CHAPTER 14

Teaching Magnetism in a Cartesian World, 1650–1700

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1 Introduction

Just before Christmas in 1641, the University of Utrecht held its usual rounds of disputations in philosophy. A candidate and student of Henricus Regius (1598–1679) claimed that every natural phenomenon could be explained by René Descartes's new philosophy without employing concepts such as the 'forms' or 'qualities' of the Aristotelians.[1] His opponent, Lambertus Van den Waterlaet (1619–1678), asked him how he would account for magnetic attraction without referring to 'forms' and 'qualities.' The unknown student was stumped and did not know how to answer. Somewhat feebly, he offered the announcement that Descartes was working on such an explanation. Gisbertus Voetius (1589–1676), who was presiding over the disputation, reacted with sarcasm: feeding the committee with hopes would be convenient for Jewish philosophers, he pronounced, who would give up as soon as they face the smallest difficulties and simply trust on the arrival of Elias, heralding the Messiah.[2]

Three years later, in July 1644, Descartes published his *Principles of Philosophy*. The longest section, namely fifteen per cent of the entire work, is devoted to a single topic: magnetic phenomena.[3] The use of magnetism, e.g., in navig-

1 This is reported in Schoock, *Admiranda methodus* (Utrecht, 1643), ****2r: "opponente [...] inferente, absque formis et qualitatibus praesentis omnia naturalia explicari posse. Cum eius specimen edi peteret Defendens et cum eo praeses vel in uno magnete, excipit arcanum quid inesse, atque ita concederentur qualitates occultae, quas tamen semper negare videntur." Cf. also Verbeek, *La querelle d'Utrecht*, 177; Bos, "Correspondence," 96, n. 9; Duker, *School-gezag en eigen-onderzoek*, 96–97.

2 Schoock, *Admiranda methodus*, ****2v: "similes esse tales philosophos Iudaeis seu Rabbinis, qui quotiescumque aqua ipsis haeret aut nodus insolubilis occurrit, dicere solent 'Elias veniet.' Interim spem pretio apud nos non emi." This alludes to Mal. 3, 23–24. On Schoock's and Voetius's anti-Semitic tendencies, cf. Pollmann, "The Bond of Christian Piety," 66.

3 Magnetism comprises 55 paragraphs, cf. Descartes, *Principia philosophiae* IV 133–184, AT VIII-A 275–311, *Principles* 259–293. For a quantitative analysis, cf. especially Meschini, *Indice dei* Principia philosophiae, 407. The lexeme MAGNES counts 198 instances. On Descartes's theory of magnetism, cf. Sander, *Magnes*, 717–743. This theory will not be re-sketched in this

ation with compass needles and the difficulty to explain the alleged magnetic action at a distance in natural philosophy had made magnetism a highly relevant topic by then, both with regard to theoretical and practical matters.[4] Descartes's main goal was the corpuscularian and mechanistic explanation of thirty-four magnetic properties, which Descartes knew mainly through the landmark publication *De magnete* (1600) by William Gilbert (1544–1603), and through his correspondence with the polymath Marin Mersenne (1588–1648).

In his explanation, Descartes first postulates a 'subtle matter' that pervades all seemingly solid bodies.[5] Then, to explain magnetism, he assumes compounds of matter as screw-shaped particles which he calls *particulae striatae*. Any magnetic body, even the earth itself, has a certain sphere of activity limiting its interaction with other magnetic bodies, defined by the radius of the orbital path along which the screw particles travel (see Figure 14.1). These screw particles can enter corresponding threads that run exclusively through magnetic bodies. Alignment of a magnet or a magnetic needle along the north-south axis of the magnetic Earth is caused by the flow of the particles that 'push' the magnetic object in the respective direction. In an equally mechanistic fashion, he explains attraction and repulsion between magnets. The details of this theory do not need to concern us at present, but it is already evident that the Cartesian theory is radically different from the so-called 'occult qualities' of the Scholastic tradition.[6] Descartes's account of magnetism is thus paradigmatic of his more general agenda to account for all physical phenomena by means of nothing but the geometric and kinematic properties of corpuscles—an account that can be labelled as "mechanistic."

Descartes's account of magnetism was highly anticipated; he frequently mentioned it in his correspondence, and it was widely discussed, criticized and celebrated shortly after its publication.[7] With his *Principles of Philosophy*, Descartes's aimed at creating a university textbook following and taking over the role of Scholastic textbooks used in the schools of his day.[8] He did so by implementing original rhetorical and visual strategies and by integrating a lot

chapter, as there is various literature dealing with it already. See the references in Sander, *Magnes*, 717–743; Sander, "*Terra AB*."

4 See Sander, *Magnes*.

5 See especially AT XI 24, AT I 176. This subtle matter was deduced from a theory of elements presented earlier in his *Principia*.

6 See note 13.

7 Sander, *Magnes*, 719–728; Strazzoni, "How Did Regius Become Regius?," 374, n. 51; Van Berkel, "Descartes' Debt to Beeckman," 48–59.

8 Cf. as a starting point, Ariew, *Descartes among the Scholastics*. On Descartes's intentions concerning the teaching of his philosophy, see Chapter 1, in this volume.

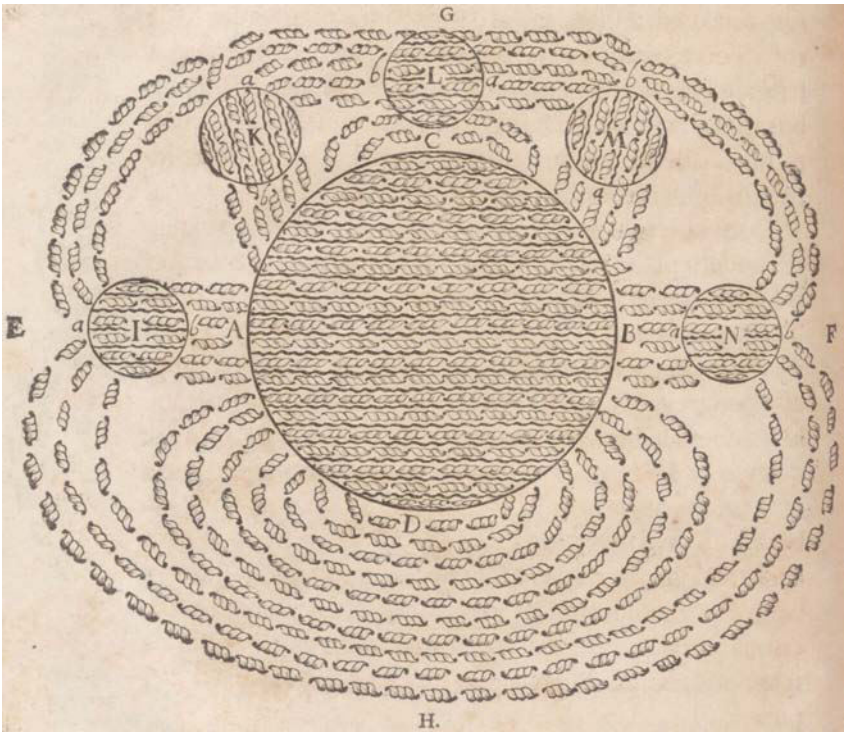

FIGURE 14.1 Descartes's "Terra AB". Descartes, *Principia philosophiae* (Amsterdam, 1644), IV 146, 271.
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of topics—e.g., magnetism—into the canon of textbook natural philosophy.[9] Moreover, studies have shown how Descartes's role within the Utrecht controversy impacted on his philosophy and shaped some aspects of his *Principia*.[10] Magnetism was a subject of longstanding controversy in Utrecht university disputations, in which Descartes's magnetism theory was also closely associated with its advocacy on the part of Regius.

What has not yet been the subject of scholarly work and will thus be the focus of this chapter is the fate of Descartes's theory of magnetism in the classroom after the publication of his *Principles of Philosophy*. Many writ-

9 His highly persuasive, richly illustrated and up-to-date theory of magnetism is a significant example of this pedagogical strategy. Cf. Zittel, *Theatrum philosophicum*, 382–395; Lüthy, "Where Logical Necessity," 97–133; Sander, "*Terra AB*."

10 The role of his magnetism theory has only occasionally been recognized in this regard. Cf. as a starting point Verbeek, *La querelle d'Utrecht*.

ten records testify to a wide diffusion of Descartes's thoughts on magnetism and thereby to the reception of his theory of magnetism as an example of the acceptance, transformation and refusal of Cartesian natural philosophy in European institutions of higher education in the 'Scientific Revolution.' It is almost a commonplace in current historiography to point out that this revolution, if it can be so designated, did not happen in an instant and did not simply replace one paradigm, say Aristotelianism, with another, say Cartesianism.[11] Most historians describe the acceptance of Cartesian thought in the seventeenth century as a long and gradual development, as a non-linear, non-monolithic, complicated, multi-layered process, not free of contradictions. As correct as this historiographical picture is, so much too does it need further confirmation based on historical sources. It first, and maybe foremost, needs case studies that provide cross-sectional analyses over longer durations and considering various locations.

This chapter, as with several more in this volume, aims to contribute to this array of case studies on the inclusion and reception of Cartesianism in academic learning in early modern Europe. Its result will not contest the 'big picture' but will add to it and confirm it. Theories of magnetism, as was the case with many other topics, were controversial among different schools of thought. Explaining magnetism touched core elements of natural philosophy and metaphysics, as well as the question of the extent to which natural phenomena could and should be explained at all—a normative question thus. Moreover, by the time Cartesian philosophy emerged, magnetism was often included as a topic in university curricula, being one of the most important 'enabling conditions' for any academic dispute about Cartesianism. Magnetism as a case study is therefore taken to be a reasonable choice.

2 The Institutional Context of Descartes's Theory of Magnetism

The Utrecht controversy occasioned the first criticism of Descartes's physics within an institutional context.[12] While Descartes was not affiliated to this university, his philosophy was eagerly promoted there by Henricus Regius, with Descartes becoming involved in the controversy through letters and pamphlets. Between 1639 and 1644, Descartes and Regius, proponents of a mechanistic and corpuscularian 'new' natural philosophy, were opposed by those

11 Cf., e.g., Garber, "Descartes and the Scientific Revolution."

12 Cf. also Bos, "Correspondence"; Descartes, *The Correspondence, 1643*, 182–192; Van Ruler, *The Crisis of Causality*; Goudriaan, *Reformed Orthodoxy and Philosophy*.

who defended a Calvinist version of Aristotelianism at Utrecht, especially Gisbertus Voetius and Martin Schoock (1614–1669). The physics of the *Principia* was to a large degree shaped during this controversy. The explanation of magnetism was part of this but, of course, never the central point of the entire controversy. However, the debate about the cause of magnetism exhibited the deeper epistemological and metaphysical disagreements between the two camps: the dispute frequently returned to the question of how Descartes's 'new type' of natural philosophy was able to cope with phenomena such as magnetic attraction that were usually accounted for by means of so-called 'occult qualities.'[13]

Sketching the debate on magnetism at Utrecht prior to the publication of the *Principles of Philosophy* in 1644 shall uncover a general pattern of critique against Descartes's theory of magnetism which informed also its later reception. The complicated series of events arguably began with Henricus Regius being appointed as a professor of theoretical medicine at Utrecht in 1638.[14] One year later, in 1639, the topic of magnetic attraction was brought up in a university disputation for the first time—planting the seeds of arguments (*semina contentionum*) yet to come.[15] From a later record of this disputation, of which the text itself has not come down to us, it can be inferred that Florian Schuyl (1619–1669) proposed a traditional Aristotelian explanation of magnetic attraction, while his unnamed opponent, presumably a student of Regius, defended the 'new philosophy' and refused the 'occult qualities' assumed in magnetic attraction. Regius, personally present at the disputation, claimed that

13 Cf., as a starting point, Weill-Parot, "Astrology, Astral Influences, and Occult Properties"; Hutchison, "What Happened to Occult Qualities?"; Sander, "Tempering Occult Qualities."

