sur la cause de la pesanteur* (originally written in 1669, but published in 1690); Jacques Rohault's *Traité de physique* (1671); Pierre Varignon's *Nouvelles conjectures sur la pesanteur* (1690); Philippe Villemot's *Nouveau système ou nouvelles explications du mouvement des planètes* (1707); Nicolas Malebranche's influential 1712 addition to the sixteenth *éclaircissement* of the *Recherche de la vérité*, in which he proposed to treat globular particles as microscopic vortices; as well as Jean Bouillet's prized *Dissertation sur la cause de la pesanteur* (1720), which built upon Malebranche's theory.²⁹

These works formed the heterogenous French tradition upon which Castel built his mechanical system.³⁰ Although they varied considerably from one another, these efforts all sought to elucidate the cause of *pesanteur*. Some also attempted to reduce terrestrial *pesanteur* and planetary movement to a single principle of impulsion — an unthink-

²⁹ Huygens, Christian. *Traité de la lumière*, 125-180; Rohault, *Traité de physique*, 129-130; Pierre Varignon, *Nouvelles conjectures sur la pesanteur* (Paris: J. Boudot, 1690); Philippe Villemot, *Nouveau système ou nouvelle explication du mouvement des planètes* (Lyon: L. Declaustre, 1707); Nicolas Malebranche, "Éclaircissement XVI" in *Œuvres Complètes*, vol. 3 (*Recherche de la vérité et éclaircissements*), ed. Genevière Rodis-Lewis and A. Robinet (Paris: Librairie philosophique Vrin, 1964), 253-305, esp. 270-285. Jean Bouillet, *Dissertation sur la cause de la pesanteur qui a remporté de le prix de l'Académie des Belles-Lettres, Sciences et Arts [de Bordeaux] pour l'année mil sept cens vingt* (Bordeaux: R. Brun, 1720). Malebranche and Bouillet's small vortices theory accounted for *pesanteur* and the preservation of celestial equilibrium without having to posit the excess of movement of celestial particles, which Huygens had calculated would need to be seventeen times greater than the spin of terrestrial matter to take effect. Since no such movement was detectable, Malebranche proposed that celestial particles be regarded as vortices endowed with a centrifugal movement comparable to that driving planets away from the sun, thus repelling other particles like springs, and keeping terrestrial matter down. Gaukroger, *Collapse of Mechanism*, 28, footnote 37.

³⁰ The list provided above is far from complete. To these titles, one could add passages from Charles Perrault's *Essais de physique, ou Recueil de plusieurs traitez touchant les choses naturelles* (Paris: Coignard, 1680), the various memoirs of Joseph Saurain and M. Saulmon in the *Mémoires de l'Académie Royale des Sciences*, and a host of brief discussions of *pesanteur* as part of the Cartesian-inspired treatises published in the second half of the seventeenth century. This tradition also continued after Castel's treatise, notably in Joseph Privat de Molière, *Leçons de physique, contenant les éléments de la physique déterminés par les seules lois de mécaniques*, 4 vol. (Paris: Veuve Brocas, 1734-1738). See Aiton, *Vortex Theory* for thorough discussion of these and the previously listed works.

able move for an Aristotelian, but one that followed from the reductionist goals of the mechanical philosophy.³¹ With the exception of Malebranche and his followers, few explicitly treated *pesanteur* and celestial equilibrium as instances of the same phenomenon (i.e., they might explain them by appealing to the same general principle of impulsion, but they were not treated as one). Those who did explore this possibility tended to confine their reasoning within the bounds of mathematical astronomy or analytical mechanics, rather than making claims about physical reality. Such was the case, for instance, of geometers like the Marquis de l'Hôpital (1661-1704) and Pierre Varignon (1654-1722), who spearheaded the Académie Royale des Sciences' program of analytical mechanics at the turn of the eighteenth century. Deeply influenced by the dynamics of Leibniz, the phenomenalism of Malebranche, and in time, the mathematical discoveries of Newton's *Principia*, these *académiciens* and their colleagues laid the groundwork for later efforts to harmonize Cartesian vortical physics with Kepler's and Newton's mathematical laws. But in the meantime, their publications showed little to no concern for the physical implications of their mathematical treatment of central forces.³²

Newton's greatest contribution to natural philosophy was possibly his decision to embrace these implications and defy traditional disciplinary boundaries by substituting descriptive mathematical equations for causal explanations, calling that sufficient.³³ His

³¹ This would also have been difficult for a strict adherent to Descartes's system. Indeed, if one believes that the sun consists in a concentration of the first element (the faster and freer kind) and that same principle explaining the *pesanteur* of bodies toward the earth obtains on the scale of the solar vortex, it follows that the planets should be driven toward the center of this vortex by the centrifugal expansion of subtle particle, instead of floating, as they seem to do, in their medium.

³² Shank, *Newton Wars*, 58. For a more thorough treatment, consult Blay, *Naissance de la mécanique analytique*.

³³ The impact that the new physico-mathematical approach had upon eighteenth-century natural philosophy is discussed with great acumen by Yves Gingras in "What Did Mathematics Do To Physics?" *History of Science* 39 (2001): 383-416.

discovery of the inverse square relationship, which described a gravitational force keeping planets in elliptical orbits around the sun and accounted for the accelerated fall of bodies on Earth, was primarily a mathematical rapport and was understood as such by many of his early readers in France. But Newton had no qualms about claiming that he had discovered a law of nature. Gravitational attraction was for him an empirically verifiable, physical phenomena that awaited a mechanical explanation (if such could be found experimentally), but that did not require one to be legitimate. In this, he could find validation in a distinguished tradition of experimental philosophy and support in the writings of British collaborators like Robert Boyle and John Locke (not to mention their respective disciples).³⁴

Castel was dissatisfied with all of these approaches to the question of *pesanteur*. He regarded the development of analytical mechanics at the Académie Royale des Sciences with suspicion because of the way in which it abstracted mathematics from concrete natural objects. In contrast, one of the main reasons for which he objected to Newton was his adequation of dimensionless points and mathematical curves to actual bodies and actual forces — a move he regarded, as did many of his compatriots, as a category mistake. He was just as worried about the physical and metaphysical implications of traditional, vortical-impulsionist physics, especially as it had evolved since the time of Descartes. For instance, one of Castel's main concerns was the Cartesian insistence on the homogeneity of matter, since it made it difficult to account for the harmonious and orderly structure of the universe. Homogenous matter whirling at high speed was a sure recipe for a planetary omelet, especially if celestial corpuscles themselves behaved like vorti-

³⁴ Gaukroger, *Collapse of Mechanism*, 150-225.

ces, as Malebranche would have it. Since Castel denied this theory any validity, he did not fear heavenly disruption *per se*. He did, however, apprehend the moral and theological consequences of a belief in the possibility of such disruption.³⁵

It is in this context that Castel formulated his own alternative to Cartesian impulsion and Newtonian attraction, namely “repulsion,” which reduced universal *pesanteur* to the repelling effort of insensible particles whose distinct mechanical structures led to their sorting and separation into kinds (the natural resolution of mixtures that the previous chapter discussed), and therefore to the formation of a static equilibrium between nestled, heterogenous heavenly spheres. Castel developed his explanation of the “insensible system of *pesanteur*,” in a series of articles published in the *Mémoires de Trévoux* between 1731 and 1733 that proposed a hybrid between Aristotelian forms and Cartesian corpuscular mechanics, and continued to refine this theory until the end of his life.³⁶ Yet, this causal explanation of *pesanteur* was largely absent from the *Traité* in 1724. This absence was strategic and deserves elucidation in the next section.

Structure and Method of Castel’s Mechanical System

³⁵ More on this in chapter 5, below.

³⁶ Castel, “Lettre du P. Castel D[e] L[a] C[ompagnie] D[e] J[ésus] à M. l’abbé de Saint-Pierre sur la véritable cause primitive et insensible de la pesanteur en général, et de la chute des corps en particulier. Première lettre,” *Mémoires de Trévoux* (Dec 1731): 2071-2083; “Seconde lettre du P. Castel à M. l’abbé de Saint-Pierre sur la véritable cause primitive et insensible de la pesanteur en général, et de la chute des corps en particulier,” *Mémoires de Trévoux* (Dec. 1731): 2084-2095; “Lettre du P. Castel D[e] L[a] C[ompagnie] D[e] J[ésus] à M. l’abbé de Saint-Pierre sur la véritable cause primitive et insensible de la pesanteur en général, et de la chute des corps en particulier. Troisième lettre,” *Mémoires de Trévoux* (Jan. 1732): 57-79; “Lettre du P. Castel D[e] L[a] C[ompagnie] D[e] J[ésus] à M. l’abbé de Saint-Pierre sur la véritable cause primitive et insensible de la pesanteur en général, et de la chute des corps en particulier. Quatrième lettre,” *Mémoires de Trévoux* (Feb. 1732): 221-240; “Lettre du P. Castel jésuite à M. le chevalier de Ramsai, pour servir d’éclaircissement au système de la pesanteur,” *Mémoires de Trévoux* (Nov. 1732): 1850-1867; “Seconde lettre du P. Castel, jésuite, à M. le chevalier de Ramsay, au sujet de la pesanteur,” *Mémoires de Trévoux* (April 1733): 659-671; “La cause tout à fait primitive de la pesanteur expliquée par le P. Castel, jésuite,” *Mercur de France* (August 1754): 11-26.

While springing from the French tradition of *pesanteur* mechanics, the *Traité* played with generic conventions on at least two counts. The first pertains to the argumentative structure of Castel's argument, which can be summed up as a physical demonstration of the universal scope of *pesanteur*. The second pertains to the method of analysis deployed throughout the treatise. Castel's decision to "delay" the discussion of the mechanical cause of *pesanteur* arose from this method. Aware of Descartes's mistakes and keen to point out the failure of his successors to rectify them, Castel attributed their incapacity to produce a convincing causal explanation to the limited perspective from which they approached the problem (a vestige of the common "prejudice" that cast *pesanteur* as a terrestrial phenomenon), as well as to their synthetic style of argumentation, which gave priority to hypotheses over the "historical facts" of nature. In voicing these objections, Castel echoed not only Cotes's preface to the second edition of the *Principia* (1713), but also typical Jesuit responses to Cartesianism.³⁷ Castel's critique was in fact grounded primarily in the latter rather than in Newton's methodology. Yet, his echoes of Newtonian objections were not coincidental; they signaled his attempt to cut a middle way in an increasingly polarized debate between Cartesians and Newtonians. From a historiographical standpoint, they also complicate the received historical narrative that accepts this dichotomy.

Castel distanced himself from his fellow Frenchmen by explicitly characterizing the earthbound definition of *pesanteur* as misleading and by structuring his argument around a demonstration of its universal scope. Starting with an analysis of the common

³⁷ Roger Cotes, "Editor's Preface to the Second Edition" of Isaac Newton, *The Principia: Mathematical Principles of Natural Philosophy*, 385-399. For a useful discussion of the Jesuits' response to Cartesian science, especially in the first two decades of the *Mémoires de Trévoux*, see Healy, "Mechanistic Science," 25-89.

experience of falling objects, the first book of the *Traité* reveals the full scope of *pesanteur directe*, defined in the abstract as the weighing of a whole body's parts toward its center. After establishing that the parts of the earth weigh toward its center, Castel generalizes *pesanteur* to all bodies in the universe through a series of analogies. He concludes:

All the whirls of the universe weigh upon the center of the universe, to which they belong as parts; all the celestial bodies of a whirl weigh upon the center of this whirl, to which they belong as parts; all terrestrial bodies, and all the bodies that constitute a celestial body, weigh upon the center of that celestial body to which they belong as parts; yet these bodies — terrestrial bodies for instance — even the smallest of them, have parts; it is thus necessary, according to the general law, that these constituent parts weigh upon the center of their whole.³⁸

Along the way, he assimilates direct *pesanteur* to the force that “globifies” planets and water drops; to the principle of union responsible for making bodies cohere and persevere as wholes; to light emanation, conceived as a reciprocal phenomena to *pesanteur*; and to the central fire of the earth, conceived of as the by-product of the pressure exerted by weighing matter toward the planet's core.³⁹ In the second book, Castel attempts to demonstrate that in a *plenum*, *pesanteur directe* entails a reaction, that is, a repulsion from the center toward the periphery. He compares this *pesanteur reciproque* to a spring or counterweight mechanism. This results in a kind of universal oscillation, or balancing,

³⁸ Castel, *Traité de la pesanteur* I, 81: “Tous les tourbillons de l'univers pèsent sur le centre de l'univers, dont ils font partie; tous les astres d'un tourbillon pèsent sur le centre du tourbillon, dont ils font partie; tous les corps terrestres, et tous les corps qui compose un astre pèsent sur le centre de l'astre, dont ils font partie; or ces corps, les corps terrestres par exemple, même les plus petits, ont leurs parties; il convient donc, selon la loi générale, que ces parties composantes pèsent sur le centre de leur tout.”

³⁹ In Book 4, Castel provides a useful statement of intent: “Dans tout le cours de cet Ouvrage, & surtout dans le premier Livre de ce premier Volume, on peut remarquer que mon principal but est par tout de sapper la pluralité des Systèmes, & de ramener tout à l'unité, & à la simplicité primitive de la Nature; & en particulier au simple Système de la Pesanteur, qui est en effet le Système primitif. J'ai déjà insinué assés ouvertement, que tous les Mécanismes de l'Union, & du Ressort des Corps, de leur Organisation, de leur Circulation, de leur Génération, tous leurs Phénomènes en un mot pouvoient s'expliquer par le simple effort que les diverses substances, qui les composent, font pour se surmonter selon leur divers degrés de Pesanteur relative, & que les Plantes, par exemple, ne se forment, ne se dévelopent, ne croissent, n'exercent en général leurs diverse fonctions quelconques; qu'en vertu de cette tendance continuéle, qu'elles ont vers le Centre de la Terre.” Ibid., 344.

that accounts not only for the libration of the moon and the various “balancing” of planets with respect to their point of equilibrium, but also for the circulation of fluid within the earth and within plants and animals. Finally, the third book completes Castel’s argument with a buoyant discussion of *pesanteur relative*, by which he explains celestial equilibrium.

But it is by now, it seems, very obvious to me that the entire system of nature — I mean of mechanical nature, all that is mechanical — reduces to relative *pesanteur*, which places and moves diverse bodies and their substances in concentric layers and in circular orbs (deformed by some light and insensible undulation) without it being possible to attribute to nature any other system than this one, nor to convince her [nature] to act by any other principle than *pesanteur*, nor by any other inclination, than that which she reveals as she continually places every body, and every substance, within the layers and spherical and circular circumferences that corresponds to its relative *pesanteur*.⁴⁰

Relative *pesanteur* thus refers to the specific weight of substances and to their location with respect to one another, but more generally, it accounts for the harmonious arrangement of the entire universe. Ultimately, all of nature can be reduced to direct, reciprocal, and especially relative *pesanteur*.⁴¹

For Castel, the history of the progress of natural philosophy could be summed up as the gradual recognition of the universality of *pesanteur* (to be distinguished from the

⁴⁰ Ibid., 381: “Mais il est désormais, ce me semble, fort évident que tout le système de la nature, je dis la nature mécanique, et tout le mécanique, se réduit à la *pesanteur relative*, qui place et fait mouvoir les divers corps et leurs substances dans des couches concentriques et dans des orbés circulaires, altérés par quelques ondulations légères et insensibles, sans qu’on puisse jamais attribuer à la nature d’autre système que celui-là ni la convaincre d’aucune autre action que celle de la pesanteur, ni d’aucune autre pente que de celle qu’elle manifeste sans cesse de placer chaque corps, et chaque substance, dans les couches, et dans les circonférences sphériques et circulaires, selon le degré précis de leur pesanteur relative.”

⁴¹ Ibid., 380-381: “La nature est très-simple en soi-même. [...] Tout ces noms de fermentation, de putrefaction, de végétation, de nutrition, decoction, d’attraction, d’exaltation, &c. n’étant en effet que des noms, ou tout au plus des effets, des Phénomènes accidentels à la nature mécanique, & des déguisement de son vrai Système, c’est-à-dire de la Pesanteur relative.”

discovery of its cause, which still lay in the future).⁴² This recognition consisted in *seeing*, with ever increasing clarity, the unity and harmony of nature.⁴³ It was Newton who had first grasped the universality of *pesanteur* and demonstrated mathematically that all bodies exert a mutual action on one another in direct proportion to their mass and in inverse square proportion to the distance between their centers. Whether it was conceived of as an attraction, an impulsion, or more neutrally, a *tendency*, this relationship could account for planetary as well as terrestrial movement, and possibly bio-mechanics. Opting for mathematical rigor over conceptual intelligibility, Newton referred to gravitational *attraction* as a place-holder describing an empirically verifiable phenomena without venturing a causal explanation. He believed in the existence of such a cause and hoped to discover it one day, but he also believed that any hasty speculations about it would be idle.

The fact that Newton had made this discovery nearly forty years before Castel did not make our Jesuit feel like he was beating a dead horse. There was too much at stake, from a pedagogical standpoint, to censure the reiteration of his discoveries. Although Newton had the genius to discover universal *pesanteur*, his demonstration did not meet the requirements of *saine physique* that Castel promulgated. Like most French philosophers since the publication of the *Principia*, Castel argued that, in natural philosophy, one must provide explanations for natural phenomena in physical and natural historical rather

⁴² This was, in a nutshell, the argument of the second volume of the *Traité*. See chapter 6, below.

⁴³ For an interesting parallel, see Gaukroger's characterization of the Leibnizian project in *Collapse of Mechanism*, 97-149, as well as 150-151: "As we have seen, for Leibniz understanding takes the form of an essentially perspectival grasp: the aim is to expand the perspective available to us in a systematic way and to harmonize perspective. The point of the philosophical exercise is to develop a form of intellectual grasp that reveals to us systematic connections, typically in the form of an underlying harmony, between everything at the most fundamental level."

than mathematical terms. The abstruse geometrical demonstration of the *Principia* was a *tour de force* of ingenuity, but it was insufficient to make strong factual claims about the real world. Thus, the discovery of universal *pesanteur* from Castel's perspective, had yet to be established *physically*, in a manner that was intelligible to all.⁴⁴ In this regard, much work remained to be done.⁴⁵ Castel apparently knew several *physiciens*, Cartesians in name, who still believed that celestial bodies were weightless, as if the discoveries of the previous decades had not trickled down to them.⁴⁶ This widespread ignorance among "common natural philosophers," and among the public more generally, justified establishing truths long-accepted by experts (such as the *pesanteur* of the air) and proceeding from there toward less obvious propositions (such as the contentious existence of the "central fire" of the earth). Moreover, the familiar experience of weighing and falling, Castel argued, had misled several first-rate philosophers into asking the question of the cause of *pesanteur* incorrectly, along the lines of "what causes a rock thrown in the air to fall back to the ground?" and to ignore, or treat as a separate problem, the movement of

⁴⁴ This argument was raised in the reviews of the first and second edition of Newton's *Principia* that appeared in the *Journal des sçavans* in August 1688 (pp. 152-153) and March 1715 (p. 153), and oft-repeated afterwards. Cited in Shank, *Newton Wars*, 72. Castel was not borrowing from these reviews, however, so much as echoing a more diffused scholastic stance vis-à-vis mathematics and physics that was propagated through the Jesuit colleges. For a discussion tying epistemological and ontological debates over disciplinary boundaries to Jesuit theological polemics, see Feldhay Rivka, "Knowledge and Salvation in Jesuit Culture," *Science in Context* 1 (1987): 195-203.

⁴⁵ Castel was particularly impressed by Villemot's work in this respect. Castel, *Traité de la pesanteur* II, 475-482, esp. 475: "Or il me paroît que M. Villemot est en effet un des Auteurs qui a enrichi le Systême de la *Pesanteur*, d'un plus grand nombre de vûës. D'abord il l'adopte dans toute l'étenduë, dans laquelle M. Newton le donne; il fait plus, il l'explique; mais l'explique d'une manière qui n'est pas indifférente pour le Systeme sensible, dont il est ici question." For instance, Villemot understood the analogy between *pesanteur* and light, and like Castel recognized importance of the central fire in this theory, with the important difference that Villemot thought the central fire caused *pesanteur* rather than the other way around, and that this fire originated in purely mechanical movement, rather than in a rupture of planetary equilibrium (as Malebranche did, and Castel after him).

⁴⁶ *Ibid.*, 400: "Je puis dire que j'ai connu divers Cartesians, qui avoient vieilli dans l'Ecole de Descartes, & qui étoient assez au fait de ses principes; mais qui n'avoient aucune idée de la *Pesanteur* des Astres."

planets with respect to the sun and the earth. Castel believed that investigating a deceptively simple phenomenon like the fall of an object prevented one from seeing the bigger picture.⁴⁷ Physics would be better served if *pesanteur* were considered from a more general standpoint after a rigorous analysis and reduction of its common manifestation.

This brings us to the second way in which Castel's distanced himself from the French tradition of *pesanteur* mechanics: his marked preference for analysis over synthesis.⁴⁸ Early modern natural philosophers typically distinguished between two methods for structuring an argument. The method of analysis, which was often called the "method of discovery," prescribed reasoning by inference from known to unknown propositions. Analyzing entailed breaking the former into constituent parts susceptible to comparison, recombination, and ultimately reduction, thus leading to the discovery of underlying principles.⁴⁹ In contrast, synthesis, also known as the "method of doctrine," proceeded deduc-

⁴⁷ The *Mercure* published an apology of Castel's *Traité* in which this thought is made explicit: "Vous voyez, Messieurs, que la réponse à la question proposée, *pourquoi une pierre tombe*, dépend de toute la suite du système general, & qu'elle en est même le dernier résultat. L'eussiez-vous crû? du moins les *Cartesiens* ne l'ont pas même imaginé, & il faut avouer qu'en ce point, comme en beaucoup d'autres, ils n'ont guere vû que la surface des choses." [Guillaume-François] Joly [de Fleury?], "Discours critique prononcé par M de Joly, avocat au Parlement dans une assemblée de gens de lettres le jeudi 22 de février 1725 au sujet du *Traité de la pesanteur universelle des corps* du P. Castel, et des observations generales de M. l'Abbé de Saint-Pierre sur ce nouveau système, insérées dans les *Mémoires de Trévoux* du mois de décembre dernier," *Mercure de France* (Avril 1725): 671-672.

⁴⁸ There is a considerable literature that discusses this subject, although it is unfortunately confusing and contradictory (a reflection, in part, of the variety of interpretations given to these methods by early modern philosophers themselves). Various accounts have nonetheless informed my understanding, including Gaukroger, *Collapse of Mechanism*, 125-145; Jaakko Hintikka and Unto Remes, *The Method of Analysis: Its Geometrical Origin and its General Significance* (Dordrecht and Boston: D. Reidel Publishing Company, 1974); Timothy J. Reiss, "Neo-Aristotle and Method: Between Zarabella and Descartes," in Stephen Gaukroger, John Schuster, and John Sutton, *Descartes' Natural Philosophy* (London: Routledge, 2000), 195-227; Shank, *Newton Wars*, 174-177; Niccolò Guicciardini, *Isaac Newton on Mathematical Certainty and Method* (Cambridge, MA: The MIT Press, 2009), esp. 31-57 and 309-315; Walter J. Ong, SJ, *Ramus, Method, and the Decay of Dialogue: From the Art of Discourse to the Art of Reason*, 2nd ed. (Chicago: University of Chicago Press, 1983), 263-267.

⁴⁹ This method was interpreted differently depending on whether one understood it mathematically (in which case, it was algebraic and stood for calculus in the eighteenth century) or experimentally (where it took the form of experimental contraptions aiming to reveal the underlying principles of a phe-

tively from unknown propositions (i.e., undemonstrated axioms) to known propositions, that is, propositions in need of a formal demonstration but assumed to be true (ideally because they had been previously discovered by means of analysis). In mathematics, synthesis was exemplified by Euclidean proofs; in natural philosophy, it had an analogue in the “geometrical” systems of Cartesian philosophers.

Castel considered both methods complementary and reciprocal. Yet his physics treatise only exemplified analysis — a choice reflected in the structure of his argument as well as in his decision to “postpone” the synthetic discussion of the cause of *pesanteur* to a sequel. Unfortunately, he was not explicit about this decision. This confused some of his readers, who expected a synthetic, that is, a doctrinal exposition of the cause of *pesanteur*.⁵⁰ It fell to one of Castel’s earliest supporters — a lawyer at the Parlement of Paris named Joly, to explicate Castel’s intention.⁵¹ In a laudatory apology of the *Traité* published in the *Mercure de France*, Joly explains that “to analyze” something

is to consider carefully all of its parts, to observe their conditions and their main rapports, to represent them to the eyes with short and familiar expressions, to combine them together according to prescribed rules, and to compare again the results of these combinations, until these repeated operations, becoming ever simpler, lead us at last to the equation (*égalité*) of the unknown thing [with the known], and to the desired resolution.⁵²

nomena). The analysis of curves, for instance, yielded equations, which in turn can be generalized by further comparisons; the analysis of light led to the discovery of its constituent colors, etc.

⁵⁰ See, for instance, Charles Irénée Castel de Saint-Pierre, “Observations générales de Monsieur l’Abbé de Saint Pierre sur le Traité de la Pesanteur,” *Mémoires de Trévoux* (December 1724): 2233-2245, which makes such a remark.

⁵¹ Possibly Guillaume-François Joly de Fleury (1675-1756), although the relationship between him and Castel is obscure. For more information about Joly’s life and work, see David Feutry, *Guillaume-François Joly de Fleury. Un magistrat entre service du roi et stratégies familiales* (Paris, École des chartes, 2011). On the Joly de Fleury’s dynasty more generally, consult Paul Bisson de Barthélemy, *Les Joly de Fleury, procureurs généraux au Parlement de Paris au XVIII^e siècle* (Paris: SEDES, 1964).

⁵² Joly, “Discours critique,” 671-672: “C’est de considerer attentivement toutes les parties de son objet, d’en observer les conditions & les rapports principaux, de les représenter aux yeux par des expressions courtes & famlieres, de les combiner ensemble selon les regles prescrites, & de comparer de nouveau les résultats de ces combinaisons, jusqu’à ce que ces operations repetées, & toûjours devenues plus simples nous conduisent enfin à l’égalité de la chose inconnuë, & à la résolution cherchée.”

In other words, Castel's treatise aimed to reveal proportions between known and unknown terms by finding rapports between a multiplicity of observable phenomena in order to reduce these to their simplest underlying principle. (Notice here the close connection to the notions of genius and discovery discussed in the previous chapter.) Joly defined the method of synthesis as the reverse but complementary approach, "better known and practiced by all those who teach:"

[I]t consists in the return of the mind in its footsteps and on the same road. While in [the analytic method], the mind of the discoverer examines, searches, goes forth, proceeds, arrives [somewhere new], in [the synthetic method], it comes back from its goal, it observes the traces of its previous approach, it confirms its discovery by comparing it to the things it knew beforehand — a little bit like [how] a traveler, newly-arrived on an unknown island, takes measures of the land and of the sky, confirming his discovery of a new part of the world by comparing it to all the other parts, and by estimating the path that lead him to it.⁵³

Synthetic demonstrations did not lead to the discovery of new principles. Instead, it took principles already discovered by analysis as givens and retraced the steps of the argument in a formal proof. The discovery of a new land was complete only after having figured out, step by step, exactly how one had gotten there.

The metaphor of a journey was not chosen at random. Rather than opening, in the Cartesian fashion, with definitions and suppositions about the microscopic world and building upon them a "likely hypothesis" to account for *pesanteur*, the first three books of Castel's treatise transported readers on a journey across the universe, the purpose of

⁵³ Ibid., 672: "La methode Synthetique, plus connuë & pratiquée de tous ceux qui enseignent, conduit l'esprit dans une route bien differente, ou plutôt c'est le retour de l'esprit sur ses pas & dans la même route. Dans celle-là l'esprit de l'inventeur examine, cherche, va, s'avance, arrive; dans celle-ci il revient de son but, il observe les vestiges de ses démarches, il s'assure de sa découverte par la comparaison qu'il en fait avec toutes les choses qu'il connoissoit déjà: à peu près comme un voyageur arrivé dans une Isle inconnuë, mesure la terre & les Cieux, pour s'assurer que la partie du monde qu'il a découvert par la comparaison qu'il en fait avec toutes les autres, & par l'estimation du chemin qui l'y a conduit."

which was to broaden the reader's perspectives on the narrowly conceived problem of terrestrial heaviness. Take for instance, the beginning of the first book, where Castel asks his reader to imagine standing on the moon, and to try convincing its putative denizens that there is such a thing as earthly *pesanteur*. Selenites, like most Terrans, would look up at the sky and see a bright and seemingly weightless celestial body, hovering above them, such that the proposition would seem absurd at first.⁵⁴ But upon closer inspection (with the help of a powerful telescope, for instance), one could show them the constant movement of our planet's parts — a ceaseless agitation of people, plants, animals, winds, tides, vapors, exhalations and smokes, as well as signs of a boiling subterranean fire occasionally gushing from volcanoes — suggesting that at every instant it stood on the the brink of destruction. Indeed, the centrifugal movement and collision of all these parts should result in dispersion or chaos.⁵⁵ Yet this was not, had never been, and presumably would never be observed. The only way to account for the “immutability of this globe in the midst of diverse movement,” was thus to assent to the existence of terrestrial *pesanteur*.⁵⁶ The point of Castel's thought experiment is that what is true of the earth from the moon's perspective, must also be true of the moon, the planets, and the sun, which we all observe (or presume) to be in a similar state of internal agitation.⁵⁷

⁵⁴ One forgets that pre-modern thinkers did not picture the earth as seen from space in the way we do. Castel seemed to have imagined it as comparable to the moon's appearance from a terrestrial standpoint, and not as our familiar 'blue planet.'

⁵⁵ Castel, *Traité de la pesanteur* I, 11: “ce n'est pas une expérience, c'est l'observation de toute la Nature qui nous apprend que tout Corps dont les parties sont en mouvement, se dilate d'abord, & bientôt se dissipe, comme la fumée dans l'air, ou comme la flamme, & mille autres corps dans la Machine du vuide, lorsqu'on a tiré l'Air, qui les resserre dans ses espaces étroits.”

⁵⁶ *Ibid.*, 9.

⁵⁷ The moon is clearly made up of a mixture of parts (its surfaces seems covered with seas and mountains), while sunspots indicate that the sun too is made up of agitated parts. The constituency of other planets and other suns need be inferred by analogy.

Taking common observations and unanalyzed concepts as the starting points of his analytic journey, Castel examines manifestations of *pesanteur* at the level of terrestrial bodies and then gradually expands his views to encompass the earth, the moon, the sun, the other planets, their respective vortices, the general vortex of the solar system, the distant stars and their respective worlds, in other words, the whole universe as it is, but also as it could be, if its laws were different. Contemplating counterfactual scenarios was one of Castel's favorite analytic strategies.⁵⁸ By disrupting nature through thought experiments, he hoped to reveal its laws more openly than by approaching it from a conventional standpoint. The third book of the *Traité* is particularly rich in this regard. It culminates with the reader witnessing a possible universe in which God tears the earth from its station, retaining it with chains, so that one may see what would happen to its parts under these conditions; the reader also witnesses the destruction of the sun, of planets, and satellites and observes what impact this has on all the remaining parts of the world system; the lumping and mixing of celestial bodies are depicted as if they were drops of oil, water, and mercury in a jar. Castel ultimately shakes the entire universe into a state of chaos, so as to show how matter *should* revert to a state of equilibrium by virtue of the hydrostatic principles he has established over the course of his argument. By contemplating the upheaval of the universal equilibrium, Castel uncovers the harmony of the Divine crea-

⁵⁸ Many of which were similar or identical to those of medieval scholastic theologians such as John Buridan. It would be interesting to trace these influences further, as Castel seems to have studied several of these text (directly or indirectly). This strategy must also be associated with the classical rhetorical proof of *ekphrasis*, "the striking image created by fiction" that early modern philosophers and astronomers sometimes used to make their readers "see" what is, in effect, beyond their senses, as well as to "cosmic *anamorphosis*," or proof by "curious" or "multiple perspectives," (including extra-terrestrial ones), a rhetorical strategy notably used by Kircher's disciple Kaspar Schott in his work on perspective. For more on this subject, see Frédérique Ait-Touati, "Seeing from Afar," *Histories of the Future* (essay presented to a conference held at Princeton on 6 and 7 February 2015), accessed December 2015, <http://histscifi.com>. Accessed 4 November 2015.

tion and shows his readers that they intuitively *expect* the scattered matter of a hypothetical celestial sphere to coalesce and separate itself from the matter of other spheres in the manner he describes. He wants the same readers to reflect again upon the fall of a stone on earth and realize that this phenomenon is really just an instance of the great cosmic combobulation of heterogenous substances.

Although this does not constitute a journey in the usual sense of the term, Castel was unmistakably influenced by seventeenth-century imaginary voyages in which readers were meant to contemplate the earth from the moon or another planet or to accompany a character in a visionary ascent through the heavenly spheres, usually with the help of an angel or teacher disclosing the order of creation along the way.⁵⁹ Unlike these philosophical fantasies, the *Traité* contains no narrative nor dialogue; yet its argument is analytical and, in a way, exploratory. Castel expects his readers to follow him “from the known to the unknown” on a reasoning path. Instead of giving them a *synthetic* report of his findings, he invites them to travel along and see with their own eyes.⁶⁰

In stark contrast to the typical association of teaching with synthesis, Castel and his apologist Joly express a clear preference for analysis when sharing philosophical dis-

⁵⁹ The archetype of this genre was Scipio’s Dream, found in book 6 of Cicero’s *Republic*, which serves as a model or source of inspiration for many ancient, medieval and early modern works. Closer to Castel were Kepler’s 1634 *Somnium* (Johannes Kepler, *Kepler’s somnium; the dream, or posthumous work on lunar astronomy*, ed. Edward Rosen [Madison: University of Wisconsin Press, 1967]); Huygens’s *Cosmotheoros, sive Terris coelestibus, earumque ornatu, conjecturae* (Hagae-Comitum: Apud Adianum Moetjens, 1699), and Kircher’s *Itinerarium exstaticum quo mundi opificium coeleste* (Rome: Vitale Mascardi, 1656). The latter in particular made a strong impression on Castel; seeing that it had not been translated from Latin, and that readers may not be familiar with its content, Castel even provides a synopsis of the work in the second volume of the *Traité* (pp. 411-413). On the philosophical dream literature, consult Frédérique Ait-Touati, *Fictions of the Cosmos: Science and Literature in the Seventeenth Century* (Chicago: University of Chicago Press, 2011), 17-75 and 95-129.

⁶⁰ This synthetic report actually comes at the end of the second volume in the form of a lengthy “systematic table” serving both as a table of contents (structuring the argument in the order it would follow in a textbook) and as a thematic index. This table is an intriguing piece of work, the only one of its kind I have found for this period. It would be interesting to see whether other philosophers used such device, and if so, whether Castel was their model.

coveries. As a reader, Joly felt it was more exciting.⁶¹ As the author, Castel felt it was more compelling.⁶² More importantly, both felt that the synthetic method, although tempting because of its demonstrative rigor in geometry, had to be used with caution in natural philosophy.⁶³ Many tended to use it too hastily and failed to provide an account of the path that led them to “discover” the principles they then assumed were truths in need of a demonstration. Some authors even omitted analysis altogether and were guilty of constructing arbitrary systems, or as their critics liked to put it, of “writing novels.” This trope was typical of Jesuit criticism of Descartes and his followers and, to some extent, a caricature of their work.⁶⁴ But it also had a famous precedent in Newton’s own decision to eschew speculation about the cause of *pesanteur*. Indeed, the second and third editions of the *Principia Mathematica* had issued a similar warning against making hasty hypoth-

⁶¹ Joly, “Discours critique,” 683: “Mais indépendamment de la solidité de cette methode, quel goût, Messieurs, & quelles délices pour le lecteur qui, conduit comme par la main, marche à côté de son Auteur, & partage avec lui le charme des nouveautez qu’il découvre, quelquefois placé dans des points de vûes où l’on lui fait appercevoir comme dans un lointain le terme de sa carrière, s’avançant toujours flaté par l’espoir d’y arriver? voilà l’effet de l’Analyse. La Synthese, au contraire, que nous presente-t-elle? ce ne sont d’abord qu’énigmes & que paradoxes; on se trouve transporté tout à coup dans un pays inconnu’ & puis voilà un Docteur intéressé à établir son sentiment qui vient vous remener avec autorité dans un pays tout connu. Pour moi, Messieurs, il me semble voir une piece de Theatre qui commence par le dénouement, & dont on vient ensuite me raconter froidement l’intrigue.”

⁶² Indeed, Castel challenged the usual association of synthesis with teaching, reversing them so that analysis would be the best way to learn and synthesis the true key to making discoveries. More on this in chapter 4, below.

⁶³ Castel believed the exact opposite to be true of mathematics, thereby marking a clear preference for geometry over infinitesimal analysis and other algebraic disciplines. Mathematical analysis indeed used various algorithms to abridge calculation; it was more direct and more powerful than geometry in its capacity to generalize from particulars, but it also skipped steps required by more formal geometrical demonstrations. Proponents of geometrical analysis, of course, objected that this method relieved the mind from the burden of imagining or tracing figures, and that geometry was more obscure than analysis due to all the necessary detours and ancillary constructions required in its formal demonstration. See Gaugroker, *Collapse of Mechanism*, 243-244.

⁶⁴ A good example of this would be Père Gabriel Daniel’s popular *Voyage du monde de Descartes* (Paris: Veuve de Simon Bénard, 1690), which recounts the journey of a Cartesian with a potential convert to the world that Descartes has built for himself in a self-deluding, drug-induced fantasy (with reference of course to his *Traité de la Lumière et du Monde*).

eses in natural philosophy.⁶⁵ While Castel regarded Newton's rejection of hypothesis as disingenuous (what was "attraction" if not a hypothesis?), in principle he agreed with him that unchecked speculations had no place in natural philosophy.⁶⁶

Castel's warning was more than a trope. It was a methodological statement reflected in the argument of the *Traité*. His methodological self-restraint befuddled readers who expected him to engage with the causal question, but Castel was adamant: before casting this argument in doctrinal form, he first needed to establish the "state of the question" analytically. Failing to do so would undermine any synthetic demonstration, since the starting point of such demonstration would potentially rest upon a misconstrual of familiar phenomena.⁶⁷ In this respect, Castel's rationale differed from Newton's, for whom speculation about causes ought to be eschewed altogether until experiments yield sufficient evidence to proceed by inference. For Castel, the inferential basis was already within reach of he who knows where and how to look at nature; adopting the method of analysis simply entailed refraining from hypothesizing a cause at the outset, lest it distort

⁶⁵ The famous "hypotheses non fingo," which appears in the "General scholium" appended to the *Principia* in 1713, and again in 1728. Newton, *The Principia: Mathematical Principles of Natural Philosophy*, trans. and ed. I. Bernard Cohen, Anne Whitman, and Julia Budenz (Berkeley: University of California Press, 1999), 943.

⁶⁶ At the same time, Castel also believed in the heuristic value of hypotheses, as often repeated in his review of Newtonian works. See for example, see the second part of his "[Review of 'sGravesande's] *Physices elementa mathematica* [...]," *Mémoires de Trévoux* (Octobre 1721): 1761-1796: "Il y a beaucoup à dire pour & contre les hypothèses: on désapprouve avec l'Auteur celles où il n'y a que de l'imagination, parce qu'enfin la Physique n'est pas un Roman où le pur possible doivent être admis, ni même un Poème où le vraisemblable puisse suffire: c'est une histoire raisonnée qui a pour objet le vrai, le réel, ce monde enfin tel que Dieu l'a fait. / Mais l'aurore précède le jour; quelques rayons échappent à travers la nuë annoncent que le soleil va paroître, et les hypotheses, je dis celles que la nature offre elle-même à un esprit attentif et judicieux, sont comme l'aurore & les premiers rayons d'une vérité naissante. Vouloir proscrire toute hypothese, c'est fermer souvent l'entrée à la vérité." Castel also adds that "[s]i toutes les hypotheses ne doivent pas être généralement prosrites, toutes les experiences ne sont pas également recevables, quoi qu'en dise notre Auteur qui semble vouloir réduire les hommes à n'avoir absolument que des yeux." (1765).

⁶⁷ For instance, one might hypothesize a possible cause to explain the fall of a rock toward the earth and fail to realize that this cause should also explain the shape and movements of planets, the principle of union, light, the central fire, circulation, etc.

one's sight. Like Newton, his goal was to discover the cause of *pesanteur* and demonstrate it synthetically; unlike him, he thought that it actually lay at the end of his analytic journey.

But as it turns out, the *Traité* did not carry the reader to its desired endpoint. It left the “insensible system” of *pesanteur* (the inquiry into its invisible cause) for a sequel and limited the analysis to a reduction of the “sensible system” of the world.⁶⁸ This was not an admission of failure on his part. Castel considered his contribution substantial, insofar as demonstrating the universal scope for *pesanteur* on physical grounds was a major step toward establishing the “state of the question.” Castel thought that the *Traité* came close to revealing the cause of *pesanteur* and that he would soon be ready to publish his findings. What gave him cause to withhold their publication in 1724, and delay it for several years thereafter, was his realization that establishing the state of the question required *more* than cutting a middle way between Cartesian *pesanteur* and Newtonian universal gravitation. As he suggested in his “Lettre à M. C.,” progress in physics would require analyzing the labyrinthine interplay of physical and spiritual causes prior to attempting any reduction of nature to the universal principle of *pesanteur*. In other words, analysis, or discernment of spirit, had to take place at a higher level. Castel began this exercise in the second half of the *Traité*, to which we will turn after a brief recapitulation.

Summary

When Castel coined the expression *pesanteur universelle*, he deliberately played on a conceptual ambiguity. On the one hand, he engaged with the long-standing French

⁶⁸ He did, however, provide something like a synthetic account of the *sensible* system of *pesanteur* in the “Table systématique” found at the end of the *Traité*'s second volume.

tradition of vortical physics, which sought to elucidate the cause of *pesanteur* in qualitative mechanical terms and excluded the connotations of Newtonian gravitational attraction. On the other hand, he distanced himself from what he regarded as his compatriots' misconstrual of *pesanteur* as an earthbound phenomena, arguing that in order to find its cause, one first needed to acknowledge its universality at a phenomenal level, as Newton had done. In this respect, the first three books of the *Traité* provided a French counterpoint to Newton's argument and method and to the Newtonian tradition in general. Indeed, Castel saw his analysis of the sensible phenomena of *pesanteur* as completing his English predecessor's discovery that "everything weighs" (i.e., that all bodies weigh or tend toward all the centers of the universe), a statement that falls short of capturing Newton's achievement in mechanics, but that Castel regarded as an accurate description of the Englishman's contribution to *physics*, understood as a history of nature and a causal inquiry. For as brilliant as Newton's mathematical formalization of universal gravitation was, he had yet to provide not only an intelligible causal explanation at the microscopic level (for which most of his critics reproached him), but also a physical and accessible demonstration of its sensible system (which Castel attempted to provide).

Castel was neither a Cartesian nor a Newtonian, but something of his own that bore the mark of both traditions. The reverse is also true: he was neither an anti-Cartesian nor an anti-Newtonian. By weighing up his predecessors' methods and insights against his own (and those of other predecessors like Aristotle and Kircher especially), he achieved a unique perspective on the natural philosophical debates of his time and laid the ground for the original contribution he expounded in the second half of his treatise. Accordingly, one should read Castel's mechanical system as an original contribution to

early eighteenth-century natural philosophy rather than as a derivative (or reactionary) effort. Moreover, Castel's stance in the battle of Cartesians and Newtonians serves as a reminder of the complex reality behind this simplistic historiographical dichotomy.

Four years after Castel's death, Le Cat shared his thoughts on Castel's *Traité* in the *éloge* he read at the Académie des Sciences, Belles lettres et Arts of Rouen: "Sparkling with *esprit*," this work had the merit of being filled with "a multitude of new facts, connected to a load of similarly novel views that considerably expand the theory and the empire of *pesanteur*, while waiting for its true cause."⁶⁹ This assessment was preceded by an intriguing discussion of the treatise's ambitious scope, wherein Le Cat expressed a mixture of admiration, puzzlement, and reservations. "None of the circumstances of the phenomenon of *pesanteur*," he began,

none of its rapports with the other parts of the Universe, nor even with the sublunary phenomena, meteors, animals, plants, minerals, and the *bowels of organized earth*, are omitted from this treatise. Indeed, Père Castel summons nature in its entirety [...] before the tribunal of *pesanteur*.⁷⁰

Such was the main achievement of the first three books of the *Traité*, "where [Castel] establishes, following the example of Kepler and Newton, a universal gravitation (*gravitation universelle*) that brings all stars, all bodies, and all material particles toward one another, and which acts upon all these beings from the circumference to the center and from the center to the circumference."⁷¹ The parallels drawn with Kepler and Newton suggest

⁶⁹ Le Cat, "Eloge," 4r: "[...] cet ouvrage même tant pétillant d'esprit, d'une multitude de faits nouveaux, liés à une foule de vuës pareillement nouvelles, et qui étendent considérablement la théorie et l'Empire de la pesanteur, en attendant sa véritable cause." Le Cat read and took notes about Castel's *Traité* for the purpose of writing his *Éloge*. Evidence of this can be found in Le Cat, "Analyse du *Traité physique de la pesanteur universelle des corps* du R. P. Castel," B23, Archives de l'Académie de Rouen, Bibliothèque municipale François Villon, Rouen.

⁷⁰ Le Cat, "Eloge," 3r.

⁷¹ *Ibid.*, 3r.

that Castel's near contemporaries could read his physical demonstration of the sensible system of universal *pesanteur* as a tributary of the Newtonian synthesis of celestial and terrestrial mechanics rather than as a rejection of it. In fact, Le Cat thought that by limiting the treatise's discussion of the cause of *pesanteur* to the phenomenal level (as opposed to the micro-corpuscular), Castel offered no more than "a spiritualized, disguised, and distorted Newtonianism."⁷² Given that Castel "had been a zealous Cartesian throughout his life" and that he was best-known for his attempts to refute the *Principia* and the *Opticks*, this was paradoxical.⁷³ Le Cat's ambivalence about Castel's Newtonian influence was the direct outcome of the polarization that had taken place between Cartesians and Newtonians over the previous three decades. In the aftermath of the "Newton Wars" (to borrow Shank's expression), Le Cat did not expect to find the Jesuit's presence on both sides of the battlefield. As I suggested above, this paradox resolves itself when Castel's contribution is recognized as the reconciliation and culmination of several natural philosophical traditions, instead of ascribing to him a particular philosophical allegiance.

But Castel not only sought to reconcile the insights of his predecessors: he also intended to crown them with his own. As Le Cat put it, "this — the vastest field that physics can offer him — [did] not satisfy his fervent and impetuous imagination; it is too narrow for him [...] *aestuat infelix, angustô limite mundi* (Unhappy man! He frets at the narrow limits of the world)."⁷⁴ As Juvenal satirized Alexander the Great's unquenchable thirst for blood and conquest, so Le Cat criticized Castel's boundless philosophical ambition: "The material world [...] is not enough for him; this new Alexander needs a vaster

⁷² Ibid., 4r.

⁷³ Ibid., 4r.

⁷⁴ Ibid., 3r. The Latin quotation is from Juvenal, *Satires* X, line 168.

theater yet: an intellectual world. Père Castel thus sees in this single phenomenon of *pe-santeur* the concurrence of two systems, one of *mechanism*, he says, and the other of *lib-erty*.⁷⁵

Le Cat had little positive to say about this second system: “everybody feels how the very word liberty is misplaced in physics” and that “all the phenomena he summons in its defense could soon be revealed as false witnesses, were they better interrogated.”⁷⁶ By the 1760s, natural philosophers were becoming more comfortable with the idea of a deterministic universe, while others willingly embraced the existence of active, non-mechanical natural principles — physical causes that essentially fulfilled the vivifying and disruptive role of Castel’s “free spirits,” and made his appeal to a liberty principle unnecessary.⁷⁷ Castel’s spiritual counterweight to *universal pesanteur* fell victim to the gradual secularization of natural philosophy during the eighteenth century.

But in 1724, the generation that dominated the scientific stage had different concerns and expectations than Le Cat’s. The question arises, therefore, as to what place

⁷⁵ Le Cat, “Eloge,” 3r-4r.

⁷⁶ Ibid., 4r.

⁷⁷ Ibid., 3r-4r: “Il n’y a d’oublié dans ce traité aucune des circonstances du phénomène de la pesanteur, aucun de ses rapports avec toutes les parties du l’Univers, et mesme avec les phenomenes sublunaires, meteores, animaux, vegetaux, minéraux, *entrailles de la terre organisée*; Enfin la nature entiere est, pour ainsi dire, sommée par le P. Castel à comparaître au Tribunal de la pesanteur; Il y a plus; Ce champ le plus vaste que la Physique puisse lui offrir ne suffit pas à son imagination fervente et impétueuse; Il s’y trouve encore trop resseré [...] *aestuat infelix. angustô limite mundi*. Ce n’est point assés pour lui d’un monde materiel, où il etablit, à l’exemple de Kepler et de Neuton, l’Empire universel d’une gravitation qui porte tous les astres, tous les corps, toutes les molecules des corps les unes vers les autres, et qui agit dans tous ces Etres de la circonference au centre et du centre à la circonference; Il faut à ce nouvel Alexandre un theatre plus vaste encore, un monde intellectuel. Le P. Castel voit donc dans ce seul phenomene de la pesanteur le concours de deux sistêmes, l’un de *mécanisme*, dit’il, l’autre de liberté; Et, qu’elle est d’abord la cause mécanique? Nous sommes forcés de l’avouer: On la cherche envain dans ce volumineux ouvrage. On n’y trouve qu’un Newtonianisme spiritualisé, deguisé, alteré. Personnage singulier le P. Castel, qui a esté Carthesien zélé toute sa vie [...]. Quant au sistême de la liberté qu’il associe à celui du mécanisme, tout le monde sent combien le mot mesme de liberté est déplacé en Physique. Le Pere Castel justifie assés mal ce Paradoxe, et tous les phenomenes qu’il fait parler en sa faveur passeroient bientost pour de faux temoins, s’ils estoient mieux interrogés.”

Castel's system of universal lightness and liberty occupied in *that* context. To what problem was it a solution and what made it a legitimate contribution to natural philosophy? I maintain that Castel belonged to the generation that witnessed and responded to what Stephen Gaukroger has aptly called "the collapse of mechanism." The second half of the first volume of the *Traité* demonstrates the shortcomings of the mechanical worldview with exceptional clarity, while simultaneously participating in a rescue effort which, for all its idiosyncrasies, was emblematic of its time. Indeed, Castel's unusual appeal to the twin notions of lightness and liberty was meant to secure the reductive rigor of mechanical physics against its manifest failures without lapsing into religiously unorthodox and morally injurious denials of divine and human free will.

PART II

System of Universal Lightness and Liberty

Since Castel's theory of terrestrial circulation and his system of the action of free spirits have already been analyzed in chapter one, the following discussion emphasizes the metaphysical and theological background against which they must be read. I begin by situating the concept of universal lightness and liberty within the argument of the *Traité*, showing how it arose from unresolved tensions in its mechanical system. These tensions resulted from the reductionist strictures of mechanism, understood as a reduction of natural phenomena to matter in motion, which refused to grant active powers to matter in spite of its apparent activity. The previous two generations of philosophers had recognized and sought to address this problem by shifting the explanatory burden onto God's will or making activity immanent in nature; but as far as Castel was concerned, these so-

lutions failed to square with Christian revelation. While the first part of my argument introduces the philosophical context that justified Castel's appeal to the concept of universal lightness, the second part frames his response to these natural philosophical systems within the Jesuit crusade against atheism and determinism. This broader moral and theological context is particularly relevant for understanding why he chose to assimilate lightness to liberty. I conclude with some reflections on the role that this association may have played in the development of eighteenth-century science. The question of direct influence notwithstanding, Castel's system of universal lightness and liberty indeed emerges as an important landmark in early Enlightenment thought, arguably bridging the great metaphysical systems of the late seventeenth century, on the one hand, and the empirically driven, vitalistic, and anthropocentric systems of the mid-eighteenth century, on the other.

The Case for Universal Lightness

If we are to trust Castel's strategic account of his treatise's publication, the main bulk of the work was already in the press when he burst into André Cailleau's print shop with a three-hundred-page addition to his manuscript. These pages consisted of a fully developed version of the discovery announced in the *Mémoires de Trévoux* of December 1722, the implications of which (he felt) were simply too great not to feature in his treatise.⁷⁸ The reader trying to make sense of Castel's argument should keep in mind that, although Cailleau agreed to print the additional material, he would not let the author revise the entire manuscript. Castel had to resign himself to minor insertions, including a

⁷⁸ See chapter 1, analysis of the "Lettre à M. C."

preamble at the beginning of the fourth book alerting the reader to a sudden turn in the argument and apologizing for its incongruities.⁷⁹

The second half of his general system indeed marks an important argumentative shift, by which Castel springs from the reductive analysis of the first three books toward a more inclusive natural philosophy couched in geometrical style, and indeed, a physico-theology inspired by such works as Burnet's *Sacred Theory of the Earth* (1681, 1689) and Woodward's *An Essay Toward a Natural History of the Earth* (1695).⁸⁰ After having established the universal scope of *pesanteur* in the first three books, he seeks to account for lightness (*légèreté*), by which he means not only the tendency of bodies to rise, but also the irreducible diversity of natural phenomena that result from the interaction of *pesanteur* with lightness, including all sorts of mixtures, meteorological anomalies, and life itself. Building upon his insights about relative *pesanteur* and celestial equilibrium, he directs the reader's gaze toward the Earth's circulation and its inhabitants and proposes a thought experiment not unlike those he deployed in the third book. There Castel had his readers contemplate counterfactual scenarios of cosmic disruption so as better to reveal the laws of natural equilibrium and make their universality manifest to the eyes. Similar-

⁷⁹ Castel's reputation for being inconsistent and at times contradictory is partly due to the failure of historians to take into account the particular circumstances of the treatise's composition and printing. One of these incongruities, as will be shown, concerns the role of the sun in his explanation of the circulation of the earth and the production of mixtures. This would have important consequences for Castel's subsequent works on the tides and on meteorology, which we will explore in chapter 5, below.

⁸⁰ Thomas Burnet, *The Theory of the Earth: Containing an Original of an Account of the Earth, and of all the Changes Which it Hath Undergone, or is to Undergo Till the Consumation of All Things. The First Two Books, Concerning the Deluge, and Concerning Paradise* (London: Printed by R. Norton for Walter Kettilby, 1684-1690). Castel may have read the original Latin edition of 1681; John Woodward, *An Essay toward a Natural History of the Earth and Terrestrial Bodies, especially Minerals as also of the Sea, Rivers, and Springs with an Account of the Universal Deluge and of the Effects that it had upon the Earth* (London: Printed for Ric[hard] Wilkin, 1695). For an insightful discussion of these physico-theologies and their connection to the Cartesian hypothesis tradition, see Peter Harrison, "The Influence of Cartesian Cosmology in England," in *Descartes' Natural Philosophy*, ed. Gaukroger et al. (New York: Routledge, 2000), 168-192.

ly, book four establishes the “primitive system of the earth” — a counterfactual hypothesis of what the earth would look like were its physical mechanism considered in isolation from both celestial influence and the action of free spiritual causes. By a kind of *reductio ad absurdum*, this thought experiment established the *necessity* of the latter kind of extrinsic influences.

In the first half of his *Traité*, Castel envisioned Nature as a strictly mechanical system, maintaining that *pesanteur* was its fundamental weight or driving force and the dissociation of heterogenous particles, its mechanical *modus operandi*.⁸¹ Until the “Lettre à M. C.,” he apparently thought that this system sufficed to account for the perpetuation of movement and diversity in the world. Reciprocal and relative *pesanteur* carried the burden of generating a mechanical “balancing” and “circulation” movement comparable to the oscillation of a pendulum (and thus for the rising and repelling action of bodies), while celestial movements and variations in the heat of the sun — following Aristotle — caused mixtures and irregularities in the system and prevented the world from subsiding into an inert state.

Upon reflection, Castel changed his mind. The mechanical counterweight introduced in the second book via reciprocal *pesanteur* could explain the alternative rising and falling action of bodies, but it did not account for the perpetuation of this movement over time. Perpetual motion seemed inadmissible in the long run because Castel believed matter passive and naturally inclined toward rest. Under the blind action of *pesanteur*, matter left on its own would eventually sort itself out and settle around its center(s) of gravity. If

⁸¹ A number of secondary principles resulted from this dissociative action, notably all of those connected to the reaction of direct *pesanteur*: vibration of light, fermentation, emulsion, etc. Another way of putting it would be that *pesanteur* analyzed into fundamental constituents, while *pesanteur* in combination with lightness and free causes synthesized or generated a multiplicity of phenomena.

this need not be the case on the scale of the universe (a closed system where one might believe in the conservation of movement), it certainly would happen on earth, unless some other principle intervened to disrupt the natural tendency toward equilibrium.

An appeal to natural principles other than *pesanteur* was inescapable, yet full of pitfalls. Both in the Scholastic and the Cartesian meteorological traditions, the action and movement of the sun, the moon, and other celestial bodies, for instance, played this accessory role of rarefying and stirring matter on the surface of the earth, perhaps also causing it to ferment.⁸² In the first three books of his treatise, Castel seemed to think this explanation plausible, but in book four, he completely withdrew solar, lunar and planetary influences from the picture. This withdrawal was of course required by his “primitive Earth” thought experiment (i.e., considering the earth in isolation from the other “systems” that normally influence it), but for a number of reasons Castel had in fact become convinced that planetary action was negligible.⁸³ Just as inadmissible were Scholastic and alchemical speculations about vegetative souls and spirits. Aside from being unintelligible and potentially heretical (witness the *anima mundi* of ancient and modern Stoicism), these principles violated Castel’s metaphysical commitment to the simplicity and unity of nature. These metaphysical commitments, combined with his mechanistic assumptions,

⁸² Martin, *Renaissance Meteorology*, 7.

⁸³ Castel probably came across evidence suggesting the inefficacy of the sun’s rays on mountain heights and their well known weakness beneath the surface while reviewing the *Histoire de l’Académie Royale des science*. Part of his objections were also grounded in anti-astrological sentiments, as well as in his rejection of Newtonian gravitational attraction, as will be shown in chapter 5. Finally, it also stemmed from his reflection upon the causal disjunct between regular celestial motions and irregular effects on earth. Castel, *Traité de la pesanteur* I, 350: “Voilà ce que ne conçois pas, ou que je ne faisoit qu’entrevoir, lorsque je travaillois le Livre précédent: je croyois le Soleil fort propre à entretenir toutes les inégalités qui regnent sur la surface, & dans l’intérieur de la Terre [...]. C’est par la nécessité du Système, bien plus que par celle du raisonnement, que je conclus ainsi; car en raisonnant juste, j’aurois seulement conclu que la Terre devoit être un Sphéroïde haussé à l’Ecliptique, ou au Zodiaque, suivant la véritable route du Soleil.”

led him to reject the existence of *natural yet non-mechanical causes* in the universe.⁸⁴

Were one to introduce another natural force as a counterweight to *pesanteur*, such force would have to be mechanical. But the problem with two directly opposed mechanical forces was that the stronger would inevitably supplant the other, while two equal forces would cancel each other out.

Under these constraints, Nature would be incapable of perpetuating balancing movements and circulation in the world, let alone the generation of mixtures, irregular motions, and life in its infinite complexity. Thus, in the revised argument of the *Traité*, the first three books throw the philosophical shortcomings of the mechanical approach into sharp relief and demonstrate the need to relax the strictures of simplicity and unity. To account for the world as it actually is — full of soaring mountains, watery abysses, plants, animals, winds, waves, and irregularities — Castel *needed* an active principle capable of disrupting the equilibrium of nature without destroying *pesanteur* altogether.⁸⁵

It was thus necessary that God establish perpetually a kind of counter-nature, a counter-weight, a counter-balancing, or, if we prefer, a system of lightness, a centrifugal force, or a principle of life spread throughout nature and able to maintain circulation — life — in all its parts.⁸⁶

Through a comparison of the primitive, *a priori* state of the Earth with its actual state, the physico-theological argument of the fourth book established the necessity of grounding

⁸⁴ Brockliss and Jones, speaking about iatromechanical medicine, argue along these lines, claiming that iatromechanical thinkers “believed that creation was homogeneous; there was no distinction between inert and living bodies.” L. W. B. Brockliss and Collin Jones, *The Medical World of Early Modern France* (Oxford: Clarendon Press, 1997), 424.

⁸⁵ One could say that he generated this necessity by postulating constraint in the first place, and that we could imagine nature as a non deterministic system without the need to introduce spirits. We must recall, however, that Castel was working from the mechanical premises of the seventeenth century and that when taken to their logical limit, determinism was the outcome.

⁸⁶ Castel, *Traité de la pesanteur* I, 409: “Il a donc fallu que Dieu établit à perpétuité comme une contre-nature, un contre-poids, un contre-balancement, ou, si l’on veut un système de légèreté, une force centrifuge, ou un principe de vie répandu dans toute la nature, et capable d’entretenir la circulation, le mécanisme, la vie dans toutes ses parties.”

universal lightness in free, spiritual causes: a Christian God in the first place, and men secondarily.⁸⁷ Castel thus shifted the explanatory burden from physical principles to the interaction of “free spirits” with the natural world, a move that amounted, in his own estimation, to doubling the scope of natural philosophy. Indeed, the mechanical system of *pesanteur* considered only half of the observed physical world; a whole other half resided in the free agency of the divine and human will.

Castel’s intention was not to sacrifice methodological naturalism on the altar of divine intervention. On the contrary, he was committed to the action of secondary causes and objected to philosophers who resorted too quickly to God’s will in order to explain natural phenomena. To be sure, God had freely decreed the laws of nature, as well as their occasional miraculous suspension. But it was men’s efficacious will and the action they took to unsettle the inertness of matter that occasioned effects unaccountable by *pesanteur* alone. This opened up a field of research rather than precluding natural philosophical inquiry.

Determining the precise nature and scope of the interaction of man’s will with nature constitutes the core of the fifth and lengthiest book of the treatise.⁸⁸ In it, Castel examines the historical facts of nature in order to demonstrate not only the possibility, but also the necessity, and therefore the actuality, of man’s impact upon the surface and the depths of the earth. At the book’s core lies a detailed exposition of the mixtures and dise-

⁸⁷ Castel reasoned that the initial cause of the counterweight to *pesanteur* had to be miraculous, the direct action of some infinitely wise, powerful, infinite, free, spiritual, and eternal being — the God of of scholastic philosophers. This miracle was the universal upheaval, or chaos, discussed in the third book of the *Traité*. By interrupting the natural equilibrium, God displaced bodies from their natural places and thus gave the the first ‘swing’ they needed to balance and oscillate. Castel’s argument is clearly summarized by Schier, who traced it to Kircher’s *Iter ecstaticum*. Schier, *Louis Bertrand Castel*, 70-71.

⁸⁸ Castel, *Traité de la pesanteur* I, 430-621.

equilibrium that human activity generates and how these are integrated into the mechanism of circulation of the globe. Castel invigorates this mechanism, originally described in the first half of the treatise, with his concept of spirits, focusing on instances of balancing observed on earth, such as tides and analogous physiological and medical phenomena (breathing, bloodflow, the cyclical nature of fevers). Amid a host of conjectures testifying to the fecundity of his insight, he revisits the theory of meteorological perturbations and disasters outlined in the “Lettre à M. C.” and denies the existence of mechanical “troubles” in the system of the world (*pace* Newton) except insofar as they result from the free and unwitting actions of men. Castel’s system of the action of man arose partly from his religious meditation upon the “sad phenomena that keep all of its nature in a state of convulsion” — monsters, disasters, wars, famines — for which men’s sins and ignorance were to blame.⁸⁹

But Castel’s concept of universal lightness was not merely the logical outcome of his own argument. It also responded to a number of late-seventeenth-century philosophical systems — those of Boyle, Newton, Malebranche, Spinoza and Leibniz — which had arisen in response to the failures of the mechanical worldview. Current summaries of Castel’s argument tend to overlook this intellectual context, with the result that his contribution appears more isolated than it actually was.⁹⁰ Castel stood knee-deep in the

⁸⁹ Ibid., 590-591: “C’est à la vûë de ces tristes Phénomènes qui tiennent toute la Nature en convulsion, que j’ai saisi les premières idées du vaste Système, que je développe dans ces deux derniers Livres. [...] & j’avoüe que j’ai plus cherché depuis ce tems-là à m’en desabuser, qu’à m’en entêter; mais je dois dire aussi avec la même candeur, que tous mes efforts n’ont pû m’en distraire, toute la Nature s’empessant en quelque sorte à m’y confirmer.”

⁹⁰ One notable exception is Northeast, *Parisian Jesuits*, which is not about Castel specifically but about the intellectual world to which he and his colleagues from Louis-le-Grand belonged.

murky metaphysical and theological controversies that raged in scholarly circles at the beginning of the eighteenth century.

The Metaphysical and Theological Context of Universal Liberty

Castel was not exceptional in pointing out the shortcomings of reducing the material world to a single foundational principle (though the clarity and explicitness with which he did so set him apart). As Gaukroger puts it:

The need to accommodate forces while at the same time failing to find a place for them in the physical realm is the pressing problem for all those natural philosophers of the 1680s and 1690s who aspired to complete natural philosophy, and it is striking how close Newton comes to the solutions of Malebranche and Leibniz, which, in their different ways, remove forces from the physical realm and locate them respectively in the supernatural and in the metaphysical realms.⁹¹

Robert Boyle had already alerted the philosophical community to the limitations of mechanical reductionism in the context of pneumatic experiments the results of which seemed incompatible with the corpuscularian matter theory that he advocated elsewhere. Newton's analysis of light likewise posed a challenge to widespread assumptions about the unity of nature and about the necessity of appealing to an underlying matter theory for a physical explanation to be valid. For Boyle and Newton, and later John Locke, experimental philosophy revealed that, in some instances, seeking autonomous explanations at the phenomenal level was sufficient, and indeed more productive, than attempting to reduce macroscopic phenomena to a microscopic substratum. A valid explanation needed not be systematic and premised upon an underlying matter theory. It could also take the

⁹¹ Gaukroger, *Collapse of Mechanism*, 89.

form of a mathematical formalization or a phenomenal correlation between events.⁹² In cases where one felt the need to postulate a cause, an active principle of indeterminate nature but of impressive explanatory and predictive power was deemed preferable to a comparatively sterile mechanical reduction. Perhaps the most emblematic admission of the need for active principles of this sort is found in the conclusion of the second edition of Newton's *Opticks*.

Seeing therefore that the variety of motion, which we find in the world, is always decreasing; there is a necessity of conserving and recruiting it by active principles: such as are the cause of gravity, by which planets and comets keep their motions in their orbits, and bodies acquire great motion in falling, and the cause of fermentation, by which the heart and blood of animals are kept in perpetual motion and heat; the inward parts of the earth are constantly warmed, and in some places grow very hot; bodies burn and shine, mountains take fire; caverns of the earth are blown up, and the sun continues violently hot and lucid, and warms all things by his light. For we meet with very little motion in the world, besides what is owing to these active principles. And if it were not for these principles, the bodies of the earth, planets, comets, sun, and all things in them, would grow cold and freeze, and become inactive masses; and all putrefaction, generation, vegetation, and life would cease, and the planets and comets would not remain in their orbs.⁹³

Newton speculated that the cause of gravity, as well as a number of analogous causes, were active principles.⁹⁴ He believed that God had created the world in such a way that these active principles were essential to maintain the current arrangement of the heavens. Like Castel, he realized that gravitational attraction would not suffice if understood in purely mechanical terms. Ever unclear as to what these active principles might consist

⁹² Ibid., 153 ff.

⁹³ Newton, *Opticks: or, A Treatise of the Reflections, Refractions, Inflections and Colours of Light. Based on the Fourth Edition London, 1730, with a preface by I. B. Cohen, a forward by Albert Einstein, an introduction by E. T. Whittaker, and an analytical table of contents by Duane H. D. Roller* (New York: Dover Publication, 1952), 399-400. The parallel with Castel's own emphatic formulation of the problem is striking and, indeed, suggestive of Newton's influence.

⁹⁴ Gaukroger, *Collapse of Mechanism*, 89-94.

in, his conjectures about the existence of an aetherial medium, combined with a voluntarist interpretation of God's place in creation, provided plenty of material for his disciples to extrapolate from. Combined with suggestive discoveries in chemistry, physiology, and the physics of electricity, Newtonian active principles in effect helped paved the way for the vitalistic interpretation of nature of the late eighteenth and early nineteenth century: an explanation of nature in which immanent vital forces served to account for what mechanical reduction could not.⁹⁵

The recognition of the limits of mechanical reduction was not a uniquely British phenomenon, however, nor necessarily beholden to experimental philosophy. Two generations before Castel, several systematic philosophers on the Continent readily admitted the failures of the mechanical program. Malebranche, Spinoza, and Leibniz, to name but three of the most famous, all sought to refound this program upon firmer metaphysics. Take, for instance, Malebranche's phenomenalist reinterpretation of the Cartesian system. Addressing a problem Descartes left unresolved concerning the passivity of matter — namely the transfer of movement from one body to the next at the moment of impact — Malebranche developed an occasionalist interpretation of causation transferring the explanatory burden onto God's will. Occasionalism is the doctrine according to which God is the immediate cause of everything in the world. For Malebranche, matter did not *truly*

⁹⁵ On eighteenth-century vitalism, see Peter Hans Reill, *Vitalizing Nature in the Enlightenment* (Berkeley: University of California Press, 2005); Elizabeth A. Williams, *A Cultural History of Medical Vitalism in Enlightenment Montpellier* (Burlington: Ashgate Publishing, 2003); Ku-Ming Chang, "The Matter of Life: Georg Ernst Stahl and the Reconceptualizations of Matter, Body and Life in Early Modern Europe" (Ph.D. diss., University of Chicago, 2002), esp. 171-216; Roselyne Rey, *Naissance et développement du vitalisme en France de la deuxième moitié du XVIIIe siècle à la fin du Premier Empire* (Oxford: Voltaire Foundation, 2000); Gaukroger, *Collapse of Mechanism*, 328-383. On Newton's theory of aether, see P. M. Heimann, "'Nature is a Perpetual Worker': Newton's Aether and Eighteenth-Century Natural Philosophy," *Ambix* XX, no. 1 (March 1973): 1-25; also useful is Peter M. Heimann, "Voluntarism and Immanence: Conception of Nature in Eighteenth Century Thought," *Journal of the History of Ideas* 39, no. 2 (April-June 1978): 271-283.

cause change so much as it *occasioned* divine intervention. In a weak sense, this intervention took the form of the injection of movement at the moment of impact; in a strong sense, it meant the recreation of the entire world at every instant according to regular laws giving the illusion of secondary causation. This did not make natural philosophical inquiry pointless, for one could still wish to achieve understanding of God's plan through the study of *relational* connections at the phenomenal level; but it did make causal inquiry in terms of an underlying microcorpuscular world moot. For our present concerns, it also made the distinction between active and passive principles meaningless, insofar as all causation immediately resided in God.⁹⁶

Spinoza and Leibniz also participated in the collapse of mechanism. In contrast to Malebranche, who levelled the distinction between active and passive principles by reducing them all to God's will, Spinoza achieved similar results by reducing God and Nature to the same necessary substance and by making all things modes of the same deterministic web of cause and effects.⁹⁷ Leibniz, for his part, located active principles in monads — indivisible, non-material units of physical substance — making the physical world metaphysically possible and filling it with the vitality that passive matter lacked.⁹⁸ In various ways, Boyle, Newton, Locke, Malebranche, Spinoza, and Leibniz questioned

⁹⁶ Gaukroger, *Collapse of Mechanism*, 159. On occasionalism in the Cartesian tradition more generally, see Desmond Clarke, "Causal Powers and Occasionalism from Descartes to Malebranche," in *Descartes' Natural Philosophy*, ed. Gaukroger et al. (New York: Routledge Publishing, 2000), 131-148.

⁹⁷ On the doctrine of Spinoza and its reception in France, the classic source remains Paul Vernière, *Spinoza et la pensée française avant la Révolution*, 2 vol. (Paris: Presses universitaires de France, 1954). For a fresh look on Spinoza's philosophy and historical context, see Susan James, *Spinoza on Philosophy, Religion, and Politics: The Theologico-Political Treatise* (Oxford: Oxford University Press, 2014).

⁹⁸ On Leibniz views about the material world, see Daniel Garber, "Leibniz: physics and philosophy," in *The Cambridge Companion to Leibniz*, ed. Nicholas Jolley (Cambridge: New York, 1995), 270-352. On Leibniz's mature system of metaphysics, see Donald Rutherford, "Metaphysics: The Late Period," in *The Cambridge Companion to Leibniz*, ed. Nicholas Jolley (Cambridge: New York, 1995), 124-175. On his reception in France, consult William Henry Barber, *Leibniz in France: From Arnauld to Voltaire* (Oxford: Clarendon Press, 1755).

the assumptions of the mechanical worldview and contributed to its collapse even as they sought to refound natural philosophy on firmer ground.

Castel belonged to a generation that read and worked through the metaphysical and theological implications of these new philosophies. While he agreed with them that a strict mechanical approach could not provide a satisfying explanation for the world as we know it, he also felt that the solutions they proposed in order to remedy these shortcomings were fatally flawed on theological grounds. By placing the explanatory burden on God's will, Newtonian voluntarism undermined the regularity of nature (and thus the wisdom of its creator), while Malebranchian occasionalism in effect dispossessed men of any efficacious causal agency. Leibniz seemed to fall into a similar trap by making the metaphysical world of the monads entirely distinct from the material world, thereby denying any causal *interaction* between these two realms and conceiving instead of a pre-established harmony between the two. Although the first always appeared to cause the latter, they in fact ran on separate tracks pre-determined by God.⁹⁹ Leibniz's God, in addition, was bound by the principle of sufficient reason which, to Castel, sounded like a restriction imposed upon His freedom.¹⁰⁰ As for Spinoza's so-called pantheism, it openly denied free will to both God and man.¹⁰¹ In Castel's estimation, these systems ranged

⁹⁹ In his *Théodicée*, Leibniz distinguishes between necessity and determinism, claiming that all things are determined by their context even if they are not always necessary (i.e., the context could have, in principle, been different had God willed it otherwise). G. W. Leibniz, *Essais de Théodicée sur la bonté de Dieu, la liberté de l'homme et l'origine du mal* (Paris: Flammarion, 1999 [1710]), 124 ff [paragraphs 34 ff].

¹⁰⁰ Castel, "[Review of Leibniz's] *Essais de Théodicée*," *Mémoires de Trévoux* (Jan 1737): 5-36, (Feb 1737): 197-241, (March 1737): 444-471, and (June 1737): 953-991, esp. 966, where he writes: "[Leibniz] donne tout à la sagesse de Dieu, & ne laisse rien à faire à la liberté & au souverain domaine du Législateur. La puissance & et la bonté pour lesquelles il paroît beaucoup plus s'intéresser, austèrement bornées par cette Sagesse, & tout-à-fait dénuées de cette liberté, ne sont qu'une puissance & une bonté passives, mécaniques & aveugles malgré la sagesse, qui les entraîne plutôt qu'elle ne les dirige."

