An outline of Celestino Cominale's (1722–1785) critique of Isaac Newton's natural philosophical method

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Abstract
This essay examines Celestino Cominale's (1722–1785) self-proclaimed 'anti-Newtonianism'. Between 1754 and 1770, Cominale published four volumes under the title of *Anti-Newtonianismi*, in which he launched a sustained attack on Newton's natural philosophy. Despite a modest resurgence of interest in his work, Cominale's critique has largely been overlooked and is often dismissed as an isolated, provincial, and misguided attack on Newton's theories. This article seeks to offer a comprehensive account of Cominale's critique of Newton's natural philosophy, with a particular focus on the opening chapters of the second volume of *Anti-Newtonianismi*. It will be shown that Cominale was deeply engaged with contemporary debates surrounding Newton's natural philosophy and, at times, advanced original and insightful criticisms of Newton's natural philosophical method.

Keywords
Celestino Cominale, Isaac Newton, *Anti-Newtonianismi*, 'anti-Newtonianism', Italian 'Newtonianism'

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Introduction: Celestino Cominale and "the first detailed anti-Newtonian study"[1]

The dissemination of Isaac Newton's ideas in Italy has been the focus of numerous studies, which often emphasize how the geopolitical landscape of the peninsula, consisting of numerous kingdoms and city-states, significantly shaped their acceptance and spread.[2] Although scientific debate was thriving across Italy in the early eighteenth century, the distinct character of academic institutions played a key role in shaping the diffusion and teaching of Newton's ideas. A key factor to consider, for instance, is the diverging approaches taken by northern and southern Italy in embracing Newton's ideas. By the 1710s and 1720s, universities in the north had begun incorporating Newton's teachings into their curricula. In contrast, the south appeared slower to adopt them.[3] In the north, many scholars engaged with both the mathematical and experimental aspects of Newton's theories and they selectively integrated them with pre-existing practices.[4] Meanwhile, in the south, where most university professors were also part of the clergy, the apologetic features of Newton's natural philosophy were emphasized and its philosophical and epistemological implications were explored.[5] Although Newton's ideas were incorporated into the academic curriculum, their adoption often relied on the initiative of individual professors.[6] In Rome and Naples, Newton's ideas featured prominently in scientific discourse, prompting many scholars and intellectuals to engage in deeper study of his natural philosophy, contributing to its widespread acceptance by the 1740s.[7]

After the 1740s, critiques of Newton's natural philosophy became increasingly rare. When they did surface, they were typically dismissed, marginalised, and in some cases, nearly forgotten. A particularly intriguing example of a self-proclaimed 'anti-Newtonian'[8]

1 Celestino Cominale, *Anti-Newtonianismi pars secunda, in qua rejectis methodo, et philosophandi regulis Newtonianis, totiusque sectae principiis indicatis, evertitur prae caeteris, argumentis utplurimum ex adversariorum penu depromptis, vacuum, vis inertiae, mutua gravitas et attractio* (Naples: Ex typographia Benedicti Gessari, 1756), [av]: "primam Anti-newtonianam elucubrationem."

2 On the spread of Newton's ideas in Italy, see, for instance, Paolo Casini, *Newton e la coscienza Europea* (Bologna: il Mulino, 1983), 173–227; Vincenzo Ferrone, *Scienza, natura, religione. Mondo newtoniano e cultura italiana nel primo Settecento* (Naples: Jovene Editore, 1982); and Massimo Mazzotti, "Newton in Italy," in *The Reception of Isaac Newton in Europe*, ed. by Helmut Pulte and Scott Mandelbrote, vol. 1 (London: Bloomsbury, 2019), 159–178.

3 Mazzotti, "Newton in Italy," 164–165.

4 Ibid., 177.

5 Ibid.

6 Ibid., 173–174.

7 On the spread of Newton's theories in Rome and Naples, see, for instance, Casini, *Newton e la coscienza Europea*, 191–194.

8 On the topic of 'anti-Newtonianism', see the essays in Philippe Hamou and Neil Ribe, eds., "Figures de l'antinewtonianisme/Faces of Anti-Newtonianism (1672–1832)," *Archives Internationales d'Histoire des Sciences* 53 (2003): 115–271.

active in the post-1740s period is Celestino Cominale (1722–1785), who published four volumes of his monumental work, *Anti-Newtonianismi*, between 1754 and 1770.[9] Very little is known about Cominale, and only a handful of accounts of his life have survived.[10] According to the available sources, Cominale was born on 29 October 1722 in Uggiano la Chiesa, located in what is now Apulia. His education seems to have been an excellent one. He first studied in Lecce and later at the University in Naples, where he pursued physics, mathematics, and sciences under the mentorship of some notable scholars of his time, including Michelangelo De Rubertis (1713–1776), Francesco Serao (1702–1783), Felice Rossetti (?–?), Mario Lama (?–?), and two brothers who ardently supported Newton's natural philosophy, Pietro (1707–1746) and Nicola Di Martino (1701–1769).[11] These formative years laid the foundation for his reputation as a respected physician. A significant chapter in Cominale's life was marked by his travels across Italy, during which he visited numerous Italian universities and engaged in intellectual exchanges with leading natural philosophers. Among those he met were the chemist Jacopo Bartolomeo Beccari (1682–1766) in Bologna, and the two Minim friars, Thomas Le Seur (1703–1770) and

9 Celestino Cominale, *Anti-Newtonianismi* (4 vols.) (Naples: Ex typographia Benedicti Gessari, 1754, 1756; Ex typographia Francesci Morelli, 1769, 1770).

10 See Giovanni Battista Lezzi, "Vite degli scrittori salentini," Ms. D/5, Biblioteca Pubblica Arcivescovile di Brindisi 'A. De Leo', 1787–1807, 308v–310v; Giovanni Battista Lezzi, "Vite de' letterati salentini," Biblioteca Provinciale di Lecce 'Nicola Bernardini', Ms. n. 52, n.d., 563–565; Luigi Maggiulli, "Dizionario biografico degli uomini chiari di Terra d'Otranto," State Archive of Lecce, Ms. n.C 47, vol. 2, n. 209; Luigi Giuseppe De Simone, "Dizionario biografico salentino," Biblioteca Provinciale di Lecce 'Nicola Bernardini', Ms. n. 249, n.d., vol. 1, n. 199; Giovanni Battista De Tomasi, "Celestino Cominale," in [various authors], *Biografia degli uomini illustri del Regno di Napoli ornata de loro rispettivi ritratti, compilata da diversi letterati nazionali, dedicata a S. E. RMA. Monsig. D. Gabriele M. Gravina, Arcivescovo di Militene Cappellano Maggiore di S. M. il Re del Regno delle due Sicilie*, vol. 9 (Naples: Presso Nicola Gervasi, 1822), 196–200.

11 Not much is known about Cominale's teachers. Rossetti exchanged letters with Antonio Vallisnieri (1661–1730), published as "Sistema nuovo intorno all'Anima pensante, e alla Circolazione degli Spiriti animali," in *Raccolta d'opuscoli scientifici e filologici*, ed. by Angelo Calogerà, vol. 5 (Venice: Appresso Cristoforo Zane, 1721), 265–316. Serao was a follower of Celestino Galiani (1682–1753) (Ferrone, *Scienza, natura, religione*, 512). A biography was written about him in 1784 by Michele Arcangelo Lupoli, *De vita muniis et scriptis Francisci Serai Philosophi et Medici Neapolitani clarissimi. Commentarius* (Naples: Typographia Simoniana, 1784). Regarding De Rubertis, see Giulia Belgioioso, *Cultura a Napoli e cartesianesimo. Scritti su G. Gimma, M. Doria, C. Cominale* (Galatina: Congedo Editore, 1992), 400. De Rubertis was a physician who became famous for curing the Bishop Giuseppe Orlandi (1713–1776). Orlandi put De Rubertis in contact with notable people of the city and helped him obtaining the chair of medicine of the University of Naples in 1753. For more on Mario Lama and the brothers Di Martino, see Ferrone, *Scienza, natura, religione*, 498–502, 514–517 and Claudia Addabbo, "The *Philosophiae Naturalis Principia Mathematica* in Naples," in *Reading Newton in Early Modern Europe*, ed. by Elizabethanne Boran and Mordechai Feingold (Leiden: Brill, 2017), 23–63, 32–42.

François Jacquier (1711–1788) in Rome – collaborators on the Geneva edition of Newton's *Principia*, alongside the Genevan Professor of Mathematics, Jean-Louis Calandrini (1703–1758).[12] Upon returning to Naples, Cominale continued his medical practice while also founding and directing his own school, where students were taught a broad range of scientific disciplines.[13] He also held a position at the University of Naples. His commitment to science and education remained steadfast even after he returned to Uggiano in 1770, where he continued his work until his death fifteen years later. Beyond his medical practice, Cominale devoted himself to natural philosophical research, often exploring its philosophical implications. During his time in Naples, he authored several works, though unfortunately, many of these works seem to have been lost.[14]

In recent decades, there has been a modest resurgence of interest in Cominale's critique of Newton's natural philosophy, particularly among Italian scholars. This renewed attention has led to the publication of several essays.[15] As we will see, Cominale's *Anti-Newtonianismi* is often portrayed as an isolated, provincial, and misguided attempt to challenge Newton's theories.

Giulia Belgioioso, focusing primarily on the first volume of Cominale's *Anti-Newtonianismi* – a volume devoted to an extended critique of Newton's optics – claims that it reveals Cominale's "backwardness, combined with arrogance and stubbornness."[16] She writes: "The topic of the four volumes of his muddled work [are] […] the scientific theories of *Opticks* and the *Principia*. […] It is a work where a hypothetical and speculative science is proposed, […] The outcome is a confused argument which is not always easy to follow."[17] Belgioioso further characterizes *Anti-Newtonianismi* as "a late [and hence be-

[12] Cominale describes his travels in *Praelectio Academica de lentibus quae congregant, et segregant luminis radios, earumque effectibus habita in Regio Archigymnasio Neapolitano a Caelestino Cominale Physices, et Matheseos extra ordinem Professore. In petitione cathedrae physices experimentalis IV. Idus Septembris Ann. MDCCLIX* (Naples: Typis Francisci Morelli, 1759), iv. On the Geneva edition of the *Principia*, see e.g. Niccolò Guicciardini, "Editing Newton in Geneva and Rome: The Annotated Edition of the *Principia* by Calandrini, Le Seur and Jacquier," *Annals of Science* 72 (2015): 337–380.

