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Alte und neue Philosophie

Aristotelismus und protestantische Gelehrsamkeit in Helmstedt und Europa (1600 – 1700)

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Inhalt

Frontispiz: Titelseite aus: Jacques-Nicolas Colbert: Philosophia vetus et nova ad usum scholae accomodata, in Regia Burgundia olim pertractata, Tomus prior, qui Logicam, Metaphysicam et Philosophiam moralem complectitur, editio novissima, cum figuris aeneis et indice locupletissimo auctior et illustrior iuxta Exemplar Parisiense 1681, Nürnberg: Johannes Zieger 1682. Wolfenbüttel, Herzog August Bibliothek: M: Li 3341: Im Bildmittelpunkt steht der antike Gott Hermes, unverkennbar dargestellt mit Fügelhelm, Flügelschuhen und Caduceus. Er ist im Bildhintergrund rechts und links flankiert von je einem Vertreter der alten und der neuen Philosophie, die einander im Streitgespräch gegenübersitzen.

CHRISTOPH SANDER

Magnetism in an Aristotelian World (1550 – 1700)

Dozens of University Disputations, Kasper van Baerle's Eclecticism, and Nikolaus Andreas Granius's Marginalia*

According to the ancient doxographer Diogenes Laertius, Aristotle authored a treatise *On the Magnet* (*Περὶ τῆς λίθου*).[1] Unfortunately, this work has not come down to us, and in all of Aristotle's extant works the magnet is mentioned only twice, very briefly and without giving any insights into Aristotle's account of magnetic attraction.[2] A few Pre-Socratics, Plato, later Peripatetics, and Platonists discussed magnetic attraction at a greater length.[3] Presumably it was an issue for Aristotle as well, as his decisive denial of action-at-a-distance seems to openly contradict the phenomenon of a magnet attracting a piece of iron over a short distance. Scholastics of the Middle Ages addressed this issue but did not deal with it in depth.[4] However, when scholars in the early modern period turned to the case of magnetism with

* I thank all participants and organisers of the conference out of which this paper arose. Further, I wish to thank specifically Benjamin Wallura, Jacob Schilling and Sascha Salatowsky for taking and sending me photographs from specialist holdings. I also thank the relevant libraries for making available the illustrations. For advice on two questions of detail I thank Stefano Gulizia and Ulrich G. Leinsle. For linguistic revision, I would like to thank Orla Mulholland.

1 See ALBERT RADL: Der Magnetstein in der Antike. Quellen und Zusammenhänge (Boethius 19), Diss. Univ. München, Wiesbaden – Stuttgart 1988, esp. pp. 25, 29; DIOGENES LAERTIOS: De philosophorum vita decem, Paris: Petit 1507, esp. pp. 57v, 113r. See book 5, s. 26, line 14. A work of the same title is also ascribed to DEMOCRITUS, cf. section 47, line 16: »Περὶ τῆς λίθου. ταῦτα καὶ τὰ ἀσύντακτα«. In historical Latin translations both works are called *de lapide*. Cf. also STEPHEN MENN: Democritus, Aristotle, and the Problemata, in: ROBERT MAYHEW (ed.): The Aristotelian Problemata Physica: Philosophical and Scientific Investigations (Philosophia Antiqua 139), Leiden – Boston 2015, pp. 10 – 35, esp. p. 15: »λίθος in the feminine is quite standardly a natural magnet«. Also RADL: Der Magnetstein in der Antike (see above), p. 129 states: »Im Griechischen ist das Wort für ›Stein‹ maskulin. Wenn λίθος aber den Magnetstein meint, wird es feminin verwendet. Dies hängt möglicherweise damit zusammen, daß das weibliche Genus der Länder- und Ortsnamen, die zur Bezeichnung des Magnetsteins dienen, auf diesen selbst übertragen wird.«

2 See ARISTOTELES: De anima, 405a, 19 – 21 und Physica, 267a, 1 – 5.

3 See esp. RADL: Der Magnetstein in der Antike (see fn. 1).

4 See esp. GUDRUN THERESIA STECHER: Magnetismus im Mittelalter. Von den Fähigkeiten und der Verwendung des Magneten in Dichtung, Alltag und Wissenschaft (Göppinger Arbeiten zur Germanistik 622), Göppingen 1995; NICOLAS WEILL-PAROT: Points aveugles de la nature. La rationalité scientifique médiévale face à l'occulte, l'attraction magnétique et l'horreur du vide (XIII^{e}-milieu du XV^{e} siècle), Paris 2013. It has to be pointed out that especially ancient but also many medieval descriptions of magnetic attraction did not mention that the attraction occurs ›at a distance‹. For many, magnetic attraction was more considered a phenomenon of iron and magnet touching each other and then ›sticking‹ together.

greater interest, many argued that Aristotelian philosophy failed to account for the apparent action-at-a-distance that is observed in magnetism and in other phenomena. Promoters of various ›new philosophies‹ considered the issue of magnetism a weak spot of Aristotelian philosophy and deployed their own explanations, for example building on corpuscular or vitalist principles, against the Aristotelians, who allegedly ascribed magnetism to ›occult qualities‹.

Aristotelians did not want to let these accusations lie, and towards the middle of the 16th century they too dealt with magnetism in greater depth. This development was also mirrored on an institutional level. As most faculties of arts – the places in which philosophy was taught at universities – adhered to an Aristotelian curriculum, the topic of magnetism, being virtually absent in Aristotle's writings, had traditionally not formed a relevant topic for study and disputations. This changed in the late 16th century. University textbooks discussed the topic more extensively, exams and disputations dealt with it, and university professors studied it in greater depth and became interested in magnetic experiments.

This article will trace this inclusion of magnetism as a relevant topic for Aristotelian philosophy in the early modern period, with a focus on Central European universities. It shall be argued that there were different reasons for this development but that the early modern university, although in principle still a place for traditional Aristotelian philosophy, did not fail to read the signs of the times and so constantly updated its fields of study according to broader trends in philosophy, the sciences, institutional learning, and society. In taking these steps, Aristotelians were reacting to natural philosophical accounts outside the realm of university learning.

This article will begin by giving a very brief bibliographical and intellectual overview of the study of magnetism within and outside Aristotelian philosophy up to the early modern period.[5] Against this backdrop, three different approaches to magnetism related to Central European universities shall be sketched: First, it will be outlined how university exams and disputations dealt with magnetism. Secondly, the case of the Dutch university professor, Kaspar van Baerle (Caspar Barlaeus), will be presented, who wrote a Latin quasi-Aristotelian treatise on magnetism in the 1630s. Nikolaus Andreas Granius, professor of natural philosophy at the University of Helmstedt, will be the focus of the last section, as he left a copy of one of the major works of anti-Aristotelian philosophy, William Gilbert's *De magnete* (1600/1628), full of intriguing marginal comments.

5 For a more detailed account, see CHRISTOPH SANDER: Magnes. Der Magnetstein und der Magnetismus in den Wissenschaften der Frühen Neuzeit (Mittellateinische Studien und Texte 53), Diss. Techn. Univ. Berlin 2019, Leiden – Boston 2020, ch. 8.1.

Bibliographical and Intellectual Overview of the Study of Magnetism

Aristotle mentions the magnet – calling it just »stone« – in his *On the Soul* (405a, 19–21) when he reports Thales's belief that the magnet is endowed with a soul. In an enigmatic passage in the *Physics* (267a, 1–5), Aristotle invokes the magnet in an analogy to elucidate his theory of projectile motion. Neither passage gives the slightest idea of how Aristotle thought to explain magnetic attraction. His disciple Theophrastus briefly dealt with the magnet in his *On Stones*, but only from the perspective of natural history.[6] Many of Aristotle's commentators mentioned the magnet, but only Alexander of Aphrodisias attempted to give an explanatory account of magnetism, after citing and refuting pre-Socratic theories.[7] The most developed ancient accounts of a causal explanation of magnetic attraction are to be found in the writings of Galen (also referring to Epicurus's atomist theory), Plutarch (elaborating Plato's material account), and Lucretius (presenting the most detailed atomist theory).[8]

As well known, Aristotle's writings deeply informed both Arabic and Latin medieval thinking. Yet, Aristotle's silence on magnetism certainly did not foster interest in the topic. However, from a systematical point of view, magnetism did present a serious puzzle to Aristotelians who aimed at finding the natural causes of phenomena. On the one hand, Aristotle's strict denial of action-at-a-distance seemed to contradict the experience of a magnet attracting a piece of iron over a short distance without touching it.[9] On the other hand, the Galenic idea that elementary qualities produce qualitative change in physical bodies was at odds with magnetism as well, as attraction did not seem to occur because the magnet was hot, cold, dry, or wet.[10]

6 See esp. THEOPHRASTUS: On Stones, ed. by JOHN F. RICHARDS, EARLE RADCLIFFE CALEY, Columbus – Ohio 1956, pp. 46, 51.

7 See CHRISTOPH SANDER: Nutrition and Magnetism. An Ancient Idea Fleshed out in Early Modern Natural Philosophy, Medicine and Alchemy, in: ROBERTO LO PRESTI, GEORGIA-MARIA KOROBILI (eds.): Nutrition and Nutritive Soul in Aristotle and Aristotelianism (Topics in Ancient Philosophy 9), Berlin 2021, pp. 285–317.

8 These accounts are dealt with in RADL: Der Magnetstein in der Antike (see fn. 1).

9 Cf. esp. MARY B. HESSE: Forces and Fields: The Concept of Action at a Distance in the History of Physics, Mineola – N.Y. 2005; MAX JAMMER: Concepts of Force. A Study in the Foundations of Dynamics, Mineola (N.Y.) 1999; SILVIA PARIGI: Spiriti, effluvi, attrazioni. La fisica »curiosa« dal Rinascimento al secolo dei lumi, Napoli 2011.

10 See MASSIMO LUIGI BIANCHI: Occulto e manifesto nella medicina del Rinascimento. Jean Fernel e Pietro Severino, in: Atti e Memorie dell'Accademia toscana di Scienze e Lettere La Colombaria 47 (1982), pp. 183–234; NICOLAS WEILL-PAROT: Astrology, Astral Influences, and Occult Properties in the Thirteenth and Fourteenth Centuries, in: Traditio. Studies in Ancient and Medieval History, Thought and Religion 65.1 (2010), pp. 201–230. Cf. also SANDER: Magnes (see fn. 5), ch. 8.1.3.2.3 and 8.1.3.2.6, and ID.: Tempering Occult Qualities. Magnetism and Complexio in Early Modern Medical Thought, in: CHIARA BENEDUCE, PAUL J.J.M. BAKKER (eds.): *Complexio*. Across Times and Disciplines, Medi-

Medieval scholastics, for the most part, followed solutions to both problems that had been proposed by the Arabic philosophers Avicenna and Averroes. Somewhat simplified, it was assumed with Avicenna, who drew on Galen, that an ›occult quality‹ or ›power‹ was responsible for the qualitative change that was the cause of magnetic attraction. This quality was considered insensible, and in the medieval jargon was therefore called ›occult‹, in contrast to ›manifest‹ elementary qualities. As such, ›occult qualities‹ could only be experienced by their effects. Averroes in turn drew on Alexander of Aphrodisias, who had proposed the teleological explanation that the iron seeks to approach the magnet due to an immanent desire of the iron.[11] Averroes proposed that the magnet altered the air (being the medium) through its form, the air altered the iron, which in turn then would move to the magnet. What appeared as attraction was thus nothing but a movement of the iron induced by the form of the magnet.