14 On Regius's biography, cf. especially Strazzoni, "How Did Regius Become Regius?."

15 See *Testimonium Academiae Ultrajectinae* (Utrecht, 1643), 14: "Quae hactenus semina contentionum sub glebis delituisse videbantur, primum erumpere coeperunt, occasione disputationis D. Florentii Schuilii, pro obtinendo Philosophiae magisterio publice institutae 9 Jul. anno 1639, ubi cum Opponens, secundum sententiam novae Philosophiae, omnes qualitates attractrices et qualitatem occultam magnetis oppugnaret, Medicus [sc. Regius] stans in subselliis D. Senguerdio, ordinario Philosophiae Professori et Promotori, satis indecore insultavit, et contra Doctiss. Candidatum, D. Senguerdii discipulum, triumphum ante victoriam cecinit; cum tamen, omnium Professorum judicio, Candidatus perquam solide et dextre omnia objecta dilueret, et non inconcinne Opponentem perstringeret, atque ad terminos revocaret." Cf. also Verbeek, *La querelle d'Utrecht*, 86; Bos, "Correspondence," 24; Van Ruler, *The Crisis of Causality*, 33, n. 68. According to Verbeek, *La querelle d'Utrecht*, 463, this disputation is not to be found. It has been pointed out that the record of the event has a bias against Descartes. Senguerdius was appointed ordinary professor on 11 March 1639; cf. Voetius and Le Long, *Hondertjaarige Jubelgedachtenisse*, 77.

the opponent had won the disputation and ended up in a seemingly heated argument with Arnoldus Senguerdius (1610–1667), Aristotelian philosophy professor and Schuyl's promotor.

The report does not tell us about Regius's mechanistic theory of magnetism, nor even explicitly affirm that it was mechanistic, let alone how Descartes would have explained magnetic attraction. It was first in a medical context, namely in a controversy over the physiology of the heart, that Regius in 1640 implicitly referred to his mechanistic account of magnetic attraction.[16] His allusion to magnetic attraction and its alleged mechanistic explanation remained very short and rather elusive.[17] Meanwhile, in December 1641, Regius presided over another medical disputation at Utrecht, which again discussed the powers of the heart. The candidate was Johannes De Raey (1622–1702), and the text for the first time presented a corpuscularian account of Regius's physiology, whilst including also a short passage on the magnet:[18] Regius promises to give an explanation of magnetic attraction by means of certain ties or *vincula* and openly refused 'occult qualities.' He announces that he will show on a future occasion that magnetic action does not work by attraction but by propulsion instead. That his theory still remained so succinct and a mere promise of a full-blown account might have been due to Descartes, who did not approve Regius's account of magnetism.[19]

16 See Regius, *Spongia* (Utrecht, 1640). The context is complex: in a disputation on the circulation of blood, presided over by Regius and defended by Johannes Hayman in 1640, an attractive force of the heart is openly denied. Instead, a mechanistic account of the heart and of blood circulation is developed. The magnet is not mentioned, although the 'attractive force' of the heart in Galenic medicine was sometimes compared to the power of the magnet; William Harvey (1578–1657), to whose theory of blood circulation Regius referred, also used this comparison. See the *Disputatio medico-physiologica pro sanguinis circulatione* in AT III 728, 731, 734. Cf. also Schouten and Goltz, "James Primrose," 331–352; Strazzoni, "The Medical Cartesianism"; Fuchs, *The Mechanization of the Heart*, 146–148; Maire, *Recentiorum disceptationes*, 148, 255. In his *Animadversiones*, James Primerose (ca. 1598–1659), an English physician, not only objected to Harvey's theory, but also read the Utrecht disputation and responded very critically to Regius's and Hayman's mechanistic theory in the same year. It is this writing by Primerose against which Regius, in 1640, argued in his *Spongia*.

17 Primerose returned to the question in 1644 and attacked this account of Regius; see *Anditotum adversus Henri Regii* [...] *Spongiam* in Maire, *Recentiorum disceptationes* (Leiden, 1647), 9–10, 31.

18 See *De morborum signis* as part of the *Physiologia*, edited in Bos, "Correspondence," 245. See also Regius, *Fundamenta physices*, 186. On the background, cf. also Galen, *On the Natural Faculties*, III, 15, ed. Brock, 325; Aucante, *La philosophie médicale de Descartes*, 312; Grene, "The Heart and Blood," 324–336; McVaugh, "Losing Ground."

19 Regius sent a draft of his *Physiologia* (which was later printed) to Descartes, including the

De Raey's disputation of December 1641 was closely followed by the incident presented in the introduction of this chapter: Lambertus Van den Waterlaet's disputation, in which Regius and Voetius openly clashed on the question of the magnet. Regius informed Descartes about this disputation one month later, in January 1642. Descartes's own account was a subject of some anticipation in Utrecht University, even though he had not yet by this time developed his theory of magnetism. The argument had by then already become a high-stakes—almost ideological—dispute, although Descartes's presence in the debate up to this point was entirely mediated through Regius.

Descartes's role within the Utrecht controversy, however, was not as indirect as it may appear from these findings. Not only was he in close contact with Regius during this time, but he was also directly targeted by the attacks coming from the university establishment at Utrecht. Prompted by Van den Waterlaet's disputation, in December 1641, Voetius publicly defended traditional Aristotelian concepts such as 'occult qualities,' 'substantial forms,' 'final causes,' and the like, against the attacks put forward by Regius.[20] But Voetius was also clearly taking aim at Cartesian philosophy.[21] According to Voetius, magnetism could not be explained by means of geometrical and kinematic concepts (*per motum, quietem, situm, quantitatem, figuram*), and he accused

text of the aforementioned disputation by De Raey. Descartes replied to Regius in May 1641, AT III 546, Bos, "Correspondence," 73: "What you have written on the magnet, I would prefer to leave out, because it is not clear" (*quae habes de magnete, mallem omitti; neque enim adhuc plane sunt certa*).

20 Cf. the *Appendix de rerum naturis et formis substantialibus* of December 1641 as printed in Voetius, *Selectarum disputationum theologicarum pars prima* (Utrecht, 1648), vol. 1, 871–881. Cf. esp. Van Ruler, *The Crisis of Causality*, 9–34. For reactions, see Regius, *Responsio, sive notae in appendicem ad Corollaria theologico-philosophica*, and Bos, "Correspondence," 98–118. By 'occult qualities' Voetius meant, following Daniel Sennert, an unobservable quality of a natural body which was nonetheless the cause of its observable effects. For the philosophical background, cf. also Roux, "La philosophie mécanique (1630–1690)," 44–53; Beck, *Gisbertus Voetius*, 67; Goudriaan, *Reformed Orthodoxy and Philosophy*, 113–125. Cf. also the notes on magnetism in Van den Waterlaet, *Prodromus sive examen tutelare* (Leiden, 1642), vol. 1, 50, 88, 108; vol. 2, 9, 31–32. He refers to Voetius's charges and Regius's replies, and puts forward a list of magnetic phenomena that were to be explained by the deniers of 'occult qualities,' publicly or privately (*ad questiones hasce responsum vel publicum vel privatum exspectamus*); vol 2, 31–32. It seems that he also wanted to make good for his silence in the 1641 disputation. We also find Regius's ideas linked to ancient atomism in this chapter.

21 The theologian Voetius claimed already in 1640, in letters to Marin Mersenne, that Descartes's new philosophy showed heterodox tendencies, whilst Aristotelianism was much better harmonized with the word of the Bible; see Beck, *Gisbertus Voetius*, 64. More literature is referenced in Beck, *Gisbertus Voetius*, 60–90.

his adversaries of pansophism and arrogance as they attempted to reduce inexplicable natural phenomena to the mere collision of bodies.[22] Although Voetius's defence of 'occult qualities' is more sophisticated, it will suffice here to emphasize that, while accusing his opponents of arrogance, he invoked magnetism as a typical example of a physical effect which was to be explained by an 'occult quality.' Both Regius and Descartes, to the contrary, considered the notions of 'occult qualities' and 'substantial forms' as pernicious to the study of nature. They argued that these concepts were, by their very definition, inaccessible to human understanding.[23] Descartes even turned the moral accusation of arrogance back on Voetius. As he put it, it would be even more arrogant to define something as 'occult' only because some quality has not yet yielded to human understanding.[24]

Regius's explanatory account of magnetism in the original draft of the *Physiologia*, of which Descartes had disapproved, must have circulated, because in 1643 an extensive argument against it was articulated by Martin Schoock.[25] Schoock summarizes Regius's position as saying that magnetism does not work by attraction but by exhalations passing out at one pole, travelling around the magnetic body by some *circumpulsio* and entering the other pole. Schoock criticizes Regius for virtually eliminating a whole ontological category, namely the power of attraction, and discredits his whole theory as atomistic, invoking all of the heretical implications of the term.[26]

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22 See especially Verbeek, "From 'Learned Ignorance' to Scepticism," 31–45. Cf. also Van Ruler, *The Crisis of Causality*, 313.

23 For the text of the *Physiologia*, see Bos, "Correspondence," 240. 'Occult qualities' are also refuted in Regius, *Responsio, sive notae in appendicem ad corollaria theologico-philosophica* (Utrecht, 1642), 28–31. Cf. also a February 1642 letter from Descartes to Regius in AT III 505–506, and Bos, "Correspondence," 116. Cf. also Van Ruler, *The Crisis of Causality*, 207, 244.

24 See the letter from Descartes to Regius, [February 1642], AT III 507.

25 See Schoock, *Admiranda methodus*, 228: "Inter lapides opacos admirandus est magnes, cuius operationes non fiunt per attractionem, sed circumpulsione corporum magneticorum vi exhalationis magnetica e tellure versus septentrionem vel austrum exhalantis."