[13] Lezzi, "Vite de' letterati salentini," 563.

[14] A complete list of Cominale's works can be found in Lezzi, "Vite de' letterati salentini," 565; Maggiulli, "Dizionario biografico degli uomini chiari di Terra d'Otranto," n. 209.

[15] Belgioioso, *Cultura a Napoli e cartesianesimo*, 399–441; Gabriella Guerrieri, "Newtonianesimo e antinewtonianesimo in Terra d'Otranto nella seconda metà del '700. Note in margine a un manoscritto inedito di Oronzo Amorosi," *Physis* 37 (2000): 535–542; and, Irene Giannì, "Le aberrazioni della *libertas philosophandi*: Celestino Cominale contra Isaac Newton," in *Filosofia e scienza nel Salento dell'età moderna*, ed. by Adele Spedicati (Lecce: Pensa multimedia, 2021), 63–121.

[16] Belgioioso, *Cultura a Napoli e cartesianesimo*, 5–6: "ne svelano impietosamente tutta l'arretratezza, non disgiunta da presunzione e pertinacia."

[17] Ibid., 403: "Contenuto dei quattro tomi della sua farraginosa opera [sono] […] le teorie scien-

nighted] intervention," appearing at a time when Newton's ideas had already gained significant traction within Italian scientific and academic circles.[18] She concludes that both the title and the objective of the work – namely, to refute Newton's natural philosophy – are "pretentious."[19]

Gabriella Guerrieri cautions that "it would be misleading [...] to consider Celestino Cominale an exemplary and characteristic figure of Apulian Newtonianism; as his position appears antithetical not only compared to the Neapolitan atmosphere, but also, more specifically, to that in Salento."[20] Furthermore, she argued that although Cominale "believes he is providing indisputable proof of the weakness of this [i.e., Newton's] universally accepted theory,"[21] his critique is marred by fundamental misconceptions and a lack of acuity in both physics and mathematics.

Irene Giannì, on the other hand, challenges such dismissive and anachronistic readings of Cominale's *Anti-Newtonianismi*. She argues that Cominale's work should be understood as the product of a scholar operating within a broadly speaking Descartes-inspired framework, who employed "an adversarial method" in his critique of Newton's *Principia* and *Opticks* – an interpretation with which we concur.[22] She maintains that Cominale grounded his critique of Newton's natural philosophy in the principle of *libertas philosophandi*, which he invoked to challenge what he perceived as the uncritical acceptance of Newton's doctrines.[23] Cominale's critique of Newton's natural philosophy is indeed anchored in two guiding principles: *libertas philosophandi* and epistemological humility. The latter stems from the recognition that "everyone could discover a few things in physics but not fully examine everything." For this reason, Cominale found it reasonable "not to acquiesce entirely to the opinions of any single philosopher, but to go through them collectively; and to select from all what seemed true and more probable, and to put together for myself an eclectic physics."[24] He further remarked: "I judged that authorities should not be trusted

tifiche dell'Ottica e dei Principia. [...] Si tratta di un'opera dove viene proposta una scienza che ha carattere ipotetico e congetturale, [...] Ne viene fuori un discorso confuso che non è sempre facile seguire."

18 Ibid., 403.

19 Ibid., 399.

20 Guerrieri, "Newtonianesimo e antinewtonianesimo in Terra d'Otranto," 537: "Sarebbe fuorviante [...] considerare Celestino Cominale figura esemplare e caratteristica del newtonianesimo pugliese; giacché la sua posizione risulta antitetica non solo all'ambiente napoletano, ma anche specificatamente a quello salentino."

21 Ibid., 538: "crede di fornire le prove inoppugnabili della debolezza di questa teoria universalmente accettata."

22 Giannì, "Le aberrazioni della *libertas philosophandi*," 76–77.

23 Ibid., 88–89.

24 Cominale, *Anti-Newtonianismi pars secunda*, 30: "Quare, cum nonnulla potuerit quisque in physicis invenire, non omnia vero perlustrare; ideo placuit mihi, nullius peculiaris philosophi sen-

too much; and that, to the contrary, one should not fight for them […], as the Newtonians fight for Newton today."[25]

At the beginning of the eighteenth century, Descartes's theories gained wide-spread acceptance in southern Italy, particularly in the Neapolitan area, which soon emerged as a major intellectual hub for the study of Descartes's philosophy in the period thereafter,[26] when "his [i.e., Descartes's] fortune varied according to the different moments and contexts of the Neapolitan culture."[27] Despite the inclusion of Descartes's works in the *Index librorum prohibitorum* in 1663, various schools of thought and interpretation of Descartes's doctrines flourished. Descartes's philosophy became a vehicle to criticize Aristotle's thought and the Catholic Church in the name of *libertas philosophandi*.[28] However, with the advent of Newton's theories and the ensuing debates, Descartes's philosophy (and its many branches) fell out of favor. By the middle of the century, "throughout Europe, the discussion between Newton's followers and Descartes's epigones was rapidly drawing to a close, with the Newtonian synthesis emerging victorious."[29] When Cominale published the first volumes of *Anti-Newtonianismi*, Descartes's ideas were mostly abandoned in favor of Newton's in the Neapolitan area.

With regard to Cominale's critique of Newton's natural philosophy, scholarly attention has largely focused on his objections to specific concepts, arguments and experiments within Newton's natural philosophy.[30] What remains absent, however, is a comprehensive account that outlines the principal lines of Cominale's critique of Newton's natural philosophy. To address this, we turn to the opening chapters of the second volume of Cominale's *Anti-Newtonianismi*, where he articulates his principal objections to Newton's natural philosophy. In these opening chapters, Cominale criticized the foundational aspects of Newton's natural philosophical method. Cominale contended that Newton's natural philosophical method – particularly his mathematization of nature – is fundamentally flawed. He also presents a pointed critique of Newton's renowned *regulae philosophandi*, arguing

tentiae ex toto acquiescere, sed cunctos percurrere; & ab omnibus, quae vera, & probabiliora videbantur, seligere, & Physicam Eclecticam mihi comparare, […]."

25 Ibid., 30: "Auctoritatibus non nimis fidendum esse censui; & pro iis non secus […] pugnare, ut hodie pro Newtono pugnant Newtoniani; […]."

26 Ferrone, *Scienza, natura, religione*, 465; Casini, *Newton e la coscienza europea*, 191.

27 Maria Teresa Marcialis, "Il "cogito' e la coscienza. Letture cartesiane nella Napoli settecentesca," *Rivista di Storia della Filosofia* 51 (1996): 581–612, 581: "la sua fortuna variò in momenti e contesti diversi della cultura napoletana."

28 Ferrone, *Scienza, natura, religione*, 465.

29 Belgioioso, *Cultura a Napoli e Cartesianesimo*, 167: "in tutt'Europa la disputa fra i seguaci di Newton e gli epigoni di Cartesio si avviava a rapida conclusione con la vittoria della sintesi newtoniana."

30 Belgioioso, *Cultura a Napoli e Cartesianesimo*, 406–440; Guerrieri, "Newtonianesimo e anti-newtonianesimo in Terra d'Otranto," 538–542.

that they are inadequate as guiding principles for natural philosophical inquiry. The next section examines Cominale's critique of Newton's mathematization of nature, while the subsequent section explores his critique of the *regulae philosophandi*.

On the progress of physics and its obstacles

In the first chapter of *Anti-Newtonianismi pars secunda*,[31] Cominale set out show that "the progress of physics has been impeded, and that this is above the result of the abuse of geometry" – a trend he attributed to Newton and his followers. This statement, he acknowledged, contradicts the "vulgar opinion," that "physics has been brought to its highest perfection and peak of its evidence chiefly by the help of geometry."[32] He noted that the "Aristotelians, atomists, and Cartesians" all claimed to have perfected physics, yet

[31] Most contemporary assessments of the second part of Cominale's *Anti-Newtonianismi* were unfavorable. One notable example is Oronzo Amorosi, *Gara letteraria inedita tra i Signori Oronzo Amorosi di Galatone e Celestino Cominale di Uggiano della Chiesa. Copiata dall'autografo di esso Amorosi da Vincenzo Lillo, 1821. Introduzione, trascrizione e note a cura di Gabriella Guerrieri* (Lecce: Conte, 1999). The letters exchanged between Amorosi and Cominale in 1765 remained unpublished for over a century until they were published in the *Gara letteraria*. Initially, Amorosi pointed out several errors in Cominale's *Anti-Newtonianismi*, but the correspondence quickly developed into a heated exchange of accusations and insults. In a particularly scathing presentation letter, Amorosi wrote (p. 53): "What is the purpose of embellishing so many pieces of paper to create such a long and varied mess, if with many deceits and things he haphazardly collects, he does not untangle anything of this feigned, awful, and inappropriate learning? [Ma a che sciccherar tanti fogli a formar sì lungo, e sì svariato ciloma, se con tante anfanie e con tante cose che v'affastella d'*un erudizione* [sic] affettata, indigesta e fuor di proposito che non ne discioglie egli alcun nodo?]." Another critical voice appeared in [anon.], "Italy," in *The Library: Or, Moral, and Critical Magazine, for the year MDCCLXII. By a Society of Gentlemen*, ed. by Andrew Kippis, vol. 2 (London: printed for R. Griffiths in the *Strand*, and C. Henderson under the *Royal-Exchange*, 1762), 273–276, at 275, where the reviewer asserted that Cominale's work "pleads against him." A particularly pointed assessment appeared in a review of *Anti-Newtonianismi pars secunda*, in Pierre Rousseau, ed., *Journal encyclopédique*, vol. 4, pt. 3 (Bouillon: De l'Imprimerie du Journal, 15 June 1763), 137–138, where the reviewer wrote: "Il y a de la témérité à vouloir attaquer Newton. Ce nouveau Physicien veut absolument renverser le système de Philosophe Anglois; il ne se propose rien moins que de flétrir la gloire de cet homme immortel. Il veut combattre le système des couleurs de Newton; nous doutons qu'il y réussisse." A rare positive appraisal, however, can be found in Abate Giovanni Antonio Battarra, "Articolo d'una Lettera scritta dal sig. Abate Gio. Antonio Battarra di Rimino ad un suo Amico di Firenze il dì 22. Luglio 1760," in *Novelle letterarie pubblicate in Firenze*, ed. by Giovanni Lami, vol. 21 (Firenze: nella stamperia di Gaetano Albizzini, 1760), 570–573.