Both accounts formed a mishmash of different ideas, but no medieval philosopher tried (or succeeded) to come up with an elaborate and detailed explanation of magnetic attraction. Magnetic north-pointing, firstly described in Europe around 1200, was tackled even more rarely by scholastics. The only detailed treatise on magnetism of medieval times, authored by Petrus Peregrinus in the late 13th century, can hardly be considered Aristotelian in the stricter sense and had little impact – in terms of theory – on university-related natural philosophy.[12] Nonetheless, by the 14th century, scholastics were discussing magnetism increasingly often in their commentaries on Aristotle.[13] Outside the realm of more strict Aristotelian philosophy, e. g. in the works of Ramon Lull and Nicolaus Cusanus, different causal explanations for magnetism were proposed.

eval and Early Modern Philosophy and Science, forthcoming as special issue of Early Science and Medicine.

11 Cf. SANDER: Nutrition and Magnetism (see fn. 7).

12 See JULIAN A. SMITH: Precursors to Peregrinus. The Early History of Magnetism and the Mariner's Compass in Europe, in: Journal of Medieval History 18.1 (1992), pp. 21–74; PETRUS PEREGRINUS: Opera, ed. by LORIS STURLESE, RON B. THOMSON (Centro di Cultura Medievale 5), Pisa 1995.

13 See LYNN THORNDIKE: John of St. Amand on the Magnet, in: Isis. An International Review devoted to the History of Science and Civilization 36.4 (1946), p. 156: »quomodo adamas attrahit ferrum et etiam adamas adamantem, cum ab eo non possit evaporare aliquid, cum sit ita durum quod vix possit frangi.« See PETRUS HISPANUS: Comentario al »De anima« de Aristóteles, ed. by MANUEL ALONSO, Madrid 1944, esp. pp. 442–444; BRIAN LAWN: The Rise and Decline of the Scholastic Quaestio Disputata. With Special Emphasis on Its Use in the Teaching of Medicine and Science, Leiden 1993, p. 151: »utrum adamas per virtutem anime attrahat ferrum«. See also the manuscript in Erfurt, Wissenschaftliche Allgemeinbibliothek: Ampl. Quart. 325, fols. 170r–176v: »Quedam de magnete«; fols. 195r–197v: »Aliquod, scilicet per quantam distanciam magnes possit ferrum attrahere et de rota continue mobili«. Cf. also DIETRICH LOHRMANN: Idee und Wirklichkeit des Perpetuum mobile im Mittelalter, in: Technikgeschichte 73 (2006), pp. 227–251, p. 240, n. 33.

By 1500, when humanists were discovering and reading more ancient works beyond the Aristotelian tradition, ancient theories of magnetism too were rediscovered.[14] Simultaneously, it seems plausible that the topic of magnetism itself gained more importance due to its use in compass navigation, which became highly relevant for long-distance voyages.[15] These developments impacted both on how scholars dealt with magnetism within and without an Aristotelian framework, and within and beyond universities and schools. Girolamo Fracastoro (1540) and Gerolamo Cardano (1550) published, integrated in larger works, influential natural philosophical accounts of magnetism that contradicted Aristotelian principles to some extent.[16] In 1600, William Gilbert published his highly important *De magnete*, which openly considered his ›magnetic philosophy‹ to be an attack against Aristotelianism.[17] Moreover, he thought of his ›experimental approach‹ to magnetism also as an opposite to the allegedly ›bookish‹ account of medieval and contemporary school philosophers.[18] Last but not least, Gilbert promoted his ›magnetic philosophy‹ as a physical explanation of geokinetic cosmology and thereby provoked harsh criticism and even condemnation among defenders of a Ptolemaic and Aristotelian world view.[19] Gilbert's philosophy, or parts of it, was taken up by many in the 17th century and was often directed, in one way or another, against the Aristotelian ›establishment‹ and traditional university learning. Among many others, this included Francis Bacon, Galileo Galilei, Robert Fludd, Benedetto Castelli, Pierre Gassendi, and René Descartes.[20] In terms of natural philosophy, different blends of hermetic, alchemical, and corpuscular philosophies were particularly severe

14 See, e. g., the discussion of magnetism in GIOVANNI FRANCESCO PICO DELLA MIRANDOLA: Examen vanitatis doctrinae gentium et veritatis Christianae disciplinae, Mirandola: Maciochius 1520, p. 199r; ID.: Opera omnia. Vol. 2, Basel: Henricpetri 1573, p. 1247.

15 See, as a starting point, ART ROELAND THEO JONKERS: Earth's Magnetism in the Age of Sail, Baltimore 2003.

16 See GEROLAMO CARDANO: De subtilitate. Vol. 1: Libri 1 – 7, ed. by ELIO NENCI (Filosofia e scienza nel Cinquecento e nel Seicento. Testo inediti o rari 16), Milan 2004, esp. pp. 664 – 677; GEROLAMO FRACASTORO: De sympathia et antipathia rerum liber unus, ed. by CONCETTA PENNUTO (Studi e testi del rinascimento europeo), Rome 2008, esp. pp. 46 – 54, 60 – 62, 156 – 164.

17 See WILLIAM GILBERT: De magnete, magneticisque corporibus, et de magno magnete tellure; physiologia noua, plurimis & argumentis, & experimentis demonstrata, London: Short 1600; STEPHEN PUMFREY: William Gilbert's Magnetic Philosophy, 1580 – 1684: The Creation and Dissolution of a Discipline, Diss. Univ. London 1987.

18 See CHRISTOPH SANDER: Magnetism for Librarians. Leone Allacci's De Magnete (1625) and Its Relation to Giulio Cesare LaGalla's Disputatio de Sympathia et Antipathia (1623), in: Erudition and the Republic of Letters 5.3 (2020), pp. 274 – 307.

19 See MARTHA BALDWIN: Magnetism and the Anti-Copernican Polemic, in: Journal for the History of Astronomy Cambridge 16 (1985), pp. 155 – 174.

20 See the respective chapters (esp. ch. 8.1.3.2) in SANDER: Magnes (see fn. 5).

and influential adversaries of what they considered the Aristotelian account of magnetism, or even postulated the absence of such account.

To be sure, these were challenging times for Aristotelians interested in magnetism. In other fields of natural philosophy, where Aristotelians were being contested at the same time, e. g. in cosmology or anthropology, they could – in addition to various adjustments and original contributions – build on a medieval tradition that dealt extensively with these topics. This was not the case for magnetism. They had to start almost from scratch and could not really build on any confirmed authority in the field. Magnetism as a topic of natural philosophy, moreover, had no particular tradition in university learning, unlike other fields of *physica particularis*, e. g. meteorology, that were much more strongly present in the classroom. In spite of, or particularly because of, these presuppositions, the 16th century shows an increased interest in magnetism among university professors and Aristotelian natural philosophers. The earlier developments in this direction took place in Southern Europe. Pietro Pomponazzi outlined his causal explanation in his lectures on the *Physics* around 1518.[21] In the 1520s, Fernán Pérez de Oliva, professor of natural philosophy at the University of Salamanca, drafted his *De magnete liber unus*.[22] Fortunio Affaitati (1549), Julius Caesar Scaliger (1557), and Francesco Maurolico (1569) discussed magnetism and its explanation.[23] These philosophers cannot be indistinctly described as Aristotelians, but their magnetism theories either relied on Aristotelian principles or their work originated from an affiliation to a university tied to an Aristotelian curriculum.

More straightforward were the Jesuits, and here again initially mostly from Southern Europe.[24] Magnetism featured in many of their textbooks and commentaries, e. g. authored by Francisco de Toledo (1573), the Jesuits of Coimbra (1592), Francisco Suárez (1597), Girolamo Dandino (1610), Juan de

21 See FRANCO GRAIFF, PIETRO POMPONAZZI: Aspetti del pensiero di Pietro Pomponazzi nelle opere e nei corsi del periodo bolognese, in: Annali dell'Istituto di Filosofia. Università di Firenze 1 (1979), pp. 69 – 130, esp. pp. 116 – 120: »Quomodo ferrum moveatur ad magnetem«.

22 See FERNÁN PÉREZ DE OLIVA: Cosmografia nueva, ed. by CIRILO FLÓREZ MIGUEL (Acta Salmanticensia: Filosofía y letras 170), Salamanca 1985, esp. pp. 152 – 164.

23 See FORTUNIO AFFAITATI: Phisicae ac astronomicae considerationes: quarum catalogus versa pagina conspicitur, Venice 1549, esp. pp. 20r – 24v. See FRANCESCO MAUROLICO: Opuscula mathematica, Venice: de Franciscis 1575, esp. pp. 100 – 102; ID.: Problemata mechanica cum appendice, Messina 1613, esp. pp. 49 – 55; JULIUS CAESAR SCALIGER: Exotericarum exercitationum liber quintus decimus, De subtilitate, ad Hieronymum Cardanum, Paris: de Vascosan 1557, esp. pp. 185v – 188r.

24 Cf., as a starting point, UGO BALDINI: Legem impone subactis. Studi su filosofia e scienza dei Gesuiti in Italia (Collana dell'Istituto di Filosofia 3), 1540 – 1632, Rome 1992; ID.: The Development of Jesuit Physics in Italy, 1550 – 1700. A Structural Approach, in: CONSTANCE BLACKWELL, SACHIKO KUSUKAWA (eds.): Philosophy in the Sixteenth and Seventeenth Centuries. Conversations with Aristotle, Aldershot et al. 1999, pp. 248 – 279.

Pineda (1609), Luis del Alcázar (1614), and Lelio Bisciola (1618).[25] Their contributions were often short and rather reluctant to put forward an original or comprehensive explanation of magnetic phenomena. A full-blown theory of magnetism – probably the first of the early modern period – was however developed by the Jesuit Leonardo Garzoni, in a work written in the 1580s that only survived in manuscript and yet impacted on important scholars in the field.[26] Garzoni, also a teacher at Jesuit colleges, wrote in the vernacular and advanced the Aristotelian conceptual framework to some extent in order to tackle magnetism in a more sophisticated manner than any Aristotelian had done before him. Yet he remained fully in the framework of hylemorphism and qualities.