¹⁰¹ See below for a discussion of Castel's understanding of Spinoza and Spinozism.

from unorthodox to blatantly heretical. Their common denominator was their limitation of free will, which, as is well-known, was paramount to Catholic theology.¹⁰²

Castel's system of universal lightness and liberty must be read as participating in a widespread response to what eighteenth-century Jesuits perceived as the growing atheism of their age and deriving in part from seventeenth century-metaphysical missteps, but embodied in Castel's own days by so-called Spinozists and Epicureans. The term "atheism" did not stand literally for the denial of God's existence (such form of disbelief was exceptional at the time), so much as for various forms of irreligiosity and impiety, ranging from ancient paganism to Enlightenment deism. Spinozism and Epicurianism likewise denoted a wide range of philosophical and theological deviancies. The Jesuit's philosophical and apologetic program identified these two factions as serious threats to religion and *bonnes moeurs* across Christendom.

Succinctly put, Christian apologists tended to label as a 'Spinozist' any philosopher who proposed, or seemed to propose, that matter and spirit were essentially modifications of the same substance with the attendant implication that God and the material world were at bottom the same. Confused by the abstruseness of Spinoza's works and anxious to establish his heresy at the tail-end of familiar (and therefore easily confutable) ancient traditions, critics readily conflated his doctrine with a variety of similar-sounding yet distinct philosophical notions and traditions: pantheism, Stoic hylozoism, Italian Averroism, *anima mundi* doctrines, igneous soul theories, metempsychosis, Neo-Confucianism, and radical Cartesianism.¹⁰³ The label 'Epicurean' likewise referred to vaguely defined group of "libertines," *esprits forts*, and atomists who argued (or were

¹⁰² Northeast, *Parisian Jesuits*, 62 and 95.

¹⁰³ Vernière, *Spinoza II*, 354.

thought to argue) that the world is produced by the random collision of indivisible particles falling through infinite empty space rather than the rational creation of a divine Architect.¹⁰⁴ These views, no doubt less common than the Jesuits made it sound in their writings, amounted to denying the existence or Christian attributes of God, or to binding the spiritual world to the same deterministic laws that bound the physical world. Thus, the syncretic spirit that had given rise to these imaginary monsters merged them into one, the excessive spiritualism associated with Spinoza meeting the excessive materialism of Epicurus in the realm of philosophical extremes.¹⁰⁵

Castel's work fits within the Jesuit program. Yet his take on Spinoza and Epicurus took an interesting personal dimension. Most apologists, he observed, tended to associate "regularity" (order in the world) with "spirituality," that is, the manifestation of a rational will. Although this seems intuitive — the order suggests the existence of a designer — Castel thought that a much more powerful proof of the action of spirits lay in the existence of irregularities, which he interpreted as manifestation of freedom from the laws of nature.¹⁰⁶ Spinoza's mechanical philosophy, Castel proposed, had been too geometrical: he looked at the world through the lens of abstract thinking and saw only regularity. Fold-

¹⁰⁴ Neven Leddy and Avi S. Lifschitz, ed., "Epicurus in the Enlightenment: An Introduction," in *Epicurus in the Enlightenment* (Oxford : Voltaire Foundation, 2009), 1-11, esp. 4. See also Thomas Ahnert's contribution to the same volume, "Epicureanism and the Transformation of Natural Law in the Early German Enlightenment," 53-68, esp. 53-54. Ahnert discusses the German use of the term as a "smear word," but the same could be said in France, when uttered by religious apologists.

¹⁰⁵ Christian apologists and philosophers alike waved the names of Spinoza and Epicurus as bogeymen throughout the eighteenth century. Most innovative metaphysicians incurred the risk of being associated to either one of them. Descartes himself was thought to be — unintentionally — at the root of Spinoza's system, and both Leibniz and Malebranche were accused of walking down a slippery slope. Newtonians who argued for the existence of a vacuum and the emission of particles were for their part associated with Epicureans, whose doctrines they were reviving even if they rejected their most radical claims about God and the randomness of the world. Northeast's *Parisian Jesuits* provides a thorough discussion of these issues; see especially chapter 2, "Christianity: the philosophical problems," 55-105, which discusses the Jesuit's response to atheism in its various forms, as well as philosophical denial of providence and miracles; see also Vernière, *Spinoza*, 414-446.

¹⁰⁶ Ehrard also makes this point in *L'Idée de la nature*, 67-68.

ing everything into a general system, he “turned God into an automaton.”¹⁰⁷ Spinoza was but an extreme case of a tendency common to most mechanical philosophers:

All this evil comes from the fact that we confuse bodies with spirits; and that we demand a mathematical regularity in both: we are too much enslaved to matter, and we bring everything to our senses too much; we want that the will placed between two objects follow the system of bodies, and that it be carried by the strongest.¹⁰⁸

Epicurus, in contrast, saw the world through the eyes of a *physicien*, and in a way, saw it more clearly than Spinoza,

for it is true that liberty carries with it the impression of randomness with respect of ourselves, and that indeed, we are witness to an infinity of events which, resulting from the liberty of men, do not have any necessary relation with each other, nor with the general [physical] system of the universe.¹⁰⁹

Epicurus witnessed real irregularities, but instead of recognizing them as manifestations of free will, he attributed them to chance. His mistake, in other words, was to “attribute to bodies the system of spirit,” which is to say, the system of liberty, and to reduce God’s will to randomness.¹¹⁰

In chapter one, we saw that Castel predicted progress in natural philosophy once spiritual causes had been distinguished from natural ones. Here we see that this process of discernment was also intended as a prophylactic measure against philosophical and religious errors (just what the traditional discernment of spirit was meant to achieve).

¹⁰⁷ Castel, *Traité de la pesanteur* I, 421.

¹⁰⁸ *Ibid.*, 421-422.

¹⁰⁹ *Ibid.*, 421.

¹¹⁰ In a way, Castel was turning Epicurean randomness on its head. Epicureans could not account for the world as it actually is with the simple fall of atoms in infinite space. They had to resort to the *clinamen*, a kind of “swerve” bending the course of particles, introducing random collisions, generating aggregates, and so forth. The *clinamen*, in a way, served to account for mixtures and its related phenomena, much like Castel’s notion of free action of spirits. Only, Epicureans saw in this process as a means to explain the world without the intervention of God and spiritual beings, while Castel argued that on the contrary, this unpredictability was the strongest proof of spiritual agents. Thanks to Sean Schifano for helping me work out this insight.

Castel proposed a middle path between the blind geometry of Spinoza and the absurd and dangerous physics of Epicurus. Rather than trying to reduce bodies and spirits to mechanical necessity or to surrender the world to blind chance Castel wanted his readers to recognize the beautiful harmony resulting from the interaction of natural laws and their artful suspension by free spirits.

At first, God produced Nature, and gave it fixed and immutable rules; but when he willed to give birth to the marvels that shine throughout this universe, he superceded these rules, and without destroying them, knew how to suspend them and move away from them, without failing his transcendental wisdom, which is superior to all rules.¹¹¹

Thus, from the simplicity of nature God generated a diversity of phenomena without destroying the laws of nature but by suspending them. The “beautiful disorder” of the universe is indeed a work of art:

It is the disorder, the confusion, and the mixture that reigns in substances that make the sun shine, the [night] sky shimmer everywhere, that cause flowers to enamel the earth, and fruit to grow; and it is worth noting in passing that even our [human] arts have their primitive rules, from whose overly vast empire it is an art to free oneself, to conform to certain rules that genius inspires and taste apprehends.¹¹²

This work of art originated in God, but has since been perpetuated by human beings, who, in the likeness of their Author, were free to occasion irregularities and confusion in the world.

¹¹¹ Castel, *Traité de la pesanteur* I, 423: “Dieu produisit d’abord la Nature, & lui donna des règles fixes, & immuables; mais quand il voulut enfanter les merveilles, qui éclatent dans cet Univers, il le prit sur un ton plus haut que les règles; & sans les anéantir, il sçut les suspendre, & sans écarter même, sans s’écarter néanmoins des vûës d’une sagesse transcendante, & supérieure à toutes les Régles.”

¹¹² *Ibid.*, 423. Here Castel is paraphrasing Boileau — “Souvent, un beau désordre peut être l’effet de l’art” — and then remarks that “c’est le desordre, la confusion, le mélange qui règnent dans les substances, qui font que le Soleil éclaire, que le Ciel brille de toutes parts, que la Terre s’émaille de fleurs, & se charge de fruit; & pour remarquer en passant, tous nos Arts même ont leurs règles primitives, dont c’est un Art de sçavoir secouer le trop grand empire, pour se conformer à certaines règles que le génie inspire, & que le goût saisit.” He introduces similar aesthetic concepts of harmony in his work on the color harpsichord and the color-sound analogy. Nicolas Boileau Despréaux, “L’Art poétique,” in *Œuvres complètes*, edited by François Escal, with an introduction by Antoine Adam (Paris: Gallimard, 1966), 164.

Insofar as “universal lightness,” the counterweight to *pesanteur*, was interpreted as interrupting (rather than annihilating) the laws of nature, Castel also referred to his system as one of liberty — a space of freedom within an otherwise rigid and arbitrarily designed mechanical system. His concept of liberty had important implications, both theological and political. Leaving aside, for now, the political dimension, let us briefly consider the theological side of the question.¹¹³

Aside from refuting materialists, Castel and his fellow Jesuits were most interested in safeguarding the belief in the fundamental freedom of God and the human soul against the deterministic tendency of their time.¹¹⁴ Castel’s criticism of Spinoza, like that of his colleagues on the *Mémoires de Trévoux*, boiled down to this question of free will. Spinoza’s God was a kind of automaton, whose will was bound by necessity and who did not intervene in his Creation by means of miracles. In the web of physical causes and effects, the human soul was also necessarily determined, and for all intents and purposes, its free will was illusory. Though actual Spinozists were rare, determinists of different degrees of conviction were growing numerous among natural philosophers. Using the word *liberté* in a treatise of physics actually seemed out of place to Castel’s contemporaries who worked under deterministic assumptions when discussing natural phenomena.¹¹⁵

Castel did not believe that naturalistic inquiry into the world required a commitment to determinism, and this was reflected in his particular contribution to contemporary

¹¹³ Castel has a lot more to say about this in his unpublished “Lettre[s] sur le proverb qui dit Pescher en Eau Trouble,” Ms. 15743, Fonds Van Hulthem, Bibliothèque Royale Albert Ier, Brussels.

¹¹⁴ Père Tournemine was an important predecessor of Castel in this regard. See for instance “Conjectures sur l’union de l’âme et du corps,” *Mémoires de Trévoux* (May 1703), 864-76, (June 1703): 1063-1065, and (Oct. 1703): 1857-1870; as well as “Lettre du Père Tournemine à M. de *** sur l’immaterialité de l’âme, et les sources de l’incrédulité,” *Mémoires de Trévoux* (Oct. 1735): 1913-1935.

¹¹⁵ See Le Cat, “Eloge,” 4r.

debates over miracles. In her excellent book, Caroline Northeast situates Castel within the context of the theological debate over the nature of God's intervention in the world and argues that he represents the exceptional case of a Jesuit natural philosopher trying to "provide an account of the physical manifestation of divine Providence without recourse to miracles."¹¹⁶ Northeast contends that "the need to safeguard the prerogatives of divine liberty forced the Jesuits into an assiduous defence of miracles at the very time when the new science of mechanics served to illuminate the regularity of the laws of physics."¹¹⁷ Yet defending the existence of miracles was a tricky business, making apologists susceptible to charges of guillibility, superstition, or naive fideism. In the field of natural philosophy, it was imperative for self-respecting scholars like Castel and his peers not to resort to God's direct agency when secondary causes could account for natural phenomena. Thus, Castel did not devote as much energy to demonstrate the existence of miracles as he did trying to show that the world, in spite of its fixed natural laws, was full of irregularities. In order to win over non-believers and skeptics, Castel argued that

the capital point would be to make them see within Nature itself a hand incontestably superior to *Nature* and a kind of perpetual *miracle*, which, though natural [and here the term nature is to be taken, as it should, in its extended meaning] would nonetheless be above if not nature and natural causes in general, at least above nature and its mechanical causes.¹¹⁸

¹¹⁶ Northeast, *Parisian Jesuits*, 92-93.

¹¹⁷ *Ibid.*, 92.

¹¹⁸ Castel, *Traité de la pesanteur* I, 384-385: "Il semble donc que pour réduire tous ces Esprits forts, du moins au silence, le point capital seroit de leur faire voir dans le sein même de la *Nature*, une main incontestablement supérieure à la Nature, et une sorte de *Miracle* toujours subsistans, lesquels, quoique naturels, à prendre le terme de *naturel*, comme il faut le prendre, dans un sens plus étendu, sont néanmoins au-dessus sinon de la Nature, et des *causes naturelles* en général, du moins au-dessus de la *Nature*, et des causes mécaniques." English translation adapted from Northeast, *The Parisian Jesuits*, 93.

Simply put, these irregularities had to originate in the only free spiritual agent embodied within nature: Man.¹¹⁹

At root, the main purpose of the *Traité* was to counter what Castel perceived as the erosion of the dignity of man, which he conceived as a God-given power to act freely upon the course of nature. The Jesuits' main adversaries in the late seventeenth and early eighteenth century were, aside from Protestants, Jansenists and theologians of Augustinian leanings who held a pessimistic view of humankind: born in sin and sinful in nature, humans were, according to the Augustinian doctrine of the seventeenth century, incapable of redemption without a free gift of grace on God's part. This doctrine differed from the Calvinist notion of redemption in that it did not restrict salvation to a few, predestined souls, but from a Jesuit's perspective, this distinction did not make Jansenists any less suspect. The Jesuits, who had a more optimistic outlook, argued that although supernatural grace was needed for men to achieve salvation, sinners could actively seek to achieve this state of grace, notably by receiving the sacraments.¹²⁰ Since 1713, the Papacy had sanctioned this interpretation and condemned, with the Bull *Unigenitus*, the position of Jansen and his followers. Castel, although careful to avoid theological polemics, had been trained in the context of doctrinal controversies; he undoubtedly wrote the *Traité* with contemporary debates about nature, grace, and freewill in mind.

¹¹⁹ This leaves unanswered the tricky problem of the the mind-body relationship, a proper treatment of which would require a discussion of Castel's stance with respect to occasionalism, as well as his theory of sense perception. Humans as free spiritual agents are capable of occasioning changes in the natural course of nature insofar as they are embodied: but how does the mind interact with matter? This is a problem inherent to dualistic system of the world, and with which Descartes, Leibniz, Malebranche and countless others struggled. Castel does not, to my knowledge, provide an *a priori* explanation of this process; he accepts it on the basis of experience and argues for its necessity.

¹²⁰ On the Jesuit's stance vis-à-vis the followers of Jansen, see Northeast, *Parisian Jesuits*, 28-34, 176-183.

The Jesuits were not alone in opposing the pessimism of the seventeenth and early eighteenth century. Indeed, the eighteenth century — and the Enlightenment movement in particular — is still usually associated with an optimistic outlook celebrating the achievement and progress of mankind.¹²¹ Yet a case can be made that many Enlightenment thinkers undermined man’s dignity by limiting human reason to narrow bounds, by reducing free will to an illusion or a complex amalgam of mechanical or mathematical causes, by embracing climatological determinism, or by simply denying the immortality of the soul, which was held as the most divine aspect of mankind.¹²² Castel made just this case, and he presents us with an eighteenth century quite unlike the one we find in the received historical narratives. He was a Christian humanist who had faith in the powers of Man over nature, including his own sinful nature. God created man in his image and granted him the gift of freedom, and this very freedom was the principle of lightness or liberty that could overturn the necessity of *pesanteur*.

Answering what he and his religious order perceived as threats from various philosophical quarters — whether these were specific philosophical doctrines or the specters of Spinozism, Epicurianism, and atheism — Castel produced an original defense of the dignity of man within the framework of physics. As a Christian apologist, his goal was not only to preserve religion against encroaching developments of natural philosophy, but also to protect mechanical philosophy by clarifying its object and establishing safe

¹²¹ On Enlightenment optimism, consult Charles Frankel, *The Faith of Reason* (New York: Octagon Books, 1969). For a more nuanced study of both pessimistic and optimistic strands in the eighteenth century, see Henry Vyverberg, *Historical Pessimism in the French Enlightenment* (Cambridge, MA: Harvard University Press, 1958). See also chapter 6, below.

¹²² Schier proposes that “[Castel’s] attempt to restore man to his place as the ruler of nature was common to most of the Catholic apologists of the day. The *philosophe*, on the other hand, tended to restrict both the dignity and the influence of man with respect to the universe in general.” Schier, *Louis Bertrand Castel*, 72.

boundaries, thereby preventing it from collapsing under the weight, so to speak, of an irreducible lightness and liberty. Although Castel's theses did not win him many supporters, they had the merit of clearly delineating the shortcomings of the mechanical philosophy, as well as opening up a whole sphere of inquiry into the interaction of man with nature.

Indeed, a generation or so after the publication of Castel's treatise, a growing number of philosophers, natural historians, and physicians accepted the existence of non-mechanical forces as an alternative to the mechanistic framework. Although most of them eschewed an appeal to spiritual causation, they did rely upon mysterious animating forces or a principle of life that essentially did the same work as Castel's free spirits. The rise of Newtonianism in France (with its interpretation of gravitation as an active principle), combined with new physiological and electrical discoveries, no doubt contributed to the emergence of these ideas.¹²³ But the emergence of vitalism in France also came with a recognition of the very limitations of mechanical philosophy that Castel had help to explicate in his treatise. While any line of influence would be hard to trace (such broad historical change being overdetermined), Castel certainly has a place in that story. Coming long after seventeenth-century experimentalists and metaphysicians had first put their finger on the problem, but decades before dogmatic mechanical philosophers abdicated *en masse*, Castel's treatise is an important landmark in the transition from the mechanical worldview to the natural philosophy of the Enlightenment.

¹²³ Brockliss and Jones, *Medical World*, 430-433; Reill, *Vitalizing Nature*, 79; for a nuanced position on historiographical associations of Newtonian Enlightenment with early eighteenth-century vitalism in Montpellier, see Williams, *Cultural History*, 328-329.

Concluding Remarks

This chapter approached the *Traité de physique de la pesanteur universelle des corps*, Castel's first major work, as an original and substantial contribution to systematic physics and to early eighteenth-century natural philosophy broadly conceived. I argued that Castel's treatise was both emblematic of its time and distinctive. It was emblematic in the sense that it engaged with some of the most fundamental and pressing issues with which a natural philosopher could wrestle in the 1720s. It was distinctive insofar as the path he chose to address these issues was his own and cannot be reduced to the great "isms" of historiography.

Castel was directly involved in the epochal debates opposing Cartesian and Newtonian conceptions of gravity and scientific method. His contribution is remarkable for the way in which it manoeuvred between the reefs of his predecessors' systems. The general system of *pesanteur* he developed was indeed intended as a middle way between established Cartesian and Newtonian traditions that aimed to elucidate, each in their own way, the phenomenon of *pesanteur*. But Castel also intended his work to crown his predecessors' achievements with an original system of lightness and liberty that widened the scope of natural philosophy even as it narrowed that of physics. This system sought to resolve the deep metaphysical and theological tensions accompanying the collapse of the mechanical worldview. Castel's work participated in this important turning point in the history of science by articulating the shortcomings of his predecessors' works and expressing his discontent with the perceived deterministic and atheistic implications of the dominant philosophical systems of his time. Like many before him, he felt the need for the integration of active principles within the mechanism of nature. Unlike most contem-

poaries, however, he opted for a compromise between a materialist and a supernaturalist solution by locating this active principle in the free will and dignity of God's stewards on earth.

Castel's account of the "progress of the human mind in the discovery of the system of *pesanteur*" — the philosophical history contained in the second volume of the *Traité*, and to which I return in chapter 6 — corroborates my interpretation. By backing up his philosophical argument with a sophisticated historical analysis showing the convergence of his predecessors' minds toward the discovery of true system of the world, Castel placed his work as the culmination of previous traditions and declared the conciliatory character of his natural philosophy. If the *Traité* fails to meet modern expectations about what an eighteenth-century physics treatise should look like, it is not because Castel was derivative and out of touch with contemporary scientific developments, but because of his historical self-awareness. Castel's historical sensibility led him to engage not only with contemporaries, but also and even primarily with a long succession of predecessors.

If not *directly* influential on the long-term development of natural philosophy in France (where Newtonian theories and highly abstract analytical mechanics combined to generate a kind of physics that was alien to Castel's conception), the *Traité* was at the very least thought-provoking. Castel understood that by providing new perspectives on well-trodden topics and by establishing rapports between physics and other spheres of activity — morals, politics, history, theology, aesthetics, and so forth — he could prod dominant philosophical discourses in new and fruitful directions. The centrality of "liberty" in the *philosophes*' writings about society and nature, for instance, combined with the

polemical associations of France to “lightness” and England to “heaviness” in contemporary scientific, political, and moral discourses, raises the question of Castel’s role in the development of the Enlightenment “science of man,” which looked to natural philosophy as a model for its descriptive and normative inquiries into human nature. Accordingly, the following chapter will examine how Castel defended the moral and political utility of his speculative philosophy by outlining a physico-political project grounded in his two-fold system of the world, thereby suggesting unsuspected channels through which Castelian ideas grew and spread.

CHAPTER 3

Circulation and Physico-Politics

Yet such is the analogy between the system of bodies and the system of hearts, that the precise cause (raison) that bends the course of bodies also deviates and distorts the motions of the hearts. A curved movement, the mechanists say, is a movement hindered at every point: political thinkers should adopt precisely this definition [...]. And notice, Sir, the precision of my analogy, and I dare say [...] the sameness of the two systems.¹

— Louis-Bertrand Castel

Castel's most profound contribution to natural philosophy, the establishment of universal lightness and liberty as the necessary counterweight to the mechanism of universal *pesanteur*, ought to be read through the lens of Christian apologetics as a defence of human dignity and free will. In contrast to the reductivist mechanics and the determinist metaphysics of his predecessors, Castel's project was one of exaltation. It demonstrated the fecundity of human action on earth and argued that to truly become God's steward, "Man" first had to recognize the full extent of his impact upon the course of nature.

Like the commonplace Baconian plea for the advancement of learning, Castel's exhortations entailed that mastery of nature would come through technological means, especially in the context of infrastructural development. More importantly, he believed that nature would become more hospitable once human beings became aware of themselves as efficacious agents in the world and once they were provided with enough guidance to channel their power safely. Implicit in Castel's argument was that the kind of

¹ Louis-Bertrand Castel, "Lettre sur la Politique adressée à Monsieur l'Abbé de Saint Pierre, par le Père Castel Jesuite. A Paris ce huitième de Fevrier 1725," *Mémoires de Trévoux* (April 1725): 703: "Or telle est l'Analogie entre le système des corps & celui des coeurs, que la raison précise qui rend courbe les mouvements des corps, rend détourné & tortueux les mouvemens des coeurs. Un mouvement courbe, disent les Méchaniciens, est un mouvement empêché dans tous ses points: or il faut bien que les Politiques adoptent précisément cette définition. [...] Et remarquez, Monsieur, la précision de mon Analogie, & si j'osois le dire [...], la *mêmeté* des deux systèmes."

speculative philosophy that yielded these insights had practical potential. Indeed, a sovereign prince informed by it would reap great benefits for the state and the people.

This and the following chapters show that Castel's philosophy was more down-to-earth than scholars usually recognize. This chapter in particular focuses on the political and moral branches of his system. The discussion pivots around the "Lettre sur la politique" (1725), an important offshoot of the *Traité de la pesanteur*, written in response to the abbé de Saint-Pierre's suggestion that Castel should devote more time to the public good and less time to physics.² By establishing the particular circumstances that gave rise to this exchange, the first section of this chapter argues that Castel intended this open letter as a demonstration of the usefulness of speculative natural philosophy. Seeing the universe as "half material, half spiritual," he found exact analogies between the "phenomena of the heart and of the mind" and those of the physical world.³ By implication, knowledge of the latter promised useful insight into the former, especially in matters of governance and political economy.

The second and third sections show how Castel substantiated his claim by analyzing the physical meaning of concepts such as equilibrium, balancing, circulation, and organization and by establishing more precise rapports between them and their political and infrastructural uses. Informed by the great engineering projects that transformed his native Languedoc and by contemporary developments in political economy, Castel imagined and justified ways by which a prince might promote a healthy circulation of goods,

² Castel, "Lettre sur la Politique," 698-729; Charles Irénée Castel de Saint-Pierre, "Observations générales de Monsieur l'Abbé de Saint Pierre sur le Traité de la Pesanteur [...]," *Mémoires de Trévoux* (December 1724): 2233-2245.

³ Castel, "Lettre sur la politique," 701: "[M]ais ceux qui entrent un peu dans l'esprit de la chose, voyent bien que les Phénomènes du coeur et de l'esprit appartiennent autant que ceux des Corps, à un système mi-parti de materialisme & de spiritualisme."

peoples, and ideas throughout the realm. In effect, he positioned himself as a uniquely qualified *physico-political* advisor to the State.

Although it did not have a deep impact on the development of political economy *per se*, the physico-political project outlined in the “Lettre sur la politique” sheds light on Castel’s role in the emergence of Enlightenment moral sciences. The fourth and final section situates Castel’s thought with respect to this broader eighteenth-century intellectual canvas. Unlike contemporaries and successors who, like him, looked at the study of nature as a model for the study of man and society, Castel did not import physical concepts into moral and political matters with reductive, let alone deterministic, intentions. His subordination of morals and politics to natural philosophy writ large was atypical of Enlightenment thought because he understood the physical world as inherently shaped by the free causes, and therefore resisted attempts to reduce human activity to fixed laws of nature. Yet for all his atypicality, I maintain that he was not rowing against the intellectual current of his time so much as attempting to channel it in a different direction.

The Usefulness of Natural Philosophy

The publication of the *Traité de la pesanteur* elicited a vigorous public response ranging from heartfelt endorsement to open raillery. At one end of the spectrum stood self-proclaimed disciples like Mr. Joly, who lavished praise upon Castel’s analytic method and lively style.⁴ As one might expect, the *Mémoires de Trévoux* was expository ra-

⁴ [Guillaume-François] Joly [de Fleury?], “Discours critique prononcé par M. de Joly [...] au sujet du Traité de la pesanteur universelle des corps du P. Castel, et des observations generales de M. l’Abbé de Saint-Pierre sur ce nouveau système, insérées dans les *Mémoires de Trévoux* du mois de décembre dernier,” *Mercur de France* (Avril 1725): 671-672; Joly, “Suite du Discours Critique, inseré dans le précédent

ther than critical (Castel was almost certainly the author of the *extrait*).⁵ More guardedly, the *Journal des Sçavans* highlighted the systematic rigor of the work. It claimed that, although one might disagree with its particular theses, one could not help but be carried away by the argument.⁶ For its part, the *Acta Eruditorum* — the only foreign journal to acknowledge the work — produced a Latin summary of the first volume, its author showing Newtonian sympathies and a certain skepticism vis-à-vis Castel’s theory.⁷

More substantial criticism came in the form of public and private letters. Jean Bouillet, whose *Dissertation sur la cause de la pesanteur* Castel had previously rebuffed, returned the favor by raising a number of difficulties against his rival’s system.⁸ Soon afterward, the abbé Desfourneaux, writing anonymously, published a series of *Lettres critiques* that challenged Castel’s theory of the weight of fire, his views on primeval chaos, and his system of disequilibrium.⁹ His most thorough critic, however, was probably

Mercure, au sujet du Traité de la pesanteur universelle des Corps, du P. Castel,” *Mercure de France* (May 1725): 857-876.

⁵ “[Review of Castel’s] Traité de physique sur la Pesanteur Universelle des Corps [...],” *Mémoires de Trévoux* (March 1724): 445-473 and (Avril 1724): 614-643.

⁶ “[Review of] Traité de physique [...] par le Pere Castel de la Compagnie de Jésus,” *Journal des sçavans* (June 1724), 391-406, esp. 391: “& quelque paradoxe que paroisse une telle prétention [the insufficiency of a mechanical system after Descartes], il faut cependant convenir avec les plus éclairés qu’elle mérite toute l’attention des Philosophes: car l’Auteur ne se borne pas, à la simple découverte, ni à l’ébauche du système, qu’il propose, il entre dans un détail de conséquences & de preuves, dont l’enchaînement géométrique entraîne, comme malgré eux, ceux qui s’y rendent le moins dociles.”

⁷ “[Review of Castel’s] Tractatus physicus de gravitate universali corporum,” *Acta Eruditorum* (Oct 1724): 460-470. We can exclude from the list of international responses the anonymous “Lettre écrite de Gopolis, en Prusse, le 15 janvier, 1725,” *Mercure de France* (Fev. 1725): 401-403, which was a satirical piece surmising how the Apocalypse might take place according to Castel’s theory.

⁸ [Jean Bouillet], “Lettre où l’on propose des difficultez contre le Sistême du Pere Castel,” *Mémoires de Trévoux* (Sept. 1724): 1634-1637. One of Bouillet’s main objections concerned Castel’s seeming attribution of gravity to an inherent property of matter.

⁹ [Abbé Desfourneaux], “Lettres critiques écrites d’Angleterre au R. P. Castel [...] sur trois articles importants de son nouveau système de la pesanteur universelle, par le Chevalier ***,” (Paris: Chez Musier, 1725). For the attribution to Desfourneaux, see Schier, *Louis Bertrand Castel*, 80. See also “[Review of Desfourneaux’s] Lettres critiques écrite d’Angleterre [...],” *Journal des Sçavans* (Jan. 1726): 18-23, and Castel, “Lettre du P. Castel, Jésuite à M. de la Roque, écrite à Paris le 9 juin 1725,” *Mercure de France* (July 1726): 1537-1543.

Père Laval, SJ (1664-1728), a reputable astronomer and hydrographer stationed at the harbor of Toulon, whose critique survives in an incomplete manuscript letter that found its way into Castel's papers. Laval formulated a number of objections to Castel's theories of equilibrium, central fire, and tides. He also deplored his younger colleague's blind reliance on Kircher in supposing the existence of abysses and channels at the bottom of the sea, claiming that these alleged "facts" (and the circulation theory they supported) lacked any empirical support.¹⁰

This barrage put Castel on the defensive. Determined to hold his ground, he occasionally responded in kind with point-by-point refutations or else advised a careful re-reading of his book.¹¹ But after months of fending off objections about style, method, and unwarranted "novelties," he started showing signs of exhaustion. Evidence of this can be found, for instance, in his correspondence with the Swiss physician and naturalist Johann Jakob Scheuchzer (1672-1733).¹² In a letter dated 6 August 1725, Castel preventively downplayed the *Traité* by qualifying it as "an early work, abounding in bright and bold assertions" that might not withstand a careful scrutiny.¹³ Epistolary conventions aside,

¹⁰ Antoine de Laval, SJ, "Reflexions sur ce qui arrive a un boulet," followed by a critique of Castel's *Traité de la pesanteur*, Ms. 15751-15754 (54r-67v, esp. 60r and ff.), Fonds Van Hulthem, Bibliothèque Royale Albert 1er, Brussels.

¹¹ Castel was particularly unimpressed by Bouillet's objections, and responded with a "Réponse à la Lettre précédente [de Bouillet] par le Pere Castel, Jesuite," *Mémoires de Trévoux* (Sept. 1724): 1638-1643. He uses a more deferential tone in his "Réponse du Pere Castel aux Observations generales de Mr. l'Abbé de Saint Pierre sur le Traité de la Pesanteur universelle," *Mémoires de Trévoux* (Feb. 1725): 295-318.

¹² What survives of Castel's correspondence to Scheuchzer is preserved in Ms. H 292 (100-109); and Ms. H 305 (179-190), Scheuchzer Collection, Zentralbibliothek, Zürich. The first set are in fact two letters that Castel sent to his friend Woolhouse, who in turn transmitted them to Scheuchzer, along with a good recommendation (Woolhouse describes Castel as "un des plus sçavans philosophes que nous ayons icy à Paris" and "la meilleure plume" of the *Mémoires de Trévoux*"); see letter from Woolhouse to Scheuchzer, [1725] Ms. H 293 (111) and letter from Woolhouse to Scheuchzer, 14 July 1725, Ms. H 293 (118), Scheuchzer Collection, Zentralbibliothek, Zürich.

¹³ Letter from Castel to Scheuchzer, 6 August 1725 in Paris, Ms. H 305 (183-184), Scheuchzer Collection, Zentralbibliothek, Zürich. Explaining that it had been written "pour le commun des lecteurs"

Castel's humble stance was strategic. By directing Scheuchzer's attention toward the synthetic portion of his work — the “Table Systématique” at the end of the second volume — and away from its more controversial or frivolous features, he hoped to avoid further confrontation and win suffrage on the question of earthly circulation.¹⁴ At stake was not the treatise's argument *per se* — he made no real concessions on that front — so much as its suboptimal organization.

There was one critique, however, which did catalyze new and positive developments in Castel's philosophy. The abbé de Saint-Pierre's “Observations générales [...] sur le *Traité de la pesanteur*,” published in the *Mémoires de Trévoux* of December 1724, gave Castel cause to explore some of the ramifications of his system. Since he valued the friendship of the illustrious political theorist, Castel did not simply offer counter-arguments; he used the abbé's remarks as a prompt to elaborate his views on political economy.

and “les françois qui aiment l'enjouement du stile plutot que la solidité du discours,” Castel recommended that a serious savant like Scheuchzer begin with the “Table Systematique” included at the end of the second volume (“le seul morceau que je donnasse aujourd'hui si j'étois a recommencer”) where his system was “plus murement énoncé en style geometrique ou plutot synthetique ou didactique sans aucune superfluité de discours.” As for the alleged novelties of his argument, Castel pleaded his innocence: “en physique la nouveauté n'est pas un crime” and “toutes les decouvertes parroissent d'abord hardies et extraordinaires,” but need not be so under a more careful scrutiny.

¹⁴ Castel needed the advice of the eminent Swiss polymath for the completion of his treatise on “shells” (fossils were one of Scheuchzer's areas of predilection). Castel was particularly anxious to hear what his new correspondent had to say about his theory of the earth's circulation and organization. He was also curious to know what he thought of his biblical exegesis, and in particular, of the physico-theological interpretation of the chaos, light, and waters of Genesis I featured in the second volume of the *Traité*. Castel was looking for support outside of France and was happy to do whatever was in his power to secure it. In exchange for Scheuchzer's feedback, Castel promised to promote his most recent work — *L'homme ante-diluvien* — in the *Mémoire de Trevoux* and to facilitate its diffusion in France through his contact with the abbé Bignon, the *Journal des Sçavans*, and the Parisian printers. See Ms. H 293 (100-102), Ms. H 305 (183-185 and 187-188), Scheuchzer Collection, Zentralbibliothek, Zürich.

Saint-Pierre's "Observations générales" contained a challenge. On the whole, it was constructive and supportive: "If I offer general criticisms to the book of Père Castel," he wrote,

it is because I deem it good, and consequently, very worthy of improvement. [Castel's] mind seems systematic to me; he knows how to link (*enchaîner*) his ideas together, and it is the perfect linkage (*enchaînement*) of ideas that makes for their solidity. Only such first-class minds, with their great perspicuity, the clarity of their demonstration, and their capacity to elucidate difficulties (*éclaircissement*), can break difficult paths and show fecund truths to second-class minds.¹⁵

And yet Saint-Pierre deplored that a brilliant mind like Castel should devote his youthful energy to "idle physics," instead of working on perfecting and systematizing politics, "a science incomparably more useful" for the happiness of all.¹⁶ Unlike Bouillet, Desfourneaux and others after them, Saint-Pierre criticized the treatise not only because it failed to meet his methodological and stylistic expectations (in this respect, Castel thought the abbé was out of his depth), but also because he felt that the young man's talent could be put to better use.¹⁷ Contemplating his own life trajectory, which had led him from natural

¹⁵ Saint-Pierre, "Observations générales," 2243-2244: "Si je fais des critiques générales du Livre du Père Castel, c'est que je le crois bon, & par consequent très-digne d'être perfectionné: son esprit me paroît systématique; il sçait enchaîner ses idées les unes avec les autres, & c'est l'enchaînement parfait des idées, qui en fait la solidité: ce sont ces sortes d'esprits de la premiere classe, qui seuls, avec leur grande penetration, avec la netteté de leur démonstrations & avec les éclaircissemens aux difficultez, peuvent ouvrir des routes difficiles & montrer des véritez fécondes aux esprits de la seconde classe."

¹⁶ Ibid., 2243-2245: "Je regrette seulement, que de pareil génies ne s'appliquent pas à perfectionner une science incomparablement plus utile que n'est la Physique pour la diminution & pour l'augmentation du bonheur de la société humaine: je suis fâché que ces génies ne travaillent pas de bonne heure à perfectionner la politique; & si j'ai presque quitté l'une depuis vingt-cinq ans pour me donner presque entièrement à l'autre, c'est que dans ce tems-là je comparai les differens degrez d'utilité par rapport au public, & je remarquai dès lors, qu'outre la grande superiorité d'utilité, la politique n'étoit ni moins difficile, ni moins susceptible d'un système simple, ni moins capable de donner de veritable démonstration de découvertes merveilleuses."

¹⁷ Le Cat, "Eloge," 13r: "L'Abbé de St. Pierre gémissoit de voir un genie tel que le P. Castel s'amuser à la Physique, au lieu de se donner à l'art de gouverner les hommes et de les rendre heureux, le seul qui lui parût digne d'un bon Citoyen et d'un bon esprit."

philosophy to political economy, the old abbé hoped that Castel would follow in his footsteps.¹⁸

On the face of it, this was not an unreasonable expectation. Despite their philosophical disagreements, Saint-Pierre felt affinities between his and Castel's projects, as well as between their characters. He was not alone in doing so. "The abbé de Saint Pierre was always a friend of Père Castel," Berthier wrote in Castel's obituary, adding that they were "minds rather made for one another" even though they did not always see eye to eye.¹⁹ Le Cat agreed: "True twins by imagination, the abbé was with respect to politics what the [Jesuit] father had been with respect to physics."²⁰ There were good reasons for referring to them as "twins by imagination," not least of which was the fact they shared the same patronym, and that by the time of the Jesuit's death, both had acquired the reputation of being "half-mad" visionaries or chimera hunters.²¹ Under the pen of the

¹⁸ Upon his arrival on the ebullient intellectual scene of late-seventeenth century Paris, Saint-Pierre attended the courses of the anatomist Guichard Joseph Duverney (1648-1730) and the chemist Nicolas Lémery (1645-1715), as well as frequenting the Bourdelot Académie. Saint-Pierre bonded with several members of Malebranche's circle, including such future members of the Académie Royale des Sciences, as Pierre Varignon and Fontenelle. For more information on Saint-Pierre's life and early ties within the Parisian natural philosophical world, see Joseph Drouet, *L'Abbé de Saint-Pierre: l'homme et l'oeuvre* (Paris: Honoré Champion, 1912), esp. 18-42. For more recent assessments of the impact of contemporary scientific development on Saint-Pierre's political and moral works, see Merle L. Perkins, *The Moral and Political Philosophy of the Abbé de Saint-Pierre* (Geneva: Droz, 1959), esp. 29-37 and J. B. Shank, "The Abbé de Saint-Pierre and the Emergence of the 'Quantifying Spirit' in French Enlightenment Thought," Papers, Gustave Gimon Conference on French Political Economy, Stanford University (April 2009), accessed December 2015, http://www-sul.stanford.edu/depts/hasrg/frnit/pdfs_gimon/shank.pdf.

¹⁹ Berthier, "Eloge historique," 1106: "L'Abbé de S. Pierre fut toujours l'ami du P. Castel; ils raisonnaient encore quelquefois sur la pesanteur, puis sur la politique; & ces deux esprits assez faits l'un pour l'autre, se partageoient néanmoins dans leurs vues: l'un mettoit la Politique à la tête de tout; l'autre songeoit d'abord à la Physique, & vouloit que l'administration des Empires suivît ou imitât le Mécanisme du monde."

²⁰ Le Cat, "Eloge," 13r: "L'analogie de ceux cy fit deu amis de l'Abbé de St. Pierre et du P. Castel, tout opposé que fût leur genre d'étude; Vrays jumeaux par l'imagination, l'Abbé estoit en politique, ce que le Père estoit en Physique; Mais chacun d'eux, selon la manie ordinaire des sçavants, vouloient que sa science favorite fût celle de toute la portion choisie du genre humain."

²¹ Though unrelated by blood, Louis-Bertrand and Charles-Irénée were both Castels — a coincidence that was not lost on Le Cat. Since the name 'Castel' and its variations are very common in France, even distant ties seem unlikely.

philosophes, epithets of this sort were little more than Enlightenment tropes; yet they reveal that from a posthumous standpoint, the two Castels looked like kindred spirits.

Castel was receptive to Saint-Pierre's challenge, but had no intention of forsaking natural philosophy. For one, he did not think his work was void of practical utility. On the contrary, a quick look at his dedication of the *Traité de la pesanteur* to Charles Jean-Baptiste Fleuriau, comte de Morville (1686-1732), shows his concern with redressing natural philosophy's reputation of idleness.²² Castel begged Morville not to assess the worth of his work by its title alone. His *physique* was meant to be different from the conjectural sort that had prevailed in France in the wake of the publication of Descartes's works: it rejected mere hypotheses in favor of a historical approach grounded in repeated observations and experience.²³ It also aimed to improve the arts and trades by "defining the very nature [they] all attempt to imitate" and by "exposing in rational terms (*sous des idées réfléchies*) what artists and craftsmen "know by sentiment, sensation, or by a kind of instinct."²⁴ Moreover, Castel's system eschewed obscure calculus and contrived experiments. It relied instead on *experiences* and observations, the historical "facts" of which

²² Castel, *Traité de la pesanteur* I, i: "And such is the idea people have of *physique* — that it is a vain and idle science — that the title of this work might announce to you a rather frivolous speculation, unworthy of your time which is precious to the State." Castel brings his dedication to Morville to Saint-Pierre's attention in the "Lettre sur la politique," 700.

²³ Castel, *Traité de la pesanteur* I, ii: "C'est du côté de l'Histoire que j'ai pris la Physique, n'ayant jamais goûté ces Hypothèses tout au plus ingénieuses qui ornent la nature sans l'embellir."

²⁴ Ibid., ii: "Je me suis laissé prévenir de cette idée, que c'étoit à la Physique de définir la même nature, que tous les Arts s'efforcent d'imiter; & que le but unique du Physicien devoit être, de révéler aux Artistes dans tous les genres, leur modèle commun; en leur exposant sous des idées réfléchies, ce qui'ils saisissent le plus souvent que par sentiment, ou par sensation, & par une sorte d'instinct." An echo of this would appear in the "Lettre sur la politique," 699: "Outre que la splendeur des Etats dépend beaucoup de la perfection, à laquelle toutes sortes de sciences sont portées, la perfection des Arts utiles & nécessaires dépend en particulier de celle de la Physique. La Nature ne peut se développer impunément, & sans que les Arts se perfectionnent comme à l'envie de ce grand modèle. La Physique n'est désormais qu'une science mécanique: or c'est la Mécanique qui enfante les Arts."

anybody could verify in daily life.²⁵ This made his research accessible, in principle, to a wide audience.²⁶

But Castel's argument was more subtle than this. For him, knowledge of the physical world could inform the political world because the two were expressions of the same underlying reality.

For in envisioning Nature as a universal and fundamental system and in characterizing her in common language, I did not limit myself to the mechanism of bodies, but associated to it the free action of spirits, mixing everywhere ideas of morals, politics, and letters — in a word, ideas of all the systems subordinated to that of Nature — to ideas of physics.²⁷

In other words, by combining the mechanical system of nature (*pesanteur*) with the system of liberty (lightness), Castel's philosophy encompassed both the material and the intelligible world, such that, from his viewpoint, moral and political principles were as important in physics as physical principles were to morals and politics.

This reciprocity found expression in the *Traité* through a number of analogies. The dedication indeed announced that a discussion of vortical equilibrium might lead Castel to speak of the balance of political powers and courtly dynamics; that the collision of bodies might ring like the clashing of armies; that curved motion might find a counterpart in the difficulty of moral rectitude; and that ultimately, his history of philosophy is

²⁵ This particular understanding of experiments ought to be read as part of the Aristotelian and Jesuit traditions discussed by Peter Dear in *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (Chicago: Chicago University Press), 4 and 21-26.

²⁶ Castel, *Traité de la pesanteur* I, ii-iii: "C'est donc dans l'usage le plus ordinaire de la vie, dans ce que tout le monde voit & observe, que j'ai pris les expériences, les faits, les traits d'Histoire en un mot, dont mon système n'est que le résultat le plus immédiat; ne croyant pas d'ailleurs au-dessus du commun des esprits, une science dont l'objet est à la portée de tous les yeux." Whenever appealing to empirical evidence, Castel makes a point of providing common life examples.

²⁷ *Ibid.*, iii: "Car envisageant la Nature comme un Système universel & primitif, & prenant dans l'usage ordinaire les traits dont j'ai cru la caractériser; je ne me suis pas tellement borné au Mécanisme des corps, que je ne lui aye associé l'action libre des esprits; & que je n'aye mêlé par tout aux idées de la Physique, celle de la Morale, de la Politique, des Belles Lettres; en un mot, de tous les Systèmes subordonnés à celui de la Nature."

also a “history of the mind and sometimes of the human heart in general.”²⁸ These metaphors served a rhetorical purpose: they embellished his discourse and were meant as patron baits. Yet they also highlighted what he regarded as *real* connections between the natural and the moral realms. As Le Cat would later put it:

Father Castel maintained that there was a perfect rapport between the system of the world and the body politic of States, that both had the same tendency toward equilibrium and rest, the same pulsions and repulsions, the same balancings — perpetual antagonisms of this equilibrium; finally, according to him, the harmony of the universe was the model that politicians tend to establish in the government, whence he concluded that they cannot succeed in this endeavor without studying nature (*Physique*), and that this science is the same as the art of governing men.²⁹

Establishing rapports of this sort had practical implications: for while a speculative *physicien* might not exert any direct influence on society, he could help to systematize the art of politics by offering insight into its first model, the system of nature.

By questioning the practical potential of Castel’s natural philosophy, Saint-Pierre hit a sensitive nerve. Admittedly, the *Traité de la pesanteur* fell short of providing anything like a full-fledged political theory, let alone practical guidance. To answer his friend’s challenge, Castel needed a more systematic exposition of his natural philosophical insights on governance, commerce, and society. These he provided in January 1725, in the light-hearted yet important “Lettre sur la politique.” Using the language of physics to shed light on the moral and political realms, the letter outlined an ambitious politico-

²⁸ Ibid., iii-iv.

²⁹ Le Cat, “Eloge,” 13r: “L’Abbé de St. Pierre gémissoit de voir un genie tel que le P. Castel s’amuser à la Physique, au lieu de se donner à l’art de gouverner les hommes et de les rendre heureux, le seul qui lui parût digne d’un bon Citoyen et d’un bon esprit. Le P. Castel pretendoit qu’il y avoit un rapport parfait entre le système du monde et le Corps politique des Etats. Que de part et d’autre il y avoit mesme tendance à l’équilibre ou au repos, mesme pulsions et repulsions, mesmes balancements, antagonismes per-petuels de cet équilibre; Enfin l’harmonie de l’Univers estoit, selon lui, le modele que les politiques tendent à établir dans le gouvernement, d’où il tiroit ces consequences, qu’ils ne peuvent y reüssir sans l’étude de la Physique, et que celle ci est la mere science de cet art de gouverner les hommes.”

economic project founded on the premise that “there is only one system, and physics is a fundamental (*primitive*) science from which all the others draw (*relève*) their models and often their object of inquiry.”³⁰

The reader should not expect a rigorous treatise of political economy nor a groundbreaking discussion of politics *per se*. Castel’s primary goal was to prove the utility of his natural philosophical system. To do so, he needed only to establish the physical foundation of political economy and to present himself as a potential physico-political advisor — someone uniquely qualified to teach a Prince how to achieve mastery over nature and to increase the general well-being of his subjects.

Castel’s Physico-Political System

Castel believed that human society, just like the physical world, is a system of organized circulation resulting from the balancing movement of competing individuals (or political entities) tending toward a state of equilibrium. Politics, from his natural philosophical perspective, was the art of preventing this equilibrium from ever being reached or destroyed. As such, it was the institutionalized and regulated counterpart to the free action of spirits that vivified the physical world. To fully understand what Castel meant by this, one must think of human society as a microcosm of the system of the earth and revisit the physical concepts of equilibrium, balance, circulation, and organization from the standpoint of eighteenth-century political economy.

Like most French *physiciens* of his generation, Castel understood equilibrium in the (hydro)static sense, a conception notably embraced by Cartesians but generally admit-

³⁰ Castel, “Lettre sur la Politique,” 700.

ted by natural philosophers.³¹ The physical behavior of liquids in a state of rest was indeed a useful way to think about the arrangement of celestial and terrestrial bodies, especially if one believed, like Castel, that the difference between fluids and solids was one of degree rather than kind. On a cosmological scale, it manifested itself through the formation of more or less spherical planetary bodies (the equilibrium also preventing, in the case of the earth, the dissipation or collapse of the atmosphere). On a smaller scale, the same principle explained the shape of water drops. Castel's notion of equilibrium accounted for these phenomena but diverged from our modern understanding insofar as he maintained that, in a purely mechanical system, achieving equilibrium meant reaching a state of *absolute* rest.

His favorite illustration of equilibrium involved a transparent jar filled with oil, water and mercury, possibly with floating corks and other objects to represent the planets.³² Given enough time and the absence of external disturbances, the three substances would form, by homeomeric principle, three discrete layers as they approached and finally reached a state of equilibrium. If such scenario took place in reality, stars and planets

³¹ Castel's concept of equilibrium, though certainly related to the medical tradition, was both more general and more precise than that used in Cartesian and, more generally, mechanical theories of the body. Iatromechanical schools of medicine made use of hydraulic analogies to understand the movement of blood and other fluids, and thus gave a new twist to the old Galenic concept of humoral balance. Castel was familiar with the language of iatromechanism, but medical knowledge being a subset of more general physical laws, it is to the latter that he refers: equilibrium, balance, circulation and organization are not medical concepts related to the body but physical processes applying to bodies in general, starting on the cosmic scale.

³² Castel, *Traité de la pesanteur* II, 359-360. Castel claimed to have drawn this metaphor from the Capuchin astronomer Antonio Maria Schyrleo de Rheita, in his *Oculus Enoch et Eliae, sive radius sidereomysticus* (Antwerp: Hieronymus Verdussius, 1645), although its use was no doubt found elsewhere in his readings.

would likewise stand still in the sky. The terrestrial equivalent would be the complete separation of the four elementary spheres — fire, earth, water and air.³³

As we saw in the two previous chapters, the fact that no such absolute state was ever reached suggested that the natural world could not be purely mechanical. Castel imagined that God had initially hurled the universe into a state of chaos (like oil, water and mercury mixed up together) and imprinted upon elementary particles the *pesanteur* they needed to sort themselves out and reach their current stations and arrangements. Thanks to the acceleration they acquired while “falling” toward their proper place, these weighing particles had presumably been swaying to and fro between their point of equilibrium since the time of creation, much like the oscillatory movement of a pendulum. On a cosmic scale, this generated a simple harmonic motion resonating throughout all bodies of the universe. Left on its own, however, and given enough time, this primeval oscillation should have ceased by now, its amplitude decreasing, how ever slightly, with every period. The impossibility of perpetual motion in a world where matter is inert by definition explains why Castel had to introduce active and free causes within his system — i.e., spiritual agents not bound by the laws of nature, whose role was to counteract constantly the separating and sorting out effect (*discernement, débrouillement*) of *pesanteur* and, thus preserve movement, mixtures, and life on earth.

Castel’s concept of static equilibrium was inseparable from that of balance, or better yet, “balancing,” which consisted in the alternation between the dynamic force of

³³ The Aristotelian system obviously admitted the existence of compounds within each layer such that no sphere was purely homogenous. Explaining what generated and perpetuated these compounds was subject to debate, but most Aristotelians seemed to believe that the circular movement of the heavenly spheres was somehow impressed upon the elements on earth, thus mixing them up. See Craig Martin, *Renaissance Meteorology* (Baltimore: Johns Hopkins University Press, 2011), 6-7.

pesanteur and its static force of reaction.³⁴ On a cosmic level, balancing referred to the apsidal swaying of celestial bodies as they actively tend toward but fail to reach equilibrium. On earth, it manifested itself in machines but also in the natural ebb and flow of the air, the sea, and even the earth's crust — a peristaltic motion Castel also attributed to the heart and other organs:

This is what ties together to all the marvels of nature, and [what] constitutes its play (*fait tout son jeu*). It is the balancing of the celestial bodies that gives birth to light and movement. The ebb and flow of the sea is but a balancing; the course of rivers springing out of the earth to return underground is but a balancing. The pulse of our heart, of our lungs, or our arteries, the principle of life, in a word, that quickens all of nature, is but a balancing, a swing, a happy projection that banishes equilibrium, numbness, and death.³⁵

Since all material bodies, regardless of their size, were subject to the same action and reaction of *pesanteur*, Castel's concept of balancing essentially described the macroscopic analogue to the primeval oscillation of particles described above. In the primitive system of nature, these opposite forces did not clash so much as alternate in quick succession, like the arms of a scale swinging on a fixed point.

³⁴ Castel, *Mathématique universelle* I, 263: “*Le Principe de cette Circulation est, selon toutes les Loix de la Méchanique, d’un côté, la Pesanteur Dynamique des Corps qui les fait tous tendre à leur Centre, & couler dans les endroits les plus bas; & de l’autre côté, la Force Statique de la Réaction, & comme la Répercussion du Centre, qui surchargé de tous les Corps qui s’y précipent, ou qui y sont buttez, produit dans ces Corps liquides, hétérogenes, & combustibles une Fermentation, une chaleur, & un Feu qui les disperse en Vapeurs & en Exhalaisons jusqu’à la Surface de la Terre, de même que dans nos Corps, la pression de l’Air qui nous environne, & même de celui que la Respiration met à portée d’environner de près nos Veines & nos Organes, jointe à la Réaction des parties hétérogenes qui sont dans le Sang dont ces organes, & sur-tout le coeur sont pleins, cause les divers Battemens de ces Organes, & le Mouvement du Sang qui y circule.*”

³⁵ Castel, “Lettre sur la politique,” 708: “[C]’est là le noeud de toutes les merveilles de la nature, & fait tout son jeu. C’est des balancements des astres que naît la lumière & le mouvement. Le flux et le reflux des Mers n’est qu’un balancement: le cours des fleuves qui sortent de terre pour y rentrer, n’est qu’un balancement. Les battemens de notre coeur, de nos poulmons, de nos artères, le principe de vie en un mot qui anime toute la nature, n’est qu’un balancement, un élancement, une heureuse saillie, qui banit l’Equilibre, l’engourdissement & la mort.”

Castel's concepts of equilibrium and balancing found direct analogues in the interaction of political entities, for instance, between the inhabitants of a town, the provinces of a state, the states of an empire, and, of course, rival empires.³⁶ Although contemporary political theorists and political economists commonly used these terms in their writings, Castel was atypical in using their *precise physical meaning*.³⁷ His views should not be confused, therefore, with the "doctrine of equilibrium" that had dictated European politics during the better part of the seventeenth-century.³⁸ From his perspective, the advocates of this doctrine manifestly misunderstood the implications of their maxim when they proclaimed that empires ought to model themselves on the heavenly equilibrium. Nowhere in the universe was true equilibrium to be found: celestial bodies are always oscillating. Although statesmen should imitate the heavens by *aiming* toward equilibrium, they should also be aware that reaching it was both impossible and undesirable. Indeed,

³⁶ In fact, at bottom, he thought they were identical phenomena. At times he seems to attribute a kind of *pesanteur* to political and moral entities — a tendency or specific weight that determines their position with respect to the center of power they aspire to — and which also suggested the existence of moral points of equilibrium.

³⁷ On the two dominant metaphors used by economists of the seventeenth and eighteenth centuries, see Jean-Claude Perrot, *Une histoire intellectuelle de l'économie politique (XVIIe-XVIIIe siècle)* (Paris: Ecole des Hautes études en sciences sociales, 1992), 72 and 91-92.

³⁸ This was the very doctrine the Abbé de Saint-Pierre had opposed in his famous project for everlasting peace, and Castel certainly had it in mind here. The doctrine of equilibrium stated that to maintain peace in Europe, equilibrium between the two most powerful Houses of the time, namely France and the Habsburg Empire, had to be preserved. For a number of reasons expounded in his treatise, the abbé believed this was in fact the surest way to perpetuate conflict, not least because he too conceived of equilibrium as an absolute (a mathematical point), and thus as an impossible target. Instead of conceiving of the *rapport de force* between European nations as the two arms of a balance, he wanted European leaders to unite into a federation of states that would always insure that no one nation would be powerful enough, by comparison to all the others, to declare war or break a treaty with impunity. See Saint-Pierre's 1713 *Projet pour rendre la paix perpétuelle en Europe* (Paris: Fayard, 1986), esp. 21-49, which corresponds to the "Premier discours" of the work.

just as cosmic equilibrium would mean a motionless and lifeless universe, so would human societies suffer and perish should they ever achieve a perpetual state of rest.³⁹

Castel argued that tensions within or between political entities were ultimately responsible for human industry and ingenuity. In this respect, he associated physical *balancing* with contemporary language of “noble emulation” rather than with the notion of positive and negative *balance* of commercial exchange and the mercantilist anxieties associated with the latter.⁴⁰ Although the term “emulation” had many valences in the early modern world, it was generally understood as an acceptable form of jealousy between competitors that prompted them to surpass one another in various spheres of activity, notably the arts, the sciences, commerce, and military might.⁴¹ Just as the balancing of bodies generates fire and light in the physical world, so did the military, commercial and cul-

³⁹ Castel, “Lettre sur la politique,” 708-709: “Faites règner l’Equilibre entre les Empires, & s’il se peut, entre les Provinces, les villes, les maisons, & les simples particuliers, & vous allez en faire autant de statuës inanimées, tout-à-fait semblables à celles qu’on a trouvées, dit-on, dans quelques villes d’Afrique. Dès-lors plus de commerce, plus d’Arts, plus de Sciences, parce que dès-lors vous ôtez l’émulation, & une certaine point, une certaine saillies, & en quelque sorte l’esprit qui vivifie les Etats.” Castel was probably referring to the Abbé Saint-Pierre’s project for everlasting peace. From the Jesuit’s perspective, if Europe were to achieve a true state of perpetual peace, it would also condemn itself to perpetual torpor. (Notice that the analogy is at bottom a relation of identity: the societal-level scenario could be reduced to the cosmic one, the same principle acting on both.)

⁴⁰ Mercantilist thinkers believed that in order to achieve prosperity, the state needed to insure the positive balance of its external trade, which is to say, that the inflow of gold and silver species be superior to its outflow. This meant favoring the exportation of goods while limiting the importation of foreign commodities. The ultimate objective behind such a policy was the achievement of internal self-sufficiency and commercial hegemony, at the detriment of competing nations.

⁴¹ On the importance of this concept for eighteenth-century economic thought, see Sophus A. Reinert, *Translating Empire: Emulation and the Origins of Political Economy* (Cambridge, MA.: Harvard University Press, 2011), 29-33: “[e]mulation [...] enjoyed a wide array of meanings in a variety of context, from a noble virtue helping everyone to progress to an elegant euphemism for cutthroat competition.” Arts, science, commerce, and military strength — all these were fields in which emulation held sway. Although the term seems to have had more purchase in the latter part of the eighteenth century, Castel clearly participated in a widespread discourse. Hobbes had contrasted emulation with envy, defining it as “grief arising from that our Equals possess such goods as are had in honour, and thereof we are capable, gut have them not; not be they have them, but because not we also” (cited in Reinert 30). In France, Furetière’s dictionary gave it the more positive meaning of “noble jalousie entre les gens de sçavoir ou de vertu, qui les fait disputer à qui acquerra le plus de gloire. L’émulation est souvent cause des grandes actions.” Antoine Furetière, *Dictionnaire Universel*, s.v. “Emulation” (La Haye: Leers, 1690).

tural “balancing” between nations allow the greater ones to shine. France, for instance, was like the sun in its vortex: it supported its weight and pushed back against of all its neighbors. As the focal point of Europe, it was also its main source of “enlightenment” (*lumières*).⁴² Tensions provoked by patriotic rivalry “awaken[ed] a reciprocal ambition” that stimulated all aspects of society and benefited humankind as a whole.⁴³ Negotiations, embassies, movements of troops in times of peace: these did not serve the purpose of maintaining peace (equilibrium) so much as to make sure the nation does not fall asleep: “A little sense of war and political movement in time of peace is a wonderful spirit of life. The masterpiece of a great statesman is to reanimate all the parts of a state, enough to make it shine, but not to the point of war and sedition. One must break the equilibrium, not remove it; [nay,] suspend it, not break it.”⁴⁴ Most statesmen, Castel added, knew this by instinct, as shown by their economic and military policies. The usefulness of the natural philosopher lay in turning instinct into knowledge and showing the *rationale* behind politico-economic “balancing” so that a sovereign prince might more easily walk the fine line between the hazards of social torpor and those of war.⁴⁵

While participating in “ambient” discussion about the virtue and risks of emulation, Castel approached these issue through the lenses of moral philosophy. The Spanish Jesuit moralist Baltasar Gracián (1601-1658), whose works he admired for their apho-

⁴² Castel’s chauvinism might be excused when we recall that France was, under the Sun King of late memory, the most powerful state in Europe, its arts, sciences, fashions and tastes radiating throughout the world.

⁴³ Castel, “Lettre sur la politique,” 709.

⁴⁴ *Ibid.*, 710: “Un petit air de guerre & de mouvement politique est un merveilleux esprit de vie dans le sein de la plus profonde paix. Le chef-d’oeuvre d’un grand Politique à la tête des affaires, et de ranimer toutes les parties d’un Etat, assez pour briller, trop peu pour éclater en guerres & en séditions. Il faut rompre l’équilibre, mais n’ont l’ôter; il faut le suspendre, mais non le rompre.”

⁴⁵ Speaking of a slightly later period, Reinert explains that “[t]here thus existed a politics of administering the tension between jealousy and emulation to ensure not only that competition existed, but that it aligned with the ‘common good.’” Reinert, *Translating Empire*, 31.

risms and the attention paid to “the physical side of things” (*le physique*) in moral and political matters, was his main source of inspiration.⁴⁶ For instance, Gracián’s *El Político Dom Fernando* (originally published in 1640) painted a panegyric of Ferdinand II of Aragon (1452-1516), whose aptitude in balancing heroism with prudence, war with commerce, and activity with tranquility, had given their form and unity to the Kingdom and Empire of Spain. When Castel wrote of statesmen who intuitively knew the virtues of emulation, military mobilization, and strategic belligerence to counteract the natural tendency of a nation to stagnate, he had Gracián’s Ferdinand in mind.

Emulation was not the only way by which a state achieved prosperity; the internal health and cohesion of the body politic was also essential. While many political theorists of the sixteenth and seventeenth century saw foreign war as the solution to internecine strife, Castel was inclined to think circulation was the key.⁴⁷ Here again, Castel appealed to an old trope. The comparison between humoral and commercial circulation — money circulation in particular — in fact predated the discovery of blood circulation itself, and it was employed with different meanings by virtually every political economist of the seventeenth century.⁴⁸ By the eighteenth century, mechanical and hydraulic metaphors also

⁴⁶ Castel could have read Gracián’s oeuvre in the original, or in Amelot’s French translation. It is also likely that the recent and ongoing translation effort by his colleague Joseph de Courbeville, SJ (1668-1746) awakened his interest in the moralist’s writings. Courbeville reviewed his translation of *El Heroë*, as it appeared in *Mémoires de Trévoux* (Avril 1725): 676-698.

⁴⁷ Conceived of as an external aggression, war could serve as a rallying cry; when disputed on foreign grounds and when conceived of as conquest, it channelled internal aggression outward and was sometimes described in medicinal terms as a purge or a bleeding of stagnant humors. A dated but still succinct expression of mercantilist bellicosity can be found in Edmond Silberner, *La guerre dans la pensée économique du xvie au xviiiè siècle* (Paris: Librairie du Recueil Sirey, 1939).

⁴⁸ Simone Meyssonier, *La Balance et l’Horloge: La genèse de la pensée libérale en France au XVIIIè siècle* (Paris: Editions de la Passion, 1989), 45-46. The Florentine financier Bernardo Davanzati (1529-1606) was apparently the first to compare the circulation money to the blood flow in *Lezione delle monete* (1588). Davanzati’s analogy, however, was not as sophisticated as that used by later, post-Harveyan economists like Boisguilbert, who thought of the economic circulation of wealth as a self-regulating, self-

enriched medical ones. Both sets of metaphors suggested that the cause of crises was the obstruction or stagnation of fluids and proposed various remedies to facilitate their flow.⁴⁹ These could be infrastructural, such as the construction of roads or canals, or fiscal and political, such as the uniformization of taxes, the removal of paying tolls, and later in the eighteenth century, the liberalization of trade.⁵⁰ All but the last of these measures were advocated by Montchrétien, Sully, Colbert, Le Maître, and Vauban in the seventeenth century, and by the abbé de Saint-Pierre in the eighteenth.⁵¹ Liberalization policies, for their part, would find early defenders among Boisguilbert, d'Argenson, Melon, Cantillon, and Gournay.⁵²

contained system rather than as a flow dependent upon the injection or retrieval of funds (presumably with Galenic equivalents in the generation of new blood by eating and the removal of surplus by bleeding). See also Perrot, "Conclusion" in *La Circulation des marchandises dans la France de l'Ancien Régime: Journée d'études tenue à Bercy le 12 décembre 1997*, ed. Denis Woronoff (Paris: CHEFF, 1998), 181-193.

⁴⁹ As Perrot puts it in his *Histoire intellectuelle*, 91-92: "Les deux systèmes métaphoriques qui se partagent les faveurs des économistes offrent d'ailleurs des remèdes lexicaux pour se tirer d'affaire. Dans la perspective 'biologique', on estimera que la science s'occupe d'un corps social sain et bien constitué; la crise, c'est-à-dire la maladie, se traite conformément à la médecine hippocratique dominante en laissant faire la nature. Dans le contexte des références physiques, on parlera d'inertie, de frottement, d'oscillations; l'hydraulique est mobilisée chez Turgot, le pendule et la gravitation chez d'Auxiron."

⁵⁰ For a useful discussion of the different valences of circulation in the mercantilist and liberal understanding of internal and external commerce, see Dominique Margairaz, "L'économie d'ancien régime comme économie de la circulation," in *La Circulation des marchandises dans la France de l'Ancien Régime: Journée d'études tenue à Bercy le 12 décembre 1997*, edited by Denis Woronoff (Paris: CHEFF, 1998), 1-5. Margairaz argues that "[d]e la circulation des mercantilistes conçue comme neutralisation et moralisation de l'espace économique intérieur à la circulation des libéraux conçue comme valorisation des richesses et condition de possibilité d'une véritable croissance, on identifie, par delà une communauté du vocabulaire, une rupture dont la portée est à la fois théorique, épistémologique, et idéologique" (1).

⁵¹ Margairaz, "L'économie d'ancien régime," 3; Perrot, "Conclusion" in *Circulation des marchandises*, 182-184.

⁵² There is no good, consolidated history of early eighteenth-century French economics, and to my knowledge, no history of the circulation metaphor. Readers interested in the works of these writers can consult Gilbert Faccarello, *The Foundations of Laissez-faire: The economics of Pierre de Boisguilbert* (London and New York: Routledge, 1999); André Alem, *L'économie politique au début du XVIIIe siècle: Pratique mercantiles et théories libérale* (Paris: Arthur Rousseau, 1900); Antoin E. Murphy, *Richard Cantillon: Entrepreneur and Economist* (Oxford: Clarendon Press, 1986); Loïc Charles, Frédéric Lefebvre, and Christine Théré, ed., *Le cercle de Vincent de Gournay: Savoirs économiques et pratiques administratives en France au milieu du XVIIIe siècle* (Paris: Institut national d'études démographiques, 2011).

Interestingly enough, Castel's own analogy between organic and politico-economic circulation was mediated through his system of the earth (his purpose, after all, was to demonstrate the utility of speculative physics, not medicine). Circulation for him was a species of balancing contributing to the integration of parts to their whole as well as to the fruitfulness of nature. This mechanism, he argued, was responsible for carrying and multiplying man's artificial mixtures through the internal channels of the globe, and thus, for fuelling its central fire and counteracting the sorting action (*discernement, débrouillement*) of nature.⁵³ His theory was, of course, influenced by William Harvey's discovery of blood circulation.⁵⁴ This discovery, Castel argued, marked a turning point in the history of philosophy, from which it was no longer possible to regard the human body (or the bodies of animals and even plants) as a mere "lump of mud."⁵⁵ Harvey had demonstrated that the body is a carefully crafted machine of channels and organs.⁵⁶ By analogy, the same circulatory principle could be used to make sense of the earth's structure. Since Athanasius Kircher's application of Harvey's discovery in the *Mundus Subterraneus* (1664), one could no longer think of the globe as a disorderly heap of rocks and

⁵³ Physical circulation took place so long as the matter tending toward the center ultimately made it there in spite of the push of reaction, while the matter carried upward by the same push eventually made it to the surface. At once fueled by and conducive to elemental mixtures (first produced by free human action at the surface of the earth, then carried into the core earth and back to its surface by *pesanteur* and its reaction), this process was supposedly responsible for counteracting the discerning effect of *pesanteur* and for diversifying life on the planet — in effect, for animating it with a life of its own.

⁵⁴ Indeed, it was influenced by the very same metaphors Harvey used to explain his discovery: "The heart of creatures is the foundation of life, the Prince of all, the Sun of their Microcosm, on which all vegetation does depends, from whence all vigor and strength does flow. Likewise the King is the foundation of his Kingdom, and the Sun of his Microcosm, the Heart of his commonwealth, from whence all power and mercy proceed." William Harvey, *Exercitatio anatomica de motu cordis et sanguinis in animalibus* (facsimile of the 1628 Francofurti edition, with translation) (Birmingham: The Classics of Medicine Library, 1978), v.

⁵⁵ The reference is biblical. It meant that the human body was not just beautiful on the surface, but also carefully structured in the inside. Castel, "Lettre sur la politique," 715.

⁵⁶ Castel's appreciation of pre-Harveyan anatomy, physiology and medicine is unfair, but his main point is not so much about how people conceived of the body before the discovery of blood circulation, as about how they conceived the earth before elemental circulation.

metals, but had to picture it as an organic system, perhaps even a kind of living animal.⁵⁷

The next step — which Castel regarded as own contribution — was to grant the same organic circulation to human society.

A limited kind of circulation took place, Castel argued, when the different parts of a political entity worked together to produce and exchange goods with one another. Like the heart of the animal and the central fire of the earth, the central motor force of an empire — the will of its sovereign prince — had to foster commerce between all subordinated parts.⁵⁸ But in the same way that “everything circulates through each part of our bodies, and each part itself circulates through every other part,” this process was not limited to a simple circuit of coins and merchandise.⁵⁹ It also favored the political, cultural and intellectual integration of parts — that is, individuals and subordinated political entities.

⁵⁷ Castel, *Traité de la pesanteur* II, 425: “La connaissance que Kircher avoit du Globe terrestre; celle que Scheiner venoit de donner du Soleil; & la découverte récente de la *Circulation* du Sang dans les animaux, rappellèrent à nôtre Auteur l’idée d’un Ancien, qui comparoit la Terre à un animal. Le ridicule suranné d’une opinion si prématurée le rendirent un peu réservé sur ce point; il n’osa dire ouvertement toute sa pensée; mais il comprit bien la ressemblance exacte, qu’il y a entre le Corps intérieur de la Terre, & celui d’un Animal: & puis l’Esprit d’Analogie donnant à cette pensée toute son étendue, il transposa à tous les Astres le Système d’Organisation, & de Circulation qu’il attribuoit à la Terre [...]” Castel’s interpretation of Kircher was probably inspired by the third chapter of the Preface to the *Mundus Subterraneus*, where Kircher writes that earth should not be considered without internal structure, “pressed together from clay and mud after the Flood, hardly different from some lump of cheese.” Athanasius Kircher, SJ, *Mundus Subterraneus in XII Libros digestus*, ed. Gian Battista Vai (Bologna: Arnaldo Forni Editore, 2011). Castel was ever careful, when comparing the earth to an animal, to specify that this animal was purely mechanical. That is, he scrupulously avoided being accused of ascribing a soul to the world.

⁵⁸ Interesting stylistic and conceptual parallels can be drawn with Alexandre Le Maître’s important *La métropolitaine, ou De l’établissement des villes capitales, de leur Utilité passive & active, de l’Union de leurs parties & de leur anatomie, de leur commerce, &c* (Amsterdam: Balthes Boekholt, 1682), 5: “Comme les ruisseaux forment les rivières, & cellescy les grands fleuves; que les fleuves se jettent dans la Mer, qui regorge les mêmes eaux, & que les sources font les lacs & les étangs, d’où elles dérivent, la Nature aiant donné aux eaux un flux et un reflux continuel, les villes Capitales reçoivent leur vie et leur gloire de toutes les parties de l’Etat, & la redonne de même à toutes les Provinces. Ce que la tête est au Corps, le Prince envers les sujets, le Ciel envers la Terre, une ville Metropolitaine l’est envers les bourgs & les bourgades, les villages & les hamaux. La tête opere pour conserver toutes les autres membres & toutes les parties du corps concourent & agissent de concert, pour entretenir le Chef.” I’m not suggesting (nor excluding) a direct influence here so much as showing how Castel’s metaphors of physico-political circulation had well-known precedents in the seventeenth century.

⁵⁹ Castel, “Lettre sur la politique,” 714: “Tout circule à travers chaque partie de nos corps, & chaque partie circule elle-même à travers chaque autre partie.”

As the War of the Cévennes had demonstrated, a poorly integrated province might rebel and cause harm to the empire, just as a limb deprived of circulation putrefies and falls off.⁶⁰ Like a flow of nourishing blood insuring life and the integrity of a body, the circulation of “food, money, linens, arts, inventions, sciences, discoveries, [...] manners, habit, language, politeness, and even people, much more so their hearts and spirits” kept a nation alive by increasing the social homogeneity of its constituents and their sense of belonging to the whole.⁶¹

Note that while Castel espoused a traditional mercantilist conception of internal circulation as a tool for “realizing the complementarity and solidarity of all the members of the social body, of all the provinces of the kingdom” (in other words, a tool of political homogenization), when considered from a more general standpoint, his system does not actually distinguish between internal and external trade.⁶² In principle, even rival empires belonged to a whole (humanity) in the same way that planets were part of the vortices, and vortices were parts of the whole universe. Thus circulation was “the fertile principle of all the marvels of nature” and the “masterpiece of the highest politics,” a means of increasing the prosperity and splendor of a nation, and ultimately, the prosperity of the

⁶⁰ Ibid., 714: “Toute partie qu’une obstruction insurmontable exempte pour son malheur, de cette double loi de circulation, est morte: il faut la détacher si elle ne se détache pas elle-même.”

⁶¹ Ibid., 715-716: “Tel seroit un Empire [a vile heap] où toutes les choses ne seroient pas en une action continuelle de circuler; je dis toutes les choses, les denrées, l’argent, les étofes, les Arts, les inventions, les Sciences, les découvertes, & jusqu’aux modes & aux manières, les habits, le langage, la politesse, & même les personnes, & beaucoup plus les coeurs et les esprits. Car il importe à ceux qui gouvernent, que dans un Etat tous les membres qui le composent, prennent un certain tour d’esprit et de manières, comme d’habit & de langage qui les porte à se regarder comme faits les uns pour les autres, & en effet comme membres d’un même corps, comme parties d’un même tout.” Castel adds that imposing this integrity by means of laws or other contrivances is not going to be as effective as through a natural process of circulation.