[32] Cominale, *Anti-Newtonianismi pars secunda*, 1: "Physices […] progressus esse praepeditos; & id potissimum, Geometriae abusu, factum" ; "Physicam […] Geometriae potissimum auxilio ad summum perfectionis, ac evidentiae suae apicem esse perductam."

their views have been discarded for their lack of substance. Cominale argued that "today's [physics]" [i.e., that of Newton and its followers] will "similarly be abandoned, growing old, and time, the impartial detector of truth, will expose its errors to all."[33]

Although Cominale asserted that physics had not made significant progress, he was acutely aware of advancements in certain areas. To address this, he introduced a distinction between historical physics (*physica historica*) and theoretical and speculative physics (*physica theorica & speculativa*). He acknowledged significant advancement in historical physics, highlighting notable advancements in chemistry and the natural history of insects, referencing the pioneering work of Francesco Redi (1626–1697), Jan Swammerdam (1637–1680), Antonio Vallisneri (1661–1730) and René-Antoine Ferchault de Réaumur (1683–1757). He also noted progress in the natural history of plants, citing the work of Robert Morison (1620–1683, Paul Hermann (1646–1695), Augustus Quirinus Rivinus (1652–1723) and John Ray (1627–1705). Further, he highlighted the growth of in physico-theology through the writings of William Derham (1657–1735) and Bernard Nieuwentijt (1654–1718), as well as notable progress in anatomy.[34]

In contrast, Cominale asserted that "speculative physics, or that [part of physics] that strives to give the causes of phenomena, has not only failed to make progress since its inception, but it seems to have collapsed into the futile solutions of the ancients."[35] He illustrated this with examples from astronomy and optics, specifically referencing the explanations he believed Newton had offered in the *Principia* and the *Opticks*. Regarding astronomy, he acknowledged that the history of the heavens (*caelestis historia*) has progressed, discovering "that the heavens are not solid, as the ancients feigned; that the Earth is not the center of our system, and that the planets rather revolve around the Sun."[36] However, he argued that "when theoretical [physics] [i.e., Newton's celestial mechanics] advances to explain the cause of the motions of the celestial bodies, it is observed to be more confused than the ancient [theoretical physics], with its epicycles and solid rotating heavens."[37] Cominale argued that Newton's theory of the motion of the celestial bodies is inconsistent, because it "contends that matter is inert and lacking any intrinsic active prin-

[33] Ibid., 1: "hodierna consenescens, & tempus, aequus veri detector, omnibus errores suos ostendens, defectura pariter erit."

[34] Ibid., 2.

[35] Ibid.: "Physica speculativa, sive quae phaenomenorum rationem reddere nititur, non modo novos progressus, ut inceperat, minime fecit; sed in vanas, ac futiles Antiquorum resolutiones collapsa videtur."

[36] Ibid.: "Coelos minime solidos esse, ut finxerunt Antiqui: Terram non esse systematis nostri centrum, & Planetas potius circa solem revolvi."

[37] Ibid.: "quum Theorica motuum corporum Coelestium explicare aggreditur causam confusa magis, quam Antiqua, cum epicyclis, suisque solidis rotantibus Coelis observatur."

ciple; and then wants to give this same matter an intrinsic attractive force."[38] It is important to note that Newton himself did not endorse the view that gravity is an intrinsic force of matter. In Query 28, he explicitly suggested that gravity should be attributed to "some other Cause than dense Matter," and in the advertisement to the 1717 edition of the *Opticks* he denied having ever regarded gravity as "*an essential Property of Bodies*."[39]

Newton's *Opticks* provides a similar case. While it, according to Cominale, correctly concluded that the sun's refracted light produces seven colors through a prism, it "falsely teaches that the same light is composed of seven different types of rays," failing to explain it "according to the true mechanical laws, by which nature operates." Instead, it posits "some instinct, or innate attractive or repulsive force, or any other inclination created as necessity urges."[40] Cominale concluded: "Is this, I ask, a way of clarifying and mechanically explaining the actions of nature, or rather rejecting nothing beneath [a veil of] arcane and empty words? Therefore, it is very true that in these times, theoretical physics has relapsed into the vain absurdities of the ancients [namely, the reintroduction of occult qualities]."[41]

In the third chapter of *Anti-Newtonianismi pars secunda*, Cominale commented on Newton's natural philosophical explanations. He criticized what he saw as a fundamental inconsistency: on the one hand, Newton and his followers "despise primary causes and the first principles of things," as evidenced by Newton's self-proclaimed ignorance of the cause of gravity in the *Principia*.[42] On the other hand, they seem to elevate effects into causes.[43] In support of this latter point, Cominale cited Louis-Bertrand Castel's (1688–1757) critique of Newton's theory of the heterogeneity of white light, as presented in his *Optique des couleurs* (1740):

38 Ibid., 3: "Decernit materiam inertem esse, omnique intriseco activo principio destitutam; & dein hanc eandem materiam vi intrinseca attrahente donari vult." Cf. ibid., 27–28.

39 Isaac Newton, *Opticks or a Treatise of the Reflections, Refractions, Inflexions & Colours of Light* (New York: Dover, 1952), 369, cxxiii. For further discussion, see Steffen Ducheyne, "Newton on Action at a Distance," *Journal of the History of Philosophy* 52 (2014): 675–702.

40 Cominale, *Anti-Newtonianismi pars secunda*, 3: "Veridica demonstrat historica, Solis lucem prismate refractam septem colores producere. At falsò nimis docet Theorica, ex septem diversis radiorum speciebus eandem esse compositam. [...] non idem speculativa juxta verae mechanices leges, quibus operatur natura, explanare aggreditur; sed statim illud, aut instinctu quodam, aut vi innata attrahente vel repellente, aut alia quavis inclinatione, ut necessitas urget, creata explicat."

41 Ibid., 3: "Est ne quaeso hicce modus enucleandi, ac mechanice explicandi naturae actiones, aut potius sub arcanis, vacuisque vocibus nihil explodere? Verissimum ergo est, hisce temporibus, Physicam Theoricam in vanas Antiquorum ineptias esse relapsam."

42 Isaac Newton, *The Principia: Mathematical Principles of Natural Philosophy*, transl. I. Bernard Cohen and Anne Whitman (Berkeley (CA): University of California Press, 1999), 943.

43 Cominale, *Anti-Newtonianismi pars secunda*, 26: "Spernunt Newtoniani, a Magistro edocti, causas primas, primaque rerum principia [...];" 29: "quod erigit effectus in causas."

> It is a known fact that he [i.e., Newton] always stops at the phenomena, turns them over, notes them, enriches them with a thousand parallel, investigated, curious, and marvelous phenomena, which he immediately erects into causes and principles; refraction into refrangibility, color into colorability, redness into rubrification, gravity into gravitation, the central into centripetal, the accelerated into accelerative, tendency into attraction, and here, specifically, the spectrum into reality.[44]

At the heart of Cominale's criticism of Newton's natural philosophy lies his analysis of how Newton, in his view, misused mathematics in theoretical physics. Cominale readily embraced the usefulness of mathematics in advancing physics. "Geometry," he observed, "which considers all extension and compares and estimates magnitudes under various figures, unfolds easy ways to achieve knowledge of various proportions that exist between different parts of matter, and to measure various magnitudes."[45] However, he remarked that physicists nowadays "seek to derive physics from geometry and not at all urge geometry to serve physics, as things should be."[46] In this context, he claimed that it is highly ironic that in his *An Account of Sir Isaac Newton's Philosophical Discoveries* (1748) the Scottish mathematician Colin Maclaurin (1698–1746), "Newton's pupil" and his ardent defender, cited Francis Bacon's (1561–1626) perceptive claim that "*mathematics must round off natural philosophy, and not generate or create it*," failing to observe "that Newton himself had forced geometry to serve natural philosophy."[47] Despite the usefulness of mathematics in

[44] Ibid., 26–27, quoting Louis-Bertrand Castel, *L'optique des couleurs* (Paris: Chez Briasson, 1740), 381: "Il s'arréte toujours, c'est un fait connu, aux phaenomenes, les retourne, les constate, les enrichit de mille phaenoménes paralleles, recherchés, curieux, merveilleux, qu'il erige tout de suite en causes, & en principes; la réfraction en réfrangibilité, la couleur en colorabilité, la rougeur en rubrification, la gravité en gravitation, le central en centripete, l'acceleré en acceleratif, la tendance en attraction, & ici nommement, le *spectre* en réalité." On the French Jesuit Castel, who was involved in the *Mémoires de Trévoux*, see Jean-Olivier Richard, "The Art of Making Rain and Fair Weather: The Life and World System of Louis-Bertrand Castel, SJ (1688–1757)" (PhD diss., The John Hopkins University, 2015).