Later Jesuits directly or indirectly built on Garzoni's work, and especially targeted Gilbert's quasi-Copernican and anti-Aristotelian affront. Among the best known of these works, all monographs exclusively dealing with magnetism, are, e.g. Niccolò Cabeo's *Philosophia magnetica* (1629), Athanasius Kircher's *Magnes* (1641), Jacques Grandami's *Nova demonstratio* (1645), and Niccolò Zucchi's *Dissertatio magnetica* (c. 1645).[27] These works are very

25 See FRANCISCUS TOLETUS: Commentaria una cum quaestionibus in octo libros Aristotelis de physica auscultatione, Venice 1573, esp. pp. 105r, 198r – v; In octo libros Physicorum Aristotelis Stagiritae, hrsg. vom Collegium Conimbricensis Societatis Iesu, Coimbra 1592, esp. pp. 670 – 673; FRANCISCO SUÁREZ: Disputationes Metaphysicae (Disp. 1 – 27), ed. by CHARLES BERTON, Paris 1866, esp. pp. 664 f. See also GEROLAMO DANDINO: De corpore animato lib. VII. Luculentus in Aristotelis tres de anima libros, commentarius peripateticus, Paris 1610, esp. pp. 431 – 445; LUIS DEL ALCÁZAR: Vestigatio arcani sensus in Apocalypsi. Cum Opusculo de sacris ponderibus ac mensuris, Antwerp: Keerberg 1614, esp. pp. 283 – 286; JUAN DE PINEDA: In Salomonem commentarios Salomon præuius, id est, De rebus Salomonis Regis libri octo, Lyon: Cardon 1609, esp. pp. 208, 222; LELIO BISCIOLA: Horarvm svbsecivarvm tomus. In Qvibvs Pleraqve Ex Philosophia, & Encyclopaedia, atque omnibus ferè scientijs, ac tribus praecipuis linguis Hebraea, Graeca, Latina, non vulgaria explicata; adnotatis, emendatis, enucleatis, plurimis omnis generis scriptorum locis, vol. 2, Cologne: Hierat 1618, esp. pp. 14 – 21.

26 See LEONARDO GARZONI: Trattati della calamita, ed. by MONICA UGAGLIA (Filosofia e scienza nell'età moderna 3, Testi ineditio rari 18), Milan 2005; MONICA UGAGLIA: The Science of Magnetism Before Gilbert. Leonardo Garzoni's Treatise on the Loadstone, in: Annals of Science 63.1 (2006), pp. 59 – 84; CHRISTOPH SANDER: Early-Modern Magnetism. Uncovering New Textual Links between Leonardo Garzoni SJ (1543 – 1592), Paolo Sarpi OSM (1552 – 1623), Giambattista Della Porta (1535 – 1615), and the Accademia Dei Lincei, in: Archivum Historicum Societatis Iesu 85.2 (2016), pp. 303 – 363.

27 See NICCOLÒ CABEO: Philosophia magnetica, Ferrara: Suzzi 1629; ATHANASIUS KIRCHER: Magnes; sive, De arte magnetica opus tripartitum, Rome: Scheus, Grignani 1641; JACQUES GRANDAMI: Nova demonstratio immobilitatis terrae petita ex virtute magnetica et quædam alia ad effectus & leges magneticas, usumque longitudinum & universam geographiam spectantia, de novo inventa, La Flèche: Griveau 1645. For ZUCCHI, cf. the manuscript in Rome, Biblioteca Nazionale Centrale »Vittorio Emanuele II«, Fondo Gesuitico 1323, fols. 59 – 79. See also JUAN EUSEBIO NIEREMBERG: Curiosa filosofia, y tesoro de maravillas de la naturaleza, examinadas en varias questiones naturales, Madrid 1630, esp. pp. 115v – 170r, 213v – 214r.

different in nature but are still united in the endeavor to approach magnetism in an Aristotelian framework, often with a Christianized overtone, and mostly directed against allegedly heretical excesses in magnetic philosophy advanced by Gilbert and some of his followers. These works, including Garzoni's study, were, however, not rooted in an educational context but were rather private undertakings which the Society allowed to some extent.[28] Moreover, the origin of most of these works lies south of the Alps.

Current historiography has dealt with the question of how Aristotelian accounts of magnetism fit the greater narrative of the so-called Scientific Revolution. Stephen Pumfrey, for example, argued that the »case study of responses to magnetic philosophy exemplifies [...] the diversity of Renaissance Aristotelianism.«[29] Yet, he also stated that »[t]here is little evidence of a developed response to Gilbert's work from within established universities, at least during the crucial period of assimilation between 1600 and 1650.«[30] Marco Sgarbi has contested David Wootton's more or less explicit attempt to exclude Garzoni's achievement from the larger pattern of the scientific achievements of the early modern period, mainly for the fact that he was an Aristotelian.[31] Sgarbi rightly asks:

> »But why, instead of excluding Garzoni from the narrative of the Scientific Revolution or from the developments of ›modern science‹ just because he was Aristotelian, do we not try to include him and imagine that even these atypical Aristotelians might have made significant contributions to the advancement of knowledge?«[32]

In what follows, this article will take on both Pumfrey's and Sgarbi's research and yet point out that, based on a much wider array of sources, looking beyond intriguing examples of Garzoni (Sgarbi) and Cabeo (Pumfrey) will give a more complex and better proven picture of how Aristotelians, and especially those that were university professors, adopted magnetism as an increasingly important field of their research and philosophical enterprise.

28 Cf. also MARTHA BALDWIN: Alchemy and the Society of Jesus in the Seventeenth Century. Strange Bedfellows?, in: Ambix. The Journal of the Society for the History of Alchemy and Chemistry 40.2 (1993), pp. 41–64.

29 STEPHEN PUMFREY: Neo-Aristotelianism and the Magnetic Philosophy, in: JOHN HENRY, SARAH HUTTON (eds.): New Perspectives on Renaissance Thought. Essays in the History of Science, Education and Philosophy: In Memory of Charles B. Schmitt, London 1990, pp. 177–189, esp. p. 177.

30 Ibid., p. 179.

31 MARCO SGARBI: Renaissance Aristotelianism and the Scientific Revolution, in: Physis. Rivista internazionale di storia della scienza 52.1–2 (2017), pp. 329–345, esp. p. 332.

32 Ibid.

University Disputations on Magnetism

University disputations are a highly diagnostic instrument to determine educational contents of the past. Mostly, the record of the actual disputation, held as an oral exam, is now lost, but especially in Central European universities and colleges many very short works have been preserved that relate closely to the academic event. The arrangement for disputations which was common almost everywhere in Europe at the time consisted of a chair, the *praeses*, usually a professor, who examined (at least) one candidate, the *respondens*, i.e. the candidate(s) or student(s) who was (or were) awarded the degree.[33] Whether the disputation was held exactly in the form of its printed record and whether the student or the professor is to be considered the (main) author of the printed text, is often unclear, and has to be determined on a case-by-case basis.[34] In the printed editions, being the basis for the disputation, the concrete situation of the examination is not always clearly recognizable, as the printed disputations sometimes appear as short treatises rather than a list of theses and arguments to be defended. However, the existence of these disputations demonstrates not only what the topics to be debated in exams were but also, in detail, what content may have been taught at this particular institution at a given time. They are therefore valuable indirect snapshots of an educational situation.

Magnetism was a topic in its own right in university disputations as well. As far as the printed records go, it began in 1606, and until 1699 at least 50 of these disputations are extant.[35] Table 1 (see pp. 102–105) lists these works

33 See in particular ULRICH GOTTFRIED LEINSLE: Dilinganae Disputationes. Der Lehrinhalt der gedruckten Disputationen an der Philosophischen Fakultät der Universität Dillingen 1555–1648 (Jesuitica II), Regensburg 2006, pp. 39–48; ANTON KERN: Die Promotionsschriften der Jesuiten-Universitäten in der Zeit des Barocks. Eine bibliothekarische Studie, Köln 1954; OLGA WEIJERS: In Search of the Truth. A History of Disputation Techniques from Antiquity to Early Modern Times (Studies on the Faculty of Arts 1), Turnhout 2013; MARION GINDHART, URSULA KUNDERT (eds.): Disputatio, 1200–1800. Form, Funktion und Wirkung eines Leitmediums universitärer Wissenskultur (Trends in Medieval Philology 20), Berlin 2010; MEELIS FRIEDENTHAL, HANSPETER MARTI, ROBERT SEIDEL (eds.): Early Modern Disputations and Dissertations in an Interdisciplinary and European Context (Intersections 71), Leiden–Boston 2020. On the question of authors, see in particular HANSPETER MARTI: Von der Präses- zur Respondentendissertation: Die Autorschaftsfrage am Beispiel einer frühneuzeitlichen Literaturgattung, in: RAINER CHRISTOPH SCHWINGES (ed.): Examen, Titel, Promotionen. Akademisches und staatliches Qualifikationswesen vom 13. bis zum 21. Jahrhundert (Veröffentlichungen der Gesellschaft für Universitäts- und Wissenschaftsgeschichte 7), Basel 2007, pp. 251–274.

34 As a rule, it can be assumed that the »praeses« is the author of these writings.

35 Magnetism is also, but not exclusively, treated in BALTHASAR HAGEL, ANDREAS DE LUCHIS: Disp. philos. de metallo et lapide, ex tertio et quarto libro meteororum Aristotelis, Ingolstadt: Sartorius 1588; ADAM HIGGINS, CASPAR THIERMAIR: Disputatio philosophica in priorem Aristotelis de ortu et interitu librum, Ingolstadt: Eder 1595; OSWALD COSCAN: Disputatio Philosophica de Actione in Distans, Dillingen: Mayer 1616; ID.: Disputatio Phy-

and indicates which authors are mentioned and which topics were treated (+ indicates a topic treated, while ++ indicates that the topic was a focus of the work). Given the great quantity of sources, the following overview will only give some rather general descriptions and will engage more deeply with the sources only in some sample cases.