26 Cf. Schoock, *Admiranda methodus*, 229–230: "Sin vero nec de illis studiosus credere debeat agere per attractionem, quod nihil per attractionem agere soleat, liquido ostendatur attractionem entium classe movendam esse." Cf. Schoock, *Admiranda methodus*, 230–231: "Democriti atomi magneticis profluviis seminibusque turgeant […] Illationis nostrae absurditatem spongiis delebimus simul ac Philosophantibus, definire placuerit quid aut corpus magneticum sit, aut quid magnetici in quoque corpore inveniatur, et ad qualium entium classem hoc referri debeat." Cf. Schoock, *Admiranda methodus*, 231: "Magnetismi malum in novis quibusque opinionibus invenio, sive enim per attractionem sive circumpulsionem agant, multos ad se invitant, quorum ignorantiam scutica expiandam novi commenti palliat. Scilicet qui antiquam philosophiam in pariete nunquam pictam vider-

When Descartes published his theory of magnetism in 1644, it was neither unheralded nor completely new. Not only had he relied on Isaac Beeckman's ideas about the cause of magnetism—treatment of which is beyond the scope of this chapter—but his close contact with Regius certainly informed his theory.[27] More importantly, the Cartesian theory of magnetism was already—*avant la lettre*—employed and invoked in the Utrecht controversy, mostly through Regius's anticipation of it. Descartes's theory of magnetism was drawn into an educational, institutional conflict, and was exploited by both sides, even though it had not yet been published. Many of the assumptions made by both parties, Regius and Voetius, about which direction it would go—a corpuscularian, mechanistic account, rendering 'occult qualities' useless—were more or less correct; Descartes even concluded his account of magnetism with a general refusal of 'occult qualities' whose alleged effects could be perfectly explained by the particles he imagined.[28] However, his theory of magnetism was much more sophisticated and elaborate than either Regius, Schoock, or Voetius probably might have guessed. For the following, it suffices to underline that Descartes's theory was quite extensive, covering thirty-four magnetic effects, and was based on the concept of a certain, screw-shaped type of particle—the *particulae striatae*.

3 The Dutch Follow-Up

With the 1644 publication of the *Principles of Philosophy*, the controversy about the 'correct' explanation of magnetism in Dutch universities was not over.[29] The first to receive and adapt Descartes's theory of magnetism in Utrecht was certainly Regius himself, but his friendly collaboration with Descartes also came to an end at this time. When Regius published his own physics, the *Fundamenta physices*, in 1646, his description of magnetism seemed at first glance to be a copy of Descartes's account.[30] Descartes himself accused Regius of

unt, ventis ac sacrae oblivioni eam consecrarunt, quia per occultam circumpulsionem aut circa Fluddi aut Cartesii magnetem haerent, qui duum viri entia eiusdem se cum simplicitas ad se invitando, alarum remigio ad audacis loquentie superbaeque maledicentie sphaeram facile sublevari possunt." Cf. for more details also Sander, *Magnes*, 703, 726–727, 735.

27 On Descartes and Beeckman, cf. Sander, *Magnes*, 721–722.

28 Cf. Descartes, *Principia philosophiae* IV 187, AT VIII-A 314.

29 For the Dutch reception, cf., as a starting point, Verbeek, *Descartes and the Dutch*; Schmaltz, *Early Modern Cartesianisms*; Strazzoni, *Dutch Cartesianism*.

30 As a starting point, cf. Dechange, "Die frühe Naturphilosophie des Henricus Regius"; Ver-

plagiarism, although he did not specifically point to the section on magnetism.[31]

Regius's claimed to have worked out his account years before, and Schoock's extensive attack against it one year before the *Principia* was printed seems to prove this.[32] Regius may have developed an elaborate corpuscularian explanation of magnetic phenomena before or independently of Descartes, although there is very little evidence predating the publication of the *Fundamenta* in 1646 to suggest that this was the case. Featuring many of the same theoretical elements that are crucial also for Descartes's theory, that of Regius was conceived as an atomistic theory in the manner of Democritus. Having had access to the *Fundamenta* in draft form since July 1645, Descartes tried to prevent Regius from publishing his account. While the two men formed an alliance in the early stages of the Utrecht controversy, this alliance fell apart shortly thereafter as they came into conflict.[33] Although their quarrels did not touch upon the issue of magnetism or natural philosophy in particular, their discord might have influenced Descartes's silence about any influence from Regius regarding his theory of magnetism. His use of a different vocabulary to that of Regius, may have been a deliberate strategy on the part of Descartes to disguise this connection.[34] A student of Regius, Petrus Wassenaer (d. 1688), claimed in 1648 that Regius had developed and taught a theory of

beek, "Regius's *Fundamenta physices*"; Strazzoni, "The Medical Cartesianism of Henricus Regius."

31 This statement is made in the preface of Descartes, *Les principes de la philosophie*.

32 Regius recollected that it was a passage in the commentary by Galen on Plato's *Timaeus* that had at first given him the occasion, years earlier, to conceive of magnetic attraction as a *circumpulsio*. See Regius, *Fundamenta physices*, 141–142: "Atque ex his patet, verum esse illud Platonis, apud Galenum in Timaeo dicentis, magnetem non per attractionem, sed circumpulsionem agere, quod, ut dicam quod res est, mihi jam ante multos annos occasionem veram magneticarum operationum causam investigandi et proponendi, primum dedit." Regius refers to Galen, *Aliquot opuscula nunc primum Venetorum opera inventa et excusa, quorum sequens tibi pagella catalogum indicabit* (Leiden, 1550), 129: "Ipsum perfecto dogma per circumpulsionem […] appellatam, per quam vult respirationem perspirationemque fieri." There is no evidence suggesting that Descartes was inspired by Plato for his theory of magnetism. In fact, Plato refers to magnetic attraction in a materialistic manner, analogous to the process of breathing. Cf. Plato, *Timaeus*, 80^{c}. This certainly motivated Regius's talk of exhalation in the context of magnetic attraction.

33 Bos, "Henricus Regius et les limites."

34 See Verbeek, "Regius's *Fundamenta physices*." Regius's talk of *exhalatio* and *circumpulsio* was carefully avoided by Descartes, who used these expressions in other places and replaced them in the context of magnetism by mere synonyms such as *circumfusum* or *circumiacens*. Cf. Regius, *Fundamenta physices* (Amsterdam, 1646), 130, 133, 140, and Descartes, *Principia philosophiae* IV 133, 146, 152, 166, 186, 186, AT VIII-A 275–313.

magnetism "years before" Descartes's major publications.[35] This theory, according to Wassenaer's report, was based on "vortex-like exhalations" (*halitus vorticiosi*).

Regius was not the only one impacted by the Cartesian theory of magnetism. His Dutch colleagues engaged assiduously with Descartes's account, without, however, arriving at a clear consensus in terms of approval or criticism. Arnoldus Senguerdius, for example, who presided over the 1639 disputation that ended in a harsh dispute with Regius, in 1643 presided over another disputation in Utrecht and explicitly referred to any corpuscular explanation as *improbabilis*.[36] Although he does not mention Descartes or Regius, this critique was certainly addressed to them amongst others. Those whom Senguerdius named included William Gilbert, a notorious critic of Aristotelian philosophy and major founder of the magnetic philosophy (*De magnete*, 1600), and the Jesuit Niccolò Cabeo (1586–1650), whose *Philosophia magnetica* (1629) could be seen as an updated Aristotelian reaction to Gilbert's magnetic philosophy.[37] In a later disputation (1652) and in the second edition (1652) of his textbook *Introductio ad physicam* (1644), Senguerdius stated that the corpuscular or atomistic account had only recently been refuted (*dudum explosa*), and Descartes is mentioned in a short bibliography amongst those who "ascribe magnetic operations to the movement of corpuscles."[38]

35 See Regius, *Brevis explicatio mentis humanae, sive, animae rationalis* (Utrecht, 1657), 13: "Iam ante multos annos, cum a te nondum quicquam praeter Methodum, Metora, et Dioptricam, in publicam lucem prodisset, docuit, ut plurimis eijus auditoribus constat, […] magnetis directionem, conjunctionem et excitationem, per geminos et diversos halitus vorticiosos factam." Cf. also Verbeek, "Regius's *Fundamenta physices*," 541. In Wassenaer's *Album amicorum* of 1648, there are benevolent entries not only by Regius, but also by Arnoldus Senguerdius and Gisbertus Voetius, leading to the assumption that the social situation was not as tense as one might expect.

36 Cf. thesis 11 of *De mineralibus … Abrahamus Roodenburgh, Ultraject. Ad diem 18. Februar … Anno 1643* as printed in Senguerdius, *Collegium physicum* (Amsterdam, 1652), X1r-Y1r: "Attractio magnetica explicatu difficillima est. Improbabilis est illa opinio, quae illius causam petit ab effluvio minutissimorum corpusculorum; ut et illa quae statuit magnetem ferrum tanquam alimentum suum attrahere, et illa quae dicit illam provenire ab inimicita naturae ferreae et lapideae quae in magnete detur. Probabiliora sunt quae Gulielmo Gilberto et Nicolao Cabeo traduntur; verum nullum illud desclarandi modum hactenus video, in quo animus plane acquiescat."

37 Cf. Cabeo, *Philosophia magnetica* (Ferrara, 1629); Pumfrey, "William Gilbert's Magnetic Philosophy"; Pumfrey, "Neo-Aristotelianism and the Magnetic Philosophy."

38 Cf. *Disputatio XIII. De mineralibus in genere; item de terris, succis et metallis, in specie. Resp. Michaele Eversdijk* as printed in Senguerdius, *Collegium physicum*, 181–206, here 205: "Quantum ad magneticorum attractionem attinet, putarunt veteres ex magnete corpuscula quaedam egredi, quibus agitatis ferrum moveatur ad magnetem. Haec opinio merito

Senguerdius's reference to corpuscular accounts of magnetism in his textbooks and disputations testifies to the fact that philosophers increasingly felt the need to take a position in public while Cartesianism gained ground. His disputation of 1652 was held at the Amsterdam Athenaeum, a university-like institution, where he had taken over the chair of philosophy from Caspar Van Baerle (1584–1648).[39] One year earlier, a study on the magnet by Van Baerle was posthumously published in which he proposed a theory of magnetism that clearly employs elements of a corpuscular account, yet without clear allusions to Descartes.[40] Senguerdius's student, Florian Schuyl, who in 1639 was his candidate in the Utrecht disputation arguing against Descartes and in favour of 'occult qualities,' even converted to Cartesianism later in his career. In what has been seen as an example of a "Kuhnian paradigm shift,"[41] in 1667, Schuyl declined to continue calling magnetism 'occult' in a speech given at Leiden University.[42]

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jam dudum explosa est; consumeretur enim brevi tempore magnes, tot corpusculis ex ipso egredientibus. Praeterquam quod ab illis, non ferrum tantum aut magneticam, sed etam alia corpora eundem subirent motum. Occultum quid hic in rei natura est, in cuius ratione libens fateor, me mihi satisfacere non posse." These disputations do not contain relevant passages: Senguerd (praes.) and Eyndhoven (resp.), *Disputatio physica decima continens quaestiones de mineralibus in specie* (Utrecht, 1645); Senguerd (praes.) and Renesse (resp.), *Disputatio physica nona continens quaestiones de mineralibus in genere* (Utrecht, 1645); Senguerdius, *Physicae exercitationes* (Amsterdam, 1658). The first edition of Senguerdius, *Introductio ad physicam* (Utrecht, 1644), remained silent on mechanistic accounts of magnetic attraction; cf. Senguerdius, *Introductionis ad physicam libri sex*, 2nd ed., 456. He also repeated his remark that this type of explanation had been recently refuted; see Senguerdius, *Introductionis ad physicam libri sex*, 2nd ed. (Amsterdam, 1653), 454–455: "Causam conjunctionis ferri et magnetis, vel raptus unius ad alterum, veteres petebant ab effluviis seu corpusculis, quae ex illis corporibus egrediantur. Prolixe hoc negotium carminibus suis proponit Lucret. lib. 6. Haec sententia dudum explosa est. Quibus tamen recentiorum illa minus displicet, qui etiam a motu exiguorum corpusculorum, hujus et aliorum magneticorum effectuum causam petunt." This part remained identical in the 3rd edition of 1666, 428–430.