⁶² Margairaz, “L’économie d’ancien régime,” 3.

whole world.⁶³ Indeed, politico-economic circulation was not only analogous to but actually *embedded* within physical, and especially terrestrial, circulation. Although Castel does not say so explicitly, the reader ought to remember that he regarded the production of human artifice, in physical terms, as the production of compounds, the circulation of which was essential to the perpetuation and diversification of life on earth.

Closely related to circulation was Castel's concept of organization, the importation of which from physics into politics he regarded an original idea.⁶⁴ In any living body, organization ought to be understood as a structured network of organs, veins and arteries making the circulation of fluids possible. In the system of the earth, the network of subterranean caves, rivers and air vents channeled elemental compounds from the surface to the fiery core of the globe, and from the fiery core all the way up again. Interestingly enough, Castel understood organization not only in terms of intelligent design, but also as the natural outcome of circulation itself.⁶⁵ In other words, he believed that the circulation of parts contributed to the process of organ-making in the whole and to the instillation of a life spirit:

All things are alive in a living body. All things are alive in the great body of the earth. Its lands are fertile (*ferme*), its stones are quickened (*vive*), its

⁶³ Castel, "Lettre sur la politique," 711: "Or c'est de ces simples Balancemens que naît la circulation, ce principe fécond de toutes les merveilles de la nature, & s'il m'est permis d'élever jusques-là mes spéculations, ce chef-d'œuvre de la plus haute Politique."

⁶⁴ Of course, the idea that different parts of the body politic behave like organs subordinated to its head and soul was not new *per se* and harkens back as far as John of Salisbury's *Policraticus: of the Frivolities of Courtiers and the Footprints of Philosophers*, ed. and trans. Cary J. Nederman (Cambridge: Cambridge University Press, 1990), vol. 2, 66-68. The difference between this and Castel's analogy lies, once again, in the *reduction* it operates between the physical and the political realm.

⁶⁵ The formation of additional circulatory organs followed from circulation. Castel may have had in mind contemporaneous intussusception theories of embryonic development. The circulation of blood in the early stages of life was believed by some to generate the development and multiplication of channels and organs, thus explaining the growth of the embryo. For more information on eighteenth-century embryology, see Shirley A. Roe, *Matter, Life and Generation: 18th-Century Embryology and the Haller-Wolff Debate* (Cambridge: Cambridge University Press, 2003).

waters flowing, nothing stagnates within it, a soft warmth penetrates all its parts, the seas have their peristaltic motion, minerals are generated in its core, all that we know of its inside is pierced and organized.⁶⁶

What was true of the earth was also true of the body politic, with one nuance: at the political level “a rule is needed” to guide this quickening spirit and make sure its powers are renewed periodically, so that the circulatory movement might be perpetuated. Without going into much detail, Castel suggests that a full-fledged version of his physico-political system would explain the need for the planning of “storage areas” at regular intervals along the circuit of roads and water channels. In the body, these were called glands. In the political world, they were cities and villages, where “societies, academies, universities, colleges, bureaus, manufactures” and other gland-like “foldings” of human activity served as fixed points where circulation gained momentum. For these to work properly, a “perfect correspondence and exact subordination between particular centers and general centers was essential.”⁶⁷ Just as the various centers of the parts of the universe were providentially subordinated to the more general centers of their whole, so must a sovereign prince ensure the organized circulation of his domain through the perfect subordination of local towns to provincial capitals, provincial capitals to the “prime center” (*centre primitif*) of the empire, and the prime center to his own will.⁶⁸

⁶⁶ Castel, “Lettre sur la politique,” 714: “Tout est animé dans un corps animé. Tout est animé dans le grand corps de la terre. Les terres y sont fermes, les pierres y sont vives, les eaux y sont coulantes, rien n’y croupit, une douce chaleur penetre toutes ses parties, les Mers ont leur mouvement péristaltique, les minéraux s’y engendre, tout ce que nous connoissons de son intérieur est percé, organisé.”

⁶⁷ Castel, “Lettre sur la politique,” 728: “On ne sçauroit trop multiplier ces centres, mais l’essentiel est qu’il y ait une parfaite correspondance, & une exacte subordination entre les centres particuliers et les centres principaux.”

⁶⁸ One cannot help but see a parallel with the first book of Cantillon’s *Essai sur la nature du commerce en général: Texte de Pédition originale de 1755, avec des études et commentaires* (Paris: Institut national d’études démographiques, 1952).

Although Castel's contemporaries would have agreed that animals and plants live by organized circulation, few would have literally applied these concepts to the earth, and fewer still to human society.⁶⁹ Castel pictured the abbé de Saint-Pierre laughing at such semantic audacity, hopefully from delight rather than contempt: "You are laughing, I consent to it, but I suppose that you draw the distinction between a laughable (*risible*) and a smiling (*riante*) idea; at any rate nothing prevents one from saying the most profound truth while laughing."⁷⁰ At the risk of turning a smile into a smirk, Castel dared to push his analogy further. Convinced that there is only one system in the universe, he surmised that processes taking place in the physico-political world are taking place throughout the intelligible world of free spirits, that is, in morals, in the sciences and the arts, perhaps even in matters of faith.⁷¹ Castel did not provide a complete demonstration of this all-embracing theory; conscious of the highly speculative nature of his claim, he limited himself to demonstrating its possibility and likelihood.

Castel's physico-political musings did not have obvious practical applications nor did they crystalize into a full-fledged politico-economic theory. They did, however, reveal what he regarded as detrimental misappropriations of physical concepts. Inadequate or vague understandings of "equilibrium" and "balance," he argued, had misled some policy-makers to promote equilibrium (or peace) at all cost with negative effects for all

⁶⁹ Because we think of "organization" in terms of structured association of people and institutions, we tend to forget that this definition is fairly recent (late-eighteenth century). In the early modern world, the meaning of "organiser" was "to provide with organs" while to be organized referred a certain disposition of body or mind. See "Organiser" and "Organisation," *Centre National de Ressources Textuelles et Lexicales*, accessed 12 February 2015, <http://www.cnrtl.fr/etymologie>.

⁷⁰ Castel, "Lettre sur la politique," 713: "Vous en riez, j'y consens, mais je suppose que vous distinguez entre une idée risible, & une idée riante; enfin rien n'empêche de dire en riant les plus profondes vérités." This is a variation on the Latin locution "*ridendo dicere verum quid vetat*" (Horace, *Satirae*, 1, 1, 24).

⁷¹ *Ibid.*, 713.

the nations of Europe. A system founded on the proper physical meaning of these terms, in contrast, counseled against such measures, and thus had its utility. Moreover, it advocated politics of emulation, explained the rationale behind the multiplication of infrastructure, and favored physical, commercial, cultural, and intellectual circulation by the removal of obstacles and the organization of the realm. All of this had ramifications for policy with tangible benefits. Castel believed, for instance, that the removal of obstacles preventing the circulation of money, goods, people, and even ideas within France was the most important task the King and his ministers could take upon themselves.⁷²

We would undertake a thousand enterprises, a thousand voyages if these were made somewhat easier; the obstacles we foresee result in the abortion of most good ideas (*pensée*) people entertain for their self-improvement (*perfection*), their personal gain (*fortune*) and their betterment; but the perfection and the good of individuals is also the good of the State. A thousand projects people call chimerical — and which in effect become so [when obstructed] — would be realized if only they were allowed to hatch. Water will flow provided it is given a slope. A Frenchman asks for nothing but an occasion to imagine, to invent, to improve things, to work, and to grow.⁷³

Frenchmen (and human beings more generally) have a natural inclination toward activity. Curiosity, envy, and personal ambitions constantly drive them to compete, to be crea-

⁷² The parallel with ‘liberalism’ should not be overstated. Although Castel may have been inspired by political economists like Vauban and Boisguilbert (for instance, in upholding the idea that self-interest drives the economy, that one can think of the circulation of money and goods as a self-regulating system of equilibrium), he also envisioned the removal of obstacles (something akin to laissez-faire policies) in a much broader, much less technical, and much more idiosyncratic sense. The gap between his views, which had more in common with the courtier literature of the seventeenth century than the burgeoning science of economics, becomes increasingly apparent if we compare them to those of Cantillon, Gournay and Quesnay, let alone British political economists like Hume and Smith. For an excellent treatment of early eighteenth-century French political economy, see Meyssonier, *La Balance et l’Horloge*. Also useful is Faccarello, *The Foundations of Laissez-faire*.

⁷³ Castel, “Lettre sur la politique,” 726-727: “[I]l y a mille entreprises, milles voyages qu’on ferait si on avoit une certaine commodité; les difficultez qu’on prévoit, font avorter la plûpart des bonnes pensées que chacun roule sans cesse pour sa propre perfection, pour sa fortune, pour son agrandissement; or la perfection, le bien de particuliers est celui de l’Etat: mille projets qu’on traite de chimériques, & qui le deviennent en effet, se réaliseroient s’ils pouvoient seulement commencer d’éclore. L’eau ne demande qu’à couler, mais il faut qu’elle trouve une pente. Le François ne demande qu’à imaginer, à inventer, à perfectionner, à travailler, à croître.”

tive — to be pushed and to push back — and shine in the process of achieving great things for the State. Without proper regulations, however, this same natural tendency would, in the process of resolving its tensions, lead to social torpor and barrenness, or worse, to deadly obstruction. But with a well-advised sovereign organizing the efforts of his subjects and setting the conditions for unimpeded circulation, marvels could be accomplished: “Great ministers are great insofar as they give great men the opportunity to reach their potential. They remove obstacles, they create the slope; and so water flows, the spring is released, talents unfold, and genius shines.”⁷⁴

Contextualizing Castel’s Physico-Politics

Castel was himself among those Frenchmen of genius who needed only encouragement and an open course to shine. Indeed, he hoped for a protector capable of removing the obstacles he foresaw detractors would set against his projects.⁷⁵ One of these projects was to establish himself as a physico-political advisor to the state. The “Lettre sur la politique” was the most salient expression of this ambition. To fully understand its significance, it must be read in light of Castel’s Languedocian background, his personal concern with patronage, as well as his other works on political-economic matters. Together, these facets reveal his long-term commitment to the promotion of physico-political circulation, and thus, the practical facet of his oeuvre.

⁷⁴ Ibid., 727: “Par quel endroit les grands Ministres sont-ils grands? Parce qu’ils donnent lieu aux grands hommes de le devenir: ils ôtent les obstacles, ils font la pente, & l’eau coule, & le ressort se débande, & les talens se déploient, & le genie éclate.”

⁷⁵ The project of the ocular harpsichord, which Castel announced around the same time, provides a good example of a seemingly chimerical project that some critics tried to nip in the bud.

Castel's childhood and adolescence were marked by two major engineering projects that transformed his native Languedoc in the late seventeenth and early eighteenth century. The first was the Canal du Midi, arguably the greatest marvel of hydraulic and structural engineering in early modern Europe. The other was the construction of the great roads (*grand chemins*) throughout the province during and after the civil war in the Cévennes. The "Lettre sur la politique" used both of these projects as empirical evidence of the benefits a sovereign prince can derive when rising to the challenge of bending nature to his will.

While studying in Toulouse, Castel would have observed the ascension of barges filled with wheat, wine, and wool along the artificial water staircase that Pierre-Paul Riquet (1609-1680) and his team of engineers had imagined and then built through the mountains of the Midi. The structure was 241 kilometers long, on average twenty meters wide on the surface (ten meters at the bottom) and two meters deep. From the Garonne River in Toulouse, it rose up to the Seuil de Naurouze — the mountain pass and watershed point from which the entire system of reservoirs, dams, and watergates was supplied — and proceeded all the way down to the Mediterranean sea at Etang de Thau (Sète). It took fifteen years (1666-1681), twelve thousand men and women, and eighteen million *livres* to build, which made it the most impressive construction work undertaken under the auspices of Colbert and one of the greatest monuments of Louis XIV's reign.⁷⁶

⁷⁶ For a thought-provoking overview of the construction of the canal and of the different kinds of expertise to which Riquet appealed during his mandate, see Chandra Mukerji, *Impossible Engineering: Technology and Territoriality on the Canal du Midi* (Princeton: Princeton University Press, 2009). As Mukerji makes clear, it is very difficult to estimate the actual number of people who contributed to the canal. Determining when the Canal was actually finished is also a matter of definition (the Maréchal de Vauban was still making necessary reparation in 1694). It may be useful to compare this modern description of the canal with Castel's: "Quelle supériorité de génie, quelle grandeur de courage, pour concevoir, entreprendre, et finir un ouvrage pour lequel il a fallu remuer plus de 4000000. de toises cubes de terre, excaver

The commercial and political benefits of this enterprise outweighed its costs. By taking the Garonne river from Bordeaux to Toulouse, and the Canal from Toulouse to Sète, traders no longer had to travel all the way around Spain to carry merchandise from the Atlantic to the Mediterranean coast. The shortcut saved time and money while reducing the risks of shipwreck and piracy. It also aligned well with Colbert's mercantilist policies, which favored the accumulation of colonial riches and internal trade over export. The Canal was thus meant to stimulate the circulation of goods between southern provinces otherwise isolated from one another for lack of proper roads. It also facilitated tax collection and, by extension, the consolidation of royal power over the still proudly independent Languedoc.⁷⁷ The economic development that the region witnessed in the decades following the inauguration of the Canal probably contributed to the integration of the province to the French "empire," which Colbert conceived as a "new Rome."⁷⁸

The other major engineering works that had transformed southern France and left a strong impression on Castel's imagination were the *grands chemins* of Languedoc, which he believed had been commissioned by the Intendant Nicolas de Lamoignon de Basville (1648-1724) in order to quell the Huguenot rebellions at the turn of the century. Castel remembered the bitter civil war opposing the Camisards (or "fanatics" as they were called by Catholics) against the royal armies. Protestant uprisings were one of the

les roches, percer des montagnes, former un reservoir par une muraille de 150 pieds de hauteur, de 60. d'épaisseur & de 500 toises de longueur, enfin pour faire passer dans un país aussi sec et aride que le Languedoc, un Canal de la longueur de 170720 pas geometriques." "[Review of the Sieur de La Jonchère's] Observations sur le plan d'un canal en Bourgogne," *Mémoires de Trévoux* (Oct. 1724): 1811. Castel probably authored this review, which borrowed heavily from La Jonchère's original text.

⁷⁷ Riquet was a tax-farmer general of Languedoc and responsible for collecting the *gabelle* (salt-tax) throughout the province; his engineering venture was thus partly motivated by personal interest.

⁷⁸ Mukerji, *Impossible Engineering*, 60-90. Parallels between the Roman and French achievements in matters of the Canal are quite frequent in the contemporary literature. De la Jonchère certainly appealed to it, as would Castel in later book reviews and Jérôme Joseph de La Lande in his *Des canaux de navigation, et spécialement du Canal du Languedoc* (Paris: Veuve Desaint, 1778).

tragic consequences of the Revocation of the Edict of Nantes (1685), whereby French Huguenots, whose presence in the kingdom had been tolerated since the reign of Henri IV of Navarre, were now forced to convert or emigrate. In practice, the implementation of these measures was difficult, especially in the Cévennes, which was an isolated, forested mountain range north of Montpellier — a stronghold of Protestant resistance against Catholic persecution. Armed confrontations had begun in the late 1680s, when repression measures against Protestants intensified, but they culminated between 1702-1710 with the War of the Cévennes proper. The conflict officially ended in 1711, although religious persecutions on a smaller scale would continue until the 1787 Edict of Versailles.⁷⁹

Although he probably never witnessed any of the bloodshed that plagued the Cévennes and the surrounding countryside, Castel's imagination was marked by these events. As a child and teenager, he would have heard tales of Catholic and Protestant communities being slaughtered in turn by "rebels" and royalists. Perhaps he observed the movements of royal troops as they marched against insurgents, thus sparking his life-long interest in the military arts.⁸⁰ Perhaps he even witnessed the forced deportation of Catho-

⁷⁹ On the War of the Cévennes, consult Henri Bosc, *La guerre des Cévennes (1702-1710)*, 6 vol. (Montpellier: Presses du Languedoc, 1985-93).

⁸⁰ This is a facet of Castel's work that has been noticed but not studied by historians. His interest in the science of tactics was long-standing. In his twenties or early thirties, he apparently projected a translation of Vegetius' *De Re Militari* (the most famous Roman treatise on war). He never produced this translation, but he eventually wrote a lengthy "Discours préliminaire" for Dazin's posthumous *Nouveau système sur la manière de défendre les places par le moyen des contremines* (Paris: J. Clouzier, 1731): i-cl. His main military opus, however, was his *Exercices sur la tactique, ou la science du héros. Ouvrage utile à la jeune Noblesse qui se destine au parti des armes* (Paris: Jean-Baptiste Garnier, 1757), which he outlined in the *Mathématique universelle*, began writing in the early 1740s, but was printed only after his death. I am only aware of one surviving copy of the *Exercices*, preserved at the University Library of Liège. Summaries are available in contemporary reviews, and we may also assume that another draft existed since the abbé Joseph de Laporte's compilation of *Esprit, saillies et singularité du P. Castel* contains excerpts that do not seem to appear in any other known publication. For the known manuscripts pertaining to the *Exercice de la tactique*, see Castel, "La guerre réduite en art et en règles, en principes et en méthode comme géomé-

lic families, as it was deemed expedient by the authorities to burn farm lands to isolate and starve the enemy — a metaphorical amputation of the rotten Huguenot limbs. Ultimately, it was not through amputation but through “circulation” of troops and war machines on the royal roads that Catholics had prevailed. In his much simplified account of the war, Castel credited the Intendant of Languedoc with having driven Protestants out of their bastion by following the Roman example of cutting through the hills with roads.⁸¹

In times of war, roads facilitated the march of armies and, thus, the suppression of local rebellions. In times of peace, they insured the political integration of distant provinces to the kingdom through commerce. In addition, Castel also believed that they fostered agrarian expansion and the overall “fecundity” of the kingdom: “Pierce a state through and through with canals and great roads” he wrote, “[and] you’ll see that from this moment on, without even having to do anything, life will take hold of these great ways and of all that lead up to them.”⁸² Castel estimated that many lands in France were underexploited — “hors d’œuvre,” as he put it — mostly because they were hard to ac-

triques,” Ms. 15757 (1r-17r and 21r-52v), Ms. 20753-20756 (135r-150v), Ms. 20758 (25r-29v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

⁸¹ Castel, “Lettre sur la politique,” 723-24: “Les Cévennes étoient comme une Citadelle imprenable, où chaque forêt, chaque pointe de rocher présentoit un nouveau Fort, inaccessible aux Troupes. On perça ce païs d’outre en outre & comme à jour par des chemins Royaux, à l’aide desquels les Carosses mêmes, les Canons, & toute sorte de voitures & de machine, peuvent rouler par tout, sur la pointe même des montagnes, jusques-là inaccessibles aux gens de pied. Les Romains regardoient les grands chemins comme un des principaux nœuds de leur politique.” On the Intendant Basville, see Robert Poujol, *Basville: Roi solitaire du Languedoc: Intendant à Montpellier de 1685-1718* (Montpellier: Presses du Languedoc, 1992).

⁸² *Ibid.*, 724-725: “Percez un Etat en tout sens, de canaux et de grands chemins; dès ce moment, sans que qu’on s’en mêle, tout va s’animer dans ces grandes voyes, & dans tout ce qui y aboutit.”

cess or that no one knew they existed. For such remote areas, a great road could be “a ray of light” allowing settlers to see their agrarian potential.⁸³

The Canal du Midi and the Languedoc *grands chemins* were therefore projects worth repeating and good examples of how the action of man could organize nature for the benefit of the realm. Castel was confident that emulation was under way: “We have all reasons to hope that under the auspices of the great Prince currently at the head of the ministry, Burgundy will soon have no reason to envy Languedoc and its canal, and that many other provinces will be able to aspire to a similar good favor.”⁸⁴ Riquet’s work had demonstrated the feasibility of large-scale engineering projects; there remained only to imitate him.⁸⁵ Peter the Great had done likewise and successfully awakened Moscovia [Russia] from its torpor “by connecting [its] four seas by means of a number of great canals.”⁸⁶ The road and canal networks of China accounted for the extreme fertility of its land and people; Flanders owed its prosperity to the organization of its towns, while Holland’s riches were due to its worldwide commercial circulation. The decline of Spain, by contrast, illustrated the consequences of poor circulation within an empire.⁸⁷

⁸³ Ibid., 725: “Un grand chemin qui traverse un païs, est un rayon de lumière qui l’éclaire dans toute son étenduë; on n’y passera pas long-tems impunément, & sans que quelqu’un s’apperçoive efficacement qu’il n’y a là des terre hors d’œuvre.”

⁸⁴ Ibid., 721: “Il y a tout lieu d’espérer, que sous les auspices du grand Prince qui est à la tête du ministère, la Bourgogne n’enverra pas long-tems au Languedoc son Canal, & que bien d’autres Provinces pourront prétendre à la même faveur.” Castel probably borrowed many of his arguments in favor of canal building from Jonchère’s previously mentioned *Observations sur le plan d’un canal en Bourgogne*. The work of the Maréchal de Vauban, which circulated in manuscript form, may also have been a source of inspiration. See for instance Sébastien Le Prestre de Vauban, “[Mémoires sur la] Navigation des Rivières,” in *Les oisivités de monsieur de Vauban, ou ramas de plusieurs mémoires de sa façon sur divers sujets*, ed. Michèle Virol (Seyssel: Editions Champ Vallon, 2007): 637-691. As it turns out, Burgundy and other French provinces would only get their canals in the late eighteenth or early nineteenth century.

⁸⁵ Castel, “Lettre sur la politique,” 722.

⁸⁶ Ibid., 722.

⁸⁷ Castel’s sincerely believed that the Canal du Midi, and France more generally, set an example for the rest of Europe. Yet noticeably absent from Castel’s international survey are the infrastructural

Childhood memories and “historical” observations of this sort formed the empirical basis upon which Castel built the physico-political system of the “Lettre sur la politique.” He regarded rivers and other natural channels as real points of contact between the natural and political realms. Indeed, lakes, rivers and the sea are natural “organs” of physical and commercial or military circulation.⁸⁸ But when Nature proves insufficient for the needs of a nation, human industry must come to her aid by digging new channels and paving roads.⁸⁹ So far, princes had done by intuition what Castel now wanted them to repeat in complete awareness. The natural philosopher’s contribution to politics was to offer persuasive demonstration of the possibility and the expediency of large-scale engineering projects.

This could not be done without gaining the attention of influential ministers. Since Castel’s authorial activities cannot be dissociated from his hopes of achieving social elevation and some measure of political influence, his lifelong attempt to secure patronage deserves some attention. Although his vow of poverty forbade him to seek personal enrichment, the scope and variety of his projects required him to reach outside his religious order for financial support. As his journalistic and teaching income went straight into the communal treasury (which in return provided him with a modest allowance to cover his daily expenses), he had no choice but to rely on gifts and other forms of direct support to ensure the completion of private initiatives. The history of the fabrica-

achievements of seventeenth-century England, including roads building, urban water procurement, and marshland drainage. Whether this oversight was deliberate or not is unclear. See Eric H. Ash, “Amending Nature: Draining the English Fens,” in *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialisation*, ed. Lissa Roberts, Simon Schaffer, and Peter Dear (Amsterdam: Koninklijke Nederlandse Akademie van Wetenschappen, 2007), 117-143.

⁸⁸ Castel, “Lettre sur la politique,” 718-719.

⁸⁹ *Ibid.*, 720.

tion of the ocular harpsichord provides a good example of this. Since the Society of Jesus would not pay for Castel's enterprise, the fate of the instrument was tied to the fortunes and wavering enthusiasm of such rich patrons as Montesquieu, the Comte d'Egmont, and the Comte de Maillebois.⁹⁰ But Castel also relied upon the generosity of his patrons for more prosaic purposes, like the defrayal of printing cost for works that were neither commissioned by his superiors nor inserted within periodicals. Less tangibly, but just as importantly by early modern standards, his association with the powerful conferred upon him prestige and protection. The latter was particularly important given the ease with which Castel made enemies.

Castel's transfer from Toulouse to Paris toward the end of 1720 had opened up a number of patronage opportunities. Possibly thanks to Fontenelle, he was introduced into Parisian salons and academic gatherings, where he made "friends" and acquired the charge of their children's mathematical education.⁹¹ Since Fontenelle lived at Versailles on occasions, it is also likely he was instrumental in helping his *protégé* establish connections at court with Charles Jean-Baptiste Fleuriau, comte de Morville (1686-1732), Minister and Secretary of State for the Navy between 1722-1723, and Secretary for Foreign Affairs between 1723-1727. Close to the Regent, Philippe II of Orléans, Morville was an ideal protector for the young *physicien*. Castel dedicated the *Traité de la pesanteur* to him, hoping that a statesman and honorary *académicien* of his distinction would recog-

⁹⁰ On the patrons of the ocular harpsichord, see Couvreur, "Aperçus d'un naufrage," 114 and 117 (for the Comte d'Egmont); Jean Ehrard, "Une 'amitié de trente ans': Castel et Montesquieu," in *Autour du Père Castel et du clavecin oculaire: Études sur le XVIIIe siècle, vol. XXIII*, edited by Hervé Hasquin and Roland Mortier (Bruxelles: Université de Bruxelles, 1995), 69-81; Franssen, "The Ocular Harpsichord," 30 and ff. (for Maillebois). See also Castel's "Journal du clavecin," which relates the fortunes of the instrument.

⁹¹ See chapter 4, below.

nize the merit of his work and reward him accordingly.⁹² It is also worth noting that Castel's presentation of the *Traité* as an effort toward the improvement of the arts and sciences aligned with the Regent's nation-wide *enquête* to improve and centralize the administration of the kingdom's resources and rationalize the know-how of artisans (launched between 1718-1719). It also mirrored the practical turn that the Académie Royale des Sciences was undergoing in the 1720s under the leadership of Réaumur, Fontenelle, and Bignon.⁹³

The "Lettre sur la politique" was the occasion by which Castel fleshed out his politico-economic insights and established some credentials as a political advisor. Indeed, by advocating for the development of the kingdom's infrastructure, he meant to draw the attention of Morville and other "great ministers" more than the good graces of the abbé de Saint-Pierre.⁹⁴ Finding a receptive ear amongst the greats was difficult, however, in light of the backdrop against which Castel was making his pitch. Less than five years before the letter's publication, around the same time Castel arrived in Paris in fact, France was undergoing its first financial crash, caused by the collapse of John Law's infamous

⁹² The nature of Morville's patronage remains unclear. Castel did not leave indications that he reaped any direct benefits from this association, so it is possible that he was only "fishing" for potential patrons rather than consolidating an existing relationship. Perhaps he hoped that between Morville and Fontenelle, he might secure an honorary academic position. Morville belonged to the close circle of the Regent, whose family seems to have supported Castel's work on a number of occasions during his life. See Couvreur, "Aperçus d'un naufrage," 125 (note 48). The public notoriety he achieved over the years through his color harpsichord would eventually attract the attention of powerful men, including Louis XV, though Castel did not capitalize on this.

⁹³ Christiane Demeulenaere-Douyère and David J. Sturdy, *L'Enquête du Régent 1716-1718: Sciences, techniques et politique dans la France pré-industrielle* (Turnhout: Brepols, 2008). On the shift taking place at the Académie Royale, see Shank, *Newton Wars*, 76-94, esp. 84.

⁹⁴ The abbé did not need to be convinced of the advantages of roads and canals building, as his own writings testify. See for instance his *Mémoire sur la réparation des chemins* (signed "Saint-Pierre Eglise, 10 janvier 1708"); *Mémoire pour perfectionner la police sur les chemins* (Paris: Palais Royal, 1715); and "Projet pour rendre les chemins praticables en hiver" *Ouvrages de Politique* (Rotterdam: Jean-Baptiste Beman, 1733), vol. 4, 1-27.

Mississippi system.⁹⁵ Law's spectacular rise and fall created a climate of suspicion around project-makers who claimed they held the key to the nation's politico-economic problems. The fact that Castel's pitch never found a friendly ear ought to be read in this context and not simply as evidence of its impracticality. Even though it was to no avail, his reliance upon familiar tropes and intuitive analogies rather than upon the language of reform suggests that he was aware of the obstacles that lay on his way and attempted to propose something altogether different from the abstract systems of most political economists.

Castel was more serious and more persistent in this effort than the letter's lack of success (and frivolous tone) might suggest. Several other works of his testify to his lifelong commitment to political economy, and especially his continued interest in circulation infrastructures. Some took the form of book reviews and public endorsement of other men's project. The *extrait* of de La Jonchère's *Observation sur le Plan d'un Canal de Bourgogne* is probably the earliest example of this kind of defence.⁹⁶ The support he lent

⁹⁵ Law was a visionary Scottish economist and financier whom the Regency had invested with the power and responsibility of redressing the finances of the State in the aftermath of the War of Spanish Succession (1701-1714). The sophisticated "system" he instated in 1718 after the establishment of his *Banque Générale* proposed a number of innovative measures to address the Crown's crippling debts. These measures included the replacement of metal coins with paper money and the selling of shares in newly minted foreign trade companies. The allurements of riches surrounding the newly acquired colony of Louisiana attracted many French and foreign investors, several of whom made a fortune as Law's scheme expanded to the commerce of the French West and East Indies. By the 1720s, Law had turned the general bank into a conglomerate controlling the kingdom's foreign trade, tax farming operations, and minting. For a while, the system seemed to work. But as the amount of money in circulation kept increasing — the number and value of issued shares and paper currency increasing far beyond the gold and silver reserves that guaranteed their value — inflation spiraled out of the control. When nervous investors decided it was time to cash their investment and discovered that the Banque royale — as it had been renamed — would not, and indeed could not, let them do so, trust in the financial system collapsed. Law tried to introduce *ad hoc* measures to redress his confidence edifice, but distrust eventually turned to panic, which in turn led to his bankruptcy and to a general collapse of the kingdom's finances. A detailed account of Law's system can be found in Antoin E. Murphy, *John Law: Economic Theorist and Policy-Maker* (Oxford: Clarendon Press, 1997).

⁹⁶ "[Review of de la Jonchère's] Plan d'un canal," 1807-1811.

to the inventor Duquet and the system he designed to automate the towing of boats upstream provides another (the navigation of rivers was, after all, an essential component of Castel's circulation scheme, when canals could not be built).⁹⁷ The review of his compatriot Jean Astruc's *Mémoires pour l'histoire naturelle de la Province de Languedoc*, which paid tribute the accomplishments of Riquet and his canal, was also undoubtedly Castel's.⁹⁸ Of less certain attribution, but nonetheless representative of Castel's editorial oversight in the 1730s and early 1740s, was the review of Bergier's *Histoire des Grands Chemins de l'Empire Romain contenant l'origine, progrès et étendu quasi incroyable des Chemins militaires*, which reminds us that recent engineering feats had ancient counterparts.⁹⁹ Yet by far the most eloquent endorsement of infrastructural development was his

⁹⁷ Duquet's project consisted in harnessing the power of rivers to activate strategically positioned winches equipped with flaps, such that the passage of water would cause the winding up of cables attached to the boats that needed towing. Although it faced a number of theoretical and practical difficulties, the advantage of his machine was its partial automation and its promise of reducing costs associated with drafting horses and manpower. Duquet apparently asked Castel to write on his behalf a "Mémoire sur la Possibilité de faire servir le courant des Rivières, pour remonter les Bateaux, plus vite & à moindres frais que par le secours des hommes, des chevaux [...]," *Mémoires de Trévoux* (June 1729): 1140-1149. This work appeared in response to Henri Pitot's "Nouvelle méthode pour connoître & déterminer l'effort de toutes sortes de Machines mûës par un Courant [...]" included in the mémoires appended to Fontenelle's *Histoire de l'Académie Royale des Sciences* [...] *Avec les mémoires de mathématiques et de physique pour la même année* (1725): 78-102. Castel's authorship was obvious enough and his attack against Pitot's geometrical take on a question of practice ought to be read against the background of Castel's ongoing dispute with the Académie (see Chapter 4, below). Pitot published a "réponse à la critique de Mr. Duquet" [i.e. Castel] in the *Journal des sçavans* (Sept. 1729): 537-540; The quarrel continued as Duquet wrote his "Lettre de Mr. Duquet Ingénieur, au R. P. Castel, sur le Remontage des Batteaux par le moyen du Courant des Rivières" to which Castel responded with "Réponse du P. Castel à M. Duquet," *Mémoires de Trévoux* (Sept. 1730): 1687-1692. Jean Saurin took Pitot's defence in his virulent *Lettre Critique de Monsieur **** a Monsieur **** sur le traité de mathématique du P. C. Et les extraits qu'il a faits dans les Journaux de Trevoux des Memoires de l'Academie des Sciences de l'année 1725* (Paris: Gabriel Martin et Louis Guerin, 1730), 43-49. See also Duquet[?]. "Système nouveau, ou decouverte faite par Monsieur Duquet, sur le faire aller les Navire contre le vent en droite ligne par le vent même," *Mémoires de Trévoux* (Nov. 1728): 2108-2115.

⁹⁸ "[Review of Jean Astruc's] Mémoire pour l'histoire naturelle de la Province de Languedoc," *Mémoires de Trévoux* (Dec. 1737): 2200-2228 and (Jan. 1738): 146-174.

⁹⁹ "[Review of Bergier's] Histoire des Grands Chemins de l'Empire Romain contenant l'origine, progrès et étendu quasi incroyable des Chemins militaires," *Mémoires de Trévoux* (June 1740): 1008-1059 and (July 1740): 1301-1354.

review of a *Recueil de mémoires*, on the drainage of Languedocian marshes and on the construction of a canal between Beaucaire and the Canal des Etangs.¹⁰⁰

This last piece deserves a separate treatment, not least because it reveals Castel's direct involvement in the promotion of a canalization project. The multi-author bundle of "avis, instructions, éclaircissemens, objections, réponses, répliques, & contre-répliques" he synthesized in the *Mémoires de Trévoux* had not been published as such, and never would be. Working from "fleeting pieces" (*pièces fugitives*), including manuscripts that had been communicated to him personally, Castel wrote an essay more than a *compte-rendu*, endorsing and diffusing the opinion of a certain "Mr. Maréchal" whom he regarded as the main mind behind the project.

After describing the natural riches, pleasant climate, and human industry of his native Languedoc, Castel points out that for all the wine, honey, wax, silk, olive oil, and exquisite fruit it produces, the Bas-Languedoc in particular did not yield nearly as many useful crops as it could. Marshes and salt ponds soaked the entire coast between Narbonne and the Rhône (especially within the area bound between Agde, Aigues-Mortes, and Beaucaire), numbing the land and releasing unwholesome vapors. In order to vivify and sanitize the area, Maréchal and his colleagues showed the "possibility as well as the necessity and great good [that would result from] the projected drainage."¹⁰¹ In reclaiming fertile lands from seashore wetlands, local entrepreneurs would simply accelerate what had nature already begun — a sound approach in political-economy, Castel thought

¹⁰⁰ "[Review of Maréchal et al.'s] Recueil de mémoires, avis, instructions, éclaircissemens, objections, réponses, répliques, & contre-réplique, sur le dessechement des marais de languedoc, et sur la construction d'un canal de navigation depuis Beaucaire, jusqu'aux Canaux des Etangs qui continue le canal royal de cette Province," *Mémoires de Trévoux* (Jan. 1743): 61-109.

¹⁰¹ *Ibid.*, 69.

— the presence of all this “stagnant” water being due to slow withdrawal of the sea that had once covered the entire region.¹⁰² On this particular issue, Castel intervenes by providing historical evidence in support of this change: he relies on ancient authors as well as onomastic and architectural evidence dating from the time of Roman occupation. His discussion of the remains of the *Robine* canal, which he believed to have once been a much more important structure, is particularly telling:

It is often believed that the canal in question, which is called Robine or Great Robine, was originally the work of Romans, these proud masters of nations who also dared to take control of nature, and to tell the sea *you shall come here*, and rivers especially, *you shall go there*, thereby perpetuating, without knowing it, the sovereign command of God, who had said these things before entrusting [the world] to secondary causes.¹⁰³

Castel, like Maréchal and his colleagues, believed that the Robine and similar canals could be rebuilt or redesigned to prolong the work of Riquet. Connecting Bordeaux to Toulouse via the Garonne river, Toulouse to the Mediterranean Coast via the Canal du Midi, and the Mediterranean coast from Narbonne to the Rhone via the Beaucaire Canal (and perhaps the Rhone to Marseille and Lyon) would result in “the perfect union, the perfect unity of the two seas, and a continued bridge spanning a 120 leagues. This way France might even become the knot and the arbiter of the commerce of all the Nations of Europe.”¹⁰⁴ The Canal du Midi, by far the hardest part of the work, had already shown the feasibility of all these projects, and the resourcefulness of humankind when facing seemingly insurmountable challenges.

¹⁰² Ibid., 70-71.

¹⁰³ Ibid., 75-76: “Et l’on croit assez que le Canal en question appelé *Robine*, ou *grande Robine*, est dans son origine l’ouvrage des Romains, ces fiers maîtres des Nations, qui osoient aussi maîtriser la Nature, et dire à la Mer *tu viendras là*, & aux Rivières sur-tout, *tu iras là*; Dieu qui l’a dit une fois, ayant chargé les causes secondes, même à leur insçu, de perpetuer les effets de ce commandement souverain.”

¹⁰⁴ Ibid.,” 94.

We have pierced mountains, some of them made of marble, and placed immense subterranean arches beneath them [...]. We flattened other mountains, of which no trace remains [...]. We did something even greater: we left several mountains in their natural height, and found means to cross them on water, a water that rises even as it falls, and make large ships rise to the highest summits.¹⁰⁵

Never had man-made work been so God-like. Perhaps the greatest feat of all was the construction of Farriol Reservoir, the high masonry walls of which had transformed a valley into “an immense basin, as deep as the mountains that support it,” an improbable sea amidst the mountains, “reaching as far as the eye can see.”¹⁰⁶

Rarely was Castel so explicit about his support for the well-concerted action of man upon nature as in his defense of the drainage and canalization of Bas-Languedoc. Not everyone shared Castel’s enthusiasm. The projects pitched by Maréchal and his colleagues had been hotly contested since the time of Henri IV of Navarre by locals who made good use of their ponds. Indeed, Castel was intervening in a long-standing quarrel opposing the Etat Généraux of Languedoc (representing the interest of local land owners and salt exploiters) and a succession of entrepreneurs who had acquired the rights and letters patent for the project in 1644, 1701, and 1738, but whose ventures were bogged down at every turn by the syndics of the province.¹⁰⁷ The most recent of these entrepreneurs was not Mr. Maréchal, however, but Barillon, whose case is most interesting since

¹⁰⁵ Ibid., 88: “On perça des Montagnes, Montagnes quelques fois de Marbre, & on passa dessous des arches souterraines d’une largeur immense [...]. On aplani d’autres Montagnes, dont il ne reste aucun vestige [...]. On fit quelque chose de plus fort. On laissa plusieurs Montagnes dans leur hauteur naturelle, & on ne laissa pas de les franchir avec une eau, qui descendant toujours, s’élève, et élève les plus grands Bateaux au niveau des sommets les plus élevés.”

¹⁰⁶ Ibid., 89.

¹⁰⁷ A history of these contestations can be found in Jules Viguier, “Histoire des contestations relatives au dessèchement des marais et à la construction du canal de navigation entre Beaucaire et Aigues-Mortes 1738-1746,” *Bulletin de la Société Languedocienne de Géographie* 12 (1889), 281-302. For eighteenth-century histories of the various Languedoc canalization projects, see Bernard Forest de Belidor, *Architecture hydraulique, ou l’Art de conduire, d’élever, et de ménager les eaux pour les différents besoins de la vie...* (Paris, C.A: Jombert, 1737-53); La Lande, *Des canaux de navigation*, 157 ff.

it involved various experts — hydraulic engineers for the most part, including Henri Pitot of the Académie Royale des Sciences — whose task was to determine whether or not the project would be deleterious to the local population. Contradictory reports delayed the process for many years, until Barrillon eventually gave up and agreed to cede his rights to the États généraux. Between 1744 and 1746, deliberations took place to determine how this would be done, until it was decided that the Crown would buy back the right for 410,000 livres or a *rente* of 20,500 livres, and sell the rights back to the États généraux of Languedoc.

In a copy of a letter to the Comtesse de Maillebois dating from 1753, Castel claimed that he had played a crucial part in the last stages of these negotiations, going so far as to make himself sick by travelling from Paris to Languedoc and pleading on Barillon's behalf.¹⁰⁸ Thanks to his testimony, and possibly to the good case he had made for the project in the *Mémoires de Trévoux*, Castel claimed to have been single-handedly responsible for earning Barillon his “22 500 [sic] livres of rentes” on an investment that had cost him less than a 100 000 livres.¹⁰⁹ His reason for pointing this out at this particular stage was that his main patron at the time, the Comte de Maillebois, apparently had a vested interest in the renewal of the Beaucaire canal project. Castel claimed he could have earned his protector a substantial sum of money had it not been for two unnamed detractors, who tried to undermine his influence. While Castel's main motivation for writing to the comtesse was to encourage her to pressure her husband into honoring his

¹⁰⁸ Castel, “Lettre à la comtesse de Maillebois,” 189: “J’aillai jusqu’à plaider contre le syndic et des avocats dans une assemblée où presidoient l’archevêque de Narbonne, celui de Toulouse, l’éveque de Nimes, le commandeur de Froulay, etc. J’en fus tres malade.” The original letter lies amidst Castel's papers, in Ms. 20753-20756 (28r-29v), Fonds Van Hulthem, Bibliothèque Royale Albert 1er, Brussels. An independent confirmation of Castel's intervention has yet to be found.

¹⁰⁹ *Ibid.*, 189.

promise to fund the construction of the ocular harpischord, it also testifies to his direct and (arguably) credible interest in politico-economic matter. In Barillon's case, he had served as an advocate. In Maillebois, he pitched himself as an advisor.

There is yet another suggestive piece shedding light on Castel's physico-political ambitions. Indeed, in the 1730s Castel was apparently working on a physico-political treatise entitled *La Philosophie des Princes, ou l'Art de faire la pluie et le beau temps* — *The Philosophy of Princes, or the Art of Making Rain and Fair Weather*.¹¹⁰ My literal translation of the subtitle is intentional. A more idiomatic English rendition would be 'the Art of Calling the Shots,' or better yet, 'the Art of Being All-Powerful.' The latter underscores an interesting religious overtone that may explain an intriguing reference to this work in one of Castel's letters to Montesquieu:

I hasten to finish my Philosophy of Princes so that I may have the honor of sending it to you. I fear I will not be able to print this work in this country; there are many reasons for this, not least of which is that I would never want to hurt religion, even in appearance.¹¹¹

This work was never published. It is possible that it did not pass the Jesuit censor board.¹¹² Perhaps some of his colleagues felt that Castel's exaltation of mankind bordered on the sacrilegious. His use of the French proverb "*faire la pluie et le beau temps*," as mentioned in chapter one, was meant to be taken literally, as a prerogative of man over nature. Since the manuscript has been lost, one can only speculate about its content. Had it found its way into print, and found a dedicatee, it might have given an interesting natu-

¹¹⁰ Couvreur, "Aperçus d'un naufrage," 116-117.

¹¹¹ Letter of Castel to Montesquieu, [23 Avril 1734], Ms. 1868 (69), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux: "Je me hâte de finir ma Philosophie des princes pour avoir l'honneur de vous la communiquer. Je crains de ne pouvoir imprimer cet ouvrage, en ce pays-ci, pour bien des raisons, dont aucune n'est la religion que je serais au désespoir de heurter, même en apparence."

¹¹² Although no manuscript of this work survived, Castel's correspondence to Montesquieu shows that it was in preparation in 1734. On this subject, see Ehrard, "Castel et Montesquieu," 71.

ral philosophical twist to the “mirror of princes” genre and fulfilled the program he sketched out in his “Lettre sur la politique.”

Castel and the Science of Man

Like his work on the physics of *pesanteur*, Castel’s “Lettre sur la politique” was motivated by religious concerns over the perceived erosion of the dignity and free will of man in the writings of contemporary authors. Consequently, it also ought to be read not only as an internal development but also as a contribution and reaction to the emerging Enlightenment “science of man.”

Historians usually speak of the Enlightenment “science of man” in order to describe the theoretical ambitions of moral philosophers and mathematicians like Montesquieu, d’Alembert, Turgot, Condillac, and Condorcet, whose study of politics, commerce, laws, and customs constitute one of the distinctive features of the eighteenth century.¹¹³ Inspired by the predictive successes of Newtonian philosophy, an influential minority of Castel’s contemporaries sought to discover fixed laws governing human action and society. This endeavor — an attempt to found the moral sciences upon rigorous mathematical principles — was not so much descriptive as normative, since its goal was to identify rational and universal standards and use them to reform social and political institutions. Many worked under the assumption that in order to be happy, man needed to conform to these laws of nature.

¹¹³ The Enlightenment Science of Man “was not sociology in its modern sense because it began with the rights, wills, and decisions of individuals rather than with the observed behavior of societies. The social thinkers of the Enlightenment were reformers who wished to discover the laws by which society should be governed, rather than the laws that it actually followed.” Thomas L. Hankins, *Science and the Enlightenment* (Cambridge: Cambridge University Press, 1985), 187. Hankins is referring to Condorcet’s social science, but his remark is valid for earlier figures as well.

One of the main characteristics of the moral sciences was their inclination toward a reductive, mathematical treatment of human action and society. As such they were emblematic of what some scholars have called the “quantifying spirit” of the Enlightenment.¹¹⁴ Early representatives of this current included political thinkers like Thomas Hobbes and the abbé de Saint-Pierre, whose ambitions were to pioneer a system or “political science” capable of explaining and improving the current state of affairs while possibly predicting future outcomes.¹¹⁵ In the emerging field of probability theory, such mathematicians as Jacob and Nicholas Bernoulli, Pierre-Raymond de Montmort, and Jean Le Rond d’Alembert likewise sought to quantify the judgement of rational men in situations like gambling, the purchase of life insurance, or the rendering of trial court judgements. In parallel, “political arithmeticians” building on the works of William Petty and Edmund Halley were compiling tables of birth, marriage, and mortality rates, that revealed amazingly stable patterns. The relative success of these enterprises led some, like Condorcet and Laplace, to argue that the moral and political realm, like the physical, was mathemat-

¹¹⁴ Tore Frängsmyr, J. L. Heilbron, and Robin E. Rider, eds., *The Quantifying Spirit of the Eighteenth Century* (Berkeley: University of California Press, 1992).

¹¹⁵ Shank has recently argued that Saint-Pierre’s quantitative approach to politics was influenced not only by a number of concurrent mathematical developments in statistics and probability theory, but also by the program of analytical mechanics developed by his friend and former roommate Pierre Varignon at the Académie Royale des Sciences starting around 1700. While these mathematicians and natural philosophers found value in determining the mathematical relations governing the motion of inanimate bodies, the abbé and like-minded thinkers sought to uncover general principles governing the motions of the body politic. J. B. Shank, “The Abbé de Saint-Pierre and the Emergence of the ‘Quantifying Spirit’ in French Enlightenment Thought,” Papers from Gustave Gimon Conference on French Political Economy, Stanford University, (April 2009), accessed December 2015, http://www-sul.stanford.edu/depts/hasrg/frnit/pdfs_gimon/shank.pdf. Another important inspiration and predecessor would have been Thomas Hobbes. For enlightening discussions of Hobbes’s “political geometry,” see Hardy Grant, “Mathematics in the Thought of Thomas Hobbes,” *Mathematics Magazine* 63, no. 3 (June 1990): 147-154 and Gordon Hull, “Hobbes and the Pre-Modern Geometry of Modern Political Thought,” in *Arts of Calculation: Numerical Thought in Early Modern Europe*, ed. David Glimp and Michelle Warren (New York and London: Saint-Martin/Palgrave, 2004), 115-135.

ically determined from God's standpoint — a necessary condition, they thought, for the physico-mathematical predictability of human behavior.¹¹⁶

These mathematization efforts were both paradoxical and religiously unorthodox. They were paradoxical insofar as they assumed the existence of determinate moral laws, as immutable and regular as the laws of nature, in spite of the fact that both individuals and societies constantly seemed to contradict or fall short of this standard.¹¹⁷ They were religiously suspect because the Catholic Church held as an article of faith that free will was God's gift to humanity, and any mathematical determinism seemed to undermine this gift. The Jesuits in particular contended that divine foreknowledge of human choices did not actually determine these choices. The idea of reducing human action to inflexible laws was therefore theologically problematic. This is not to say that religious orthodoxy was incompatible with the general idea of a science of man — Castel was attempting to establish his own decades before the *philosophes* would take over the lead. The nature of his research, however, was quite different from what we might expect to find in the eighteenth century.

Castel's attitude with respect to the mathematization of human action was ambiguous. Familiar with contemporary attempts to apply algebraic analysis to the moral sciences, he granted this branch of knowledge a place in the tree of sciences of his *Mathématique universelle* (1728), as well as some measure of success:

¹¹⁶ My discussion of the mathematization of the moral sciences is heavily indebted to Lorraine Daston's *Classical Probability in the Enlightenment* (Princeton: Princeton University Press, 1988). On social mathematics, see also Keith Michael Baker, *Condorcet: From Natural Philosophy to Social Mathematics* (Chicago: University of Chicago Press, 1982).

¹¹⁷ Many were thus willing to admit the existence of free will while simultaneously trying to uncover mathematical patterns capable of accounting for, and even predicting, complex psychological, social, and economic phenomena.

What is less geometrical in itself than gambling or the Art of making conjectures in the affairs of life that are most complicated or most dependent upon men's free will and caprices, such as trials, wars, negotiations, etc. Yet, as soon as geometers took the time to throw some algebra and arithmetics at them, all this has become just as mathematical as Astronomy.¹¹⁸

Castel believed that human actions could be quantified and represented in mathematical terms. But he also distinguished between mathematical representations of reality and attempts to explain and predict phenomena as though they were regulated and “coerced” by laws. While he was wholeheartedly supportive of the former, he rejected the latter. Castel's resistance to a reductive mathematization of morals and politics was grounded in epistemological and ontological objections to the mathematization of physics. His distrust of the new, highly abstract physico-mathematics reflected a traditional understanding of the disciplinary boundary between mathematics and natural philosophy that he felt contemporary followers of Newton failed to appreciate.¹¹⁹ By eschewing *real* cause-and-effect relationships, mathematical laws *represented* rather than *determined* the course of nature.

A more fruitful combination of mathematical discipline and physics was to study the intelligible world through *qualitative* analogies, with the help of more traditional

¹¹⁸ Castel, *Mathématique universelle* I, 7: “Quoi de moins géométrique en soi, que les Jeux de hazard, ou l'Art de conjecturer dans les affaires de la vie les plus compliquées ou les plus dépendantes de la liberté & du caprice des hommes, comme les Procez, les Guerres, les Négociations, &c. Cependant dès que les Géomètres ont voulu se donner la peine d'y jeter de l'Algèbre ou de l'Arithmétique, tout cela est devenu aussi Mathématique que l'Astronomie [...]” This is not exactly an endorsement, however, since it features in the context of a discussion of the geometrical style, which gives an impression of exactitude when applied to different sciences: “Les seuls noms d'Axiomes, de Postulat, de Proposition détachées, de Théorèmes distinctement énoncez, de Corollaires numerotez ont donné aux Sciences les plus vagues, une apparence de précision & de justesse, qui a souvent fait regarder leur Auteurs comme Geometres, ou comme ayant l'Esprit géométrique, qui est de tous les Esprits celui qu'on vante le plus.” (6-7).

¹¹⁹ In other words, while historians in general tend to think of Aristotelian and Cartesian rejection of Newtonianism as a failure to understand Newton's point, I want to show that, from Castel's perspective at least, Newtonians — especially uncritical followers of Newton — were those who failed to get the Jesuit's point. For an excellent article dealing with the impact of Newtonian mathematics on eighteenth-century physics, see Yves Gingras, “What Did Mathematics Do To Physics?” *History of Science* 39 (2001): 383-416.

physico-mathematical sciences like optics, acoustic, and statics, in which geometry served to describe and even predict real-world phenomena without going too far.¹²⁰ Thus, a couple years after the publication of the “Lettre sur la politique,” Castel would nest his physico-political musings on a branch of knowledge called “physico-mathematical anthropography,” a kind of natural history of the morals and political realm informed by analogies with physico-mathematical disciplines. Postulating that “thoughts,” considered as “simple action upon the body,” are “completely analogous to the action of light and can be treated by the same geometrical principles,” he outlined a program of research that established rapports not only between between concepts but also between scientific disciplines:

Now, to give you a better sense (*laisser entrevoir de plus près*) of this system of physico-mathematical anthropography, I will point out that the metaphysics of the mind correspond to optics, the physics of the mind to acoustics, morals to dynamics, and politics to statics; and [I will also point out] that, in particular, thought — I mean the movements in the body that result (*répondent*) from the thinking of the mind — correspond to Optics; those of reflexion to catoptics, those of judgement to dioptics, those of reasoning to perspective, those of invention to chromatics, etc.¹²¹

¹²⁰ Castel believed that the object of study of mechanics, or physico-mathematics, was the world in a state of transition between potentiality and actuality. The proper object of study of physico-mathematical sciences, in other words, fell between possibility and reality. Within these bounds, the use of mathematics was not controversial in the least: optics, statics, kinematics, amongst others, were unproblematically mathematized centuries before Newton. In the application of mathematics to the world, Castel thus preferred more “tangible” geometrical representation to mathematical shortcuts, like algebraic calculus, which he felt were by their very nature abstracting reality.

¹²¹ Castel, *Mathématique universelle* I, 269: “Maintenant pour laisser entrevoir, de plus près, ce système d’Anthropographie physico-mathématique, je ferai remarquer que la Métaphysique de l’Esprit se rapporte à l’Optique, l’histoire de l’esprit à l’Acoustique, la Morale à la Dynamique, & la Politique à la Statique; & qu’en particulier la Pensée (je dis les mouvements qui dans le Corps répondent à la pensée de l’Esprit), se rapportent à l’Optique; ceux de la Réflexion à la Catoptrique, ceux du Jugement à la Dioptrique, ceux du Raisonnement à la Perspective, ceux de l’Invention à la Chromatique, &c. / Car, dans son action simple sur le Corps, la Pensée est toute analogique à l’action de la lumière & peut être traité par les mêmes Principes de Géométrie: elle se répand autour & éclaire tout ce qui l’environne, plus ce qui est près, moins ce qui est loin.”

Castel's physico-mathematical anthropography, had he fleshed it out, might have provided a fascinating example of an eighteenth-century "science of man" that relied upon geometry and yet deliberately departed from Newtonian and quantitative approaches to the moral sciences.¹²²

At bottom, what differentiated Castel's approach from that of his contemporaries was his rejection of the assumption that immutable natural laws could determine or serve as a model for the "intelligible realm." On the contrary, it was the material realm that ought to — and indeed, did — conform or bend to "free causes" (the will of God and angels first, and the will of men secondarily). In a strictly mechanical universe, causes and effects might be entirely determined; but thanks to the constant intervention of spiritual agents, no such world existed.

It is worth pointing out, however, that empirical knowledge of the *consequences* of man's action upon nature, once allied with the regulative power of a sovereign prince, could in principle lead to the development of a predictive and normative art or science of man (if not a demonstrative one). Indeed, human actions could be free in principle, yet predictable in practice, assuming they were self-regulated or subordinated to an enlightened head of the state. A useful point of comparison might be the physiocratic movement

¹²² Laplace would later come up with what Lorraine Daston calls a societal mechanics, which in many ways resemble what Castel had in mind: "Laplace constructed an elaborate analogy between the physical and moral realms. Not only were the methods of the natural and social sciences identical; Laplace hinted that the very causes which governed the two spheres were in some sense the same. He envisioned the science of man as a kind of societal mechanics, in which abrupt changes squandered the social equivalent of *vis viva*, and spoke of 'sympathetic vibrations' which touched off collective emotional reactions. Although he admitted that moral causes were 'far more complicated' than their physical analogues, Laplace nonetheless contended that his mechanical and dynamical metaphors were more than just metaphors: 'Hesitation between opposed motives is an equilibrium of equal forces [...]. An intense, continuous effort of attention exhaust the sensorium, as a long series of shocks exhaust a voltaic pile, or the electrical organ of a fish. Almost all of the comparisons which he draw from material objects to render intellectual things palpable are at bottom identities." Daston, *Classical Probability*, 381. Laplace, of course, was informed by post-Newtonian calculus and sophisticated probabilistic mathematics; not so Castel.

that arose in the mid-eighteenth century, toward the end of Castel's life. The perspective of building a new science of politico-economy based on rigorous calculations formed the methodological backbone of the physiocratic movement, yet this movement had enough in common with Castel's own approach to justify a brief excursus.

“Physiocracy” stands for the politico-economic doctrine and the program of fiscal and agrarian reforms spearheaded by the French surgeon and physician François Quesnay (1694-1774) and a small group of disciples in the mid- to late eighteenth century.¹²³ With the specter of bankruptcy hovering over France in the wake of the Seven Years' War (1756-1763), the French *économistes* — as they were called — attempted to erect and popularize a “new science” the aim of which was to redress the finances of the State through the promotion of agriculture (the main source of wealth according to their doctrine), a radical simplification of the fiscal system (imposition of single tax on land rents), and the liberalization of the domestic and international market (especially of the grain trade). One could say that they belonged to a broader economic current attempting, with mitigated success, to steer the State away from Colbert's mercantilist ideology toward a “laissez-faire” mode of governance.

The physiocrats argued for the necessity of aligning civic and economic life with universal, unchangeable “laws of nature.” These laws having been instituted by a benevolent God, human happiness could only be optimal insofar as society conformed to them

¹²³ The foundations of the physiocratic doctrine had been laid out as early as 1756-1757 with the publication of Quesnay's articles “Fermier” and “Grain” in the *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d'Alembert. University of Chicago: ARTFL Encyclopédie Project (Spring 2013 Edition), Robert Morrissey ed., accessed December 2015, <http://encyclopedie.uchicago.edu/>. It would be further developed in the Quesnay's famous *Tableau économique* (1758). The *économistes*, as they were known by contemporaries, included the likes of Victor de Riqueti de Mirabeau, Nicolas Baudeau, Pierre-Paul Lemercier de Larivière, Pierre Samuel Dupont de Nemours and also attracted the sympathy (never the full endorsement) of a number of other *philosophes* and political actors including Turgot, Condillac, and Condorcet.

(the corollary being that going against the grain of Providence would and did cause socio-economic woes). Grounded in a curious mix of empirical and statistical analysis, sensiblist epistemology, and quasi-religious intuitions, Quesnay's system required that all individuals recognize that their best interest resided in the general augmentation of the kingdom's prosperity, even though this might come at the cost of personal sacrifice. Realizing that universal acceptance of their doctrine was unlikely to take place through public education alone, some physiocrats articulated their support for a kind of legal despotism, by which the King and his ministers would be invested with the power to impose the "rule of nature" upon the entire nation.¹²⁴

In many ways, Castel's system of physico-politics anticipated the doctrine of the physiocrats. Castel's treatment of man and society through physical, and in particular circulation metaphors; his religiously-informed advocacy of infractural and agrarian development throughout the realm; and his belief in the importance of entrusting the organization of the realm to a kind of Enlightened despot willing to take the necessary means to direct the will and action of refractory subjects toward the betterment of society: all these resonate with the teachings of Quesnay. There is, however, one major difference setting Castel apart from the mid-century *économistes*. Whereas the physiocrats argued that for human society to thrive, the State ought to legislate and adopt economic policies conforming to the natural laws they had discovered by calculations, Castel believed that God created man as a free, spiritual being, dignified with the role of beautifying, fertilizing,

¹²⁴ For further treatment of the physiocratic movement, see Philippe Steiner, *La "science nouvelle" de l'économie politique* (Paris: Presses Universitaires de France, 1998); Jessica Riskin, "The 'Spirit of System' and the Fortunes of Physiocracy," *History of Political Economy* 35 (annual supplement 2003): 43-73; Liana Vardi, *The Physiocrats and the World of the Enlightenment* (Cambridge: Cambridge University Press, 2012) as well as the old, but still very useful Georges Weulersse, *Le mouvement physiocratique en France (de 1756 à 1770)*, 2 vol. (Paris: Alcan, 1910).

and improving nature. His subordination of morals and politics to natural philosophy writ large could not be reductive since the natural world as he understood it was inherently shaped by the free will of man, not the other way around.

Concluding Remarks

Both Castel and the Abbé de Saint-Pierre agreed that politics were “suited to being turned into a system.”¹²⁵ What the Jesuit hoped his friend would retain from his “Lettre sur la politique,” however, was that such system had to be rooted in the right kind of natural philosophy — his own — and that knowledge of nature yielded useful insight into the moral and political realms.

Inspired by large-scale engineering enterprises such as the Canal du Midi and the royal roads of Languedoc and confident that his physico-political understanding of equilibrium, balancing, circulation and organization was more accurate than that of ordinary political economists, Castel believed he had successfully explained why certain commercial or diplomatic policies went against the best interest of the State and why multiplying circulatory channels across the kingdom would increase its prosperity.

The analogical structure of his argument, which subordinated human society and the intelligible realm to the system of nature made the natural world a compound of mechanical laws and free causes, while having the advantage of eschewing the reductive and deterministic agenda set by a growing number of contemporaries. The utility of Castel’s science of man in nature lay not in precise predictions by means of algebraic calculations

¹²⁵ Castel, “Lettre sur la politique,” 729: “Vous m’avez fait l’honneur de me dire, Monsieur, que la Politique était susceptible d’un système, & je ne prétends par tout ceci vous prouver autre chose, si ce n’est combien j’en suis persuadé moi-même.”

and probabilities, but in making rulers aware of the power of free will over the physical world.

The “Lettre sur la politique” might have had only a minor impact on the history of the moral sciences, yet it was a major step in the evolution of Castel’s thought. Indeed, it marked Castel’s ambition to develop an even more ambitious system reaching into all spheres of knowledge and activity, including practical ones. From this intention arose the great arborescent structure of his *Mathématique universelle* — the subject of the next chapter — which transported his concept of physico-political circulation into the domain of teaching and learning. As we will see, the result was a growing, living pedagogical system, quite unlike the static and sterile linkage of propositions often associated with the caricature of rationalist philosophy.

CHAPTER 4
Tree of Knowledge:
Castel's Project for a *Mathesis Universalis*

Mathematics is like the seed that enfolds all the sciences.
— Louis-Bertrand Castel¹

It is easy to forget that Père Castel wrote the bulk of his works while surrounded by thousands of children and teenagers. Although accounts of his daily activities at Louis-le-Grand are sparse, we know that his editorial work for the *Mémoire de Trévoux* took place on site and did not grant him dispensation from teaching. On the contrary, his appointments as professor of physics and mathematics and as chamber prefect for the class of *physici* (that is, students in their second year of the three-year philosophy course) forced him to divide his time between the quiet of his cabinet and the tumult of the classroom — to say nothing of the schoolyard and the other communal areas of the College.² In addition to his regular occupations, Castel was occasionally hired as a private tutor for the

¹ Castel, *Mathématique universelle* I, 8: “La Mathématique est comme le germe dans lequel sont enveloppées toutes les Sciences.” Castel goes on to write that “[c]haque Science se propose le même objet; & à plus forte raison la Science universelle doit elle l’embrasser. Car chaque Science a son point de vûë, & n’envisage l’univers que d’un certain côté. La Mathématique le prend dans tous les points de vûë, et le contemple de tous les sens & de tous les côtés.” N.B.: All citations follow the more readily available two-volume edition of the work from 1758.

² The College records are fragmentary, occluding the nature and duration of Castel’s responsibilities besides work on the *Mémoires de Trévoux*. De Dainville’s research at the Jesuit Archives in Rome indicates that Castel taught mathematics while occupying the position of “prefet des pensionnaires” (i.e., supervisor of boarders’s studies) rather than as the titular of the college’s mathematics chair; see François de Dainville, SJ, “L’enseignement scientifique dans les collèges des jésuites,” in *Enseignement et diffusion des sciences en France au XVIIIe siècle*, ed. René Taton (Paris: Hermann, 1964), 27-65, esp. 32. Gustave Dupont-Ferrier lists Castel among the “préfet de la chambre des physiciens” in *Du Collège de Clermont au Lycée Louis-le-Grand*, 3 vol. (Paris: E. de Boccard, 1921-1925), vol. 3, p. 21, but only “à une date comprise entre le 1er oct. 1750 et 21 juillet” (vol. 1, 188-189); his source is Ms. lat. 10992 (4r), BnF, Paris. He also asserts that Castel taught calculus in 1729, in addition to elementary mathematics and various topics in mechanics. Dupont-Ferrier had access to the course notes of one of Castel’s students, Charles-François Elzéar de Vogüé, who studied at Louis-le-Grand from 1728 to 1729. These “cahiers autographes” had been conserved in the private archives of the Marquis de Vogüé, but I have not been able to locate them in the Archives Nationales (AN 567AP/10-20), where the bulk of these papers have been transferred.

sons of wealthy noblemen to oversee their academic progress and insure their moral and physical well-being.³ Besides living alongside his pupils, he also lived in the company of hundreds of colleagues including administrators, fellow teachers, novices, and resident *scriptores librorum*, all of whom had a stake in the Jesuit pedagogical mission. In other words, his was a world of educators.⁴

The most iconic expression of Castel's teaching vocation was perhaps his *Mathématique universelle abrégée*, the full title of which specifies *à la portée et à l'usage de tout le monde, principalement des jeunes Seigneurs, Ingénieurs, Physiciens, Artistes, &c. où l'on donne une notion générale de toutes les Sciences Mathématiques, & une connoissance particulière des Sciences Géométriques, au nombre de cinquante-cinq traités* (1728).⁵ This textbook aimed to “desacralize geometry” by reforming the style and lan-

³ Castel's most famous pupil was Jean-Baptiste de Secondat, son of Montesquieu. See Jules, Delpit, *Le Fils de Montesquieu* (Bordeaux: Paul Chollet, 1888), 29. Other high-born beneficiaries of Castel's teaching include boarders and externs like the young Comte de Choiseul, the Marquis de Langhac, the Duc de Montfort (Fontenelle, “Lettres de Castel à Fontenelle,” *Œuvres* XI, 164), not to forget the above-mentioned Charles-François Elzéar de Vogüé and Castel's later patron, the Comte de Maillebois. This list constitutes but a small sample of the aristocratic families with whom he would have interacted at the college.

⁴ The most complete work on Louis-le-Grand College still remains Dupont-Ferrier's magisterial study. This work provides an overview of the College's history, administrative structure, daily routine, curricular structure, as well as statistics and quantitative analysis of its population for over a period of almost five centuries.

⁵ That is, *Abridged Universal Mathematics, within the reach and for the use of everyone, especially young lords, engineers, natural philosophers, artists, etc, imparting a general notion of all the mathematical sciences and a particular knowledge of the geometrical sciences, in fifty five treatises*. There were two editions of the *Mathématique universelle*, the first published in Paris by Pierre Simon, in 1728, at the author's expense. The print run was apparently for 500 or 600 copies, 420 of which were sold right off the press. Those that remained were either sold by the *libraire* at a prohibitive cost or kept by Castel to offer as gifts. Talk of a reprint began as early as 1730, but nothing came of it. Another edition of the work was underway by the early 1740s, possibly under the auspices of Montesquieu, but it would take until 1758 for the second, expended edition to come out (Paris: N. B. Duchesne, 1758), this time under the editorial leadership of Rondet. See Rondet, “Avis au Public, touchant la nouvelle édition de la Mathématique universelle du Pere Castel, Jésuite, de la Société Royale d'Angleterre, etc, par M. Ro[ndet],” *Mercure de France* (Jan. 1754): 137-141; see also Schier, *Louis Bertrand Castel*, 122-123. The 1758 edition preserved the text of the original but included a series of documents (letters and memoirs) pertaining to mathematical quarrels preoccupying Castel around the time of the first publication. These debates consisted mostly in his discussions of mathematical paradoxes and were meant as *éclaircissements* for the more advanced material of the

guage of traditional mathematics manuals, a goal echoed in several of his works.⁶ Castel wanted to make this thorny subject easier for “the youngest of schoolboys” and more appealing to a lay audience: “I wrote [my textbook] in the common style,” he confessed to Fontenelle in one of his letters, “[so that] everybody could read it.”⁷ But the *Mathématique universelle* was more than a work of popularization. It also boasted a comprehensive overview of not only geometry but all the sciences: a two-hundred page encyclopedic chart showing the divisions of, and the connections between, all branches of knowledge. Taking a tree of knowledge as its structure, it contained numerous diagrams to help the reader visualize and memorize these relationships (see Fig. 2).⁸

Castel’s intellectual output is customarily divided into three or four main “systems,” treated more or less independently.⁹ Scholars trying to make sense of the *Mathé-*

Mathématique universelle. Apparently Castel had also planned to publish a mathematical lexicon with it, but no trace of this survives. Another related work was his *Plan d’une Mathématique abrégée, à l’usage et à la portée de tout le monde, principalement des jeunes seigneurs, des officiers, des ingénieurs, des physiciens, des artistes* (Paris: Pierre Simon, 1727) in which he announced and outlined the content and method of his *Mathématique universelle*. This pamphlet and the controversy that arose around it (discussed below) were largely responsible for the sales of the first edition.

⁶ On Castel’s mathematical style, and especially his “desacralization” of geometry, see Lyndia Roveda, “Le Père Castel et l’ethos du mathématicien,” *Rhetorica* 25, no. 2 (Spring 2007): 159-182; Shank, “A French Jesuit in the Royal Society of London: Father Louis-Bertrand de Castel [sic], S.J. and Enlightenment Mathematics, 1720-1735,” *Journal of Early Modern Studies* 1, no. 1 (2012): 151-198; and Schier, *Louis Bertrand Castel*, 111-132. Castel, however, remains the best exponent of his objectives; see his *Plan d’une Mathématique abrégée*.

⁷ Castel, “Lettres du P. Castel à M. de Fontenelle,” in Fontenelle, *Œuvre* XI, 161 and 164.

⁸ In this respect the work falls somewhere between Francis Bacon’s 1605 *The Advancement of Learning* and Diderot and d’Alembert’s *Encyclopédie des arts et métiers*, both of which featured a figurative system of knowledge in the shape of a tree diagram. On a formal level, the *Mathématique universelle* also fits within the tradition of Ramist textbooks and pedagogical reforms; see Walter J. Ong, SJ, *Ramus, Method, and the Decay of Dialogue: From the Art of Discourse to the Art of Reason*, 2nd ed. (Chicago: University of Chicago Press, 1983). Its structure and underlying methodology, however, distinguishes it from these better-known works.

⁹ Berthier divides Castel’s work thusly: “C’ étoit sur la fin de 1720, & dès-lors le P. C. jetta dans ses Ouvrages & dans le Public les fondemens de ses trois grands systèmes; celui de la pesanteur universelle; celui du développement des Mathématiques; celui de la Musique en couleurs ou du Clavecin pour les yeux. Ce n’est pas qu’il n’ait travaillé dans plusieurs autres genres. On a de lui des morceaux raisonnés sur l’Histoire naturelle, sur la Géographie, sur les Arts (Peinture, Musique, Tactique &c.) sur la Politique, sur la Morale, sur la Théologie, & si l’on faisoit un inventaire exact des Mss. qu’il a laissés, que d’observations n’y

matique universelle thus tend to read it alongside the other pieces of Castel's that sought to popularize geometry, rather than situate it within the entire body of his works.¹⁰ Given the size of his corpus, such compartmentalization is understandable. It may even seem to follow logically from Castel's own belief in a disciplinary divide between mathematics and physics. Yet this critical practice occludes important connections between his different projects and undermines the integrity of his oeuvre.

The present chapter offers a new interpretation of the *Mathématique universelle* by approaching it as a development of Castel's previous works, that is, as another step Castel had taken towards establishing a universal system. The pedagogical aim of the *Mathématique* remains crucial to my interpretation but, instead of focusing on Castel's geometry course, I approach the first, encyclopedic part of the textbook as a *mathesis universalis*, a method for teaching and achieving universal knowledge. Specifically, I argue that this method rests on the assumption that organized circulation, the same concept examined in the previous chapter, extends beyond the physical and moral realms into the intelligible realm and into the very processes of learning. It is the extension of the circulation analogy, more than any of the topical or thematic connections between the *Mathématique universelle* and the *Traité de la pesanteur* and its physico-political offshoot, that

trouveroit on pas sur toutes les parties des connoissances humaines!" See Berthier, "Eloge historique," 1102-1103. Le Cat organizes his own *Éloge* around Castel's four main books: the *Traité de la pesanteur*, the *Mathématique universelle*, the *Nouvelles expériences d'optique et d'acoustique*, and the *Vrai système de physique générale de M. Isaac Newton*. Schier's biography, for its part, grouped Castel's journalistic ideas into one broad survey of his life and proceeds with chapters on his "three main systems" — his work on *pesanteur*, his ideals concerning public education (especially on mathematics), and his ocular harpsichord — arguing they were each driven by his anti-Newtonian stance.

¹⁰ One notable exception is Corinne Gepner's *Père Castel et le clavecin oculaire*, 45-58. Gepner shows the important connections between the universal harmony Castel sought to express through his color harpsichord and the universal tree of knowledge he proposed in his *Mathématique universelle*. While Gepner tends to read Castel's various works from the perspective of his instrument and aesthetic theory, I read them as outgrowths of his natural philosophy.

justifies the present reading of the *Mathématique* as the next stage in the development of Castel's thought.

The following discussion proceeds in three phases. Using Le Cat's *éloge* as a point of departure, the first section shows that contemporary readers of the *Mathématique universelle* misunderstood its goals and the organic structure of its 'tree of knowledge.' The second section sheds light on the methodological underpinnings of the work by connecting Castel's circulation metaphor to his interpretation of the relationship between analysis and synthesis. The third and concluding section integrates Castel's textbook within his overarching project, situating it within its intellectual context and examining the Jesuit's motivations, thereby linking personal and corporate rivalries to his loftier concerns about the dignity of man.

“But a tall and beautiful tree”

In his *Éloge funèbre*, Le Cat asserts that Castel had two goals in writing the *Mathématique universelle*, both of which were “commonly regarded as impossible.”¹¹ On the one hand, the Jesuit apparently wanted to fit all the sciences within a single quarto. On the other hand, he wanted this vast body of science to appeal to — and to fall within the reach of — the general public. “Fortunately, in the last thirty-six years we have grown used to not taking the promises of authors literally[...].”¹² Le Cat's audience at the Académie des Sciences, Belles-Lettres et Arts of Rouen probably smirked in agreement.

¹¹ Le Cat, “Éloge,” 1r-14r.

¹² *Ibid.*, 4r.