Especially in the German, Dutch, Polish, and Scandinavian areas these disputations were printed.[36] All of them are written in Latin. For the most part, they were the basis for examinations in natural philosophy (*physica*) but some disputations also originate from the faculties of medicine and theology, or belong to mathematics or humanities within the faculty of arts. In these and a few other cases, a disputation's interdisciplinary qualifications are indicated by terms such as *physico-mathematica*, *philologico-physica*, or *physico-medica*. Usually the place of printing matches the location of the university or school, but Nicolai, for example, was a professor in Rostock while he had his *Disquisitio magnetica succincta* printed in Gdańsk.[37]

In general, the disputations testify to a dynamic situation as regards their authors' scholarly career, the reception of these short printed works, the way these texts engage with research of their time, and how they were produced and re-edited. In 1606, for example, Crüger himself was still a candidate for the exam in Leipzig and already in 1615 had become chairman of the examination in Gdańsk. In his disputation of 1606, over which Hunnich presided, Gilbert's *De magnete* is already mentioned. Johannes Kepler corresponded with Crüger in 1615 and also took note of his printed disputation in 1623.[38] The disputation by Cellarius from Tübingen was illustrated

sica De Corpore Coelesti, Dillingen: Mayer 1616; GISBERT VOETIUS: Selectarum disputationum theologicarum pars prima, 4 vols., Utrecht: Waesberghe 1648, pp. 672 f.; JOHANN BAPTIST ERHARDT: Principia philosophica ex universa philosophia, Ingolstadt: Ostermeyr 1661, pp. 71–80; GEORG HIERONYMUS WELSCH: Dissertatio medico-philosophica de aegagropilis, Augsburg 1668, p. 48; MARTIN SCHOOCK: Physica generalis, Groningen: Cöllen 1660, esp. pp. 11, 40, 196, 199, 228, 246, 249, 268, 271, 280, 286.

36 On British disputations about magnetism, see MORDECHAI FEINGOLD: The Mathematicians' Apprenticeship. Science, Universities and Society in England, 1560–1640, Cambridge–New York 1984, pp. 100, 103. For disputations on magnetism printed in northern and Scandinavian regions, see JORMA VALLINKOSKI: Turun Akatemian väitöskirjat: 1642–1828 (Helsingin Yliopiston Kirjaston julkaisuja 30.1–8), 8 vols., Helsinki 1962–69, esp. p. I, 3, 10, 200; JOHAN HENRIK LIDÉN: Catalogus disputationum in Academiis et Gymnasiis Sveciae, atque etiam, a Svecis, extra patriam habitarum, quotquot huc usque reperiri potuerunt, 2 vols., Uppsala 1778–1780, esp. p. I, 68, 71, 248; II, 132; III, 10, 12, 76.

37 For this author, see the register of the University of Rostock on http://purl.uni-rostock.de/matrikel/100043256 [28.02.2023]. His life dates are: * 7.5.1605 Gdańsk, † 29.12.1660 Gdańsk. He was academically employed only in Rostock, but had books printed in Gdańsk, Stettin (Szczecin), and Elbing (Elbląg).

38 Kepler corresponded with Crüger as early as 1615 and in 1623 took note of his disputation: »Careo et illius et Severinj et tuis scriptis, praeterquam disputatione de motu Magnetis«. See KEPLER to CRÜGER, 15.06.1623, in: JOHANNES KEPLER: Gesammelte Werke, 22 vols., ed. by WALTHER VON DYCK, MAX CASPAR, München 1938–2002, vol. 12, p. 138;

by numerous sketches and diagrams in the form of engravings or drawn in by hand. The engravings (see fig. 1 and 2), at least, seem to have been made by Georg Brentel the Younger, a Swabian draughtsman and engraver.[39] This also testifies to the high value such printed works were given. And these images reveal that the author knew Gilbert's work, although it was not referred to in the text.

Some of the writings should also be regarded as short texts about magnetism rather than as the written basis of an exam. Especially the works by Velthuysen, Nicolai, and Kircher belong to this group of writings; although they claim to be a disputation on the title page, they do not bear any concrete traces of this educational context in their structure. Forer's *Disputatio de magnete*, originating from the Jesuit college in Ingolstadt, was later revised and incorporated into a collection of Forer's disputations.[40] Kircher incorporated much of his disputation from Würzburg into his thick tome *Magnes*, published ten years later, in 1641. Sperling's disputation prepared the way for his treatise on magnetism within his textbook *Institutiones physicae* which appeared three years later.[41] Schmidt's Lutheran disputation in theology of 1652 was even reprinted in 1687. The disputation by Siegfried (1673) was translated from Latin into German in 1704.[42] Daniel Erici Achrelius in Turku also included one disputation on magnetism (1681) in his *Contemplationum mundi libri tres* (1682).[43] Zwinger presided over seven

vol. 13, p. 132. In 1622 Crüger from Gdańsk wrote to Philipp Müller in Leipzig about Kepler's magnetic cosmology. See CRÜGER to MÜLLER, 01.07.1622, in: KEPLER: Gesammelte Werke (see above) vol. 13, p. 92.

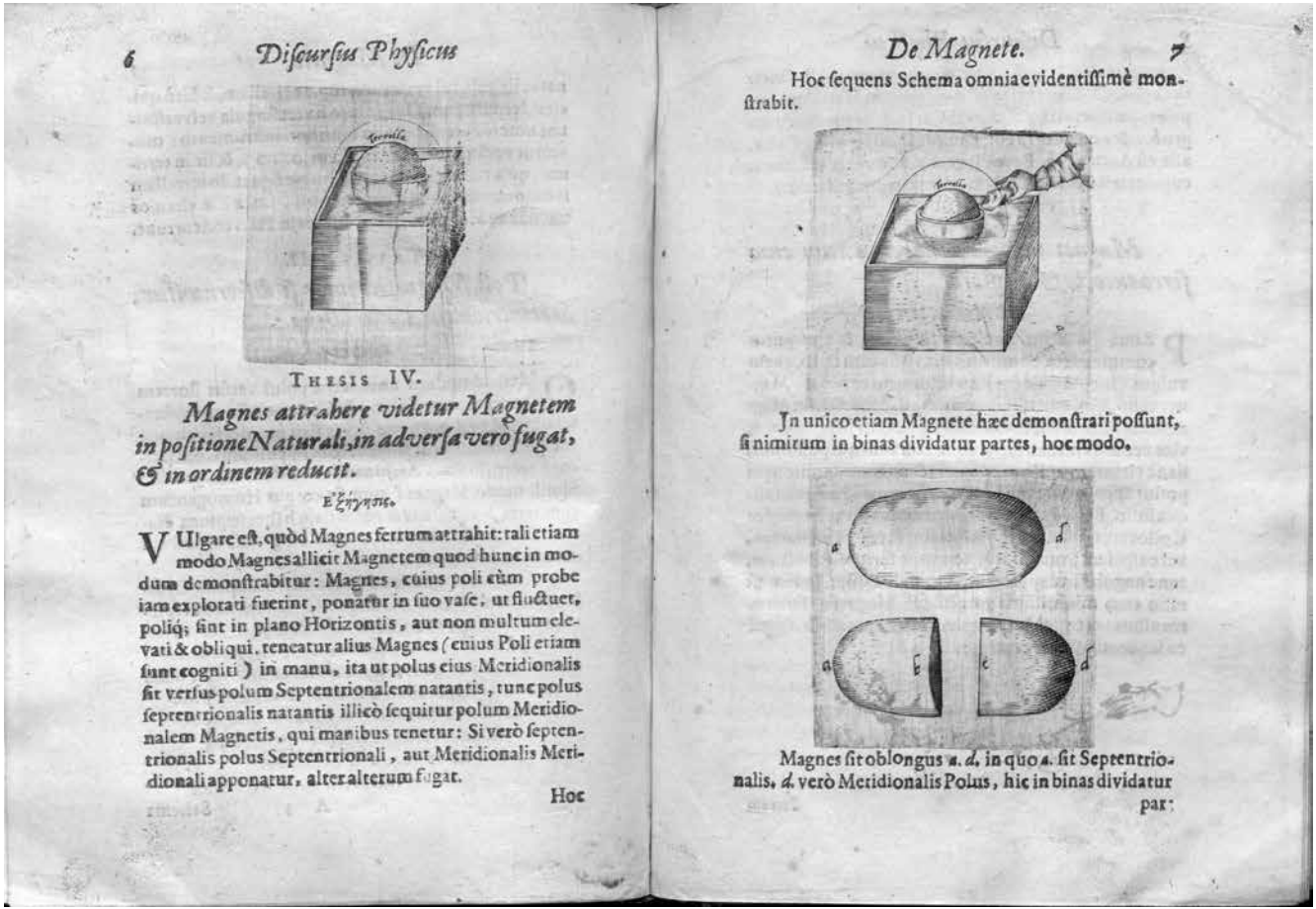
39 This print contains very carefully and specially created illustrations. In the copy from St. Gallen, Kantonsbibliothek, Vadianische Sammlung: VadSlg M 827 (K9), drawings were added in blank spaces on the printed pages at a later stage. The ex libris reads: »Georg Brentel von laugingen, der Zeit Hospitalmaister des Gottshauss zu Nördlingen«.

40 This disputation was again significantly expanded in LAURENZ FORER: Viridarium philosophicum: hoc est disputationes aliquot de selectis [...] in philosophia materiis, Dillingen: Rem 1624, pp. 226–281. The disputation (1618) was defended by Georg Mai and Johannes Marius, and thus printed with two different title pages and prefaces.

41 See JOHANN SPERLING: Institutiones Physicae, Wittenberg: Berger 1639, pp. 1047–1052; ID.: Institutiones physicae, Wittenberg ²1649, pp. 1075–1081.

42 See CASPAR ESAIAS SIEGFRIED: Curiöse Gedancken vom Magnete, M. M. (transl.), in: Deliciarum Manipulus, Das ist: Annehmliche und rare Discurse von mancherley nützlichen und curiosen Dingen 2 (1704), pp. 65–144.

43 See DANIEL ERICI ACHRELIUS, PETTER SVENSSON ULNERUS: Contemplationum mundi dissertatio decima tertia, de geocosmi semine, magnetismo rerum naturalium, tum qualitatibus veneni, Turku 1681; DANIEL ERICI ACHRELIUS: Contemplationum mundi libri tres cum indice necessario, Aboa Finnorum 1682, esp. pp. 227–232, 262–265. See also the later disputation ID., DANIEL G. HAGERT: Magnes rerum naturalium, Turku 1689. The 1681 edition contains a title page and several paratexts but the actual disputation is identical with pages 223–338 of the 1682 edition. Cf. also MAIJA KALLINEN: Naturens hemliga krafter. Daniel Achrelius' Contemplationes mundi, in: Historisk tidskrift för Finland 76 (1991), pp. 317–346, esp. pp. 331–338; EAD.: Change and Stability. Natural Philosophy at



6 Discursus Physicus

THESIS IV.

Magnes attrahere videtur Magnetem in positione Naturali, in adversa verò fugat, & in ordinem reducit.

Ἐξήγησις.

VUlgare est, quòd Magnes ferrum attrahit: tali etiam modo Magnes allicit Magnetem quod hunc in modum demonstrabitur: Magnes, cuius poli eùm probe iam explorati fuerint, ponatur in suo vase, ut fluctuet, poliq; sint in plano Horizontis, aut non multum elevati & obliqui, teneatur alius Magnes (cuius Poli etiam sunt cogniti) in manu, ita ut polus eius Meridionalis sit versus polum Septentrionalem natantis, tunc polus septentrionalis natantis illicò sequitur polum Meridionalem Magnetis, qui manibus tenetur: Si verò septentrionalis polus Septentrionali, aut Meridionalis Meridionali apponatur, alter alterum fugat.