39 Cf. Wiesenfeldt, *Leerer Raum in Minervas Haus*, 54.

40 On Van Baerle, cf. Reael and Baerle, *Observatien of ondervindingen aen de magneetsteen* (Amsterdam, 1651); Miert, *Humanism in an Age of Science*, 249; and Sander, "Magnetism in an Aristotelian World."

41 Cf. Van Ruler, "Substituting Aristotle," 160: "It exhibits all the dramatic features of a Kuhnian paradigm shift rather than a simple substitution of one scientific theory for another."

42 See Schuyl, *De veritate scientiarum et artium academicarum* (Leiden, 1672), 22. This is reproduced in Lindeboom, *Florentius Schuyl*, 125–152: "Crediturn fuit antiquitus magnetis facultatem esse qualitatem quandam occultam, quae hominis captum superet, solique magneti propria sit. Jam vero nescio an quicquam magnetis facultatibus sit manifestius,

In various disputations over which he presided before 1660, Martin Schoock clearly did not convert in this way, but kept on defending Aristotelian principles to account for magnetism against Cartesianism in various disputations over which he presided before 1660.[43] Senguerdius's son and student, Wolferdus, who also became a philosophy professor, appears to have been much more sympathetic to Cartesianism than his father.[44] Like Schuyl, Senguerdius *fils* was affiliated to Leiden University, where he taught philosophy. In one disputation (1679), he seems to claim the existence of 'occult qualities,' while in his *Philosophia naturalis* (1681), however, he presents a theory of magnetism that was clearly inspired by Descartes, although Descartes is not mentioned.[45] Senguerdius is still cautious and hesitant to determine (*non ausim determinare*) some of the details in explaining magnetic phenomena—e.g., the concrete shape of the particles—but he explicitly mentions the possibility of particles in the shape of screws, as Descartes had imagined.[46]

A further example of the lack of a clear consensus on the question of the Cartesian theory of magnetism is Jan De Raey (1622–1702), who was a student of Regius and a candidate in the disputation of 1641, in which Regius had for the first time sketched his own theory of magnetism. De Raey later moved to Leiden, where he was appointed philosophy professor.[47] His mission, according to a broad-brush description, was to combine Aristotelianism with Cartesianism. He referred to magnetism as one of the examples that 'subtle matter' would be able to account for and criticized the view of occult qualities as a cause of magnetism.[48] However, he never seems to have explicitly endorsed a mechanistic theory of magnetism à la Descartes or Regius. Later in his career, De Raey

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utpote cujus omnia effecta non modo unius aut alterius horae spatio ad oculum demonstrantur."

43 Cf. Schoock (praes.) and various (resp.), *Physica generalis* (Groningen, 1660), 11, 40, 199, 228, 239, 246, 249, 268, 271, 280, 286. Respondents are Johannes Wubbena, Pompejus Venhuysen, Winckon Tonkens, Jacob Duirsma, Marcus De Muinck and Tjapkon Conrad. Descartes is named in some of these, although his theory of magnetism is not discussed.

44 Cf. Wiesenfeldt, *Leerer Raum in Minervas Haus*, 139, 142.

45 See Senguerd (praes.) and Udemans (resp.), *Disputationum physicarum selectarum septima decima; quae est de particulis subtilibus, secunda* (Leiden, 1679), *corollaria*: "Dantur occultae qualitates." See Senguerdius, *Philosophia naturalis*, 1st ed. (Leiden, 1681), 254–259; 2nd ed. (Leiden, 1685), 355–362.

46 See Senguerdius, 1st ed., *Philosophia naturalis* (1681), 259; 2nd ed. (1685), 361.

47 Cf. n. 18. On De Raey, see Chapters 3 and 4, in this volume.

48 See De Raey (praes.) and Crooswyck (resp.), *Disputationum physicarum ad problemata Aristotelis, quintae de materia subtili* (Leiden, 1653), thesis 15; De Raey, *Clavis philosophiae naturalis* (Leiden, 1654), 24–25. De Raey did not develop a clear theory of magnetism himself in either of these works.

became professor in Amsterdam's Athenaeum. At that time, the school was the site of frequent discussions of magnetism, including the aforementioned cases of Van Baerle and Arnoldus Senguerdius. In 1658, Alexander de Bie (ca. 1620–1690) presided over three mathematical disputations on the magnet at the institution (respondents Sibertus Coeman, Johannes Brandlight, Johannes du Pire).[49] As they were primarily mathematical, they dealt with problems of magnetic declination rather than with natural philosophy, and nowhere was there any mention of Descartes. Yet, all three candidates referred approvingly either to the Jesuit Cabeo or to the Jesuit Athanasius Kircher (1602–1680), both of whom were proponents of Aristotelianism and critics of mechanistic or corpuscularian accounts of magnetism.[50]

When Sibertus Coeman (1643–1679), a student of de Bie and Arnoldus Senguerdius, died in Leiden, it fell to another of their students, none other than Burchard de Volder (1643–1709), to write the funeral oration.[51] De Volder described Coeman as trained in the principles of Peripatetic philosophy, which he also claimed for himself and his listeners, but added that "we" in physics also valued Galileo, Gassendi, and especially Descartes, "propagator of mechanical philosophy" (*illustris Mechanicae Philosophiae propagator*) and "light of our era."[52] De Volder is indeed remembered as a progressive scholar and as being sympathetic to Cartesian philosophy.[53] In his inaugural disputation at Utrecht in 1660, formally under the auspices of the rector of the university Gisbertus Voetius, he took an open stand for the Cartesian theory of magnetism in one of the corollaries: "By the *particulae striatae* [i.e., the screw-shaped particles] of Descartes, various effects of the magnet can be demonstrated."[54] He moreover

49 De Bie (praes.) and du Pire (resp.), *Disputatio de magnete, quae est de ejus ὀρθοβορεοδείξει* (Amsterdam, 1658); de Bie, (praes.) and Coeman (resp.), *Disputatio mathematica de acus magneticae deviatione* (Amsterdam, 1658); de Bie (praes.) and Brandlight (resp.), *Disputatio mathematica de acus magneticae inconstanti deviatione* (Amsterdam, 1658).

50 On Cabeo, see n. 37. On Kircher, cf. Kircher, *Magnes; sive, De arte magnetica opus tripartitum* (Rome, 1641); Baldwin, "Athanasius Kircher and the Magnetic Philosophy."

51 Cf. Coeman and de Volder, *Orationes duae, quarum altera inauguralis* (Leiden, 1679). See also Chapter 8, in this volume.

52 See Coeman and de Volder, *Orationes duae, quarum altera inauguralis*, E3^{v}.

53 On de Volder, see Wiesenfeldt, *Leerer Raum in Minervas Haus*; Miert, *Humanism in an Age of Science*; Strazzoni, *Burchard de Volder*.

54 See the *Corollaria physica* in de Bie (praes.) and de Volder (resp.), *Disputatio philosophica inauguralis* (Utrecht, 1660), A4r: "9. Vis attractrix, retentrix, expultrix mera ignorantiae asyla sunt. 10. Terra est magnes. 11. Magnetis polus tendit ad polum terrae. 12. Deviationis causa est, quod ab una parte plus terrae, quam ab altera sit. 13. Per particulas striatas Cartesii varia effecta magnetis demonstrari possunt. 14. Cabei qualitas duarum facierum non minus manifesta est quam quatuor primae qualitates."

dismissed the Aristotelian 'attractive force,' but at the same time also affirms that the conception of a 'quality of two faces,' which Cabeo used in order to explain magnetism, was no less manifest than the four primary qualities—in support of an Aristotelian theorem.[55] At the same time in Leiden (1677), de Volder presided over an disputation *De magnete*; while Descartes himself is not mentioned, his concept of *particulae striatae* does feature, this being the clearest shibboleth of the Cartesian theory of magnetism.[56] Yet, as contradictory as it may seem, the Jesuits Cabeo and Kircher are approvingly named within the text as well.

The foregoing analysis of discussions about Cartesian magnetic theory in Dutch institutions in the aftermath of the Utrecht controversy testifies to a tightly woven web of relations between, on the one hand, the scholars involved and, on the other, the different ways of dealing with the Cartesian theory of magnetism. Reactions ranged from outright refusal (e.g., Schoock), through mild critique and neglect (e.g., A. Senguerdius) or syncretistic and diplomatic acceptance (e.g., Van Baerle), to an implicit or even explicit adoption of the Cartesian doctrine (e.g., de Volder and Regius). Many of the scholars were connected to each other through the biographical tracks of their educations and careers, and partly even by family ties. Utrecht, Amsterdam, and Leiden are clearly the most relevant sites of the debate.

But what does this Dutch context prove on a more general level for the of teaching Cartesian philosophy in schools? It seems clear, at least to the extent that the case of magnetism can be taken as a valid indicator, that after the climax of the Utrecht controversy, from 1644 onwards, the situation calmed down within the institutions. Tensions remained and were apparent, but were dealt with much more discreetly. It is striking, for example, that even those who clearly sympathized with the Cartesian theory of magnetism rarely admitted this publicly and often refrained from naming Descartes at all.[57] His name had supposedly acquired a political meaning by that time. In institutions with a traditional curriculum, often still orientated towards the works and doctrines of Aristotle as a point of departure for teaching, openly appearing as a Cartesian might not have always ensured the smoothest or most promising career track. This is not to say that Dutch institutions between 1650 and 1670 did not engage with Cartesian philosophy, but it holds true that they did so in a rather balanced, nuanced and critical way.