The failure of the *Mathématique universelle* to achieve the “impossible” did not, of course, make it a *complete* failure. As Fontenelle (and Castel after him) quipped about chimerical goals, “it is impossible to attain any of these, but quite useful to try.”¹³ Although Le Cat felt the textbook’s content was superficial he did commend its systematic character. He also reminded his audience that, while the Académie Royale des Sciences of Paris had expressed strong reservations about this work when it was first published in 1728, the Royal Society of London had deemed it praiseworthy enough to elect Castel as an honorary fellow, a rare honor for a Jesuit.¹⁴

Rather than analyzing the content of the work, Le Cat unfolded before the *assemblée* of the Rouen Académie a tree diagram revealing the full scope and systematic arrangement of the work. This diagram captured his idea that the *Mathématique universelle* was “but a tall and beautiful genealogical tree of [...] all the sciences[,] an Encyclopedic tree, on the branches of which Père Castel placed a couple leaves — a few flowers even — leaving it up to the reader to transform them into fruit.”¹⁵ This metaphor was not far

¹³ Fontenelle, *Dialogues des Morts*, in *Œuvres* I, 143: “Toutes les sciences ont leurs chimères après quoi elles les courent, sans la pouvoir attraper. Mais elles attrapent en chemin, des connoissances fort solides. La Chymie a sa pierre philosophale; la Géometrie, sa quadrature du cercle; l’Astronomie ses longitudes, la Méchanique, le mouvement perpétuel. Il est impossible, dit-on ici, de trouver tout cela; mais il est fort utile de le chercher.” This passage was cited and paraphrased often in the eighteenth century. For insightful remarks on the significance of this idea see Marsak, “Bernard de Fontenelle,” 11.

¹⁴ Le Cat, “Eloge,” 4v-5r. In fact Castel owed his election to the Royal Society primarily to support from Woolhouse, who endorsed not only his *Mathématique universelle* but more broadly his bias against rational analysis, his support for the kind of geometry that the Newtonian camp favored, his praises of English science and medicine, and his project to translate John Lowthorpe’s abridgments of the *Philosophical Transactions*. See J. B. Shank, “A French Jesuit,” 165 ff. The honors bestowed upon Castel were great indeed but were underpinned by the rivalries and emulation between the Académie Royale and the Royal Society.

¹⁵ Le Cat, “Eloge,” 4r: “La mathématique universelle abrégé n’est qu’un grand et bel arbre généalogique des sciences Mathématiques, et mesme de toutes les sciences; C’est un arbre Encyclopedique, sur les branches duquel le P. Castel a laissé un peu de feuilles, quelques fleurs mesmes; c’est au Lecteur à les transformer en fruits.”

off the mark, as Castel had used it himself. Yet there was more to the Jesuit's tree of knowledge than Le Cat realized.

By entitling his textbook the *Mathématique universelle abrégée*, Castel explicitly situated it within the early modern tradition of *mathesis universalis*. Indeed, his use of the word “mathematics” should not be confused with today's. In eighteenth-century French, mathematics was more commonly rendered as *géométrie* — which itself comprised arithmetic, algebra, geometry, trigonometry, as well as more advanced infinitesimal analysis — while *les mathématiques* evoked the mixed sciences like mechanics, hydrostatics, astronomy, optics, music, naval and military architecture. When used in the singular, *la mathématique* also had strong etymological ties to the Greek term *mathesis*, which stood more generally for “knowledge” or “method.” Castel's title evoked all of these meanings, and more.

Although the first use of the expression *mathesis universalis* dates from the late sixteenth century, conceptually it can be traced back to the writings of Plato, Aristotle, Euclid, and Proclus, who first expressed the idea of a science revealing the orderly proportions of the world and containing, through its generality, the principles of all subordinated sciences.¹⁶ During the Middle Ages and the Renaissance the notion also acquired a technical aspect, becoming closely associated with Lullian combinatorial sciences and methods for achieving and memorizing knowledge. In a recent study, Frédéric de Buzon

¹⁶ The first use of the Latin term *mathesis universalis* has been attributed to the Belgian mathematician Adriaan van Roomen, who used it in his *Apologia pro Archimede* (1597); see Frédéric de Buzon, *La Science cartésienne et son objet: mathesis et phénomène* (Paris: Honoré Champion, 2013), 22. On the ancient origins of *mathesis* see Linda M. Napolitano Valditara, *Le idee, i numeri, l'ordine: La dottrina della mathesis universalis dall'Accademia antica al neoplatonismo* (Napoli: Bibliopolis, 1988) and David Rabouin, *Mathesis universalis: l'idée de "mathématique universelle" d'Aristote à Descartes* (Paris: Presses universitaires de France, 2009).

explains that two distinct understandings of *mathesis* coexisted into the early modern period, each framing different genres.¹⁷ One of them, “which may be called *mathesis generalis* or *scientia communis*,” sought “to determine elements, principles or methods” susceptible to being applied to all mathematical subdisciplines. It harkened back to Proclus’s conception and inspired later thinkers into looking for a method that would unify pure mathematics or the mathematical sciences more generally. To the concept of *mathesis generalis* or *scientia communis*, de Buzon juxtaposed *mathesis universa*, oriented instead toward “teaching” or the “encyclopedic presentation” of knowledge.¹⁸ *Mathesis universa* usually took the form of a physical book that proposed a classification of the arts and sciences (understood as academic subjects) according to a unique organizing principle. This approach was adopted by several late-scholastic and humanist textbook writers like Petrus Ramus (c. 1515-1572) and Johann Heinrich Alsted (1588-1638), for whom mathematics mattered first and foremost as part of a project of scholastic reform, rather than the reform of scientific inquiry *per se*.

By the seventeenth century, however, the expression *mathesis universalis* tended to subsume earlier terminological distinctions, such that a strict opposition between the two genres of works had now become inadequate. Descartes was arguably echoing the first, Proclean genre when, in his famous *Regulae*, he described a project for a new science, or ‘method,’ inspired by his geometrical analysis.¹⁹ He hoped that this method would unify arithmetic and geometry but also provide the foundation for all the mathe-

¹⁷ De Buzon, *La Science cartésienne*, 25.

¹⁸ *Ibid.*, 25.

¹⁹ René Descartes, “Regula IV,” in *Règles pour la direction de l’esprit*, trans. J. Sirven (Paris: J. Vrin, 1966), 18-28.

mathematical sciences, which for him included both pure and mixed mathematics.²⁰ Ultimately, he attempted to uncover a science of “measure and order” that abstracted any specific object and could thus be truly called universal.²¹ Yet his project did not simply follow in the tradition of the *mathesis generalis* or *scientia communis*: it transcended these in scope and responded to an epistemological crisis in the natural sciences that had no precedent in the late medieval world.

To some extent, the second, encyclopedic strand — the *mathesis universa* — still echoes distantly in works like Francis Bacon’s *arbor scientiae*, and later still, in Diderot and d’Alembert’s *Encyclopédie*, though by that time any Ramist influences were dissolved into more general concerns over the discovery and organization of knowledge, as opposed to its efficient pedagogical transmission. Leibniz’s venture into combinatorial sciences and conception of a universal calculating machine likewise took the genre in a different direction. But closest to Castel were the encyclopedic works of sixteenth- and seventeenth-century Jesuits, who developed yet another form of *mathesis* tailored to their apostolic mission. In the hands of Athanasius Kircher and Kaspar Schott, for instance, *mathesis* or *scientia universalis* came to reveal not just the unity and organization of knowledge but also the universal harmony of God’s creation in all its concreteness. As such, the *mathesis* was understood both as the embodiment of a method for contemplating and inquiring into nature and as an edifying tool in the service of their educational program.²²

²⁰ Descartes, *Règles*, 26.

²¹ *Ibid.*, 26-27.

²² Barthes provides a useful discussion of the Jesuit interpretation of *mathesis* in *Science, histoire et thématiques ésotériques*, 108-123: “Dans le courant du XVIIe siècle, voient le jour de vastes développements encyclopédiques dans le champs des connaissances scientifiques avec le projet, à peine voilé, d’aller

From his eighteenth-century vantage point, Castel could and did draw from all of these traditions. By subordinating all the sciences and the arts to mathematics and granting pride of place to geometry (“the primary and unique object” of his work), Castel adopted a Cartesian trope. By offering a classificatory scheme of the sciences and the arts for classroom usage, he echoed the scholastic and Ramist textbook traditions. By conceiving his work as a demonstration of the unity of the sciences — and of the harmony of the world they take as their object — he walked in the footsteps of his Jesuit precursors. The title of his textbook thus announced an all-encompassing system of knowledge acquisition originating in and structured according to a divine scheme.

A closer examination of the *Mathématique universelle*’s structure shows that for Castel, mathematics was the seed that contained all the sciences and was thus the proper point of origin for his tree of knowledge (see Fig. 3).²³ While he regarded truth as the ultimate object of mathematics, he believed that from a human standpoint its defining characteristic was certitude.²⁴ Certitude was traditionally divided into three categories, metaphysical, physical, and moral. This division hinged on the three natural ways one could obtain knowledge: by pure reason, by sense experience, and by reliance on *sensus communis*, the repeated, authoritative testimony of reliable witnesses. These three kinds of certitudes corresponded with three ways of studying the world. The first was the geomet-

bien au-delà d’une description détaillée des phénomènes constatés dans l’univers sensible. À cet égard, les œuvres de deux jésuites allemands, Athanasius Kircher et Caspar Schott, sont exemplaires” (109). Kircher wrote voluminous books on different branches of science and assembled a museum of wonders with the purpose of showing their ultimate unity, and thus to offer “une science totale de l’univers” (110). Schott, for his part, “englobe dans les mathématiques tous les phénomènes observables et accessibles à nos sens [...]. Il ne conçoit pas l’ordre mathématique comme un monde abstrait; il voit en lui, au contraire, un reflet de la réalité perceptible” (121). For Schott, “la *mathesis* ou *mathema*, constitue l’outil pédagogique par excellence de la connaissance du plan de l’univers concret ordonné par le créateur. Il s’agit, comme il l’écrit, d’un ordre résolument tourné vers l’éclosion de la vie spirituelle” (122).

²³ Castel, *Mathématique universelle* I, 8.

²⁴ *Ibid.*, 3.

rical (or metaphysical) outlook, through which one approached the world in terms of abstract measurements of discrete and continuous dimensions (*grandeurs*). This was the purview of the geometrical sciences, which abstracted the physical reality of the world to consider all *possible* universes. Second was the mechanical (or physico-mathematical) outlook, from which the world appeared an ongoing process of change, a movement from the abstract and potential to the concrete and actual. The most fundamental mechanical movements for Castel were *pesanteur* and its reaction — the fall and “reflection” of weighing bodies toward and away from their center — but he also included fine arts, techniques, and crafts as offshoots of mechanics. The third way of studying the world was the cosmographical or historical outlook, which takes the world as a *fait accompli*, the object of natural history. This included astronomy and geography, the study of minerals, plants, and animals, and the natural historical study of human and divine things. Castel found a confirmation of his threefold division in *Wisdom* 11:21, according to which God ordered all things in measure (geometry), weight (mechanics) and number (cosmography). Although he acknowledged that one could come up with a different organization scheme, he felt that these correspondences granted credibility to his system.²⁵

Geometry, mechanics, and cosmography formed the tripartite trunk of Castel’s tree of knowledge. He showed their ‘mathematical’ origins and mutual relationships in the work’s first two “developments,” his term for chapters. The third development further subdivided these branches: he divides geometry into simple, composite, and transcendental; mechanics into general, particular, and practical; and cosmography into visible, organic, and intelligible. Four additional developments followed, resulting in the exponen-

²⁵ This paragraph synthesizes the first and second “developments” of the *Mathématique universelle* I, 9-11.

tial growth of the tree. By the seventh, there counted no less than 381 ‘twigs’, and the reader had yet to reach the leaves, flowers and fruit. Castel provided these additional steps in the remaining two thirds of the book but limited himself to an elementary survey of the geometrical sciences, which included treatises on method, elementary geometry, arithmetics, algebra, conics, infinitesimals, and so forth. Mechanics and cosmography would have to wait for the sequel.

By deferring the introduction of geometrical elements far beyond his readers’ expectations (the geometry course itself starts around page 200), Castel befuddled contemporaries. Indeed, most of them expected a textbook, not a *mathesis universalis*. While Castel took pride in the fact that “[a]t least two thirds of the book [were] without figures and symbols, being written in an even style which can be read with ease (*tout de suite*),” his critics harped on its superficiality, its apparent arbitrariness, and, most of all, its repetitive structure.²⁶ Instead of providing exercises, it relied on periodic recapitulations and the expectation of multiple readings to ensure that students assimilate its content.

The book’s repetitiveness is its most striking feature. Indeed, each chapter, and each chapter subdivision, follows the same sequence. First, Castel provides a *proposition*, or title, that will serve as the preliminary announcement of a given section’s content. He then proceeds with the *development* of the subsection, listing the parts of the tree from its trunk up to its newest ramifications. The third step consists in an *enumeration*, in which Castel defines each the individual shoots. The *enumeration* is invariably followed by a

²⁶ Castel, *Plan d’une mathématique abrégée*, 5: “Les deux tiers au moins de l’Ouvrage qu’on imprime, sont sans figures, sans symboles, d’un stile uni qui se laisse lire tout de suite.” For a particularly venomous example of the criticism Castel faced, see Joseph Saurin, *Lettre Critique de Monsieur **** a Monsieur **** sur le Traité de mathématique du P. C. et les extraits qu’il a faits dans les Journaux de Trévoux [...] des mémoires de l’Académie des Sciences* (Paris: Gabriel Martin et Louis Guérin, 1730).

recapitulation of the subsection.²⁷ The *recapitulation* does not merely summarize the previous steps, it “revisit[s] [and] compare[s] them with one another, connect[ing] them, and bring[ing] them back to the general proposition in order to seize its goal, its system, and, most importantly, its spirit.”²⁸ While the *development* and the *enumeration* analyze the initial *proposition*, the *recapitulation* synthesizes them. To this four-step sequence Castel attaches a tree diagram and then repeats the cycle for each subdivision of a given chapter.²⁹ A general recapitulation follows, comparing and highlighting the mutual relationships of these subdivisions and connecting them to the main trunk. The whole process starts anew for each of the seven chapters, dragging the reader through an exponential number of subsections and general recapitulations.³⁰

These repetitions strained readers looking for a straightforward textbook, but what these readers failed to appreciate was that Castel intended for the repetitions to replicate the process of *circulation* inside a growing tree, a mechanism that insured the integrity

²⁷ For instance, the first subdivision of the fourth development is entitled: “Premiere Partie. La Géométrie. I. Sous-division en neuf branches.” Castel, *Mathématique universelle* I, 20. This is the *proposition*. Castel then *develops* Geometry, which we already know branches into 1) simple, 2) composite and 3) transcendental, and further ramifies into 1a) method, 1b) elements, and 1c) practical; 2a) science of calculation, 2b) conics, and 2c) practical; 3a) infinitesimal analysis, 3b) science of curves, and 3c) practical (the numbering is mine). In the *enumeration*, Castel explains that 1a) “La *Method*, est la manière ou l’Art de traiter régulièrement une Science pour la perfectionner [...] pour perfectionner ceux qui la cultivent”; 1b) “Les *Elements* de Géométrie apprennent théoriquement à mesurer les Lignes droites, les Angles, les figures rectilignes, & même le Cercle”; 1c) “La *Pratique de la Géométrie simple*, apprend à mesurer tout cela, en effet, & d’une manière usuelle & pratique” (21). And so on for all nine branches of geometry, all nine branches of mechanics, and all seven branches of cosmography. Castel, *Mathématique universelle* I, 20-38.

²⁸ Castel, *Mathématique universelle* I, 137: “La *Récapitulation*, reprend tout ce détail de Propositions, les compare, les enchaîne, les ramene à la Proposition générale, pour en bien saisir le But, le Système, & sur-tout l’Esprit.”

²⁹ The terminology Castel used is reminiscent of scholastic logic and classical art of rhetoric, but also have parallels in Descartes’s rules of analysis. The exact filiation of these terms is still unclear to me, and would require more research into treatises on method and scholastic textbooks that Castel would have had at his disposal.

³⁰ Castel was well aware that his method presented difficulties. He reflected on this in one of the book’s numerous asides, *Mathématique universelle* I, 168: “Or c’est là précisément que j’ai éprouvé la difficulté presque insurmontable de faire marcher de front toutes les parties, de manière que je pusse toujours passer du connu à l’inconnu, quoique réellement mon progrès se fasse de l’inconnu au connu & du composé au simple, c’est-à-dire, du Tout au parties, & du General au detail.”

and ‘vitality’ of the system.³¹ The *Mathématique universelle* was more intricate, more organic than a mere “genealogy” or “encyclopedic tree” of knowledge, such as the diagrams found in Bacon’s *New Organon* or in earlier Ramist textbooks. As Castel explained in his *Plan d’une mathématique universelle abrégée*, a teaser he published in 1727, the goal was not to abridge all knowledge into a single volume but rather to offer the outline of a course or, better yet, a *curriculum*.

Let no one imagine [...] that we are announcing a ten or twenty-volume Encyclopedia; it is a Universal Mathematics in its Plan, in its principles, but not in its execution and in its detail. It is its spirit rather than its complete body. Those who seek outlines for other works will find a good number of them in it, and at least a complete course of mathematics.³²

The phrase “it is its spirit rather than its complete body” has a two-fold meaning. On one level, it refers to the organizing principle of the work, the method that Castel wanted his fellow teachers to grasp and experiment with. While he regarded the geometrical portion of the book as complete, the rest of the work was conceived as the foundation and scaffolding for additional courses.³³ Acknowledging the superficial character of his curriculum, he predicted that instructors would develop their own specialized courses and thereby join him in the development of a universal corpus.³⁴

³¹ One of Castel’s most biting critics, for example, writes that “Tel est le Traité de Mathématique qu’il vient de donner au Public. C’est une confusion systematique, un cahos mal débrouillé, de définitions, de divisions, de subdivisions capable de rebuter le lecteur le plus patient.” See Saurain, *Lettre critique*, 2, and below for the context of his attack.

³² Castel, *Plan d’une mathématique abrégée*, 6: “Qu’on n’aille pas s’imaginer néanmoins que c’est une Encyclopédie qu’on annonce en dix ou vingt volumes; c’est une Mathématique universelle, dans son Plan, dans ses principes, mais non dans son execution & dans son détail. C’en est l’esprit plutôt que le corps entier. Ceux qui cherchent des plans d’ouvrages y en trouveront un bon nombre; & pour le moins celui d’un cours complet de Mathématique.”

³³ Castel, *Mathématique universelle* I, 131: “En tout cas on n’a qu’à prendre tout ce qui est dans les Livres, & à le transporter dans mon Plan, sous les titres que nos diverses branches indiquent; & voilà un Cours tout fait, dans toute sa plénitude, & une vraie *Encyclopedie*.”

³⁴ *Ibid.*, 168. In fact, Castel reveals that he had first written down his encyclopedic plan of the work for some students who ultimately failed to consult it: “Dans sa première Destination, ce Plan n’avoit

But on a more subtle level, Castel also used the term ‘spirit’ in the physiological (or “economic”) sense. He found an analogy between the circulation of nourishing juices inside plants and animals and the book’s active redirection and thus circulation of the reader’s mind.³⁵ His system not only had potential for growth in the hands of other instructors but could also accompany and guide the growth of his students’ understanding of the sciences:

Thus I begin by presenting Mathematics as a seed, as a fertile germ, capable as it develops to give birth, so to speak, to all the sciences. To sustain the metaphor, this science [seed], once nourished, fermented, digested by some easy explanations, breaks its envelope, throws roots, shoots stems, divides itself into branches, branches which subdivide themselves into twigs, and twigs which finally cover themselves with leaves, becoming beautiful with flowers and rich with fruit that the reader can pick at will, because his mind somehow undergoes the same growth as the tree, which he can always see, and almost touch.³⁶

He first advises his readers to climb up and down his tree of knowledge and play in its branches — he used the term *voltiger*, which describes the action of fluttering or swinging like an acrobat, likely keeping in mind the children and teenagers in his readership.

été fait que pour diriger deux personnes de beaucoup de mérite & d’une grande capacité qui avoient entrepris de l’exécuter en son entier, mais que leurs diverses affaires ont empêché jusqu’ici de l’achever. / De sorte que mon plan étant resté comme inutile entre mes mains, je le laissai se meurer quelques années; jusqu’à ce qu’enfin, il y a un an, je pensai à le donner au Public avec une simple Explication de toutes les Parties, afin qu’il ne fut pas tout-à-fait perdu, prévoyant que quelqu’un pourroit en profiter pour nous donner enfin d’un Cours complet de Mathématique.”

³⁵ Variations on this metaphor were already old, if not commonplace; see Ong, *Ramism*, 208.

³⁶ Robert Boyle, *Works*, vol. 3, 449, cited in Marsak, “Bernard de Fontenelle,” 40: “Je présente donc d’abord les Mathématiques comme une semence, comme un germe fécond & capable, en se développant, d’enfanter en quelque sorte toutes les sciences. Soutenant la Métaphore, cette science nourrie, fermentée, digérée par quelques explications faciles, rompt son envelope, jette des Racines, pousse des Tiges[,] se divise en Branches, les Branches se subdivisent en Rameaux: enfin les Rameaux se couvrent de Feuilles, s’embellissent de Fleurs, s’enrichissent de Fruits qu’on cueille à son gré, parce que l’Esprit du Lecteur prend en quelque sorte tous les accroissement que prend l’Arbre, qu’il a toujours sous les yeux, et presque sous la main.” See Castel, *Mathématique universelle* I, iii, but compare this with Robert Boyle’s reflection on a project for a natural history of crafts and trades by the Royal Society: “For I look upon a good history of trades as one of the best means to give experimental learning both growth and fertility, and like to prove to natural philosophy what a rich compost is to trees, which it mightily helps, both to grow fair and strong, and to bear much fruit” (40). One may note that while the metaphor is similar, it does not apply to the work itself but instead to the progress of natural philosophy. The history that Boyle has in mind gets compared to a fertilizing agent.

He predicts that they will become familiar with its structure, integrate its content, and eventually grow mental trees of their own. The tree diagrams might look dead, but the trees in their mind were anything but.

Le Cat and other critics saw the tree but failed to recognize its internal organization. For Castel, the curriculum of the *Mathématique universelle* was not the dry skeleton of an encyclopedia but, instead, a living system meant to “unfold” with each chapter. The static diagrams were misleading in this respect. Channels not immediately apparent in superficial reading awaited discovery by students who would read the text over and over again. Indeed, there were different ways to circulate — or *voltiger* — through the *Mathématique universelle* only the most obvious of which was the progression from left to right, that is, from the general and complex to the particular and simple. A vertical reading was also possible, allowing the reader to see, for instance, how the arrangement of twigs and nodes in the geometrical section mirrored a corresponding arrangement in the physical and cosmographical division or that there was a progression from the abstract and potential to the concrete and actual in each of the main parts, as well as from the top of the entire tree to the bottom. By envisioning his textbook as an animated system made up of internal channels and conduits, he not only draws on the vegetable realm but also suggests parallels between universal mathematics and the internal organization of an empire of science, bridging the physico-political and the intelligible realms. The opening sentences of the work could not be more explicit:

In the Sciences, just as in Empires, there is a kind of universal monarchy that constantly fuels a noble rivalry [*émulation*] among the savants, who have always been busy fighting over it. All are wont to expand their do-

main (*objet*), and to elevate their own Science into the main, universal, and unique one.³⁷

The tendency to place one's science of choice at the top of the hierarchy of knowledge was a common "trade prejudice" that Castel thought he had avoided by grounding (*rappor-ter*) all the sciences into the most general category: universal mathematics. His goal was not to crown himself geometer-king but "to reestablish [...] the commerce and corre-spondence among all the sciences." To do so, he "grouped them in an outline that reveals at once the linkage, subordination, and mutual rapport that they all have with respect to all, and with one another individually (*rapport mutuel de toutes avec toutes, de chacune avec chacune*), and in particular with Geometry."³⁸ "Emulation, commerce," "correspon-dance," "subordination," "mutual rapport" of parts with respect to each other and their whole — this language echoes the *Lettre sur la politique*, which Castel probably wrote while working on the *Mathématique universelle*. The previous chapter to this dissertation showed how drawing analogies between bodily and earthly circulation helped Castel comprehend the nature of political entities and promote the proliferation of roads and ca-nals in France. This was the best way to insure a healthy flow of goods and people be-tween the provinces as well as foster a sense of unity within the kingdom (or, as Castel called it, "the empire"). Castel extended his views on circulation into the "intelligible realm," and in particular to the process of knowledge acquisition. Discrete propositions

³⁷ Castel, *Mathématique universelle* I, 1: "Dans les Sciences, comme dans les Empires, il y a une sorte de Monarchie Universelle, qui ne laisse pas d'entretenir une noble émulation parmi les Sçavants, de tout tems occupez à se la disputer. Chacun aime à aggrandir son objet, & à ériger sa Science en principale, universelle, & unique."

³⁸ Ibid., 2: "Enfin résolu de rétablir, au meilleur de mes capacités, le commerce & la correspon-dance entre toutes les Sciences, je les ai réunis dans un Plan qui en fait voir, d'un coup d'oeil, l'enchaînement, la subordination, le rapport mutuel de toutes avec toutes, de chacune avec chacune, & sur-tout avec la Géométrie que je traite ensuite en entier [...]."

and particular sciences demanded similar integration and the repetitive structure of the work offered a contrivance with which Castel could achieve this goal.

Method of Circulation

For an eighteenth-century textbook, Castel's *Mathématique* was highly unusual. Accustomed to "study[ing] Geometry and all Mathematics by way of synthesis," his readers expected him to open with elementary propositions, definitions, or axioms, and proceed from these to more complex demonstrations, proofs and theorems.³⁹ Indeed, this sequence was a convention of the early modern *elements* genre.⁴⁰ Being sensitive to a question frequently asked by his students — *what's the point of all this?* ("À quoi bon tout cela?"⁴¹) — Castel decided to go the opposite route. Instead of burdening his reader "with the dry and minute details of disconnected and too rigidly scientific propositions" he "began by showing him the Goal, the end-point, the finality, the use, all the whys and wherefores of geometry."⁴² Since geometry's purpose was most evident when applied to other branches of knowledge (mechanics and cosmography) and since as a mode of knowing it shared a common root with these other branches, it seemed to him that the best starting point for his course was also the most general, the one which contained them

³⁹ Castel, *Plan d'une mathématique*, 6: "C'est par voie de synthese qu'on procede jusqu'ici dans la maniere d'enseigner & d'étudier la Géometrie & toutes les Mathematiques. On commence brusquement par une premiere proposition, définition, ou axiome; de-là on va à une autre, & puis à une autre: & après une cinquantaine de propositions qui n'ont d'autre liaison marquée que parce que l'une cite quelquefois l'autre; cela s'appelle un livre qui est suivi d'une autre livre semblable. On en parcourt ainsi dix à douze; & la fin du Volume avertit que c'est la fin d'un Traité."

⁴⁰ Student notebooks that survive from the early-eighteenth century show that mathematics was thought in the synthetic way in the colleges and universities.

⁴¹ Castel, *Mathématique universelle* I, ii, italics original.

⁴² *Ibid.*, ii: "Je commence par lui montrer le But, le Terme, la fin, l'usage, tous les tenans, tous les aboutissans de la Géometrie, avant que de le jeter dans un détail sec et minuitieux de propositions détachées et trop rigidement scientifiques."

all. Castel thus proceeds to unpack this seed's constituent parts and their respective subdivisions, until he reaches individual propositions (in principle, this was to be done not only in geometry but in the other branches of learning as well). This process admits no postulates or 'floating tidbits' of knowledge: all would naturally grow out of the tree.

Foreseeing that some readers would be confused by his teaching method, Castel prefaces his work with an "Absolutely necessary warning" on how to read his book. He insisted that students *read* it before *studying* it.⁴³ While most mathematics textbooks required the complete attention of students and forced them to stop whenever they stumbled across a difficult passage or challenging exercise, Castel wanted the reading to be easy — even entertaining — so as to instill the taste and habit for geometrical abstraction: "The true method would be to scan it with the eyes five or six times, to see its titles, its plans, and its overall arrangement; then to read it quickly two or three times, skipping what will seem less legible, more detailed, or more dryly geometrical."⁴⁴ Castel's idea was for his readers to let their minds freely explore the content of the textbook — to circulate through it — until they understood it as a whole, made up of interconnected parts. Only after having grasped the spirit of the system should a motivated student *reflect* upon it.⁴⁵ This last step could be repeated as many as twenty times, for the author designed the textbook such that every successive reading would yield further discoveries.

⁴³ Ibid., i.

⁴⁴ Ibid., iv: "La vraye méthode seroit de le parcourir d'abord cinq ou six fois des yeux, pour en voir les titres, les Plans, & toute l'ordonnance général; de le lire ensuite deux ou trois fois rapidement en passant tout ce qui paroitra à l'oeil moins lisible, plus détaillé, plus sechement géométrique [...]"

⁴⁵ But never with *attention* — that is, with effort. Castel drew an interesting distinction between attention and reflection. He did not want his readers to struggle with the text in a way that would obstruct their spirit and hinder the flow of their reading. Instead, he wanted them to use reflection (*réflexion*), the meaning of which was in fact closely connected to the concepts of circulation, return, and synthesis. "Reflection" for Castel was a curved motion. It is a term he uses to describe the movement of light through

Castel believed that the best way to learn anything was to proceed from the general to the particular, and from the known to the unknown. Like the *Traité de la pesanteur universelle*, the *Mathématique universelle* adopted analysis as a teaching method:

“The Method I followed is exactly analytic, especially in the beginning sections where the reader needs more help. I had noticed that all men seemed naturally to have general and vague ideas of the sciences and that it was from there that we had to start to lead them from the known to the unknown.”⁴⁶

Reversing the usual understanding of analysis and synthesis, Castel argued that analysis (and not the ‘path of invention’) was better suited for the training of young minds and that synthesis (rather than the ‘method of doctrine’) was the true process by which philosophers made their discoveries.⁴⁷ That teachers still more commonly used the synthetic method was an unfortunate consequence of the mistaken notion that in order “to proceed from the known to the unknown, one must go from the simple to the composite, and from the detail to the whole.”⁴⁸ Castel thought that “nothing is more captious than to pretend that simple ideas are the easiest and the first ones [to be grasped] in the sciences.”⁴⁹ Even if vaguely understood, complex ideas fell within everyone’s reach, while clear and distinct notions could only be achieved with time and effort that few could afford. His *ré-*

space, the upward movement opposing *pesanteur*, and, indeed, the path of any body in a plenum (and thus any body in the universe. *Ibid.*, 269.

⁴⁶ *Ibid.*, iii: “La Méthode que j’ai suivie, est exactement analytique, sur-tout dans les commencemens où le Lecteur a plus de besoin d’aide. J’avais remarqué que tous les hommes avoient comme naturellement les idées générales & vagues des sciences, & qu’il falloit commencer par-là pour les mener du connu à l’inconnu.”

⁴⁷ See chapter 2 for a further treatment of the questions of analysis and synthesis.

⁴⁸ Castel, *Plan d’une mathématique*, 7: “Toute cette methode, qu’on vante tant, au lieu de vanter uniquement ceux qui ont pû n’en être pas mille & mille fois rebutez, est fondée sur une idée qui regne; que pour aller du connû à l’inconnû, il faut passer du simple au composé, & du détail au tout. Il est de fait néanmoins que toutes les autres méthodes, qu’on ne vante pas tant, mais qu’on goûte mieux, procedent tout au rebours, du general au détail, & du composé au simple, par voie d’analyse, de division & de sousdivisions.”

⁴⁹ *Ibid.*, 7: “Rien n’est plus captieux que de prétendre, que les idées simple sont les plus faciles & les premieres dans les Sciences.”

gentage in southern France and his experience at Louis-le-Grand had taught him that children were “naturally impatient” and prone to distractions, their minds having difficulty retaining chains of disconnected mathematical definitions and propositions long enough to witness their synthesis (a geometrical proof, for instance). Most students ended up quitting their studies long before they could appreciate the coherence, beauty, and usefulness of a geometrical demonstration. Those who persevered despite initial difficulties eventually found themselves possessing a “body [of knowledge] without consistence and without connections.”⁵⁰ Castel’s analytic method, in contrast, guaranteed an organized body of knowledge. Instead of grafting disconnected parts together, he would see that his student’s knowledge unfolded naturally, just as a tree grows from a seed.⁵¹

That being said, however, the distinction between the analytic and the synthetic methods ought not be overstated. Castel wanted instructors to understand that “Nature never separates analysis from synthesis, nor synthesis from analysis [...]. Its entire system is a perfect circulation, and each thing has its periodic revolution within.”⁵² In perhaps the single most important passage of the *Mathématique universelle*, the treatise on

⁵⁰ Ibid., 7: “On arrive, c’est-à-dire, on arriveroit, si on avoit la patience & les facultez d’aller à travers tout ce détail de Propositions sèches & speculatives, à saisir un corps sans consistence & sans liaison, dont on n’a pû jusques-là prendre l’esprit ni le goût, ni presque en prévoir le but & l’usage; à moins que la nature ne vous ait fait tout exprés pour cela, avec un petit nombre d’esprits choisis que tout le reste du genre humain admire, sans pouvoir les imiter.”

⁵¹ Castel’s approach may be usefully compared to that of Alexis Claude Clairaut (1680-1766), who would make a similar critique of “les éléments ordinaires” in his *Éléments de Géométrie* (Paris: Lambert et Durand, 1741), i, in which he that dry propositions tend to overwhelm beginners. Unlike Castel’s, however, Clairaut’s approach led beginners step by step along the path of geometrical invention, following what he believed had been the progress of the first geometers (somewhat similar to the operation in Castel’s *Traité de la pesanteur* tracing the “progress of the human mind”). Clairaut too proposed problems to solve, rather than enabling a general perspective on the mathematical science, or smothering geometry with superfluous “foreign ideas” about the history and content of disciplines beyond geometry. Clairaut’s pedagogical concern may have been indebted to Castel, but I suspect that the *Mathématique universelle* was one of the textbooks Clairaut had in mind when formulating this last criticism.

⁵² Castel, *Mathématique universelle* I, 291: “La Nature ne sépare jamais l’Analyse de la Synthese, ni la Synthese de l’Analyse, & ne fait point de Branches sans Racines, ni d’Artere sans Veines. Tout son Système est une Circulation parfaite, & chaque chose y a sa Revolution périodique.”

method that opens his geometry course proper, Castel argues at length that analysis and synthesis are not only “reciprocal” and complementary, but they actually contain each other.⁵³

Castel illustrates this mutual embeddedness with examples from the natural world. The vegetal realm reveals that a “seed contains a plant, which in turns contains seeds,” the implication being that seeds develop into plants by way of analysis and produce seeds by way of synthesis. Likewise, “[r]ivers leave the sea by analysis, by finding their ways through a thousand subterranean channels, and return to it by synthesis, by gradually coming together [*se confondant*] [...]”⁵⁴ Castel’s most compelling example came from the works of anatomists, who showed that blood circulated from the heart through branching arteries, capillary ramifications, and a root-like network of veins, in a constant cycle of analysis and synthesis. This analogy is particularly convincing because anatomists themselves borrowed metaphors from the vegetal realm to describe the ramification of blood channels — the very same language Castel used to describe his tree of knowledge. In fact, he even suggests that the various tree diagrams included with the work to illustrate his analysis of each section should be completed by the reader with their synthetic mirror images, which had thus far only been presented in written form in

⁵³ Ibid., 289-290: “On a dit jusqu’ici [...] que la Méthode de Doctrine qu’on appelloit fort mal-à-propos *Synthese*, étoit réciproque à la Méthode d’Invention confonduë avec l’Analyse./ Mais on n’a pas pris garde que chacune de ces Méthodes renfermoit l’autre, & que c’étoit toujours la même, mais dans un Ordre renversé.” These reflections are found primarily in the discussion of method in the eighth development but they are also anticipated in the previous chapters. Unfortunately, Castel’s chief twentieth-century biographer did not take Castel’s metaphor seriously. Indeed, although he considered the methodological discussion of the *Mathématique universelle* the most interesting part of the work for contemporary readers, Schier simply dismisses this passage, writing that “epistemology was not Castel’s strong point”; see Schier, *Louis Bertrand Castel*, 126.

⁵⁴ Castel, *Mathématique universelle* I, 290.

the recapitulations.⁵⁵ The result would have been a tree in which the topmost twigs were connected to the roots of the main trunk.

Castel regarded his discussion of method as one the most original contributions of the *Mathématique universelle*.⁵⁶ He considered that by showing the co-dependence of “invention” and “doctrine,” he could break from the methodological distinction formulated by his predecessors, among them Descartes, Galen, and even Girolano Cardano (1501-1576).⁵⁷ The extent to which he was methodologically innovative is less significant than the self-reflective nature of his insight. Castel indeed applied his methodological theory to the structure of his textbook, a fact that goes a long way toward explaining its idiosyncrasies. In the previous section, we saw how each subdivision of the work followed a cycle of *proposition, development, enumeration, and recapitulation*. Castel’s discussion of method (itself embedded in a subdivision of the work) described analysis in the very same terms. He also paired this discussion to his treatment of the method of invention — or synthesis — by describing a reverse sequence that began with the empirical *collection* of phenomena, then *combined* and *reduced* these into simple principles, and finished with

⁵⁵ Castel, *Mathématique universelle* I, 291-292: “Ce seroit ici le lieu de présenter les deux Plans de ces deux Méthodes, réunis en un seul. Mais il ne sont pas loin, on peut les consulter; & d’ailleurs on voit désormais assez tout l’Artifice de ces Récapitulations: ce n’est pas la peine de faire acheter deux fois la même chose au Lecteur sans nécessité; en tout cas il n’a qu’à faire lui-même cette Réunion & à l’insérer ici, s’il le juge à propos. Je serois assez de cet avis. C’est l’Esprit de cet Ouvrage.”

⁵⁶ *Ibid.*, 71. See also “Lettres du P. Castel a M. de Fontenelle,” in Fontenelle, *Œuvres* XI, 161.

⁵⁷ Castel, *Mathématique universelle* I, 138-141. On Cardano, see p. 71: “La Méthode est, en effet, une chose si estimée, que rien n’a fait tant d’honneur à *Descartes* que le Discours qu’il nous a donné là-dessus. Que seroit-ce s’il avoit saisi, dans toute sa précision, ce bel Art, dont il n’a donné qu’une ébauche, dans le détail de quatre Regles? / Il faut même rendre justice à qui elle appartient. *Cardan* qui est une es-pece de génie monstrueux, dont il y autant de bien à dire que de mal, & autant de mal que de bien n’avoit pas laissé, d’après *Galien*, qu’il a eu la bonne foi de citer, de saisir la Méthode générale des Sciences, fort à peu-près la même que *Descartes* nous l’a donnée ensuite.” It is also worth pointing out that Castel omits to mention Newton; a deliberate choice considering that Castel was cognizant of the Englishman conception of the two methods as a reciprocal process (though what he meant by this was slightly different from Castel’s views); see chapter two of this dissertation.

a *return* or verification of the discoveries.⁵⁸ While *recapitulation* was the synthetic moment of analysis — the point where students were apt to make discoveries on their own — the *return* consisted in the analytic moment of synthesis, when inventors could confirm their discoveries and thus prepare themselves to teach this new material. Castel thus held that the circulatory structure of his textbook embodied the relationship between the two methods.⁵⁹

The Tree and the Mountain

Castel advocated teaching mathematical sciences to young children, nobles, engineers, philosophers, craftsmen and artists. The idea that the arts and sciences would flourish once firmly set on mathematical foundations was commonplace in the late seventeenth and eighteenth centuries but Castel took it a step further than most of his contemporaries by arguing for the diffusion of this knowledge in the public arena. In fact, his facilitation of difficult subjects for the public was arguably the mainstay of his philosophical oeuvre. The original method he developed in the *Mathématique universelle* and in its encyclopedic outline of the sciences indeed served as a model for several more special-

⁵⁸ Castel, *Mathématique universelle* I, 291: “C’est le Retour qui est la Méthode de Doctrine dans celle d’Invention: c’est par là qu’après avoir fait la découverte un Esprit s’en met tout-à-fait en possession, s’endoctrine lui-même, & se met en étant d’endoctriner les autres. / C’est aussi la recapitulation qui, dans la Méthode de Doctrine, contient celle d’Invention, & lui sert de Prélude. / Après que, par l’Enumération, on a expliqué à ses Auditeurs ou à ses Lecteurs tout le détail, on le Combine, ou le Compare, on le ramene au Principe d’où il a découlé; on Généralise, on Réduit & puis on conclut par la même Proposition, par laquelle on avoit commencé. / Car c’est ne connoître l’une & l’autre Méthode qu’à demi, que de dire que dans l’une on va du Détail au Principe en général; & dans l’autre du Principe général au Détail. / Dans l’une et dans l’autre on finit par où l’on a commencé.”

⁵⁹ *Ibid.*, 290: “On peut même remarquer qu’une Plante, un Arbre en poussant des *Branches* vers le Ciel, en poussant aussi sous le nom de *Racines* dans l’intérieur de la Terre. La Méthode d’invention sert de Racine à la Méthode de Doctrine: car un n’enseigne que ce qui est inventé; & le dernier But de l’Invention est d’instruire, & pour le moins de s’instruire soi-même. / La Méthode de Doctrine sert de même de Racine à la Méthode d’Invention: car on enseigne que ce qui est inventé; & le dernier but de l’Invention est d’instruire, & pour le moins de s’instruire soi-même.”

ized endeavors to follow. These included courses in military tactics, music, and physics (including one on astronomy), all of which were embedded in his *mathesis universalis*.⁶⁰ In 1738, Castel also revisited his pedagogical theory by publishing a series of four *entretiens* entitled *Géométrie naturelle en dialogue*, written in a light style reminiscent of Fontenelle's *Entretiens sur la pluralité des mondes* and geared towards the lay audience of the Parisian *salons*.⁶¹ More widely known is his *Vrai système de physique générale de M. Isaac Newton, exposé et analysé en parallèle avec celui de Descartes, à la portée du commun des physiciens*, a treatise he published in 1743, but which he had apparently begun writing before publishing the *Traité de la pesanteur*.⁶² When examined from the moral and aesthetic standpoint, even his publications on the ocular harpsichord have an educational purpose. Indeed, one of Castel's arguments against skeptics of the feasibility of his color harpsichord but also of the delectability of the spectacle it was supposed to offer, was that unskilled eyes needed training to perceive and appreciate the harmony in

⁶⁰ The course outlines on military tactics and music were both proposed as appendices for the *Mathématique universelle*, but only took the form of tree diagrams. The complete course on tactics — with text and diagram — was published posthumously, under the title *Exercices sur la tactique, ou la science du héros. Ouvrage utile à la jeune Noblesse qui se destine au parti des armes* (Paris: Jean-Baptiste Garnier, 1757). Manuscripts related to his music course have been preserved with Castel's other papers in Brussels; see Ms. 15744, Fonds Van Hulthem, Bibliothèque royale Albert 1er. His physics courses may have circulated in manuscript; one was apparently taught at the College of Navarre by the abbé Jean-Mathurin Mazéas, "mon premier Éleve, autre moi même [...] Professeur de Navarre qui dicte ma Physique et pour qui je l'ai faite exprés." See letter from Castel to P. Le Franc, dated 22 Sept. 1748, Paris, C23, Archives de l'académie, Bibliothèque municipale François Villon, Rouen. In his correspondence with Montesquieu, Castel describes his astronomy course as the last hundred pages of his physics course and reveals his intention to recast it as a "9- or 1200 page-long work." His physics and his astronomy course materials have both been lost. See Ms. 1868 (74), Fonds Montesquieu, Bibliothèque Mériadeck, Bordeaux.

⁶¹ See Castel, "Géométrie naturelle en dialogues," in *Nouveaux amusements du coeur et de l'esprit* (The Hague: Zacharie Châtelain, 1738: vol. 1, 79-94 ("Premier entretien") and 185-202 ("Second entretien"); vol. 2, 197-214 ("Troisième entretien") and 214-225 ("Quatrième entretien").

⁶² That is, the *True System of General Physics of Mr. Isaac Newton, Exposed and Analyzed in Parallel with that of Descartes, within the Reach of Common Natural Philosophers* (Paris: Sébastien Jorry, 1743). The publication history of this work is also noteworthy: more polemical than pedagogical in tone, the *Vrai système* nonetheless conforms to Castel's overarching scheme of simplifying difficult topics for a lay readership — in this case, the foundations of Newtonian physics for natural philosophers without training in mathematics.

the same way that uneducated ears need training for the listener to fully enjoy a complex musical piece or that an eater's tongue must grow accustomed to an unusual flavor. The instrument he proposed to create would not only serve to facilitate the learning of music and painting, but also to educate the senses more generally.⁶³

As Schier rightly observes, Castel was unafraid of the *libido sciendi*, the love of learning that theologians sometimes regarded as a dangerous distraction from pious living. "It is better," Castel writes in his *Géométrie naturelle en dialogue*,

that geometry be the science of everyone, at the risk of seeing it wither because of a couple mistakes, than to keep it mysteriously bound within the limits of a truth hidden at the bottom of a well. Do you believe we should forbid men all knowledge, all thought, all use of reason because by thinking, reasoning, and cultivating the sciences, one risks making a mistake? Better then never to walk, for in walking, one risks falling.⁶⁴

Although some have argued that he changed his mind toward the end of his life upon realizing that his popularized works had produced many more "half-savants" than whole ones and, moreover, that these unwanted spawns were prone to irreligious behavior, Castel certainly had no such qualms in his thirties, forties, and fifties, when he was actively looking for new ways to "facilitate" public instruction.⁶⁵

⁶³ Castel, "Nouvelles expériences d'optique [...]," *Mémoires de Trévoux* (Aug. 1735): 1479; (Nov. 1735): 2335-2372; (Dec. 1735): 2684-2685.

⁶⁴ Castel, "Géométrie naturelle en dialogue. Second entretien," 194: "Il vaut mieux que la géométrie soit la science de tout le monde, au hasard de la voir flétrir de quelques erreurs, que de la tenir mystérieusement resserrée dans les bornes d'une vérité cachée dans le fond d'un puits. Ne croyez-vous pas qu'il faille interdire aux hommes toute science, toute pensée, tout usage de leur raison parce qu'en pensant, en raisonnant, et en cultivant les sciences on s'expose à donner dans l'erreur? Il ne faudra donc jamais marcher, parce qu'en marchant, on s'expose à faire une chute."

⁶⁵ For one formulation of this argument, see Schier, *Louis Bertrand Castel*, 130-132. Correctives to this picture will be brought in chapter 6, where I show that Castel's old-age "desillusionment" has been read out of context. Evidence of Castel's continued interest in public education specifically include, for instance, his public support for the establishment of a free "technical drawing" school. See "Copie d'une lettre du R. P. C[astel] J[ésuite] au sujet du projet d'établissement d'écoles gratuites de dessein," *Mercure de France* (March 1746): 74-78. The announcement of this anonymous project also features in the *Mémoires de Trévoux* (Feb. 1746): 184-187.

The engraving on the first page of the *Mathématique universelle* features an allegory illustrating Castel's ideal of public education (see Fig. 4).⁶⁶ To the left stands a tall tree surrounded by a crowd of people. They carry baskets and stand ready to pick its fruit or catch them as they fall. The surrounding countryside would be peaceful were it not for the dark and towering mountain to the right and the thunderstorm hovering above it. Those attempting to climb this mountain are visibly defeated by the task. The summit of this ascent is shrouded in clouds: it is the ineffable name of God, written in Hebrew, hanging in mid-air, a sacred mystery. At the front and center of the composition stands yet another group, visibly arguing about whether they should go pick apples or climb the mountain. The tree represents Castel's approach to mathematics and the people surrounding it his pupils. The mountain thus stands for the traditional approach to geometry — a daunting, fearsome path — and the climbers the idolaters of mathematical mysteries. From Castel's perspective, the bystanders' choice seems easy enough, though not all mathematicians would agree.

In the early eighteenth century, natural philosophy had already trickled down to the educated laymen thanks to the works of authors like Fontenelle, whose *belle physique* deftly allied educative and entertainment value. But mathematics remained as arcane as ever. In fact, with the development of Leibnizian and Newtonian infinitesimal calculus and its growing application in rational mechanics, eighteenth-century mathematics was becoming increasingly abstruse, beyond the reach of most natural philosophers, let alone

⁶⁶ The review of Castel's *Mathématique universelle* published in the *Journal des sçavans* (June 1729): 351-354, esp. 351, contains a slightly different exegesis of the frontispiece. See also Dainville, "Enseignement scientifique," 59.

lay readers.⁶⁷ Castel felt that ‘professional’ geometers who had mastered the finer subtleties of the art were jealous of their knowledge, and held it with pride as a mark of their intellectual superiority (not unlike the priestly class of the ancient world or early modern guildmasters holding onto their professional secrets). Castel had no patience for this attitude: “For this oracular, apophtegmatic or profound and abstract air that Geometry gives itself inspires in beginners a kind of contemplation and ecstasis which is exhausted after three or four days of studies, and which disappears at the first difficulty.”⁶⁸ Billing himself as the rare embodiment of a *géomètre-physicien*, his goal was to “put geometry within their reach,” a task for which he knew “no better means than to demote (*dégrader*) it from the mysterious height where it has been hoisted until now.”⁶⁹ Castel reflected that geometry, insofar as it is demonstrative, should be the easiest of the sciences, the most self-evident. Unfortunately, textbooks were traditionally couched in highly technical, even hermetic language and followed an ineffective teaching method; instead of making their content plain, they shrouded it in mystery. The result was a science admired by all but appreciated by few.

Castel’s solution was to write in a popular, conversational style and use lively quotidian imagery to make geometry *likeable* and *tasteful* and thus better adapted to classrooms and salons. To make technical definitions more palatable, for instance, he

⁶⁷ Gingras, “What Did Mathematics Do to Physics?,” *History of Science* 39 (2001): 383-416; John L. Greenberg, “Mathematical Physics in Eighteenth-Century France,” *ISIS* 77, no. 1 (March 1986): 59-78.

⁶⁸ Castel, *Mathématique universelle* I, ii: “Car cet Air d’Oracle, d’Apophtegmes, ou de raisonnemens profonds & abstraits, que la Géométrie se donne, inspire à un commençant une espece de contemplation & d’extase que trois ou quatre jours d’étude épuisent, & qui disparaît à la première difficulté.”

⁶⁹ *Ibid.*, 3: “On se tromperoit fort, si on se persuadoit que c’est par le Préjugé de métier dont j’ai parlé, que je mets les Mathematiques en possession de toutes les Sciences; puisqu’après le plan dont je me sers pour mettre la Géométrie a leur portée, je ne connois point de moyen plus efficace pour faciliter cette Science que de la dégrader un peu de cette hauteur mystérieuse où on l’a guindée jusqu’ici.”

recommended that teachers compare geometrical objects to commonplace items, like appetizing foods that could be easily grasped by the senses and likely to whet a child's appetite for geometry.⁷⁰ Castel believed in the importance of a gradual, inductive approach to learning. To make one's own reason receptive to abstraction, the best course was to first accustom the senses and imagination. The taste for geometry was best acquired through the use of concrete examples, an approach that may seem obvious to a modern reader but which was surely considered innovative at the time.⁷¹

This approach was not, however, the simple expression of a vague and diffuse Enlightenment ideal. Underpinning Castel's ideals of public education and his debates over pedagogical method were personal quarrels and corporate rivalries, notably between the Parisian Jesuits and the Académie Royale des Sciences. As the main science editor for the *Mémoires de Trévoux*, Castel was responsible for reviewing the activities of academicians, either by providing excerpts from their published work or by reviewing Fontenelle's *Histoire de l'Académie des Royale des Sciences* and its appended *mémoires*. Castel's reviews were respectful in tone but critical and rarely impartial. Throughout his *extraits* he included commentaries, using the journal to promote his own theories, to warn the readers of egregious mistakes he found in others' works, and to suggest ways to improve their research. By engaging with the *académiciens*, he hoped to raise his public profile and possibly earn an honorary position at the Académie, such as the one occupied by Père Thomas Gouye, SJ (1650-1725), from 1699 until his death in 1725.

⁷⁰ Castel, *Plan d'une mathématique abrégée*, 2-3. This is also the main theme that runs through Castel's "Géométrie naturelle en Dialogue."

⁷¹ Schier sees in this aspect of Castel's works an anticipation of Rousseau; see *Louis Bertrand Castel*, 132.

Though offered in earnest, Castel's criticisms were often interpreted as marks of irreverence. Over the years, tensions had built up between the academicians and the Jesuit *Mémoires*, tensions that degenerated into what has been called Castel's "quarrel with the Academy."⁷² Though long in the making, the quarrel proper seems to have broken out shortly after the publication of Castel's *Plan d'une mathématique abrégée*.⁷³ At some point in 1727, Castel received an unsigned "Avis" from four geometers connected to the Académie Royale des Sciences, who offered their feedback and claimed to have the Jesuit's best interests in mind. In reality, though, their criticisms were harsh and at times openly insulting. The four skeptics did express legitimate concerns over the ambitious scope of the proposed *Mathématique universelle* and argued that Castel's definitions of mathematical terms were often inadequate or inaccurate. But most often they harped on his style, which they found overly conversational, rhetorical, idiosyncratic, and provincial, going so far as to sarcastically suggest that the *Plan* be "translated" into French lest it achieve the exact opposite of what Castel had intended: "Avoid this bad taste, my Reverend Father, if you want to be read. Write like a gentleman (*galant homme*), and not like

⁷² For a detailed discussion of this complicated quarrel, see J. B. Shank, "A French Jesuit," 175-180. Shank examines this quarrel from the perspective of Woolhouse's campaign in favor of Castel's election to the Royal Society, and shows that the Jesuit's Anglophilia — that is, his alliance with English geometers against the French proponents of continental analysis — was a key factor in obtaining his membership. With occasional exceptions, noted below, I follow Shank's interpretation.

⁷³ While the *Plan d'une mathématique universelle* symbolizes Castel's break from the analytical program of the Académie, it was in fact preceded by several reviews containing remarks that undoubtedly displeased some members of the Académie; see for instance his "[Review of Fontenelle's] Histoire de l'Académie royale des sciences de l'année 1718. avec les Mémoires de Mathématique & de Physique pour la même année," *Mémoires de Trévoux* (June 1722): 989-1031, esp. 991-922, where Castel "proposes doubts" to Saurin, J. Bernoulli, and Fontenelle regarding their exposition of, and solutions to, specific mathematical problems: "S'il étoit permis de le dire, il semble [que M. Saurin] auroit pû proposer le problème d'une maniere plus simple & plus générale [...]" (989); "Seroit-il possible que deux Academiciens du sçavoir de M. Bernoulli, & de la sagacité de M. de Fontenelle, fussent tombez ici, je n'ose dire dans une contradiction manifeste, du moins dans une inadvertance considerable? Je n'ai garde de le croire, mais il a toujours été permis de proposer des doutes à d'aussi grands Maîtres [...]" (992).

a college author, that your expressions may be, so to speak, like pure crystal . . .”⁷⁴ The critics were harsh, but at least had the decency not to publish their letter.⁷⁵

Though he claims otherwise in his correspondence, Castel took these criticisms as personal insults.⁷⁶ They evidently embittered his subsequent reviews of the academicians’ work, among them Fontenelle’s *Elements de la géométrie de l’infini*⁷⁷ and, most importantly, the *Histoire de l’Académie Royale des Sciences, avec les mémoires de mathématique, & de physique pour l’année 1725*, in which he questions the mathematical

⁷⁴ See “Avis sur le Plan d’une Mathématique universelle,” Ms. 15751-15754 (50v-51r), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels: “Évités ce mauvais gout, mon R. P. si vous voulez etres lû, Ecrivez en galant homme, et non en auteur de College, que vos expressions soient pour ainsi dire Comme un pur cristal dont tous les prin consiste a laisser [...] les objetz qui font au dela dans tout leur naturel, laissés a des Ecrivains moins riches que vous en pensées le soin de barbouiller leur papier des couleurs empruntées de la Rhetorique [...] Retranchez dans le livre que vous venés d’annoncer, toute cette vaine parure qui sied mal a un auteur Geometre, faites en sorte qu’on ne fasse aucune attention a vôtre style, et soyez assuré que vous aurés très bien Ecrit.”

⁷⁵ By contrast, the review that did appear in the *Journal des sçavans*, which had ties to the Académie, was rather prosaic, though skepticism shrouds the final note about the motto of the work: “Ordinis haec virtus erit et venus aut ego fallor,” a verse from Horace’s *De arte poetica*, meaning “the virtue and charm of order shall be, or I am mistaken.” “[Review of Castel’s] Mathématique universelle abrégée,” *Journal des sçavans* (June 1729): 351-354.

⁷⁶ See “Lettre de Castel à Fontenelle, s. d. [1728?],” in Fontenelle, *Œuvres* XI, 162: “Vos Messieurs me menacent fort depuis eux ans [...]. Pour moi, je ne leur veux aucun mal, & il n’y en a aucun à qui ne ne fisse plaisir, s’il daignoit m’y employer. Je ne suis, Dieu merci, ni rancunier, ni mal-faisant; je loue plus que je ne blâme; & quand je blâme même, c’est un badinage plutôt qu’une poursuite sérieuse. Car une certaine vivacité de style et d’expression feroit croire que je suis fort piqué contre ces Messieurs; il n’en est rien, & je me fais un vrai amusement de tout ce qu’ils peuvent dire ou faire. Il a été même un temps où je pouvois être plus sensible. Mais désormais il n’y a tout au plus que leur intention dont je pourrois être fâché, & du reste je leur ai de très-grandes obligations.”

⁷⁷ See Castel’s “[Review of Fontenelle’s] Élemens de la géométrie de l’infini,” *Mémoires de Trévoux* (July 1728): 1233-1263 and (March 1729): 415-442. Some scholars read Castel’s disagreement with Fontenelle over certain passages of the *Élemens* as a chapter of his quarrel with the Académie, on the grounds that it originated in Castel’s rejection of the Académie’s program of rational analysis in favor of a more concrete style of natural geometry. For instance, Shank suggests that “[b]y exposing these inadequacies with Fontenellian clarity and eloquence, Castel thus countered Fontenelle’s effort to demonstrate the rationality of infinitesimal analysis with a clear and distinct exposition of its irrationality”; see *Newton Wars*, 203. See also Niderst, *Fontenelle*, 313-316. I am not entirely convinced by these interpretations, which project much more acrimony into the Castel-Fontenelle correspondence than the documents justify. It is not impossible, too, that the sudden end of their epistolary exchange around the same time reflects an archival loss. Much of Castel’s correspondence, formerly held at the library of the Jesuit College in Paris disappeared after the suppression of the Society of Jesus.

and pedagogical aptitude of some of the academicians.⁷⁸ Castel maintained a respectful tone, but was decidedly confrontational, throwing jabs at a number of living and dead academicians and stamping the seal of his disapproval in print, thus, *publically*.⁷⁹ To be fair, the critique in question came after the *Journal des sçavans* had itself published a harsh review of his *Mathématique universelle*.⁸⁰

From the perspective of the Académie, Castel's affront was unacceptable. Stepping up in defense of his fellow academicians — it would have been indecorous for them to respond directly — the aging mathematician Joseph Saurin (1659-1737) published an anonymous *Lettre critique* in which he proceeded to undermine Castel's reputation.⁸¹ Indeed, he framed the letter as a response to a friend asking whether Castel would be a reliable tutor for his son. Saurin's ironic response leaves no doubt about his contempt for the Jesuit's teachings:

What wrong won't a master do to his [pupils], when in accommodating their laziness, and in flattering their self-love, he persuades them that they know much when they know nothing. Here I do not pretend to say, Sir, that you should worry about P. C[astel]. in this regard. You will be the judge of that. For my part, I want to believe that he has as much modesty and acuity of mind as his books lack.⁸²

Saurin presented the *Mathématique universelle* as a reflection of Castel's character, pointing out its superficial coverage of difficult material, its deliberate attempt to avoid

⁷⁸ Castel, "[Review of] Histoire de l'Académie royale des sciences [...]," *Mémoires de Trévoux* (Nov. 1729): 1972-1987 and (Jan. 1730): 103-122.

⁷⁹ The academicians whom Castel attacked included Varignon, Nicole, Lagny, and Dortous de Mairan, and Pitot.

⁸⁰ Shank reverses the order: Castel responded to the academy's attack, not the other way around. The review of Fontenelle did however precede the review of the *Journal des scavans*, so it is possible there is a back-and-forth at work here. See *Newton Wars*, 205-206.

⁸¹ Saurin, *Lettre Critique* [...] (Paris: Gabriel Martin et Louis Guerin, 1730).

⁸² *Ibid.*, 2: "Quel tort ne leur fait donc pas un maitre, lorsqu'en s'accommodant a leur paresse, & en flattant leur amour propre, il leur persuade qu'ils savent beaucoup, lorsqu'ils ne savent rien. Je ne prétends pas dire ici Mr. que cela soit à craindre du P. C. vous en jugerés. Pour moi je veux croire qu'il a autant de modestie & de justesse d'esprit qu'il en paroît peu dans ses Livres."

burdening the reader's mind with difficulties, and its mistakes. He also proceeded to refute Castel's 1730 review of the *Histoire de l'Académie des Sciences* for the year 1725 and his involvement in the Pitot-Duquet debate (discussed in chapter 3). Saurin's goal was to discredit Castel as a potential preceptor for the sons of nobility, one of his only ways to obtain patronage at Louis-le-Grand and with it the financial resources for his publications and other projects.⁸³ Indeed, eighteenth-century mathematics praeceptors — be they *académiciens* seeking to round up their pensions or Jesuits seeking to increase their prestige — all competed for a limited number of patrons and pupils. Salaries and social standing depended in large part on reputation. Although I have yet to find conclusive evidence of direct competition, it is possible that Castel's irreverence and his novel, potentially threatening approach to textbook writing earned him the enmity of several geometers, notably those of the Académie Royale des Sciences, and by extension, their friends.⁸⁴

By raising questions not only about the quarrelers' mathematical competence but also about their moral worth as teachers or clients, this quarrel reveals not only the personal but also the collective and corporate interests underlying the relationship between

⁸³ The quarrel continued as Castel responded to Saurin's attack with a letter (now lost) supposedly written by an eleven-year-old student at Louis-le-Grand College named Guioit who demonstrated the effectiveness of Castel's teaching. Saurin, who did not appreciate being schooled by a child and even less so by an adult pretending to be a child, responded with irony, which elicited another response from Guioit-Castel; see Castel, "Réponse de M. Guioit à la réponse de M*** [on a geometrical proposition about the geometrical lune.]" (S.l: s.n., 1730).

⁸⁴ Indeed, Saurin's critique would be reviewed by the *Bibliothèque des savants*, a periodical headed by Saurin's sympathizers, with the express intention of accentuating its impact on the general public; see "Review of Saurin's] Lettre Critique de Monsieur **** a Monsieur ****," *Journal des sçavans* (Oct. 1730): 603–611. While pedagogy may not have been a major concern for all *académiciens* as such, it certainly was for the Jesuits, whose college competed with the Oratory, the College Royal, and the University of Paris (not yet under their influence). See also David J. Sturdy, *Science and Social Status: The Members of the Académie des Sciences, 1666-1750* (Woodbridge: Boydell Press, 1995), 375-398, esp. 378-381, which shows that several academicians filled the ranks of these teaching institutions.

the Académie and Parisian Jesuits. To ensure Castel's demise, the mathematicians of the Académie collectively addressed a formal complaint to the Duke of Maine, patron of the *Mémoires de Trévoux*, as well as to the Cardinal Fleury, so as to force the board of journalists to apologize publically and punish their presumptuous critic.⁸⁵ The academicians formed a tightly knit and influential scientific aristocracy that the Jesuit journal could not afford to ignore. Accordingly, the editorial board printed the required retraction and ensured that the author of the review was reprimanded.⁸⁶ But Castel was not fired — if anything, he ascended in the editorial line of the journal and would soon be involved in other disputes with the Academy peacocks (notably Réaumur).⁸⁷ Though the editorial board did not defend him publically, they ultimately had no obligation to, since its reviews were published anonymously.

Castel's "ethos" as a geometer, and the *mathesis universalis* he endeavored to create, fit the pedagogical agenda of the Jesuit college.⁸⁸ In the early eighteenth century the Parisian Jesuits were busy rejuvenating their program, developing new teaching tools

⁸⁵ See Shank, "French Jesuit," 179; see also Schier, *Louis Bertrand Castel*, 18-19, who cites Bertrand, *L'Académie des Sciences et les académiciens de 1666-1793* (Paris: Hetzel, 1869): 158-161. Echoes of the quarrel reached missionaries in China. In one of his letters to P. Gaubil, the Sinologist Fréret interprets Castel's stance vis-à-vis the Académie as a response to their decision not to admit Jesuits into their honorary ranks after the passing of P. Gouye; see Letter of Fréret to Gaubil, dated 8 August 1737, in *Document inédits relatifs à la connaissance de la chine en France de 1685 à 1740*, ed. Virgile Pinot (Geneva: Slatkine Reprints, 1971), 156: "Vos PP. de Paris ont cru que c'estoit contre eux que ce règlement avoit esté fait et peut estre le ton que le R. P. Gouye avoit pris lorsqu'il avoit rempli ces Places dans l'académie avoit-il fait désirer le Règlement. [...] En conséquence de l'opinion de vos PP. les Journalistes de Trévoux et surtout le P. Castel déclarèrent à l'Académie des sciences une guerre ouverte et ne perdirent aucune occasion de l'attaquer dans tous leurs journaux. La chose fut si vive que l'Académie en porta ses plaintes au Duc du Mayne et au Cardinal Fleury."

⁸⁶ See Castel, "[Review of] Histoire de l'Académie Royal [sic] des Sciences, année 1726, avec les mémoires des Mathématique, & de Physique pour la même année [...]" *Mémoires de Trévoux* (May 1730): 879-894, esp. 893-894.

⁸⁷ See Schier, *Louis Bertrand Castel*, 33-34.

⁸⁸ See Rhoveda, "Le Père Castel," 160-165.

and manuals to facilitate learning.⁸⁹ Also significant is the fact that around the same time that this dispute was unfolding, the *Mémoires de Trévoux* printed a series of positive reviews of a number of pedagogically-oriented works produced by Castel and his colleagues.⁹⁰ Castel's lengthy *extrait* of his own *Mathématique universelle* was indeed soon followed by reviews of Noël Regnault's *Les Entretiens physiques d'Ariste et Eudoxe*, as well as several other works by Claude Buffier.⁹¹ Throughout the remainder of his journalistic career, Castel would seize every occasion to review new mathematical and natural philosophical textbooks, always with an eye for Jesuit authors and other philosophers who shared his and his order's pedagogical views and a critical stance towards those who did not.

The *Mathématique universelle* differed from traditional and more technical school manuals in that it reflected the primary goal of Jesuit education: ensuring that the sons of nobility became *honnêtes hommes*, that is, well-rounded, socially adept, virtuous gentlemen. Although Jesuit colleges were renowned for offering a solid elementary training in

⁸⁹ Barthes, *Science, histoire et thématiques ésotériques*, 91-98.

⁹⁰ Good examples of these works include Claude Buffier's numerous textbooks, such as his *Nouveaux éléments d'histoire et de géographie à l'usage des pensionnaires du Collège Louis-le-Grand* (Paris: Bordelet, 1731); his *Cours de sciences sur des principes nouveaux et simples pour former le langage, l'esprit et le cœur dans l'usage ordinaire de la vie* (Paris: G. Gavelier et P. F. Giffard, 1732); and his *Pratique de la mémoire artificielle pour apprendre et pour retenir aisément la chronologie et l'histoire universelle* (Paris: N. Le Clerc, 1712). Guillaume-Hyacinthe Bougeant's *Observations curieuses sur toutes les parties de la physique, extraites & recueillies des meilleurs mémoires* (Paris: Jacques Mongé, 1719) and the subsequent two volumes edited by the Oratorian Nicolas Grozelier in 1726 and 1730 should also be recalled, as should Noël Regnault's best-selling *Entretiens physiques d'Ariste et d'Eudoxe* (Paris: J. Clousier, 1729) and his *L'origine ancienne de la physique nouvelle: où l'on voit dans des entretiens par lettres: ce que la physique nouvelle a de commun avec l'ancienne, le degré de perfection de la physique nouvelle sur l'ancienne, les moyens qui ont amené la physique à ce point de perfection* (Paris: J. Clousier, 1734).

⁹¹ [Castel], "[Review of Castel's] *Mathématique universelle* [...]," *Mémoires de Trévoux* (April 1729): 695-721, (May 1729): 855-875, and (Sept. 1729): 1587-1612; [Castel?], "[Review of Regnault's] *Entretiens physique d'Ariste et d'Eudoxe* [...]," *Mémoires de Trévoux* (Feb. 1730): 197-219 and (March 1730): 440-461; "[Review of Buffier's] *Cours des sciences sur des principes nouveaux et simples* [...]," *Mémoires de Trévoux* (Aug. 1732): 1291-1309, (Oct. 1732): 1682-1706, and (Feb. 1733) 315-331. See also [Castel?], "[Review of Grozelier's] *Observations curieuses sur toutes les parties de la physique* [...]," *Mémoires de Trévoux* (Dec. 1730): 2114-2123.

mathematics — Louis-le-Grand in particular could boast a competent faculty that taught more than rudimentary geometry — much of the instruction dispensed to children and teenagers emphasized grammar and rhetoric over any particular specialization. Students needed sufficient knowledge to move about within worldly circles without passing for a fool but not so much they passed into pedantry. More important than abstruse mathematical or technical knowledge, they held, was a proper moral and religious upbringing. The rigor and precision of mathematics were considered formative for the mind and for the heart and, like natural philosophy, as ancillary to religion.⁹² Castel's *Mathématique universelle* had similar goals, privileging method and repetition over problem-solving and offering an all-encompassing survey of knowledge rather than a specialized course. Organized around a theological conception of the world in which God was the author of nature, it produced an all-embracing *mathesis universalis* meant to inculcate a sense of divine harmony in young readers' minds — the sense, that is, that God made everything according to measure, weight and number.⁹³ Such was what Castel's tree of knowledge proposed as the alternative to his rivals' towering, forbidding mountain.

Castel's *Mathématique universelle* was not well received by his contemporaries, who shared a different philosophy of education. Few saw its potential as a textbook and fewer still could see where it fit within his broader project (such a vision would have required knowledge of Castel's whole corpus, more easily available to historians than to his

⁹² Barthes, *Science, histoire et thématiques ésotériques*, 91-92. See also Dainville, "Enseignement scientifique," 51-58.

⁹³ A good overview of the Jesuit pedagogical and religious program can be found in Barthes, *Science, histoire et thématiques ésotériques*, 59-123.

contemporaries). The second, posthumous edition of the work went virtually unnoticed.⁹⁴ Yet Castel's approach exerted its quiet influence, if only through the courses he gave at Louis-le-Grand, his main laboratory for testing his pedagogical ideas, and through his disciples who taught outside the Jesuit College, like Rondet and Jean-Mathurin Mazéas.⁹⁵ His idiosyncratic methodology of circulation did not outlast him, but his analytic tree diagrams, his tendency to teach through examples, and his use of common language no doubt inspired, directly or indirectly, the composition of more accessible textbooks throughout the eighteenth and nineteenth centuries, to say nothing of Diderot and D'Alembert's *Encyclopédie*, which was tributary to more than just Bacon's tree of knowledge.

Concluding Remarks

In this chapter, I have argued that Castel's tree of knowledge ought to be read as a *mathesis universalis*, a method for learning and teaching a comprehensive course in the sciences and the arts. As such, it offered something different from the typical geometry textbooks, encyclopedias or dictionaries of the time. While scholars might well mine its

⁹⁴ This is shown for instance by the absence of any substantial reviews in the contemporary journals, save for a curt announcement in the *Mémoires de Trévoux* (May 1758), 1331-1332.

⁹⁵ Little is known about Rondet, except that he seems to have studied mathematics with Castel, and collaborated with him throughout his life. The two men worked together on the French translation of Edmund Stone's treatise on fluxional calculus; see Edmund Stone, *Analyse des infiniments petits*, trans. M. Rondet (Paris: Gaudoin et Giffard, 1735). Castel wrote the "Discours préliminaire" to this translation; see iii-c). Rondet also helped Castel promote and realize the ocular harpsichord; see Schier, *Louis Bertrand Castel*, 155, who cites Georg Wolfgang Krafft, *Sermone in solemnibus academiae scientiarum imperialis conventu die XXIX aprilis, anni MDCCXLII publice recitati* [Petropolis, s.n., s.d.], 21). His name also recurs in a letter from Castel to Trublet, dated 10 March 1756, Waller Ms. fr01689, Uppsala Universitetsbibliothek, Uppsala, which suggests he was involved in the distribution of Castel's anonymous *L'Homme moral*. For his part, Jean-Mathurin Mazéas was apparently Castel's first student and the author of the *Éléments d'arithmétique, d'algèbre et de géométrie, avec une introduction aux sections coniques, ouvrage utile pour disposer à l'étude de la physique et des sciences physico-mathématiques* (Paris: Lemercier, 1758). Mazéas's textbook does not adopt Castel's method but does betray a similar concern over facilitating the learning of beginners.

rich repository of definitions to shed light on the scientific typology and disciplinary nexus of the early eighteenth century, its main interest for this dissertation lies in what it reveals about the evolution of Castel's oeuvre.

First, it tells us much about the internal development of the Castel's system. The structure and objectives of the *Mathématique universelle* are grounded in his highly polyvalent concept of organized circulation. As such, his textbook adds a further dimension to the analogical argument developed in the *Traité de la pesanteur* and the "Lettre sur la politique." While the previous chapter demonstrated how Castel's physics overflowed into moral and political realms, this chapter has argued that it likewise shaped his understanding of the intelligible realm, and of the process of learning in particular. One might even read the extension of his analogy as self-reflexive. Like the circulation of fluids and spirits in the vegetable, animal, terrestrial and political bodies, his use of circulation as a metaphor for *method* furthered the coherence of a potentially eclectic body of works. From a modern reader's perspective, it certainly runs throughout his oeuvre and helps organize its labyrinth.

Second, the *Mathématique universelle* represents an important step in the evolution of Castel's thought toward a practically-oriented natural philosophy. Just as the "Lettre sur la politique" sought to demonstrate the moral and political implications of speculative physics, his geometry textbook endeavored to convince readers of the importance and necessity of mathematics in the cultivation of the sciences and the arts. Read horizontally, the tree guided the reader from the general to the particular; but read vertically, it progressed from theory to practice, from the abstract to the concrete, and from possibility to actuality. Castel's concern with the applicability of geometrical thinking anticipates a

host of later works on the physico-mathematical sciences and the mechanical arts, as well as the hands-on labor he would eventually undertake (or at least commission) in his workshop. From this viewpoint, Castel participated in the rise of Enlightenment utilitarian thinking as well as in the promotion of the mechanical arts.

Third, the *Mathématique universelle* marks the point in Castel's career when he began to conceive of his oeuvre as an ambitious "body of science" (*corps de science*) that harmonized geometry, physics, and (natural) history, the three trunks that sprang from the seed of universal mathematics. Due to its negative reception in France and the ridicule it incurred in the subsequent decades, Castel would seldom mention his textbook in the future and when he did he often downplayed its merit. Yet such silence does not mean that he abandoned his project. While I have referred to the *Mathématique universelle* as one further step toward a universal system, it should be clear that it was not an offshoot of his physics (or physico-politics), but an architectonic venture, a systematization of all knowledge. This change in scale and perspective allowed him to nest his previous findings alongside one another on the nodes of his *arbor scientiae*.⁹⁶ It also allowed him to map out what needed to be done to achieve a complete curriculum of the arts, and to announce a number of specific courses he had yet to produce (some of which he in fact outlined or published). Had he had enough time and resources at his disposal, it is likely he would have continued on this path and encouraged others to follow his lead.