Hoc

De Magnete. 7

Hoc sequens Schema omnia evidentissimè monstrabit.

Jn unico etiam Magnete hæc demonstrari possunt, si nimirum in binas dividatur partes, hoc modo.

Magnes sit oblongus *a. d.* in quo *a.* sit Septentrionalis, *d.* verò Meridionalis Polus, hic in binas dividatur par:

Fig. 1: Engravings inserted in: Conrad Cellarius, Johannes Beckhius: Discursus physicus de magnete, Tubingae 1625. St. Gallen, Kantonsbibliothek, Vadianische Sammlung: VadSlg M 827 (K9)

partes æquales, & pars *a.* vasculo imponatur ut fluctuet: tunc polus *a.* Septentrionalis verterur in Meridiem, ut prius: similiter etiam *d.* movebitur in Boream ut in integro *b. v.* & *c.* quæ antea continuæ erãt partes nunc divisæ, alia est Australis *b.* Borealis verò *c. b.* trahere videtur *c.* cupiens uniri & in pristinam continuationem reduci.

THESIS V.

Magnes mutuum habet actum cum ferro excocto & conflato.

Ἐξήγησις.

PRima illa virtus manifesta, maximè & antiquitus commendata, est mutuus ille actus cum ferro, quem vulgus (ineptè quidem) attractionem appellat: Magnes enim, si minoris fuerit quantitatis ferro, ferum Magnete excitum & frictum attrahere videtur Magnetem & vice versa. Ex his iam facilè coniecturâ assequi possumus, hanc virtutem nullo modo attractionem sed coitionem potius appellandam esse, cum ipsis συμπαθεια quasi aliqua insit. Et hoc quidem tali demonstrabitur Exemplo: Collocetur lingula vel versorium supra verticitatem, vel cuspidem, manibusq; teneatur ferrum excoctum, tunc lingula ferro appropinquanti avidè assilit. Eadem est ratio cum minutissima portiuncula Magnetis: ferro n. manibus tenentis Magnes grani quantitate assilit, Quod ex sequenti patebit exemplo.

Ferrum

Ferrum enim in se & sua Natura non excitum Magnete, easdem (quamvis debiliores) habet virtutes, ut in sequentibus demonstratur. SUBERIS CORTEX exiguus, nucis avellanæ magnitudine rotundus, traijciatur filo ferreo, ad medium usq; fili, hæc in aqua tranquilla cum nataverit, apponatur, natantis fili extremitati aliud filum, ita tamen ut non tangat, tunc filum cum filo (lentè quidem) mutuum habebit actum, & quasi coitionem, filum etiam natans remotis omnibus impedimentis & in tranquillo loco dirigit se ad utrosq; polos.

Ut ex hoc patebit Exemplo.

THESIS VI.

Mutuus ille actus cum ferro, non à Materiali, sed à formali provenit causa.

Ἐξήγησις.

PRimò enim si esset à materiali, tunc si solida, densa, crassaq; in medio interposita essent inter corpora illa, aut Magnetica in crassissimorum, solidissimorum corporum Centris inclusa, non paterentur ferrea à Magnete. Secundo ignis in corpore Magnetico destruit, & evertit Magneticas vires, non quia virtutes præcipuas expellit: sed quia totius formam Materiæ demolitione deformat rapida illa & violenta vis flammea. Veluti in corpore humano animæ facultates primariæ non uruntur: sed ustulatum corpus manet sine facultatibus. Ferrum

Fig. 2: Drawings inserted in: Conrad Cellarius, Johannes Beckhius: Discursus physicus de magnete, Tubingae 1625. St. Gallen, Kantonsbibliothek, Vadianische Sammlung: VadSlg M 827 (K9)

disputations on the magnet between 1685 and 1697 in Basel, but the disputations are just preprints of chapters of his *Scrutinium magnetis physico-medicum* (1697).[44] This all proves to a highly dynamic process of the production and re-use of these disputations, especially as university textbooks.

Many of these sources are very similar in content. Usually, they start with a short natural-historical inventory and then discuss natural-philosophical problems concerning magnetic attraction and north-pointing. As a rule, the authors aim to refute philosophical arguments of other philosophers and to offer their own, albeit very brief, considerations about the causes of magnetic phenomena. Experiments from other works are often described or even conducted by the author or his peers himself: for example, Forer refers to experiments with a magnet from Ingolstadt; Crüger and Lagus give the first printed value for magnetic declination from Gdańsk;[45] and De Volder, chairing a disputation in 1677, owned magnets and compass needles and probably did experiments with those.[46]

Cosmological debates, triggered by Gilbert's Copernicanism, are rarely present. Sometimes, peripheral subjects regarding magnetism were treated as well, e.g. the magnet's medical powers or theological tropes related to magnetism. A particularly controversial topic, also featured in some of these

the Academy of Turku (1640–1713) (Studia historica 51), Helsinki 1995, esp. pp. 206–209. See also, yet exclusively metaphorical, DANIEL ERICI ACHRELIUS: Scientiarum magnes: recitatus publice anno 1690, die 25 novembris cum regis optimi natalem [...] celebraret jubilæum Academia Aboensis, Turku: Wallium 1690. Another example is PETRUS HOFFWENIUS: Synopsis physica, disputationibus aliquot Academicis comprehensa, Stockholm 1678, esp. pp. 112–120.

44 See THEODOR ZWINGER: Scrutinium magnetis physico-medicum, Basel: Richter 1697. Pages 1 to 160 of 214 were pre-published as disputations.

45 See PETRUS CRÜGER, ADRIANUS STODERTUS: De motu magnetis disputatio publica ordinaria, Danzig: Hünefeld 1615, th. 11; DANIEL LAGUS, JOHANN WALTHER LESLE: Contemplationis physicae de magnete sectio posterior thematis addens proprietates, divisionem cognata et opposita: disquisitioni publicae destinata in Gymnasii Dantiscani [...] praeside Daniele Lago [...] respondente Johanne Walthero Lesle, Dantiscano Borusso ad diem Jun. [...] anno M.DC. XLVI, Danzig: Typis Rhetianis 1646, p. E1r; EMANUEL KAYSER: Beobachtungen der magnetischen Declination in Danzig: und Bemerkungen dazu, Danzig 1864, p. 24. In a copy of Crüger's disputation held at Halle, Universitäts- und Landesbibliothek: Qb 1136 (2), bound together with a copy of WILLIAM GILBERT'S *De magnete* (ed. Rostock: Hallervord 1628, shelfmark Qb 1136 [1]) an anonymous reader added an extensive description of a magnetic experiment on a blank page following the disputation and annotated Gilbert's work eagerly, see https://digitale.bibliothek.uni-halle.de/vd17/content/titleinfo/8789123 [28.02.2023]. This proves that disputations were read vis-à-vis established studies such as Gilbert's work.

46 See a list of items belonging to de Volder (inventory of 1705), cit. in ANDREA STRAZZONI: Burchard de Volder and the Age of the Scientific Revolution (Studies in History and Philosophy of Science 51), Cham 2019, p. 54, n. 134: »Een zylsteen met een anker daar aen hangende. Een doosje met eenige acus magneticae, nevens een kleyne zijlsteen ongewapent.« JOHANNES BALTHASAR HELVETIUS, BURCHERUS DE VOLDER: Disputatio philosophica de magnete, Leiden 1677, th. X, refers to an experiment conducted by de Volder.

disputations and in other disputations in its own right, was the so-called ›weapon-salve‹.[47] This cure of pseudo-Paracelsian origin was promoted to heal wounds at a distance by working magnetically. As the use of the salve was condemned by most Catholic and many Protestant authors as a work of the devil, it was mainly refuted in the classroom as well.

Almost all the candidates had to take note of Gilbert's work. The works by Cabeo and Kircher were also referenced soon after their publication. This shows that the universities can by no means be accused of a significant delay in taking note of new research. In addition, these authors were quoted and criticized regardless of whether the university was Protestant or Catholic. Especially among the disputations before 1650, the most cited works of early modern natural philosophy include widely used textbooks such as Julius Caesar Scaliger's *Exotericarum exercitationum liber* (1557),[48] Daniel Sennert's *Epitome naturalis scientiae* (1618),[49] and Johann Sperling's *Institutiones physicae* (1639).[50] Occasionally, the disputations also cite each other: Pomarius (Wittenberg 1649) and Waldschmidt (Marburg 1683) are examples of disputations quoted in other disputations.

Especially before 1650, the predominant natural-philosophical attitude was rather conservative, i. e. Aristotelian in all shades of this term. Above all, the immateriality of the magnetic force of attraction was an essential axiom in many examined sources. Although an indistinct labelling of all these disputations as ›Aristotelian‹ would be short-sighted, Aristotelian philosophy is nowhere openly criticized before 1650. Since a traditional, even canonical, Aristotelian theory of magnetism was lacking, the disputations deal with causal explanations not by following any scheme. Closest to a non-Aristotelian explanation before 1650 came Sperling, talking about »occult effluvia«, and often referring to his teacher Daniel Sennert, who partly drew on Aristotelian principles, partly deviated from them.[51] Pomarius (1649) quoted

47 See esp. MARK A. WADDELL: The Perversion of Nature. Johannes Baptista Van Helmont, the Society of Jesus, and the Magnetic Cure of Wounds, in: Canadian Journal of History 38.2 (2003), pp. 179 – 198; ROBERTO POMA: Magie et guérison. La rationalité de la médecine magique, XVI^{e} – XVII^{e} (Universités), Paris 2009.

48 See SCALIGER: Exotericarum exercitationum liber quintus (see fn. 23), pp. 185v – 188r. On the use of Scaliger's work in Jesuit writings, see also ULRICH GOTTFRIED LEINSLE: Wie treibt man Cardano mit Scaliger aus? Die (Nicht-)Rezeption Cardanos an der Jesuitenuniversität Dillingen, in: MARTIN MUSLOW (ed.): Spätrenaissance-Philosophie in Deutschland 1570 – 1650. Entwürfe zwischen Humanismus und Konfessionalisierung, okkulten Traditionen und Schulmetaphysik (Frühe Neuzeit 124), Tübingen 2009, pp. 253 – 277.