55 Cf. n. 37.

56 See de Volder (praes.) and Helvetius (resp.), *Disputatio philosophica de magnete* (Leiden, 1677).

57 See note 29.

Focusing on the Cartesian theory of magnetism, it appears significant that empirical and theoretical achievements by two Jesuits, Cabeo and Kircher, were so openly approved within the Dutch institutions—even if the confessional animosities between Calvinists and Jesuits might appear much stronger and more blatant than any suspicion of heresy in Descartes. These Jesuits, too, were operating in an Aristotelian framework, which made them a helpful support in fighting mechanical physics, regardless of any theological disputes. A Jesuit or Aristotelian blend of magnetic theory needed not be taken as contradictory to a corpuscularian account. Van Baerle and de Volder, for example, seemed to be very much in favour of combining elements from both currents of natural philosophy, even if this remained very vague. Yet—and this is an important point—maybe with the exception of Regius's *Fundamenta*, none of the sources analyzed in the Dutch context discussed magnetism with the rigour and sophistication Descartes had exhibited in his *Principles of Philosophy*. Illustrations, for example, which are an important feature in Descartes's account, are lacking in any of the disputations examined. A full-blown support and approval of the Cartesian theory of magnetism as developed in the *Principles of Philosophy* was rare in the Netherlands in the first decades after its publication.

4 The Cartesian Theory of Magnetism Taught in European Schools

Seen from a wider geographical perspective and reaching further into the seventeenth century, the critique and the defence of Cartesian principles in explaining magnetism was livelier, and conducted more openly, in other parts of Europe, as the following spot tests and examples will show.

Although Descartes was not always mentioned, several Dutch scholars included only rather short chapters specifically dedicated to the magnet in their natural philosophical textbooks. Looking at the treatment of magnetism in a selection of seventeen textbooks published (most of them in various editions and even translations) between 1653 and 1727 all over Europe presents strong evidence for the impact of Descartes's theory of magnetism, particularly from the 1670s onwards.[58] This clearly characterizes Cartesianism as

58 Cf. especially Mouy, *Le développement de la physique cartésienne*, 82, 160, 225; Clarke, *Occult Powers and Hypotheses*, 136, 146, 160, 168, 216; McClaughlin, "Descartes, Experiments" 333; Roux, "Was There a Cartesian Experimentalism in 1660s France?," 62–63, 74–75, 77 (n. 116), 80, 82; Dobre, "Rohault's Cartesian Physics," 209, 215; Vermeir, "Mechanical Philosophy," 301; Maignan, *Pars secunda philosophiae naturae* (Toulouse, 1653), 1410–1457;

a phenomenon of European scale. Some of these textbooks are clearly and self-professedly Cartesian (e.g., those by Jacques Rohault, Antoine Le Grand, or Pierre-Sylvain Regis), some are clearly anti-Cartesian (e.g., those by Jean-Baptiste de La Grange, or Joannes Vicentius), while others are eclectic and conciliatory (e.g., those by Jean-Baptiste Du Hamel, Francesco Lana de Terzi, or James Dalrymple). All of them deal with the subject in a way whereby there is no question about the influence of Descartes's theory of magnetism, but not all of them name Descartes. Most of them deal with the topic as extensively as it was dealt with in the *Principles of Philosophy*, structuring it in more or less in the same way, namely by discussing various magnetic phenomena one after another. Some of them even add similar illustrations to render the theory more understandable.[59]

4.1 *A Particular Case: Louvain*

Including magnetism in textbooks of natural philosophy made it much more likely that students would come into contact with the Cartesian theory of magnetism, albeit mediated through the views of another author. However, it remains difficult to determine how many of those who refer to Descartes's theory of magnetism in an institutional context had actually read the *Principles of Philosophy*. That his theory of magnetism made it into classrooms, and also into classrooms far beyond the Netherlands, is evidenced by quite a few sources. A particularly well-documented example is the University of Louvain, where Cartesian doctrines were discussed early, found their first supporters around 1650, were condemned in 1662, and served as the basis for an entire curriculum from around 1670 onwards.[60] At the beginning of this process, Louv-

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Fabri, *Physica* (Leiden, 1671), vol. 4, 1, 16, 23, 129; Rohault, *Traité de physique* (Paris, 1671), 198–236; Rohault, *Tractatus physicus* (Geneva, 1674), 561–603; Rohault, *Tractatus physicus* (Amstedam, 1708), 403–426; La Grange, *Les principes de la philosophie* (Paris, 1675), 243–304; Vincentius, *Discussio peripatetica* (Toulouse, 1677), 356–407; Du Hamel, *Philosophia vetus et nova* (Nuremberg, 1682), vol. 2, 497–507; Le Grand, *Institutio philosophiae*, 2nd ed. (Nuremberg, 1683), 450–458; Du Hamel, *Philosophia vetus et nova* (Paris, 1684), vol. 2, 416–429; Lana de Terzi, *Magisterium naturae et artis* (Brescia-Parma, 1684–1692), vol. 3, 366, 369–375; Dalrymple, *Physiologia Nova Experimentalis* (Leiden, 1686), 486; Bartholin, *Specimen Compendii Physicae* (Copenhagen, 1687), 14–15; Dechales, *Cursus* (Leiden, 1690), vol. 2, 524–527; Regis, *Cours entire de philosophie* (Amsterdam, 1691), vol. 2, 220–257; Le Clerc, *Physica* (London, 1696), 125–133; Hilleprand, *Examen doctrinae Cartesianae* (Vienna, 1707), 98–134; Ode, *Principia philosophiae naturalis* (Utrecht, 1727), 95–109. The majority of these works have not been the subject of study. No examples from the British Islands and the Iberian Peninsula have been included here.

59 See Sander, "*Terra AB*."

60 For Cartesianism in Louvain, see especially the Chapters 15, 16, and 17, in this volume. See,

ain's professor Libert Froidmont (1587–1653), an early critic of Descartes, had not yet discussed the Cartesian theory of magnetism at the university.[61] His pupil, Vopiscus Fortunatus Plemp (1601–1671), also a professor in Louvain, was critical of many Cartesian doctrines and had discussed magnetic theory in his writings.[62] Plemp's writings on magnetism did not mention Descartes—who in any case had not yet published his *Principia*—but opted for an immaterial cause of the phenomenon, referring to 'sympathy,' and clearly taking for granted 'attractive forces' in nature, as had most physicians operating in a Galenic framework.[63]

Around 1650, there were Louvain professors who championed Cartesian ideas. One such professor was Willem Van Gutschoven (1618–1667). In a disputation presided over by him in 1651, his candidate openly argued along these lines, making magnetism a phenomenon only to be explained by "the laws of statics" and based on the principles of "matter and motion."[64] A 1652 lecture on natural philosophy attributed to Willem Van Gutschoven followed similar

as a starting point, in particular Vanpaemel, "Cartesianism in the Southern Netherlands," 221–230; Vanpaemel, *Echo's*; Radelet-de Grave, "Les Jésuites," 72–125. For the student notebooks that are discussed in the following, see especially Vanpaemel, Smeyers and Smets, eds., Ex cathedra; Mirguet and Hiraux, *Collection de cours manuscrits*.

61 Cf. Sander, *Magnes*, *ad indicem*.

62 See Plemp, *Ophthalmographia*, 1st ed. (Amsterdam, 1632), 78–79, 119, 256, 321; Plemp, *Fundamenta medicinae*, 3rd ed. (Louvain, 1654), 40, 42, 62, 66, 184, 204. Concerning Froidmont, Plemp and the teaching of Cartesianism in seventeenth-century Louvain, see Chapter 15, in this volume.

63 See Plemp, *Ophthalmographia*, 1st ed. (Amsterdam, 1632), 321: "Cuius causa tam mihi manifesta est, quam cur Magnes ferrum trahat. Blandimur vero nobis tantisper, dicendo: ob sympathiam accurrere ad oculos sanguinem." This passage was not included in later editions; see also Plemp, *Fundamenta medicinae*, 184: "magnes attrahit ferrum […] sine superadita facultate […] per […] vim trahentem […]. Facultas appetens […] reperitur […] in magnete […]." See also Plemp, *Ophthalmographia*, 3rd ed. (Louvain, 1659), 74: "non aliter quam magnes incorpoream quamdam vim ex se fundit, qua ferrum rapit." For background on the theoretical assumptions, see Sander, *Magnes*, 642–743.

64 Van Gutschoven (praes.) and Van Werm (resp.), *Philosophia* (Louvain, 1651), B2^{r}: "II. Praefatis principiis haec verba subsidio sunt: sympathia, antipathia, antiperistasis, virtutes magneticae, influentiae caelestes, qualitates occultae, et tota farrago praepotentum facultatum. Nobis materia et motus sufficiunt, ut ex ipsis tanquam principiis unicuique obviis, effectus naturales secundum leges staticae deducamus. III. Sic nulla potentia superaddita magnes ad polos mundi se dirigit; alterum magnetem et ferrum trahit, et fugat; illico ferro quod attingit, vim suam secundum ferri longitudinem communicat; ferro armatus videsies plus ferri sustinet; et licet magnetis poli contrarie sint virtutis, aeque tamn ad ferrum sustinendum se invicem iuvant, etc." This passage is also repeated in the identical disputation contained in Van Veen and Van Gutschoven, *Philosophia quam praeside*, B2^{r}. Magnetism as *explanandum* for a mechanical account is also briefly referred to

lines, as one of his students' notebooks reports: it argued at much greater length for the Cartesian theory of magnetism, and even mentioned his *particulae striatae*.[65] Descartes's name itself, however, was still not mentioned in this context.

Van Gutschoven's older brother, Gerard (1615–1668), also defended Cartesian natural philosophy. Around 1659, in his *Animadversiones in Ophthalmographiam*, he launched into an attack against Plemp. His critique touched on the magnet only once, and only as an incidental example, but Plemp's reply is more revealing. He ridiculed the mechanistic theory of particles orbiting a magnet as some sort of miraculous dance, and also attacked Regius, a *secator Cartesii*, for his alleged experimental proof of this orbit of particles.[66] In 1666, a Franciscan teacher at Louvain University, Willem Van Sichen (1632–1691), in his *Cursus* also explicitly targeted Descartes and his theory of magnetism.[67] His argument was epistemic: the precise means through which magnetism was caused were uncertain, and Descartes's *particulae striatae* were seemingly contrived without any solid reason.

But times were changing in Louvain, and Cartesian natural philosophy was on the rise. One of his students' notebooks shows that in 1675, Joannes Stevenot (ca. 1640–1718) lectured quite extensively on the Cartesian theory of magnet-

in Van Gutschoven (praes.) and Van Werm (resp.), *Philosophia* (Louvain, 1651), B2^{r}. Cf. also Geulincx, *Saturnalia*, 142–143; Vanpaemel, *Echo's*, 82.

65 See MS., Brussels, MS. II 737: anonymous (professor) and Meesters (student), *Physica* (1652), fols. 261^{v}–262^{v}. The attribution of the lecture to Willem Van Gutschoven is based on circumstantial evidence and argued for in Chapter 15, in this volume.