⁹⁶ Indeed, his textbook contains numerous passages adapted from or referencing his other works. The section on mechanics, for instance, defines the object of dynamics and statics by drawing from his *Traité de la pesanteur*. The cosmographical section of the book contains discussions of the internal structure and circulation of the earth that are taken from his physics treatise. The section on the arts — and especially optics, painting, and music — all reveal similarities with Castel's early insights concerning his theory of the music of colors, most of which he had yet to develop.

Finally, the *Mathématique universelle* testifies to Castel's growing concern with public education. I have tried to show that this concern not only arose from a widespread Enlightenment ideal but also from a more pragmatic context that involved personal and corporate rivalries and tensions between different philosophies of education. Above all, Castel's *mathesis universalis* constitutes a forceful statement of his faith in the dignity of mankind. Indeed, the encyclopedic scope and pedagogical purpose of his textbook can only function alongside the assumption that the human mind and heart can be improved. They reveal Castel's confidence in humanity's capacity for intellectual and moral growth and his self-confidence in providing the right tools and methods to foster this growth.

VI. DEVELOPEMENT. pag. 96.

MATHÉMATIQUE UNIVERSELLE	GÉOMÉTRIE	SIMPLE	METHODE	MATHÉMATIQUES GÉNÉRALES	Arithmétique Algèbre Géométrie Mécanique
			ELEMENTS	NATURELLE DÉMONSTRÉE	Arithmétique Algèbre Géométrie Mécanique
			PRATIQUE	EXERCITION	Arithmétique Algèbre Géométrie Mécanique
		COMPOSÉE	SCIENCES DE SAUCE	ARITHMÉTIQUE ALGÈBRE ANALYSE	Arithmétique Algèbre Analyse
			LES CONIQUES	PRÉPARATION EXERCITION USAGE	Arithmétique Algèbre Analyse
			ANALYSE DE L'INFINI	PRATIQUE	Arithmétique Algèbre Analyse
		TRANSCENDANTE	LES COURBES	PRÉPARATION EXERCITION USAGE	Arithmétique Algèbre Analyse
			PRATIQUE	PRÉPARATION EXERCITION USAGE	Arithmétique Algèbre Analyse
			PRATIQUE	PRÉPARATION EXERCITION USAGE	Arithmétique Algèbre Analyse
		MECANIQUE	GÉNÉRALE	DYNAMIQUE	MOUVEMENT UNIFORME MOUVEMENT ACCELERÉ MOUVEMENT MIXTE
STATIQUE	DES PRINCIPES APPLICATION DES PRINCIPES			Mécanique Astronomie Géographie	
PARTICULIÈRE	DES CORPS NATURELS		ELEMENTAIRE MIXTE CURVÉS	Mécanique Astronomie Géographie	
	DES QUALITÉS MATHÉMATIQUES		OFFICIELLE ACQUISITION	Mécanique Astronomie Géographie	
	D'INSTINCT DE SENTIMENT DE DIRECTION D'ARTICLE DE JUSSE DES PRÉFÉRENCES		DES PRINCIPES DES PRÉFÉRENCES	Mécanique Astronomie Géographie	
PRATIQUE OU ARTIFICIELLE	DE GOUT OU D'IMITATION		DES MANIÈRES ARCHITECTURE FIXE ARCHITECTURE MOUVANTE	Mécanique Astronomie Géographie	
	DE GENIE		PAR DEHAUT D'IMAGINATION	Mécanique Astronomie Géographie	
	ASTRONOMIE		ELEMENTAIRE PRATIQUE	Mécanique Astronomie Géographie	
COSMOGRAPHIE	VISIBLE		GÉOGRAPHIE	SCAVANTE CIVILE PRATIQUE	Mécanique Astronomie Géographie
			GÉOGRAPHIE	MECANIQUE DE LA TERRE MECANIQUE COSMOGRAPHIE GÉNÉRALE	Mécanique Astronomie Géographie
	ORGANIQUE	ZOOGRAPHIE	COSMOG. ANATOMIQUE MÉDECINE COSMOGRAPHIQUE	Mécanique Astronomie Géographie	
		PHYTOGRAPHIE	COSMOG. BOTANIQUE COSMOG. AGRICULTURE	Mécanique Astronomie Géographie	
		ANTHROPOGRAPHIE	SYSTEME DE L'ESTRAT SYSTEME DE COEUR	Mécanique Astronomie Géographie	
	INTELLIGIBLE	THEOGRAPHIE	DE LA TRINITÉ DE LA TRINITÉ	Mécanique Astronomie Géographie	

Figure 2: Louis-Bertrand Castel, "Sixième développement," Fold out from *Mathématique universelle* [...], 2nd ed., vol. 1 (Paris: N. B. Duchesne, 1758).

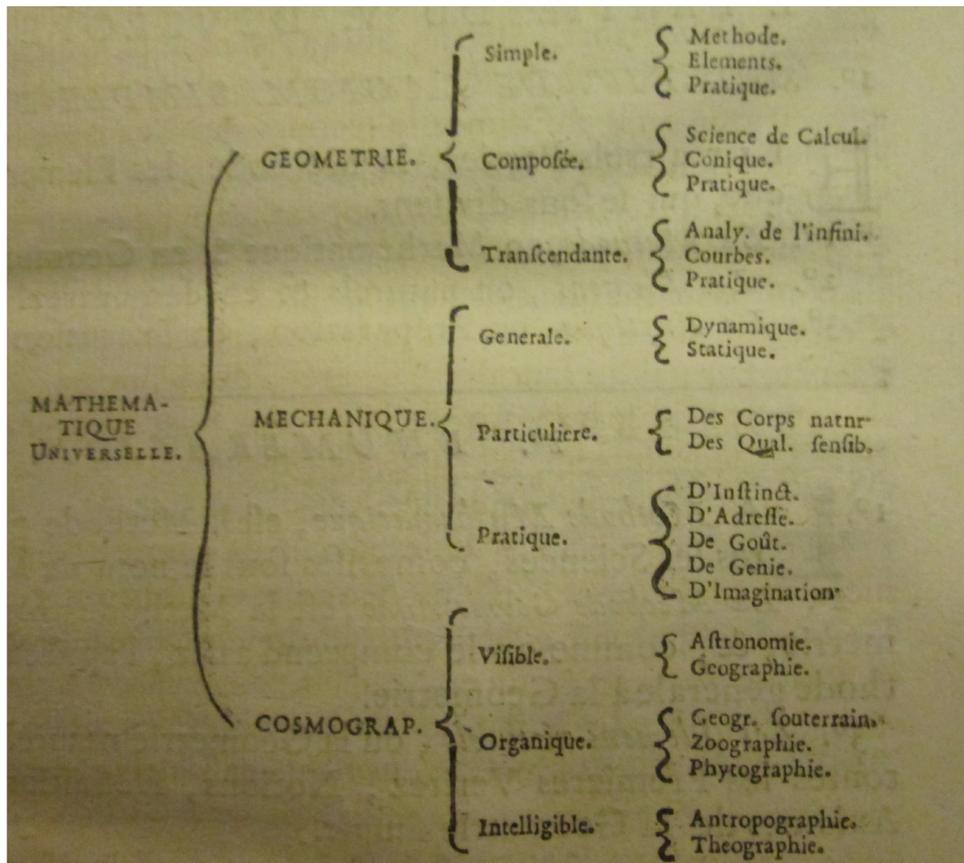


Figure 3: Louis-Bertrand Castel, “Quatrième développement” *Mathématique universelle* [...], 2nd ed., vol. 1 (Paris: N. B. Duchesne, 1758), 38.

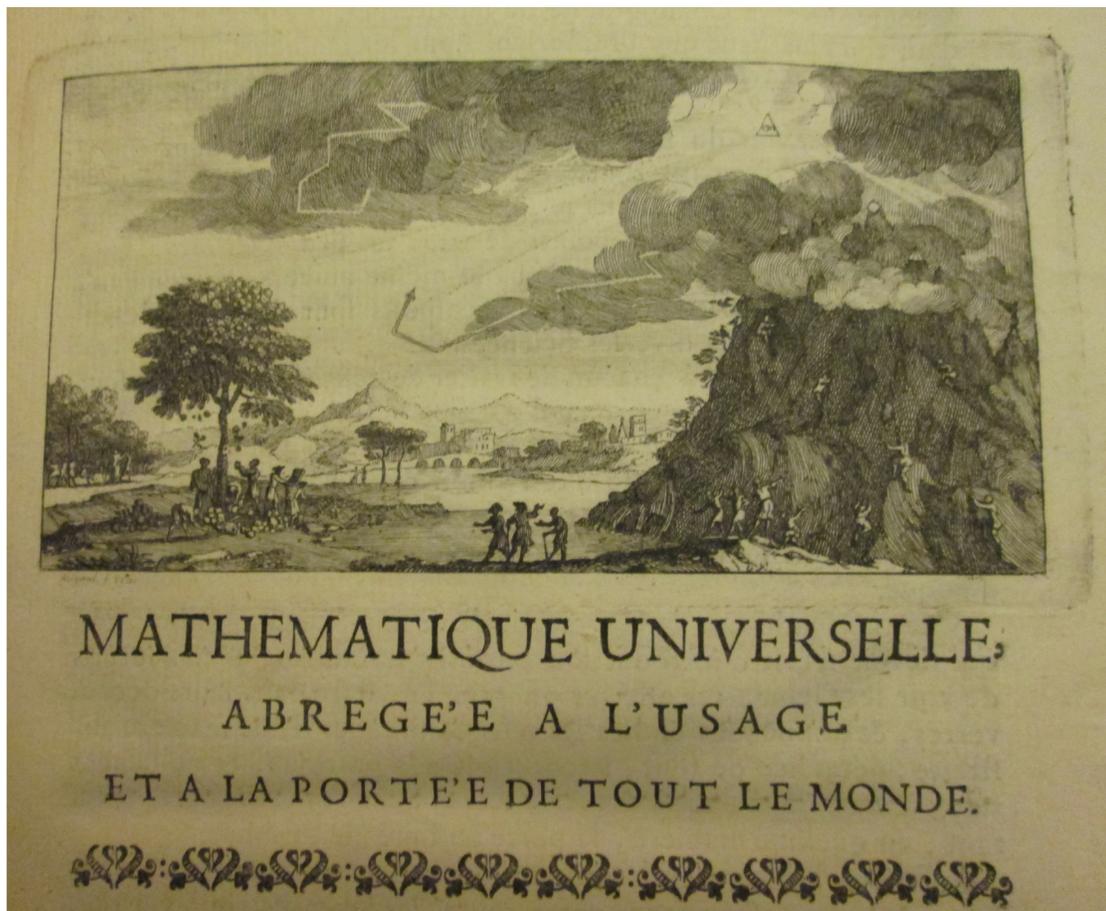


Figure 4: Frontispiece of Louis-Bertrand Castel, *Mathématique universelle* [...], 2nd ed., vol. 1 (Paris: N. B. Duchesne, 1758), 1.

CHAPTER 5

Wandering Stars Walking the Earth

*[E]very body, when only considered as a primitive system, is the precise expression —
and like the faithful mirror — of the entire system of the universe.*
— Louis-Bertrand Castel¹

On 20 October 1736, Paris and its countryside were hit by a violent windstorm. Its gusts were so powerful that they knocked down chimneys, uprooted trees, tore off statues from the portal of Notre-Dame, and sent flying a heavy lead sheet from the roof of the Louvre until it crashed a hundred-fifty feet away in front of a terrified passerby. This “furious wind” was then followed by an unseasonable heat wave. Both at Court and in town, word had it that the sun had gone off its course.²

Unsurprisingly, journalists picked up and fanned the rumor. On 30 October, the *Gazette de Hollande*, a bi-weekly newspaper printed in Amsterdam, associated the windstorm with a report asserting that the astronomers of the Académie Royale des Sciences had observed a fifteen-minute delay in the rising and setting of the sun over the last few months. Apparently, one of Jupiter’s satellites had also gone missing, which suggested that the celestial machinery was falling apart.³

¹ Castel, *Traité de la pesanteur* I, 362: “De sorte que dans leur point de vûë, chacun des Corps, à ne considerer que leur Système primitif, est l’expression précise, & comme le Miroir fidèle du Système entier de l’Univers.”

² Other rumors apparently included that the earth’s axis had suddenly tilted, or that the shape of the earth had changed. The latter ought to be read in the context of the geodesic measurement controversies of the 1730s. These variations on the theme of planetary change are reported in the different writings analyzed below.

³ Reported in the *Gazette d’Amsterdam* 87 (30 October 1736), 3 (Oxford : Voltaire Foundation, 2000), CD-ROM: “[Paris, Octobre 22] Les Astronomes de l’Observatoire ont observé depuis quelques tems, que le lever du Soleil étoit retardé d’un quart d’heure, & que son Coucher étoit pareillement retardé d’un quart d’heure: Ces Mrs avoient déjà remarqué dès l’Été dernier une difference sensible dans le Lever & le Coucher du Soleil, & ils attendoient l’Equinoxe pour voir si la course du Soleil se rétablirait dans sa justesse ordinaire, mais ce rétablissement ne s’est point fait, ce qui, à ce qu’on prétend, n’étoit jamais arri-

The international scare that ensued, if there was ever one, was of a short duration. Aided by the return of seasonal weather, the astronomers of the Observatory confirmed this was a hoax. On 16 November, the *Gazette* published an erratum that blamed unscrupulous astrologers for feeding them the false report.⁴ By then, fear of imminent apocalypse had receded into the distant future.

Père Castel probably witnessed the windstorm from his quarters on rue St-Jacques. Meteorological irregularities neither frightened nor surprised him, nor did he believe in the possibility of solar disturbance. As far as he was concerned, the real disturbance came in the wake of the storm as a number of anxious visitors — “twenty, thirty, forty,” he reckoned — sought reassurance in his expert opinion.⁵ Although he had little time to spare, the insistence of foreign correspondents who wondered about the implications of the storm prompted him to take up the pen to settle the question once and for all.

A little more than a month after the storm, Castel published an anonymous but easily identifiable *Lettre philosophique pour rassurer l’univers contre les bruits populaires d’un dérangement dans le cours du Soleil; au sujet du vent furieux & de la chaleur*

vé. Les mêmes Astronomes ont aussi observé qu’un des Satellites de Jupiter avoit disparu: On travaille à en découvrir la cause, comme aussi du Phenomene extraordinaire par rapport au Soleil. Il fit ici avant-hier un Vent si violent, que plusieurs Cheminées en furent renversées, divers Arbres deracinez & quelques Statües du Portail de l’Eglise de Notre Dame abbatuës: Ceux qui marchoient dans les Ruës pouvoient à peine se soutenir, & il étoit si impetueux qu’il détacha de dessus les Galeries du *Louvre* un morceau de plomb de 12. piez en quarré qui étoit à demi-roulé, & le jetta à plus de 150. pas de sa place. Un Particuliez qui passoit près de l’endroit où ce morceau de plomb fut jetté tomba évanouï de frayeur: Ce Vent a aussi causé de grands dommages à la Campagne.”

⁴ *Gazette d’Amsterdam* (16 November 1736) (Oxford: Voltaire Foundation, 2000), CD-ROM: “Le bruit qui s’étoit répandu il y a quelques tems à la Cour & à la Ville du derangement du Soleil dans sa Course & de la disparition d’un Satellite de Jupiter, n’étoit qu’une fiction de quelques Astrologues qui ont cherché à en imposer au Public.”

⁵ Louis-Bertrand Castel, *Lettre philosophique pour rassurer l’univers contre les bruits populaires d’un dérangement dans le cours du Soleil; au sujet du vent furieux & de la chaleur extraordinaire qu’il fit le Samedi 20 Octobre dernier 1736* (Paris: Prault père, 1736), 2.

*extraordinaire qu'il fit le Samedi 20 Octobre dernier 1736.*⁶ The *Lettre philosophique* “establishe[d] upon most certain principles the regularity of celestial motions” in order to undermine the foundations of these kinds of rumors and dispel popular anxieties. It also “explain[ed] the particular causes of [meteorological] disturbances,” that is, the specific reasons why unseasonal temperature and unpredictable weather are occasionally observed.⁷ More polemically, Castel alerted his readers to what he regarded as relics of astrological superstitions in the “fashionable” philosophical systems that divided public opinion — notably those of Descartes and Newton, and to a lesser extent, those of Gasendi and Aristotle. By the same token, he promoted his own system as a viable and morally responsible alternative to those of his rivals.

The *Lettre philosophique* offers precious insight into the evolution of Castel’s system of physics. It reveals both a clear commitment to his earlier discoveries and his desire to establish them as important and distinct contributions to natural philosophy. He used the letter to reiterate theories he had put forth twelve years earlier in his *Traité de de la pesanteur*, namely those pertaining to circulation, the central fire of the earth, and the action of men upon nature. His objective was to free the earth and its credulous denizens from the alleged “empire” of the heavenly bodies and to shift this dignity from the stars to human beings — the true wandering stars responsible for meteorological irregularities.

⁶ Or *Philosophical Letter to Reassure the Universe Against the Popular Rumors of a Disruption in the Course of the Sun; on the Subject of the Furious Wind and Extraordinary Heat of this Past Saturday October 20th, 1736*. Few copies of this 32-page pamphlet survived. I would like to thank Dr. Earle Havens, Curator of Rare Books and Manuscripts at the Johns Hopkins Sheridan Libraries for recently acquiring one (bound with the *Seconde Lettre philosophique*). The *Lettre* was also inserted in the 12th brochure of the equally rare *Glaneur François*; in the bound edition of this periodical, the letter is found in vol. 3, 73-102.

⁷ [Louis-Bertrand Castel], “[Announcement of] *Lettre philosophique pour rassurer l’univers*,” *Mémoires de Trévoux* (February 1737): 367-368: “Cette lettre est d’un Physicien tres connu dans le monde. Il y établit sur les principes les plus certains la regularité des mouvements celestes, & explique les causes particulieres de derangemens, ou plutôt de la variété qu’on observe dans les saisons, & et des changemens qui arrivent en divers tems dans la temperature des mêmes climats [...].”

The first part of this chapter provides a detailed analysis of this argument and emphasizes the continuities in the evolution of Castel's thought.

Adhering to his theses, Castel implied, was essential to restoring the universe's tranquility of mind. Although the universe never responded, a number of critics did.⁸ These included abrasive reviewers from the *Observations sur les écrits modernes* and the *Réflexions sur les ouvrages de littérature*, the playful author of an "Arrest burlesque" in the *Mercure de France*, not to mention Castel's own self-indulgent review in the *Mémoires de Trévoux*. Rather than expressing gratitude for the "great Comforter" (*Réassureur*), most reviewers found the *Lettre philosophique* presumptuous, took issue with its argument, and sought to undermine the credibility of its author. Too proud to let these attacks go unanswered, Castel wrote a *Seconde Lettre*, this time "to reassure the universe against the critics of the first one."⁹ This prompted another set of reviews, followed by a *Troisième lettre* (signed by a sympathetic third party named Pariet Despars) and a last salvo of critiques, with which the skirmish came to an end.¹⁰ The second part of this chapter reviews this quarrel, which is worth studying for a number of reasons.¹¹ For one, it serves as a colorful case study of early eighteenth-century polemical journalism that

⁸ Voltaire makes this remark in his 1738 "Lettre à Rameau," in *Œuvres complètes de Voltaire*, vol. 18c, ed. Theodore Besterman et al. (Oxford: Voltaire Foundation, 2008), 23: "[O]n a déjà écrit plusieurs brochures pour rassurer l'univers, pour éclaircir l'univers. Imitez l'univers, Monsieur, ne lui répondez pas."

⁹ Louis-Bertrand Castel, *Seconde lettre philosophique pour rassurer l'univers contre le critiques de la première. En réponse à MM. les auteurs des Réflexions sur les ouvrages de littérature* (Paris: Prault père, 1737). This piece also appeared in the 13th brochure of the *Glaneur François*, vol. 3, 191-216.

¹⁰ Henri Pariet Despars [and Louis-Bertrand Castel?], *Troisième lettre philosophique en réponse à la seconde pour rassurer l'Univers; Au sujet des Réflexions sur la première, et contre les critiques du Cône, du Parallepipede, et de la pesanteur du feu* (Paris: Prault père, 1737). Inserted in 15th brochure of the *Glaneur François*, vol. 3, 289-317.

¹¹ Schier summarizes this quarrel in his biography of Castel, but his reading does not do justice to the complexity of the dispute and the depth of the argument (at least in its early stages). In his defense, Schier did not have access to the all the pieces of the puzzle and had to rely on the reviews and the excerpts they contained. See Schier, *Louis Bertrand Castel*, 38-40.

sheds light on the circles of critics in which Castel operated, as well as on their respective writings and publishing practices. Moreover, we will see that it presaged, and to some extent may have precipitated, an important shift in Castel's career.

Sow the Wind...

The *Lettre philosophique* addressed several issues that Castel had briefly touched upon in his *Traité de la pesanteur* and which seemed ripe for a *reprise* after the public scare of October 20th.¹² It began with an inquiry into the origins of the rumors of cataclysm that often arose in the wake of unusual meteors.¹³ When nature seems out of joint, he observed that “the people” (*le Peuple*) tend to look up to the sky for answers and imagine that the cause of seasonal anomalies must have something to do with the course of the sun, or the moon, or some general disruption in the equilibrium of the heavenly spheres.¹⁴ By “people,” Castel meant both the unschooled and the learned who lived their lives unreflectively. Yet there was more to it. He claimed that the rumors that had spread in the wake of the windstorm had also made a strong impression on “philosophers of the

¹² “[Review of Castel’s] Lettre Philosophique, pour rassurer l’Univers,” *Mémoires de Trévoux* (April 1737): 692-706. This review was almost certainly written by Castel himself. It lists the “four or five great questions of physics” that the *Lettre philosophique* raised, and does so more clearly than the letter itself — a sign that Castel recognized that its main argument had been misunderstood by his critics.

¹³ Meteors here must be understood in the early modern sense of atmospheric phenomena, including those taking place below the surface of the air.

¹⁴ Castel, *Lettre philosophique pour rassurer l’univers*, 5-6: “[P]ourquoi un simple retour de chaleur modérée en Octobre, un coup de tonnerre à Noël, un peu de neige le jour de Saint Jean, font-il recrier l’Univers: Que *les saisons sont dérangées*, que *les climats sont altérés*, que *l’axe de la terre est incliné*, que *la terre s’est allongée ou accourcie*, que *son centre de gravité est changé*, que *le cours du soleil est interrompu*, que *cet astre a retrogradé*, que *les jours sont allongés*? Car tout cela a esté dit, & dit par des gens qui ne sont pas si Peuple, puisque voilà bien des choses qui passent sa capacité, & même son incapacité, & qu’il faut sçavoir quelque chose, pour être ignorant jusqu’à ce point?”

first order.”¹⁵ How was it that a false report regarding a freak storm could hold sway over *their* minds?

The answer, Castel surmised, lay in the widespread acceptance of mistaken Cartesian and Newtonian cosmologies that made the *savants*, and *a fortiori* the public, receptive to mistaken notions of celestial fragility. While popular fear of comets and eclipses had long been dispelled by “the light of philosophy,” persistent popular anxieties surrounding meteorological anomalies suggested that philosophers were still incapable of explaining them away.¹⁶ Truth be told, their systems gave credibility to rumors of celestial disruption.

Indeed, by filling up the universe with vortices of infinitely subtle, mobile, and soft (*molle*) matter, Cartesians made celestial disruptions theoretically plausible in the long run:

A Cartesian would not be surprised if a planet or a sun (*astre encrouté ou désencrouté*) were to invade another [celestial body], or to escape from it, wandering from vortex to vortex, or settling in ours.¹⁷

Cartesian physics, especially its Malebranchian variant with its small vortices (*petits tourbillons*), could hardly account for the observed arrangement and stability of planetary

¹⁵ Ibid., 7.

¹⁶ Ibid., 5: “Les questions des Antipodes, des Eclipses, des Comettes, sont des questions si éclaircies pour les sçavans, que la clarté en rejaillit tout naturellement sur le Peuple même. Il faut donc que les questions du chaud & du froid, leurs causes, la cause de la diversité des saisons & des climats, les raisons physiques de l’alternative de l’hyver & de l’été, dans les divers tems, dans les divers pays, soient encore un mystere pour les sçavans mêmes, puisque le Peuple, & en verité tout sorte de Peuple, Peuple peuple, Peuple même savant en mille autres choses, en porte l’ignorance à un tel excès.”

¹⁷ Ibid., 6-7: “Dans le système Cartésien tout est mobile, tout est subtil, tout est fluide, tout est fragile. Un Astre encrouté ou désencrouté, envahi par un autre, ou qui lui échaperoit, & s’en iroit errer de tourbillon en tourbillon, ou viendroit se fixer jusques dans le nôtre, ne surprendroit point un Cartésien [...]. Le dérangement des Saisons & du cours du Soleil, & de tous les Astres, n’est donc qu’un jeu pour un Cartésien.” This led some to claim that the sun’s course is, both in principle and in practice, less regular than manmade clocks and pendulum. Castel deemed this notion absurd: timekeeping devices are only regular insofar as they conform to the regularity of sun or the stars, their points of reference. “[Review of Castel’s] Lettre Philosophique,” 697: “Nous n’aurions aucun point fixe pour la mesure réguliere du tems, si le cours du Soleil & des Astres étoient réellement irrégulier.”

orbits. Castel criticized that “in the Cartesian system, all is mobile, all is subtle, all is fragile.” How could homogenous heavenly spheres not smash into one another in their rapid revolutions? In the *Traité de la pesanteur*, he compared the Cartesian-Malebranchian universe to numberless, rapidly whirling shell-less eggs expected to remain whole and orderly!¹⁸ While subtle Cartesians might conjure up hypotheses to save the phenomena (if not the Universe, which was never actually at risk of turning into an omelet), a less sophisticated reader might take rumors of celestial disruption seriously.¹⁹

The Newtonian system, for its part, suggested that the arrangement of the universe could not last long without God’s intervention (*manus emendatrix*). A world in which celestial bodies floating in a vacuum were held together by a mysterious, attractive force seemed very precarious indeed. To make things worse, Newton’s work actually *predicted* the loss of motion in the universe and thus its eventual disruption. The Englishman’s theories of light-particle emission and earthly exhalations also suggested a progressive dispersion of solar and terrestrial matter, despite no such phenomenon having ever been observed. In short, the Newtonian system required periodic, perhaps even constant, miracles to maintain order and thus constantly stood on the verge of collapse.²⁰

¹⁸ Castel, *Traité de la pesanteur* II, 421: “Je compare les *Tourbillons Cartésiens* à un nombre innombrable d’œufs qu’on mettrait les uns sur les autres dans un espace resserré; assurément ces œufs n’en feroient bientôt plus qu’un; mais c’est bien pire ici: ces œufs sont 1°. Sans coque, 2°. Sans pellicule extérieure, 3°. Ils sont d’une matière infiniment subtile, & tout au plus d’une matière globuleuse, qui n’a ni arme ni défenses, ni inégalités, ni pointes pour repousser la matière environante, qui elle même lui ressemble parfaitement en ce que cette matière tourne, & par conséquent fait effort pour se dissiper, & se confondre avec la matière qui l’environne, & qui fait le même effort pour aggrandir son *Tourbillon*.”

¹⁹ Castel also feared that the inherent weaknesses of the Malebranchian vortical hypothesis gave credibility to another, more perilous system, that of “the great Newton, who first founded his great celestial void and his general attraction upon the ruins of the great celestial vortices.” See his “*Démonstration Physico-Mathématique de la vérité des grands Tourbillons de Descartes, & de la fausseté des petits Tourbillons de Mallebranche, contre l’hypothèse du vuide et de l’attraction*,” *Mémoires de Trévoux* (June 1739): 1242-1269, esp. 1242.

²⁰ Castel, *Lettre philosophique*, 8.

The alleged instability of the Cartesian and Newtonian systems reminded Castel of the Epicurean doctrine, which had been revived by Gassendi in the seventeenth century, but since then co-opted by so-called “atheists” and “libertines.” For these materialists, the Universe’s current order was the contingent product of the random collision of atoms falling in a void, rather than a machine purposefully designed to last. Descartes and Newton were not Epicureans proper, but from Castel’s perspective, their systems were founded on a slippery slope. While they might not believe that such disturbances had actually taken place, they did not deny — let alone disprove — their possibility. Nor did they fully appreciate their disruptive social and moral consequences.²¹ How could the common people *not* pay heed to rumors of imminent apocalypse in such circumstances?²²

After showing the detrimental implications of these natural philosophical systems, Castel asked whether the course of celestial bodies could ever be disrupted by natural means — to which he answered with a categorical ‘no.’ Sixteen years earlier, an illustrious Cartesian identifiable as Fontenelle had objected to him that “matter is fragile, and the future long.”²³ Then as now, this observation struck him as odd. By what right did one appeal to an indefinite future to support the *possibility* of heavenly disruptions? Had six thousand years not elapsed since the birth of mankind — six thousand years of stargazing and measurement suggesting that the heavens were orderly, regular, and predicta-

²¹ Ibid., 6. His worry was that the Epicurean doctrine, combined to rumors of impending Apocalypse, led to materialism, atheism, and the denial of free will, and thus to a dissolute lifestyle and social unrest.

²² Castel, “[Review of] *Lettre Philosophique*,” 699.

²³ Castel, *Lettre philosophique*, 9. In a letter dated 17 August [1721?], in which the perpetual Secretary of the Académie Royale des Sciences gave Castel feedback on what must have been a draft of the *Traité de la pesanteur*, one reads: “Je ne suis guère de votre avis sur la constance de la nature, c’est-à-dire, sur la perpétuité de la forme ou constitution présente de l’Univers. Le mouvement est un principe nécessaire de changement, & l’avenir est bien long” (my emphasis). See Fontenelle, *Œuvres* XI, 141-144.

ble? Did historical and astronomical records not testify that the planets had always remained within their proper bounds? Repeated observations had shown the periodicity of eclipses and made their prediction possible; astronomy as a whole was founded on the assumptions that the heavens were geometrical and that nature followed regular laws.²⁴ In his various writings on the cause of *pesanteur*, Castel explained celestial equilibrium in terms of the heterogeneity of insensible particles, which he supposed repelled one another and thus tended toward a relative equilibrium. But one did not need to rely on such *a priori* principles to realize that heavenly stability was a historical fact and that the alleged fragility of matter was pure fiction.²⁵

The fact that modern astronomical observations revealed the complexity of planetary motions did not entail that they were irregular or fragile. On the contrary, the sizes, figures, and revolution patterns of celestial bodies were manifestly immutable.²⁶ Castel did not advocate a return to Aristotelian physics, which supposed that different laws governed the heavens and the earth; he struck a middle course between the modern and the ancient perspectives by admitting both the corruptibility of parts and the incorruptibility of wholes. The moon, for instance, was undoubtedly made up of elements analogous to those found on Earth. Its uneven surface suggested mixtures, and therefore motion gov-

²⁴ Castel, *Lettre philosophique*, 10: “C’est sur le passé qu’on peut raisonner avec quelque vraisemblance de l’avenir, car la Physique dans sa notion correcte, n’est qu’une histoire, l’expérience seule y sert de base au raisonnement géométrique.” See also Castel, “[Review of] *Lettre Philosophique*,” 699: “Pour lui [Castel] il s’en tient à la grande règle de la Physique, qui est de juger de l’avenir par le passé, & de ne décider les questions de Physique que par l’expérience, par l’observation, par l’histoire des faits.” As explained in chapter 1, Castel conceived of physics as a geometrically informed history of nature.

²⁵ Castel, *Lettre philosophique*, 11.

²⁶ *Ibid.*, 11-12. Castel points out that Lucretius’s prediction that the earth was slowly vanishing away by the loss of vapors and exhalations had not been verified by observations; surely, there would be some sensible evidence for this loss if the earth (or the heavenly bodies) were changeable as wholes? To the objection that ancient estimates of the size of the earth had been downscaled by recent measurements, and thus suggested that the size of the earth had diminished over time, Castel responded that in this regard, the ancients’ calculations had been flawed and imprecise.

erned by the same laws that governed terrestrial motion. Yet historical records gave no indications that it had ever changed *as a whole*.²⁷ The same could be said of the sun, and by analogy, of the planets and the fixed stars. The observed appearance or disappearance of stars and comets did not constitute a valid objection: at stake was not the existence of “change” so much as the possibility of jolts in the regular arrangement of the universe.²⁸ For Castel, a sudden, natural retrogradation of the sun like that hypothesized on the occasion of the windstorm was inadmissible. Nature in everything proceeded by insensible, gradual steps.

The crux of Castel’s argument, however, was his denial of a direct causal connection between celestial bodies and the specific meteorological, seasonal, and climatic variations observed on Earth.²⁹ Even if one were to admit the possibility of heavenly irregularities, it did not follow that the experience of weather anomalies had anything to do with the planets and the stars. Like most eighteenth-century philosophers, Castel did not believe in elective and judicial prognostications. Like many contemporaries, he took pride in living in an enlightened century, free from the fetters of superstition, and yet everywhere he noticed and deplored the survival of astrological practices.³⁰

²⁷ Scriptural evidence of this also counted as historical. Note also that Castel knew that the moon and the planets accelerate and decelerate in the course of their revolution, just as he was aware of apsidial and other seemingly erratic movements; yet these, when considered from the perspective of a greater whole, were predictable and regular.

²⁸ Castel’s interpreted ‘new’ and ‘disappearing’ stars as periodical phenomena that did not offer incontrovertible evidence of sudden, fundamental changes in the celestial equilibrium. Comets were closer instances of the same phenomenon, and the discovery of their periodicity added support to his claim about the regularity of the heavens.

²⁹ Castel, *Lettre philosophique*, 17: “En un mot, le mécanisme parfait dans le Ciel, est à tout momens en défaut sur la terre; & ce sont deux systèmes qui ne sont en aucune sorte concertés à l’unisson.”

³⁰ For a useful collection of essays on the Enlightenment’s treatment of superstition, which brings important nuances to this simplified adversity thesis, consult Bernard Dompnier, ed., *La superstition à l’âge des Lumières* (Paris: Honoré Champion, 1998).

For there *were* proponents of astrology in the eighteenth century, and not only among the unlearned. Some important figures in the medical world for instance attempted to re-establish astral medicine on sound foundations even as they rejected earlier astrological practices as superstitious. Prominent among them was the English physician Richard Mead (1673-1754), whose influential *De Imperio Solis ac Lunae in Corpora humana, & Morbis inde oriundis (Of the power of the Sun and Moon on Human Bodies and the Diseases Arising Therefrom)* appeared for the first time 1704, was translated into English in 1712, republished in 1737, and reviewed by the Jesuits in 1739 before undergoing additional reeditions in the 1740s and 1760s.³¹ Mead's theory was that most diseases could be attributed to circulatory and animal spirit disturbances caused by the quality and pressure of the air we breathe and that these variations in the air were caused, in turn, by the pressure and rarification affects of the sun, the moon, and the other celestial bodies.³² Another well-known example is the Montpellier-trained physician Théophile de Bordeu (1722-1776) who reflected, in a piece meant for the *Encyclopédie*, that the moon might also exert specific influence upon the human body.³³ Though probably influenced by Mead, Bordeu's connection with Montpellier also seems significant. Some of his predecessors and colleagues were also Castel's interlocutors, notably on the question of aerial niter, the alleged vivifying principle, or celestial fire, thought to play a role in the

³¹ Richard Mead, *De Imperio Solis ac Lunae in corpora humana et et morbis inde oriundis* (London: Raphaelis Smith, 1704); [Castel?], [Review of Richard Mead's] Tractatus [...] de Imperio Solis ac Lunae in corpora humana," *Mémoires de Trévoux* (April 1739): 773-787. The treatise was joined to Mead's *Mechanica expositio venenorum variis Dessertionibus comprehensa*, which was also reviewed in the *Mémoires de Trévoux* (March 1739): 482-513. The subtle sarcasms used in response to some of Mead's "Newtonian" ideas leaves little doubts as to the identity of the reviewer.

³² A brief but more neutral summary of Mead's treatise had also appeared in the *Mémoires de Trévoux* (Aug. 1705): 1449-1451.

³³ Paraphrased in Ehrard, *L'idée de la nature*, 363.

growth of plants, which originated in astrological and Paracelsian theories (see chapter 1). Henri de Boulainvillier's *Astrologie Mondiale: histoire du mouvement de l'apogée du soleil ou Pratique des règles d'astrologie pour juger des événements généraux* (1711) provides another example of Enlightenment astro-meteorology outside the bounds of medicine. Though this treatise remained unpublished until the twentieth century, it is interesting for its attempt to link the character and fate of nations to solar influences, as well as for the Spinozist twist it gave to traditional astrology.³⁴ As was shown in chapter two, Castel was vehemently opposed to this and other kinds of determinism.

But Castel's rejection of celestial influence was more radical than that. Extending his criticism of astrology to include astro-meteorology, he went so far as to question the role that the sun and the moon play in weather and seasonal variations. He also rejected more controversial theories ascribing tides, fountains, earthly exhalations, volcanic eruptions, and epidemics to the action of heavenly bodies. Indeed, he suggested that those who advocated these theories were unwittingly holding on to relics of superstitions that moderns had endeavored to banish from natural philosophy.³⁵

The great irony, Castel argued, was that by blurring the Aristotelian divide between sub- and superlunary realms, the so-called "moderns" no longer recognized that the predictive successes of astronomy, when compared to the dismal failure of weather prognostication, justified drawing a distinction between celestial and terrestrial phenome-

³⁴ Henri de Boulainvillier, *Astrologie mondiale: Histoire du mouvement de l'apogée du soleil; ou, Pratique des règles d'astrologie pour juger des événements généraux, 1711*, ed., Renée Simon (Garches: Éditions du Nouvel Humanisme, 1949).

³⁵ Castel formulated this argument most clearly in the *Traité de la pesanteur* I, 541-567, esp. 558 in the context of the discussion of the tides (see below).

na.³⁶ “The calendar is certain, the almanac isn’t,” that is, the heavens are regular and predictable, whereas meteorological phenomena are *essentially* irregular and unpredictable.³⁷ Castel saw that “celestial and terrestrial phenomena are not necessarily bound by the chain of cause and effect (*enchaînés*), and more generally, that “[m]echanically speaking, the irregular cannot be the cause or the effect of the regular.”³⁸ Thus the gradual approach and recession of the sun with respect to the earth could not cause the sudden alternation between cold and warm weather, let alone specific meteorological phenomena. To be fair, most contemporary philosophers attributed seasonal and weather variations to more proximate causes such as winds, rivers, earthly and fiery exhalations. Yet, in attributing these causes to the action of the sun, they begged the question: how could the *regular* movement in the heavens produce *irregular* causes of weather variations?³⁹

Castel’s radical rejection of astro-meteorology, however, had its limits. He did not deny that the sun is our main source of light and that it allows us to keep track of time. He also granted that its heat did play a necessary role, but crucially, not a sufficient and determinant one, in seasonal and climatic variations. When closest to us (that is, when its rays hit us most directly), the sun provides enough *external* heat to crack open the pores of the earth and to draw out its *internal* heat. When it recedes, the earth’s pores close up, and Fall and Winter settle in. The sun could thus be held as the “vague and general cause

³⁶ Castel, *Lettre philosophique*, 15-16.

³⁷ *Ibid.*, 14: “Le Calendrier est certain mais l’Almanach ne l’est pas [...]. Le cours des Astres, du Soleil en particulier, est invariable, jusqu’à pouvoir être mesuré, prédit, & calculé d’avance par les principes de la Géométrie & par les règles du calcul; au lieu que les Saisons & tout ce qui les concerne, l’hiver & l’été, le froid & le chaud, le beau tems, la pluie, les vents, les frimats, les météores sont variables, & si variablement variables, qu’il n’y a ni géométrie, ni calcul, ni génie, ni science, ni astronomie, ni astrologie, ni calendrier, ni almanach, qui puisse y atteindre, non plus en vérité qu’aux variations des Etres libres & pensans, tels que nous sommes.”

³⁸ Castel, “[Review of] *Lettre philosophique*,” 703: “L’irrégulier ne peut être la cause ni l’effet du régulier, mécaniquement parlant.”

³⁹ Castel, *Lettre philosophique*, 18-19.

of seasonal and climatic diversity,” since it explained why summers in general tend to be warm, why winters in general are cold, and why there are different climatic zones on the planet.⁴⁰

Yet for Castel, the “proper and immediate cause” of climatic and seasonal diversity was the subterranean heat of the globe, which caused all sorts of fermentations beneath the surface and at the bottom of the sea.⁴¹ Like the pulsating heart of an animal or the main spring of a machine, this central fire was the true principle of life, the motor of winds, vapors and exhalations, all of which combined to generate familiar meteors. The sun, for its part, served as a mechanical counterweight swinging from tropic to tropic.⁴² As Castel argued in the fourth book of his *Traité de la pesanteur*, the effect of the sun’s heat on Earth was more superficial than most people realized. Its rays did not penetrate deep beneath the surface, and though they were felt quite strongly in valleys, where light is reflected and “focused” by the surrounding mountains, their action diminished at higher altitudes, thereby revealing the relative weakness of their source. The widespread idea that the sun might cause fountains to spring, metallic ores to “cook,” or combustible substances to ignite beneath the crust, thereby creating earthquakes and volcanic eruptions, seemed unlikely.⁴³

⁴⁰ Ibid.: “Le Soleil est donc la cause vague & générale de la diversité des Saisons & des Climats.” It is not clear whether Castel meant the perihelion and aphelion when he talked about the sun getting closer or farther; it would be a gross mistake if he did. More likely he meant the varying height of the sun on the horizon, the actual cause of seasonal variation.

⁴¹ Ibid., 23: “[M]ais la chaleur intérieure, les feux souterrains, le feu central est la cause particulière, propre & immédiate de ces climats & de ces Saisons, de leur diversité, & sur tout de leur irrégularité.”

⁴² Castel, “[Review of the] *Lettre Philosophique*, 705: “[Castel’s] sentiment est que la Terre entière étant pourtant un vraie machine, elle a son poids & son balancier; son ressort intérieur & son contre-ressort extérieur, comme nos corps dont le coeur est le ressort & le mobile intérieur, immédiat & approprié, & dont l’Air, le Soleil & les autres agens extérieurs sont le contre-ressort.”

⁴³ Castel, *Lettre philosophique*, 19-20, 22; Castel, *Traité de la pesanteur* I, 347-359. In the *Traité de la pesanteur*, Castel argues that when considered as a primitive system, the earth’s atmosphere and low-

Castel's unusual stance vis-à-vis the action of the sun had an interesting precedent in writings about the moon. In the mid-1720s, he campaigned to free the tides from the "empire of the moon" by relying on the pulsating action of the central fire to explain a host of "balancing" phenomena reminiscent of the peristaltic motions of the heart and the lungs. In the fifth book of the *Traité de la pesanteur*, he explained that the ebb and flow of the sea, though traditionally associated to the moon, could not be matched reliably to the latter's regular cycles. Whether they explained the tides by appealing to the alchemical concept of humid radical, to Cartesian pressure, or Newtonian attraction,"the advocates of this bond perpetuated the same kind of superstitions associating lunar cycles with fevers and epidemics, the circulation of sap and the growth of bone marrow, and the fullness of crayfish.⁴⁴ In a series of articles published in the *Mercure Galant* on the occasion of two tide-related phenomena, Castel discredited these theories as various form of "sea lunatism" (*lunatisme des mers*) which of course was his way of insinuating that their proponents were lunatics.⁴⁵ From his perspective, the dazzling complexity of tidal patterns

er regions would not be disturbed by the action of the sun, which at most would make it swell or bulge slightly beneath its path. It is only through the intervention of a system of mixture, as explained in chapter one, that the sun's action can elevate vapors and exhalations and participate in other meteorological phenomena like the winds.

⁴⁴ Castel, *Traité de la pesanteur* I, 553-558. The list of superstitions associated with the action of the moon was a trope. One finds it, for instance, in Pierre Bayle's *Pensées sur la comète*, first published in 1682. Castel, who was no fan of Bayle, would nonetheless have seen his work as building upon Bayle's attack on superstitions. Castel criticizes his predecessors' and contemporaries' theories in his "Lettre sur le flux et le reflux de la mer du R. P. C[astel]. a M. A*** écrite le 26 nov. 1725," *Mercure de France* (Jan 1726): 59.

⁴⁵ Already in his *Traité de la pesanteur* I, 559-560, Castel announced his intention to write "une ample dissertation sur le Flux et Reflux." Although he never finished this work, the report of two unexplained meteorological phenomena gave him the opportunity to argue for the merit of his earthbound interpretation of the tides, not unlike how the "furious wind" of 20 October 1736 gave him a pretext to write the *Lettre philosophique*. The first phenomenon was reported in the *Mercure* (May 1724): 878-879 and consisted of a fresh water well near the sea, the level of which rose when the tide receded and lowered when the tide rose. Castel's explanation was one of several which the *Mercure* published over the following months; see "Lettre du R. P. Castel de la Compagnie de Jesus, aux Auteur du Mercure, sur un phénomène dont il est parlé dans celui du mois de Mai dernier," *Mercure* (July 1724): 1505-1511. The second phenom-

observed from coast to coast compelled one to admit that their cause must be irregular and earthbound — the result of a kind of uneven fermentation or ebullition ([un] *boüillonnement, une effervescence, un gonflement, aestus, intumescencia*) taking place beneath the seafloor.⁴⁶ He also asserted that his system of terrestrial circulation from the center to the periphery and from the periphery to the center (a movement distributed along many different channels, hence the variations observed), was superior to explanation relying on the diurnal and annual rotation of the earth.⁴⁷ At most, he was willing to concede the ex-

ena consisted of the sudden rise of the water level observed in the harbor of Marseille on 29 June 1725, which was accompanied by a powerful stench. Once again, Castel was one of several correspondents to propose a physical explanation. Castel, “Lettre sur le phénomène du port de Marseille,” *Mercur de France* (Sept 1725): 1975-1981. This particular debate elicited more controversy as a number of participants challenged Castel to substantiate his system or discredited him on the ground that the report on which he had based his conjectures was flawed. See, for instance, Père Alexandre, “Lettre écrite au P. Castel sur son explication du flux d’un Puits,” *Mercur de France* (Jan 1726): 147-149; M. de la Bruyere. “Réponse au Pere Castel sur son explication du flux & reflux de la mer,” *Mercur de France* (Jan 1726): 69-78; and especially Jean-Antoine Barras de la Penne, “Lettre de M. de Barras a l’occasion du Phenomene de Marseille, &c. & Du Flux et Reflux ordinaire & extraordinaire que l’Auteur a vu dans le Port de Marseille,” *Mercur de France* (Mars 1726): 495-520. Père Alexandre, future winner of the Académie de Bordeaux’s 1726 essay competition on the cause of the tides, encouraged Castel to submit his own entry to the contest (he did not, but his “theory of fermentation” was criticized by one of the candidates; see Ms. 828 (52/3), Archives de l’Académie, Bibliothèque municipale Mériadeck, Bordeaux). De la Bruyère and Barras de la Penne both presented themselves as local experts who contrasted their hands-on experience with Castel’s cabinet speculations. See also Castel’s responses: “Lettre sur le flux et le reflux de la mer du R. P. C. a M. A*** écrite le 26 nov. 1725,” *Mercur de France* (Jan 1726): 56-67; “Réponse géométrique du P. Castel a M. de Barras, premier chef d’escadre des galeres du roi [on the phenomenon which happened in the harbor of Marseille],” *Mercur de France* (May 1726): 871-880; “Lettre du Pere Castel a M. de la Roque, écrite a Paris 9 juin 1725,” *Mercur de France* (July 1726): 1537-1543. See also his “Lettre du R. P. Castel, Jesuite, sur le Phénomène du Tonnerre, dont il est parlé dans le Mercur du mois de Septembre 1724, écrite à M. de la R[oque] [...],” *Mercur de France* (Oct. 1724): 2160-2163.

⁴⁶ Castel, “Lettre sur le phénomène du port de Marseille,” 1979. On the complexity of tidal patterns, Castel primarily relied upon Georges Fournier, *Hydrographie contenant la théorie et la pratique de toutes les parties de la navigation* (Paris: M Soly, 1643) as well as Bernhard Varenius, *Geographia generalis* (Amsterdam: 1671). See Castel, “Lettre sur le flux et le reflux de la mer du R. P. C. a M. A***,” 62: “[C]ar il n’y a, dit Fournier dans son *Hydrographie*, livre 9, ch. 16., aucun flux & reflux qui regne universellement par toutes les côtes, par exemple, ès côtes de l’Europe, ès marées y roulent si diversement, qu’en cette Mer il y a presque autant de mouvemens & chutes différentes, qu’il y a de côtes dans ses Provinces: or ce que dit Fournier, tous les gens de mer le disent; qu’on lise la Geographie de Varene, l’*Atlas*, & tous les Journaux de mer, je n’en citerai qu’un exemple. Le détroit de Magellan est entre deux grandes Mers, l’*Atlantique* & la *Pacifique*, & cependant le flux y arrive en même temps de ces deux Mers, venant ici de l’Occident, & là de l’Orient, ou plutôt du Nord.”

⁴⁷ Castel, “Lettre sur le flux et le reflux de la mer,” 65. Castel possibly had Galileo’s theory of the tides in mind. For a brief overview of Galileo’s theory of tides, see David Edgar Cartwright, *Tides: A Scientific History* (Cambridge: Cambridge University Press, 1999), 28-30.

istence of a moon-tide *correlation*, the apsidal motion of the moon being plausibly caused by the same underlying peristaltic motion responsible for the swelling of the sea and its surrounding atmosphere.⁴⁸

Paradoxically, Castel's conception of the material world as a *plenum* forced him to concede that celestial bodies must have some kind of mechanical impact on Earth, since in the absence of a void, all bodies must be directly or indirectly connected to one another. In one of the most beautiful passages of the *Traité de la pesanteur* — the same passage this chapter's epigraph comes from — Castel meditates on the regular waves and patterns that the stars and planets trace upon the surface of the earth in the course of their revolutions: "All the bodies that surround it engrave in relief their mark, their situation, their movement, and all their phenomena upon its surface [...]. It would be a curious spectacle to contemplate all these waves: one would need very sharp eyes."⁴⁹ Yet, the regular swellings caused by the limited rarifying action of the sun, and to a lesser extent, the moon, the other planets, and the stars, were completely lost amidst irregular ripples on its surface.

But in the midst of all these variations introduced on Earth by another system, [i.e. the system of the action of man] in no way would one be able to

⁴⁸ Castel, "Lettre sur le flux et le reflux de la mer," 66-67. Castel saw this as a reversal of Villemot's theory of the tides, which hypothesized that the vortex or sphere of the moon pressing upon the seas causes the tides. It made more sense, Castel argued, to think that the earth's atmosphere reaches as far as the moon, and that it is the center of the earth that determines the motion of both systems rather than that of the moon.

⁴⁹ What makes this image even more powerful is that Castel did not restrict it to the Earth, but to any body in the universe. As such, it sounds like a physical counterpart to Leibniz metaphysical monads. It is also interesting that Castel uses the same metaphor of the mirror when describing the nature and faculties of the human mind in the sixth part of his "Nouvelles expériences d'optique et d'acoustique," *Mémoires de Trévoux* (Dec. 1735): 2665-2666: "L'esprit n'est point une cire, n'est point une bouë molle, l'esprit est un miroir: c'est-là son vrai point de comparaison, quoiqu'encore fort imparfait. Le propre et le spécifique caractère du Miroir est, sans aucune trace Physique & corporelle, de représenter tous les objets quelconques avec la même distinction qu'ils ont en eux mêmes [...]. La différence du Miroir et de l'Esprit, est que l'esprit est un Miroir actif qui se représente à lui-même; & que le miroir est passif, & ne représente qu'à l'oeil d'autrui."

recognize the primitive system; in the same way that one would not be able to discern the regularity of the waves excited by one or several stones thrown in the midst of water filled with heterogeneous bodies and agitated by a thousand diverse movements.⁵⁰

However faithful a mirror of the universe the earth might be in principle, in practice the action of free spirits blurred its reflexion.

Castel reformulated the problem in the *Lettre philosophique* by asking how the central fire of the earth, which he construed as a mechanical reaction to *pesanteur*, did *not* result in regular waves on the surface. One way around this problem was to deny the existence of these irregularities and accept weather anomalies as the combination of a very large number of systems, the interplay of which human senses were too feeble to discern.⁵¹ But Castel deemed this solution unacceptable. He had already made up his mind about the necessity of integrating the free actions of spirits into mechanical philosophy; a purely mechanical earthbound meteorological theory was as problematic as an astro-meteorological one within such framework.⁵² By postulating that “[t]here are real irregularities in the winds, fires, and all that affects seasons and climates,” he prepared the ground for a resolution foregrounding his most original theory — a kind of Promethe-

⁵⁰ Castel, *Traité de la pesanteur* I, 362: “De sorte que dans leur point de vûë, chacun des Corps, à ne considerer que leur Système primitif, est l’expression précise, & comme le Miroir fidèle du Système entier de l’Univers. Chacun des Corps qui l’environnent, y grave en relief son empreinte, sa situation, son mouvement, & tous ses Phénomènes. [...] Ce seroit un spectacle curieux de contempler toutes ces Ondes: il y faudroit des yeux bien perçans. Mais au milieu de tous les dérangemens qu’un autre Système a introduits sur la Terre, on ne sçauroit en aucune sorte reconnoître le Système primitif; de même qu’au milieu d’une Eau remplie de Corps hétérogène, & agitée de milles mouvement divers, on ne scauroit discerner la régularité des Ondes qu’y excitent une, ou plusieurs pierres qu’on y jète.”

⁵¹ Castel explained that winds or flames, though their movements seem random, would be regular if isolated from their environment. Castel, *Lettre philosophique*, 26-27: “Le feu est donc régulier, & le vent ne l’est pas moins en lui-même. De soi il y a toujours devant lui, & ne s’engendre que selon les loix de la nature, loix mécaniques, loix mathématiques, loix géométriques.”

⁵² His system is here dictating his choice, not so much his faith. There is an important difference between a purely mechanical meteorological theory and meteorological/climatic determinism. The former makes no claim of curbing the freewill of men, while the latter steps in that direction explicitly. Interestingly enough, the argument from the weakness of human minds was traditionally used in support of astrology in the face of its failure to predict particular events.

an move whereby he not only brought the heavenly fire down to earth, but also stripped the stars from their astrological dignity in order to invest men with dignity of their own.⁵³

The action of man upon nature explained all sorts of phenomena, including those traditionally grouped under the category of meteors.⁵⁴ As we saw in chapter one, Castel believed that by tilling the land, digging canals, cutting forests, building cities, extracting metals from mines, and producing and consuming all sorts of goods, mankind was able to generate mixtures and provoke, thanks to the circulation mechanism of the earth set in motion by the fiery core, a fecund disequilibrium in nature. For Castel, windstorms like that of 20 October 1736 were not caused by celestial influences, but by ploughs in a field. They were truly irregular because men were its truly irregular cause. In lieu of a conclusion, Castel joked that, if the sun ever was to go off its course and scorch the earth, it would have to be mankind's fault, like Phaethon in Greek mythology.⁵⁵ Until then, the universe could rest assured that no wind would carry news of cosmic disruption.

Ironically, apart from dispelling fear of impending apocalypse, Castel provided little reassurance for *humans*, who still lay at the mercy of storms and other whims of nature. Knowing that natural catastrophes are ultimately caused by the unpredictable activity of man on earth, rather than by the stars, might bring resignation, but nothing like reassurance. Midway through the *Lettre philosophique*, Castel conjured a powerful image: “Men are wandering stars walking the earth: one could not predict their march, at least

⁵³ Castel, *Lettre philosophique*, 27. I would like to point out that Castel's reasoning, although guided by his system, was not necessarily flawed. He may have thought, for instance, that an infinitely complex interaction of particular mechanical causes could not take place in a purely mechanistic universe, that is, a universe without free causes capable of complicating the action of *pesanteur* and its reaction.

⁵⁴ *Ibid.*, 27.

⁵⁵ *Ibid.*, 30-31: “Si leur action pouvoit atteindre au Soleil, le cours en seroit tout aussi inégal. Le jour que Phaëton y mis la main, la Terre par l'organe de Lully ou de Quinault, chanta ces paroles à Jupiter” (ends with a citation from Philippe de Quinault's opera libretto for *Phaeton*).

not in a certain and infallible way.”⁵⁶ Unlike the planets — which indeed are no real wanderers — humans truly follow variable and unpredictable paths.

Or do they? As argued in chapter three, free will might make human beings unpredictable in principle, but this did not mean that their motions are *random*. For one, humans are creatures of habit, and habits can be studied. Moreover, wills and bodies can be curbed by persuasion and, if needs be, by force or arms. Although he never makes the claim explicit, Castel thought that the study of man’s work on nature might allow us to achieve knowledge (or at least awareness) of the far-reaching consequences of our actions, thus restoring something like prelapsarian, Adamic prescience. This explains why he approved of and reported on various contemporary attempts to observe and measure temperature, rain, and tidal patterns, and why he took interest in the development of thermometric devices, notably with the aim of measuring more precisely the actual heat of the sun’s rays.⁵⁷

⁵⁶ Ibid., 13: “Les hommes sont les astres variables sur terre; on ne sçauroit prédire leur marche, d’une maniere au moins certaine & infallible.”

⁵⁷ It is interesting, for instance, that Castel corresponded with members of the Académie des Arts of Lyon, and in particular with Jean-Pierre Christin (1683-1755), inventor of the centigrade thermometer and author of several memoirs on meteorological issues, including “Sur la chaleur directe du soleil, observée par le même instrument” (1747). The surviving letters between the two men concern Castel’s theory of colors. Correspondence between Christin, Jacques-Barthélemy Micheli du Crest (1690-1766) and the Prince of Dombes indicate that Castel had received the new thermometers from Lyon and written about them in the *Mémoires de Trévoux*; see Ms. 268 I/136r-142v (for the Castel-Christin exchange) and Ms. 268 I/177r-187v (for the relevant mentions of Castel in Christin’s letters), Archives de l’Académie de Lyon, Bibliothèque du Palais des Arts, Lyon. See also Denis Reynaud and Yoshiko Terao, ed., “Deux Lettres du Père Castel à l’Académie de Lyon,” *Mémoires de l’Académie des sciences, Belles-Lettres et Arts de Lyon pour l’année 2012*, vol. 12 (Lyon: Edition de l’Académie, 2013): 190-195. On Christin and his invention, see François Casati, *Le Thermomètre de Lyon* (Lyon: Éditions lyonnaises d’art et d’histoire, 1992), esp. 37-59. On the Jesuit reception of the “thermomètre de Lyon” see Castel, “[Review of Micheli’s] Description de la méthode d’un thermometre universel,” *Mémoires de Trévoux* (June 1742) 992-1003; [Castel], “Nouvelles littéraires [...] De Lyon [including an excerpt from Charles Bordes’s *Mémoires sur la dilatation du Mercure dans le Thermomètre*,]” *Mémoires de Trévoux* (July 1743): 2125-2128; [Castel?], “[Summary of the] Assemblée publique du 6. Décembre 1747. de l’Académie des beaux Arts, actuellement établie sous le Titre de Societé Royale,” *Mémoires de Trévoux* (Sept. 1748): 2058-2068.

Tightly connected to Castel's previous works, the *Lettre philosophique* reiterates familiar examples of geophysical transformations orchestrated by ancient and modern rulers and suggests that, if properly guided, mankind might be able to exert a certain control over the weather: "Who is this philosopher who rid his country of earthquakes by having deep wells dug at regular interval, to release winds trapped underground [*éventé les mines*]?" Did Cyrus not "reduce the Euphrates and its floods to nothing by dividing it into three hundred and sixty canals... [?]"⁵⁸ Harkening back to the "Lettre à M. C." and the "Lettre sur la politique," Castel also evokes misty Versailles and its artificial fountains, the Canal du Midi and its impact on the air of Languedoc, not to forget China, reputed for having been modeled, like a garden, after the fancy of its emperors. Once again, Castel expressed his intention to publish his intriguing *Philosophie des Princes, ou l'art de faire la pluye & le beau tems*.⁵⁹

Both the rejection of astral influences in favor of an earthbound system and the celebration of the dignity of man continued to surface in his subsequent writings. Sometimes the reference is explicit, as in book reviews that touch on the subject of tides or astrological superstitions.⁶⁰ At other times, the allusions are more subtle. In his unpublished

⁵⁸ Castel, *Lettre philosophique*, 29.

⁵⁹ *Ibid.*, 29: "Avec un peu d'intelligence on en vient quelque fois à bout, & on la plie tout à fait. Quel est ce Philosophe qui délivra son Pays des temblemens de terre, en faisant creuser d'espace en espace des Puits profonds, qui éventoient les mines? Les Rois peuvent beaucoup pour l'embellissement, l'amélioration, la perfection de leurs Etats. La Chine est presque toute dans son climat comme dans son terroir, l'ouvrage de ses Empereurs. J'ai vû un Livre intitulé la *Philosophie des Princes & des grands Seigneurs, ou l'art de faire la pluye & le beau tems*. C'est un beau titre, mais est-il vrai? Je le crois. On peut aplanir des Montagnes, combler des Vallées, ramasser des eaux, les disperser, les distribuer; faire des canaux, des levées, des écluses, &c. Tout est difficile, tout est possible. Cyrus anéantit l'Eufrate & ses inondations, en le partageant en trois cent soixante canaux qui le mirent à sec."

⁶⁰ Castel was almost certainly the reviewer of Richard Mead's previously mentioned *De imperio solis*, as well as the author of "[Review of a] Lettre sur la comete, brochure in 12," *Mémoires de Trévoux* (July 1742): 1155-1179. A similar critique of astrology was formulated in the *Mémoires de Trévoux*'s review of *Théâtre critique Espagnol, ou Discours differens sur toutes sortes de matieres, pour détruire les*

“Lettres [...] sur la Perfection générale de géographie, et sur celle de l’Amérique Septentrionale en particulier” (“Letters [...] on the perfection of geography in general, and that of North America in particular), Castel jokingly expressed his concern “that the sky might depopulate the earth.”⁶¹ This was his way of deploring that contemporary geographers, as they increasingly relied upon mathematical astronomy, were ridding their maps of the names of nations and related chorographical, topographical, and natural historical observations that once made for their charm and usefulness. In geography as in meteorology, Castel placed the earth and its denizens at the center and the heavens at the periphery.

... *Reap the Storm*

erreurs communes, the French translation of Benito Gerónimo Feijoo y Montenegro’s *Teatro crítico universal* (a collection of essays against various forms of superstitions published between 1726 and 1740). The author of this multi-part review was more likely Charlevoix than Castel, but the views it contained on astrology certainly resonated with the later. See “[Review of Feijoo’s] *Theatre critique Espagnol*,” *Mémoires de Trévoux* (Feb. 1743): 254-280; (March 1743) 478-492; (April 1743): 640-653 (this one especially because it concerns superstitions about comets and eclipses); (May 1743): 861-868 and 869-882; (June 1743): 1055-1064 and 1063-1077. For the attribution to Charlevoix, see Carmelo Saenz de Santa Maria, “Feijoo y las Memorias de Trevoux,” *Il simposio sobre el Padre Feijoo y su Siglo*, vol. II (Oviedo: Centro de Estudios del. S. XVIII, 1983), 53-60, esp. 58.

⁶¹ Castel, “Papiers du Pere Castel sur le passage de la mer d’ouest” [which comprise his “Lettres [...] sur la Perfection générale de géographie, et sur celle de l’Amérique Septentrionale en particulier”], Ms. 13373 (15v), Manuscripts français, BnF, Paris: “C’est pour le coup que je crains tout de bon que le Ciel ne depeuple la Terre.” Castel’s geographical work has scarcely been studied. His interest in geography was not new, but it crystalized in 1752 with a series of letters addressed to the abbé Raynal (1713-1796), then the editor of the *Mercure de France*, in which he suggests ways to improve geography and, in particular, the geography of North America. His main concern was the discovery and establishment of a land-route to Asia via the rumored “Northwest passage,” but he also promoted hydrographical and topographical studies. For a useful summary and analysis of a portion of these papers, see Marthe Emmanuel, “Le passage du Nord et la ‘mer de l’ouest’ sous le régime français — Réalités et chimères,” *Revue d’histoire de l’Amérique française* 13, no. 3 (1959): 361-372.

Most surviving copies of Castel's books show little to no signs of reading.⁶² It was not primarily through these works, however, that the public became acquainted with his ideas, but through the articles he published in journals. Much attention so far has been placed on his contributions to the *Mémoires de Trévoux*, which hosted the majority of his signed and unsigned pieces. Yet one must recall that his presence was felt from the very beginning of his Parisian career in several other periodicals, most of which were less scholarly than the Jesuit monthly. Among these stood the *Mercure de France*, the pages of which were split between poetic *galanteries*, news of the *Grand Monde*, and the correspondence of Parisian and provincial philosophers, historians, and geometers. Castel also published several articles in such lesser-known venues as the *Clef du cabinet*, the *Journal de Verdun*, and the *Nouveaux amusemens du cœur et de l'esprit*, not to mention a variety of anonymous pamphlets.

Castel's *Lettre philosophique* appeared both as a standalone piece and in the third volume of the *Glaneur François*, a short-lived, irregular periodical composed of a variety "of short, fugitive pieces in verse and in prose... of historical and literary anecdotes, [and] of pleasant lines [*traits*]." ⁶³ Castel probably knew the editors, the man of letters and financier Charles Etienne Pesselier (1712-1763) and his main collaborator Jean-François Dreux du Radier (1714-1780). (Dreux du Radier was a friend of the *Procureur Général* Guillaume François Joly de Fleury, whom the readers will recall was possibly one of

⁶² At least based on my anecdotal survey of archives and libraries in France, Belgium, England, and the United States. It would be interesting to compare surviving sets of the *Mémoires de Trévoux* and *Mercure de France* in order to see whether these have more annotations.

⁶³ Prologue of the first pamphlet, cited in the Denise Koszul, "Le Glaneur François (1735-1737)," *Dictionnaire des Journaux (1600-1789)*, accessed December 2015, <http://dictionnaire-journaux.gazettes18e.fr/journal/0587-le-glaneur-francais>: "de petites pièces fugitives en vers et en prose, et non imprimées ; des anecdotes historiques et littéraires, les traits plaisants ou qui, du moins, m'ont paru tels."

Castel's earliest supporters.⁶⁴) The *Lettre philosophique* was thus printed on friendly grounds for an educated but non-specialized audience seeking intellectual and literary entertainment. In his own review of the work, Castel asserted that this "Public ha[d] found this *Lettre* stylistically well-written, geometrical (i.e., derived unambiguously from first principles), and conclusive."⁶⁵

In reality, the *Lettre philosophique* elicited a number of hostile responses, which open a window onto the world of eighteenth-century critics in which Castel had to perform — a world of polemics and quarrels he ostensibly despised, yet ever so often kept returning to. In contrast to most of his detractors, Castel considered himself a serious, well-established, physicist-geometer and a respected journalist, who wrote not only to entertain the public, but also to instruct it. For all his wit and stylistic *légèreté*, he wrote with a sense of self-importance and authority that often attracted the mockery of his contemporaries. Moreover, literary critics with connections and sympathies with Cartesian or Newtonian circles did not hesitate to stretch the purview of their journals to confront him on his natural philosophical and moral high ground. These were excellent ingredients for a storm.

The first review of the *Lettre philosophique* appeared in the seventh volume of the *Observations sur les écrits modernes*, in the form of a letter dated 29 December 1736. Its

⁶⁴ Both Pesselier and Dreux du Radier frequented the literary circle of a certain Fréchet de Lanchy to which Castel might have been indirectly connected. Other friends and connections of Dreux du Radier included Pierre Nicolas Bonamy, chief editor of the *Journal de Verdun*, Lenglet Dufresnoy, Guyot-Desfontaines, Falconet, Boureau Deslandes, and Le Camus. Tiphaigne de la Roche also seem to have collaborated with the *Glaneur François*, as would Pariet Despars (see below). See Alain Nabarra, "Charles Pesselier (1712-1763)," and François Moureau, "Jean-François Dreux du Radier (1714-1780)," *Dictionnaire des journalistes (1600-1789)*, accessed December 2015, <http://dictionnaire-journalistes.gazettes18e.fr>, accessed 15 September 2015.

⁶⁵ "[Review of] *Lettre Philosophique*," 693: "Le Public a trouvé cette Lettre d'un bon stile, & d'un raisonnement sur tout net, géométrique & concluant."

author was almost certainly the Abbé Pierre François Guyot-Desfontaines (1685-1745), the main editor of the journal. Indeed, the concluding lines of the anonymous review read like his signature:

The Author of the Letter can be of great service to the people of the Kingdom of Laputa, should he consent to have it sent to this country. You know that the state of the Sun is a great cause for worry over there, and that every morning everyone asks for news of how it fares. See Gulliver's Travels...⁶⁶

Desfontaines is best remembered today as a successful polemicist and self-appointed arbiter of literary taste, but he was also the French translator of Swift's masterpiece and the author of a sequel of sort, *Le Nouveau Gulliver* (1730).⁶⁷ Together with other *beaux esprits* of his generation, Desfontaines embodied a brand of particularly abrasive journalism, of which Castel was one of many victims.⁶⁸

Desfontaines contended that Castel's *Lettre philosophique* was both unnecessary and inconclusive. Nobody worried about the windstorm anymore and inferential reasoning did not, in his opinion, constitute a sufficient warranty of future stability: "The only thing he shows is that the fact [of celestial disruption] has not yet happened since the be-

⁶⁶ Pierre François Guyot-Desfontaines, abbé, "Lettre 97 [includes review of Castel's *Lettre Philosophique*]," *Observations sur les écrits modernes* 7 (December 1736): 167-168. On the periodical itself, see Jean Sgard, "Observations sur les écrits modernes," *Dictionnaire des journaux* (1600-1789). An excerpt of Desfontaines's review (mistakenly presented as a review of Pariet Despars's *Troisième lettre philosophique*) is found in the collection of *Esprit de l'Abbé Desfontaines, ou Réflexions sur différents genres de science et de littérature, avec des Jugemens sur quelques Auteurs & sur quelques Ouvrages tant Anciens que Modernes*, vol. 3, ed. Joseph de La Porte (London: Clement, 1757), 240-241.

⁶⁷ See Voltaire, *Le Preservatif, ou Critique des Observations sur les écrits modernes* (La Haye: J. Neaulme, 1738); Desfontaines, *La Voltairomanie* [1738], ed. by Mark H. Waddicor (Exeter: University of Exeter, 1983); Desfontaines, *Nouveau Gulliver, ou voyage de Jean Gulliver, fils du capitaine Gulliver* (Amsterdam: Aux dépens de la Compagnie, 1730).

⁶⁸ After fifteen years among the Jesuits and a couple more on the editorial team of *Journal des sçavans* (1724-1727) — a tenure interrupted by a couple of brief incarcerations — Desfontaines eventually took the helm of the controversial *Nouvelliste du Parnasse* (1731-1732). After that journal too was forced to shut down, he co-founded the *Observations sur les écrits modernes* (1735-1743). For more information on Desfontaines's career, see Thelma Morris, *Abbé Desfontaines et son rôle dans la littérature de son temps* (Geneva: Studies on Voltaire and the Eighteenth Century, 1961).

ginning of the world” and that “the ancients had some reasons to believe that the heavens are incorruptible.”⁶⁹ He was, thus, a “better rhetorician than physicist” and a historian of philosophy rather than a philosopher.⁷⁰ Desfontaines’s attacks were superficial. He said nothing, for instance, about Castel’s theory of the cause of meteorological irregularities or his paradoxical argument about the weakness of the sun’s influence on Earth. The goal was to generate polemic and thereby increase the sales of his journal, not to engage in sophisticated philosophical exchanges.⁷¹

A somewhat more substantial review appeared not long after in the first volume of the *Réflexions sur les ouvrages de littérature*.⁷² The content and tone of this journal were similar to that of the *Observations* and the main charges it levelled against the *Lettre philosophique* echoed Desfontaines’s: “Who guarantees [the author of the *Lettre*] that this great and immense machine [the universe], however perfect we suppose it is, does not tend, like all machines, toward its own destruction, as the very consequence of the

⁶⁹ Desfontaines, “Lettre 97,” *Observations sur les écrits modernes* 7 (December 1736), 167: “[...] il prouve seulement que le fait n’est pas encore arrivé depuis le commencement du monde, & il insinué judicieusement que les Anciens ont eu quelque raison de dire que les Cieux étoient incorruptibles.”

⁷⁰ *Ibid.*, 168.

⁷¹ On Desfontaines’s journalistic brand, see Shank, *Newton Wars*, 333-334.

⁷² Boistel d’Welles, Jean-Baptiste-Robert / Henri Pariet Despars [?], “[Review of Castel’s] *Lettre philosophique pour rassurer l’univers d’un dérangement dans le cours du Soleil*,” *Réflexions sur les ouvrages de littérature* 1, no. 14 (December 1736): 313-324. The author of this review is hard to identify. Schier believes it was the Abbé François Granet (1792-1741), a collaborator of Desfontaines who became editor of the *Reflexions* in 1737 (Schier, *Louis Bertrand Castel*, 39). Yet, according to the *Dictionnaire des journalistes*, Granet did not work on the journal’s first volume. Madeleine Fabre, “François Granet,” *Dictionnaire des journalistes (1600-1789)*. The initial *Réflexionnaires*, it has been suggested, could have been a certain De la Blontière, replaced by Jean-Baptiste-Robert Boistel d’Welles (1717-1777) and at least one additional collaborator. See Paul Benhamou, “Réflexions sur les ouvrages de littérature,” *Dictionnaire des journaux (1600-1789)*: “Nous avons trouvé dans l’exemplaire des *Réflexions* se trouvant à la B.M. de Grenoble une inscription sur la page de titre du premier volume qui renforce l’hypothèse de Cioranescu: ‘les 4 Ieres feuilles sont de M. de la Blontière, toute la suite est de Mrs. Bointel et’ – l’inscription s’arrête là malheureusement!” The missing name could have been Pariet Despars, as we will see below. See also Henri Stavan, “Jean-Baptiste-Robert Boistel d’Welles,” *Dictionnaire des journalistes (1600-1789)*. We know little about these men of letters, but since Desfontaines was supposedly responsible for seeing that Granet take over the journal, it is possible some of them were part of his circle.

laws of motion it follows?”⁷³ Castel’s appeal to the reliability of astronomy and geometry as evidence for the regularity of heavenly laws was a methodological assumption, not an ontological guarantee against the passage of time.⁷⁴ The reviewer illustrates his point by subverting Castel’s metaphor of the “wandering star walking the earth:”

If we observe three men walking back and forth in an alley at different, regular rates during three hours, we will be able to predict their future positions, their conjunctions, and their oppositions, just as if they were planets. But what does this say about their movement beyond those three hours?⁷⁵

Another charge brought against the *Lettre philosophique* was that Castel’s claim to reassure the universe was a merely a pretext to sully rival philosophical systems and to promote his own.

I see a man whom Aristotle, Epicurus, Descartes, and Newton all have the misfortune of displeasing. This thereby makes him perfect, outside the four great systems that are currently somewhat fashionable; he has, no doubt, some singular and new idea he wants to share, but before doing so, he must clear the ground and overthrow his old adversaries to better crush them. To all of them he gives but one head: the generic Philosopher that he attacks.⁷⁶

This reading supports my earlier suggestion that the *Lettre philosophique* was a foil to reiterate, disseminate, and further establish Castel’s most distinctive discoveries. But ra-

⁷³ Boistel d’Welles/Despars [?], “[Review of Castel’s] *Lettre philosophique*,” 317: “Mais qui l’assure que cette grande & immense machine, pour parfaite que nous la supposons, ne tend pas comme toutes les autres qu’à sa propre destruction, en conséquence même des loix des mouvemens qu’elle observe?”