49 See DANIEL SENNERT: Epitome naturalis scientiae, Wittenberg 1618: Heiden, pp. 387 – 394.

50 See n. 41.

51 JOHANN SPERLING, SAMUEL CRAMERUS: Disputatio Physica De Actionibus Magneticis, Wittenberg: Rothe 1636, th. 9. On Sennert, see EMILY MICHAEL: Daniel Sennert on Matter and Form. At the Juncture of the Old and the New, in: Early Science and Medicine. A Journal for the Study of Science, Technology and Medicine in the Pre-Modern Period 2 (1997),

Sennert's son, Andreas Sennert, but only in a linguistic question.[52] However, already Pomarius ascribed the account of ›occult qualities‹ to some »Peripatetici« – implying a critical distance – and refers to accounts by Sperling, Daniel Sennert, and Andreas Libavius.

Around 1650, the situation changed slightly. An early instance of open distancing from Aristotelian principles in a university disputation on magnetism may be found in a disputation from Wittenberg, chaired by Letsch in 1661.[53] Yet, Letsch did not clearly opt for a material cause, as did, e. g., Sturm (Altdorf 1671) and even the Jesuit Emili (Parma 1682).[54] In Utrecht, as is well known and has been sketched elsewhere, René Descartes' and Henricus Regius' corpuscular philosophy was vehemently attacked by the university's philosophy professors, and their theory of magnetism was an early battleground for this clash of philosophies, contested particularly in disputations at the Dutch universities.[55] The accounts of Descartes, Regius, and some of their follower's accounts were discussed in other classrooms as well: Waldschmidt (Marburg 1683) and Scheid (Strasbourg 1683) were already clearly influenced by Descartes' corpuscular theory. Watson (Rostock 1651), who referred to Regius' *Fundamenta physices*, and Helwig (Berlin 1662) both continued to defending ›occult qualities‹, and Zwinger (Basel 1685 – 1697) dealt with Descartes' theory in an eclectic manner. Bilberg, chairing a disputa-

pp. 272 – 299; EMILY MICHAEL: Sennert's Sea Changes. Atoms and Causes, in: CHRISTOPH LÜTHY, JOHN EMERY MURDOCH, WILLIAM R. NEWMAN (eds.): Late Medieval and Early Modern Corpuscular Matter Theories (Medieval and Early Modern Science 1), Leiden – Boston 2001, pp. 331 – 362; WOLFGANG UWE ECKART: Antiparacelsismus, okkulte Qualitäten und medizinisch-wissenschaftliches Erkennen im Werk Daniel Sennerts (1572 – 1637), in: AUGUST BUCK (ed.): Die okkulten Wissenschaften in der Renaissance (Wolfenbütteler Abhandlungen zur Renaissanceforschung 12), Wiesbaden 1992, pp. 139 – 157; SANDER: Magnes (see fn. 5), p. 711 f. SPERLING: Institutiones Physicae (see fn. 41), p. 1050 quotes SÉBASTIEN BASSON: Philosophiae naturalis adversus Aristotelem libri XII, Geneva: Rouiere 1621, p. 567 which offers a corpuscular explanation of magnetism, and Basson's work is to be considered anti-Aristotelian, see CHRISTOPH LÜTHY: Thoughts and Circumstances of Sébastien Basson. Analysis, Micro-History, Questions, in: Early Science and Medicine. A Journal for the Study of Science, Technology and Medicine in the Pre-Modern Period 2.1 (1997), pp. 1 – 73.

52 See SAMUEL POMARIUS, CHRISTOPHORUS FICKEL: De magnete disputatio physica, Wittenberg: Wendt 1649, § 4.

53 See JOHANNES CHRISTOPHORUS LETSCH, JOHANNES RIHM: Disputationem physiologicam, De Magnete, Wittenberg: Henckel 1661, § 9 f.

54 See GIOVANNI FRANCESCO EMILI: Magneticarum motionum investigatio problema physicomathematicum, Parma: Vigna 1682.

55 See THEO VERBEEK (ed.): La Querelle d'Utrecht. René Descartes et Martin Schoock, Paris 1988; JOHAN ARIE VAN RULER: The Crisis of Causality. Voetius and Descartes on God, Nature, and Change, Leiden – New York 1995; ANDREA STRAZZONI: Dutch Cartesianism and the Birth of Philosophy of Science. From Regius to 's Gravesande, Berlin – Boston 2019. See in more detail CHRISTOPH SANDER: Teaching Magnetism in a Cartesian World (1650 – 1700), in: DAVIDE CELLAMARE, MATTIA MANTOVANI (eds.): Descartes in the Classroom. Teaching Cartesian Philosophy in the Early Modern Age, Leiden – Boston 2023, pp. 313 – 342.

tion in Uppsala in 1687, tried to reconcile the Aristotelian and the Cartesian accounts, e.g. by quoting Jean-Baptiste Du Hamel's *Philosophia vetus et nova* (1678) as the *celeber Peripateticus* who affirmed that ›occult qualities‹ and ›substantial forms‹ are hardly useful to explain magnetism, which is to be explained in mechanical terms instead.[56] Schwimmer (Jena 1671) in turn discussed the corpuscular accounts of Pierre Gassendi and Kenelm Digby.

Although these disputations often do not offer groundbreaking new insights or major theories, they do provide information about the ›normal science‹, i.e. institutionally consolidated and established knowledge shared by a comparatively homogeneous scientific community.[57] The major development – and not a disruptive event – seems to be that by 1650 corpuscular theories were discussed and approved more often in universities and schools, yet Aristotelian principles were still defended in other disputations after 1650. Beyond the contents of the writings, the mere existence of these disputations about magnetism is meaningful, too: a certain set of phenomena was established as the subject of examination and research. This development clearly reflects the emergence of a ›magnetism science‹, i.e. a field of research on magnetism, also present in university education and among Aristotelians. Even an allegedly conservative approach in natural philosophy did not lead to ignorance of the empirical research and the causal theories of the world beyond the university.

Kaspar Van Baerle and His Eclectic Theory of Magnetism

In 1658, Alexander de Bie, professor at the Athenaeum in Amsterdam – an institution that is considered the predecessor of the University of Amsterdam – presided over three disputations on magnetism that were printed in the same year.[58] In one of them, the candidate, Joannes de Pire, who after his exam continued his studies at Utrecht, also had to face the problem of

56 See ANDREAS PLAAN, JOHAN BILBERG: Disputatio physica de magnete, Uppsala 1687, esp. p. 18; JEAN-BAPTISTE DU HAMEL: Philosophia vetus et nova. Tomus posterior qui physicam generalem et speciale tripartitam complectitur, ed. by JACQUES NICOLAS COLBERT, vol. 2, Nuremberg: Zieger 1682, esp. pp. 423 f. Considering Du Hamel a Peripatetic is disputable. Descartes is also briefly mentioned in JOHAN BILBERG, ERICUS E. ODHELIUS: Specimen cogitationum de magnetismis rerum, Stockholm 1683.

57 Cf. THOMAS S. KUHN: The Structure of Scientific Revolutions, Chicago ³1996, p. 10: »›[N]ormal science‹ means research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice.«

58 Cf. DIRK VAN MIERT: Humanism in an Age of Science. The Amsterdam Athenaeum in the Golden Age, 1632–1704 (Brill's Studies in Intellectual History 179), Leiden–Boston 2009, pp. 378 f., 385.

›occult qualities‹ as being the cause of magnetic phenomena. The professor teased him that ascribing an effect to an ›occult quality‹ is hardly knowledge. The Dutch student tackled this by referring to Cabeo's ›Aristotelian‹ idea of a ›two-faced quality‹ (which Cabeo in turn took from Garzoni).[59] The Jesuit Cabeo – de Pire called him a *vir magnus* and another Dutch respondent, Sibertus Coeman, even *vir incomparabilis* – was this respondent's updated Aristotelian weapon against his professor's alleged professional skepticism. Already before these three disputations at the Athenaeum magnetism had been treated at length by one of the school's professors, Kaspar van Baerle.

In 1651, a short volume was published in Amsterdam under the title *Observatien of Ondervindingen aen de Magneetsteen, en de Magnetische kracht der Aerde* (see fig. 3).[60] It contained a rather idiosyncratic magnetism theory by van Baerle, who became a professor at the Athenaeum in 1631 and died in 1648. The book was a posthumous co-publication by van Baerle and Laurens Reael, an admiral of the Dutch Republican Navy and Governor-General of the Dutch East Indies from 1616 to 1619. After Reael's death in 1637, he left a Dutch manuscript in which he recorded his numerous observations and experiments on magnetism and the ›magnetic force of the earth‹.[61] Reael travelled large parts of Dutch India and obviously had an interest in magnetism, with which he must have been familiar, at least rudimentarily, through the use of the nautical compass.[62] The book is an astonishing bilingual study, comprising Reael's Dutch descriptive approach, mostly delivering

59 See JOANNES DU PIRE, ALEXANDER DE BIE: Disputatio de magnete, quae est de ejus ὀρθοβορεοδειξει, Amsterdam: Banningius 1658, p. B1r.

60 See LAURENS REAEL, KASPAR VAN BAERLE: Observatien of ondervindingen aen de magneetsteen: en de Magnetische kracht der Aerde, Amsterdam: Spillebout 1651.

61 On Reael, see also MARTINE JULIA VAN ITTERSUM, HUGO GROTIUS: Profit and Principle. Hugo Grotius, Natural Rights Theories and the Rise of Dutch Power in the East Indies, 1595–1615 (Brill's Studies in Intellectual History 139), Leiden – Boston 2006, p. ad indicem.