66 See Plemp, *Ophthalmographia*, 3rd ed. (1659), 249: "Ita est: nam dum omnia naturae opera mechanice, clare et distincte demonstrare conantur, in multos errores labuntur. Vide, quae dicant de motu magnetis ad ferrum, vel ferri ad magnetem; quas comminiscantur particulas ramosas, crassas, striatas; quas exire fingunt, impelli, repelli, redire, et nesco quas choreas agere, nullo praesultore, choraule vel chorago." See also Plemp, *Ophthalmographia*, 3rd ed. (1659), 255: "Illa agentia creata intelligo, quae operantur in distans aliquid a se emittendo; qualia sund calida, frigida, sonora, odora, purgantia, venena. Magneti esse circularem sphaeram activitatis ipse Henricus Regius secator Cartesii scribit in sui Physices fundamentis. Et magnes scobi seu ferragini chalybis immersus eamdem sibi circumquaque seu spherice adfigit, ita ut inde specie erinacei eximatur. Motus absurde huc producitur; quia non est agens, sed vel actio vel passio. Gravitas etiam non est tale agens, quod in distans aliquid a se emittit."

67 See Van Sichen, *Integer cursus philosophicus* (Antwerp, 1666), vol. 2, 58: "Potuisset certe Deus ita naturam instituisse, ut actio illa magnetica fieret per effluvia spirituum magneticorum, vel per particulas striatas, vel per qualitatem toto medio diffusam, aut etiam sic, ut actio inchoetur in distanti, vel denique per alium modum nobis occultum: quis autem de facto a natura adhibeatur, res est plane incerta." On Van Sichen, cf. also Monchamp, *Histoire du cartésianisme*, 430; Coesemans, "Faculties of the Mind," 198. Cf. also Birlens (praes.) and D'Overschie (resp.), *Theses philosophicae* (Louvain, 1660), B2^{r}: "Motus corpusculorum Carthesii tam est occultus, quam qualitates occultae."

ism.[68] Around this time, when Louvain had in practice established a Cartesian curriculum, Michael Hayé (d. 1676), a local printer, began producing engravings from some of the woodcuts of Descartes's *Principles of Philosophy*. Among others, he produced an engraving of the main image related to the theory of magnetism.[69] Three students included copies of it in their notebooks on *physica*: Leo Josephus Daco in 1678, Albertus Boone in 1680, and Balthasar Cox in 1687.[70] While Cox only dedicated a few lines to the magnet (fol. 307^{r}), Boone (fols. 178^{r}–180^{v}) and Daco (fols. 324^{v}–328^{v}) clearly tried to record a full explanation of the Cartesian theory of magnetism. Daco did not name Descartes here, but referred to his concept of the *particulae striatae*, and also began his section with a critique of 'occult qualities.' Boone mentioned Descartes by name, but more interesting still is the fact that his notes were based on lectures by the Louvain professor Léger Charles De Decker (1645–1723). De Decker is known as the presumed author of an anonymously published anti-Cartesian work, the *Cartesius seipsum destruens* of 1675, which harshly attacked Cartesian philosophy, yet not his theory of magnetism explicitly.[71] This criticism is likewise absent from the student's notes on the Cartesian theory of magnetism, making De Decker's anti-Cartesian polemics appear more as a private battle than the official position taken in the classroom—or, at least this seems to have been the case as far as magnetism was concerned.

One textbook that was especially important in informing the teaching of physics at Louvain was Jacques Rohault's *Traité de physique* (1671, translated into Latin 1674).[72] As has been mentioned, Rohault (1618–1672) followed Descartes in his account of magnetism. In the course of the eighteenth century,

68 See MS., Louvain, MS. 261: Stevenot (professor) and Van den Biesche (student), *Physica* (1675–1676), fols. 495^{v}–501^{v}. Cf. also Vanpaemel, *Echo's*, 99–102. On Stevenot, see Chapter 16, in this volume.

69 Cf. Vanpaemel, "The Louvain Printers."

70 MS., Brussels, MS. II 106: Wauchier (professor) and Daco (student), *Physica* (1678), fol. 326^{r}; MS., Louvain-la-Neuve, MS. C165: De Decker and Van Goirle (professors) and Boonen (student), *Physica & Metaphysica* (1680–1681), fol. 179^{r}; MS., Brussels, MS. 21127: anonymous (professor) and anonymous (student), *Physica* (1757), fol. 306^{r}. It seems that the page order in Ms. C165 is mixed up. Cf. however Vanpaemel, *Echo's*, 100: "In het laat-cartesiaanse curriculum kreeg het magnetisme weer wat meer ruimte toebedeeld, maar het wist niet uit te stijgen boven het niveau van een curiosum, ergens tussen de behandeling van de fossielen en de mineralen geplaatst. Een afzonderlijk dispuut werd aan het magnetisme niet gewijd."

71 Cf. [De Decker], *Cartesius seipsum destruens* (Louvain, 1675), 10–16; Vanpaemel, "Cartesianism in the Southern Netherlands," 225; Geudens and Papy, "The Teaching of Logic at Leuven University," 376.

72 Cf. Vanpaemel, "Rohault's *Traité de physique*." Cf. also n. 58.

the Cartesian theory of magnetism is dealt with extensively and frequently in Louvain University student notebooks.[73] Also in the second half of the eighteenth century, Hayé's magnetism engraving was reproduced by, amongst many others, the engraver Petrus Augustinus Denique (1683–1746). These prints were included in several notebooks of students at Louvain.[74]

4.2 *Other Parts of Europe*

Student notebooks bear a close witness to what was actually taught in classrooms, and rarely are they preserved as numerously and completely as at Louvain. However, printed university disputations, which survived in much greater numbers, also testify to the wider use of the Cartesian theory of magnetism in teaching. Most of these disputations occurred in German-speaking territories or in Scandinavian or Baltic areas.[75] Disputations *De magnete*, with discussions of the Cartesian theory of magnetism, were held in Weissenfels near Leipzig (1673), Strasbourg (1683), Marburg (1683), Basel (1685, 1686, 1692, 1697), Erfurt (1687), and Zerbst near Magdeburg (1693).[76] The positions taken by the authors

73 Referenced manuscripts are held in three libraries: Brussels, Koninklijke Bibliotheek van België / Bibliothèque royale de Belgique (KBB), KU Leuven Libraries (KUL), Louvain-la-Neuve, Archives de l'Université catholique de Louvain (AUL). In brackets, the date of composition is indicated. The folia indicate the section(s) on magnetism. Cf. KBB, MS. II 737 (1652), fols. 261v–262r; MS. II 106 (1678), fols. 324v–328v; MS. II 5444 (1739), fols. 248v–251r; MS. II 3294 (1763), fols. 172v–178r; MS. II 3214 (1720–1721), fols. 274v–279r; MS. II 3703 (1730–1731), fols. 289v–298r; MS. II 4269 (1754–1755), fols. 343v–348r; MS. 21127 (1756–1757), fols. 182v–187v; MS. II 4523 (1758–1759), fols. 215v–222r; MS. II 5602 (1760–1761), fols. 371r–378r; KUL, PRECA0021 (1785), fols. 99r–101v; MS. 247 (1772), fols. 40r–44r; MS. 302 (1774), fols. 178r–187v, 191v–192r; MS. 261 (1675–1676), fols. 495v–501v; MS. 211 (1686–1687), fol. 307r; MS. 326 (1750–1751), fols. 203v–212v; MS. 359 (1754–1755), fols. 158r–164r; MS. 284 (1779–1780?), fols. 122v–129r; AUL, MS. C210 (1761), fols. 273r–278v; MS. C202 (1774), fols. 97r–101v; MS. C163 (1781), fols. 134r–139v; MS. C59 (1785), fols. 211r–216r; MS. C165 (1680–1681), fols. 178r–180v; MS. C72 (1714–1715), fols. 257v–262r; MS. C75 (1738–1739), fols. 286r–291v; MS. C4 (1755–1756), fols. 566r–574v; MS. C28 (1746), fols. 287v–290v.

74 Cf. Sander, "*Terra AB*."

75 This bibliographic result depends on whether disputations were printed at all; see especially Friedenthal, Marti and Seidel, eds., *Early Modern Disputations*.

76 See Siegfried (praes.) and Pfundt (resp.), *Disputatio physica de magnete* (Weissenfels, 1673); Siegfried, "Curiöse Gedancken vom Magnete" (Dresden, 1704); Scheid (praes.) and Kast (resp.), *Quaestionum decades duae de magnete* (Strasbourg, 1683); Waldschmidt (praes.) and Kursner (resp.), *Disputatio physica, de magnete* (Marburg, 1683); Zwinger (praes.) and Gernler (resp.), *Disquisitionum physicarum de magnete prima* (Basel, 1685); Zwinger (praes.) and Gemuseus (resp.), *Disquisitionum physicarum de magnete secunda* (Basel, 1686); Zwinger (praes.) and Gemuseus (resp.), *Disquisitionum physicarum de magnete quinta* (Basel, 1692); Zwinger (praes.) and Schönauer (resp.), *Disquisitionum physicarum de magnete septima* (Basel, 1697); Zwinger, *Scrutinium magnetis physico-medicum* (Basel,

in these disputations mostly approve the Cartesian theory of magnetism. In Weissenfels, Strasbourg, Marburg, and Zerbst, Descartes's theory of magnetism was welcomed, while the disputation at Erfurt takes a middle position. Theodor Zwinger (1658–1724), in several of the disputations he presided over in Basel, integrated the Cartesian account into his eclecticism, and also referred to disputations on the topic by, amongst others, De Volder, Wolferdius Senguerdius, Du Hamel, and Johann Jakob Waldschmidt (1644–1689).[77]

In a miscellany manuscript of seventeenth-century Gotha, an anonymous German translation can be found of just the section on magnetism from Descartes's *Principles of Philosophy*.[78] The context of the production of this translation, which also reproduces the images, remains unknown, but circumstantial evidence points towards an educational setting, maybe the private tuition of Ernest I, Duke of Saxe-Gotha (1601–1675) and/or his many sons. The Duke was interested in magnetism, and experiments relating to this interest were conducted in Gotha as well.[79] Moreover, Veit Ludwig von Seckendorff (1626–1692), who was educated at Gotha's Ernestine Gymnasium and under the Duke's protection, was acquainted with Cartesian philosophy when Daniel Lipsdorp (1631–1684)—a propagator of Cartesian thought—was the court mathematician in Weimar between 1653 and 1656.[80] As the Gotha manuscript also contains a text by Andreas Reyher (1601–1673), the rector of the Gymnasium at that time, the translation of the part on magnetism has elsewhere, not implausibly, been ascribed to this pedagogue or his circle.[81]

While Cartesianism, and the Cartesian theory of magnetism in particular, seems to have flourished in the German-speaking regions, Descartes did not break through so easily south of the Alps, especially in the Catholic Italian territories. Although the general reception of Cartesian thought in Italy in the

1697); Vesti (praes.) and Fischer (resp.), *Disputatio physico-medica de magnetismo* (Erfurt, 1687); Limmer (praes.) and Wolff (resp.), *Dissertatio philosophica, de magnete ejusque effectibus* (Zerbst, 1693). See also Murhard, *Versuch einer historisch-chronologischen Bibliographie des Magnetismus* (Kassel, 1797). Waldschmidt promoted Cartesian ideas in many of his disputations in Marburg; cf. Schlegelmilch, "The Scientific Revolution in Marburg."