[45] Ibid., 3: "Geometria enim, quae extensum omne considerat, & magnitudines sub variis figuris comparat, ac metitur, facillimas pandit vias ad varias proportiones dignoscendas, quae inter diversas materiae partes existunt, variasque magnitudines dimetiendas."

[46] Ibid., 4: "ex geometria physicam educere contendunt; & minime physicae geometriam inservire cogunt, ut revera se res habere deberet."

[47] Colin Maclaurin, *An Account of Sir Isaac Newton's Philosophical Discoveries in Four Books* (London: Printed for the Author's Children, 1748), 35: "*Mathesin philosophiam naturalem terminare debere, non generare aut procreare*"; Francis Bacon, *The Oxford Francis Bacon*, ed. by Graham Rees with Maria Wakely, vol. 11 (Oxford: Clarendon Press, 2012), 155; Cominale, *Anti-Newtonianismi pars secunda*, 4: "non observabat, Newtonum ipsum geometriae philosophiam naturalem inservire coegisse." For a discussion of Bacon's view on the role of mathematics in physics, see e.g. Giuliano Mori, "Mathematical Subtleties and Scientific Knowledge: Francis

advancing physics, Cominale warned that "where it is poorly applied, it has the power to produce the most fertile errors, as Louis-Bertrand Castel cautions."[48] Cominale stated that the application of mathematics to nature, "due to the solidity and evidence of its demonstrations," seems to be a privileged and certain method in physics. However, he continued, "its abuse has reached the point where it has lost most of its evidence," resulting in "mathematicians being no less entangled in their demonstrations than physicists are regarding natural philosophical questions."[49]

To distinguish between proper and incorrect applications of mathematics in physics, Cominale, indebted to the Dutch scholar Nieuwentijt, differentiated between pure mathematics and mixed mathematics.[50] While Nieuwentijt himself regarded Newton's natural philosophical work as exemplary cases of mixed mathematics, Cominale viewed it instead as exercises in pure mathematics. Pure mathematics, Cominale explained, builds on abstract ideas, that "not only never existed outside the intelligible world or the world of ideas, but also will never exist." Mixed mathematics, on the other hand, is based on ideas "that really exist outside the intelligible or intellectual world."[51] Regarding pure mathematics, Cominale wrote:

Bacon and Mathematics, at the Crossings of Two Traditions," *The British Journal for the History of Science* 50 (2017): 1–21.

48 Cominale, *Anti-Newtonianismi pars secunda*, 4: "ubi male applicatur errores foecundissimos progignere valet, ut admonet Benedictus Castellus." For relevant excerpts, see Castel, *L'optique des couleurs*, 370–407, esp. 386–387: "Car voila l'inconvenient de la géometrie & de la justesse du raisonnement, de rendre l'erreur féconde & systematique."

49 Cominale, *Anti-Newtonianismi pars secunda*, 4: "Mathemata ob soliditatem ac evidentiam suarum demonstrationum prae caeteris facultatibus scientiae nomen sibi vindicasse videntur. At nostra hac tempestate eo devenit abusus, ut evidentiae suae maximam partem amiserint. Quoniam saepe saepius mathematicos in suis demonstrationibus implexos videmus non minus, quam physicos in naturalibus quaestionibus."

50 He referenced the French translation of Nieuwentijt's, *Het regt gebruik der werelt beschouwingen, ter overtuiginge van ongodisten en ongelovigen* (Amsterdam: By de Wed. J. Wolters, en J. Pauli, 1715). For a discussion of Nieuwentijt's distinction between pure and mixed mathematics, see Steffen Ducheyne, *Physics in Minerva's Academy. Early to Mid-Eighteenth-Century Appropriations of Isaac Newton's Natural Philosophy at the University of Leiden and in the Dutch Republic at Large, 1687–c.1750* (Leiden: Brill, 2025), 125–132. The terms 'pure mathematics' and 'mixed mathematics' were introduced previously by Willem Jacob 's Gravesande in 1719 (ibid., 126). It should be noted that Bacon, whom Cominale, as we have seen, cited, already distinguished between pure and mixed mathematics (for a discussion, see Gary I. Brown, "The Evolution of the Term 'Mixed Mathematics'," *Journal for the History of Ideas* 52 (1991): 81–102, 81–83).

51 Cominale, *Anti-Newtonianismi pars secunda*, 4: "Alterum ideæ constituunt, quas ipsi ut meras ideas abstractas considerant, quaeque non modo nunquam extra Mundum intelligibilem, sive Idearum extiterunt: sed nec etiam existent. Alterum obiectum constituunt ideae, quae realiter extra Mundum intelligibilem sive intellectualem existunt." The terms 'pure mathematics' and 'mixed mathematics' are Nieuwentijt's, not Cominale's.

> The first ideal and abstract mode of philosophizing is observed in speculative geometry, of which Euclid's *Elements*, Archimedes's *The Method of Mechanical Theorems*, Theodosius of Bithynia's *Spherics*, and Apollonius' of Perga's *Conics* are examples, Algebra, and other similar [branches of mathematics]. In these, a point is conceived as a thing without parts, a line as a length without breadth, and a solid as penetrable; and in algebra, magnitudes or solids bestowed with more than three dimensions are proposed and examined. Yet these are abstract modes of conceiving things that never existed in the corporeal world. However, they are granted to geometers to solve and demonstrate their wonderful problems and theorems.[52]

To illustrate the difference between pure and mixed mathematics, Cominale referenced a quotation drawn from Pierre Gassendi's (1592–1655) *Syntagma philosophicum* (1658), according to which in pure geometry mathematicians have created "a kind of most free kingdom for themselves" by "abstracting quantity from matter" and supposing lines created by the 'flowing' of a point, lines lacking length and breadth, and the like.[53] In an embellishment that appears like it is part of the quotation from Gassendi but is not, Cominale added that while such assumptions is perfectly acceptable for pure mathematicians operating "in their kingdom of abstraction (*regno abstractionis*)," they are not permissible for physicists, who operate "in kingdom of matter (*regno materiae*)."[54] In the 1740s, Castel, to whom Cominale is indebted, contended that Newton mistakenly mixed mathematics

[52] Ibid., 4–5: "Primus idealis, & abstractus philosophandi modus observatur in Geometria speculativa, cujus generis sunt, Elementa Euclidea, Theoremata Archimedis, Sphaerica Theodosii doctrina, Sectiones conicae Apollonii Pergaei, Algebra, aliaque similia; In quibus concipitur punctum tamquam res, cujus nullae sunt partes, linea, ut longitudo latitudinis expers, & solidum penetrabile; & in Algebra proponuntur & examinantur magnitudines, sive solida pluribus, quam tribus dimensionibus donata. Verum hi modi sunt abstracti concipiendi res, quae in Mundo corporeo nunquam extiterunt. Attamen Geometris conceduntur, ut mira problemata, & Theoremata sua resolvant, & demonstrent."

[53] Pierre Gassendi, *Opera omnia*, vol. 1 (Lyon: Sumptibus Laurentii Anisson, & Ioan. Bapt. Devenet, 1658), 264b: "inprimisque Geometræ, quantitatem abstrahentes à materia quoddam quasi regnum sibi ex ea fecerunt quam-liberrimum, quippe nullo facto à materiae crassitie, pertinaciáque impedimento. Quare & supposuere inprimis in ea sic abstracta eiuscemodi dimensiones, ut punctum, quod foret prorsùs immune partibus fluendo lineam, longitudinemve latitudinis expertem crearet; [...]. [...] Atque istæ quidem suppositiones sunt, ex quibus mathematici intra purae, abstractaeve Geometriae cancellos, & quasi regnum consistentes suas illas praeclaras demonstrationes texunt, quasdámve adeò mirabileis, ut fidem omnem alioquin excessurae sint, ut nuper viri praeclari *Cavalerius*, & *Torricellius* ostenderunt de acuto quodam solido infinitè longo, & cuipiam tamen parallelepipedo cylindróve finito æquali."

[54] Cominale, *Anti-Newtonianismi pars secunda*, 5: "*uno igitur verbo Mathematici sunt, qui in suo illo abstractionis regno ea indivisibilia supponunt, quae sine partibus, sine longitudine, sine latitudine sint, ac eam multitudinem divisionemque partium, quae ad finem nunquam perveniat. Non item vero physici, quibus in regno materiae versantibus tale nihil licet.*"

and physics, thereby blurring the line between mathematical and physical explanations.[55] According to Cominale, Newton's mathematical program is misguided because it mixes "the kingdom of abstraction" and "the kingdom of matter":

> Let the moderns ponder this question and let them see how well they align with Newton's *Principia* and how this method inadequately blends ideal entities with real ones; […]. For whoever wishes to philosophize in physics in this manner, is one not easily led to praise ideal entities for real ones? […] In the meantime, who does not see that philosophizing with these ideal principles is the same as wrongly and excessively introducing ideal entities into real physics, which do not exist in nature?[56]

By way of example, Cominale mentioned that followers of Newton, such as the Scottish mathematician and natural philosopher John Keill (1671–1721), have argued that matter is infinitely divisible based on purely mathematical arguments.[57] This conclusion was unacceptable for Cominale and he stated that this would imply, as Antonio Genovesi (1712–1769), "the glory of our city [i.e., Naples]" and a Naples-based follower of Newton, has observed, that "bodies […] would be unions of modes without substance."[58]

Next, Cominale presented a number of detailed arguments highlighting the shortcomings of Newton's mathematical approach to physics. He criticized Newton because

[55] For a discussion of Castel's critique of Newton's *Principia*, see Yves Gingras, "What did Mathematics do to Physics?," *History of Science* 39 (2001): 383–416, 398–403.