62 Reael was also in contact with scholars such as Constantijn Huygens, Galileo Galilei or Isaac Beeckman. On correspondence with Huygens, see for instance CONSTANTIJN HUYGENS: De Briefwisseling D.2: 1634–1639, ed. by JACOB A. WORP, Den Haag 1913, pp. 164 f., 213, 228, 232, 235, 243, 327. Magnetism, especially in DESCARTES to HUYGENS, 25.01.1642, in: RENÉ DESCARTES, CONSTANTIJN HUYGENS: Correspondence of Descartes and Constantyn Huygens, 1635–1647, ed. by LEON ROTH, Oxford 1926, pp. 163, 165. Huygens praises Reael's research (*qu'il avoit beaucoup estudiée*). Also in 1640 HUYGENS seems to refer to Reael's magnetic experiments. On Beeckman's extant exchange of letters, see volume 4 of ISAAC BEECKMAN: Journal tenu par Isaac Beeckman de 1604 à 1634, ed. by CORNELIS DE WAARD, La Haye 1939. The correspondence with Galilei can be recapitulated from the index of GALILEO GALILEI: Le opere di Galileo Galilei, 20 vols., ed. by ANTONIO GARBASSO, GIORGIO ABETTI, Firenze 1968. See also MATTEO VALLERIANI: Galileo Engineer (Boston Studies in the Philosophy and History of Science 269), Diss. Humboldt-Univ. Berlin 2009, Dordrecht – London – New York 2010, pp. 288–294. Also his magnetic research was already known during his lifetime; Descartes' biographer Adrien Baillet later even gave him the title of first representative of magnetic philosophy, even before Gilbert and Cabeo. See ADRIEN BAILLET: La vie de Monsieur Des-Cartes, 2 vols., Paris: Horthemels

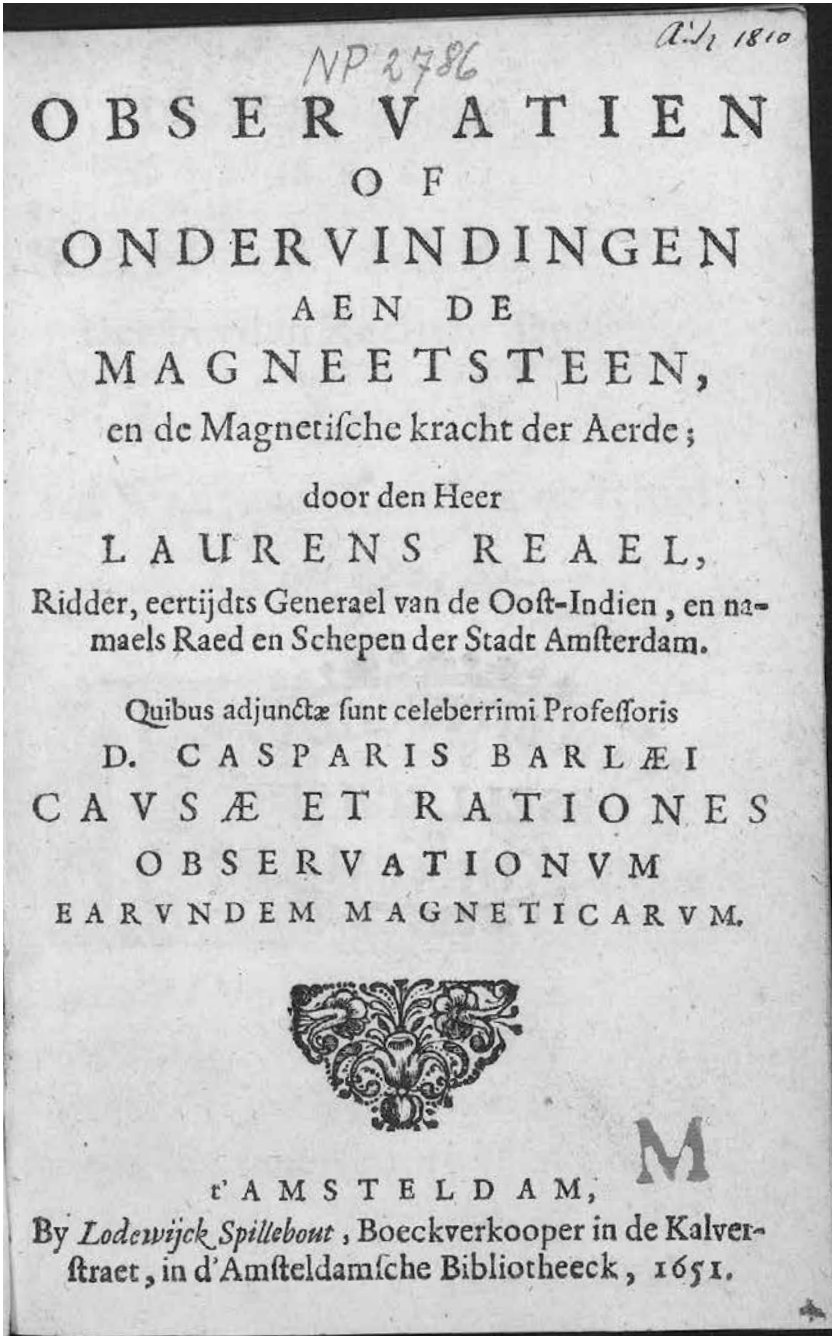


Fig. 3: Title page of Laurens Reael, Kaspar van Baerle: Observatien of ondervindingen aen de magneetsteen, en de Magnetische kracht der Aerde, Amsteldam: Spillebout 1651. Zürich, Zentralbibliothek: NP 2786, https://doi.org/10.3931/e-rara-37247 [01.03.2023]

certain observations, and van Baerle's attempt to explain these phenomena in Latin from the perspective of natural philosophy, which the title page refers to as *causae et rationes observationum earundem magneticarum*.[63] When and whether Reael and van Baerle ever worked together remains doubtful, but van Baerle's contribution was probably made after 1631.[64]

This publication, and van Baerle's part of it in particular, delivers interesting insights into a university professor's interest in magnetism in the first half of the 17th century. Van Baerle even explicitly described himself as an Aristotelian.[65] Pumfrey assessed his theory to be based on »scholastic concepts« and claimed: »There is no advance here on medieval analyses«.[66] In

1691, vol. 1, p. 319: »Il passoit puor le prémier homme du siecle dans la Philosophie magnetique, et Gilbert ny Cabeus n'avoient rien à luy apprende sur ce sujet.«

63 Reael's remarks lack almost any theoretical reflection; he is not interested in a theory of magnetism, but in a series of experiments and observations. He knew Gilbert's work and the Copernicanism claimed there, which was also followed by Simon Stevin, see REAEL, VAN BAERLE: Observatien of ondervindingen aen de magneetsteen (see fn. 60), p. 33. Van Baerle's Latin commentaries and explanations add nothing experimentally to Reael's dossier. Often he only paraphrases his explanations, but in many places he also tries to give a natural-philosophical explanation for them.

64 See INEKE PHAF-RHEINBERGER: The »Air of Liberty«. Narratives of the South Atlantic Past (Cross/Cultures 96), Amsterdam – New York 2008, p. 42: »In all probability, Barlaeus and Reel worked on the manuscript together after Barlaeus's appointment to the *Athenaeum* [1631]. In his introduction, the publisher Lodewijk Spillebout remarks that this was a long-forgotten manuscript, damaged by water leakage, dirt, and scratches, before he finally succeeded in publishing it.« In a letter to Johannes Bodaeus van Stapel of May 1629, van Baerle mentions the magnet and Gilbert's work, but says nothing to suggest that he was already working on a treatise on it. See VAN BAERLE to VAN STAPEL, 24.05.1629, in: KASPAR VAN BAERLE: Epistolarum liber, 2 vols., Amsterdam: Blaeu 1667, pp. 285 – 287. Differences between magnetic and electrical attraction are discussed there, which is also dealt with in REAEL, VAN BAERLE: Observatien of ondervindingen aen de magneetsteen (see fn. 60), p. 77. In his *Mercator sapiens*, written around 1632, the phenomenon of declination is only briefly described. Cf. CATHERINE SECRETAN: Le »Marchand philosophe« de Caspar Barlaeus. Un éloge du commerce dans la Hollande du siècle d'or (Vie des Huguenots 24), Paris 2002, p. 156. In 1643, Andreas Colvius mentions in a letter of 10 September 1643 to Gerhard Johannes Vossius that van Baerle asks for a copy of a work entitled »de Arte Magnesia«. This probably refers to ATHANASIUS KIRCHER, JOHANN JACOB SCHWEIGKHARD VON FREIHAUSEN: Ars magnesia: hoc est disquisitio bipartita empeirica seu experimentalis, physico-mathematica de natura, viribus et prodigiosis effectibus magnetis, Wurzburg: Zinck 1631. Van Baerle's own »quaestiones philosophicae de Magnete« were still »expected«, i. e. not yet in circulation, but obviously already anticipated. See COLVIUS to VOSSIUS, 10.09.1643, in: GERARD JOHANNES VOSSIUS: Doctissimi clarissimique Gerardi Joannis Vossii et ad eum virorum eruditione celeberrimorum Epistolae, 2 vols., London: Smith, Walford 1693, vol. 2, p. 253: »Vidi apud D. D. Arminium scripta quaedam de Arte Magnesia, quae si meis sumptibus transcribi possent, faceret mihi magnus Barlaeus insignem gratiam. Sed haec vix ab eo petere auderem. Quocirca eius de Magnete philosophicas quaestiones expectanda nobis erunt.«

65 Cf., e. g., KASPER VAN BAERLE: Oratio, de Coeli Admirandis, Amsterdam: Blaeu 1636, p. 12.

66 See PUMFREY: Neo-Aristotelianism and the Magnetic Philosophy (see fn. 29), p. 180; VAN MIERT: Humanism in an Age of Science the Amsterdam Athenaeum in the Golden Age, 1632 – 1704 (see fn. 58), p. 249.

fact, however, van Baerle's theory is very eclectic and by no means exclusively scholastic, as an outline of its essential characteristics shows.

Thanks to Reael's profound investigations, which the professor sometimes supplements, van Baerle takes into account a large repertoire of magnetic phenomena, in particular related to geomagnetism, i. e. the behavior of a compass needle. References to works on magnetism by others are rare but occasionally reveal that the authors also had a good overview of the state of research on magnetism.[67] Unlike what Aristotelians usually did, van Baerle speaks of *effluvia magnetica*, of *spiramina* or *spiracula magnetica*, of a *fluxus magneticus*, of *corpuscula*, and even of *atomi*.[68] For example, he explains that rust prevents the *effluvia* of the iron from flowing into the magnet and vice versa.[69] Aristotelians such as Garzoni had already made use of the idea of a sphere of activity, i. e. the range within which a magnet acts.[70] Van Baerle however explains that the sphere for the magnet's ability to make an iron needle align to it extends further than that of attracting the iron, which is due to the different fineness or coarseness of the *effluvia*.[71] A similar corpuscular assumption explains why the sphere of activity extends further through dense bodies than through the air.[72] These explanatory approaches clearly show that the author has in mind a material nature of *effluvia*, especially as he repeatedly writes of *pori* through which *effluvia* penetrate.

Nevertheless, van Baerle repeatedly refers to concepts from the tradition of theories that renounced such material entities: for example, a magnet loses its ›substantial form‹ when it is too small or heated by fire.[73] He also assumes ›qualities‹ as *explanans*, without aiming at a corpuscular understanding of this

67 See REAEL, VAN BAERLE: Observatien of ondervindingen aen de magneetsteen (see fn. 60), esp. pp. 18, 33, 87.

68 See ibid., esp. pp. 7, 9 f., 23, 54, 57.

69 See ibid., p. 41: »rubigo impedit egressum effluvii e ferro in lapidem, et ingressum effluvii [sic!] e lapide in ferrum«.