77 See especially Zwinger, *Scrutinium magnetis physico-medicum*, 32–37.

78 See MS., Gotha, Chart. A 707: anonymous, *Kürtzliche Erleuterung*, fols. 190r–202v: "Kürtzliche Erleuterung etlicher Vorgaben von der Würkung des MagnetSteins nach Anleitung und gesetzten Grundstücken von Cartesio." Another part of the manuscript is described in Cooper, "Placing Plants on Paper," 257–277. I thank Jacob Schilling for information on the background of this manuscript and its context. A digital copy of the manuscript is available at https://ch-sander.github.io/raramagnetica (accessed 12 December 2021).

79 Cf. Collet, *Die Welt in der Stube*, 61, n. 114.

80 Cf. Strauch, *Veit Ludwig von Seckendorff*, 150; Lipstorp, *Specimina philosophiae Cartesianae*.

81 See Lotze and Salatowsky, *Himmelsspektakel*, 193.

seventeenth century is not to be investigated here, some examples shall be given of how his theory of magnetism was received in the Roman Jesuit context. In their daily academic life in their many colleges and universities all over the world, Jesuits were, above all, teachers, and the Collegium Romanum was their flagship institute.[82] As is well known, Descartes was himself educated in a Jesuit college.[83] By their statutes and many decrees tied to Aristotelian philosophy, tensions between the Jesuits and Descartes existed already during his lifetime and did not stop after his death. As in the Utrecht controversy, metaphysical issues were at stake, such as the acceptance of 'substantial forms' and 'occult qualities.' Unlike Utrecht's theologians, however, many Jesuits were interested in studying magnetic effects in their own right, not least the aforementioned Cabeo and Kircher.[84] Cabeo's *Philosophia magnetica* preceded Descartes's *Principles of Philosophy* by fifteen years. Kircher's *Magnes*, which was also read by Descartes, also predated the publication of the Frenchman's work.[85] In the third edition of *Magnes* (1653), however, Kircher mentioned Descartes and criticized him as one of Epicurus' followers.[86]

The Jesuit college in Rome also possessed some of Descartes's writings.[87] In the same year of Kircher's reference to Descartes, 1653, Niccolò Zucchi (1586–1670) deals with the Cartesian theory of magnetism in his manuscript study *Philosophia magnetica*.[88] Yet, he does not name Descartes, but only his *particulae striatae* and again considers this theory as atomistic.[89] Zucchi also included a longer digression on the theory of magnetism as put forward by Emmanuel Maignan (1601–1676) in 1653, who himself reworked Descartes's account.[90] In later Jesuit textbooks of natural philosophy, Descartes's theory of

82 Cf., as a starting point, Grendler, *The Jesuits and Italian Universities*.

83 Cf., as a starting point, Ariew, *Descartes among the Scholastics*.

84 Cf. Vregille, "Les jesuites et l'etude du magnetisme terrestre"; Sander, *Magnes*, 846–855.

85 See AT XI 635–639; Sander, *Magnes*, 163. Cf. also n. 37 and n. 50.

86 See Kircher, *Magnes*, 3rd ed., 38.

87 Blum, *Studies on Early Modern Aristotelianism*, xii, remarks, "in the handwritten index to the books of the Roman College, Descartes or Cartesius is to be found under letter 'S': de Schartes."

88 Cf. Sander, *Magnes*, 856–857.

89 See MS., Rome, Fondo Gesuitico 1323: Zucchi, *Philosophia magnetica per principia propria proposita et ad prima in suo genere promota* (completed *post* 1653), fol. 70r/66r: "[…] asserentes per diffusas a polis Terrae particulas striatas, quae circa Terram convolvantur, aut per spiritus a centro Terrae provenientes determinari inclinationem magneticorum ad Terram, quod novissime quidam qui cupit novus Author haberi confidentissime protulit, cum tamen asseruisset per meatas magneticorum parallelos exire spiritus determinatinos motuum, qui a magneticis exercentur."

90 See MS., Rome, Fondo Gesuitico 1323: Zucchi, *Philosophia magnetica*, fol. 65r, and n. 58.

magnetism was openly discussed and refuted, mostly on the basis of his having invented particles that have no rational or empirical basis.[91] To which extent this criticism was aired in classrooms is hard to determine, but from other contexts it is known that Cartesian natural philosophy was criticized also in teaching.[92]

Looking to the north of Europe, a different picture emerges.[93] In the Finnish Turku, Cartesianism was discussed in the classroom from 1660, but "did not become *the* new paradigm."[94] Descartes was not mentioned in disputations on magnetism, but, e.g., Daniel Erici Achrelius (ca. 1644–1692) (presiding in 1689) and Petrus Olai Hahn (1651–1718) (presiding in 1689) argued in favour of the emissions of particles or atoms, yet without clear mechanistic commitments.[95] In Sweden too, Cartesianism was discussed from the 1660s.[96] In Uppsala, the first traces of Descartes at the university date to 1663, where Petrus Hoffwenius (1630–1682) was one of Descartes's first promoters.[97] Hoffwenius was educated at Leiden, and the early teaching of Descartes was orientated along the lines set out by Cartesian textbooks of the first generation.[98] In 1678, Hoffwenius

91 Fabri, *Physica*, vol. 4, 1, 16, 23, 129; Lana de Terzi, *Magisterium naturae et artis*, vol. 3, 366, 369–375; Dechales, *Cursus seu mundus mathematicus*, vol. 2, 524–527; Hilleprand, *Examen doctrinae Cartesianae*, 98–134.

92 Cf., e.g., Hellyer, *Catholic Physics*.

93 For disputations on magnetism printed in northern Europe, cf. Vallinkoski, *Turun Akatemian väitöskirjat*, vol. 1, 3, 10, 200; Lidén, *Catalogus disputationum in Academiis et Gymnasiis Sveciae*, vol. 1, 68, 71, 248; vol. 2, 132; vol. 3, 10, 12, 76.

94 Quote with italics from Kallinen, *Change and Stability*, 39. Cf. also Kallinen, "Kartesiolaisuus Turun akatemian meteorologisissa väitöskirjoissa 1678–1702," 67–98; Kallinen, "Naturens hemliga krafter," 317–346; Salminen, "Barokin filosofis-teologisen synteesin hajoaminen maassamme," 52–84.

95 Cf. Hahn (praes.) and Procopoeus (resp.), *Disputatio physica amicitiam magnetis cum ferro exhibens* (Abo, 1698), 21: "verum tutissimum videtur statuere cum recensioribus hujus rei investigatoribus, ex Magnete atomos profisci in ferrum, cum ejusdem fere rationis sit utriusque constitutio, ferri nempe ac ipsius Magnetis, adeo ut adhaereant invicem jactis atomis, cum sane nullum corpus detur, quod non halitus et vapores a se emittat." Cf. also Achrelius and Ulnerus, *Contemplationum mundi*, 10. On magnetism in Turku's disputations, cf. Kallinen, "Naturens hemliga krafter," 331–338; Kallinen, *Change and Stability*, 206–209.

96 Cf. Lindborg, *Descartes i Uppsala*; Eriksson, "Framstegstanken"; Dunér, *The Natural Philosophy of Emanuel Swedenborg*.

97 Cf. Lindborg, *Descartes i Uppsala*, 176, 176, 181–183, 251.

98 Among those used were publications by Jan De Raey (1654), Johann Clauberg (1664) and Johann Tatinghoff (1655). Cf. the short comments in Tatinghoff, *Clavis philosophiae naturalis antiquo-novae* (Leiden, 1655), 19–20, 73–74. His endorsement is very implicit, while mentioning "particulae striatae" and refuting 'occult qualities.' Cf. also Lindborg, *Descartes i Uppsala*, 103. Clauberg, *Physica, quibus rerum corporearum*, 229, 279–280, explicitly

published a collection of disputations including one on the magnet, which originated from his activities at the University of Uppsala and which were republished in Pärnu two decades later.[99] Hoffwenius presented Descartes's theory in a succinct form, without polemics against Aristotelians. By 1683, Andreas Drossander (1648–1696) was already using Hoffwenius's disputations as the basis for his own lectures on Cartesian philosophy in Uppsala.[100] His manuscript account on the magnet follows Hoffwenius and is also short, but he explicitly argued against 'occult qualities.'

But the early attacks to which Cartesianism was subjected in Uppsala were not to end soon, even if two further Uppsala disputations and one from Lund make Sweden in the last two decades of the seventeenth century appear a Cartesian stronghold when it came to magnetism.[101] Especially Johan Bilberg (1646–1717), presiding over one of the Uppsala disputations, is a well-known figure in the history of Cartesianism in Sweden.[102] In 1689, the controversy over the acceptance of Cartesian philosophy reached its peak at the university of Uppsala; Bilberg, as professor of philosophy, defended Cartesian philosophy against the theologians of the university. At the time of his *De magnete* disputa-

abstained from a long discussion (p. 221: "quia brevitatis studio doctrinam de Magnete […] omisi") and referred readers to his *Physica contracta* for the principles, and to Descartes directly, p. 279: "Quomodo magnes ad ferrum moveatur sine ulla attractione, cognitione, appetitu, Physica Cartesiana Princip. parte quarta clarissime docet eum qui non plane est excaecatus." The magnet is only briefly mentioned in Clauberg, *Physica contracta in qua tota rerum universitas*, 196–197. Like De Raey, neither Clauberg nor Tatinghoff discussed magnetism in detail, but they both soon subscribed to Descartes's theory of magnetism in their works. The reception of Descartes's theory of magnetism is not dealt with in Trevisani, *Descartes in Deutschland*. Tatinghoff's textbook is based on disputations held at Wittenberg where the Aristotelian theory of magnetism was criticized early; cf. Sander, "Magnetism in an Aristotelian World (1550–1700)."

99 Hoffwenius, *Synopsis physica, disputationibus aliquot Academicis comprehensa*, 1st ed. (Stockholm, 1678), 112–120; 2nd ed. (Stockholm, 1698), 78–84; 3rd and 4th eds. (Pärnu, 1699 and 1700), 105–112. The second edition also included a copy of a woodcut used by Descartes to depict his theory of magnetism.

100 See MS., Uppsala, A 209: Andreas Drossander, *Prolegomena in physicam Hoffwenii* (1683), fols. 75^{v}–76^{r}.

101 Bilberg (praes.) and Plaan (resp.), *Disputatio physica de magnete* (Uppsala, 1687); Vallerius (praes.) and Linnrot (resp.), *Disputatio physico mathematica de pyxide magnetica* (Stockholm, 1699); Riddermarck (praes.) and Aulaenius (resp.), *Dissertatio philosophica de magnetis ac ferri amoribus & odiis* (Lund, 1692). Cf. also Bilberg (praes.) and Odhelius (resp.), *Specimen cogitationum de magnetismis rerum* (Stockholm, 1683). There, Descartes is mentioned twice but his theory of magnetism is not discussed, nor is any causal theory of magnetism.