[56] Cominale, *Anti-Newtonianismi pars secunda*, 7–8: "Perpendant quaeso haec Recentiores, videantque, quam bene hisce consonent Principia Mathematica Philosophiae naturalis Newtoni; & quomodo methodus haec male entia idealia cum realibus miscet; […]; qui enim hac in physicis philosophari voluerit, nonne facile entia idealia pro realibus venditare inducitur? […] Interim quis non videt, quod idealibus hisce principiis philosophari idem sit, ac in physica reali male nimis entia idealia introducere, quae in natura minime existunt?."

[57] John Keill, *Introductio ad veram physicam seu lectiones physicae* (Oxford: Impensis Thomae Bennet, 1702), 17–27.

[58] Cominale, *Anti-Newtonianismi pars secunda*, 9: "quod corpora, ut urbis nostrae decus Antonius Genuensis docte nimis admonet, essent uniones modorum absque substantia." The original statement occurs in Antonio Genovesi, *Disciplinarum metaphysicarum elementa, Mathematicum in morem adornata*, vol. 1 (Venice: Ex typographia Remondiniana, 1764), 183: "Si corpus quodlibet est physicὼs in absolutum infinitum divisible, corpus quodlibet est unio modorum sine prima substantia." On Genovesi, see e.g. Paola Zambelli, "Antonio Genovesi and Eighteenth-Century Empiricism in Italy," *Journal of the History of Philosophy*, 16 (1978): 195–208; Ferrone, *Scienza, natura, religione*, 609–641 and Addabbo, "The *Philosophiae Naturalis Principia Mathematica* in Naples," 43–45. On his physical work, see Immacolata Bergamasco and Maria Lippiello, "Il libro di Antonio Genovesi sulla fisica," in *Atti del XXIII Nazionale di storia della fisica e dell'astronomia, Università degli Studi di Bari, Dipartimento di Fisica, Bari, 5–7 giugno 2003*, ed. by Pasquale Tucci, Augusto Garuccio and Maria Nigro (Bari: Progedit, 2004), 61–82.

he "abstracts forces from acting bodies, or considers them merely mathematically, since he desires to perfect mathematics alone."[59] To support his critique, Cominale selectively quoted several isolated passages from the *Principia*.[60] He referenced Newton's statement in the *Praefatio*, where Newton asserted that "it seemed best in this treatise to concentrate on *mathematics* as is relates to natural philosophy."[61] Additionally, Cominale quoted comment in the scholium to Section 11 of Book I, which states that "Mathematics requires an investigation of those quantities of forces and their proportions that follow from any conditions that may be supposed."[62] To further illustrate Newton's disregard for physical causes, Cominale cited Definition 5, which claims that "*Centripetal force is the force by which bodies are drawn from all sides; are impelled, or in any way tend, toward some point as to a center*."[63] He also referenced the introductory text to Section 11 of Book I, where Newton writes: "For this reason I now go on to set forth the motion of bodies that attract one another, considering centripetal forces as attractions, although perhaps – if we speak in the language of physics – they might be more truly called impulses. For here we are concerned with mathematics; and therefore, putting aside any debates concerning physics, we are using familiar language so as to be more easily understood by mathematical readers."[64] Finally, he quoted the opening section to Book III, where Newton stated: "In the preceding books I have presented principles of philosophy that are not, however, philosophical but strictly mathematical – that is, those on which the study of philosophy can be based."[65] From these quotations, Cominale arrived at the following two conclusions:

> From the principles of Newton just explained, two things can be concluded. First, that Newton delivers the mathematical or abstract principles of natural philosophy rather than the real ones. Therefore, Newtonian physics will be merely intellectual or ideal. Furthermore, by this method, Newton compels geometry to serve physics in a repugnant manner. And since from ideal principles only ideal things and conclusions may flow, Newtonian physics will be an empty phantom, which perhaps will not exist outside the intelligible world: and thus, under Newtonian mathematics, by the abuse of geometry, ideal physics has been restored, akin to [its state] under the Peripatetic metaphysics in the past. In this [respect] in particular, if my opinion does not fail me, physicists should strive to form the intelligible world from observations of and the most exact experiments on bodies; certainly not

[59] Cominale, *Anti-Newtonianismi pars secunda,* 9: "Abstrahit Newtonus ab agentibus corporibus vires, sive mathematice tantum illas considerat, quoniam mathesin tantum excolere cupit."
[60] Ibid., 9.
[61] Newton, *The Principia*, 381.
[62] Ibid., 588.
[63] Ibid., 405.
[64] Ibid., 561.
[65] Ibid., 793.

> to erect the corporeal from the intelligible, as the Newtonians do, whilst they try to erect physics from the bosom of ideal geometry. And that these things are very true, I observe secondly, that Newtonians everywhere change abstract terms into real entities. They use the term 'attraction' abstractly, as the effort by which bodies tend either towards each other or towards some center; nor do they investigate or determine whether this effect depends on an extrinsic impelling force or on an intrinsic force. Subsequently, they exalt those abstract forces or effects into causes and assert that bodies truly have an innate attractive force, which are rather forces of impulses, as Newton himself teaches.[66]

According to Cominale, this represents a reversal of the proper method in physics, wherein historical physics, i.e. the exact description of phenomena, should precede theoretical physics, which provides the causes of these phenomena.[67] Cominale was not the first to argue that Newton's *Principia* is ideal rather than physical. Castel – whom Cominale cited – similarly observed that Newton relied on "purely ideal, abstract, and mathematical causes, that have nothing to do with the idea of cause and physical, effective, and operative influence."[68]

To elaborate on his critique of Newton's mathematized physics, Cominale discussed how the renowned Cantabrigian inadequately applied the notion of 'common center of

[66] Cominale, *Anti-Newtonianismi pars secunda*, 9–10: "Ab expositis modo Newtoni placitis duo colligere datur. Primo Newtonum principia mathematica, sive abstracta philosophiae naturalis tradere potius, quam realia. Erit igitur Physica Newtoniana mere intellectualis, sive idealis. Insuper Newtonus hac methodo Geometriae physicam turpe inservire cogit. Et cum ex principiis idealibus nonnisi res, & conclusiones ideales profluere possint; erit physica Newtoniana inane Phantasma, quod extra mundum intelligibilem forsan non existet: & en quomodo sub mathematicis Newtonianis, abusu Geometriae, physica idealis reddita est, non secus ac sub methaphysicis Peripateticis fuit olim. In eo praecipue, ni mea me fallit opinio, incumbere deberent physici, ut mundum intelligibilem observationibus, ac experimentis exactissimis ex corporeo efformarent; minime vero ex intelligibili corporeum educere, ut Newtoniani faciunt, dum è sinu idealis Geometriae phyicam educere contendunt. Et quod verissima haec sint, observo secundo, Newtonianos passim voces abstractas in entia realia commutare. Vocem attractionis usurpant abstracte, ut conatum illum, quo corpora, vel ad se invicem, vel ad aliquod centrum, tendunt; neque quaerunt, neque decernunt, num effectus ille dependeat a vi extrinseca impellente, an vero a vi intrinseca. Deinde abstractas vires illas sive effectus exaltant in causas, & asserunt, corpora revera vim innatam attrahentem habere, quae vires potius impulsus sunt, ut Newtonus ipse docet."

[67] Cf. Cominale, *Anti-Newtonianismi pars secunda*, 31: "In philosophando, physicam historicam, sive exactam phaenomenorum descriptionem Physicae Theoricae, quae phaenomenorum omnium rationem reddere, & causas exponere studet, praecedere feci."

[68] Louis-Bertrand Castel, *Le vrai système de physique générale de M. Isaac Newton* (Paris: Chez Claude-François Simon, 1743), 99: "*raisons purement idéales, abstraites & mathématiques* qui ne portent avec elles aucune idée de *Cause* & d'influence *physique*, *effective*, *opérative*."

gravity' to celestial bodies. Cominale observed that, when used legitimately, the notion of 'common center of gravity' between two bodies refers to the point on the lever (or any other medium) around which the two bodies equally exert their forces, when the centers of the two bodies are suspended from the ends of a lever (or are connected by any medium). He explained that, although both bodies are separate from each other, they will balance around a certain point as parts of a whole, forming a single body united by the lever (or another medium).[69] Newton and his followers misuse this concept when they mathematically consider the centers of gravity of, for example, the Earth and Moon. They "connect these centers with an ideal, namely mathematical line; and on this ideal line, they seek a point, found by the mind and calculation, which they commend as real, around which they want to balance the Earth and the Moon."[70] Furthermore, Cominale noted that "the Earth and the Moon, and the other planets, are highly distinct bodies, separate from each other, and united by no medium; because they float, as Newtonians please, in an immense vacuum; and so, they can in no way exert their forces around any common point."[71]

Newton's rules of philosophizing

In the second chapter of *Anti-Newtonianismi pars secunda*, Cominale offers a critique of Newton's first three *regulae philosophandi* – the foundational rules that underpin the theory of universal gravitation presented in Book III of the *Principia*.[72] Newton's first rule and its commentary read: "*No more causes of natural things should be admitted than are both true and sufficient to explain their phenomena*. As the philosophers say: Nature does nothing in vain, and more causes are in vain when fewer suffice. For nature is simple and does not indulge in the luxury of superfluous causes."[73] Cominale observed that this rule comprises two distinct parts. The first aims to prevent "philosophy from transforming into vain inventions of opinions" by avoiding hypotheses.[74] Here Cominale referenced

[69] Cominale, *Anti-Newtonianismi pars secunda*, 10.

[70] Ibid., 11: "linea ideali, mathematica nempe, eadem centra conjungunt; & in hac linea ideali quaerunt punctum, & mente, calculoque inventum, tamquam reale, venditant; circa quod aequilibrari volunt Terram & Lunam."

[71] Ibid., 11: "Lunam & Terram, caeterosque Planetas corpora esse distinctissima, & a se invicem disjuncta, nulloque medio unita; innatant enim, ut placet Newtonianis, in vacuo immenso; adeoque nullo pacto posse vires suas circa commune aliquod punctum exercere."