⁷⁴ The reviewer thus disregarded Castel’s assumption that God guaranteed the reliability of the laws of nature.

⁷⁵ Here, the reviewer puts men and planets on the same level, whereas Castel crucially distinguished between man endowed with free will and celestial bodies bound by the laws of nature.

⁷⁶ Boistel d’Welles/Despars [?], “[Review of Castel’s] *Lettre philosophique*,” 323: “[...] que de signaler son antipatie, dirai-je contre la Philosophie courante, ou contre les Philosophes qui la professent? J’ai lieu d’être en suspend; car à qui en veut-il? la chose est assez obscure. Je vois un homme à qui Aristotle, Epicure, Descartes & Neuton ont également le malheure de déplaire. Le voilà par conséquent parfait, hors des quatre grands système qui ayent aujourd’hui quelque vogue, il a, sans doute, quelqu’opinion singuliere & nouvelle dont il va nous faire part. Attendons auparavant, il faut nettoyer la place & renverser les anciens adversaires pour les écraser plus facilement. Il semble leur donner à dessein qu’une tête, c’est le Philosophe en général qu’il attaque [...].”

ther than ascribing this effort to an established author, the reviewer suggested it was written by a new, anti-philosophical and idiosyncratic system-builder — indeed, it is not clear whether the reviewer recognized Castel as the author.⁷⁷ In any case, he dismissed the letter's thesis on the ground that it stated the obvious: "This is what we all knew already: namely, that the irregularity of the actions and of the arbitrary operations of men influence the mechanism of nature. For who does not know that?"⁷⁸

These attacks on the *Lettre philosophique* help us determine what part of Castel's argument his contemporaries (mis)understood or chose to (mis)represent. They also give us a sense of the obstacles Castel had to surmount to establish his ideas. Sarcasm notwithstanding, the objections his detractors raised against it hardly meet modern expectations of journalistic criticism. For one, they generally eschewed addressing the core issues of his work. They paid little attention, for instance, to Castel's reference to the system of the action of men, although it was the culminating point of the argument.⁷⁹ When they did raise natural philosophical objections, they harped on methodological questions with relatively little sophistication and a lot of sophistry. One must recall that his critics had relatively little training or interest in natural philosophy. Theirs were witty, but hasty,

⁷⁷ Ibid., 324: "Dans son triomphe il défie & Descartes & Neuton, il s'agit d'expliquer l'irrégularité des saisons, malgré la régularité du Soleil, c'est le nœud gordien. *Voilà, sans doute, aussi le nouveau système qui va paroître pour le dénouër ou le couper*" (Emphasis mine).

⁷⁸ Ibid., 324: "Non, c'est le sentiment général aujourd'hui; c'est ce que Descartes, Neuton, & tous les autres ont pensé, du moins, s'il ne l'ont pas absolument énoncé; en un mot, c'est ce que nous sçavons tous; sçavoir, que l'irrégularité des actions, & des operations arbitraires des hommes, influent dans le mécanisme de la nature. Car qui est-ce qui ne sçait pas cela?" This statement is significant — it shows the extent to which Castel's ideas were "in the air."

⁷⁹ Moreover, Castel expected to be recognized by "readers truly initiated into the sciences and the history of good litterature" (i.e., those who had read his *Traité de la Pesanteur* and related articles) because the system of the actions of men, in connection of that of the central fire and circulation of the earth, had been his most distinctive contribution to natural philosophy. Castel, "[Review of the] *Lettre philosophique*," 706.

reviews meant to entertain and sell, not philosophical refutations. Ridicule had more pay off than reasoning.

Although Castel prided himself on maintaining decorum when replying to his adversaries, he had no qualms about courting readers through similar derisive strategies once he had established that he was not the aggressor. The *Lettre philosophique* was Castel's way of feeling the pulse of the public reaction to his earlier discoveries. Disappointed by the results, he wrote a second brochure which appeared on 1 February 1737 in the thirteenth issue of the *Glaneur François*. Unsigned like the first one, it was framed as if a friend was writing on behalf of the author of the first letter.⁸⁰ Entitled *Seconde lettre philosophique pour rassurer l'Univers contre les critiques de la premiere, en reponse A messieurs les uteurs des Réflexions sur les ouvrages de literature*, this sequel is difficult to summarize without getting enmeshed with the specific arguments raised by Desfontaines and the authors of the *Reflexions*. It can be said, in general, that Castel offered a cogent response to their objections, one punctuated with sarcastic jabs against their journalistic practice, which he described as "full of irony, but empty of reasoning."⁸¹ The quarrel thus moved away from meteorological theory to focus instead on what constitutes a good argument in natural philosophy and who had the authority to arbitrate it. Critics,

⁸⁰ Castel was more isolated than his opponents, who formed a tightly-knit network of critics. That was not a problem: Castel was more than willing to make up his own anonymous allies.

⁸¹ Castel, *Seconde lettre philosophique*, 25: "Les deux dernieres pages de leur écrit, sont pleines d'ironie, au défaut de raisons." To the claim that the *Lettre philosophique* had been published too late to reassure anyone, Castel replied that it addressed the matter *philosophically* and was, therefore, useful independently from the event that had triggered its writing. Unlike journalistic reviews, philosophical letters required reflection and time. Most importantly, Castel had written a defense of inferential reasoning in natural philosophy that showed how it is not mere 'a pleasant reason,' but fundamental to everything we do in the sciences. He conceded his opponents' view that a change in the earth's axis or in the celestial structure was possible, but that such an event would take place gradually, not suddenly. Castel also refuted the view that pendulums and clocks are more regular than the sun, and he contested the validity of the analogy between predictions made about the position of three men walking down an alley at regular pace for a given time and prediction of planetary positions over 6000 years of astronomical observations.

Castel suggested, should imitate the sun and stay within their bounds. If their province was grammar and style, they should let real philosophers discuss questions of physics and astronomy.⁸²

Predictably, a second salvo of indignant reviews followed with the quarrel degenerating into a petty dispute over Castel's use of distasteful neologisms (a serious matter of controversy at the time), filled with *ad hominem* attacks and red-herrings. On 6 April 1737, Desfontaines made clear that he was very much aware of Castel's authorship of the first and second *Lettres philosophiques*⁸³ through malicious allusions to the author of a certain *Mathématique universelle*:

Who does not know that one Geometer, for instance, gave the name of squared beam to a parallelepiped, and that of pointy hat or sugar loaf to a cone? By these new ways of speaking, has he not thought he was leveling all difficulties of geometry? But what if one day sugar loaf makers decided to give them the shape of Dutch cheese? So much for simplifying Geometry with new terminology!⁸⁴

This misrepresentation of Castel's project to *illustrate* mathematical figures with common images — as opposed to *renaming* them — not only demonstrates Desfontaines's lack of good faith, but also, and more importantly, his familiarity with Castel's quarrel with the Académie. Indeed, he had worked for the *Journal des Sçavans* around the time

⁸² Ibid., 13: “Et voilà de graves & assidus reformateurs, inquisiteurs & correcteurs de la Littérature qui ignorent que la Phisique n'est qu'une histoire dans ses principes, comme elle n'est qu'une Géométrie dans ses conséquences. Car la Phisique a deux yeux, selon tous ceux qui la connoissent au peu: l'expérience & le raisonnement. L'expérience, l'observation, c'est l'histoire naturelle qui nous la donne; elle nous donne les expériences & les observations de tous les hommes de tous les Pays & de tous les tems; & le raisonnement propre de la Phisique, ne peut être, & n'est autre, que celui de la Géométrie, tournée en mécanique, lorsqu'on l'applique aux corps, à leurs forces, à leurs movemens.”

⁸³ [Desfontaines?], “Lettre 113 [Review of the *Seconde Lettre philosophique*,]” *Observations sur les écrits modernes* 8 (April 1736): 188-191.

⁸⁴ Ibid., 189: “Ne sçait-on pas qu'un Geomètre, par exemple, a donné le nom de Poutre écartée à un Parallelepipède, & celui de Chapeau pointu ou de Pain de Sucre à un Cône? Par ces nouvelles façons de parler, n'a-t'il pas cru applanir toutes les difficultés de la Géométrie? Mais si dans la suite on s'avisait dans les fabriques de donner aux Pains de sucre, non la figure Conique, mais celle des Fromages de Hollande: Eh bien! on en seroit quitte pour changer les termes de la Géométrie.”

of this dispute, which suggests there were precedents to the two men's enmity.⁸⁵ Desfontaines also seized the opportunity to ridicule Castel's theory of the weight of fire.⁸⁶ Such misconceived notions, the *Observateur* implied, were Castel's real enemies. Time would prove him right, and indeed, although Castel continued to argue for the existence of the central fire, he rarely reiterated his claim that fire was, in fact, the heaviest of elements.

The *Réflexions sur les ouvrages de littérature* likewise issued a brief reply to Castel's imputations of journalistic impropriety.⁸⁷ By 1737, the editorship had been handed over to the Abbé François Granet (1692-1741). Granet was no outsider to the dispute as a close collaborator of Desfontaines's on the *Observateur*. His assessment of the situation echoed that of his friend: like the *Mathématique universelle*, the *Lettres philosophiques* had failed both to instruct and entertain the reader.⁸⁸ Interestingly, he admitted that the author of the *Reflexions*' first review — whoever he might be — was misguided to suggest that “one day some change in the course of the sun, the moon, or the stars could hap-

⁸⁵ It is also worth pointing out that Desfontaines previously had quarreled with the *Mémoires de Trévoux* during his tenure on the *Nouvelliste de Parnasse*, notably with Père Courbeville, on the occasion of his translation of Gracián's work (see chapter 3). He had also reviewed other works by Castel, such as his anonymous *Lettre de Monsieur *** à Madame la Princesse de *** Au sujet des Essais historiques et critiques sur le goût* [de l'Abbé Cartaud de la Vilatte] (Paris: Prault père, 1736). This piece had also appeared in the 11th brochure of the *Glaneur François*, vol. 3 (Paris: Prault père, 1736), 25-49.

⁸⁶ Desfontaines, “Lettre 113,” 190: “Laissons notre Philosophe Géomètre défendre courageusement sa Place assiégée, & braver l'artillerie des Assiégeans, c'est-à-dire l'action brusque du plus lourd des Elémens, qui, selon lui, est le feu.” Desfontaines was picking up on the extended military metaphor that Castel deployed in the *Seconde lettre philosophique*. The young *Observateurs* and *Réflexionnaires* (as Castel calls his reviewers) had declared war against a foe they did not recognize, or else they would not have dared besieging so strong a castle with so little preparation. Due to their inexperience, they had fallen for the trap set by the author of the *Lettre philosophique*, and they wasted all their fire power on the most obvious, but strongest part of its fortification — his argument for the regularity of heavens and the place of historical date in physics — while ignoring its least defended and most controversial components — Castel's system of the action of men and related ideas. In their confusion, they had gone so far as to concede a kind of victory to the author by granting him exactly what he wanted to hear: that everyone already knew “that the irregularity of the actions and of the arbitrary operations of men influence the mechanism of nature.”

⁸⁷ François Granet, “[Review of the] *Seconde lettre philosophique pour rassurer l'univers contre la critique de la première*,” *Reflexions sur les ouvrages de littérature* 2, no. 12 (April 1737) (Paris: Pierre Gisse, 1737): 286-288.

⁸⁸ Granet, “[Review of the] *Seconde lettre philosophique*,” 286-287.

pen.”⁸⁹ But this concession was a jumping off point to mock Castel’s verbosity and lack of humility: the author of the *Lettres philosophiques* should thank his critics for having given him the opportunity to write too much and to cast himself in such a good light. “Besides,” if still unhappy about the reviews he received, “the Comforter of the universe can console himself [...] with these humble words taken from the *Mathématique Universelle*: ‘It is indeed for the sake of a few frogs, croaking when it rises, that the Sun must go back under the horizon from which it came.’ He is the *Sun* and his critics are the *frogs*.”⁹⁰ If you call your critics frogs, expect them to croak.

In the summer of 1737, the *Glaneur François* published yet another brochure entitled *Troisième lettre philosophique en réponse à la seconde pour rassurer l’Univers; Au sujet des Réflexions sur la première. & contre les critiques du Cône, du Parallelipede, & de la pesanteur du feu* (henceforth *Third Philosophical Letter*).⁹¹ Unlike the previous two brochures, this letter was signed. Not by Castel, as one might have expected, but by a certain “Monsieur Pariet Despars, Accadémicien [sic] de Florence,” who took up Castel’s defense against his critics and embraced the Jesuit’s theory of the weight of fire.

⁸⁹ Ibid., 287-288: “Les personnes qui ont composé le premier volume de ces Réflexions en raisonnant sur ces matieres, ont avancé qu’il pouvoit arriver un jour *quelque changement dans le cours du soleil de la Lune & d’aucun astre*. Nous avouons de bonne foy que cette prédiction est chimérique, mais quel bon gré ne leur en doit pas sçavoir le grand *rassureur* de l’univers, puisque sans elle il auroit été obligé d’en rester à la treizième page de sa lettre? Leur critique a encore servi à l’essor de son amour propre qui en pris occasion de dire qu’*il est au fait de l’histoire de la Physique, & que la réputation de l’ouvrage & de l’Auteur n’est pas une chose dont il soit permis de se jouër avec si peu d’égard & de respect*.” (That Granet did not author the first review and did not seem to be closely related to first group of editor matters with regards to our interpretation of the *Troisième lettre philosophique* below.)

⁹⁰ Ibid., 288. “Au reste le rassureur de l’univers peut se consoler de tout ce qu’on peut écrire contre lui par ces paroles modestes tirées de la *Mathématique universelle*. ‘C’est bien pour quelques grenouilles qui croassent à son lever, que le soleil doit rentrer sous l’horison d’où il sort.’ Il est le *soleil* & ses critiques sont les *Grenouilles*.”

⁹¹ Henri Pariet Despars [or Castel?]. *Troisième lettre philosophique en réponse à la seconde pour rassurer l’Univers; Au sujet des Réflexions sur la première, et contre les critiques du Cône, du Parallelipede, et de la pesanteur du feu* (Paris: Prault père, 1737).

The tone and content of the letter are so odd that contemporaries read it as a work of Castel's in disguise, and modern scholars, as a burlesque of Castel.⁹² Despars begins by claiming authorship of the review of the first *Lettre philosophique* found in the *Réflexions*. He then proceeded to apologize for his rashness and offers as an excuse that he did not know who was the author of the *Lettre* at the time he wrote his review; indeed that he had been tricked into writing it!⁹³ As an admirer of the famous Jesuit, Despars wrote the *Troisième lettre philosophique* to repair his mistake and to demonstrate that he was not “a servile imitator” of Desfontaines, Granet, and like-minded rag-writers.

After this contrived *mise en scene*, Despars criticizes new critical journalism for its tendency to hinge and play on words rather than ideas. Deploring that so many journalists write reviews in which authors are easily identifiable (*littérature nominale*), he accuses these same journalists of quoting out of context. Despars illustrates his point by juxtaposing the passages Desfontaines attributed to the *Mathématique universelle* in his reviews of the *Seconde lettre philosophique* to the actual text of Castel's treatise. Noticing important discrepancies, he remarks that “we should not be exposed, among men of letters, to this kind of forgery.”⁹⁴

⁹² This was Schier's suggestion, although Castel's biographer admitted to not having found this letter and relying instead on its reviews. Granet, as we will see, thought that the author was Castel, which suggested to Schier that the burlesque was so good its critics took it seriously.

⁹³ A friend of his — apparently the first author of the *Réflexions* — had asked him to take his place while urgent matters called him elsewhere. Meanwhile, an intermediary (he refers to him as a *parasitic Hawker* (*Colporteur parasite*) arrived while the printing had begun to hand him the first *Lettre philosophique*, presenting it as the work of a “new, apprentice philosopher” rather than as that of a respected physicist. In haste, Despars had drafted a review and, “following the plan of [his] friend,” had adopted the “tone of the modern critics” — an impertinence he regreted.

⁹⁴ Despars [Castel?], *Troisième Lettre Philosophique*, 6-7: “Parmi les Gens de Lettres, il me semble qu'on ne devoit pas être exposé à ces sortes de contre-façons: les Paroles du Géometre ressemblent-elle à celles de l'Observateur? Celui-là comme il lui convient parle Science, & donne la définition du *Parallelipede* & du *Cône*, telle que la donnent tous les Géometres; il ajoûte, non pas que le *Cône* est un *Pain de sucre*, mais qu'un Pain de sucre, les Ifs de nos Jardins sont taillés en pointes de *Cône*.”

Despars also observed that Desfontaines ended his review of the *Seconde lettre philosophique* with a derisive reference to Castel's theory that fire is the heaviest of elements. This diversion, thrown at the reader without further explanation, was meant to undermine his credibility as a philosopher. Despars felt that this sophism deserved an answer. The demonstration of the weight of fire was a "delicate" argument requiring that many common assumptions (*préjugices*) be removed before it be successfully established. Having "become familiar with the system of this famous physicist," Despars offered to spell out this argument, an endeavor that took up the better part of the *Troisième lettre philosophique*.⁹⁵ Presented in a geometrical style, his exposition is divided into nine propositions based closely on the argument of the *Traité de la pesanteur*.⁹⁶ Assuming Despars's demonstration was sincere, his defense of the weight of fire makes him one of Castel's most ardent followers.

Unless, of course, the author of the *Troisième lettre philosophique* was Castel himself. I could find only one independent reference confirming the existence of the Abbé Henri Pariet Despars, who apparently was a member of the Florentine Academy

⁹⁵ Ibid., 12: "J'ai donc lû, sur le simple indice de l'*Observateur*, l'Article de la Pesanteur du Feu; je suis entré dans le systême du célèbre Physicien, j'ai goûté son sentiment; la pesanteur du Feu ne m'a plus paru un problème, je crois pouvoir moi-même en démontrer la vérité. Comme la question est délicate, & semée de préjugée, je vais la traité selon les loix de l'Analyse. Je la partage en plusieurs Propositions, qui vont toutes à prouver que le feu est le plus pesant des corps."

⁹⁶ The first seven propositions show, on the basis of common observations, that fire is not only heavy, but the heaviest of all elements, and that it is found at the center of the earth. The eighth proposition argues that this fire is the effect of *pesanteur*, and that this is the *a priori* proof of the seven previous propositions. The ninth is a curious calculation of the estimated total weight of the earth upon its center. If 100 lbs. of green hay is enough to provoke combustion (an observation made by Castel), how much more likely was it that (approx.) 670,904,791,160,000,000,000,005 lbs. (!) of earthly material, some of which combustible, would generate a fire at the core of the planet! Ibid., 25-29. Despars takes the specific weight of tin as a median between the heaviest earthly material (gold) and the lightest (oil). A cubic foot of tin weighing 316 lbs., he multiplies this by the volume of the earth in cubic feet. The calculation is done very meticulously, step-by-step, to the point that it is comical to the modern reader, and somewhat ridiculous to some of its contemporaries.

(probably an associate member living in Paris in the 1730s).⁹⁷ But was this abbé the real author of the brochure, and was he, as the *Troisième lettre philosophique* claims, a repentant reviewer of the *Réflexions*? The way in which Desfontaines and Granet responded to Despars certainly precludes any reading of the *Troisième lettre philosophique* as a burlesque of Castel; they read it as a serious piece of writing, albeit one venting “ridiculous” ideas.⁹⁸ Pariet could have been a prêt-nom, however, someone who consented to sign the letter to conceal the identity of its real author. Granet was certainly inclined to think Castel was the man behind the mask and that Despars was only the “surrogate father” of the letter.⁹⁹ Yet, he later published an erratum revealing he had learned, since the publication of the third volume of the *Réflexions*, that Despars was the real author of the

⁹⁷ A French cantata inserted in a collection of congratulatory poems published in 1733 for the wedding of Vincenzo Riccardi to Maria Magdalena Ortenzia Gerini. See Pariet Despars, “L’Amour & l’Hymen réunis. Cantate à trois voix,” in *Applausi poetici per le nozze dell’Illustrissimo Signor Marchese cavalier Vincenzo Maria Riccardi con [...] Maria Magdalena Ortenzia Gerini* (Florence: Tartini e Franchi, 1733), 34-37.

⁹⁸ Desfontaines, “Lettre 146,” *Observations sur les écrits modernes* 10 (September 1737): 259-264. Dated 28 September 1737, Desfontaines’s review contained an exposition of Boerhaave’s theory of fire (as exposed in his *Elementa Chemiae*, vol 1) with the intention of further undermining the credibility of Castel’s theory. Desfontaines claimed that all philosophers considered absurd Castel’s theory that fire is the heaviest of elements and that it is the product of *pesanteur*. Granet also mocks Castel’s theory of the weight of fire, cites two of the Jesuit’s arguments without refuting them, and writes ironically about the calculation of the sphere of fire’s weight, which “piquera également la curiosité des Physiciens.” Indeed “[i]ls retrouveront partout le feu & le génie de l’Auteur du système sur la pesanteur universelle, & de la mathématique universelle, qui, comme on sçait, aime à faire jouer son imagination sur les paradoxes & les idées singulieres.” Granet, “[Review of the] Troisième Lettre Philosophique,” *Reflexions sur les ouvrages de littérature* 3 (Paris: Pierre Gissey, 1737), 139.

⁹⁹ Granet, “[Review of the] Troisième Lettre Philosophique,” *Reflexions sur les ouvrages de littérature* 3, no. 6 (Sept. 1737) (Paris: Pierre Gissey, 1737), 137: “Mais ce Roman est très-mal ajusté: quelque vive que soit l’amitié de M. D***. pour l’Auteur des Lettres philosophiques, il n’est guere vrai-semblable qu’il se déchaîne si ouvertement contre l’un des Auteurs des Observations qui ne l’a jamais attaqué. Sous le masque de M. D***, on sent un autre Auteur véritablement piqué de quelques plaisanteries.” Granet also listed Castel as the author and Despars as the “père adoptif” in the index of the third volume of the *Réflexions*.

letter.¹⁰⁰ Castel might still have been closely involved in its writing, but this correction suggests he may in fact have had a supporter.¹⁰¹

Something ought to be said at this point about the practice of writing anonymously in the Republic of Letters and about the problems this practice poses to the historian trying to interpret a quarrel like this one. Anonymity was a very common journalistic practice in the seventeenth and eighteenth centuries. Authors, reviewers, and even publishers adopted it for a number of good reasons. It could be used, for instance, as a security measure, as in the case of illegal or controversial publications. It could be a way to diminish the risk of reprisals on the part of a reviewed author, either by making it difficult to trace back a critic or by making it hard to connect a reviewed work to its author. Most importantly, anonymity (and pseudonymity) was a fashionable guesswork game serving the social function of telling apart those who belonged to the club from those who did not. But when the game turned into a house of mirrors, confusion arose — and not just for the historian and contemporary outsiders.

Castel was an adept of this game, as many of his writings and other quarrels attest.¹⁰² The three *Lettres philosophiques* illustrate the peculiarities of this writing and crit-

¹⁰⁰ Granet, “Nota,” *Reflexions sur les ouvrages de littérature* 4, no. (Paris: Pierre Gissey, 1737), 24.

¹⁰¹ The demonstration of the weight of fire was certainly written with the *Traité de la Pesanteur* in hand, and several passages of the letter certainly sounds like Castel’s own. It is too easy to imagine Castel like his detractors depicted him: a man of paradox and an isolated eccentric who advanced theories no philosopher would endorse. In reality, Castel was not without supporters.

¹⁰² Interestingly enough, in the context of the quarrel over his system of the tides, Castel expressed his aversion toward authors of the *Mercure* who challenged him under the cover of anonymity; see his “Lettre du Pere Castel, jésuite, a M. de la Roque, écrite à Paris, le 9 juin 1725,” *Mercure de France* (July 1726): 1537-1539). This did not prevent him from frequently making use of this device. Aside from his reviews in the *Mémoires de Trévoux*, which were anonymous by the journal’s policy, it is worth reminding the reader that he used one of his pupil’s name — a certain Guioit — to respond to Saurin’s critique of the *Mathématique universelle*, covered his name with stars (***) in his critique of Cartaud de la Vilate’s *Essai sur le Goût*, debated with himself on French music as an “Academicien of Rouen writing to

icizing practice. Indeed, the quarrel's structure was a complicated mirror-game. It began with a first unsigned *Lettre* (by Castel), which referred to the theory of an unnamed philosopher (Castel), in response to rumors propagated by an anonymous newspaper article of the *Gazette de Hollande*. The first *Lettre philosophique* was then reviewed by a number of anonymous critics (Desfontaines, Boistel or Pariet Despars) who probably, but not necessarily, recognized Castel as their target. A second anonymous letter appeared (also by Castel), supposedly written by a friend of the author of the first letter. Reviewers (Desfontaines, and now Granet) showed they were not fooled by this trope by suggesting connections between the author of the two letters and the well-known author of the *Mathématique universelle*, without actually naming him. Things got trickier with the *Troisième lettre*, depending on who was thought to have written what, and with what degree of sincerity. The critics who responded to Despars had the last words of the quarrel, but they were unsure about who they were responding to.

Besides providing an illustration of the publishing and criticizing practices of early eighteenth-century journalists, the quarrels helps us outline Castel's network and that of his detractors. The discussion has brought to light a number of shadowy figures, all of whom related to one another by trade or by interest. To these men, one could add the printers and booksellers who were in league with the authors. All of these friends and foes belonged to Castel's world and serve as a reminder that his idiosyncrasies and difficult character did not condemn him to solitary confinement.

The content of the quarrel also offers insight into the differing contemporary views on natural philosophical authority. We see that Castel considered himself a natural

an Académicien of Bordeaux," and published an anonymous — though easily identifiable — refutation of Rousseau's *Second Discours* without the consent of the Parisian Jesuit censors (see chapter 6, below).

philosophical reference — a physicist-geometer — whose reputation and expertise entitled him to the respect of his reviewers. His critics, who were men of letters interested in “speaking about science,” but who did not “speak science” (to borrow Castel’s expression) did not see things that way.¹⁰³ They confronted him on natural philosophical grounds, but injected derision into otherwise solid arguments between competing authorities. While *reviewers* had little to lose in this particular polemic, Castel’s reputation was at stake. At a time when the public was taking an ever increasing part in intellectual debates, the question arose as to whether “dilettantes” should be allowed to deride the works of “experts.”

It is also worth pointing out that it is around the time of the quarrel— when he was at the height of his fame, but also most vulnerable to attacks — that Castel began to privilege polemical pamphlets, fugitive pieces, and the “shredded letters” (a reference to short epistles intended for serial publication in periodicals) over large books. His concerns were that the public was no longer interested in reading massive volumes and that he needed to adapt to his readership’s taste in order to get his message across.¹⁰⁴ This was not a complete break from his earlier strategy: Castel had authored fugitive pieces in the 1720s just as he would continue to publish books in the 1740s and 1750s. But between his earlier and later works, his argumentative strategy underwent a shift, becoming less

¹⁰³ Castel, *Seconde lettre philosophique*, 2.

¹⁰⁴ Castel expresses this concern most clearly later in his life, in the “Lettre[s] sur le Proverbe qui dit pescher en eaux troubles,” Ms. 15743 (7v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. “Ce n’est je crois plus la mode de faire des Livres, depuis que les manteaux de cheminés des dames sont devenues les Bibliothèques des Messieurs, ou en arrivant au premier coup de diner ils vont prendre le Livre du jour, c’est a dire la feuille courante, dont il lisent le titre, tandisque Madame à sa toilette en develope le fonds en un mot et demi, l’autre demi mot etant pour la femme d’atour.” See also Castel, “Plan d’impression,” Ms. 15747, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels, published with a critical commentary in *Autour du Père Castel: Études sur le XVIIIe siècle*, vol. XXIII, edited by Hervé Hasquin and Roland Mortier (Bruxelles: Université de Bruxelles, 1995), 153-159, esp. 153-154.

systematic, less “geometrical,” and ever more “historical.” The quarrel of the *Lettres philosophiques* was the last time, to my knowledge, that Castel (through Despars) presented his physical theories about fire, circulation, and the action of man as parts of a system — a reflection not only of the fact that systems were becoming increasingly unfashionable in France, but also that he had realized that his oeuvre would be better served if he adapted it to the literary taste of the public.

Concluding Remarks

Influenced by late seventeenth-century “luminaries” like Bayle and Fontenelle, eighteenth-century writers like Castel adapted long-standing anti-astrological tropes to flatter the taste of their contemporaries. The specific objections they raised against the alleged empire of the stars on Earth were, on the whole, less damaging than the derisive tone with which they relegated astrology — along with alchemy and natural magic — to the rank of “vulgar” superstition. Ironically, a similar deployment of ridicule would strike down Castel’s own anti-astrological work.

In April 1737, when the second round of the quarrel was already well under way, the *Mercur de France* published another anonymous response to the *Lettre philosophique*, which took the form of an *Arrest Burlesque* — a mock royal proclamation issued by the Sun to all his subjects.¹⁰⁵ This satirical piece announced the Sun’s outrage after having heard that one of his subjects had dared “to degrade Him” by challenging His prerogative as universal warmth-giver, by denying His dominion over volcanoes and mines, and by suggesting the existence of another sun, a usurper hidden within the

¹⁰⁵ “Arrest Burlesque sur une Lettre Philosophique pour rassurer l’Univers, &c.,” *Mercur de France* (Avril 1737): 724-726.

earth.¹⁰⁶ For these and other reasons, the *Arrest* ordained a retraction under penalty of imprisonment in the cold jails of the moon — the same prison where Copernicus had once languished for claiming that the Sun is a prisoner of His own estate.¹⁰⁷ In other words, the burlesque implied that Castel was a lunatic. Unless, of course, it was his detractors's indignation that was being mocked.¹⁰⁸

¹⁰⁶ Ibid., 724-725: “[U]n de nos Sujets auroit osé dans un libelle intitulé, *Lettre Philosophique, &c.* chercher à nous dégrader, et auroit, au grand étonnement de tous les Philosophes Phisiciens et des divers Peuples qui nous sont soûmis, voulu nous dépouiller de nos plus plus beaux droits et des fonctions, prérogatives et privileges dont nous jouissons depuis un temps immémorial, et donc la pleine possession ne nous avoit jamais été contestée ni par Platon, Aristote et autres que nous aurions créés les Connoisseurs et Spéculateurs de nos vrais attributs, ni par Descartes, Newton, Leibnits et autres que nous aurions élevés dans la suite aux mêmes Charges et Dignités. Cependant, malgré des Titres si sûrs et si évidens, ledit Auteur n’auroit pas laissé de s’en prendre à nous, et de vouloir que nous ne fussions pas cause des variations irrégulieres qui regnent dans les Saisons pour le froid ou le chaud qui s’y fait sentir ou plus tôt ou plus tard, suivant que nous l’avons déterminé, sans que la régularité de notre cours puisse nous priver de ce droit; qu’il ne nous fût pas permis non plus d’aller au delà des Tropiques, quand bon nous semblera, et cela parce que depuis six mille ans nous n’aurions pas eû la curiosité d’y aller, aimant point, ainsi que font tant d’autres Souverains, à nous écarter trop du centre de nos Etats; s’ingerant encore ledit Auteur de fixer les bornes de notre Empire à dix pieds de profondeur sous la surface de la Terre, et voulant élever là les limites de notre Puissance et activité, comme si ce n’étoit pas nous qui allussions porter le feu jusques dans la centre de la Terre et allumer ces Incendies souterrains, dont nous nous plaisons à effrayer nos Peuples Terriens, disant aussi que nous ne faisons qu’ouvrir en nous aprochant, ou laisser fermer en nous éloignant des issues ou comme des especes de soupiraux, d’où s’exalent des vapeurs chaudes et fécondes, propres à animer la Terre et ceux qui l’habitent; faisant entendre ainsi sourdement qu’elle contiendrait dans son centre comme une autre espece de Soleil caché, quoique bien inférieure à nous, qui seroit la source de tous les biens qu’elle ne tient que de nous; voulant enfin, au grand scandale de tous nos bons Sujets, ne nous faire passer auprès d’eux que pour une Lanterne propre à les éclairer, et pour une Pendule qui n’est destinée qu’à leur marquer les heures.”

¹⁰⁷ Ibid., 726: “[N]ous avons ordonné et ordonnons audit Auteur de se rétracter incessamment sous peine d’être enfermé dans nos froides prisons de la Lune, les mêmes où fut détenu si long-temps Copernic, ce fameux coupable qui avoit osé prétendre que nous étions comme enchaîné au centre de nos Etats; mais voulant favoriser de plus en plus ceux qui se montrent les zelés défenseurs de nos droits et de nos privileges, nous les invitons à se rendre au plutôt dans les Lieux qui se trouvent situés sur nos routes ordinaires, afin qu’ils y viennent couronner leurs têtes de nos rayons perpendiculaires et recevoir de nous les chaudes influences dont nous souhaitons de les honorer. Donné au Firmament dans un de nos Palais d’Hyver, l’an 5737. de notre Regne.”

¹⁰⁸ I tend to favor the latter interpretation. The model for this piece was Boileau’s *Arrest donné en la Grand’chambre du Parnasse, en faveur des Maître-ès-Arts, Medecins et Professeurs de l’Université de Stagyre au Pays des Chimère: pour le maintien de la doctrine d’Aristote* (also known as *Arrest Burlesque*). First published anonymously in 1671, Boileau claimed authorship in the 1701 edition of his complete works. He explained that he had written it to prevent the University of Paris from obtaining official support in Parliament for the ban on the teaching of the new philosophy, especially that of Descartes. Written from the perspective of a mock university, the *Arrest’s* support for the ban was obviously satirical. Since the *Arrest burlesque* later published in the *Mercur*e is also written from the perspective of an indignant authority (the same that had led to the condemnation of Copernicus to the “cold jails of the moon”) it is plausible

Castel's unorthodox theory of the tides in the 1720s and his "libel" against the sun in the 1730s helped establish his reputation as a half-reasonable, half-mad philosopher more than it did his natural philosophy. But despite his tendency to get ahead of himself and argue *à outrance*, Castel was no lunatic. What makes his radical rejection of celestial influence difficult to square is that it is easy to read it in a false light, as a retrograde attempt to rescue Aristotelian philosophy (as suggested by his introduction of a form of sub- and superlunary realm divide), or on the contrary, as a monument of Enlightenment dogmatism (as suggested by his excessive anti-astrological sentiment). This false dichotomy pulls Castel back and forth between the camps of the 'Ancients' and the 'Moderns,' and it misrepresents both his project and the context in which he was writing, where no clear-cut camps existed in practice. Castel's appropriation of Aristotelian-scholastic concepts was not the atavistic reflex of a dogmatist. The way he adapted and updated Aristotelian ideas to the knowledge and philosophical marketplace of his day — and hitched them to current events that generated public anxiety — testifies to this truth. His polemical critique of the Cartesian, Newtonian, and neo-Epicurian worldviews should likewise make clear that he was not simply siding with the Moderns against the so-called Ancients. His treatment of rival natural philosophical systems shows that he intended his alliance between ancient and modern ideas to be an original contribution to contemporary debates, even as he elsewhere granted his predecessors a share of the truth. Castel's system of natural philosophy both resonates with and jars our eighteenth-century Enlightenment narratives, but he himself was perfectly at ease in his own time.

the *Arrest* was authored in support of Castel. It is also possible that the author intended to mock both sides of the quarrel.

The quarrel of the *Lettres philosophiques* offered a snapshot of Castel's physical theory twelve years after the publication of his system of the world, as well as a glimpse into the journalistic world in which he both made and defended his reputation. It showed that he was still committed to the discoveries he had made known in the *Mémoires de Trévoux* and in the *Traité de la pesanteur*, but that to make them palatable to a wider audience, he needed to adopt a new strategy: instead of writing a treatise, he used the sensationalistic rumors of a solar anomaly to demonstrate the sobering effect and the usefulness of his philosophy in comparison to that of Cartesians, Newtonians, Epicureans, and Aristotelians. His views synthesized some of their ideas, but ultimately he offered a different perspective on reality — one in which the most striking feature was the central role that mankind played in nature. He was self-consciously participating, in other words, in the process of maturation and consolidation of progress that he regarded as inherent to discovery and which he had always described as rife with obstacles. Briefly touched upon in chapter one, this subject will feature again in the next chapter, which examines Castel's views on the dignity and history of mankind through his latter-day assessment of his own intellectual legacy.

CHAPTER 6

One Man's Dignity

Scripture is the key to everything. I am satisfied with having drawn from geometry and physics what little analysis and spiritual discernment one needs for disembroiling the chaos of history. But I am even more satisfied with having left systems aside a little, to run for substantial facts, both human and divine.
— Louis-Bertrand Castel¹

Castel rarely used the expression “dignity of man,” and when he did, he meant something different from our present usage. In the early eighteenth century, the term “dignity” belonged primarily to the vocabulary of jurisprudence. A dignity was an “honorable quality” attached to a magistracy, a prefecture, an important office, or a charge. It was a mark of one’s preeminent social status and respectability, a title one attached to one’s name (such as “his Excellency” or “his Honor”). By extension, the dignity of an individual could also mean his or her “grandeur, sublimity, majesty, [and] splendor.”² Rarely was it used to denote the intrinsic worth of an individual, let alone as a justification for universal rights, as it does today.

¹ Louis-Bertrand Castel, “Lettre du P. Castel à Mr. l’Abbé Trublet. Paris, 19 mars 1754,” *Abeille du Parnasse* 10, no. 12 (Septembre 1754): 89-92: “L’Ecriture est la clef de tout. Je me sais gré d’avoir puisé dans la Geometrie et la Physique le peu d’analyse et d’esprit de discernement dont on a besoin dans le débrouillement du cahos de l’Histoire. Mais je me sais encore plus de gré d’avoir laissé un peu là les Systèmes, pour courir aux faits substantiels, humains & divins.” This letter, the original of which has been lost, was printed by Jean Henri Samuel Formey (1711-1797), the editor of the journal. Formey was the Perpetual Secretary of the Royal Academy of Science of Berlin between 1748 and 1797. The abbé Nicolas Charles Joseph Trublet (1697-1770), archdeacon of St-Malo, held the charge of Royal Censor for works of *belles-lettres* when Castel corresponded with him. He was involved in the approbation and distribution of Castel’s anonymous *L’Homme moral*, which is the main source for this chapter. See Louis-Bertrand Castel, letter from Castel to Trublet, circa beginning of March 1756, and letter from Castel to Trublet, 10 march 1756, Ms. fr01679 and Ms. fr01689, Waller Manuscript Collection, Uppsala Universitetsbibliothek, Uppsala.

² *Dictionnaire universel français et latin* [dit de Trévoux], 3e ed., s.v. “dignité,” (Paris, 1732); Antoine Gaspar Boucher d’Argis, “Dignité.” *Encyclopédie*, eds. Denis Diderot and Jean le Rond d’Alembert (University of Chicago: ARTFL Encyclopédie Project, 2013), Robert Morrissey, ed., accessed December 2015, <http://encyclopedie.uchicago.edu/>.

That being said, the *idea* of dignity as intrinsic moral worth was well-established in the eighteenth century. For instance, references to man as “the image of God” — a creature endowed with an immortal soul, a breath of the divine, and thus a moral essence setting him apart from the rest of creation — were commonplace. This expression was dear to Castel, who understood human beings to be God’s stewards on earth (a dignity in its own right). Endowed with free agency, men performed something like a constant miracle on behalf of the Creator. Their prerogative was to rule over nature on His behalf; their duty, to till the earth and perpetuate its beauty, its fecundity, and its diversity.

The previous chapters identified Père Castel’s preoccupation with the dignity of man as one of the leading threads of his oeuvre. Indeed, it runs through his discussion of the action of free spirits, his principle of universal lightness and liberty, his projected philosophy of princes, his contribution to pedagogy, as well as his opposition to various forms of physical, mathematical, and especially astro-meteorological determinism. This chapter shows how this concern surfaced again toward the end of his life in the context of his crusade against “the deism of the day.”

For Castel, “deism” was a catchphrase standing for pyrrhonism, anticlericalism, materialism, atheism, and actual deism, all of which he considered implicitly or explicitly dangerous for religion, government, and civilization.³ The root of this evil, he main-

³ In one particularly impassioned passage, Castel defines “le Pyrrhonisme, le Déisme, l’Athéisme” as “la somme totale des monstres & la triple chimere des esprit orgueilleux, enthousiastes, fanatiques & frénétiques presque, qui veulent tout anéantir, arts, sciences, &c.” Castel, *L’Homme moral*, 243. Castel’s hyperbolic use of catchall terms like “deism” must be read as the eighteenth-century French counterpart to seventeenth-century English anxieties about the elusive threat of “atheism,” which “was not only the absolute denial of God [...], but also a host of less egregious dissensions from lesser theological point that were perceived as ‘tending toward’ a denial on the part or all of the orthodox understanding of God’s nature.” See Lawrence M. Principe, *The Aspiring Adept: Boyle and his Alchemical Quest* (Princeton: Princeton University Press, 1998), 202. As these theological dissensions often took the form of mockeries, it followed that “wits” and satirists were also suspect from an orthodox standpoint. See Michael Hunter, “Science and

tained, was *bel esprit*: the fashionable obsession with performative wit that led some philosophers to disregard historical facts (including those of Scripture) in favor of metaphysical bravura and clever turns of phrase.⁴

The taste currently ruling over all literature, both sacred and profane, is but the taste for *bel esprit* or the most rarefied metaphysics (*métaphysique à la pointe de l'esprit*), which is without substance, without fact, without historical foundation, consisting only in ideas, set in the realm of vague possibilities, and assuredly in falsehood. For the world is as it is, and in actual nature, only facts are real and substantial.⁵

Malebranche, Leibniz, Bayle, Fontenelle, Voltaire, Pope, Diderot, Rousseau, and even his friend Montesquieu were all guilty of deploying their literary talent to support subversive hypotheses and imaginary worlds with no bearing on reality.⁶ What these authors had in common was their “philosophical pride” (*orgueil philosophique*), that is, their conceit that they could philosophize without the guidance of history and Revelation. Castel remembered Fontenelle telling him, twenty-five years earlier, that “when [he] wished to write, [he] forgot everything, erasing everything from [his] mind, drawing everything out of [himself].”⁷ More recently, Diderot had made a similar remark: “Mr. d’Alembert and I

Heterodoxy: An Early Modern Problem Reconsidered,” in *Reappraisals of the Scientific Revolution*, ed. David C. Lindberg and Robert S. Westman (Cambridge: Cambridge University Press, 1990), 440-443.

⁴ Bel esprit thus understood corresponds to what Voltaire and others preferred to call “faux bel esprit,” the clever and refined formulation of false ideas. See Voltaire, “Esprit,” *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.*, eds. Denis Diderot and Jean le Rond d’Alembert. University of Chicago: ARTFL Encyclopédie Project (Spring 2013 Edition), Robert Morrissey, ed., accessed December 2015, <http://encyclopedie.uchicago.edu/>

⁵ Castel, “Projet d’impression,” 157: “Le goût régnant dans toute la littérature sacrée et profane n’est qu’un goût de bel esprit ou de métaphysique à la pointe de l’esprit, sans substance, sans faits, sans fondement historique, tout par idées, dans le possible vague, et à coup sûr dans le faux. Car dans le monde tel qu’il est, dans la nature actuelle, les faits seuls sont réels et substantiels.”

⁶ Ibid., 157: “Tout est décharné, désossé, sans corps, sans substance, sans forme même dans toutes les sortes de mondes physiques, moraux, théologiques, qu’enfante le bel esprit de mode: ce n’est qu’abstraction, généralité, possibilité, sentences, bons mots, conceiti, traits, frivolités, bagatelles, pantins, ponpons.”

⁷ Ibid., 157: “Le plus bel esprit que je connaisse, réputé tel du public, me disait, il y a 25 ans et plus: ‘Quand je veux composer, j’oublie tout, j’efface tout de ma tête, je tire tout de moi.’ Les voilà tous, et

will draw out a whole Encyclopedia from ourselves.” Unfortunately for them, the only thing the *beaux esprit* could draw out of themselves was “deism and fantastic worlds.”⁸

Castel believed that the best defense against philosophical deism was the study of history. Accordingly, during the last decade of his life he envisioned the publication of a monumental history of the arts and sciences, the main objective of which was to establish the divine origins of all branches of human knowledge in natural and Scriptural “facts.” This apology for civilization would also have celebrated the achievements of the French nation, the superiority of its character, the antiquity of its laws, and the salutary alliance between its kings and its Church (by opposition to the British nation, for instance, whose vaunted liberties and resulting political instability had given rise to all sorts of heresies).⁹ Last but not least, his history of the arts would carry Jesuit apologetic onto scientific and technical ground, thus turning one of the deists’ best weapons against themselves: their alleged knowledge of nature.¹⁰

pour mieux oublier ce qu'ils ont appris d'ailleurs, ils en prennent le contre-pied, surtout en fait de religion et de gouvernement, se défiant de toutes les manières de penser qui ne sont pas la leur propre et personnelle. Voilà le propre orgueil philosophique.”

⁸ Ibid., 157: “J’objectai il y a 2 ans à un faiseur d’Encyclopédie, homme d’esprit, que je n’aimais pas à le voir remplir des in-folio des découvertes, pensées et paroles d’autrui. Il me répondit, Mr. d’AI[embert] et moi vous ferons voir une Encyclopédie toute tirée de nous-mêmes. Cela n’est que trop vrai pour l’article de la religion. De lui-même, le plus bel esprit ne peut tirer que le déisme, et un monde fantastique tel que celui de Malebranche qui encore voulait qu’on lui donnât matière et mouvement.”

⁹ Castel’s chauvinism was probably fuelled by the rising tensions between France and England, which stood on the brink of the Seven Years’ War.

¹⁰ Castel felt he was particularly well-suited to instill new energy in this apologetic campaign: “La proscription de ce déisme est la propre affaire des jésuites en matière de doctrine. La Soc[iété] y a perdu son crédit. Je ne crois pas qu’il y faille de gros ouvrages. Nous en avons assez de faits, et de bons et très bons. Il faut les dépecer au courant, au gré, au goût, au ton du public en dissertations, en feuilles volantes [...]. C’est le grand but de mes feuilles, pour peu que je les laisse aller, j’ai, je crois, mission et commission pour cela. 1° Je suis jésuite; 2° le R. P. Général, l’écrivait il y a dix ou douze ans au R. P. Frogerais de me faire travailler à des livres des piété. Bonne piété pour moi et ma compétence, la proscription du déisme, hérésie philosophique autant que théologique. 3° je suis dans quatre ou cinq académies comme ces beaux esprits; 4° ils se targuent de philosophie et de géométrie. Dieu merci, ils savent que j’en ai plus qu’eux.” Castel, “Plan d’impression,” 157-158.

This project involved the reorganization and reprinting of Castel's entire oeuvre, a collection he once referred to as *De omni scibili* ("On Everything Knowable").¹¹ Had it been brought to fruition, it would have taken the form of a "swarm" of self-standing yet interrelated brochures, letters, and *feuilles volantes* written for the edification and entertainment of the public. Their sale, he hoped, would allow him to fund a Jesuit academy of geographical and physico-mathematical sciences. This ambitious and ultimately thwarted scheme provided the framework for what Castel *did* publish in the 1750s.

Of all the parts this universal history was meant to comprise, only two found their way into print during Castel's lifetime. The first consisted in an anonymous, two-part defense of French music published in 1754, towards the end of the Querelle des Bouffons and in response to Jean-Jacques Rousseau's incendiary *Lettre sur la musique française* (1753).¹² Although interesting, this intervention can be set aside for our purpose, since its argument was incorporated into a second, more general apology for the dignity of man that was written to refute Rousseau's *Discourse Against the Sciences and the Arts* (1750/1751) and his *Discourse on the Origins and Basis of Inequality among Men* (1755).¹³ Published anonymously in 1756, *L'Homme moral opposé à l'homme physique*

¹¹ This was possibly a reference to Pico della Mirandola's motto. Castel would have known Pico through his *Oration on the Dignity of Man*, which the Florentine humanist meant as an annex to his famous *900 Theses — De omni re scibili* was apparently the motto he placed at the head of this compilation. By the eighteenth century, the expression was proverbial, and sometimes satirical, by adding "and even more."

¹² [Louis-Bertrand Castel], *Lettres d'un academicien de Bordeaux sur le fond de la musique, à l'occasion de la Lettre de M. R. *** contre la Musique Française* (Paris: Claude Fosse, 1754); [Louis-Bertrand Castel], *Réponse critique d'un Académicien de Rouen, à l'Académicien de Bordeaux, sur le plus profond de la musique* (S.l.: s. ed., s. d. [1754]); Jean-Jacques Rousseau, "Lettre sur la musique Française," in *Œuvres complètes* vol. 5, ed. B. Gagnebin and M. Raymond (Paris: Gallimard, 1995), 287-328. For Castel's involvement in the *Querelle des Bouffons*, see Philippe Vendrix, "Castel et la musique: Quelques aspects inédits," in *Autour du Père Castel*, 132-134; Schier, *Louis Bertrand Castel*, 49-51. The Querelle des Bouffons arose in 1752 between supporters of French and Italian music after an itinerant Italian troupe had performed Pergolesi's *La serva padrona* at the Academie Royale de Musique.

¹³ Rousseau, "Discours sur les sciences et les arts," in *Œuvres complètes*, vol. III, ed. Bernard Gagnebin and Marcel Raymond (Paris: Gallimard, 1964), 1-30; Rousseau, "Discours sur l'origine et les

de M. R.: *Lettres philosophiques où l'on réfute le déisme du jour* (*The Moral Man Opposed to the Physical Man of Mr. R.: Philosophical Letters Where the Deism of the Day is Refuted*) delivered a biting critique of Rousseau's method and theses.¹⁴ Joining a chorus of scandalized reviews, it denounced his inquiries into the origins of mankind's moral and social woes as irreligious, politically subversive, and misanthropic.¹⁵ Although Rousseau was Castel's primary target, he was also a pretext for the Jesuit to launch his assault on deism and *bel esprit*.

Studies on Castel tend to neglect *L'Homme moral* and to downplay the originality of its argument.¹⁶ According to Donald Schier, "Castel made it abundantly clear [...] that he was speaking in defense of the established order of things, that he was opposed to any view of life which did not have as one axis the supreme authority of the Church, and as the other the absolute authority of the Crown."¹⁷ Devoting less than three pages to its argument, Schier dismissed it as "only another example of the somewhat weak apologies which were all that the conservative forces in the eighteenth century had to oppose to the more brilliant but superficial reasoning of the *philosophes*."¹⁸ Treating it as an outlier in Castel's scientific career — likely a commission from his superior — he did not see how

fondements de l'inégalité parmi les hommes," in *Œuvres complètes*, vol. III, ed. Bernard Gagnebin and Marcel Raymond (Paris: Gallimard, 1964), 109-223.

¹⁴ [Louis-Bertrand Castel], *L'Homme moral opposé à l'homme physique de Monsieur R***. Lettres philosophiques, où l'on réfute le Déisme du jour* (Toulouse: s.n., 1756). Rather than being released separately, its 42 letters were printed as a single book, making it one of the most substantial responses to Rousseau's controversial works.

¹⁵ Rousseau's rejection of society led to many such accusations of misanthropy on the part of his fellow *philosophes*. See Mark Hulliung, "Rousseau, Voltaire, and the Revenge of Pascal," in *Cambridge Companion to Rousseau*, ed. Patrick Riley (Cambridge: Cambridge University Press, 2001), 57-77, esp. 58.

¹⁶ Instead, scholars have directed their attention towards the rich mine of information it contains about Castel's friendship with Montesquieu. See Ehrard, "Castel et Montesquieu," 69-81; Caccavo, "La correspondance."

¹⁷ Schier, *Louis Bertrand Castel*, 53.

¹⁸ *Ibid.*, 54-55.

it belonged to the rest of his oeuvre. I argue, however, that this book, in fact, deserves full critical attention, not least because of its unusual self-reflexivity. From Castel's perspective, Rousseau was writing not as a moral or political philosopher, but as a bad *physicien* who reasoned from false hypotheses to false conclusions, ignored the historical facts of Scripture, and stripped man of his essential moral attributes until there remained nothing but the physical husk of an imaginary beast man. To Rousseau's alleged materialism, Castel opposed a defense of the dignity of man grounded in sacred history, and because he felt *personally* attacked, an apology for his own oeuvre. Far from being an outlier, *L'Homme moral* was integral to the grand *remaniement* of Castel's works and served as an occasion for him to reflect upon his lifelong contribution to the arts and sciences.

This chapter examines Castel's last battle for the dignity of man by contextualizing and analyzing *L'Homme moral*. The first and second sections provide biographical and intellectual background for the subsequent analysis. More specifically, the first section reconstructs the circumstances that gave rise to and frustrated Castel's latter-day publication project, while the second section examines Castel's views on the history and destiny of mankind and reconciles his outlook on progress with his views on the post-lapsarian decadence of humanity. The third section turns to Castel's refutation of Rousseau's *First* and *Second Discourses*. Finally, the concluding section demonstrates how he interpreted his opponent's work in the light of his own natural philosophy. Indeed, *L'Homme moral* can be read as a retrospective self-assessment of his intellectual legacy.

Scheming in Silence

In the immediate aftermath of the *Lettres philosophiques* quarrel (1736-1737), two things were clear: the universe was not about to end, nor was Castel's career. The following years were, in fact, some of his most prolific, opening with a series of polemical book reviews that culminated with the publication of his *Optique des couleurs* (1740), a synthesis of his research on color theory, and his *Vrai système de physique générale de Mr. Isaac Newton* (1743), a systematic refutation of the *Principia*.¹⁹ Witnessing the consolidation of Cartesian and Newtonian factions as well as an unprecedented rise of public interest in scientific controversies, the turn of the 1740s was a pivotal moment in the re-

¹⁹ Here is a selection of the most important and most easily identifiable "anti-Newtonian" reviews and essays Castel contributed during these years: "[Review of] La figure de la Terre, déterminée par les Observations de Messieurs de Maupertuit, Clairaut, Camus, Le Monnier [...]," *Mémoires de Trévoux* (June 1738): 1282-1307; "[Review of Voltaire's] *Éléments de la philosophie de Newton*," *Mémoires de Trévoux* (Aug. 1738): 1669-1709 and (Sept. 1738): 1846-1867; "[Review of Algaroti's] *Il Newtonianismo per le dame*," *Mémoires de Trévoux* (Jan. 1739): 5-26; "Projet d'une nouvelle optique des couleurs, fondée sur les observations, & uniquement relative a la peinture, a la teinture, et aux autres arts coloristes," *Mémoires de Trévoux* (April 1739) 804-820; "[Review of Fautrière's] *Examen du Vuide ou Espace Newtonien*," *Mémoires de Trévoux* (June 1739): 1145-1153; "Demonstration physico-mathématique de la verité des grands Tourbillons de Descartes, & de la fausseté des petits tourbillons de Mallebranche, contre l'hypothese du Vuide et de l'Attraction," *Mémoires de Trévoux* (June 1739): 1242-1269; "[Review of Musschenbroek's] *Essai de physique*," *Mémoires de Trévoux* (Oct. 1739): 2112-2151 and (Nov. 1739): 2435-2450; "Réfutation de quelques principes de la philosophie moderne," *Mémoires de Trévoux* (June 1740): 1094-1098; "[Review of Castel's] *L'optique des couleurs* [...]," *Mémoires de Trévoux* (June 1740): 1235-1263; "[Review of Gamache's] *Astronomie physique, ou principes generaux de la nature, appliqué au Méchanisme astronomique, & comparés aux Principes de la Philosophie de Newton*," *Mémoires de Trévoux* (Oct. 1740): 1955-1992 and (Nov. 1740): 2193-2209; "[Review of Castel's] *Le vrai système de physique générale de M. Isaac Newton*," *Mémoires de Trévoux* (Oct. 1743): 2584-2630 and (Dec. 1743): 2974-2020. The Jesuit journal also published numerous reviews related to Joseph Privat de Molière's *Leçons de physique*, 4 vol. (Paris: Veuve Brocas, 1734-1738) and his debates with the Newtonian Pierre Sigorgne, some of which may have been written by Castel; see "[Review of Privat de Molière's] *Leçon de physique, contenant les elements de la physique, déterminées par les seules loix des Méchaniques, expliquées au College Royal de France*," *Mémoires de Trévoux* (Nov. 1734): 2044-2080, (Jan. 1738): 5-24, (Jan. 1740): 5-31 and (Feb. 1740): 315-350; "[Review of Sigorgne's] *Examen et Refutation des Leçons de Physique, expliquées par M. de Molieres au Collège Royal de France*," *Mémoires de Trévoux* (July 1741): 1249-1286. See also Privat de Molière, "Leçons de physique expliquées au Collège Roial..." *Mémoires de Trévoux* (Nov. 1732): 1954-1976 and "Observations de M. l'abbé de Moliere [...] Adressée aux Auteurs de ces Mémoires [in response to their review of the *Leçons de physique*'s first volume]," *Mémoires de Trévoux* (Jan. 1736): 169-175. I am excluding from this list a number of pieces authored by Castel that touched on color theory, military topics, mathematics, and geography, etc. The reader will find a more extensive list in the bibliographical appendix.

ception of Newton in France and a propitious one for Castel to release these treatises.²⁰

By the time they were in circulation, he had become one of the most famous and most controversial Jesuit philosophers in Europe.

Things changed between 1746 and 1750. After more than twenty-five years of loyal service, Père Castel lost his position of influence on the *Mémoires de Trévoux* and was forced to withdraw from its board of editors. The precise circumstances in which this took place are unclear. What is known is that the official nomination of Père Berthier as chief editor in 1745 came with a mandate to restructure the journal. This reform replaced the polyphonic journalism of the previous decades with a more coherent editorial line and aimed at curbing polemics. Berthier had one feisty editor in his line of sight.²¹

Castel's humiliating discharge could have come as a relief to him, but it did not.²² His journalistic duties had been time-consuming, preventing him from devoting his ener-

²⁰ This is one of the main arguments of Shank's *Newton Wars*, 343-402. The polarization between the disciples of Descartes and Newton, and the debates that ensued, started at a much earlier period; however, the polemical and public turn that this controversy took around 1740 was quite novel. In the introduction to his *Vrai système*, Castel claims that he had started working on this treatise before even publishing his *Traité de la pesanteur* and revised it ever since, allegedly waiting for Newton to pass away and his halo to fade prior to releasing it publically. The halo did not fade as expected — quite the contrary — but that was just as good an incentive to jump into the fray. Although he undeniably felt more sympathies for Descartes than Newton, he did not spare Cartesian disciples, and he continued to promote his own work as an alternative to theirs.

²¹ Schier, *Louis Bertrand Castel*, 44-46; Pappas, *Berthier's Mémoires de Trévoux*, 24-26, and ff. Castel continued to publish reviews in the journal several years after Berthier's arrival, but his interventions became comparatively few and far between. By the 1750s, Berthier was writing the entire journal almost single-handedly, in effect succeeding Castel as the Society of Jesus's natural philosophical mouthpiece in France. Much to his chagrin, Castel witnessed the journal's stance vis-à-vis Newtonianism shifting from overtly hostile to guardedly neutral with Berthier showing more enthusiasm than his predecessor for experimental philosophy.

²² In his correspondence with Montesquieu, Castel betrays his bitterness when he describes the journal as "villain" and "ignoble." At the same time, he recognized that after having contemplated the possibility of some form of legal action against Père Berthier, he preferred to let go and be relieved of its burden: "Heureusement le R. P. B[erthier] votre ami et le mien m'a aidé à me débarasser de cet ignoble journal qui m'enterroit. Vous vites le Projet d'une guerre que je voulois lui faire enfin ou soutenir contre lui qui m'attaquoit. je laschai, il est vrai cette artillerie. A peine la chose fut faite que voyant nos gens embarrassés entre leur idole et moi, je me désistai juridiquement de toute poursuite en laissant le journal et obtenant

gies to other projects. With more time on his hands than he had had since his transfer to Paris, he was now free to spend the rest of his life teaching, tinkering with his ocular harpsichord, and preparing manuscripts for publication. The problem was that along with his job, Castel had lost his main platform for publication. Without this outlet, the prolific author was more or less reduced to silence, while his pile of manuscripts continued to rise in his cubby-hole.²³

Castel's limited financial resources, combined with the obstacles set by Jesuit censors (*réviseurs*) in Paris, forced him to look for new channels of publication. For a while, it seemed like his recent admission into the ranks of the royal academies of Bordeaux (1746), Rouen (1748), and Lyon (1748) might give him new visibility.²⁴ In the thank-you note he wrote to his correspondents upon learning about his election, he advertised his works-in-progress and promised that many more would come.²⁵ The letter he

main levée pour mes ouvrages a imprimer.” Letter from Castel to Montesquieu, circa 1750, Ms. 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux.

²³ In fact, this “silence” was partly self imposed. In 1756, he would confess to Rousseau: “Et moi, qui par pure raison d’œconomie, & pour ne pas heurter de vrais préjugés, ai trouvé à propos de surseoir à mes ouvrages en grand nombre, depuis quinze ou vingt ans, & qui affecte de me taire totalement, depuis huit ou dix ans, en si beau sujet de parler depuis que vous parlez, je ne me plains de rien, si ce n’est peut-être de ma trop grande circonspection vis-à-vis de vous, & d’un petit nombre de vos pareils, plus précautionnés que vous cependant.” Castel, *L’Homme moral*, 218-219.

²⁴ In the 8 May 1746 entry of the *Registre de l’Académie Royale des Belles lettres, sciences et arts de la ville de Bordeaux où sont contenues les délibérations des académiciens ordinaires*, one reads that Castel has been admitted to the rank of “académicien associé.” Ms. 1696 (2), Fond Lamontaigne, Bibliothèque municipale Mériadeck, Bordeaux. In the 3 March 1748 entry, the *Registre* of the Rouen academy announces that “Le p. Castel fut reçu associé.” B4/1, Archives de l’Académie de Rouen, Bibliothèque municipale François Ville, Rouen (see also C23, which contains a letter from Castel to Le Franc dated 22 Sept 1748 in which the former asks to be considered for election; a letter from Cideville to Le Cat, dated 28 December 1748, warning against the election of a Jesuit; and a letter from Le Cat to Castel, dated 8 or 9 December 1748 congratulating him for his election). The entry of the *Journal de l’Académie des Beaux Arts de Lyon* likewise confirms his election in Lyon. My claim that Castel prepared the ground for his election is based on my attribution of several “comptes-rendus” of these academies’s sessions (or individual academicians’ works) scattered throughout the *Mémoires de Trévoux* in the 1730 and 1740s.

²⁵ For instance, the Académie of Lyon acknowledged the reception of a similar letter in its *Journal*, on 15 January 1749: “Le P. Castel jesuite qui fut reçu Académicien associé de l’Académie le 28 decembre dernier en a écrit une lettre de remerciement adressée au P. Beraud qui l’avoit proposé, dans laquelle il fait une énumération de ses ouvrages.” A letter he addressed to Le Cat and the other members of

addressed to Le Cat and his colleagues in Rouen even flirted with the possibility of joining efforts to launch a collaborative writing project (*corps littéraire*).²⁶ If such collaboration failed, he hoped he might at least be able use his multiple memberships as a warranty against intellectual theft. By sending copies of his discoveries to several academies at once, he would ensure that no single one would appropriate his ideas.²⁷

As it turns out, Castel never shared his work with his provincial correspondents. Instead, he called upon high-born patrons for financial support, including his former pupil Yves Marie Desmarets, Count of Maillebois (1715-1791), who was nominated honorary member and President of the Académie Royale des Science in Paris in 1749. Through Maillebois, he also reached several other high-ranking aristocrats at Court, including the Maréchal de Saxe and the Prince of Conti, who showed some interest in his military theo-

the Rouen academy provides such a list; see C21, Archives de l'Académie de Rouen, Bibliothèque municipale François Villon, Rouen.

²⁶ Letter from Castel to Le Cat, C21, Archives de l'Académie de Rouen, Bibliothèque municipale François Villon, Rouen: "Mais cette unanimité, cette communauté de pensées et de travaux, doit être une chose fort difficile et comme moralement impossible puisque nous avons vu depuis près de 100 ans avorter les plus beaux Projets en ce genre, formés par les sociétés littéraires les plus célèbres, et qui ont d'ailleurs le mieux réussi par la seconde espèce de concert plus libre de divers ouvrages indépendants, faits par les divers particuliers." One of the precedents Castel possibly had in mind was the Parisian Académie Royale des Sciences's project for a general history of the arts and trades, which had been started and aborted several times since 1666.

²⁷ This was particularly important for his treatise on navigation and longitude (now lost). For an account of the misfortunes of this work, see Manuel Couvreur, "Aperçu d'un naufrage," 110-111; Letter from Castel to Montesquieu, Ms. 1868 (72), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux. The latter reads: "Si vous le voulés, si votre, notre academie le veulx je lui enverrai un Prospectus un peu plus explicatif de cette affaire et de mon dessein. Pourquoi ne le voudroit elle pas. Je l'enverrai au meme tems a Lion, Rouen &c. Cela ne les engage a rien qu'a me donner un conseil general et directif de bon sens, d'amitié comme a un membre particulier. Si quelqu'une de ces 3 academies regnicoles ou toutes 3 vouloient se joindre a moi pour demander au Roi ou a toutes les academies un jugement, je ferois tout passer par leur canal, je soumettrois tout d'abord a la primeur de leur revision. Elle n'y seroient en cela que pour juger si la chose merite d'être proposée, comme de simples reviseurs." Castel recounts how he had unsuccessfully tried to submit his discovery to the Royal Society, and then to that of the Académie Royale des Sciences in Paris. With his newly acquired memberships in the provincial academies, he considered simply submitting his solution to the protracted problem to a wider public, and let the latter be the judge of his merit.

ries and his *clavecin*.²⁸ But since Maillebois's largesse did not suffice to overrule his superiors, Castel also turned to his *alma mater* — the Jesuit Province of Toulouse — where another friend, Père Cayron (1672-1754), interceded on his behalf with the provincial father and the College's rector. From there, Castel hoped to orchestrate some grand project beyond the reach — and behind the back — of his Parisian detractors.²⁹

Scholars have noticed this curious episode in Castel's life and discussed limited aspects of the secret project it was supposed to bear out.³⁰ Yet none seem to have fully grasped the scope of what he had in mind. My interpretation of Castel's papers and correspondence has led me to the following conclusion: Forced to withdraw from the *Mémoires pour l'histoire des sciences et des beaux-arts* (*Mémoires de Trévoux*), he decided to erect his own monument to the history of the arts and sciences. This monument was comprised of two parts. On the one hand, he envisioned the foundation of a Jesuit-run

²⁸ In addition to Maillebois, Castel's manuscripts variously mention the Maréchal de Saxe, the Maréchal de Puysegur, and the Prince of Conti. See especially Ms. 15757, Ms. 20753-20756, and Ms. 20758, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels, which contain what remains of Castel's treatise on tactics and a series of dedication drafts. Once again, a thorough study of Castel's actual and desired patronage network would be rewarding.

²⁹ On Pierre-Jean Cayron, SJ (1672-1754), see Yves Castan, "La vie du Père Cayron et la Persistance du Modèle Jésuite en Languedoc," *History of European Ideas* 3, no. 2 (1982): 161-168; Jean Serane, SJ, *Vie du Révérend Père P. J. Cayron, de la Compagnie de Jesus* (Avignon: Chez Niel, 1767); Couvreur, "Aperçus d'un Naufrage," 125. The French Jesuit Archives in Vanves also contain some documents in the Fonds personnel A 1 Toulouse. Cayron exchanged letters with Castel to get feedback on his system of the world; in exchange, he was also offering his advice on Castel's projected writings. Five letters from Cayron (and sadly, none from Castel) have been preserved in Ms. 15751-15754 (16r-39v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. In one letter dated 2 March 1749 in Toulouse, Cayron acknowledges the reception of a prospectus in which Castel had apparently revealed the full scope of an "affair of importance," enjoining him to wait for the election of a new, more receptive Provincial father (expected to take place later that same year) before undertaking anything of that magnitude. Cayron also relayed the advice of R. P. Laroquette, soon to become head of the *Maison Professe* in Toulouse, who was receptive to Castel's project but recommended that he come in person to discuss it (34r-v). In another letter, this one undated, Cayron reveals that Castel sought permission from Rome for what must have been a temporary transfer to Toulouse (38r-v). Yet another letter, dated 26 July (date illegible) in Toulouse, alluded once more to the project and the part that Maillebois in particular was to play in it; the ocular harpsichord, for which Castel had been promised 2000 écus, was apparently part of it; so was his treatise on war and a treatise on imagination (39r-v).

³⁰ See Couvreur, "Aperçus d'un naufrage," 111 and 117-123; Schier, *Louis Bertrand Castel*, 48. Schier suggested that Castel's letters on French music and *L'Homme moral* were both part of his grand design, which I believe is correct.

academy for applied, physico-mathematical sciences like navigation, astronomy, and geography. He referred to this academy as his “Collège Louis 15,” attributed its blueprint to Kircher, and described it as a collaborative enterprise between Jesuit *savants* from different provinces, including data-gathering missionaries stationed around the world. In a letter addressed to Père Joseph Pierre de Bonnécamp (1707-1790), professor of hydrography at the Jesuit College of Quebec, Castel argued that although the Society of Jesus was primarily known for its contributions to “theology, morals, history, literature, and erudition,” its brightest achievements were “mostly in the mathematical and geographical sciences.” Since Jesuits — and missionaries in particular — were the “geographer[s] of the universe,” Castel’s plan was to

perpetually establish (*fonder [...] à perpétuité*) six Jesuits here [in Paris] for the improvement of geography, and the arts and science of astronomy, navigation, and mathematics that depend upon it, and to found just as many in Toulouse or in Montpellier my fatherland, and then three in Lyon, three in Bordeaux, three in Rheims, for a total of about twenty, and if I may thirty, in the style of the Bollandists of Antwerp.³¹

³¹ Louis-Bertrand Castel, “Copie de la Lettre au R. P. Bonecamp du 15 de may 1750,” Ms. Français 13373 (4v), Manuscrits français, BnF, Paris: “J’ai un grand dessein pour la gloire et la perf[ect]ion de la comp[agni]e. Le commun des jesuites ne la connoit que du coté de la theologie, de la morale, de l’histoire, des belles lettres, de l’erudition. C’est surtout dans les sciences math[émat]iques et surtout geographiques qu’elle a brillé. A propr[emen]t parler un jesuite est le geographe de l’univers. Les missionnaires le sont par etat. La plus part des dec.[?] en ce genre viennent de nous. Je veux fonder une academie géographique parmi nous. Kircher en a imprimé un plan il y a plus de 100 ans a Rome. On le lui vola des anglois dis on. Les acad[ém]ies se sont formées sur ce plan. Kircher demontre que nous sommes plus en etat qu’elles de l’executer. Je serois comblé si de vous a moi nous pouvions faire la découverte de ce passage [du nord ouest] ou au moins de cette mer de l’ouest, et des bornes de l’amériq[ue] sept[en]tri[on]ale de ce coté du nord ouest. Il y faut un ho[mm]e d’esprit et d’esprit vif comme vous. N’y allés pas vous meme, mais tachés de trier de bons memoires de ceux qui y vont, et prenés moi pour les mettre en oeuvre. Votre pos[iti]on est dans le juste milieu où il me faut quelqu’un pour me seconder: mon vrai plan est de fonder ici 6 jesuites au moins a perpetuité pour perf[ectio]nner la geographie, et les arts et science d’astronomie, de naviga[tio]n, de math[emat]ique qui en dependent, d’en fonder autant a toulouse ou a mon[pe]llier ma patrie, et puis 3 a lion, 3 a bordeaux, 3 a Rheims faisant une 20ne en tout, et si je puis une 30ne dans le gout des bollandistes d’anvers. Par mes ouvrages bien administrés desormais, car jusqu’ici j’ai tout donné gratis, je vois devant moi de quoi fonder les 6 premieres places, et par autrui de quoi fonder les 6 autres. Les autres pro[vinc]es s’aideront comme elles pourront si je ne le puis. je commencerai par mes deux pro[vinc]es favorites, Paris où je suis, et Toulouse d’où je suis. si entre vous et moi nous faisons cette découverte, alors la cour nous aideroit. j’ai bien ma marine et mes longitudes (ma Boussole s’entend où je crois les tenir plus qu’a demi) qui pourront aussi nous faire aider de la cour.” Castel also mentions his

Perhaps Castel envisioned a network of endowed chairs, along the model of the Royal chairs of hydrography already attached to various Jesuit colleges. This would make sense given his hopes of getting support at Court, as well as his attempted negotiation with the College of Toulouse. Certainly, his objective was to put the Society of Jesus on the Enlightenment map.³² To do so required offering a Jesuit counterpart to large-scale collaborative enterprises, such as those sponsored by the Académie Royale des Sciences and by the Benedictine order (hence the reference to the Bollandists). Unfortunately, the lack of *esprit de corps* and personal rivalries in Paris frustrated his efforts and forced him to maneuver in secret.³³

Castel's collegium never materialized, yet it was one of the main motivations behind the second part of his grand design: the re-edition of his entire oeuvre. A prospectus for this enterprise survived in the form of a "Plan d'impression," which Castel kept to himself and for the eyes of those he trusted most.³⁴ In it he reflected on his writing method, his strategy to deal with censors (*réviseurs*), as well as on the best way to print and market his work. Founding an academy required funds. To get funds, he needed readers.

Collège in his "Projet d'impression," possibly the same prospectus that he sent to Père Cayron in 1749. Castel, "Plan d'impression," 156.

³² Letter from Castel to Montesquieu, 1750, Ms. 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux: "J'ai un dessein utile, glorieux a la France, aux arts, aux sciences. Je veux entre nous forcer les jesuites a servir les arts, les sciences fortes et le Public. Il y faut une fondation de places scientifiques, physico mathematiques, il y faut de l'argent. J'y consacre tout le revenu de mes ouvrages, parmi lesquels il y a de la Marine, de la Boussole, et presque des Longitudes. *Vederemmo.*"

³³ Castel, "Copie de la Lettre au R. P. Bonecamp du 15 de may 1750," Ms. 13373 (4v), Manuscrits français, BnF, Paris: "Croyés moi ne vous fiés qu'à moi. Je vous dis que les jesuites n'ont pas mon zele pour les jesuites, et qu'aujourd'hui le bien et l'esprit par[ticu]lier ont delié tous les coeurs, tenant encore par un fil à la comp[agni]e chacun, mais point trop l'un a l'autre, et chacun à chacun. Les procureurs memes de mission donnent à la cour et surtout à l'acad[émi]e tout ce qu'ils en recoivent, et a moi rien."

³⁴ Castel, "Plan d'impression," 153-159. The original is found in Ms. 15747, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. A revised version of this "Plan" was also used for his "La Clef de l'histoire et des arts, arts surtout d'architecture et d'agriculture, artsmême de magnificence et de goût où, selon les lois de la vraie, bonne et belle nature, on concilie le vrai et le merveilleux de toutes choses," preserved in the same collection, Ms. 15745 (lr- 15v).