102 Cf. especially Nilsson, "Johan Bilberg"; Eriksson, "Framstegstanken"; Lindborg, *Descartes i Uppsala*, 288.

tion (1687), this controversy was already at its height. The text of the disputation shows that Bilberg (and his student Andreas Plaan) explicitly approved the Cartesian theory of magnetism, but also referred, e.g., to the Jesuits Kircher and Cabeo. His dismissal of 'occult qualities' clearly echoes the words of both Descartes and Regius: Only the principles of mechanics safeguard the explanation of natural phenomena and avoid "the figments of 'forms' and 'qualities', concepts more obscure than the phenomena through which they purport to be explained."[103] He, more or less apologetically, concludes his disputation by quoting "some Peripatetic," who makes much the same point.[104] In fact, the quotation is taken from a widely used textbook, the *Philosophia vetus et nova* (1678), which was published anonymously in various editions but is understood to be the work of Jean-Baptiste Du Hamel (1624–1706).[105] Although conciliatory and comparative from the outset, much of this work's natural philosophy, and its theory of magnetism in particular, is more Cartesian than Aristotelian. Bilberg is clearly trying to use this as an example even of a Peripatetic claiming that magnetism is to be explained by mechanical principles, although his chosen source has a clear bias towards Cartesianism.

Another Swedish author of one of the disputations on the magnet, Andreas Riddermarck (1651–1707), had travelled to Dutch cities and later taught both in Lund and Uppsala.[106] His disputation of 1692 is a clear stand for the Cartesian theory of magnetism, although he avoids mentioning Descartes by name, and refrains from attacking Aristotelian concepts.

Harald Vallerius (1646–1716) was another known supporter of Descartes in Sweden, but his 1699 disputation from Uppsala deals more with the magnetic compass and its historical invention than with magnetic theory.[107] Descartes's

103 See Bilberg (praes.) and Plaan (resp.), *Disputatio physica de magnete* (Uppsala, 1687), 11–12: "Et cum naturam semper aequaliter operari exinde colligimus, principia Mechanica omnium utilissima cernimus ad opera illa demonstranda, quae si non omnino talia fuerint qualia supponimus, non multum tamen ab illa dispositione abludere possunt. Hac opera scilicet evitare licet fictionem illam formarum et qualitatum, quarum notitia obscurior est rebus ipsius quae per illas solent demonstrari."

104 See Bilberg (praes.) and Plaan (resp.), *Disputatio physica de magnete* (Uppsala, 1687), 18: "Quae omnia et alia huius generis plurima facile ad mechanica principia referuntur. Nec necesse est qualitatem occultam, quae nihil explicat, aut formam substantialem obtenere, non magis quam intelligentiam quandam comminisci. Cum enim effectus naturae explicare volumus, quantum fieri potest, quaerenda est causa, cuius idea clara sit, non obscurior ipso quod querimus."

105 Cf. Du Hamel, *Philosophia vetus et nova* (Paris, 1678), vol. 2, 423–424. Cf. also Du Hamel, *De meteoris et fossilibus libri duo* (Paris, 1660), 202: "Placet mihi Cartesii sententia."

106 Cf. Tegnér and Weibull, *Lunds Universitets historia*, vol. 2, 115–116.

107 This text has to be understood against the background of 'Rudbeckiansim'; cf. especially

theory of magnetism is referred to twice, and it seems that Vallerius is willing to follow Descartes's principles in explaining magnetism.[108] He also refers to propagators of the Cartesian account, like Du Hamel or Rohault, and to critics, like the Jesuits Cabeo, Kircher, Giovanni Battista Riccioli, and Claudius Franciscus Milliet Dechales. Even if these references do not concern magnetic theory, they well illustrate how eclectic these authors were at the end of the century, and that the theoretical disagreements of their referenced sources could easily be smoothed over in the practice of teaching by using them selectively or by focusing on aspects beyond the disputed issues. With Olaus Rudbeck's work, Swedish academia had meanwhile created its own paradigm, whose distinguished antiquarianism could synthesize Cartesianism with Jesuit authors maybe more easily than the natural philosophical curricula in preceding decades and in other countries.

5 Conclusion

What is to be learned from the analysis of the reception of Descartes's theory of magnetism? When the Cartesian theory of magnetism was attacked or defended in controversies of the 1640s and 1650s, the theory of magnetism itself was nothing more than an adjunct to more general issues, such as the acceptance of 'occult qualities' or 'attractive forces' in nature. The dispute was often triggered within the context of medicine, and it was often theological arguments that were invoked to dismiss Cartesian physics and metaphysics at the larger scale opened up by these disputes. The major concepts relevant in magnetism—'qualities' and 'attraction'—were taken to be important features of Galenic medicine and the analogy between magnetism and physiological processes was very common in this tradition.[109] The assumption of 'substantial forms' and 'qualities' was also very much presupposed in rational theological discourses, e.g., in explaining aspects of Christology, creation, and the sacraments.[110] This

Roling, *Odins Imperium*, vol. 2, 731–733, 751, 753. He mentions Bilberg, but not his disputation of 1687 or his attitude towards Cartesianism. See Vallerius (praes.) and Linnrot (resp.), *Disputatio physico mathematica de pyxide magnetica* (Stockholm, 1699), 54.

108 Vallerius (praes.) and Linnrot (resp.), *Disputatio physico mathematica de pyxide magnetica* (Stockholm, 1699), 44, 58.

109 Cf. Sander, "Nutrition and Magnetism"; Sander, "Tempering Occult Qualities."

110 Cf., e.g., Hellyer, *Catholic Physics*, 90–114; Beck, *Gisbertus Voetius*, 60–90; Goudriaan, *Reformed Orthodoxy and Philosophy*. See also Goudriaan, ed. and transl., *Jacobus Revius*, 180–183.

held true, more or less, for all Christian confessions at the time: Descartes's theory of magnetism and *a fortiori* his metaphysics were attacked in Lutheran, Calvinist and Catholic institutions. Claiming that magnetic attraction could be explained by nothing else but particles and their motion was a direct attack on Galenic principles, an indirect attack on Aristotelian principles, and potentially a problematic claim in theological contexts, at least in the eyes of few. Such a claim could be said to have undermined or questioned the philosophical underpinning of the major faculties at almost every university at this time. There is little wonder, then, that it met with such resistance, and from there became associated with some subsequent efforts to reconcile Cartesian with Aristotelian thought.

Only in the 1660s did magnetism become a topic in its own right within university learning, with long sections in the curriculum and textbooks discussing causal explanations. Teaching and its literary production were thereby established as the main battleground for these longstanding controversies. Against this background, the medical or broader relevance of concepts such as 'attraction' or 'quality' became less obvious within the discussions on magnetism. These discussions belonged to *physica particularis*, dealing with minerals and the like, and not, as previously, to general natural philosophical discussions about concepts such as 'attraction' or 'quality.' The discussions on magnetism thus became not only more focused, but were also relocated within the system of learning.

Looking more closely at the development of controversies on magnetism theory from a natural philosophical perspective, it seems that their dynamics exhibit more signs of convergence than of radicalization. Authors sympathetic to the Cartesian theory of magnetism did not, for example, always pick up Descartes's exact theory of screw-shaped particles, and regarded the form of the particles as beyond determination by any theory. Aristotelian authors were not keen on promoting 'occult qualities' and often seemed to distance themselves from this concept, which arguably provided the largest attack surface for Descartes and his followers. This is not to downplay the systematic differences between the opposing sides in the debate: elaborate attempts such as that of Van Baerle to combine both theories remained rare. While the adversarial rhetoric remained hostile, camps grew more aware of the weak spots of their own theory as seen from the opponent's perspective. They adjusted accordingly. The Aristotelians, especially, tried to turn the tables by claiming that the invisible particles and their motion were 'occult' at best. More often they claimed that the *particulae striatae* were just dreamt up without any basis in empirical evidence—*fingere*, *comminiscari*, and *excogitari* are recurrent terms.

It is also noteworthy that sources tended to avoid openly naming Descartes even while unmistakably addressing his theory of magnetism. More often this tendency shows in his followers, especially in phases and contexts of controversy and transition. Critics, on the other hand, tend to frame the Cartesian theory of magnetism as atomistic, alluding to magnetism theories as put forward by Epicurus and Lucretius. These are primarily tactical manoeuvres. Owing to its atheistic connotations, atomism was levelled as a charge more than as the sober description of some philosophical resemblance. Making positive public references to Descartes in the second half of the seventeenth century was also a political statement, given the reputation, or at least the suspicion, of his doctrines as 'heretical', as testified not least by Catholic censorship and condemnation.

On this more political and partly even confessional side of the story, it should also be emphasized that the reception of Descartes's theory of magnetism was not a binary set-up in terms of predictable opponents. Particularly, but not exclusively, Descartes's critics found unlikely allies in the Jesuits Niccolò Cabeo and Athanasius Kircher, and even in William Gilbert. These works were not books typically studied in university classes, and Jesuits were certainly not typical warrantors for Protestant and Calvinist authors, not to speak of Gilbert, who stridently attacked Aristotelianism and traditional university learning.[111] However, they all agreed in their refusal of corpuscularian accounts. On the other hand, Descartes openly acknowledged Gilbert in his *Principles of Philosophy* and his followers also referred to Cabeo and Kircher. While this was mostly for their more empirical findings than for their theories, their theories were not attacked by Descartes's followers in this connection.

On the level of university education, this policy of appealing to named authors across the political or confessional divide arguably led also to a widening of the pool of authors and books that may have been mentioned (and perhaps also discussed) in the classroom. Arguing against Descartes produced new alliances, introducing new authors and thereby new 'knowledge.'

Alongside Descartes's intriguing theory of magnetism adding to the scope and content of a Cartesian curriculum, another effect is probably even more important. The way in which Descartes dealt with magnetism was quite original, both formally and in terms of the length at which he rehearsed his arguments. Both aspects were often adopted along with the theory itself. Many subsequent textbooks describe magnetic effects as extensively, including empirical and experimental findings, and depict both theory and observation visually as

111 Cf. n. 37.

Descartes had done.[112] This was equally true for some of his critics. At least structurally, by arguing against Descartes, they also imitated him, e.g., by discussing single magnetic effects one after another; many can also be seen to illustrate their sections on magnetism in ways similar to those of Descartes.[113]

This development holds true for textbooks, for preserved student notebooks, and for printed disputations. The very fact that forty out of forty-nine preserved seventeenth-century printed disputations on the magnet date from after 1644 is not to be attributed exclusively to the influence of Descartes's theory of magnetism, but it testifies to a general development rendering magnetism an increasingly important and established topic for university learning.[114] Descartes had some share in making such a development possible, especially as far as it concerns the way natural philosophy was taught at universities and schools. Even if not all students in the 1680s, and maybe not even the majority of them, were taught the Cartesian theory of magnetism, the fact that they were taught any theory of magnetism, and the manner in which this happened, in one way or another owed much to Descartes and the publication of his *Principles of Philosophy* in 1644.

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112 Cf. also Lind, *Physik im Lehrbuch*, 87: "Für den Magnetismus wird meist Descartes' Wirbeltheorie angenommen."

113 Cf. Sander, "*Terra AB*."

114 Cf. Sander, "Magnetism in an Aristotelian World (1550–1700)."

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