[72] Because, as Cominale noted, the fourth rule is often omitted by Newton's followers, he chose to mention it without offering further discussion (ibid., 25).

[73] Newton, *The Principia*, 794.

[74] Cominale, *Anti-Newtonianismi pars secunda*, 12: "ne Philosophia in vana abeat opinionum commenta." Although Cominale did explicitly state it, this is a direct quotation taken from an annotation by Jean-Louis Calandrini in Isaac Newton, *Philosophiae naturalis principia mathematica* [...]. *Perpetuis commentariis illustrate, communi studio Thomae Le Seur & Francisci Jacquier,* vol.

an annotation to Newton's first rule by Calandrini, included in the Geneva edition of the *Principia* (1739–1742) that was produced by Le Seur and Jacquier. Calandrini wrote: "if we wish to philosophize with evidence and certainty, we should neglect all hypotheses; for a hypothesis, if legitimate, indeed provides the possibility of a cause, but not at all its existence, since the same effect can be produced in many ways."[75] Cominale also referenced similar remarks by the newly appointed Leiden professor Pieter van Musschenbroek (1696–1761) in the French edition of his *Beginsels der natuurkunde* (1739),[76] as well as by Giovanni Maria Della Torre (1713–1782), a Naples-based follower of Newton.[77] Returning to Calandrini's annotation to the first *regula philosophandi*, Cominale highlights the second part of Newton's first rule, which prescribes that "no more causes of natural things are to be admitted than suffice to explain their phenomena." This, Calandrini argued, is obvious, "since when the true cause of an effect has once been found through experience, and especially when it has been demonstrated with the help of mathematics that that cause has that power which is sufficient to produce the effect, it is clear, however, that any other cause is useless."[78]

Cominale's first objection to the first rule is that nature is not, in fact, simple and often produces similar effects through different causes. To substantiate his claim, he drew on examples from the generation of animals and plants. Regarding animal generation, he cited Herman Boerhaave's (1668–1738) *Praelectiones academicae*, which outlines three distinct modes of animal reproduction: through the union of male and female specimen; via a

3, pt. 1, 2 (Geneva: Typis Barrollot & Filii, 1739–1742; henceforth: *Principia*$_{\text{Geneva}}$), note (a).

75 Cominale, *Anti-Newtonianismi pars secunda*, 13, quoting Newton, *Principia*$_{\text{Geneva}}$, vol. 3, pt. 1, 2, note (a): "si velimus cum evidentiâ ac certitudine philosophari; omnes hypotheses negligendæ nobis sunt; hypothesis enim si legitima est, causæ quidem possibilitatem, minimè verò existentiam adstruit, cum effectus idem pluribus modis produci possit."

76 Pieter van Musschenbroek, *Beginsels der natuurkunde beschreeven ten dienste der landgenooten* (Leiden: Samuel Luchtmans, 1739); Id., *Essai de physique*, transl. Pierre Massuet, vol. 1 (Leiden: Samuel Luchtmans, 1739), 14: "C'est pourquoi on ne doit pas raisonner par Suppositions; car il est clair, que dès que l'on suppose une Cause, on reconnoit n'être pas au fait de la véritable, puisqu'autrement il ne seroit pas nécessaire de faire des Suppositions. Toute conclusion, que l'on tire d'une Supposition, est bien éloigné de pouvoir être regardée comme Preuve, & nous laisse dans la même incertitude où nous étions auparavant."

77 Giovanni Maria Della Torre, *Scienza della natura*, vol. 1 (Naples: Appresso Raffaele Gessari, 1748), 4: "E per vero dire tolta di mezzo questa regola, dobbiamo introdurre immediatamente i possibili, già esclusi dalla Fisica." On Della Torre, see Ugo Baldini, "Della Torre, Giovanni Maria," in [various authors], *Dizionario biografico degli italiani*, vol. 37 (Rome: Instituto delle enciclopedia italiana), 573–577.

78 Cominale, *Anti-Newtonianismi pars secunda*, 13, quoting Newton, *Principia*$_{\text{Geneva}}$, vol. 3, pt. 1, 2, note (a): "nam cum vera effectûs causa per experientiam semel inventa est, & matheseos ope præsertim demonstratum est causæ illius eam vim quæ ad effectum producendum sufficiat, liquet aliam quamlibet causam esse inutilem."

specimen possessing both male and female organs, which interact with the corresponding organs of another such specimen; and through hermaphroditic specimens capable of self-fertilization.[79] Reflecting on the third case, Cominale posed a rhetorical question, "Now, if the axiom were true, namely that more is in vain when less will do, would not human generation be deemed superfluous? For it could have been accomplished by lesser means."[80] Cominale extended this argument to the plant kingdom, citing the reproduction of palms and acorns. He challenged Newton's notion of the simplicity of nature: "If Newton understands nature herself as the totality of things," he stated, "I deny that it is simple; is there anyone among mortals who could never perceive its diversity? Who could wish for its simplicity? Does not its variety delight, please, and demonstrate the power of the supreme deity?."[81] Returning to Calandrini's abovementioned annotation – which asserts that once a sufficient cause has been identified, all other causes are rendered useless – Cominale offered a pointed critique:

> For has he [i.e., Calandrini] not taught himself that the same effect can be produced in many ways? And can it not be arisen from very different, even opposite causes, as we will see below?[82] Why, therefore, if a single cause of a given effect is found, is the inquiry into others useless? It was first required to demonstrate that the same identical effect can be produced by only one and the same cause; then, certainly, the inquiry into other causes was useless, but the first part of this proposition indeed has not thus far been demonstrated; and I do not know whether Calandrini can [prove] it hereafter.[83]

[79] Cominale, *Anti-Newtonianismi pars secunda*, 14; Herman Boerhaave, *Praelectiones academicae in proprias institutiones rei medicae*, ed. by Albrecht von Haller, vol. 6 (Venice: Apud Simonem Occhi sub insigno Italiae, 1743–1745), 111–112.

[80] Cominale, *Anti-Newtonianismi pars secunda*, 14: "Nunc si verum esset axioma, frustra nempe fieri per plura, quae fieri possunt per pauciora; nonne frustranea dicenda foret humana generatio? fieri enim poterat per pauciora."

[81] Ibid., 15: "si per Naturam intelligat Newtonus ipsam rerum universitatem, nego, simplicem illam esse; ecquis Mortalium unquam ejus diversitatem percipere potuit? Ecquis ejusdem simplicitatem peroptare posset? Nonne ejus varietas delectat, juvat; & supremi Numinis potentiam demonstrat?."

[82] A couple of pages further, Cominale observed, for instance, that plants can be dried by both excessive heat and excessive cold (ibid., 20).

[83] Ibid., 15–16: "Nam, nonne ipse docuit, idem effectum pluribus modis produci posse? Nonne & a diversissimis causis, imo, & ab oppositis, ut videbimus infra, produci potest? Cur ergo dati effectus, inventa unica causa, inutilis est inquisitio aliarum? Demonstrare prius oportebat, idem identice effectum non nisi ab una eademque causa produci posse; tunc certe inutilis foret aliarum inquisitio: verum propositionis hujus pars prior adhuc demonstrata non est; & nescio, an id possit imposterum Calandrinus."

It is worth noting that Cominale was not the first to critique Newton's *regulae*, drawing on the complexity of the animal and plant kingdoms. As recent scholarship has shown, Van Musschenbroek advanced similar criticism independently.[84] However, Van Musschenbroek's objections surfaced only after the publication of *Beginsels der natuurkunde*, on which the French translation – used by Cominale – was based. Musschenbroek's objections were first made public in his *Introductio ad philosophia naturalem* (1762).[85] It appears therefore that Cominale critique – that Newton *regulae philosophandi* mistakenly presuppose the simplicity of nature – is an original one.

In his critique of the first *regula philosophandi,* Cominale further emphasized the irony that Newton, "who is proclaimed the greatest enemy of hypotheses," has himself introduced hypotheses.[86] To illustrate this, he cited a speculative passage from Query 31 of the *Opticks* (first edition: 1704), in which Newton proposed that "God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportions to Space, as most conduced to the End for which he form'd them; […]. […] Now by the help of these Principles [i.e., active principles such as gravity and the cause of fermentation and cohesion] all material Things seem to have been composed of the hard and solid Particles above-mention'd, variously associated in the first Creation by the Counsel of an intelligent Agent."[87] Cominale argued that this contention is no less speculative than the hypotheses of the ancient atomists, Democritus and Epicurus, which Newton "poorly adapted."[88] It can be argued, however, that this line of criticism fails to do justice to Newton's natural philosophy. Newton himself clearly distinguished between the demonstrative part of natural philosophy and the speculative part of natural philosophy. The demonstrative part is embodied in the mathematical demonstrations and experimental investigations in the *Principia* and the *Opticks*. The speculative part of natural philosophy, explicitly framed as exploratory, is to be found in the Queries added to the *Opticks*.[89] Cominale concluded his discussion by contending that hypotheses cannot – and should not – be entirely expelled from physics. To support this claim, he once more turned to Calandrini's abovementioned annotation which states:

> Nevertheless, where the hope of obtaining certainty from experiments and from there proceeding mathematically does not appear, it is permissible to use certain particular hypothe-

84 Ducheyne, *Physics in Minerva's Academy*, 359–364.

85 Pieter van Musschenbroek, *Introductio ad philosophiam naturalem,* vol. 1 (Leiden: Apud Sam. et Joh. Luchtmans, 1762), 15–16.