Since he could not find enough at court, he had to rely on the broader public.³⁵ The public had a short attention span, however, and would not show interest in his books unless he reshaped them to suit its taste. Castel realized that by cutting his material into small, serial pieces — written in conversational style, such as letters — he stood a better chance of convincing the *libraires* to print and the readers to buy. He calculated, optimistically, that a regular output of brochures could generate enough revenue to cover the printing of additional ones, until the whole enterprise snowballed and allowed him to endow his academy.³⁶

By the early 1750s, Castel reckoned that he had published the equivalent of at least ten quartos in books and articles throughout his career, all of which he could plunder and reshape for his fickle readers.³⁷ He also estimated that he had accumulated enough

³⁵ Letter from Castel to Montesquieu, 1750, Ms. 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux. “Il a six ans que je revis mes troupes [i.e., his books]; et que me trouvant de quoi donner 10 ou 12 assés grands ouvrages je voulus imprimer, mais tout a la fois, voilà la folie. Il falloit de grands secours. J’ai tenté la voye de la Cour, trop foiblement pour y reussir. Enfin je me suis retourné vers le Public, et j’ai vu que je pouvois donner mes ouvrages piece a piece, morceau à morceau.”

³⁶ Castel, “Plan d’impression,” 155. “Chaque feuille peut me valoir 4 louis ou 10 pistoles avec les libraires fr[ançais]. [Je] les gagne et même 6. Sans libraires en faisant les frais moi-même, je puis gagner 20 pistoles et avec le temps, en donnant 2 et 3 feuilles par semaine. À 4 feuilles par mois, c’est au moins 200 écus, et en un an 6000 livres au moins. Je suis assez sûr d’aller à 10000, et même 15 pouvant donner de temps en temps des volumes complets que ces feuilles auront annoncé et ébauché, et dont ils seront comme la nouvelle édition.”

³⁷ This was apparently already under way: “On reimprime ici ma Mathematique en deux volumes in 4. to avec l’addition d’un Dictionnaire geometrique. il y a un volume et demi d’imprimé. On vient d’imprimer a Vienne en autriche mon optique traduite en latin. On traduit tous mes ouvrages imprimés a Dresde. Quelqu’un a recueilli tout ce que j’ai mis dans les memoires et cela pourra faire 4 ou 5 volumes in 4to.” The idea of adapting his work to the taste of the public was not new, witness the quarrel of the *lettres philosophiques pour rassurer l’univers*, discussed in chapter 5. Already in the mid-1720s, Montesquieu had suggested to Castel that small publications would serve him better than ponderous tomes: “[V]ous m’aviés connu il y a 25 ans je ne me connoissais pas moi meme. Vous me conseillate des lors de donner beaucoup de petits ouvrages. Je le pouvois, je le devois, et me voila forcé d’y revenir aujourd’hui.” In the mid or late 1730s, Montesquieu had also offered “de faire tout imprimer en Hollande par le moyen de Mr. le C[ount] de Vanhoé [?], et de m’assurer la vente de 300 exemplaires.” Castel now regretted not having taken the offer; see Letter from Castel to Montesquieu, 1750, Ms. 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux.

manuscripts to produce the equivalent of twelve to fifteen additional quartos.³⁸ These included his physics and astronomy courses,³⁹ a music course,⁴⁰ his treatise on navigation and longitude,⁴¹ his letters of geography, a treatise on war,⁴² a treatise on imagination,⁴³

³⁸ “J’ai la valeur de 10 in-4° déjà publiés soit dans les journaux, soit en ouvrages à part: et j’en avais autant à donner il y a 6 ou 7 ans. Comme je ne sais rien faire, chercher même à imprimer, que la plume à la main, c’est en cherchant à imprimer depuis 6 ou 7 ans que j’ai fait 5 ou 6 nouveaux ouvrages, et j’en ai bien 12 ou 15 à imprimer en autant de volumes in-4° en faisant tous les jours de nouveaux pour trouver la façon de faire aller les anciens non imprimés.” Ms. 15747 (15r), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. Published in *Autour du Père Castel*, 153. Castel gives different estimates in other writings: “j’en ai bien 50 petits de 2, 3 ou 400 pages, et a mesure que j’y mets la main ils foisonne a merveille.” Letter from Castel to Montesquieu, 1750, Ms. 1868 (74), Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux. “J’en ai 40 ou 50 [feuilles] sur la Guerre, plus de 60 sur la religion, le gouvernement, les moeurs et les arts, une vingtaine sur la marine, et 12 sur les longitudes. Cela fait comme 150 feuilles prêtes.” Castel, “Plan d’impression,” 156.

³⁹ An overview of these courses are found in Letter from Castel to Le Cat, C21, Archives de l’Académie de Rouen, Bibliothèque municipale François Villon, Rouen: “Un des principaux que je voudrais imprimer au plutot et desque j’aurai pu le retoucher un peu, c’est une physique complete que je composai il y a 5 ou 6 ans pour des Professeurs de l’université de Paris qui l’enseignent depuis ce tems la. Cette Physique renferme une geometrie abregée mais complete faite exprés sous le nom de Geometrie physique ou j’ai mis cette science abstraite en un stile fort physique, et fort intelligible. On y trouve aussi une mecanique et statique, hydrostatique, aerostatique, geostatique asses completes: asses completes les sciences d’optique et d’acoustique, l’astronomie &c. et tous les Principes des arts mechaniques et liberaux. Voila mon premier ouvrage qui aura plusieurs volumes. J’ai sur la marine divers ouvrages a donner. Ce ne sont pas je crois mes moindres ouvrages. J’y traite asses a fond les 3 parties (science, art et metier) de la marine. Je mets a part un ouvrage sur les Longitudes, dont je me flate actuellement de tenir la Resolution du Probleme important, fort a peu prés.”

⁴⁰ Couvreur regroup several manuscripts on music under the title *Traité de musique*. Ms. 15744, Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. Other music-related manuscripts in this archive, including drafts of a treatise on bell forging, Ms. 15748 (1r-27v), Ms. 20753-20756 (1r-17v, 116r-134r), Ms. 20758 (30r-32v). For a useful overview, see Vendrix, “Castel et la musique,” 129-137.

⁴¹ This treatise has been lost, and with it, whatever method Castel had in mind (though one can be fairly certain that it was not as consequential as he thought). The improvement of navigation and naval architecture more generally was its probable main goal. Castel took interest in the compass (see for instance his correspondence with the astronomer Pierre Bouguer (1698-1758). Bouguer, “Minutier de lettre au P. Castel, à Paris le 14 mai 1747,” C 2/8, Bouguer Papers, Archives de l’Observatoire, Paris [available on microfilm]).

⁴² Multiple drafts of its dedication survived, as well as a several fragments from its core. Castel, “La guerre réduite en art et en règles, en principes et en méthode comme géométriques,” Ms. 15757 (1r-62v), Ms 20753-20756 (135r-152v), Ms. 20758 (25r-29v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. As Couvreur points out, these manuscripts should not be confused with Castel’s posthumous *Exercices sur la tactique, ou la science du héros*.

⁴³ Also lost. Couvreur suggests that Ms. 15755 (18r) from Castel’s papers in Brussels may have once been part of this work. This fragment has been edited as “Traité sur l’imagination,” in *Autour du Père Castel*, 185-186. See also Letter from Castel to Cayron, Toulouse 24 June 1750, Ms. 15751-15754 (36r), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

letters on the ancient history of arts and sciences and on the earthly paradise,⁴⁴ as well as a miscellany of letters on morals, religion, and politics against English deism.⁴⁵ Most importantly, it included his “Journal du clavecin,” also written in epistolary form, which he reserved as the overture for his *opera omnia*.⁴⁶ On paper, the ocular harpsichord symbolized his entire oeuvre: a colorful spectacle aiming to harmonize the arts and the sciences. By metonymy, it stood for the gamut of letters, fugitive pieces, and brochures, whose “music” would be his gift to posterity.⁴⁷

This collection formed a universal history of the arts that consolidated the gradual shift of emphasis that had taken place over the course of his career, from geometry and systematic physics to history and theology:

One could call the collection of my works *De Omni scibili*. Arts and sciences — I have studied them all equally, and I wrote more or less on everything. And since in the last 5 or 6 years, I have ended up studying history, I have since then turned everything to history, and I can speak of everything as a historian — historian of the arts, of the sciences, just as of peoples and empires. And it is precisely because of this that I feel I have arrived at the truth of many things. The only things I know to be true are historical — facts.⁴⁸

⁴⁴ Surviving in the previously cited “Clef de l’histoire et des arts,” Ms. 15745 [1r- 15v]), but also in his “Conciliation naïve et physique du vrai et du merveilleux des arts de l’antiquité. Lettre[s] du P. C[astel] J[ésu]ite à M[onsieur] I[e] C[omte] de M[aillebois],” Ms. 15745 (17r-23r, 25r-26r); Ms. 20758 (10r-24r-v), and his “Lettre au R. P. Berthier sur un passage de Diodore,” Ms. 15756 (1r-16v.), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

⁴⁵ Castel, “Lettre[s] sur le proverbe,” Ms. 15743 (7r- 149v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. Couvreur discusses these and other relevant manuscripts in “Aperçus d’un naufrage,” 107-127, but he does not explain how they belonged to the same general enterprise.

⁴⁶ Castel, “Plan d’impression,” 156 : “C’est par mon clavecin que mes feuilles vont donc commencer. Comme c’est mon ouvrage favori, et l’ouvrage favori du public, il me servira de texte et d’introducteur dans tous mes autres ouvrages. J’ai sur lui la valeur de 20 feuilles toutes faites.”

⁴⁷ Castel draws this analogy in his “Clef de l’histoire et des arts,” 162: “Je viens à vous avec une liasse de papiers de toutes couleurs comme mon clavecin, dont la multitude des touches et la variété des tons et des modes seroient capables, en retardant le plaisir des spectateurs, d’accabler le petit germe de vie qui me reste à développer, si vous ne me permettiés en quelque sorte de jeter toute cette liasse au vent pour éparpiller tant de papiers comme la poussière ou, si vous l’aimés mieux, comme des essains de papillons, de toutes couleurs en effect ; lesquels chenilles, il y a 30 ans, chrysalides il y en a 20, ont eu le tems de prendre des ailes, n’ayant peut être de recommandable que la legereté de leur vol inpromptu.”

⁴⁸ Castel, “Plan d’impression,” 156.

Although geometry, physics, history, and theology coexisted happily throughout his works, his new priorities by the late 1740s were to establish the sacred origins of human knowledge in historical (Scriptural) facts and to contain with it the rising wave of philosophical deism.

Castel's grand project failed. There were several reasons for this, some having to do with obstinate censors and hesitant printers; others with Castel's dissatisfaction with his drafts and the compulsive edits to which he subjected them.⁴⁹ With his health declining fast in the early 1750s, Castel may simply have run out of stamina. Rather than taking flight, the "feuilles volantes" of *De omni scibili* collapsed under their own weight, with the notable exception of his letters against Rousseau's deism. For reasons that will become clear in the subsequent discussion, Castel badly wanted *L'Homme moral* to appear in print, and he therefore saw it through.

Rise and Fall

From an ontological standpoint, Castel, like many of his contemporaries, understood mankind as occupying a privileged place in the great chain of being.⁵⁰ The immortal soul of man placed him above an infinite gradation of lesser animals, plants, and min-

⁴⁹ A survey of Castel's manuscripts at the Bibliothèque royale Albert 1^{er} in Brussels provides ample evidence of this editorial frenzy. Castel himself saw it as an inconvenience: "J'ai comme trop de facilité, soit naturelle, soit acquise. Comme je remanie mes premiers ouvrages imprimés et non imprimés, et toujours des sciences et matières qui me sont fort familières, j'étends, je déduis, j'ajoute, et en retranchant même, je fais de nouveaux ouvrages. Tous les ouvrages d'un auteur ne sont que le même ouvrage retourné. Comme je travaille même dans le neuf, un ouvrage est une mine, une carrière de nouveaux ouvrages. / Il n'est donc presque pas possible que j'imprime un ouvrage déjà fait. En le recopiant simplement, je fais un nouvel ouvrage." Castel, "Plan d'impression," 153. This was another reason for which he decided to print his oeuvre in the form of brochures, instead of in 4°, or even in 12°.

⁵⁰ On the widespread use of this metaphor in the eighteenth century, see Arthur O. Lovejoy, *The Great Chain of Being* (Cambridge, MA.: Harvard University Press, 1936), esp. 183-241.

erals, while his physical nature subordinated him to an infinite gradation of pure spirits. In the fifteenth century, Pico della Mirandola (1463-1494) famously argued in his *Oration on the Dignity of Man* that this middle point was the envy of all creatures, since from it humans could both contemplate the order of creation rationally and experience it physically.⁵¹ According to Pico, the true dignity of man resided in his capability and freedom to either make himself God-like or beast-like. Although he did not share the Neo-Platonic ambitions of the Florentine magus, Castel's account of what mankind could achieve collectively was nothing short of demiurgic. Moreover, his objections to contemporary deism were largely based upon his impression that it degraded man instead of fostering his elevation.

Castel's interpretation of the dignity of man may be usefully contrasted with those put forth by Leibniz and Alexander Pope, whose philosophies Castel came to regard as expressions of fatalism to be rejected alongside other philosophical heresies. In his review of the *Théodicée* (1710), Castel contended that Leibniz's doctrines of *optimum* (the view according to which God had created all that was as it should be, in the best, most rational way) and pre-established harmony (which makes our minds and bodies run parallel courses) set unacceptable limits upon human and divine freedom: "*Optimism*, that of Mr. Leibniz at least, is but a materialism in disguise, a spiritual Spinozism."⁵² Castel's case against optimism extended to Pope's *Essay on Man* (1734), in which the great chain of being featured as a plenitude of interconnected creatures, all fixed in their proper

⁵¹ Giovanni Pico della Mirandola, "Oration on the Dignity of Man" in *The Renaissance Philosophy of Man*, ed. Ernst Cassirer, P. O. Kristeller and J. H. Randall Jr. (Chicago: University of Chicago Press, 1948), 223-254.

⁵² Castel, "[Review of Leibniz's] Essais de théodicée," *Mémoires de Trévoux* (Feb. 1737): 208-209.

place. According to Pope, happiness lay within the reach of those who saw beyond their limited human perspective and recognized that in the greater scheme of things, the divine order of things was good. From Castel's own perspective, arguing that "all is well" amounted to denying the existence of evil, or that evil was a consequence of the Fall. By the same token, it neglected to mention its glorious remedy — Revelation — and therefore condemned men to accept their disgrace as inevitable.⁵³ Despite their best intentions, Leibniz and Pope misunderstood the true dignity of man, which consisted in his freedom to rise or fall from his station.

Closer to Castel's understanding of the dignity of man was Francis Bacon's advocacy for the collective improvement of civilization in his celebrated *Advancement of Learning* (1605).⁵⁴ For Bacon, technical and philosophical knowledge acquired with the guidance of a sound method would elevate the human condition to new heights and mark

⁵³ For a discussion of the *Mémoires de Trévoux's* reception of the *Essay on Man*, and more generally, of Pope's reception in France, see Alessandro Zanonato, *La dispute du fatalisme en France 1730-1760* (Paris: Presses de l'université de Paris-Sorbonne, 2004), 391-397. Despite Zanonato's efforts, Castel's opinion of Pope remain difficult to pin down. The *Mémoires de Trévoux* published several reviews of the *Essay of Man* between 1736 and 1737. The first and most elogious, "[Review of Pope's] *Essay sur l'homme... traduit de l'Anglois en François* [by Mr. Silhouette]," *Mémoires de Trévoux* (June 1736): 1191-1219, was followed less than a year later by a critical letter in two parts, which accused Pope of deism and proceeded to demonstrate how it was implicit in his system. "Réflexions sur le livre de M. Pope, intitulé *Essai sur l'homme*," *Mémoires de Trévoux* (March 1737): 401-235 and (April 1737): 707-723. Another review of a different French translation of the *Essay* appeared soon afterwards, by the same supportive author(s) of the first review. "[Review of Du Resnel's] *Les Principes de la morale et du goût en deux poèmes, traduits de l'anglois de M. Pope*," *Mémoires de Trévoux* (July 1737): 1277-1300. Zanonato attributes the second, most critical intervention to Castel, which makes sense given that it followed his review of Leibniz, in which he alluded to a certain "Mr. P[ope]" as an English deist (Castel, "[Review of Leibniz's] *Essais de théodicée*," *Mémoires de Trévoux* [Feb. 1737]: 221-222) and that several of the arguments laid against the *Essay on Man* in the second review would find their way into Castel's own anti-deistic writings. Yet there are two problems with this attribution. First, the last review specifies that the author of the "Réflexion sur le livre de M. Pope" was not on staff. Second, the style of the first and last review is much closer to Castel's than that of the second. It may be safest to argue with Zanonato that the journal's opinion on Pope was ambivalent and that an initial endorsement was followed by a critical phase as the deist implications of his poem had been laid bare by other critics.

⁵⁴ Francis Bacon, *The Advancement of Learning*, ed. William Aldis Wright. (Oxford: Clarendon Press, 1920). The Latin title of this work, *De dignitate et augmentis scientiarum*, make the connection clearer.

the fulfillment of a millenarian prophecy. Bacon's project was inseparable from his faith in progress and civilization, a faith Castel shared (short of its millenarian associations), as did most of the scientific academies of Europe during the seventeenth and eighteenth centuries. Castel's quest for the empowerment of man over nature, his encyclopedic and pedagogical enterprises, as well as his project for a Jesuit academy all testify to his belief in mankind's capacity to improve, if not morally, at least intellectually.

Castel's clearest expression of this belief was contained in the second volume of the *Traité de la pesanteur*, the little-studied "system of the progress of the human mind" that he offered as a historical counterpoint to the geometrical and physical demonstrations of the first volume.⁵⁵ Tracing the development of his theory of universal *pesanteur* from the muddled insights of the pre-philosophical mind to its most recent Cartesian and Newtonian expositions, Castel showed how the philosophical endeavors of his predecessors all converged toward the elucidation of the true system of the world.⁵⁶ He described the progress of the human mind as a gradual and cumulative process of enlightenment:

No, indeed, a discovery is never but an addition to those of our predecessors. They saw what we see, but they saw it only up to a certain point, and we expand our view a little further. So much work has to be done so that from the darkness we may arrive in broad daylight. First it's a shimmer, then a possibility, then a conjecture, with time a likelihood, a truth, a

⁵⁵ Schier succinctly describes this second volume as "a recapitulation of the progress of the human mind toward the explanation of the universe by the principle of *pesanteur relative*." Schier, *Louis Bertrand Castel*, 75. Castel described it as "le système des progrès de l'esprit humain dans la découverte du Système de la Pesanteur." Castel, *Traité de la pesanteur* II, 9.

⁵⁶ The second volume of the *Traité de la pesanteur* is divided into four parts. The first discusses the pre-philosophical conception of *pesanteur*, corresponding roughly to the uneducated man's understanding of the concept, regardless of his epoch; it also reviews many of the arguments found in the first volume and adds additional evidence for Castel's theory of fire and terrestrial circulation; the second discusses the opinions of ancient thinkers, regrouped according to whether or not they believed in the motion of the earth and in the plurality of worlds; the third part discusses Christian philosophers and contains a very interesting theory of chaos structured according to the rules of Biblical exegesis; the fourth discusses the main modern philosophers who were in one way or other engaged in the debate over the existence and nature of gravity. Appended to the fourth book is a series of chapters refuting Newtonian arguments, which was probably taken from Castel's earlier draft of his *Vrai système*.

[self]-evidence, a proof, a demonstration, and an axiom. And all the degrees have their nuances, and their intermediate degrees, that must be climbed regularly, one at a time, in order to reach the summit.⁵⁷

Another commonplace metaphor Castel used to describe this process was that of maturation. The science of his day took more than two thousand years to ripen, and men like Descartes, Newton, and himself, though brilliant in their own rights, only had to pluck the fruit.⁵⁸

Yet Castel's view of progress was not naïve.⁵⁹ He did not think that the history of philosophy was a passive, straightforward, and necessary ascent from darkness to daylight; war, plague, and other catastrophes occasionally caused important setbacks and regressions. Nor did he think that everything ever uttered by Greek, Scholastic or Modern natural philosophers had its place in the true system of nature. Following Leibniz, he distinguished between the positive and negative assertions of past thinkers. Mistakes in philosophy, he maintained, were generally denials of propositions; positive assertions, in contrast, were rarely 'false' when considered from the limited viewpoint of those who

⁵⁷ Castel, *Traité de la pesanteur*, II, 455-456: "Non, non, jamais une Découverte n'est qu'une Addition à celles de nos Prédecesseurs: ils ont vû ce que nous voyons, mais ils ne l'ont vû que jusqu'à un certain point; & nous étendons un peu plus loin nôtre vûê. Il y a tant de démarche à faire, avant que des ténèbres, on arrive au grand jour. D'abord c'est une lueur, ensuite une possibilité, puis une conjecture, avec le tems une vrai-semblance, une verité, une évidence, une preuve, une Démonstration, un Axiome: & tous ces Degrés ont leurs nuances, & leurs Degrés intermédiaires, qu'il faut régulièrement monter l'un après l'autre, avant que d'arriver au Faîte." This citation not only provides a clear statement of Castel's theory of discovery: it actually provides a typology of eighteenth-century concepts of certainty. The gradation he draws from "glimmer" to "axiomatic daylight" was probably quite representative. It is a useful scale against which to interpret passages where such terms as "conjectures", "truth" or "demonstration" are used against one another.

⁵⁸ In Newton's case, one might even be tempted to say he only had to sit and for the fruit to fall... *Blague à part*, this meant that the recent quarrel opposing the Moderns and the Ancients was therefore moot. Moderns were further up the scale of truth than the Ancients, but they owed their so-called discoveries to the accumulated efforts of their predecessors.

⁵⁹ The accusations of naïveté are captured by this passage from Schier, *Louis Bertrand Castel*, 75: "For Castel was as rigorous in his belief in progress as he was naïve about it. He did not conceive that retrogression was possible. In his view, each philosopher in each generation added his mite of truth to the common fund of wisdom, and none was wholly wrong, and the life of no one of them was wasted. It was the glory of Newton to have assembled these hypotheses, these intuitions, this knowledge into a system, and Castel's task to correct Newton, and to explain the phenomena which had baffled the Englishman."

formulated them.⁶⁰ When scrutinizing the systems of the past, in other words, one had to read them in context.

Castel also believed that the historical analysis of scientific ideas played an active role in the process of discovery.⁶¹ As a *trévousain* journalist, he was by trade a historian of the sciences and the arts. His task was to record and critique scientific and technical achievements on the grounds that achieving historical perspective was integral to natural philosophy and facilitated its progress. The result was “a history unlike all the others that have been given on the subject,” bringing all previous opinions toward a “fixed and precise goal, which may serve as a key to assess and embrace them all from a single viewpoint.”⁶² Unlike traditional Laertian and Plutarchan doxographies, “which are like dry and rawboned skeletons, or even like a confusion of scattered limbs,” Castel structured his history around the concept of *pesanteur* to form “a systematic but animated body, as if [he] undertook to give the spirit of Opinions” rather than simply cataloguing them.⁶³ It is worth noting in passing that he employed a similar language when comparing the organization of his *Mathématique universelle* to that of ordinary geometry treatises, whose

⁶⁰ For instance, denying that the sun is larger than the earth would be mistaken; but the statement ‘the sun is smaller than the earth’ — which one might encounter among common men or some ancient philosophers — is not strictly speaking false, if one qualifies it with ‘relative to an observer on Earth.’ Castel acknowledges his indebtedness to Leibniz in various places, including in his otherwise severe “[Review of Leibniz’s] *Essais de Théodicée*,” *Mémoires de Trévoux* (Feb. 1737): 206.

⁶¹ Inviting others to follow suit and write similar histories of philosophical concepts, one could even argue that he was laying the foundation of a new genre, a kind of philosophical history of scientific concepts that aimed to achieve a better understanding of human progress. Castel, *Traité de la pesanteur* II, 374-375: “C’est comme l’ébauche, je n’oserois dire le modèle d’un ouvrage si nécessaire, que je donne dans ce second Tome; car je ne me flatte pas d’entrer dans tous les détails, & dans toutes les discussions, qu’on pourroit faire en suivant encore de plus près que je ne le fais, les Auteurs, & leurs pensées: Il me suffit d’ériger l’Histoire de la Philosophie en Système.”

⁶² *Ibid.*, 77: “[...] une Histoire fort différente de toutes celles qu’on en a donnée: car sans nous trop embarrasser de l’ordre des tems, & des lieux, notre but unique sera de rapporter toutes les pensées des Anciens à un but fixe & précis qui nous serve de clef pour en juger, & de les embrasser toutes dans un seul point de vûë.”

⁶³ *Ibid.*, 98: “[...] c’est ici un Corps systématique, mais un Corps animé, & comme l’esprit des Opinions que j’entreprends de donner.”

“bodies are without consistence and without connections,”⁶⁴ and again when contrasting his historical approach to the *bel esprit*’s “emaciated, boneless, bodiless, insubstantial, and formless” metaphysics.⁶⁵ These echoes suggest that Castel saw the development of his entire oeuvre as a circulation process and the reprinting of its parts in the form of a universal history as a way to give it a second life.

Castel’s faith in technical and scientific progress was offset by his belief in the post-lapsarian decline of human nature. Though dominant in his mature works, this seemingly pessimistic strand, in fact, runs through his entire oeuvre and cannot simply be attributed to the bitterness or melancholy of old-age (nor was his relative optimism, for that matter, confined to his early works). Therefore one must try to explain how Castel’s conception of the dignity of man reconciled both progress and decline.

Castel interpreted the Genesis account of the Fall literally and historically. He considered “factual” the proposition that the present human condition was due to the curse that God cast upon Adam and Eve and their children for their disobedience. Ever since their expulsion from Eden, humans knew death and shame. Men had to labor for their survival, and women to suffer in childbirth. Adam lived 900 years, but the longevity of his descendants steadily decreased over subsequent generations, especially after the Flood, which had precipitated this decline. Their bodies shrunk too and so did their architectural monuments (witness the Tower of Babel and Noah’s Ark). Original sin also affected their mental faculties. Adam had known the true names of all living beings and, therefore, their essence. Such knowledge faded with the Fall, and with it the original reli-

⁶⁴ Castel, *Plan d’une mathématique universelle*, 7: “[...] un corps sans consistance & sans liaison.”

⁶⁵ See note 6 of the present chapter.

gion, as the early men lost sight, with a few exceptions, of the light of Revelation. Pagan idolaters of the past and savage peoples in the present both testified to the corruption of their heart. Replacing God's original teachings, a myriad of false rites and deities and fables had plunged mankind into depravity, until at last God made Himself man and brought new light onto the world.⁶⁶

For Castel, as for many sacred historians of the seventeenth and eighteenth century, God's curse extended beyond the physical, intellectual, and spiritual decline of humanity to include the very nature of the globe. Prior to the Fall, the earth yielded its fruit effortlessly; now it was barren and full of thorns and had to be tilled. Fertility came at the cost of sweat and blood.⁶⁷ From a hospitable garden over which man had complete dominion, nature had turned into a hostile environment, requiring men to deploy feats of ingenuity to address their fundamental needs. All the great arts of humanity — clothes-making, agriculture, herding, masonry, metallurgy, navigation — were discovered and

⁶⁶ This overview of Castel's understanding of the Fall is pieced together from several of his works, including the *Traité de la pesanteur*, *L'Homme moral*, "La Clef de l'Histoire et des arts," and most importantly, his so-called "Lettre au R. P. Berthier sur un passage de Diodore," which was probably written in the late 1740s; see Ms. 15756 (1r-16v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels. This dissertation was to be part of Castel's universal history of the arts, but it apparently originated in his attempt to convince his colleague Père Bro[t]tier? to recover the lost work of R.P. Claude Sicard (1677-1726) on the ancient Biblical monuments of Egypt, where the latter had travelled as a missionary. The *Lettre* mixed reflections and calculations on the origins of man and civilization, on the Biblical curse, and on the size of cities and urban planning of ancient cities. It was not strictly related to Diodorus Siculus, except insofar as the later believed that life had its origins in the swamps of the Nile: "Nous partons toujours du point, selon moi, impie de ce Diodore de Sicile qui fait eclore les hommes des marais du nil, d'abord serpents, grenouilles ou têtards, et hommes enfin. Encore y a-t'il là un air de tradition saine, mais dégradée; Dieu, mais Dieu meme ayant tiré l'homme du Limon, et l'ayant paitri, figuré de ses mains, et animé de son souffle immediat" (3v). It goes without saying that Castel could draw from countless sacred histories, theological disquisitions, and erudite treatises on pagan antiquity to substantiate his views on the origin and the Fall of mankind. His sources included the works of Bossuet, Rothin, Guyon, which he mentions on various occasions, as well as Huet and Lafitau. Other influences would have included English natural theologians and historians of the earth like Burnet, Woodward, and Whiston, and possibly authors writing in the *prisca theologia* tradition. On the related topic of Castel's Babelian speculations, see Nadine Vanwelkenhuyzen, "Du Jardin des délices au désert des Tartares: variations du père Castel sur l'origine des langues," in *Autour du Père Castel*, 139-147.

⁶⁷ Castel, *Traité de la pesanteur* I, 619.

brought to perfection by the first generations of men out of necessity.⁶⁸ But even these arts had diminished over time just as the great civilizations deep antiquity — Babylon and Egypt for instance — had dwindled in size, population, and splendor.⁶⁹ The history of humanity, for Castel, played out on a downward slope.⁷⁰

It is significant that thirty years before Castel began addressing these theological questions directly, the first volume of his *Traité de la pesanteur* already concluded with a reminder of the Biblical curse.⁷¹ Indeed, his physics were intimately connected to his theological interpretation of the human condition. The physical consequences of the Fall coincided with those of universal *pesanteur*. Indeed, the blind weighing action of nature was the efficient cause of the weight of years and of the suffering that accompanies it. Thanks to *pesanteur*, “sight grows weak, the ear goes dull, the tongue stutters, lips tremble, teeth fall; a thousand humors pour down into our legs; catarrhs besiege the entire body; nerves go stiff; ice spreads throughout our limbs.” Just as the crack in a wall announces the general collapse of a building, “everything down to the furrows on our brows announce the approach of our demise.”⁷² Death, God’s punishment for Adam’s disobedi-

⁶⁸ Castel, “Lettre au R. P. Berthier,” Ms. 15756 (1r-1v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels.

⁶⁹ Castel, “Lettre au R. P. Berthier,” Ms. 15756 (3v), Fonds Van Hulthem, Bibliothèque royale Albert 1er, Brussels: “Depuis la Malediction de la Terre, tout est dégradé comme de con[cert?] La nature dégradée a dégradé l’art, et l’art a dégradé la raison, notre orgueilleuse raison, d’autant orgueilleuse qu’elle est plus dégradée [...]. Nos villes sont donc dégradées et de toute façon, en grandeur, en magnificence, en dessein, execution, en régularité, en beauté, en commodité, en propreté, en air, en lumière, &c.”

⁷⁰ On this “declensionist narrative” and historical pessimism in seventeenth and eighteenth centuries, consult Henry Vyverberg, *Historical Pessimism in the French Enlightenment* (Cambridge, MA.: Harvard University Press, 1958). Vyverberg focuses primarily on canonical and lay authors of the Enlightenment, but his argument “that a belief in progress was neither the exclusive focus nor the one logical consummation of Enlightened French philosophy, and that historical pessimism too had its roots deep in the ‘philosophical’ movement itself” applies just as well to Castel (i).

⁷¹ Castel, *Traité de la pesanteur* I, 621: “La Terre sera maudite dans ton travail, dit Dieu, *maledicta terra in opere tuo*.”

⁷² *Ibid.*, 441: “Non non, ce n’est pas par une seule infirmité que l’âge accélère nôtre rüine, & déploie les semences de nôtre mortalité: la vûë s’affoiblit; l’oreille s’émousse; la langue bégaye; les lévres

ence, was from a natural philosophical perspective a gradual phenomenon beginning at the time of birth, when nature first begins to separate constituent parts of the body according to their relative weight and slowly returns it to the earth from whence it came.

But Castel's system of the world was twofold. Universal *pesanteur* was counteracted, and perhaps ultimately caused by, a principle of lightness. One must recall that lightness originated in the action of free spirits. Men grew and stayed alive by freely suspending the action of nature; they prevented their buildings from collapsing through regular repairs; they regenerated and preserved their mind and bodies by ingesting food, building shelters, making clothes, and tilling the land — in other words, by opposing spiritual levity to physical gravity. This “operation of the earth” was also the means by which the world, though still impoverished by comparison to the garden of delights, preserved its diversity, fertility, and beauty.⁷³ “To operate the earth [...] is, I think, to draw out by means of the arts this wealth of riches, this variety of forms, this swarm of beauties, or marvels, or rarities, the seed and germs of which God himself and God alone has spread during the first six days of creation.”⁷⁴ In his “Journal du clavecin,” Castel described the post-lapsarian state as a shift from major to minor key; a state of loss, no

tremblent; les dents tombent; milles humeurs se jétent sur les jambes; les caterres assiégent le Corps entier; les nerfs se roidissent; une glace se répand dans tous nos membres; tout jusqu'aux traits sillonnés de nôtre visage annonce nôtre prochain trepas. Dans un Edifice, toutes les parties se démentent [sic!] de concert; les fondemens, le fâtes, les murailles, les plancher, les voûtes, tout croule, si nous n'avons soin de le réparer, de le relever.”

⁷³ See chapter 2, above.

⁷⁴ Castel, “Lettres d'un Académicien de Bordeaux en faveur des arts à loccasion des Paradoxes de Mr. R. contre toute sorte de Littérature,” Ms. 15 743 (1r-2v and 3r-4v), Fonds Van Hulthem, Bibliothèque royale Albet 1er, Brussels. For a modern edition, see Louis-Bertrand Castel and Raymond Trousson, ed., “Deux Lettres du P. Castel à propos du Discours sur les sciences et les arts,” *Essays on Diderot and the Enlightenment in Honor of Otis Fellows*, 140 (1974): 297: “Operer la terre, operer la nature, operer un jardin, c'est je crois par les arts en tirer ce fonds de richesses, cette varieté de formes, cet essaim de beautés, de merveilles, de raretés dont Dieu meme et Dieu seul y en a repandu la semence et le germe aux premiers six jours de la creation.”

doubt, but one that did not prevent men from playing music and perfecting the arts and sciences with humility within the bounds of a fallen world.⁷⁵

Thus Castel's views on historical decline did not contradict his belief in the possibility of moral and intellectual progress. Just as he was confident that Christ's atonement on the cross granted salvation to all who freely embraced the teachings of the Catholic Church, so too did he believe in the redemptive qualities of divinely sanctioned arts and sciences. On the most fundamental level, he thought that the action of man actually had an impact on the world in the same way good deeds had an effect on spiritual health. While embracing the truth of Jesus Christ might bring one back into a state of grace and ensure salvation, the physical and intellectual restoration of mankind took place through the cultivation of the land and the improvement of the arts. Put differently, the Church was essential to one's heart and soul, and so the arts to the body and the mind. It was this analogy, I believe, that justified Castel's use of the history of the arts as a weapon against philosophical deism.

Against the Deism of the Day

Castel's biblical and providential interpretation of the origin and destiny of mankind was one of many competing views in the eighteenth century. Some, like the Jansenists, believed that men were irremediably corrupt, standing no chance of redemption

⁷⁵ Castel, "Journal du clavecin," 53v: "La nature des choses est diminuée, affoiblie, enervée, infirmée. Tout le jeu de l'univers comme celui de l'arc en ciel et de la Musique est monté dans le mineur [...]. Toute la nature, tous nos arts, tous nos organes, tous nos sens, toutes nos facultés portent le deuil de leur première perfection. Tout est maudit entre nos mains et autour de nous. Tout est en discorde, et en dissonance. / Il me semble que voilà la clef de la Physique, et de toute science et de tout art, et que si l'on veut on pourra désormais faire de vrais systemes, de vrais arts, de vraies decouvertes, en le prenant toujours sur le mineur, sur le diminutif, dans le ton le plus bas, au lieu que nous avons le fol orgueil de vouloir toujours le prendre sur le haut ton, et dans le grand de notre première origine dont notre ame conserve en elle même une sorte de souvenir."

without God's arbitrary bestowal of grace; for them, history was a process of decline. Others like Bayle and Fontenelle maintained, somewhat less pessimistically, that history was in a state of perpetual flux or cyclical rises and falls. Then there were those like the abbé de Mably (1709-1785) and Etienne-Gabriel Morelly (1717-1782), who viewed history as a process of progressive regeneration.⁷⁶ The most controversial among them proposed naturalistic accounts of men's origins that followed the physical and moral evolution of our species through a series of stages, from a primitive state to a more advanced level of civilization.⁷⁷ These views were often coupled with heretical notions: Pelagian denial of the Fall, materialistic explanations of the soul, revisions of ancient chronologies, or even claims that God — or at the very least religious institutions — were human inventions. Such full-blown heresies remained relatively rare, yet Christian apologists like Castel felt that they represented a threat and actively sought to nip them in the bud by denouncing all historical inquiries into the origins of man that deviated too freely from Scripture.

Castel paid particular attention to works that implied a materialistic progression from a state of nature to that of modern society. He was concerned with *beaux esprits* who used the figure of the *sauvage* (wild man) as an example of unadulterated virtue and as a means of undermining — willingly and foolishly — man's God-given dignity and

⁷⁶ See Vyverberg, *Historical Pessimism*, 54-61, which discuss theories of historical "regeneration."

⁷⁷ A classical source for this type of speculation was Diodorus Siculus, *Bibliotheca Historica*, Book I, ch. 7-8; Among the modern thinkers who proposed controversial theories about the origins of life, see Benoît de Maillet, *Telliamed ou Entretien d'un philosophe indien avec un missionnaire français sur la diminution de la mer, la formation de la terre, l'origine de l'homme* (Amsterdam: L'Honoré et fils, 1748).

with it the pillars of Christian civilization.⁷⁸ It is at this junction that we must turn to Rousseau, whom Castel regarded as the most recent and most boisterous “convert” of this sect. Needless to say, Castel’s interpretation of Rousseau tells us as much about himself as about Rousseau’s alleged “deism” and “materialism.”

The Genevan-born musician, novelist, and philosopher Jean-Jacques Rousseau (1712-1778) needs no introduction, yet this familiarity is an obstacle to our understanding of Castel’s response to his early works. Remembered today as the *enfant terrible* of the Enlightenment, a prodigy who scandalized his contemporaries with paradoxes, yet seduced them with unmatched eloquence, the celebrated author of the *Nouvelle-Héloïse*, of the *Emile*, of the *Contrat Social*, and of the *Confessions* bears little resemblance with the young man Castel first befriended, and then declared his enemy.⁷⁹

In the Fall of 1741, an as-yet-unknown Rousseau moved to Paris with the hope of making a name for himself. He carried fifteen silver *louis* in his pockets, the draft of a play, a new system of musical notation, and several letters of recommendation from the abbé de Mably.⁸⁰ One of them was addressed to Père Castel. Settling down at the Hotel Saint-Quentin, rue des Cordiers (not far from Louis-le-Grand College), Rousseau possi-

⁷⁸ See Michel de Montaigne, “Des Cannibales” in *Les Essais*, 2n ed., ed. Villey-Saulnier (Paris: PUF, 1965), 202-214; Bernard le Bovier de Fontenelle, *De l’origine des fables* (1724), ed. J-R Carré (Paris: F. Alcan, 1932); François Cartaud de La Vilate, *Essai historique et philosophique sur le goût* (Paris: s.n., 1736); Maillet, *Telliamed*; not to mention Rousseau’s *Discours sur l’inégalité*.

⁷⁹ For a succinct introduction to Rousseau’s oeuvre, consult Patrick Riley, “Introduction: Life and Works of Jean-Jacques Rousseau (1712-1778)” and George Armstrong Kelly, “A General Overview,” in *The Cambridge Companion to Rousseau*, ed. Patrick Riley (Cambridge: Cambridge University Press, 2001), 1-7 and 8-56.

⁸⁰ Gabriel Bonnot, abbé de Mably (1709-1785), was the brother of the famous Abbé de Condillac and distinguished philosopher in his own right. Rousseau had met him in Lyon during his stay there en route toward Paris.

bly made the acquaintance of the Jesuit in one of the nearby cafés. Their encounter, it turns out, proved instrumental to the young man's career.⁸¹

In his *Confessions*, Rousseau recounts that a year or so after his arrival, he was still looking for a protector. Thanks to some friendly connections, he had managed to get an audience at the Académie Royale des Sciences, where his *mémoire* on musical notation was read, but received with less enthusiasm than he expected. Disappointed and seized by a kind of lethargy, he was sleepwalking through his days when he ran into Père Castel, who inspired him with the following advice: "Since musicians [... and] savants won't sing with you in unison, change chords, and go see women; you may have more success there [...] Nothing gets done in Paris without women [...]." To make sure he was well understood, he issued the following warning: "[Women] are like curves; wise men are like their asymptotes, ceaselessly getting closer to them, but never touching them."⁸² Being asymptotically familiar with the Parisian salons himself, Castel then took the liberty of putting in a good word with some of his female acquaintances, who showed interest in the young man and soon brought him under their protection. Thus a Jesuit could later

⁸¹ The account of Rousseau's encounter with Père Castel can be found in most biographies of the former, and inevitably draw from his *Confessions*. Jean-Jacques Rousseau, *Les Confessions de J. J. Rousseau*, in *Œuvres Complètes*, vol. 1, ed. Bernard Gagnebin and Marcel Raymond (Paris: Gallimard, 1959), 283 and 288-289. *L'Homme moral* confirms Rousseau's version, but omits most of the details of the anecdote (1-3). For a scholarly account of Rousseau's arrival, see Maurice Cranston, *Jean-Jacques: The Early Life and Work of Jean-Jacques Rousseau, 1712-1754* (Chicago: University of Chicago Press, 1982), 156 and ff.

⁸² Rousseau, *Confessions*, 288-289: "J'entendais ainsi tranquillement la fin de mon argent, et je crois que je serais arrivé au dernier sou sans m'en émouvoir davantage, si le P. Castel que j'allais voir quelquefois en allant au café, ne m'eût arraché de ma léthargie. Le P. Castel était fou, mais bon homme au demeurant: il était fâché de me voir consumer ainsi sans rien faire. "Puisque les musiciens, me dit-il, puisque les savants ne chantent pas à votre unisson, chez de corde et voyez les femmes. Vous réussirez peut-être mieux de ce côté là. J'ai parlé de vous à Madame de Besenval, allez la voir de ma part. C'est une bonne femme qui verra avec plaisir un pays de son fils et de son mari. Vous verrez chez elle Mme de Broglie, sa fille, qui est une femme d'esprit. Mme Dupin en est une autre à qui j'ai aussi parlé de vous: portez-lui votre ouvrage; elle a envie de vous voir, et vous recevra bien. On ne fait rien dans Paris que par les femmes. Ce sont comme des courbes dont les sages sont les asymptotes; ils s'en approchent sans cesse, mais ils n'y touchent jamais." See Cranston, *Jean-Jacques*, 158, 160-161.

boast to have facilitated Rousseau's integration into the more worldly circles of Parisian society.

Castel's first impressions of Rousseau were positive. Indeed, he recognized himself in the young man's "frankness and naïveté" and believed that the respect was mutual.⁸³ When he heard, several years later, about the *Discours sur les sciences et les arts*, and then read the *Lettre sur la musique française* and his *Discours sur l'inégalité*, Castel felt personally betrayed. Interpreting these works as invectives against learning, French taste, and the sacred institutions of the *ancien régime* respectively — in other words, against all that *he* stood for — Castel decided Rousseau had fallen prey to the deism of the day and turned into an enemy of humanity. Accordingly, Castel took upon himself to refute him and, hopefully, bring him back to reason.⁸⁴

The frustrations Rousseau experienced trying to maneuver in sophisticated Parisian society found a first major outlet in his *Discours sur les sciences et les arts*.⁸⁵ This prize-winning essay, submitted for the *concours* of the Academie de Dijon in 1750 and published in 1751, both seduced and scandalized its readers. It brought Rousseau fame almost overnight and elicited such a vigorous public response that the *Mémoires de Tré-*

⁸³ Castel, *L'Homme moral*, 1-2: "Vous avez mérité tout à fait cette amitié par la façon franche et naïve dont vous vous prétentiez à moi en arrivant à Paris il y a peut-être douze à quinze ans, et il me parut que vous étiez content de la franchise et de la naïveté avec laquelle je répondis à la vôtre, jusqu'à vous donner entrée auprès de quelques personnes distinguées capables d'honorer votre mérite et de récompenser votre talent." Rousseau's appreciation of Castel, no doubt inflected by their subsequent conflict, was that the Jesuit was "mad, but at bottom still a rather good man." Rousseau, *Confessions*, in *Œuvres Complètes* vol 1, 288-289.

⁸⁴ I am deliberately leaving aside the *Lettre sur la musique française* and Castel's response to it (see note 12 of the present chapter). A proper treatment of these texts would require a thorough survey of the Querelle des Bouffons as well as a discussion of Castel's musical theory, which is impossible within the bounds of this chapter.

⁸⁵ The full title of this work runs: *Discours qui a remporté le prix à l'Académie de Dijon en l'année 1750. Sur cette question proposée par la même Académie: Si le rétablissement des sciences et des arts a contribué à épurer les moeurs.*

voux feared it would last “as long as the siege of Troy.”⁸⁶ Rousseau’s *Discours* argued, against the expectations of most readers but in conformity with well-known classical tropes, that far from having purified European *mores*, the revival of learning witnessed in the previous centuries in the Latin West had had a corrupting effect.⁸⁷ In the first section of the essay, Rousseau observed that progress in the arts and sciences was often accompanied by the moral and military decline of civilizations, while people who resisted the allurements of the arts tended to remain physically and morally virtuous. This was not a mere coincidence, he maintained, but a strong correlation observed throughout history with the regularity of a moon-tide cycle.⁸⁸ Shifting from history to philosophy, the second half of the *Discourse* attempted to establish a causal link between the two phenomena. The main thrust of his argument was that by making men idle and by instilling in them a taste for luxury, the arts led to decadent taste and to the physical and moral weakening of all citizens. Life in Paris, where concern for appearances ruled supreme, was emblematic of such decadence. Beneath the masquerade of civilities, there lay a nest of

⁸⁶ It should be pointed out that the prize was awarded not so much for the content as for the style and persuasiveness of the dissertation. For two recent takes on the reception of Rousseau’s winning entry, see Jeremy L. Caradonna, “Chapter 4: Dijon Revisited” in *Enlightenment in Practice*, 118-142 (Caradonna uses the quote from the *Mémoires de Trévoux* as one of chapter 4’s epigraphs); Raymond Trousson, *Jean-Jacques Rousseau jugé par ses contemporains: du Discours sur les arts et les sciences aux Confessions* (Paris: Honoré Champion, 2000), 11-57.

⁸⁷ Rousseau, *Discours sur les arts et les sciences*, in *Œuvres complètes* vol. 3, 9: “Où il n’y a nul effet, il n’y a point de cause à chercher: mais ici l’effet est certain, la dépravation réelle, et nos âmes se sont corrompues à mesure que nos sciences et nos arts se sont avancés à la perfection.”

⁸⁸ *Ibid.*, 10: “L’élévation et l’abaissement journalier des eaux de l’océan n’ont été plus régulièrement assujettis au cours de l’astre qui nous éclaire durant la nuit que le sort des mœurs et de la probité au progrès des sciences et des arts. On a vu la vertu s’enfuir à mesure que leur lumière s’élevait sur notre horizon, et le même phénomène s’est observé dans tous les temps et dans tous les lieux.” Given Castel’s own theory of the tides, which acknowledged the correlation between the ebb and flow of the sea and movement of the moon, but denied the moon its causal agency, one wonders what he might have thought of Rousseau’s analogy if he had read the discourse directly.

hypocrites, cynics, and pyrrhonists, as well as unjustified moral and political inequalities.⁸⁹

Castel drafted a response to the *Discours sur les sciences et les arts*, which survived amidst other papers for his history of the arts.⁹⁰ This critique hinged on Rousseau's cavalier treatment of historical evidence: "Mr. R. fixes his attention too much on the objects of his frustration (*chagrin*) and does not give enough consideration to the essential circumstances, which alone are capable of characterizing them. He does not draw the history of the subjects he handles."⁹¹ Castel agreed with Rousseau that purely speculative sciences and arts of luxury *could* be detrimental to society; all sciences indeed ought to find their application and utility, lest their practitioners and beneficiaries become idle.⁹² He also conceded that the arts and sciences "do not sufficiently banish vices and flaws from society, that they often only compensate or cover them up, and that they even occa-

⁸⁹ Still, Rousseau concluded his essay by admitting — it was in his interest to do so! — that under the proper guidance of royal academies such as that of Dijon, learning could take a turn for good. His views, in other words, were not as bleak as his critics made him sound. Rousseau, *Discours sur les arts et les sciences*, 26-30.

⁹⁰ Castel and Trousson, "Deux lettres," 292-301. Castel wrote this response after having read Rousseau's *Lettre sur la musique française*, a polemical pamphlet published in 1753 that formulated a similar attack on French taste in music and triggered its own set of responses from the Jesuit, who thereby became involved in the *Querelle des bouffons* opposing proponents of Italian and French music. See [Castel], *Lettres d'un academicien* and [Castel], *Réponse critique d'un Académicien de Rouen, à l'Académicien de Bordeaux, sur le plus profond de la musique*. As for the first *Discours*, Castel claimed to have read it only through the responses of its critics. He must have felt confident enough that his refutation was on target since he eventually recuperated its ideas in *L'Homme moral*.

⁹¹ Castel and Trousson, "Deux lettres," 299: "Mr. R. fixe trop son attention sur les objets de son chagrin, et ne prend pas assez garde aux circonstances essentielles seules capables de les caracteriser. Il ne fait pas assez l'historique des choses qu'il manie." The passage goes on: "Il ne les manie qu'en littérateur, et les prend trop à la lettre en effect. Il veut caracteriser la France, les François par la musique, par les arts; au lieu de caracteriser notre Musique et nos arts par nous mêmes. Or il ne peut nous caracteriser nous memes que par notre histoire."

⁹² This preoccupation with "practice" was a component of Castel's shift from theoretical system to the mechanical arts. It was one of the structural features of his *Mathématique universelle*, which, from top to bottom moved from the abstract to the concrete, from theory to application, from metaphysics to history. It was also reflected in his increased interest in fabricating his ocular harpsichord.

sion particular ones that are the refinement of those they seem to proscribe.”⁹³ But unlike Rousseau, Castel did not see vice as the outcome of learning, but as a consequence of men’s vanity and ignorance (respectively the cause and consequence of the Fall). Instead of arguing that the arts corrupt taste and mores, he attributed this effect to underlying historical circumstances and to the character of the nation and individuals that cultivated them. The state of the arts in Paris, for instance, was not itself the cause of decadence; rather, the decadence of Parisian society led to frivolous arts.⁹⁴

At that point, Castel did not go so far as to accuse Rousseau of “deism.” He did contend, however, that the main flaw in his argument was his complete disregard of *sacred* history. The arts had their origin in God’s teaching and to associate them with corruption was to ignore their sanctity. The sciences and the arts may in some circumstances “corrupt men in particular,” but they “correct humanity as a whole.”⁹⁵ Moreover, no institution ensured the collective “correction” of mankind better than the Church, whose historical ties to institutions of learning were undeniable. Moral and intellectual education had always been associated with priests, who were the “learned (*docteurs*) of nations” and who needed “science” to perform their office. Everywhere “civilized states and Christian princes in particular” had also founded institutions to promote the sciences and

⁹³ Castel and Trousson, “Deux lettres,” 298: “Et j’imagine de meme que dans son Discours contre les Lettres, les Sciences et les Arts, Mr. R. n’a voulu dire non plus, si ce n’est qu’elles ne bannissent pas assez de la societ e bien des vices et des defauts, qu’elles ne sont souvent que les pallier ou les couvrir, qu’elles en occasionnent meme de particuliers qui sont le raffinement de ceux qu’elles semblent proscrire.”

⁹⁴ Moreover, not all that seemed corrupt and frivolous in France grew from a rotten core. Castel suspected that Rousseau’s Calvinist background and gravity of character made him insensitive to French ‘lightness,’ that is to say, the tendency to take matters lightly and display an air of nonchalance when tending to serious and not-so-serious business. *Ibid.*, 299. This was, incidently, a thesis he developed more fully in his unpublished “Lettre[s] sur le proverbe qui dit Pescher en eaux troubles.”

⁹⁵ Castel formulates this thesis in *L’Homme moral*, in a section that refers back to Rousseau’s first *Discours*: “[S]ur quoi j’avancerois cette th ese, que les Lettres, Arts & Sciences, corrigent les hommes en grand, & les corrompent peut- tre en petit, en d tail” (233). Castel claimed that, time allowing, he would write a demonstration of this thesis, no doubt as part of his history of the arts.

the arts, while on a smaller scale, every father's duty was to ensure the proper upbringing of his children.⁹⁶ The implication was that priests, princes, and household patriarchs, the traditional triumvirate of early modern society, were divinely sanctioned purveyors of knowledge.

Rousseau's "revolt against all forms of learning" was not only contrary to Castel's most profound convictions, but also potentially dangerous: "to undermine the sciences, the unique Principle or universal instrument of a good education in all civilized (*policés*) people of the universe, both ancient and modern, is to attack *bonnes moeurs* in their roots (*principe*)."⁹⁷ In Rousseau, Castel discerned the critical spirit of seventeenth-century skeptic Pierre Bayle, with the difference that the Dijon Academy laureate was louder and more overtly biting than his (admittedly more insidious and more dangerous) predecessor.⁹⁸ Refuting him, and through him, a host of like-minded *beaux esprits*, was therefore necessary, lest the infection spread.

If the first *Discours* hit a sensitive nerve, what came next fully convinced Castel to intervene publicly. In 1754, Rousseau submitted a second, much more subversive essay to the Académie de Dijon.⁹⁹ Like his previous work, the *Discours sur l'origine et les fondements de l'inégalité parmi les hommes* criticized contemporary institutions. But in-

⁹⁶ Castel draws a list of the historical connections between Church and learning: "1° que selon l'Écriture la science repose sur les levres du Prêtre. 2° que les Prêtres sont partout, chez les payens memes et chez les heretiques et schismatiques, les docteurs des nations. 3° que le service de Dieu et l'Eglise la plus sainte exige de la science. 4° que les Etats policés et les Princes chrétiens ont fondé partout des academies, des colleges, des ecoles. 5° enfin que tous les Peres de famille font élever leurs enfants dans les lettres, dans les sciences ou dans les arts." Castel and Trousson, "Deux lettres," 300.

⁹⁷ Castel and Trousson, "Deux lettres," 301: "[C]'est attaquer les bonnes moeurs dans leur Principe que de sapper les Sciences, Principe unique ou instrument universel d'une bonne education, chez tous les Peuples policés de l'univers, anciens et modernes."

⁹⁸ See Castel, "Comparaison entre Bayle et Rousseau de Genève," in *Esprit, saillies et singularités*, 391-392.

⁹⁹ The contest opened in 1753, but the Academy did not crown a winner until 1754. Rousseau's text was rejected on account of its excessive length and seditious content.

stead of blaming the sciences and the arts for the moral depravity of his peers, Rousseau challenged the enshrined socio-political inequalities of the day by revealing them as humanly rather than divinely sanctioned. It did so by attributing their emergence and legitimization to the contingent process through which mankind had abandoned its original “state of nature” and embraced life in society. Abrasive in tone and unorthodox in content, the argument posed a challenge to secular and religious authorities and dabbled in a number of theologically sensitive issues.¹⁰⁰ Castel answered this challenge with *L’Homme moral*.¹⁰¹

Rousseau began his essay by deliberately setting aside the account of Genesis, in effect substituting his own naturalistic “hypothesis” for original sin and the Fall.¹⁰² “Let us begin by setting facts aside,” he proclaimed in his introduction, “since they do not bear on the question.” Cautious to concede the “historical truths” of Scripture according to which “God himself had drawn men out of the state of nature” by investing them with moral and intellectual faculties, he compared his argumentative strategy to those found in

¹⁰⁰ For a useful analysis of the *Discours sur l’inégalité*, see Jean Starobinski, Introduction to *Discours sur l’origine et les fondements de l’inégalité parmi les hommes*, by Jean-Jacques Rousseau (Paris: Gallimard, 1969), 9-38.

¹⁰¹ Despite Schier's claims to the contrary, Castel's systematic refutation leaves no doubt that he had read Rousseau's *Discours sur l'inégalité*. It was the first *Discours* that Castel claimed to have read only through the criticisms of others. Schier, *Louis Bertrand Castel*, 53.

¹⁰² Here I follow Jean Starobinski's introduction to *Discours sur l'inégalité*, 19-20: “S’il est vrai que, de tous les écrits de Rousseau, celui-ci fait le moins de place à l’exposé des convictions chrétiennes de Rousseau, ce n’est pas seulement parce qu’il est marqué par l’esprit de l’*Encyclopédie* et par l’influence de Diderot; c’est aussi parce que, formulé comme une révélation de l’humain, ce *Discours* est tout entier un acte religieux d’une sorte particulière, qui se substitue à l’histoire sainte. Rousseau recompose une *Genèse* philosophique où ne manquent ni le jardin d’Eden, ni la faute, ni la confusion des langues. Version laïcisée, “démystifiée” de l’histoire des origines, mais qui, en supplantant l’Ecriture, la répète dans un autre langage. Ce langage est celui de la réflexion conjecturale, et toute surnature en est absente. La théologie chrétienne étant abrogée, ses schèmes constituent néanmoins les modèles structuraux selon lesquels la pensée de Rousseau s’organise. L’homme, dans sa condition primitive, émerge à peine de l’animalité; il est heureux: cette condition primitive est un *paradis*; il ne sortira de l’animalité que lorsqu’il aura eu l’occasion d’exercer sa raison, mais avec la réflexion naissante survient la connaissance du bien et du mal, la conscience inquiète découvre le malheur de l’existence séparée: c’est donc une *chute*.”

Cartesian-style histories of the earth. That is, he considered it a heuristic to achieve a better understanding of human nature in general.¹⁰³ This justification was somewhat disingenuous. The assertive way in which he narrated the emergence of human faculties and the establishment of artificial inequalities leaves little doubt that he favored his naturalistic account over Moses's.¹⁰⁴

Castel certainly did not buy Rousseau's disclaimer. This deliberate exclusion of facts was turning into a pattern and was fashioned after a brand of natural philosophy that Castel disliked.

Here is a kind of philosophy which, as a philosopher, I have never understood. Yet it has somehow prevailed in France since Descartes, and Newton has not corrected [this inclination] to reason endlessly and assertively on the basis of obviously and positively false hypotheses, which run directly against the best received history and the most positive facts, to say nothing of faith, tradition, and religion. How are philosophers to be believed, when they say that they seek the truth?¹⁰⁵

¹⁰³ Rousseau, *Discours sur l'inégalité*, in *Œuvres complètes*, vol. 3, 132-133: "Commençons donc par écarter tous les faits, car ils ne touchent point à la question. Il ne faut pas prendre les Recherches, dans lesquelles on peut entrer sur ce Sujet, pour des vérités historiques, mais seulement pour des raisonnemens hypothétiques et conditionnels; plus propres à éclaircir la Nature des choses qu'à montrer la véritable origine, et semblable à ceux que font tous les jours nos Physiciens sur la formation du Monde. La Religion nous ordonne de croire que Dieu lui-même ayant tiré les Hommes de l'état de Nature, ils sont inégaux parce qu'il a voulu qu'ils le fussent; mais elle ne nous défend pas de former des conjectures tirée de la seule nature de l'homme et des Etres qui l'entourent, sur ce qu'auroit pu devenir le Genre-humain, s'il fût resté abandonné à lui-même."

¹⁰⁴ Starobinski is again insightful: "Ainsi, par un transfert de responsabilité dont on n'a peut-être pas assez souligné l'importance, Rousseau présente comme une oeuvre humaine ce que la tradition définissait comme un don originel de la nature ou de Dieu. Création humaine, le perfectionnement du langage articulé; création humaine, l'union durable du mâle et de la femelle; création humaine, la société, la propriété, les règles formelles du droit; création humaine, la morale, sitôt qu'elle se fonde en raison et outrepasse, dans ses prescriptions, le simple instinct de conservation et l'élan obscur de la sympathie. Tous ces développements, certes, supposent des facultés virtuelles, mais ils n'en sont pas l'inévitable réalisation; il n'y a rien de nécessaire, aux yeux de Rousseau, dans le passage de la perfectibilité au perfectionnement, 'l'homme est libre de le vouloir ou de le refuser, ou, à tout le moins, de l'accélérer ou de le ralentir.'" Starobinski, Introduction to *Discours sur l'inégalité* by J. J. Rousseau, in *Œuvres complètes*, vol. III, 24-25.

¹⁰⁵ Castel, *L'Homme moral*, 40: "Voilà, par exemple, un genre de philosophie, que comme philosophe, je n'ai jamais compris, & qui a pourtant comme prévalu en France depuis Descartes, & dont Newton ne nous a pas corrigé, de raisonner à perte de vue avec affirmation sur des Hypothèses évidemment, positivement fausses, & directement contraires à l'Histoire la mieux reçue & aux faits les plus positifs, sans parler de la foi, de la tradition, de la Religion. Et comment les Philosophes veulent-ils être crus, lorsqu'ils disent qu'ils cherchent la vérité?"

Castel simply could not come to terms with Rousseau's paradox. How could facts be irrelevant to the question? What was the point of a philosophical inquiry into origins that did not rely on the historical evidence at hand?¹⁰⁶ Rousseau's attempt to determine the nature of man and the origin of inequality philosophically — that is, to determine it rationally and *a priori*, as one looking for causes, rather than historically and *a posteriori*, as one trying to make sense of effects — led him “from one precipice to a hundred more.” In matters pertaining to theology, it was indeed safer to reason on the basis of tradition and experience than to speculate in vain: “The vast majority of men, including philosophers, only agree on (*conviennent*) effects insofar as they know their causes; but this is almost always impossible in natural and purely physical matters, and complete madness in supernatural matters of religion and faith.”¹⁰⁷ An arbitrary and false supposition such as the denial of the intrinsic moral nature of man led to dangerous consequences — not least of them the risk of social disruption — which men like Rousseau did not foresee because they philosophized without theological training.¹⁰⁸

¹⁰⁶ Ibid., 43-44: “Réellement les Philosophes & les savans Erudits sont a plaindre avec leurs systèmes, de vouloir éternellement deviner les origines de toutes choses, tandis que Moïse nous les donne tout au vrai dans sa Genese ou dans son Pentateuque, & cela sans mystère, sans ambiguïté; & dans son historique le plus simple & le plus naïf.”

¹⁰⁷ Ibid., 252: “Le grand commun des hommes, Philosophes même, ne conviennent des effets, qu'autant qu'ils en connaissent les causes, chose presque toujours impossible dans les affaires les plus naturelles & de pure physique, & tout-à-fait folle à entreprendre dans les affaires surnaturelles de Religion & de foi. Sur quoi, en parlant de vous & de vos questions, toutes de droit & de pure possibilité, selon vous, je disois que d'un précipice vous vous étiez jetté dans cent autres, & qu'une erreur avoironcelé dans votre esprit & sous votre plume des montagnes d'erreurs, des Dédales, des labyrinthes d'erreurs, sans aucune issue pour vous en tirer; votre façon d'esprit & d'argumentation sophistique, vous entravant à chaque pas dans de nouveaux entrelacements, formant de nouveaux embrouillemens, dont vous resserriez les noeuds, à force des les multiplier.”

¹⁰⁸ Ibid., 48-49: “M. R. n'est pas Théologien: il en convient assez, ses pareils s'en vantent même. Ces Messieurs croient que tout est dit, lorsqu'ils ont dit: je suis Philosophe & ne suis pas Théologien. Et tant pis s'ils ne le sont pas. La Philosophie est selon Cicéron même, la science des choses divines & humaines, & c'est par conséquent une Théologie en première instance. / Éternellement la Philosophie profane est en divorce avec la Philosophie sacrée, qui est la Théologie. Éternellement celle-ci reclame contre celle-

Theological errors abound in the *Discours sur l'inégalité*. Perhaps the most obvious was its treatment of the so-called “state of nature” as a purely physical condition. The second *Discours* speculated about what man might have been like in the true state of nature, that is, the condition prior to life in society. Rousseau argued that his predecessors — Grotius, Hobbes, Locke — never painted a true state of nature. Keen on justifying their preconceptions of natural rights, they confused the modern *sauvage* with the original man and inevitably contaminated their “natural man” with features belonging to a life in society, in which corruption and inequalities were already well-established. In order to achieve a more accurate picture, Rousseau stripped humans of their supernatural gifts and examined them first as physical beings, fully formed but in the infancy of their species. He described these early men as animals whose bodies, health, and senses developed in response to their physical circumstances. He also reduced their moral faculties — what distinguishes them from beasts — to freewill and perfectibility (a capacity to improve or change) and the only sentiments to self-preservation and pity. Together, these allowed man to develop his higher faculties and achieve his current state of social organization; but it is also this potential for progress that brought about undesired moral evil and physical decline. Furthermore, this potential actualized thanks to contingent, external circumstances.¹⁰⁹ Then, having established what he meant by “state of nature,” Rousseau proceeded to outline a “probable” sequence of events that accounted for the emergence of inequality proper. These included the full development of memory, imagination, lan-

là, & la Foi même contre la raison. Tout est sacré en quelque sorte comme ouvrage Dieu, & il n’y a de profane que ce que nous profanons. On a beau faire, la foi tient à tout, & tout ce qui n’est pas pour elle est contr’elle à coup sûr: je ne connois que la Géométrie qui soit de pure raison, de pure idée claire & démonstrative.”

¹⁰⁹ Rousseau, *Discours sur l'inégalité*, 131-164.

guage, reflexive reason, self-love, and from there, the emergence of mutual dependence through the specialization of labor, private property, the tyranny of appearances, and finally, the institutionalization of servitude through positive law.¹¹⁰

Interpreting this narrative as an affront to the teachings of the Church — which it was — and to the dignity of man as he understood it, Castel argued that Rousseau’s sole aim was to degrade man to the status of a beast. Why should one want to do so was beyond Castel’s comprehension. Ultimately, he imputed this outburst of misanthropy to nefarious philosophical influences.

[B]ehold the progress of your reasoning, part of which you state out loud, part of which you whisper. From matter comes physical movement; from movement — which pertains to the physical — results the mechanical; the mechanical produces the organic; the organic engenders the living animal, and the animal produces the reasonable, i.e., man, who is not worth much according to you because, absolutely speaking, the reasonable, i.e., man, produces the faithful Christian, the subject, the learned, from whence results the divine, which is the accumulation (*conglobat*), so to speak, of all these things.¹¹¹

This chain of reasoning, which Castel argued must undergird the *Discours sur l’inégalité*, left little or no place for supernaturalism and genuine freedom in the world. The putative existence of a fully formed yet purely physical human being, whose moral and rational life were supposedly emergent properties of matter, had to be grounded in the rejection of Providential history, and in the adoption of irreligious philosophical assumptions about

¹¹⁰ This hypothetical history of the development mankind from a primitive innocence to urban decadence is contained in the second half of the discourse. *Ibid.*, 164-194. Rousseau provides a good summary of this progression midway through his narrative, on p. 174.

¹¹¹ Castel, *L’Homme moral*, 217: “Au besoin, la matière est éternelle & infinie, selon Descartes même. Pour le mouvement, on l’a trouvé, depuis Malebranche, essentiel à la matière, comme Epicure & Spinoza même, & peut-être Bayle aussi l’avoient prévu. Et voilà le progrès de votre raisonnement, moitié tout haut, moitié tout bas. De la matière, sort le mouvement physique; du mouvement, du physique, résulte le mécanique; le mécanique engendre l’organique; l’organique produit l’animal vivant, & l’animal produit le raisonnable, l’homme, qui ne vaut pas grand chose selon vous, parce qu’absolument, le raisonnable, l’homme, produit le fidèle, le Chrétien, le sujet, le Savant, d’où résulte le Divin, qui est le *conglobat*, comme on dit, de toutes ces choses-là.”

matter, movement, and emergence of life in general. Rousseau's "system" seemed founded on the same slippery slope that threatened radical Cartesianism and which led to Spinozism or Epicureanism.

Although Castel and Rousseau both believed that man was better off in his original, natural state than he was now, they disagreed fundamentally on what this state was. For Castel, it was a state of grace and positive virtue. It existed in Eden and was structured around the family unit, and later, kinship. The love of parents for their children was reciprocal and binding, children having a duty to obey their progenitors and forefathers, and all men having the duty to obey the law forbidding consumption of the fruit.¹¹² In contrast, Rousseau's hypothetical state of nature consisted in the amoral life of solitary beasts. His "natural man" — or as Castel preferred to call it, his "physical man" — knew what he knew by imitating other animals among which he lived.¹¹³ When male and female chanced upon one another, they briefly united to satisfy primal urges, but did not do so out of a sense of duty, let alone as husband and wife.¹¹⁴ If they begat a child, its cries dictated the mother's conduct, not motherly love. Perhaps language itself had arisen from infants trying to communicate their needs.¹¹⁵ Imperious by nature, sons and daughters did not owe anything to their parents and were free to do as they pleased once they were old enough to part ways.¹¹⁶ Castel considered this reversal horrific. Not only were they in-

¹¹² Ibid., 169-171.

¹¹³ Where Rousseau spoke of "natural man," Castel preferred the term "physical man." This substitution was significant. Since Castel wanted his reader to regard man as moral *by nature*, "physical man" offered a clearer opposition to "moral man" than "natural man."

¹¹⁴ Castel, *L'Homme moral*, 205-210.

¹¹⁵ Ibid., 82.

¹¹⁶ Ibid., 52 and 169.

sults to human dignity; they were invitations to seditious behavior.¹¹⁷ Rousseau only made things worse by suggesting that free will and man's perfectibility — traditional hallmarks of his dignity — were the necessary ingredients to his perdition — by which he did not mean original sin, but the development of civilized life!

Castel was shocked by Rousseau's characterization of his hypothetical beast-men as good and innocent. The grounds for this assertion seemed to be Rousseau's misconception of the real-world *sauvages* as virtuous beings, who no longer lived in their initial state of nature but nonetheless had remained much closer to that state than civilized men.¹¹⁸ For reasons similar to those expounded in the *Discours sur les sciences et les arts*, Rousseau held their rustic way of life in admiration. Their vices were less damning than ours, their physical health far superior, and their simple mores preferable to urban sophistication. Most of all he valued their liberty. The *sauvage* lived his life among equals, while the life of civilized men was a kind of slavery, defined by artificial social and political bonds that they inherited rather than chose.¹¹⁹

Castel agreed with Rousseau that life within city walls came at the cost of physical softness and artificial ties and obligations; he even admitted that God's primary intention for mankind, after setting Adam and Eve in the garden of delights, could not have

¹¹⁷ Ibid., 172-178.

¹¹⁸ Ibid., 96-97: "Encore aimai-je mieux convaincre ici M. R. d'une simple ignorance de l'histoire et des faits positifs, que de lui faire un crime d'une erreur volontaire, ou d'un raisonnement de mauvaise foi. Ce nom de Sauvage le trompe; il a toujours dans l'esprit ses Sauvages fantastiques, semés un à un dans les forêts, parmi des *troupeaux* de bêtes [...]." Castel suspected that the anecdotes of feral children found in Europe had clouded Rousseau's judgement: "Rien n'est moins vérifié, rien n'est plus apocryphe que ces historiettes-là. Du reste, rien ne ressemble moins à ces Nations, grandes Nation des Sauvages de l'Amérique" (96). By qualifying these nations as "great," Castel referred to their size and their social organization, not to their moral superiority.

¹¹⁹ For more context on Rousseau's idealization of the *sauvage*, consult Stelio Cro, *The Noble Savage: An Allegory of Freedom* (Waterloo, On: Wilfrid Laurier University Press, 1990), 131-150 and more generally, Gilbert Chinard, *L'Amérique et le rêve exotique dans la littérature française au XVIIe et XVIIIe siècle* (Paris: Librairie Droz, 1934).

been for them to cultivate arts and science nor to found cities.¹²⁰ Yet in a post-lapsarian state, urban life was preferable to a wretched existence in the wilderness. Far from feeling that life in society — that religious life even — deprived him of his freedom, Castel considered it the necessary condition for true freedom, which was freedom from the tyranny of instinct, error, and sin. Although Castel had no first-hand experience of the Jesuit missions, he had read and heard enough reports about the *sauvages* of the New World to know Rousseau's idealization for what it was. *L'Homme moral* contained several correctives based upon Jesuit relations — relations Rousseau had consulted and decided to disregard — including gruesome descriptions of the violence and misery that North American tribes inflicted on each other in times of war.¹²¹ In this regard, wild men and barbarians who knew no bounds nor restraints stood below Europeans, and, thus, very far below the original state of nature.¹²²

¹²⁰ Castel, *L'Homme moral*, 118: "Les Villes, pour parler clair, ne sont en quelque sorte que la seconde intention du Créateur: elles sont tolérée & de pure concession." For Castel, the lifestyle that remained closest to the original state of nature was an intermediate state between the degenerate and solitary existence of Rousseau's *sauvage* and the life in crowded cities, namely, that of the Tartar nomad, who lived with his family or clan within tents and who never settled for too long in one place. He likewise greatly admired the life of soldiers (and for that matter, the life of missionaries), who lived simply and with a sense of duty vis-à-vis their kin, and of obedience vis-à-vis their leader. What Castel had to say on this subject can be found in the letters of *L'Homme moral* recounting his friendship with Montesquieu. In these, he explains how he had suggested to his friend that a fourth kind of government should be added to the typology of the *Esprit des lois* (monarchical, republican, despotic), and that this addition should underpin all others, insofar as it was the true state of nature from the others derived. *Ibid.*, 115ff, esp. 125. Castel's fascination with this topic connects to his interest in the art of war and military campaign in particular. Castel may have been the author of the "[Review of Perrin's] Dissertation sur l'origine des tentes et pavillons de guerre," *Mémoires de Trévoux* (Dec. 1735): 2515-2524.

¹²¹ Castel, *L'Homme moral*, 139-143.