86 Cominale, *Anti-Newtonianismi pars secunda*, 16: "qui[…] hypothesium inimicissimus depredicatur."

87 Cominale, *Anti-Newtonianismi pars secunda*, 16–17; Newton, *Opticks*, 400–402.

88 Cominale, *Anti-Newtonianismi pars secunda*, 17.

89 For a discussion, see Ducheyne, "Newton on Action at a Distance."

> ses to investigate the truth with new experiments, just as astronomers have applied various hypotheses to predict and more accurately observe celestial phenomena, and thus to investigate their true causes by conjecturing.[90]

Cominale then shifted attention to Newton's second rule of philosophizing, which states: "*Therefore, the causes assigned to natural effects of the same kind must be, so far as possible, the same.*"[91] Cominale argued that because this rule is a corollary of the first,[92] it too must be rejected in light of his critique of the first rule. He added that "in fact, Newtonians abuse this [rule] more than Newton himself; for he wisely qualifies it with the expression, *so far as possible*; and in his illustration, he limits himself to examples such as the respiration in man and in beast, the descent of stones in Europe and in America, [and] light in kitchen fire and the sun."[93] Newton added the phrase "*quatenus fieri potest*" in the second edition of the *Principia*,[94] a modification that can be interpreted as an implicit acknowledgement that the second rule, although effective in the context of the argument for universal gravitation, is not universally applicable.

Next on Cominale's list is Newton's third rule of philosophizing, which states: "*Those qualities of bodies that cannot be intended and remitted* […] *and that belong to all bodies on which experiments can be made should be taken as qualities of all bodies universally.*"[95] According to Cominale, if this rule is true, then "the most famous system of mutual gravity of all bodies collapses, and attraction – adorned with so many praises and loaded with so many honors, to which all the phenomena of nature are attributed today – vanishes very much like the wind."[96] To support this provocative claim, Cominale pointed out: "Because, ac-

[90] Cominale, *Anti-Newtonianismi pars secunda*, 19, quoting Newton, *Principia*$_{\text{Geneva}}$, vol. 3, pt. 1, 2, note (a): "Verumtamen ubi certitudinis obtinendæ ab Experimentis & indè Mathematicâ via procedendo spes non affulget hypothesibus quibusdam particularibus uti licet ad veritatem novis experimentis indagandam, quemadmodum Astronomi varias adhibuerunt hypotheses ut phænomena cælestia prædicere & accuratius observare, atquè ità veras eorum causas conjectando investigare possent."

[91] Newton, *The Principia*, 795.

[92] Cf. Della Torre, *Scienza della natura*, vol. 1, 4.

[93] Cominale, *Anti-Newtonianismi pars secunda*, 20: "Revera Newtoniani magis, quam Newtonus hac abutuntur; nam ipse sapienter advertit, *quatenus fieri potest*; & in illustratione affert tantum exemplum Respirationis in homine, & in bestia; Descensus lapidum in Europa, & in America; Lucis in igne culinari, & in Sole."

[94] Alexandre Koyré, I. Bernard Cohen, and Anne Whitman, eds., *Isaac Newton's 'Philosophiae Naturalis Principia Mathematica': The third edition (1726) with variant readings*, vol. 2 (Cambridge: Cambridge University Press, 1972), 550–551.

[95] Cominale, *Anti-Newtonianismi pars secunda*, 22; Newton, *The Principia*, 795.

[96] Cominale, *Anti-Newtonianismi pars secunda*, 22: "corruit celeberrimum de mutua corporum omnium Gravitate systema, & vento simillima evanescit tot laudibus condecorata, tantisque muneribus onerata, Attractio, cui hodie omnia naturae phaenomena accepta referuntur."

cording to Newton and all the Newtonians, gravity and attraction are one and the same; and both are not at all constant in bodies, since they can be remitted and intended in the same bodies, solely by varying the distance from the center of the Earth."[97] To show that this interpretation aligns with Newton's doctrine and that of his followers, Cominale cited Newton's own comment on the third rule, where he states that "Gravity is diminished [diminuitur] as bodies recede from the earth."[98] He also referenced a similar observation by the Leiden professor Willem Jacob 's Gravesande (1688–1742).[99] Now, if it is true that gravity and attraction can be intended and remitted by varying the distance, then they cannot be regarded as universal qualities of bodies, according to Cominale. As he argued: "Thus, the distance of a body from the center of the Earth, or of bodies mutually attracting or gravitating, could increase so that their gravity completely vanishes, and then the bodies would no longer attract each other or else fall back towards the Earth, because they are devoid of all centripetal force."[100] Although Newton clearly stated that gravity diminishes as the distance increases according to the inverse-square law, he did not support the notion that gravity could be wholly nullified as the distance increases.[101]

Conclusion

Cominale regarded Newton's natural philosophy (and that of his followers) as a popular yet ultimately transient school of natural philosophical thought. Central to his critique is his assertion that Newton's natural philosophy hinders the progress of physics through its misuse of the mathematical method. Cominale argued that Newton's *Principia* exemplifies an inversion of the proper natural philosophical method: rather than beginning with the analysis of phenomena and building toward theoretical physics, Newton attempted to

[97] Ibid., 22: "Quia, juxta Newtonum, Newtonianosque omnes, Gravitatio, & Attractio unum idemque sunt; & ambae minime in corporibus constantes sunt, quoniam remitti & intendi possunt in iisdem corporibus, sola variata distantia a centro Terrae."

[98] Cominale, *Anti-Newtonianismi pars secunda*, 23; Newton, *The Principia*, 796.

[99] Cominale, *Anti-Newtonianismi pars secunda*, 23; Willem Jacob 's Gravesande, *Physices elementa mathematica, experimentis confirmata. Sive introductio ad philosophiam Newtonianam*, vol. 2 (Leiden: Apud Johannem Arnoldum Langerak, Johannem et Hermannum Verbeek, 1742), 988: "[gravitas] immutabilis est in singulis Particulis; ad eandem Distantiam semper eadem; auctâ autem Distantiâ decrescit Vis, ut Quadratum Distantiæ augetur."

[100] Cominale, *Anti-Newtonianismi pars secunda*., 23: "Si vera, inquam sunt haec, vi expositae regulae, Gravitas, & Attractio minime ut qualitates corporum omnium accipi possunt. Nam eo increscere poterit distantia corporis a centro Terrae, sive corporum se mutuo attrahentium, aut gravitantium, ut gravitas eorum omnino evanescat; & tunc corpora non amplius se attraherent, aut versus Terram relaberentur, quia omni vi centripeta destituta."

[101] For a discussion, see Steffen Ducheyne, *"The main Business of Natural Philosophy:" Isaac Newton's Natural Philosophical Methodology* (Dordrecht: Springer, 2012), 114–118.

derive physics from mathematics. Drawing upon 's Gravesande's and Nieuwentijt's terminology, Cominale viewed Newton's *Principia* as an exercise in pure mathematics, rooted in abstract ideas that lack correspondence with physical reality. Consequently, Newton's *magnum opus*, in Cominale's view, remains an idealized construct, one that conflates mathematical explanations with physical explanations, rather than a genuine contribution to physics. As we have seen, Cominale's critique of Newton's mathematization of nature was influenced by the ideas of the Descartes-inspired Jesuit Castel.

While Cominale's critique of Newton's third *regula philosophandi* may fall short, his analysis of the first and second *regulae* is original, anticipating similar comments later made by Van Musschenbroek. As we have seen, Cominale challenged the principle of nature's simplicity underlying the first and second *regulae* by appealing to the generation of animals and plants. These phenomena, he argued, reveal nature's inherent diversity and show that similar effects can arise from different causes. To strengthen his critique, Cominale implied that even Newton acknowledged the second *regula* is not universally applicable, by adding the words "*quatenus fieri potest*."

Cominale was well-read in Newton's *Opticks* and *Principia*, and he demonstrated a broad familiarity with the works of several prominent proponents of Newton's natural philosophy, including Calandrini's annotations in the Geneva edition of the *Principia*, Maclaurin's *An Account of Sir Isaac Newton's Philosophical Discoveries*, Keill's *Introductio ad veram physicam seu lectiones physicae*, 's Gravesande's *Physices elementa mathematica, experimentis confirmata*, the French translation of Van Musschenbroek's *Beginsels der natuurkunde*, Genovesi's *Disciplinarum metaphysicarum elementa*, and Della Torre's *Scienza della natura*. Intellectually speaking, Cominale was far from the isolated and provincial figure he is often taken to be. As shown, Cominale was deeply engaged with contemporary debates surrounding Newton's natural philosophy. Moreover, he drew upon the arguments and conceptual frameworks of a wide range of authors – not only figures such as Gassendi and Castel, but also scholars like Nieuwentijt, Boerhaave and Van Musschenbroek, who are traditionally regarded as supporters of Newton's project – and, in doing so, he simultaneously contributed his own counterarguments to the ongoing debate. Although certain aspects of his critique may fall short, Cominale offered a distinctive and original critique of Newton's first *regula philosophandi*. It is our hope that this article will encourage further research into Cominale's work and its place within the broader landscape of eighteenth-century critiques of Newton's natural philosophy.[102]

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References

[anon.], "Italy." In *The Library: Or, Moral, and Critical Magazine, for the year MDCCLXII. By a Society of Gentlemen*, edited by Andrew Kippis, vol. 2, 273–276. London: printed for R. Griffiths in the *Strand*, and C. Henderson under the *Royal-Exchange*, 1762.

Abate Battarra, Giovanni Antonio. "Articolo d'una Lettera scritta dal sig. Abate Gio. Antonio Battarra di Rimino ad un suo Amico di Firenze il dì 22. Luglio 1760." In *Novelle letterarie pubblicate in Firenze*, edited by Giovanni Lami, vol. 21, 570–573. Firenze: nella stamperia di Gaetano Albizzini, 1760.

Addabbo, Claudia. "The *Philosophiae Naturalis Principia Mathematica* in Naples." In *Reading Newton in Early Modern Europe*, edited by Elizabethanne Boran and Mordechai Feingold, 23–63. Leiden: Brill, 2017.

Amorosi, Oronzo. *Gara letteraria inedita tra i Signori Oronzo Amorosi di Galatone e Celestino Cominale di Uggiano della Chiesa. Copiata dall'autografo di esso Amorosi da Vincenzo Lillo, 1821. Introduzione, trascrizione e note a cura di Gabriella Guerrieri*. Lecce: Conte, 1999.

Bacon, Francis. *The Oxford Francis Bacon*, ed. by Graham Rees with Maria Wakely. Vol. 11. Oxford: Clarendon Press, 2012.

Baldini, Ugo. "Della Torre, Giovanni Maria." In [various authors], *Dizionario biografico degli italiani*. Vol. 37, 573–577. Rome: Instituto delle enciclopedia italiana, 1989.

Belgioioso, Giulia. *Cultura a Napoli e cartesianesimo. Scritti su G. Gimma, M. Doria, C. Cominale*. Galatina: Congedo Editore, 1992.

Bergamasco, Immacolata, and Maria Lippiello, "Il libro di Antonio Genovesi sulla fisica." In *Atti del XXIII Nazionale di storia della fisica e dell'astronomia, Università degli Studi di Bari, Dipartimento di Fisica, Bari, 5–7 giugno 2003*, edited by Pasquale Tucci, Augusto Garuccio and Maria Nigro, 61–82. Bari: Progedit, 2004.

Boerhaave, Herman. *Praelectiones academicae in proprias institutiones rei medicae*, ed. by Albrecht von Haller. Vol. 6. Venice: Apud Simonem Occhi sub insigno Italiae, 1743–1745.

Brown, Gary I. "The Evolution of the Term 'Mixed Mathematics'." *Journal for the History of Ideas* 52 (1991): 81–102.

Casini, Paolo. *Newton e la coscienza Europea*. Bologna: il Mulino, 1983.

Castel, Louis-Bertrand. *Le vrai systême de physique générale de M. Isaac Newton.* Paris: Chez Claude-François Simon, 1743.

Castel, Louis-Bertrand, *L'optique des couleurs*. Paris: Chez Briasson, 1740.

Cominale, Celestino. *Anti-Newtonianismi pars secunda, in qua rejectis methodo, et philosophandi regulis Newtonianis, totiusque sectae principiis indicatis, evertitur prae caeteris, argumentis utplurimum ex adversariorum penu depromptis, vacuum, vis inertiae, mutua gravitas et attractio.* Naples: Ex typographia Benedicti Gessari, 1756.

Cominale, Celestino. *Praelectio Academica de lentibus quae congregant, et segregant luminis radios, earumque effectibus habita in Regio Archigymnasio Neapolitano a Caelestino Cominale Physices, et Matheseos extra ordinem Professore. In petitione cathedrae physices experimentalis IV. Idus Septembris Ann. MDCCLIX.* Naples: Typis Francisci Morelli, 1759.

De Simone, Luigi Giuseppe. "Dizionario biografico salentino." Biblioteca Provinciale di Lecce 'Nicola Bernardini', Ms. n. 249, n.d., vol. 1, n. 199.

De Tomasi, Giovanni Battista. "Celestino Cominale." In [various authors], *Biografia degli uomini illustri del Regno di Napoli ornata de loro rispettivi ritratti, compilata da diversi letterati nazionali, dedicata a S. E. RMA. Monsig. D. Gabriele M. Gravina, Arcivescovo di Militene Cappellano Maggiore di S. M. il Re del Regno delle due Sicilie*, vol. 9, 196–200. Naples: Presso Nicola Gervasi, 1822.

Della Torre, Giovanni Maria. *Scienza della natura.* Vol. 1. Naples: Appresso Raffaele Gessari, 1748.

Ducheyne, Steffen. "Newton on Action at a Distance." *Journal of the History of Philosophy* 52 (2014): 675–702.

Ducheyne, Steffen. *Physics in Minerva's Academy. Early to Mid-Eighteenth-Century Appropriations of Isaac Newton's Natural Philosophy at the University of Leiden and in the Dutch Republic at Large, 1687–c.1750.* Leiden: Brill, 2025.

Ducheyne, Steffen. *"The main Business of Natural Philosophy:" Isaac Newton's Natural Philosophical Methodology*. Dordrecht: Springer, 2012.

Ferrone, Vincenzo. *Scienza, natura, religione. Mondo newtoniano e cultura italiana nel primo Settecento.* Naples: Jovene Editore, 1982.

Gassendi, Pierre. *Opera omnia.* Vol. 1. Lyon: Sumptibus Laurentii Anisson, & Ioan. Bapt. Devenet, 1658.

Genovesi, Antonio. *Disciplinarum metaphysicarum elementa, Mathematicum in morem adornata.* Vol. 1. Venice: Ex typographia Remondiniana, 1764.

Giannì, Irene. "Le aberrazioni della *libertas philosophandi*: Celestino Cominale contra Isaac Newton." In *Filosofia e scienza nel Salento dell'età moderna*, edited by Adele Spedicati, 63–121. Lecce: Pensa multimedia, 2021.

Gingras, Yves. "What did Mathematics do to Physics?." *History of Science* 39 (2001): 383–416.

's Gravesande, Willem Jacob. *Physices elementa mathematica, experimentis confirmata. Sive introductio ad philosophiam Newtonianam*. Vol. 2. Leiden: Apud Johannem Arnoldum Langerak, Johannem et Hermannum Verbeek, 1742.

Guerrieri, Gabriella. "Newtonianesimo e antinewtonianesimo in Terra d'Otranto nella seconda metà del '700. Note in margine a un manoscritto inedito di Oronzo Amorosi." *Physis* 37 (2000): 535–542.

Guicciardini, Niccolò. "Editing Newton in Geneva and Rome: The Annotated Edition of the *Principia* by Calandrini, Le Seur and Jacquier." *Annals of Science* 72 (2015): 337–380.

Hamou, Philippe and Neil Ribe, eds. "Figures de l'antinewtonianisme/Faces of Anti-Newtonianism (1672–1832)." *Archives Internationales d'Histoire des Sciences* 53 (2003): 115–271.

Keill, John. *Introductio ad veram physicam seu lectiones physicae.* Oxford: Impensis Thomae Bennet, 1702.

Koyré, Alexandre, I. Bernard Cohen, and Anne Whitman, eds. *Isaac Newton's 'Philosophiae Naturalis Principia Mathematica': The Third Edition (1726) with Variant Readings*. Vol. 2. Cambridge: Cambridge University Press, 1972.

Lezzi, Giovanni Battista. "Vite de' letterati salentini." Biblioteca Provinciale di Lecce 'Nicola Bernardini', Ms. n. 52, n.d., 563–565.

Lezzi, Giovanni Battista. "Vite degli scrittori salentini." Ms. D/5, Biblioteca Pubblica Arcivescovile di Brindisi 'A. De Leo', 1787–1807, 308v–310v.

Lupoli, Michele Arcangelo. *De vita muniis et scriptis Francisci Serai philosophi et medici Neapolitani clarissimi. Commentarius.* Naples: Typographia Simoniana, 1784.

Maclaurin, Colin. *An Account of Sir Isaac Newton's Philosophical Discoveries in Four Books.* London: Printed for the Author's Children, 1748.

Maggiulli, Luigi. "Dizionario biografico degli uomini chiari di Terra d'Otranto." State Archive of Lecce, Ms. n.C 47, vol. 2, n. 209.

Marcialis, Maria Teresa. "Il 'cogito' e la coscienza. Letture cartesiane nella Napoli settecentesca." *Rivista di Storia della Filosofia* 51 (1996): 581–612.

Mazzotti, Massimo. "Newton in Italy." In *The Reception of Isaac Newton in Europe*, edited by Helmut Pulte and Scott Mandelbrote, vol. 1, 159–178. London: Bloomsbury, 2019.

Mori, Giuliano. "Mathematical Subtleties and Scientific Knowledge: Francis Bacon and Mathematics, at the Crossings of Two Traditions." *The British Journal for the History of Science*, 50 (2017): 1–21.

Newton, Isaac. *Philosophiae naturalis principia mathematica* […]. *Perpetuis commentariis illustrate, communi studio Thomae Le Seur & Francisci Jacquier*. Vol. 3, pt. 1. Geneva: Typis Barrollot & Filii, 1739–1742.

Newton, Isaac. *Opticks or a Treatise of the Reflections, Refractions, Inflexions & Colours of Light.* New York: Dover, 1952.

Newton, Isaac. *The Principia: Mathematical Principles of Natural Philosophy*, transl. I. Bernard Cohen and Anne Whitman. Berkeley (CA): University of California Press, 1999.

Nieuwentijt, Bernard. *Het regt gebruik der werelt beschouwingen, ter overtuiginge van ongodisten en ongelovigen.* Amsterdam: By de Wed. J. Wolters, en J. Pauli, 1715.

Richard, Jean-Olivier. "The Art of Making Rain and Fair Weather: The Life and World System of Louis-Bertrand Castel, SJ (1688–1757)." PhD dissertation, The John Hopkins University, 2015.

Rossetti, Felice. "Sistema nuovo intorno all'Anima pensante, e alla Circolazione degli Spiriti animali." In *Raccolta d'opuscoli scientifici e filologici*, edited by Angelo Calogerà, vol. 5, 265–316. Venice: Appresso Cristoforo Zane, 1721.

Rousseau, Pierre, ed. *Journal encyclopédique*. Vol. 4, pt. 3. Bouillon: De l'Imprimerie du Journal, 15 June 1763.

Van Musschenbroek, Pieter. *Beginsels der natuurkunde beschreeven ten dienste der landgenooten.* Leiden: Samuel Luchtmans, 1739.

Van Musschenbroek, Pieter. *Essai de physique*, transl. Pierre Massuet. Vol. 1. Leiden: Samuel Luchtmans, 1739.

Van Musschenbroek, Pieter. *Introductio ad philosophiam naturalem*. Vol. 1. Leiden: Apud Sam. et Joh. Luchtmans, 1762.

Zambelli, Paola. "Antonio Genovesi and Eighteenth-Century Empiricism in Italy." *Journal of the History of Philosophy* 16 (1978): 195–208.