¹²² Castel's interest in the *sauvages* and his appreciation for the complexity of their social organization was sparked by Joseph François Lafitau's *Moeurs des sauvages américains comparées au moeurs de premiers temps* (Paris: Saugrain l'aîné, 1724), which he reviewed ("[Review of Lafitau's] Moeurs des sauvages américains," *Mémoire de Trévoux* (Sept. 1724) 1565-1609, (Nov. 1724) 2001-2029 and (Feb. 1725): 197-239) and forwarded to Montesquieu with very high praise: "Je vous envoie le 1er tome du P. Lafitau: je souhaite que vous en soyés content; car je m'intéresse bien autant pour cet ouvrage que pour le mien, et c'est l'estime qui en décide: le système du P. Lafitau m'a ébloui à un point que je ne saurois exprimer" (Letter from Castel to Montesquieu, Paris, s.d. [1724?], Ms. 1868 [66], Fonds Montesquieu, Bibliothèque municipale Mériadeck, Bordeaux). Published in 1724, Lafitau's work was a system of symbolic

Castel indeed regarded the existence of the real *sauvages* as the final stage in a lengthy process of historical degeneration. Some of Castel's clearest statements on the subject are contained in his letters on geography, where he discusses the protracted issue of Native American origins.¹²³ Over a period of two hundred years, the presence of men in America had given rise to a wide range of questions among European scholars: Was America connected to Asia or other continents? Was America known to the Ancients? Was it populated before the Flood? Who were its inhabitants' ancestors? Why, when, where, and by what means did they cross into America? Closely related to these questions was the issue of determining whether they were human, and if human, how they should be treated by colonial authorities. Castel entered the debate obliquely by asking why Europeans who first landed on the eastern shore of the Americas encountered

theology aiming to demonstrate the common religious origins of all customs. After accumulating and sifting through pagan histories, travel narratives, missionary reports, and his own notes — Lafitau established systematic analogies between the customs and religious symbols of the New World's "*sauvages*" and the Old World's "*barbares*." Lafitau hoped he could gain insight into the "earliest times" (*premiers temps*). Moreover, he believed that where Ancient authors had been too terse, New World Indians might be more loquacious, and vice versa. The main motivation for this project was religious. Lafitau wanted to forestall impious attempts to discredit the universal consent argument, according to which all people on earth believed in the existence of a superior deity, in the immortal soul, and in the afterlife, thereby guaranteeing that religion was not a human invention (which is precisely what the so-called 'deists' and 'atheists' were arguing). While some *esprits forts* were abusing the mistaken reports of early missionaries and travellers and pointing to native American nations as counterfactual examples of lawless, godless, yet harmonious societies, Lafitau wanted to show that they, in fact, had laws, mores and customs grounded on religious principles ultimately traceable back to the original Revelation. There is a considerable literature on Lafitau. For solid overviews of his system, see Andreas Motsch, *Lafitau et l'émergence du discours ethnographique* (Sillery, Qc: Septentrion, 2001); David Allen Harvey, "Living Antiquity: Lafitau's *Moeurs des sauvages américains* and the Religious Roots of the Enlightenment Science of Man," *Proceedings of the Western Society for French History* 36 (2008): 75-92. Another important source would have been Pierre François Xavier de Charlevoix's *Histoire et description générale de la Nouvelle France* (Paris: Rollin, 1744), along with host of Jesuit relations and *Lettres édifiantes*.

¹²³ Castel, "Sur l'origine et la dégradation des sauvages et des autres Peuples du double continent de l'Amérique," Ms. 13373 (43r-44v), Manuscrits français, BnF, Paris. The debate on American Indian origins still had purchase in the 18th century, notably among Jesuit scholars. Both Lafitau and Charlevoix reviewed and commented upon this question in their works. For general surveys of the debate, see Lee Eldridge Huddleston, *Origins of the American Indians: European Concepts, 1492-1729* (Austin: University of Texas Press, 1967) and Giuliano Gliozzi, *Adamo e il nuovo mondo: La nascita dell' antropologia come ideologia coloniale: dalle genealogie bibliche alle teorie razziali (1500-1700)* (Florence: Nuova Italia, 1976).

sauvages, while on the western side of the continent, they discovered full-blown empires comparable to those of Europe and Asia. Perceiving a puzzling west-to-east decline in civilization across the entire American continent, he conjectured that the descendants of Sem, one of Noah's sons, must have crossed from Asia into North America in successive waves via some land bridge, such that the first occupants of the Pacific shore had gradually been driven east, by war and scarcity of food, until the whole continent was populated.¹²⁴ In the seventeenth and eighteenth century, migrations — especially forced migrations — were commonly regarded as a cause of civilizational decline. Without the stability of sedentary life, wandering nations face the harshness of nature and thus worry primarily about the essential necessities: finding food and water, shelter, clothes. As a result, the more sophisticated arts and sciences are abandoned and gradually forgotten. The further the remove from the birthplace of civilization, where the arts and sciences were cultivated to a high degree, the more barbaric, ignorant, and morally depraved a nation tended to become.¹²⁵

With hindsight, it is easy to see how Rousseau's early critical writings lay the groundwork for his mature philosophy, which was — on the whole — hopeful and constructive. But readers who did not live long enough to take these later masterpieces into account could respond only to a partial picture — and this picture was bleak. By drawing unfavorable comparisons between the serfdom of civilized people and the free life of the *sauvage* and by suggesting that men were once akin to wild animals, living a rustic yet innocent and blissful existence, Rousseau sounded like a misanthrope to contemporaries

¹²⁴ Ibid., 43r-44v.

¹²⁵ Castel's scheme was probably inspired by Lafitau and Charlevoix's own accounts. These in turn relied on the diffusionist narrative that was common in Renaissance and Early Modern history and geography.

who valued the benefits of city life. By failing to appeal to divine Providence in his historical narrative, he also made himself religiously suspect. Both discourses elicited vigorous objections from the public. Refutations came from the camp of *philosophes* as well as from religious and politically orthodox circles.¹²⁶ As for Castel's response, one finds it inflected both by his commitment to fight impiety and by his sense of being targeted by Rousseau's invective — a mistaken sense perhaps, but one that calls for explanation.

The Moral Man against the Physical

Castel wrote *L'Homme moral* to “convert” and “civilize” Rousseau as a missionary would a *sauvage*. Yet there was more at stake in *L'Homme moral* than the salvation of Rousseau's soul, or even the defense of the dignity of man *in abstracto*. Indeed, evidence would suggest that, as a natural philosopher, Castel took things personally. At stake was also his own dignity.

One of the least appreciated features of *L'Homme moral* is Castel's insistence on treating the *Discours sur l'inégalité* as an instance of bad natural philosophy and its author as a *physicien* inquiring into moral, historical, and theological matters without the requisite training.

Mr. R. always starts from this purely materialistic principle, that a celestial body, a planet or a stone moving in circle around another celestial body or a dexterous hand [i.e., by means of a string] [...] tends to escape by the tangent in a straight line. Now if this principle, which is a tendency rather

¹²⁶ Concerning the reception of Rousseau's discourse, see G. de Reynold, *Jean-Jacques Rousseau et ses contradicteurs: Du "Premier Discours" à "l'Inégalité" 1750-1755* (Fribourg: Imprimerie de l'oeuvre de Saint-Paul, 1904); Trousson, *Jean-Jacques Rousseau*, 13-57, 85-129. The *Discours sur l'inégalité* was condemned by the Church and placed on the Index of prohibited books on the grounds that it denied the original sin and advocated Pelagianism. Several of the objections raised against Rousseau were innocent or deliberate misinterpretations of his argument. For instance, Rousseau did not argue for a *return* to a state of nature, yet many argued that this was the extent to which he was willing to push his misanthropy.

than a law (*droit*), were actually taking place physically, the ruin of the universe would ensue, all things immediately falling back in this way into a state of confusion, elemental discord, or primeval and original chaos [...] such as it would have existed before God said: *‘fiat lux & fiat firmamentum.’*

It is the subordinated society of spirits, hearts, and even bodies that constitutes the physical as well as the moral or theological light and firmament of this universe. In the very order of celestial bodies and planets, there is always a sun or principal planet that governs its vortex, in spite of the tendency that all these bodies have to become the principal one or to recede from it. It is a pity that Mr. R. is a *physicien* up to that point exclusively. There are people who would be better off if they knew nothing but their catechism. A half savant ever preaches ignorance.¹²⁷

Today one hardly associates Rousseau with natural philosophy, let alone with celestial mechanics, and for good reason since he made no explicit claim on the subject. Yet modern disciplinary boundaries occlude some of the implications of early modern science for moral and political philosophy and *vice versa*. Castel, whose mind freely flowed back and forth between the physical and the moral realms, thought that celestial bodies were governed by the same principles presiding over the behavior of men in the polity. The mistaken “materialistic principle” that he imputed to Rousseau must be understood analogically. If Rousseau knew that the stability of the true system of the world — i.e., the twofold system expounded in the *Traité de la pesanteur* — depends on the continued activity of free spirits in the moral realm, he would not have presumed to upset the “subor-

¹²⁷ Castel, *L’Homme moral*, 158-159: “M. R. part toujours de ce principe, purement matérialiste, qu’un corps, astre, ou pierre qui se meut en courbe autour d’un astre ou d’une main adroite, c’est-à-dire, tend à s’échapper par la tangente en ligne droite. Et encore, si ce principe, qui n’est qu’une tendance plutôt qu’un droit, avoit lieu dans le physique même, il en résulterait la ruine de l’Univers, retombant tout de suite par-là dans la confusion, dans la discorde des éléments, dans le cahos primitif & *originnaire*, si l’on veut, tel qu’il pouvoit être avant que Dieu dît: *fiat lux & fiat firmamentum*. / C’est la société subordonnée des esprits, des coeurs, des corps même, qui fait la lumière & le firmament de cet Univers, physique autant que moral & théologique. Dans l’ordre même des astres & des planètes, il y a toujours un soleil ou une planète principale, qui donne la loi à tout son tourbillon, malgré la tendance qu’elles ont toutes à devenir la principale, ou à s’en écarter. C’est dommage que M. R. soit Physicien jusques-là exclusivement. Il y a des gens qu’il feroit mieux qui ignorassent tout, excepté leur catéchisme. Un demi Savant ne prêche jamais que l’ignorance.”

minated society of spirits, hearts, and bodies” and thrown everything into a “state of confusion.”¹²⁸

From Castel’s viewpoint, Rousseau was guilty not only of impiety and seditiousness, but also of ignorance and philosophical carelessness.

You are determined first to disentangle the *artificial man* from the *originary and natural man*. You say you speak of him only like a philosopher, and what is worse, like a natural philosopher (*physicien*); and it is on this account that you propose a problem to be solved. ‘What experiment would be necessary to achieve knowledge of the natural man, and by what means can one conduct these experiments in society[?]’ Do you regard man as an entirely physical being? It seems so, since you invoke only physical experiment to know him, to fathom him (*le deviner*). Yet man is, according to Scripture, the Gospel, and the Catechism — according to experience itself — a wholly moral and wholly spiritual being, whose body and mind are both subordinated to his faith and to all theological (*théologiques et théologiques*) virtues, to moral virtues at least.¹²⁹

By stripping man of his moral attributes and attempting to disentangle the artificial from the natural in him, Rousseau had inadvertently adopted Castel’s method of discernment and turned it on its head. In his “Lettre à M. C.,” Castel argued that a good *physicien* ought to distinguish the purely natural from the irreducibly miraculous or artificial so as to determine their proper object of study. Castel did not refer explicitly to this letter in

¹²⁸ Ibid., 159.

¹²⁹ Ibid., 16: “Votre but décidé, est d’abord de démêler l’*homme artificiel*, de l’*homme originaire & naturel*. Vous n’en parlez, dites-vous, qu’en Philosophe, & ce qui est pis, qu’en Physicien; & c’est là-dessus que vous proposez un problème à résoudre. ‘Quelles expériences seraient nécessaires pour parvenir à connaître l’homme naturel, & quels sont les moyens de faire ces expériences au sein de la Société.’ Regardez-vous donc l’homme comme un Etre tout physique? Cela paraît, puisque vous n’invoquez que les expériences physiques pour le connaître, pour le deviner. L’homme est pourtant selon l’Ecriture, l’Evangile, & le Catéchisme, selon l’expérience même, un Etre tout moral & tout surnaturel, dont le corps comme l’esprit sont subordonnés à la foi & à toutes les vertus théologiques & théologiques, aux vertus morales du moins.” The “expériences” to which he alludes refer to Rousseau’s suggestion that natural philosophers might conduct what we would call social experiments on human beings to understand their origins and nature (see Rousseau, *Discours sur l’inégalité*, 123-124). Castel believed this approach was a dead end. One can isolate man’s body and study its organization in purely physical terms, as the anatomist does, but a natural philosopher that takes man as a living being must consider him in his entirety — body, spirit, and soul — just as a philosopher interested in the study of nature must consider it whole, not merely under the duress of experimental procedures.

L'Homme moral, but he did remind the reader of his *Traité de la pesanteur*, where he adopted the same approach.

[...] since my [...] *Traité de la pesanteur* in 1724, I have half-liberated this physics from the realm of matter, and have associated moralism and liberty — the liberty that you love so much — to mechanism, and lightness, spirit-like, to the gross *pesanteur* of bodies; to the point of recently demonstrating that this lightness is the true and unique physical cause of this *pesanteur*. In a word, I have introduced, with distinction, that moralism in the purely physical, while you endeavor to introduce the purely physical into the purely moral (*moralisme*), to the point of smothering the latter completely. You are therefore my aggressor, and I am only defending myself against you, or from you.¹³⁰

While Castel envisioned the study of the action of free spirits upon nature as opening a new and important quarry for natural philosophy, Rousseau deliberately set aside man's moral and spiritual gifts, only to rediscover them at the end of a long, naturalistic and contingent process of incremental development. In effect, he failed to recognize that man is fundamentally a free cause, subordinated to his faith and to moral virtues — an agent whose action cannot be reduced to a blind mechanism nor to a concurrence of random historical events.

That Castel read Rousseau's *Discours* in the light of his own natural philosophy and saw "a special contradiction" between them is indisputable: "Of all those who med-

¹³⁰ Castel, *L'Homme moral*, 78: "Or vous savez que cette Physique même je lai dès mon premier Ouvrage du *Traité de la Pesanteur* en 1724 affranchie à moitié du règne de la matière, & que j'ai associé le moralisme & la liberté même que vous aimez tant, au mécanisme, & la légèreté comme spirituelle à la pesanteur brute des corps; jusqu'à démontrer, depuis peu, que cette cette légèreté était la vraie & l'unique cause physique de cette pesanteur. En un mot, j'ai introduit avec distinction le moralisme dans le pur physique, & vous vous efforcez d'introduire le pur physique dans le pur moralisme, jusqu'à en étouffé totalement celui-ci. Vous voilà donc mon agresseur, & je ne fait que me défendre contre vous ou de vous." The demonstration here refers to his "Cause tout à fait primitive de la pesanteur expliqué par le P. Castel, jésuite," *Mercur de France* (August 1754): 11-26. His argument was that the cause of gravity, in its final analysis, and quite paradoxically, was lightness; although the *Traité de la pesanteur* argued that pesanteur and lightness were reciprocal actions, intimations of his later insights are present in his interpretation of God's *lux fiat* as the introduction of *universal pesanteur* into the world, the force separating the cosmic chaos — water from land — into its constituent parts.

dle with philosophy, geometry, and physics even [...] I have regarded myself, I admit it, as the most directly attacked by your brutal, bestial, and physical animal men.”¹³¹ Their enterprises, he maintained, were diametrically opposed, for “just as your philosophy brings everything back to the purely physical, the material, or at most, the animal; my physics, on the contrary, brings everything back to the moral, the spiritual, the theological even.”¹³² But if their views were so starkly different, why did he feel the need to draw this parallel?

The answer may lie in Castel’s growing concern with the public perception of his oeuvre. In 1756, people knew him for his ocular harpsichord, but hardly took interest in the rest of his works. Muzzled by his superiors, he had been more or less silent for over a decade. His drawers were still full of works-in-progress and his universal history of arts — let alone his *Collège Louis XV* — nowhere near completion. Had he been granted another decade or two, perhaps some of these projects would have materialized. But at 67, he felt the weight of years and the need to make a final statement — to set the seal, so to speak, upon his intellectual legacy. *L’Homme moral* was an opportunity to do so.¹³³

From his detractors’ perspective, however, Castel’s character was not so different from Rousseau’s. ‘Frivolous,’ ‘paradoxical,’ ‘overly imaginative,’ ‘too prone to polemics and novelties,’ as ‘excessive’ in his critiques of deism as Rousseau was in his attack on

¹³¹ Castel, *L’Homme moral*, 76.

¹³² Ibid., 77-78: “Je veux vous dire sur tout ce que vous savez, je crois, que comme votre Philosophie ramène tout au pur physique, matériel & tout au plus animal; ma Physique au contraire ramène tout au moral, spirituel, théologique même.”

¹³³ The fact that *L’Homme moral* was anonymous does not undermine my interpretation. Castel’s authorship was obvious, and the only reason he wanted it to remain anonymous was to avoid attracting the attention of his Jesuit superiors in Paris, who had not approved its publication: “Je vous prie de ne dire a personne qu’il est de moi comme le sachant, à autant qu’il vous plaira comme le devinant. Je ne me soucie pas qu’on me devine, je ne veux pas seulement qu’on me connoisse, surtout les jesuites. Ils n’en douteront pas: mais il est essentiel qu’ils ne le sachent pas positivement.” Letter from Castel to Trublet, circa beginning of March 1756, Ms. fr01679, Waller Manuscript Collection, Uppsala Universitetsbibliothek, Uppsala.

the arts and sciences: such accusations were not entirely groundless; as Castel himself might have put it, *les extrémités se touchent*. With historical hindsight, one might even argue that Castel was not far off from being a *bel esprit* himself — if not by conviction, at least by virtue of his style.¹³⁴ In fact, it is precisely the ease with which he mingled among and maneuvered against contemporary *philosophes* as a Jesuit natural philosopher that makes him such an interesting window onto the early Enlightenment world.

Distancing himself from his arch-nemesis was essential if posterity was to remember him for what he actually stood for. Castel therefore offered *L'Homme moral* as a retrospective self-assessment of his works, circulating through his previous achievements, as it were, to bring them back to life, and to show how they all participated in the same corpus of “geometrical and historico-theological natural philosophy.”¹³⁵ While Rousseau’s “supposed novelties directly destroy[ed] the arts, the science, the government, the mores, religion, and at last human society as a whole, and therefore God,” his contributions were “very innocent and but purely philosophical, physical, and even geometrical speculations.”¹³⁶ Castel insisted, for instance, that the so-called “novelties” of his ocular harpsichord — of all his ideas, the most scrutinized by critics — had been no more than “additions to the sciences and the arts.” He offered his musical discoveries to the public “as a good citizen,” always mindful to acknowledge his sources and his debts,

¹³⁴ Castel was aware of this similarity, as shown by his “Lettre du P. Castel à Mr. l’Abbé Trublet,” 92: “*Nota* que je vous cite là les deux Auteurs que j’estime le plus [Montaigne and Fontenelle], mais dont (tout franc) je n’ai jamais fait que les tailleurs de l’habit & harnois dont je revêts le corps Physico-Geometrico-Historique que j’édifie de mon mieux.” Castel meant that, stylistically speaking, he admired Montaigne and Fontenelle’s *bel esprit*, but only imitated it to give his own body of work an attractive appearance. In her study of Castel’s aesthetic theory, Corinne Geppner shows how some of Castel’s ideas — his ocular harpsichord in particular — reflected and inadvertently participated in contemporary *libertin* discourse about the senses, pleasure, boredom. Geppner, *Père Castel*, 151-158.

¹³⁵ Castel, “Projet d’impression,” 159: “C’est par ma physique géométrique et historico-théologique que je me crois le plus en état de [...] réfuter tous [les déistes].”

¹³⁶ Castel, *L’Homme moral*, 76.

and he meant his color music as “a doubling of the old music” rather than as a challenge. In this he differed from the author of the *Lettre sur la musique française*, who denied its existence altogether.¹³⁷

Moving from music to physics and mathematics, Castel explained (somewhat disingenuously) that in these fields too he had only endeavored to produce a constructive, conciliatory synthesis of his predecessors’ work rather than creating novelties for their own sake, or worse, for destructive purposes.

I can point out to you that in physics, my novelties have never been other than an increased benefit to the Public, and to ordinary physics. / I have never undertaken to destroy Descartes: no one has truly praised him and made him shine more than I. But I have associated to him a thousand good things which are in Aristotle and in Newton, and even when I refuted Newton, I praised his person and showed his real merit. I have reconciled everything, in order to add a few rather new points of view that make theirs shine brighter. I have returned to physics many of its ancient riches, by lending it new ones.

The historical character of his physics was perhaps one of his greatest sources of pride. He could also say the same of his mathematical works, which he framed historically and organized in a way that was both accessible to all and offensive to none but the purists.

In my mathematics especially, I deprived the public of none of its ancient possessions; I have added a few truths to those of geometry. The easy style that I introduced therein, and which has first offended some geometers,

¹³⁷ Ibid., 219-221: “Je ne le dissimule pas: c’est l’air seul de nouveauté dont on m’accuse un peu, qui m’a sagement imposé à moi-même, une sorte de silence, depuis à peu près vingt-cinq ans que mon clavessin nommément m’a donné ce grand renom, renom, je l’avoue, odieux de nouveauté, de système, d’imagination. Cependant cette nouveauté-là & toutes mes nouveautés sont très-innocentes & de pures spéculation philosophique, physique même & géométrique. / Toutes vos nouveautés prétendues, détruisent directement les Arts, les Sciences, le Gouvernement, les moeurs, la Religion, & enfin la société l’humanité toute entière, & par conséquent la Divinité. Et après avoir tant parlé, vous vous plaignez que ce n’est pas à vous, qu’on permet de parler, et moi qu’on tient comme en arrêt, vis-à-vis de mon clavessin & de mes ouvrages, en me disant pourtant toujours de faire & d’imprimer; je ne me plains de rien: mais j’observe, / 1° Que mes nouveauté, mes ouvrages, mon clavessin ne sont nouveautés, qu’en addition aux Sciences, aux Arts, à l’ancienne Musique, la musique ordinaire, l’auriculaire. [...] 2° J’ai procédé régulièrement & en bon citoyen. Je n’inventai mon clavessin, qu’après voir applaudi aux découvertes de M. Rameau, & en mis le Public en possession. Ma nouvelle Musique ne fut qu’une confirmation & un complément, un *a fortiori*, un redoublement de l’ancienne musique [...].”

has only made this science more popular and multiplied the number of geometers. The algebra, in particular, and the infinitesimal analysis itself, has only received from me increase in truth, clarity, and facility.¹³⁸

However significant his musical, physical, and geometrical “discoveries” had been, Castel considered that his real genius lay in his capacity to find novel views in the old, and to make himself tall by standing upon the shoulders of his predecessors.

The last point is particularly important, in light of the most damning reproach laid against Castel through his life, namely, his pretension that men could impose their will upon the earth like the giants of fables, and the first men of Biblical history. This pretension was occasionally misinterpreted as a measure of his ego, as if he wanted for himself the power he granted to “free spirits” in general. Castel was aware of these allegations and humored them by comparing himself to Alexander the Great who, after having conquered the world, reputedly found it too narrow. “Your pretensions are terrible, mine are grand,” he exclaimed, addressing himself to Rousseau directly.

I have almost said it. I am this spirited Langely (another name for Alexander). But there is no rashness in this. I only have the heart and the ambition of a man in society with all other men. For Alexander wanted to be the sole master of the whole world, while I only want to be so in society with all men, and of God mostly, without even excluding you, Sir [Rousseau], of such a beautiful society.¹³⁹

¹³⁸ Ibid., 222: “[J]e puis vous faire observer qu’en physique, mes nouveautés n’ont jamais été qu’en accroissement de bénéfice pour ce Public, & pour la physique ordinaire. / Je n’ai jamais entrepris de détruire Descartes: personne ne l’a réellement plus vanté & plus fait valoir que moi; mais je lui ai associé mille bonnes choses, qui sont dans Aristote & dans Newton & réfutant même Newton, j’en ai vanté la personne & fait valoir le mérite réel, J’ai tout concilié, pour y ajouté quelques points de vue assez nouveaux, qui font briller les leurs, J’ai remis la physique en possession de bien de ses richesses anciennes, en lui prêtant de nouvelles. / Dans ma mathématique sur-tout, je n’ai privé le Public d’aucune de ses anciennes possessions; j’ai ajouté quelques vérités à celles de la géométrie. Le style facile que j’y ai introduit, & qui a révolté d’abord quelques Géomètres, n’a fait que rendre cette science plus populaire, & multiplier le nombre des Géomètres. L’algèbre nommément & l’analyse de l’infini même, n’a reçu que des accroissements de vérité, de craté, de facilité de ma part.”

¹³⁹ Ibid., 79: “Vos prétentions sont terribles, les miennes sont grandes; non, je ne m’en cache pas / *Le fougueux Langely, qui de sang altéré, / Maître du monde entier, s’y trouve trop serré* / [trans. of Juvenal on Alexandre, transl. by Boileau] Je l’ai presque dit, ce fougueux Langely, c’est moi. Mais il n’y a point de fougue à cela. Je n’ai que le coeur, je n’ai que l’ambition d’un homme, en société du reste de tous les

Whatever Rousseau might think, God had made the world for Himself as well as for man — for “Man-God,” Castel proposed in a daring rapprochement, “proudly for Him, modestly for me.”¹⁴⁰

Castel’s interpretation of Rousseau’s discourses remind us that these texts were more than political or even moral essays. Indeed, they were works of natural philosophy with theological and personal stakes. Castel was not actually a target of Rousseau; nor was the *actual* Rousseau the main target of *L’Homme moral*. Rather, the Genevan misanthrope served as an example of what could go wrong when philosophy is pushed *à outrance* without the yardstick of history. Although Castel thought that Rousseau was too excessive, too loud, too overtly scandalous to constitute a real threat, he hoped that his refutation would cast a shadow on the “metaphysics” of his fellow *beaux esprits*.

One Man’s Legacy

Whether or not Castel intended it as such, *L’Homme moral*, the last work whose publication he directly oversaw, and the only major one to come out of the projected *remaniement* of his oeuvre, was a suitable last chapter to his life. His confrontation of Rousseau threw his own work into relief, and it contained not only a final plea for the dignity of man, but also an apology for himself and what he stood for.

hommes. Car Alexandre vouloit être seul maître du monde entier, & moi je ne veux l’être qu’en société de tous les hommes, & de Dieu même, & sur-tout, sans vous exclure vous-même, M. d’une si belle société.”

¹⁴⁰ Ibid., 79-80: “L’homme tel qu’il est, est le propre règne du moralisme & de la liberté. Laissez-moi ce champ de bataille-là au moins, sauf à moi, je ne le cache pas, d’en faire le champ de bataille du monde même le plus physique, le plus mécanique, le plus matériel. Si faut-il un homme pour remonter la machine à laquelle vous ne faites que l’asserter si indécement [...] Au besoin je ne craindrais pas, M. tous vos Philosophes physiques ou Physiciens, qui voudroient me nier que le monde entier, fait pour Dieu, est fait aussi pour l’homme, l’Homme-Dieu, ajouterois-je tout de suite, fièrement pour lui, modestement pour moi, & pour vous-même qui étant fils & frère de cet Homme-Dieu, entrez, si vous le voulez, en part de sa gloire & de ses intérêts.”

My reading of this “testament,” if I may call it so, leaves us with a different impression of the man than the one handed down by previous scholars. Old age and isolation, it has been suggested, made Castel melancholy, bitter, and defeated.¹⁴¹ Some passages from his later works indeed read as formal disavowals of his youthful projects. In one instance, he even confessed that his over-confidence in his ability to instruct the public and his naive trust in his reader’s willingness to learn in good faith, had been detrimental to the arts and the sciences.

Today science is too widespread, too easy, too widely available. It is within the reach of too many heads that do not have the strength to bear it [...]. For thirty years I have been a journalist. I have put mathematics into a kind of dictionary, and my fantasy has always been to facilitate everything — arts, science, and literature. I thought that I was thereby waging war against half-science, and that I was making everyone fully savant. For every savant I made, I have made three hundred and thirty half-savants, quarter savants, and half-quarter savants; and it has been more than fifteen years since I recognized in good faith that I had failed. For this, I beg the public’s forgiveness.¹⁴²

But was Castel repentant? Considering that a second edition of his *Mathématique universelle* was on its way under the auspices of his collaborator Rondet, and that he himself was still working on his universal history of the arts, it seems unlikely. One must read the previous passage in the context of his strategic vis-à-vis with Rousseau, that is, the parallel he drew between their work and their persona.¹⁴³ Castel’s affected humility was meant to contrast favorably with Rousseau’s rashness. If apology there was in *L’Homme moral*,

¹⁴¹ Schier, *Louis Bertrand Castel*, 48 and 57.

¹⁴² Castel, *L’Homme moral*, 248: “La Science est aujourd’hui trop répandue, trop facile, & à trop grand marché. Elle est trop à la portée de bien des têtes qui n’ont pas la force de la porter [...]. J’ai été trente ans Journaliste. J’ai mis les mathématiques en une espèce de Dictionnaire, & ma fantaisie a toujours été de tout faciliter, Arts, Science & Littérature. J’ai crû par-là faire la guerre à la demi-Science & rendre tout le monde pleinement Savant. Pour un Savant que j’ai fait, j’ai fait trente & trois cens demi-Savants, aquarts & demi-quarts de Savant; & il y a plus de quinze ans que j’ai reconnu de bonne foi que j’avois manqué mon coup & mon but. J’en demande pardon au Public.”

¹⁴³ *Ibid.*, 225.

it was in the classical Greek sense of the term — *apologia* — a defense rather than an act of contrition.

Indeed, with the exception of a few quarrels, what could he reproach himself for?¹⁴⁴ From his earliest to his latest works, Castel sought to convince readers of the primacy of mind over matter, of lightness over weight, of freedom over mechanical law and blind chance. All his life he worked for the promotion of the arts and the spread of learning, while devoting himself to the defense of his faith in God and in Man. He was also keen to bridge the growing divide between the physical, moral and divine sciences, and saw analogies as key to achieving a truer, better, and more beautiful theory of the world. As a result, he developed a coherent oeuvre which, though it never took root between Descartes's or Newton's systems, nonetheless grew to a wonderful breadth and richness, and remained true to itself to the end.

¹⁴⁴ While Castel is remembered today for having been involved in a number of quarrels, he himself seemed to have thought he had been successful at avoiding them: “Sur 300 morceaux peut-être que j’ai donnés en 30 ans au journal, à peine a-t-on incidenté 3 ou 6 fois en tout, et ce n’a jamais été l’affaire en tout de 4 ou 6 heures de travail pour moi.” Castel, “Plan d’impression,” 154.

CONCLUSION

Gone Full Circle and Spiraling Onward

As I rearrange my first printed and unpublished works, and [as I handle] sciences and material with which I am very familiar, I expand, subtract, add, and even as I cut them down I create new works. All the works of an author are but the same work turned over (retourné). When I labor on new things too, a work is a mine, a quarry of new works.
— Louis-Bertrand Castel¹

This study began from the premise that a “half mad, half reasonable” philosopher whose name appear in the margins of almost every great work of the Enlightenment could hardly have been marginal in his lifetime. It demonstrated the need to reconsider Castel’s writings as part of a coherent and insightful enterprise — one deeply rooted in the Jesuit natural philosophical tradition of the seventeenth century, yet perfectly able to grow, flourish, and disperse its seeds in the air of the eighteenth. It also showed the importance of avoiding facile categorizations of his system as “Aristotelian,” “Cartesian” or “anti-Newtonian” in favor of a more sensitive biographical and historical contextualization of his oeuvre. Accordingly, the previous chapters identified and followed two constitutive threads of Castel’s philosophy: the metaphor of circulation, which structured the development of his thought; and his concern for the dignity of man, which motivated him to write in the first place. One might conceive of these intertwining threads as the formal and final causes of his endeavor.

Where the threads of circulation and dignity met, Castel argued for the empowerment of mankind. This is perhaps best captured by his repeated use of the proverb

¹ Castel, “Plan d’impression,” 156: “Comme je remanie mes premiers ouvrages imprimés et non imprimés, et toujours des sciences et matières qui me sont fort familières, j’étends, je déduis, j’ajoute, et en retranchant même, je fais de nouveaux ouvrages. Tous les ouvrages d’un auteur ne sont que le même ouvrage retourné. Comme je travaille même dans le neuf, un ouvrage est une mine, une carrière de nouveaux ouvrages.”

“making rain and fair weather,” a leitmotif found verbatim in the “Lettre à M. C.,” the “Lettre sur la Politique,” and the *Lettres pour rassurer l’univers*, and alluded to in the *Traité de la pesanteur*, the *Mathématique universelle*, and in *L’Homme moral*.² His aim was to raise awareness of the efficacy of free will on the mechanism of nature. From his viewpoint, the perpetuation of movement and life on earth was possible only through a principle of lightness or liberty, which originated in the free will of spiritual agents. Struck by the large scale engineering projects of his day and by the impact that urban life and industry had on the surrounding countryside, he nonetheless believed that human activity had, within reasonable bounds, to be *encouraged* rather than minimized, because this was the task for which God had appointed Adam as his steward. Castel saw men’s “operation of the earth” both as a punishment and as a postlapsarian process of physical, moral, and intellectual restoration.

Though rooted in tradition, Castel’s system of the action of man upon nature was an original contribution to Enlightenment natural philosophy. His main historiographical significance lies not in his exceptionality, however, so much as in what he reveals about the scope and vivacity of early eighteenth-century scientific imagination. Virtually unique in ascribing weather irregularities, natural disasters, and the very shaping of the globe to *on-going* human activity, he nonetheless shows that it was possible, by the early eighteenth century, to conceive that humankind might exert a profound impact on the planet, and that this impact could have positive or catastrophic consequences if not properly understood. By so doing, he participated in, and may have inspired, a number of

² As for his lost *Philosophy du Prince, ou l’Art de faire la pluie et le beau temps*, one can only suppose that it offered a demonstration of the practical benefit of Castelian natural philosophy, once understood by a ruler capable of directing the will power of his subjects.

near contemporaries who likewise envisioned the possibility of anthropogenic geological and climatic change.

In the eighteenth century, empirically-minded savants throughout Europe and correspondents in foreign colonies were increasingly busy gathering observations, including thermometric and barometric measurements taken in the Baconian hope that by shedding light on climate and meteorological patterns, men might one day harness them.³ The *Mémoires de Trévoux* reported these findings regularly, either directly or indirectly through its reviews of Fontenelle's *Histoire de l'Académie Royale des Sciences*.⁴ It is plausible that Castel was the recipient of such reports, and thus an important node in this circulation network.⁵ He certainly took interest in contemporary conversations about the influence of climate on the character, mores, and laws of nations, and on the impact of the air on men's health, and of cities on the quality of the air. Recent scholarship has shown that the triad of French climate theorists constituted by Jean Bodin (1529-1596), the Abbé Dubos (1670-1742), and Montesquieu (1689-1755) grossly oversimplifies the early modern discourse on climate and weather.⁶ However influential these authors may

³ See an account of the kind of work performed in the British context, see Jan Golinski, *British Weather and the Climate of Enlightenment* (Chicago: University of Chicago Press, 2007), 108-136.

⁴ To give only one example, see "[Review of Fontenelle's] *Histoire de l'Académie Royale des Sciences avec les Memoires de Mathematique & de Physique, pour l'année 1719*," *Mémoires de Trévoux* (Dec. 1722): 2113-2122, which reports on La Hire's meteorological observations performed at the Observatoire (2113), Maraldi's report on northern lights (2114), and Mairan's essay "Sur la cause générale du froid de l'hyver, & de la chaleur de l'Eté" (2114-2122).

⁵ This network, it is worth noting, extended beyond the border of France to include England, Switzerland, Flanders, Italy, Spain, Prussia, Austria, and even Russia. These represent opportunities for additional archival research, which may shed light on Castel's European reception.

⁶ Scholars have broadened their account of early modern climatological thinking by looking at the experimental works of Bacon, Boerhaave, Hales, Arbuthnot, Humes, Buffon, as well as to the representations of nature produced by English, Deutch and French physico-theologians. For a classic account, see Clarence J. Glacken's *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (Berkeley and Los Angeles: University of California Press, 1967), 429-460, 551-622. Yet most environment histories still begin with the late-eighteenth century, or with cursory treatments of early modern thought and practices on the subject. See for instance James Rodg-

have been in the history of moral, esthetic, and political thought, many others in the seventeenth and eighteenth century speculated about the interplay of physical and moral causes, or else envisioned practical means of shaping, with divine sanction, a more hospitable place for man in nature. Castel engaged with these ideas and gave them a systematicity they previously lacked.

Castel's physico-political insights can be compared profitably with those of late Enlightenment thinkers like Buffon. The last chapter of the *Époques de la nature* (1778), for example, features humanity as a geological agent capable of counteracting the cooling of the central fire of the earth and thus of ensuring the long-term sustenance of life on its surface.⁷ Musings about man's impact on nature found their way into several of Buffon's works and have been traced back both to classical and modern sources, as well as to North American reports about the effects of large-scale coast deforestation.⁸ But it is not

er Fleming, *Historical Perspectives on Climate Change* (Oxford: Oxford University Press, 1998), 1-19. With the current surge of interest in environmental studies, this trend is bound to change. Recent sophisticated analyses of seventeenth- and eighteenth-century ideas on climate include Golinski, *British Weather*; Nicolas Fressoz and Fabien Rocher, "Le Climat Fragile de la Modernité," *La vie des idées*, 20 April 2010, Accessed 22 Sept. 2015, laviedesidees.fr; Sara Miglietti, "Mastering the Climate: Theories of Environmental Influence in the Long Seventeenth Century" (Ph.D. diss., Warwick University, 2015); William Barton and Sara Miglietti, "An Eighteenth-Century Thought Experiment on Climate Change: Johann Jakob Scheuchzer's *De ignis seu caloris certa portione Helvetica adsignata* (1708)," *Lias. Journal of Early Modern Intellectual Culture and its Sources*. Forthcoming.

⁷ Georges Louis-Leclerc de Buffon, *Les Époques de la nature*, vol. 2 (Paris: Imprimerie royale, 1780), 190 ff: "Supposons donc le monde en paix, & voyons de plus près combien la puissance de l'homme pourroit influencer sur celle de la Nature. Rien ne paroît plus difficile, pour ne pas dire impossible, que de s'opposer au refroidissement successif de la Terre & de rechauffer la température d'un climat; cepedant l'homme le peut faire & la fait [...]. Assainir, défricher, & peupler un pays, c'est lui rendre de la chaleur pour plusieurs milliers d'années" (190). Buffon then provides several examples of how human daily activity and infrastructural transformation of the world exert an impact on the climate. "Je donnerais aisément plusieurs autres exemples, qui tous concourent à démontrer que l'homme peut modifier les influences du climat qu'il habite, & en fixer pour ainsi dire la température au point qu'il lui convient (196-198). And further "C'est de la différence de température que dépend la plus ou moins grande énergie de la Nature, l'accroissement, le développement & la production même de tous les êtres organisé ne sont que des effets particuliers de cette cause générale: ainsi l'homme en la modifiant, peut en même tems détruire ce qui lui nuit & faire éclore tout ce qui lui convient" (200).

⁸ Clarence J. Glacken, "Count Buffon on Cultural Changes of the Physical Environment," *Annals of the Association of American Geographers* 50, 1 (March 1960): 1-21, esp. 2-3.

unthinkable these reports stirred memories of the *Traité de la pesanteur* (or of one of its offshoots) which Buffon had most likely read or heard about in his youth. Exploring these connections further and integrating Castel into the fast-developing field of environmental history is a promising avenue of research.

Philosophes like Buffon were unlikely to acknowledge their debts to their Jesuit critic, especially after the expulsion of 1764. Yet most were familiar with his works and showed interest in at least some of his projects. The most overtly influential was arguably his ocular harpischord and the sensiblist theory of physico-aesthetics that undergirded it. If I chose to relegate Castel's harpischord *clavecin* to the background, it was not to downplay its importance so much as to prevent it from blinding us to the less dazzling, yet more fundamental facets of his natural philosophy. A firmer grasp of Castel's oeuvre is needed if one is to shed new light on his well-known instrument. In a revised version of this work, I intend to show that his circulation metaphor, his concern with human dignity, and his theory of man's place in nature were as central to his theory of color-music as they were to the rest of his work. The ocular harpischord was, I would suggest, the mechanical offshoot of his physico-spiritual system as well as a symbol for his entire philosophy.

Castel's military interests likewise require a better integration into the rest of his oeuvre. Unlike the *clavecin*, which attracts considerable scholarly attention, his musings on the art of war have yet to receive adequate treatment.⁹ Historians of science and philosophy often forget that war loomed large in the background of eighteenth-century France. It should not surprise us, therefore, that it was on the mind of Jesuit mathemati-

⁹ The most substantial reconstruction of Castel's military work can be found in Couvreur, "Aperçus d'un naufrage," 111-114. See also Schier, *Louis Bertrand Castel*, 4, 22-23.

cians who tutored young noblemen aspiring to a military career and occasionally trained future fortification engineers. One finds a welter of seventeenth- and eighteenth-century treatises seeking to establish the principles of a science of war, and the Jesuit made an important contribution to this literature.¹⁰ Castel disapproved of war on moral and natural philosophical grounds, yet he excelled at applied mathematics, of which tactical arts (comprising ballistic, pyrotechnics and the science of fortification) formed an important branch. What fascinated him most about war, however, was motion and the circulation of troops. One has to remember that in the eighteenth century, military campaigns and siege warfare in particular were codified like a ballet. In its ideal form, a battle or a siege was expected to be orderly and civilized, or as Castel might have put it, geometrical. It is worth noting that a careful study of Castel's war-related documents also reveal useful information about Castel's patronage network. Several letters found at the Bibliothèque royale Albert 1er in Brussels suggest that he was trying to use his treatise on war as a way to gain the favors of powerful figures. For a while, he even had reason to think that the Comte de Maillebois would read his manuscript to none other than Louis XV!¹¹

Castel's contribution to Enlightenment thought in general was thus substantial. He himself deserves a place in eighteenth-century historical narratives and should change the way we think about this period. His reconciliation of mechanical philosophy with free will, although unsatisfying to materialist successors, had the merit of sharply delineating the shortcomings of the mechanical philosophy for contemporary readers and providing a voice to those among them who professed their interest in scientific development while

¹⁰ Dennis De Lucca, *Jesuits and Fortifications: The Contribution of the Jesuits to Military Architecture in the Baroque Age* (Leiden: Brill, 2012). Castel gets a passing remark on p. 193.

¹¹ See Castel, "Lettre à la Comtesse de Maillebois," 187-188.

upholding their faith. Castel also played an underappreciated role in the emergence of the moral science concerned with understanding and improving the human condition, as well as in the establishment of sensiblist aesthetics and life sciences. A case could likewise be made for his influence on fields such as the popularization and history of science through his books and his book reviews. Of the 300 reviews he reportedly wrote, many have yet to be identified (the reader will find a non-exhaustive, but nonetheless quite extensive list of certain and likely attribution in my bibliography.) The Jesuit reception of early eighteenth-century science in France will have to be carefully reconsidered in light of these findings; too often are Castel's personal views conflated with that of the Society of Jesus. Indeed, whenever scholars speak of the *Mémoires de Trévoux's* reception of Cartesian or Newtonian science during his thirty year tenure, chances are they are speaking about Castel. This suggests that he was more influential than is generally admitted, not only among his contemporaries, but in our historiography.

Castel helps improve our understanding of the Scientific Revolution and its aftermath by featuring Jesuits as full participants, colleagues and even precursors to better-established figures of the canon. Although partisan and often self-serving, his historical and journalistic writings provide us with a sophisticated narrative in which key scientific figures like Copernicus, Galileo, Harvey, Kepler, Descartes and Newton feature alongside Jesuits like Scheiner, Fabri, Saint-Vincent, Pardies, Grimaldi, and most of all Kircher, not to mention a host of living colleagues. His own contribution shows that the Society of Jesus played a role in France in the development of eighteenth-century natural philosophy, even though natural philosophy itself was undergoing profound changes. Castel notably believed that physics and mathematics would benefit from firmer and

deeper historical foundation. So did many of his brethren — Tournemine, Bougeant, Regnault, Lafitau, Charlevoix, to name but a few — who traced modern discoveries to their ancient roots to curtail the pride of the *novatores* and demonstrate the unity of truth. There was more in this approach than a moral admonition. Castel actually thought that scientific progress would result from historical inquiry, both in the sense of a natural historical consideration of “facts,” and in the sense of historical perspective. This deserves emphasis in light of the tendency of historians and philosophers of science to limit the activity of eighteenth-century Jesuits to their classroom setting, or to printed works serving the diffusion and popularization of scientific ideas.¹² While it is true that the Society of Jesus was less involved in cutting-edge scientific advances than it had been in the sixteenth and seventeenth centuries, such assessment inevitably takes the modern sense of “discovery” as its measuring rod. We should revisit the involvement of these authors in light of what *they* considered to be genuine philosophical achievements.

As a polymath who developed his theories in a variety of disciplinary contexts, and who reflected abundantly on their relationship, Castel provides historians with an opportunity to better understand the formation of these disciplines and the evolution of the early modern quest for universal knowledge. He provides an alternative perspective from which to make sense of themes usually arrogated by secular “Enlightenment” figures. The study of mankind and its place in nature is one of the key features of the eighteenth-century, irrespective of philosophical affiliations. At its core lies a tension between the desire to celebrate the achievements of civilization — an assertion of man’s capacity to

¹² For a common statement of this thesis, see Olivier Perru, *Hommes d’église et science au XVIIIe siècle: vers une harmonie entre raison, nature et création* (Paris: Librairie Philosophique Vrin, 2012), 223-297. It is worth pointing that Castel does not feature in Perru’s discussion of French Jesuits natural philosophers.

rule the world — and a program of social and moral improvement that aimed at making man conform to the laws of nature — an acknowledgment of his subservience to physical and moral causes. Castel’s sensitivity and response to this tension shows he was keenly aware of one of this era’s main currents of thought. At the same time, his attempt to resolve this tension by introducing “spirit in matter” instead of “matter in spirit” illustrates how an eighteenth-century philosopher could channel this current along other courses than materialistic or deterministic ones. Castel’s oeuvre indeed suggests new ways of understanding how science and religion – far from being in conflict – worked together at one point to foster Enlightenment practices and ideologies.

APPENDIX: Castel's Works

This list of Castel's work builds upon Schier's and Couvreur's respective bibliographies, which I have reorganized, corrected, and considerably augmented, especially in the book review section. It remains a provisional, non-exhaustive list, and thus an invitation for scholarly debates. Titles preceded by "[?]" are likely but uncertain attribution. Readers should keep in mind that the anonymity of Castel's reviews makes their identification difficult without the help of explicit authorial cross-references, third-party confirmations, or distinctive linguistic cues.

Signed and/or Authenticated Works

- Castel, Louis-Bertrand. "Principes physico-mathématiques du mécanisme de la nature dans la réfraction de la lumière." *Mémoires de Trévoux* (March 1720): 540-559.
- . "Lettre du R. P. Castel, de la Compagnie de Jesus, à M. de *** [on the parallelism of the earth in the copernican system]." *Mercurie Galant* (Jan. 1721): 5-17.
- . "Mémoire pour l'histoire des découvertes qu'on a faites en mathématiques dans ces derniers siècles." *Mémoires de Trévoux* (June 1721): 998- 1045.
- . "Eloge historique de M. Leibniz." *Mémoires de Trévoux* (Aug. 1721): 1350-1368.
- . "Lettre du P. C. au R. P. Dufesc [on the vortex theory]." *Mémoires de Trévoux* (Dec. 1721): 2095-2098.
- . "Conjectures sur la nature des corps visqueux." *Mémoires de Trévoux* (Feb. 1722): 223-248.
- . "Conjectures de physique sur la raison qui fait qu'on laboure les terres, sur leur fertilité, sur la génération des plantes, et autres corps organisés, et sur bien d'autres phénomènes qui en dépendent ou qui y ont du rapport." *Mémoires de Trévoux* (March 1722): 509-527.

- . “Conjectures sur les pierres figurées qu'on trouve à Saint-Chaumont dans le Lyonnais et en mille autres endroits de la terre, aussi bien que sur les coquillages et les autres vestiges de la mer.” *Mémoires de Trévoux* (June 1722): 1089-1102.
- . “Lettre à M. C. par le P. C. J.” *Mémoires de Trévoux* (Dec. 1722): 2072-2097.
- . “Lettre du P. C. à M. Lac [on the Newtonian or Epicurian system of the propagation of light].” *Mémoires de Trévoux* (Feb. 1723): 312-325.
- . *Traité de physique sur la pesanteur universelle des corps*. 2 vol. Paris: André Cailleau, 1724.
- . [?] “Réplique à M. de Saint-Yves qui sert d’addition à son Traité des maladie des yeux, par M. B***, chirurgien-oculiste.” *Journal des sçavans* (Feb. 1724): 196-207. [Attribution by Schier]
- . “Lettre du R. P. Castel de la Compagnie de Jésus, aux auteurs du Mercure, sur un phénomène dont il est parlé au mois de mai dernier [on the rising and receding of water inside a well near the sea].” *Mercure Galant* (July 1724): 1505-1511.
- . “Lettre du père C[astel] à M. B[ouillet] sur la cause de la pesanteur.” *Mémoires de Trévoux* (Aug. 1724): 1486-1497.
- . “Réponse à la Lettre précédente [from Bouillet] par le Pere Castel, Jesuite.” *Mémoires de Trévoux* (Sept. 1724): 1638-1643.
- . [?] “Remarques sur l’avertissement que M. Winslou a fait insérer dans le Journal des sçavans du mois de juin 1724 [...] par l’auteur du mémoire inséré dans le Journal des sçavans de février 1724.” *Mémoires de Trévoux* (Oct. 1724): 1812-1828. [Attribution by Schier]
- . “Lettre du R. P. Castel jésuite sur le phénomène du tonnerre dont il est parlé dans le Mercure du mois de septembre dernier, écrite à M. de La R[oque]. A Paris, ce 8 octobre 1724.” *Mémoires de Trévoux* (Oct. 1724): 2160-2163.
- . “Extrait d’une lettre écrite par le R. P. Castel, jésuite, à M. D[e] L[a] R[oque], pour servir de réponse à une autre lettre sur un effet extraordinaire du tonnerre, insérée dans le Mercure du mois de janvier 1725.” *Mercure de France* (Feb. 1725): 399-401.
- . “Réponse du Père Castel aux Observations générales de Mr. l’Abbé de Saint Pierre sur le Traité de la Pesanteur universelle.” *Mémoires de Trévoux* (Feb. 1725): 295-318.

- . “Lettre écrite par le R. P. Castel, jésuite, à m. D[e] L[a] R[oque] au sujet de la lettre de Gépolis, sur le Traité de la pesanteur des corps, insérée dans le *Mercur* du mois de février dernier.” *Mercur de France* (March 1725): 522-523.
- . “Lettre sur la Politique adressée à Monsieur l’Abbé de Saint Pierre, par le Père Castel Jesuite. A Paris ce huitième de Février 1725.” *Mémoires de Trévoux* (April 1725): 698-729.
- . “Lettre du père Castel à monsieur Varinge, mathématicien de S. A. R. M. le duc de Lorraine.” *Mémoires de Trévoux* (July 1725): 1337-1339.
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- . “[Review of] *Exercitationum Francofurtensium* [...]” *Mémoires de Trévoux* (Aug. 1721): 1325-1350 and (Nov. 1721) 1960-2001.
- . “[Review of Bouillet’s] *Dissertation sur la cause de la pesanteur* [...]” *Mémoires de Trévoux* (Jan 1722): 109-136.
- . “[Review of J. de Brye’s] *L’art de tirer les armes: réduit en abrégé méthodique* [...]” *Mémoires de Trévoux* (Feb. 1722): 275-297.
- [?] “[Review of Gautier’s] *Nouvelles conjectures physiques, concernant la disposition de tous les corps animés, [followed by] Nouvelles conjectures sur la peste. En deux lettres, l’une de Mr. Gautier, l’autre de Mr. Baux* [...]” *Mémoires de Trévoux* (Feb. 1722): 332-345.
- [?] “[Review of Gautier’s] *Nouvelles conjectures sur le Globe de la Terre où l’on fait voir de quelle maniere la Terre se detruit journellement pour pouvoir changer a l’avenir de figure* [...]” *Mémoires de Trévoux* (April 1722): 730-750.
- [?] “*Nouvelles littéraires* [...] de Paris.” *Mémoires de Trévoux* (May 1722): 928-931.
- . [Review of Fontenelle’s] *Histoire de l’Académie royale des sciences de l’année 1718. avec les Mémoires de Mathématique & de Physique pour la même année* [...]” *Mémoires de Trévoux* (May 1722): 761-790 and (June 1722): 989-1031.
- . “[Review of Gamache’s] *Système du mouvement* [...]” *Mémoires de Trévoux* (May 1722): 845-866.
- . “[Review of Crouzas’s] *Commentaire sur l’analyse des infiniment petits* [...]” *Mémoires de Trévoux* (July 1722): 1189-1215.

- [?] “[Review of Ferrand’s] L’Art du Feu ou Peindre en Email, dans lequel on découvre les plus beaux secrets de cette science, avec des instructions pour peindre et apprêter les couleurs de miniatures dans leur perfection [...]” *Mémoires de Trévoux* (July 1722): 1234-1246.
- [?] “[Review of] Méthode générale pour tracer les Courbes rampantes de bois, propres à la construction des Escaliers [...] suivi de la description d’un Instrument très-comode & très simple pour décrire toute sorte d’Ovale [...]” *Mémoires de Trévoux* (Aug. 1722): 1449-1455.
- [?] “Relation de ce qui se passa dans l’Assemblée publique de l’Académie Royale des Sciences, tenuë au Louvre le Mercredi après la Quasimodo [Based on the report of M. Decourt and M. Reynaud] [...]” *Mémoires de Trévoux* (Sept. 1722): 1615-1634.
- [?] “Pieces qui ont remporté le Prix de l’Académie Royale des Sciences [...]” *Mémoires de Trévoux* (Sept. 1722): 1643-1660. [Summarizes Crouzas and Mas-sy’s essays on the nature of mouvement.]
- . “[Review of Rameau’s] Traité de l’harmonie réduite à ses principes naturels [...]” *Mémoires de Trévoux* (Oct. 1722): 1713-1743 and (Nov. 1722): 1876-1910.
- . “[Review of Fontenelle’s] Histoire de l’Académie Royale des Sciences avec les Memoires de Mathematique & de Physique, pour l’année 1719 [...]” *Mémoires de Trévoux* (Dec. 1722): 2113-2137 and (Jan. 1723): 78-98.
- . “[Review of Borin’s] La musique théorique, et pratique, dans son ordre naturel, nouveaux principes [...]” *Mémoires de Trévoux* (Jan. 1723): 43-51.
- [?] “[Review of] Secrets concernant les Arts, & Métiers [...]” *Mémoires de Trévoux* (March 1723): 412-417.
- [?] “[Review of Le Breton’s] Les clefs de la philosophie Spagirique [...]” *Mémoires de Trévoux* (March 1723): 417-420.
- . “[Review of Sanctorius’s] La Medecine statique, traduite en François par feu M. Le Breton, Medecin de la Faculté de Paris [...]” *Mémoires de Trévoux* (March 1723): 436-442.
- [?] “[Review of Gauger’s] Théorie de nouveaux Thermomètres & de nouveaux Baromètres [...]” *Mémoires de Trévoux* (March 1723): 456-474.
- [?] “[Review of Camus’s] Traité des forces mouvantes [...]” *Mémoires de Trévoux* (April 1723): 707-729.

- [?] “Extrait d’un Memoire [de Collin des Tourelles] adressé a un des Auteurs du Journal de Trevoux [Castel?] sur la quadrature du cercle.” *Mémoires de Trévoux* (May 1723): 904-907.
- . “[Review of Michelotti’s] De Separatione Fluidorum in corpore animali Dissertatio Physico-Mechanico-Medica [...]” *Mémoires de Trévoux* (July 1723): 1243-1258.
- . “[Review of Newton’s] Traité d’optique sur les réflexions, réfractions, inflexions et les couleurs de la lumière, trad. par M. Coste [...]” *Mémoires de Trévoux* (Aug. 1723): 1428-1450.
- [?] “[Review of Senac’s] Nouveau cours de Chymie, suivant les principes de Newton, et de Sthall, avec un Discours Historique sur l’origine et les progres de la Chymie [...]” *Mémoires de Trévoux* (Oct. 1723): 2020-2045 and (Feb. 1724): 197-222.
- . “[Review of Castel’s] Traité de physique sur la Pesanteur Universelle des Corps [...]” *Mémoires de Trévoux* (March 1724): 445-473 and (Avril 1724): 614-643.
- [?] “[Review of Folard’s] Nouvelles découvertes sur la Guerre, dans une Dissertation sur Polybe, où l’on donne une idée plus étenduë du Commentaire entrepris sur cet Auteur, & deux Dissertations importantes, détachés du Corps de l’ouvrage [...]” *Mémoires de Trévoux* (July 1724): 1230-1256.
- [?] “[Review of Réaumur’s] L’art de convertir le fer forgé, en Acier; & l’Art d’adoucir le fer fondu ou de faire des ouvrages de fer fondu [...]” *Mémoires de Trévoux* (July 1724): 1230-1256.
- . “[Review of Lafitau’s] Moeurs des sauvages Ameriquains comparées aux Moeurs de premiers tems [...]” *Mémoires de Trévoux* (Sept. 1724) 1565-1609, (Nov. 1724) 2001-2029 and (Feb. 1725): 197-239).
- [?] “[Review of Abbé Desfourneaux’s] Essai d’une philosophie naturelle, applicable a la vie, aux besoins et aux affaires, fondée sur la seule raison [...]” *Mémoires de Trévoux* (Sept. 1724): 1684-1705.
- [?] “[Review of the Sieur de La Jonchère’s] Observations sur le] plan d’un canal en Bourgogne [...]” *Mémoires de Trévoux* (Oct. 1724): 1807-1811.
- [?] “[Review of Huet’s] Traité philosophique de la faiblesse de l’esprit humain [...]” *Mémoires de Trévoux* (June 1725): 989-1021.
- . “[Review of Fontenelle’s] Histoire de l’Academie Royale des Sciences, avec les Mémoires de Mathematiques & de Physique pour 1721 [...]” *Mémoires de Trévoux* (July 1725): 1200-1222 and (Aug. 1725): 1359-1378.

- . “[Review of Fontenelle’s] Histoire de l’Academie Royale des Sciences, année 1722. avec les Mémoires pour la même année [...]” *Mémoires de Trévoux* (Nov. 1725): 1926-1955 and (Dec. 1725): 2216-2230.
- . “[Review of Roger Cotes’s] Harmonica Mensurarum, C’est-à-dire, l’harmonie des mesures ou l’Analyse & la Synthèse perfectionnées par les mesures des rapports & des angles, avec divers Opuscules Mathématiques [...] ouvrages posthumes mis au jour par M. Robert Smith [...]” *Mémoires de Trévoux* (March 1726): 418-447.
- . “[Review of Varignon’s] Eclaircissement sur l’Analyse des infiniment petits [...]” *Mémoires de Trevoux* (July 1726): 1197-1209.
- . “Extrait d’un Ecrit Intitulé, Réflexions sur la Démonstration que M. de Malezieux a prétendu donner de la Règle de Kepler [...]” *Mémoires de Trévoux* (Aug. 1726): 1436-1440
- . “[Review of Castel’s] Plan d’une mathématique [...]” *Mémoires de Trévoux* (June 1727): 1157-1164.
- . “[Review of Lozeran du Fesc’s] Dissertation [...] sur le tonnerre [...]” *Mémoires de Trévoux* (Aug. 1727): 1411-1417.
- . “[Review of Rameau’s] Nouveau système de musique théorique [...]” *Mémoires de Trévoux* (March 1728): 472-481.
- . “[Review of Fontenelle’s] Élemens de la géométrie de l’infini [...]” *Mémoires de Trévoux* (July 1728): 1233-1263 and (March 1729): 415-442.
- . “[Review of Castel’s] Mathématique universelle [...]” *Mémoires de Trévoux* (April 1729): 695-721, (May 1729): 855-875 and (Sept. 1729): 1587-1612.
- . “[Review of] Histoire de l’Académie royale des sciences, avec les mémoires de mathématique, & de physique pour l’année 1725 [...]” *Mémoires de Trévoux* (Nov. 1729): 1972-1987 and (Jan. 1730): 103-122.
- [?] “[Review of Regnault’s] Entretiens physiques d’Ariste et d’Eudoxe [...]” *Mémoires de Trévoux* (Feb. 1730): 197-219 and (March 1730): 440-461.
- . “[Review of Fontenelle’s] Histoire de l’Académie Royal [sic!] des Sciences, année 1726, avec les mémoires des mathématique, & de physique pour la même année [...]” *Mémoires de Trévoux* (May 1730): 879-894.
- [?] “[Review of Grozelier, ed.’s] Observations curieuses sur toutes les parties de la physique [...]” *Mémoires de Trévoux* (Dec. 1730): 2114-2123.

- . “[Review of d’Azin’s] Nouveau système sur la manière de défendre les places [including Castel’s Discours préliminaire] [...]” *Mémoires de Trévoux* (Aug. 1731): 1324-1336.
- . “[Review of Rameau’s] Dissertation sur les différentes Méthodes d’accompagnement pour le Clavecin ou pour l’Orgue; avec le Plan d’une nouvelle Méthode, établie sur une Mécanique des doigts, que fournit la succession fondamentale de l’Harmonie [...]” *Mémoires de Trévoux* (March 1732): 445-466.
- [?] “[Review of De Moivre’s] Miscellanea analytica de seriebus & quadraturis, &c. [...]” *Mémoires de Trévoux* (May 1732): 828-838.
- . “[Review of Colonna’s] De la nature, ou, de la Génération des choses [...]” *Mémoires de Trévoux* (June 1732): 998-1010; (July 1732): 1174-1187.
- . “[Review of Fontenelle’s] Histoire de l’Académie Royale des Sciences pour l’année 1728. avec les Mémoires de Mathématique & de Physique pour la même année [...]” *Mémoires de Trévoux* (Nov. 1732): 1889-1909; (Dec. 1732): 2070-2087.
- . “[Review of Stirling’s] Methodus differentialis, sive Tractatus de summatione & interpolatione serierum, &c. C’est-à-dire, Méthode différentielle, ou sommation & interpolation des séries infinies [...]” *Mémoires de Trévoux* (Nov. 1732): 1936-1954 and (Dec. 1732): 2037-2050.
- . “[Review of Fontenelle’s] Histoire de l’Académie Royale des Sciences & des Mémoires de l’année 1729 [...]” *Mémoires de Trévoux* (Feb. 1734): 296-306 and (May 1734): 836-853.
- . “Nouvelles littéraires. Allemagne. De Vienne en Autriche. [Includes ‘Extrait d’une Lettre écrite de Vienne au sujet de deux Miroirs paraboliques qui produisent des effets merveilleux à de grandes distance,’ the author of which is unspecified].” *Mémoires de Trévoux* (March 1734): 554-559.
- . “[Review of Cartaud de la Vilate’s] Pensées critiques sur les Mathématiques, ou l’on propose divers préjugés contre ces sciences, a dessein d’en ébranler la certitude, & de prouver qu’elles ont peu contribué à la perfection des beaux Arts [...]” *Mémoires de Trévoux* (April 1734): 662-672.
- . “[Review of Clermont’s] Oeuvre de Mr. Clermont, contenant l’Arithmétique Militaire & la Geometrie pratique de l’Ingenieur. L’Arithmétique divisée en trois parties, troisième édition corrigée & de beaucoup augmenté [...]” *Mémoires de Trévoux* (May 1734): 803-818.

- [?] “[Review of J. B. Adrien de Mercastel’s] Arithmétique démontrée par un Prestre de l’Oratoire, ancien professeur de Mathematique dans l’Université d’Angers [...]” *Mémoires de Trévoux* (May 1734): 818-820.
- . “[Review of Montesquieu’s] Considérations sur les causes de la grandeur des Romains et de leur décadence [...]” *Mémoires de Trévoux* (June 1734): 1030-1067.
- . “[Review of Privat de Molière’s] Leçon de physique, contenant les elements de la physique, déterminées par les seules loix des Méchaniques, expliquées au College Royal de France [1st volume] [...]” *Mémoires de Trévoux* (Nov. 1734): 2044-2080.
- . “[Review of Colonna’s] Histoire naturelle de l’Univers, dans laquelle on rapporte des raisons physiques sur les effets les plus curieux et les plus extraordinaires de la nature [...]” *Mémoires de Trévoux* (March 1735): 412-434 and (April 1735): 668-683.
- [?] “[Review of] Commentarii academiae scientiarum imperialis petropolitanae [...]” *Mémoires de Trévoux* (June 1735):1012-1041, (Nov. 1737): 1976-1995, and (May 1738): 781-807.
- . “[Review of Réaumur’s] Mémoires pour servir à l’histoire des insectes [...]” *Mémoires de Trévoux* (June 1735): 1116-1137 and (July 1735): 1237-1262.
- [?] [Review of Buffon’s translation of Hales’s] La statique des vegetaux [...]” *Mémoires de Trévoux* (Oct. 1735): 2054-2073 and (Dec. 1735): 2414-2436.
- [?] “[Review of Perrin’s] Dissertation sur l’origine des tentes et pavillons de guerre [...]” *Mémoires de Trévoux* (Dec. 1735): 2515-2524.
- . “[Review of Woodward’s] “Geographie physique, ou essay sur l’histoire naturelle de la Terre [...]” *Mémoires de Trévoux* (Feb. 1736): 244-262.
- . “[Review of Gersaint’s] Catalogue raisonné de coquilles & autres curiosités naturelles [...]” *Mémoires de Trévoux* (May 1736): 1027-1034.
- . “[Review of Rondet’s translation of Stone’s] Analyse des infiniment petits [...]” *Mémoires de Trévoux* (May 1736): 1095-1118.
- . “[Review of Du Halde’s] Description géographique, Historique, Politique, & Physique de l’Empire de la Chine & de la Tartarie Chinoise, enrichie des Cartes générales & paritculieres [...]” *Mémoires de Trévoux* (March 1736): 521-554, (June 1736): 1299-1338, (July 1736): 1362-1400, and (August 1736):1859-1894.
- [?] “[Review of Pope’s] Essay sur l’homme [...] traduit de l’Anglois en François [by Mr. Silhouette] [...]” *Mémoires de Trévoux* (June 1736): 1191-1219

- . “[Review of Privat de Molière’s] Leçon de physique, contenant les elements de la physique, déterminées par les seules loix des Méchaniques, expliquées au College Royal de France [vol. 2].” *Mémoires de Trévoux* (Sept. 1736): 1925-1966.
- [?] “[Review of Pope’s] Les principes de la morale et du goût en deux poèmes, traduits de l’anglois de M. Pope [by Du Resnel] [...]” *Mémoires de Trévoux* (July 1737): 1277-1300.
- . “[Review of Leibniz’s] Essais de théodicée [...]” *Mémoires de Trévoux* (Jan. 1737): 5-36, (Feb 1737): 197-241, (March 1737): 444-471 and (June 1737): 953-991.
- . “[Announcement of Castel’s] Lettre philosophique pour rassurer l’univers [...]” *Mémoires de Trévoux* (February 1737): 367-368.
- . “[Review of Castel’s] Lettre Philosophique, pour rassurer l’Univers contre le bruits populaires d’un dérangement dans le cours du Soleil, au sujet du Veux furieux, & de la chaleur du 20. Octobre 1736 [...]” *Mémoires de Trévoux* (April 1737): 692-706.
- . “[Review of Pariet Despars’s] Troisième Lettre Philosophique, en Réponse à la seconde pour rassurer l’Univers, au sujet des Réflexions sur la première, et contre les critiques du Cône, du Parallepipede, et de la pesanteur du feu [...]” *Mémoires de Trévoux* (August 1737): 1520-1521.
- . “[Review of Le Blond’s] Coloritto or The Harmony of Colouring [...]” *Mémoires de Trévoux* (Aug. 1737): 1435-1444.
- . “[Review of Fontenelle’s] Histoire de l’Académie Royale des Sciences, année 1730. avec les Mémoires de Mathématique & de Physique pour la même année, tirés des Registres de cette Académie [...]” *Mémoires de Trévoux* (Aug. 1737): 2106-2142.
- . “[Review of Rameau’s] Génération harmonique ou Traité de Musique Theorique & Pratique par M. Rameau [...]” *Mémoires de Trévoux* (Dec. 1737): 2142-2167.
- . “[Review of Privat de Molière’s] Leçons de physique contenant les élémens de la Physique déterminés par les eseules loix des méchaniques, expliquées au College Royal de France [vol 3] [...]” *Mémoires de Trévoux* (Jan. 1738): 5-24.
- [?] “[Review of Jean Astruc’s] Mémoire pour l’histoire naturelle de la Province de Languedoc [...]” *Mémoires de Trévoux* (Dec. 1737): 2200-2228 and (Jan. 1738): 146-174.

- [?] “[Announcement of] Lettre de M. d’Anville au R. P. Castel, S.J. au sujet des pays de Kamtchatka et de Jeço et réponse du P. Castel.” *Mémoires de Trévoux* (Feb. 1738): 357.
- . “[Review of G. Ehr. Hambergerus’s] Elementa Physices, & C’est-à-dire: Elements de physique, écrits selon la Méthode mathématique à l’usage des Classes [...]” *Mémoires de Trévoux* (April 1738): 664-677.
- [?] “[Review of Vauban’s] De l’Attaque et de la défense des Place [...]” *Mémoires de Trévoux* (June 1738, part 2): 1206-1241.
- [?] “[Review of] La figure de la Terre, déterminée par les Observations de Messieurs de Maupertuit, Clairaut, Camus, Le Monnier [...]” *Mémoires de Trévoux* (June 1738): 1282-1307 and (Aug. 1738): 1537-1579.
- “Review of Voltaire’s] *Éléments de la philosophie de Newton* [...]” *Mémoires de Trévoux* (Aug. 1738): 1669-1709 and (Sept. 1738): 1846-1867.
- . “[Review of Algaroti’s] Il Newtonianismo per le Dame o vero Dialoghi sopra la luce e i colori [...]” *Mémoires de Trévoux* (Jan. 1739): 5-26.
- [?] “[Review of Pope’s] Maximes et reflexions morales traduites de l’Anglois, avec une Traduction nouvelles en vers de l’essai sur l’homme de M. Pope [...]” *Mémoires de Trévoux* (Feb. 1739): 246-279.
- [?] “[Review of Ratz de Lanthenée’s] Elemens de géométrie, ou Principes de la Mesure de l’Etenduë, expliqués très-clairement par démonstrations la plupart nouvelles, & surtout sans le secours des Proportions [...]” *Mémoires de Trévoux* (March 1739): 415-420.
- [?]. “[Review of Mead’s] *Mechanica expositio venenorum variis Dessertionibus comprehensa* [...]” *Mémoires de Trévoux* (March 1739): 482-513.
- [?]. [Review of Richard Mead’s] *Tractatus* [...] de Imperio Solis ac Lunae in corpora humana [...]” *Mémoires de Trévoux* (April 1739): 773-787.
- . “[Review of Fautrière’s] Examen du Vuide ou Espace Newtonien [...]” *Mémoires de Trévoux* (June 1739): 1145-1153.
- . “[Review of the] Pièces qui ont remorté le prix de l’Académie royale des sciences, en M.DCCXXXVIII [...]” *Mémoires de Trévoux* (July 1739): 1416-1432.
- . “[Review of Musschenbroek’s] Essai de physique [...]” *Mémoires de Trévoux* (Oct. 1739): 2112-2151 and (Nov. 1739): 2435-2450.

- . “[Review of Privat de Molière’s] Leçons de physique contenant les élémens de la Physique déterminés par les eseules loix des mécaniques, expliquées au College Royal de France [...] Tome 4 [...]” *Mémoires de Trévoux* (Jan. 1740): 5-31 and (Feb. 1740): 315-350.
- . “[Review of Seguin’s] Démonstration arithmétique et géométrique de la vraie quadrature du cercle [...]” *Mémoires de Trévoux* (Jan. 1740): 146. [Followed by “Lettre du P[ère] C[astel] a M. D. sur cette quadrature[...].” *supra*.]
- . “[Review of Giovanni Bianchi’s] De conchis &c., C’est à dire, Livre de Janus Plancus de Remini sur les coquillages les moins connus: avec un Essai touchant le flux et le reflux de la Mer supérieure sur le Rivage & dans le port de Rimini [...]” *Mémoires de Trévoux* (April 1740): 600-619.
- . “[Review of Euler’s] Mechanica, sive motus scientia [...]” *Mémoires de Trévoux* (May 1740): 816-834 and (July 1740): 1407-1422.
- . “Nouvelles littéraires. France. De Paris. [Announcement of Castel’s] Optique des Couleurs [...]” *Mémoires de Trévoux* (May 1740): 733.
- . “Nouvelles littéraires. France. De Paris. [Review of Sieur Premerie’s] Nouvel Art de substituer les Ouvrages de Fer forgé, blanchi & étamé sans crainte de rouille & sans besoin de nouvel étamage, aux Ouvrages de cuivre exposés à la rouille du verd de gris, & à l’étamage nouveau [...]” *Mémoires de Trévoux* (May 1740): 735-741. [Also includes an announcement of Castel’s *Optique des Couleurs*, 733.]
- . “[Review of Castel’s] L’Optique des couleurs [...]” *Mémoires de Trévoux* (June 1740): 1235-1263.
- . “[Review of Bourguet’s] Lettres philosophiques sur la formation des sels et des cristaux, et sur la génération et le mécanisme organique des plantes et des animaux a l’occasion de la pierre lenticulaire avec un mémoire sur la théorie de la terre [...]” *Mémoires de Trévoux* (Aug. 1740): 1636-1665.
- [?] “[Review of Gamache’s] Astronomie physique, ou principes generaux de la nature, appliqués au Mécanisme astronomique, & comparés aux Principes de la Philosophie de Newton [...]” *Mémoires de Trévoux* (Oct. 1740): 1955-1992 and (Nov. 1740): 2193-2209.
- . “[Review of Emilie du Châtelet’s] Institutions de physique [...]” *Mémoires de Trévoux* (May 1741): 881-893.
- . “[Review of Sigorgne’s] Examen et Refutation des Leçons de Physiques, expliquées par M. de Molieres au Collège Royal de France [...]” *Mémoires de Trévoux* (July 1741): 1249-1286.

- . “[Review of Privat de Molières’s] Réponse aux principales objections contenues dans l’Examen des Leçons de Physique de M. l’Abbé de Molière, en forme de Lettres à M. Sigorgne [...]” *Mémoires de Trévoux* (July 1741): 1287-1315.
- . “[Review of Mairan’s] Lettre de M. de Mairan, secretaire perpetuel de l’Academie Royale des Sciences a Madame ***. Sur la question des forces vives, en réponse aux objections qu’elle lui fait sur ce sujet dans ses Institution de physique [...]” *Mémoires de Trévoux* (Aug. 1741): 1381-1389.
- . “[Review of Emilie du Châtelet’s] Réponse de Madame *** à la lettre de M. de Mairan [...] Sur la question des forces vives [...]” *Mémoires de Trévoux* (Aug. 1741): 1381-1389.
- . “[Review of Geminiani’s] Guide harmonique ou Combinaison simple et sensible de tous les rapports que le sons peuvent avoir entre eux [...]” *Mémoires de Trévoux* (Aug. 1741): 1475-1509. [Published before the publication of the *Guide harmonique* itself.]
- [?] “[Review of Trabaud’s] Principes du mouvement et de l’équilibre pour servir d’introduction aux mechaniques et à la physique [...]” *Mémoires de Trévoux* (Dec. 1741): 2225-2250 and (Sept. 1742): 1565-1595.
- . “[Review of Micheli’s] Description de la méthode d’un thermometre universel [...]” *Mémoires de Trévoux* (June 1742): 992-1003.
- [?] “[Review of] Lettre sur la comete, brochure in 12.” *Mémoires de Trévoux* (July 1742): 1155-1179.
- [?] “[Review of Kuhn’s] Méditations sur l’origine des fontaines, l’eau des puits, et autres problemes qui ont du rapport a ce sujet [...]” *Mémoires de Trévoux* (July 1742): 1286-1307.
- . “[Review of Maréchal et al.’s] Recueil de mémoires, avis, instructions, éclaircissemens, objections, reponses, repliques, & contre-replique, sur le dessechement des marais de languedoc, et sur la construction d’un canal de navigation depuis Beaucaire, jusqu’aux Canaux des Etangs qui continue le canal royal de cette Province [...]” *Mémoires de Trévoux* (Jan. 1743): 61-109.
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