70 Cf. FRITZ KRAFFT: Sphaera activitatis – orbis virtutis. Das Entstehen der Vorstellung von Zentralkräften, in: Sudhoffs Archiv. Zeitschrift für Wissenschaftsgeschichte 54 (1970), pp. 113 – 140; SALVADOR CASTELLOTE CUBELLS: »Actio in distans« y la »sphaera activitatis«. El problema de la causalidad entre cosas o cuerpos distantes especialmente de la causa, en Francisco Suárez, in: GONZALO ALBERO ALABORT (ed.): Logos y vida: homenaje al professor D. Juan José Garrido Zaragozá, Valencia 2015, pp. 49 – 74.

71 See REAEL, VAN BAERLE: Observatien of ondervindingen aen de magneetsteen (see fn. 60), p. 52: »Vis directrix per longius spatium se exerit, quam attractrix. Ratio est, quia ut directio fiat, sufficit effluvium tenue, quod facile movet acum fluitantem in cuspide: ut tractio fiat ab acu opus est maiore labore, et per consequens crassiore et potentiore effluvio. At quod tale est, breviore spatio continetur, quam tenue et laxum et rarius effluvium.«

72 See ibid.: »Virtus Magnetica tam longe se diffundit per corpora crassissima, quam per apertum aera. Ratio, quia cum haereat in effluvio subtiliori, penetrat poros corporum repletos aere.«

73 See ibid., p. 31. Cf. also ibid., p. 60: »Ferrum candens vel ignitum a Magnete non trahitur, vel, quia ferrum candens desinit esse ferrum et formam suam substantialem amittit, ut quidam Philosophorum sentiunt.«

concept.[74] In addition, he refers to the assumption of a ›sexuality‹ between the magnet and iron in order to explain certain magnetic powers, which invokes a teleological understanding.[75] However, van Baerle also emphasizes the limits of his theory several times, when he qualifies his explanation partly as ›conjecture‹ (*conjectura*) and in other questions even entirely abstains from the indication of a cause.[76]

Van Baerle's and Reael's publication is an exception in many regards. One exceptional feature certainly is van Baerle's idiosyncratic and eclectic magnetism theory, put forward by someone who considered himself an Aristotelian and was affiliated to an educational institute. Compared to printed disputations, van Baerle's investigation is much more elaborate, and thanks to Reael's thorough empirical research the amount of *explananda*, i. e. properties and powers of a magnet, is much larger than any university disputation would have had the time to consider and treat academically. Van Baerle's ideas were published posthumously and without any direct connection to the Amsterdam school, and his treatise also seems to have been a private undertaking in the first place and not one particularly fostered by the Athenaeum. But rather than assuming a two-faced, self-contradictory identity of van Baerle – university professor vs. eclectic philosopher and researcher – it seems more justified to regard both aspects of his career and scientific persona as expression of what Aristotelianism had become or could mean in the mid-17th century: a rather vague and open framework to do all sorts of research, and one that made use of a much wider spectrum of philosophical concepts than were part of an ›Aristotelian‹ framework a hundred years earlier.

Nikolaus Andreas Granius as Reader of Gilbert's *De Magnete*

In van Baerle's case, we have seen his scientific output but we know hardly anything about his private studies on magnetism, or how he, while being a university professor, studied the literature on magnetism which to some degree also informed later university disputations at the Athenaeum. If we turn to the University of Helmstedt, we find an opposite example. Although the well preserved records of Helmstedt's university prove that there was

74 See REAEL, VAN BAERLE: Observatien of ondervindingen aen de magneetsteen (see fn. 60), pp. 30, 39. See also ibid., p. 59: »eadem qualitas magnetica in duas acus«.

75 See ibid., pp. 43, 61.

76 See ibid., esp. pp. 22, 38, 46. Cf. ibid., p. 20: »Utrum verum virtus illa terrae insit radicaliter, et inde in aerem se diffundat, an vero caelo insit radicaliter, ac inde in aerem et terram ipsam dimanet, incerto est.« Cf. ibid., p. 51: »Magneti inest vis directrix, quae acum dirigit in Septentrionem. Inest eidem vis attractrix, qua acum ad se invitas. Quae virtutes an sint re diversa, an ratione solummodo, non facile dixerim.«

no early modern disputation on magnetism, it seems that one of the university's professors had been an eagerly interested reader of Gilbert's *De magnete*.[77] A copy of the second edition of Gilbert's work (1628) apparently was meticulously read and studied by Nikolaus Andreas Granius, as many marginalia and annotations testify.[78] Granius taught natural philosophy in Helmstedt and bequeathed his rich library to the university library after his death in 1631.[79] Not much is known about his natural philosophical orientation, but Stefano Gulizia, based on Granius's writings and the notes left in his books, characterizes him as a Peripatetic who occasionally deviated from the Aristotelian tradition.[80]

Granius's notes on Gilbert hardly relate to his attitude towards Aristotelianism. Gilbert's attacks on Aristotle and university learning are not commented on by Granius. However, his marginalia and annotations make him appear a humanist and a natural philosopher with great interest in experiments and the applied sciences, such as navigation. Many of his minor engagements with the text play out on a grammatical or typographical level – Granius is repeatedly unsatisfied with the editor of this edition, Wolfgang Lochmann, a scholar from Stettin (Szczecin). Already on the title page (see fig. 4) he changed Lochmann's announcement of textual and visual fidelity (*diligenter recognita et emendatius quam ante in lucem edita, aucta et figuris illustrata*) into its opposite: *diligenter* he corrected to *negligenter*, *emendatius* to *vitiosus* and *illustrata* to *obscurata*. He remains faithful to this agenda and corrects Lochmann's text in numerous places. Granius even, almost pedantically, corrected the *errata* of Lochmann's edition.

However, the focus of his interest are the parts of Gilbert's work that deal with geomagnetic phenomena (declination, inclination) and with Gilbert's quasi-Copernican cosmology. In many places, detailed remarks and small pen drawings in the margin reveal that Granius was eager to understand Gilbert's ideas and theories (see fig. 5 to 9). His annotations reveal a geometrical and schematic way of thinking, trying to conceptualize Gilbert's prose in diagrammatic forms (see fig. 7 and 9). In other cases, he engaged with the

77 On Helmstedt, see the contribution by Benjamin Wallura in this volume.

78 See the copy in Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46.

79 Cf. PAUL RAABE (ed.): Handbuch der historischen Buchbestände in Deutschland, vol. 2 (2 vols.), Hildesheim 1998, esp. pp. 74, 210. See also ARNE LOSMAN: Nicolaus Andreae Granius: svensk professor i Helmstedt, in: IVO ASMUS (ed.): Gemeinsame Bekannte. Schweden und Deutschland in der Frühen Neuzeit (Geschichte – Forschung und Wissenschaft 2), Münster 2003, pp. 133 – 143.

80 See STEFANO GULIZIA: Cosmology and Scholarship in Seventeenth-Century Helmstedt. The Baltic Mathematician and Scientific Mediator Nicolaus Andreae Granius (c. 1569 – 1631), in: PIETRO DANIEL OMODEO, VOLKHARD WELS (eds.): Natural Knowledge and Aristotelianism at Early Modern Protestant Universities (Episteme in Bewegung. Beiträge zu einer transdisziplinären Wissensgeschichte 14), Wiesbaden 2019, pp. 109 – 122.

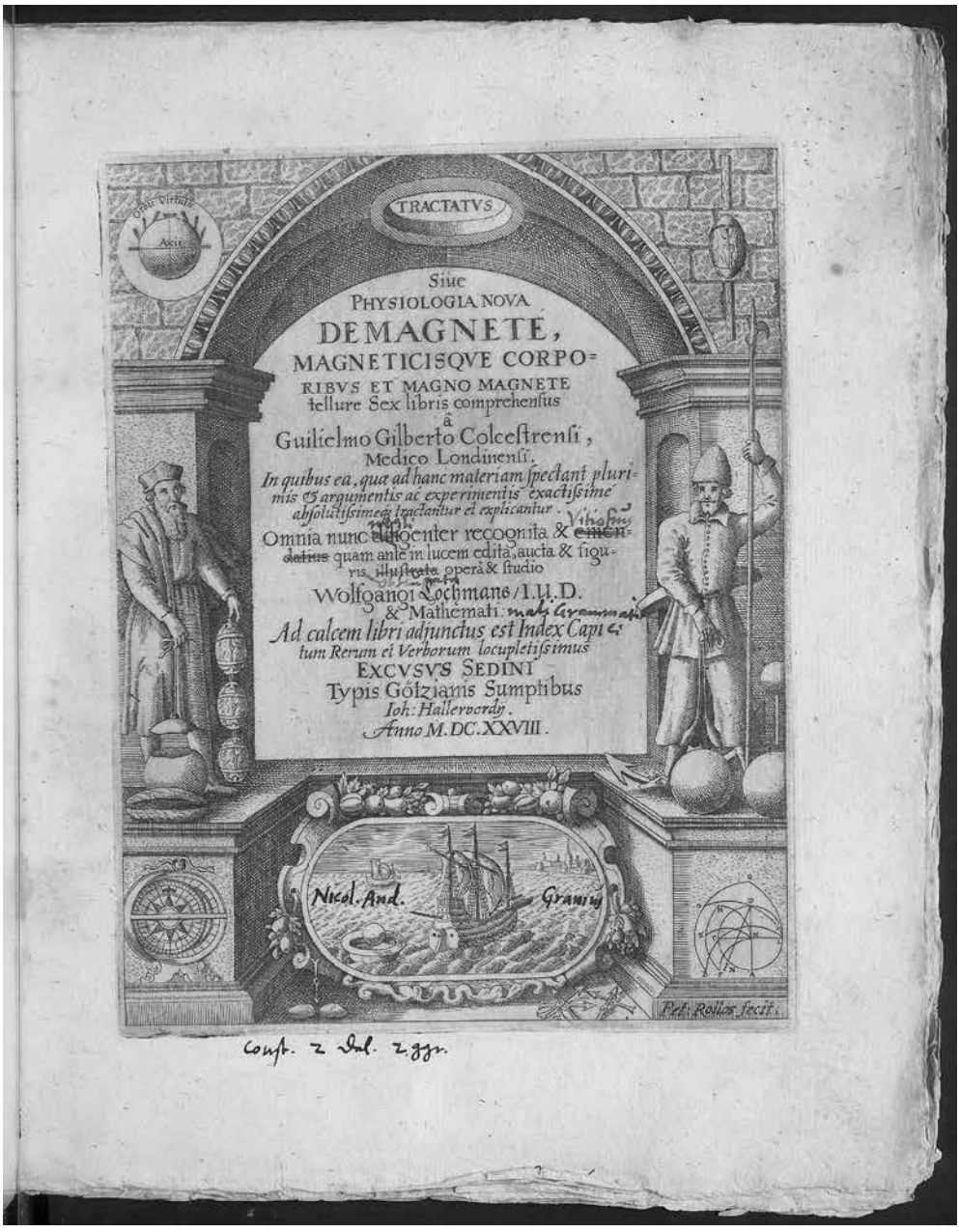
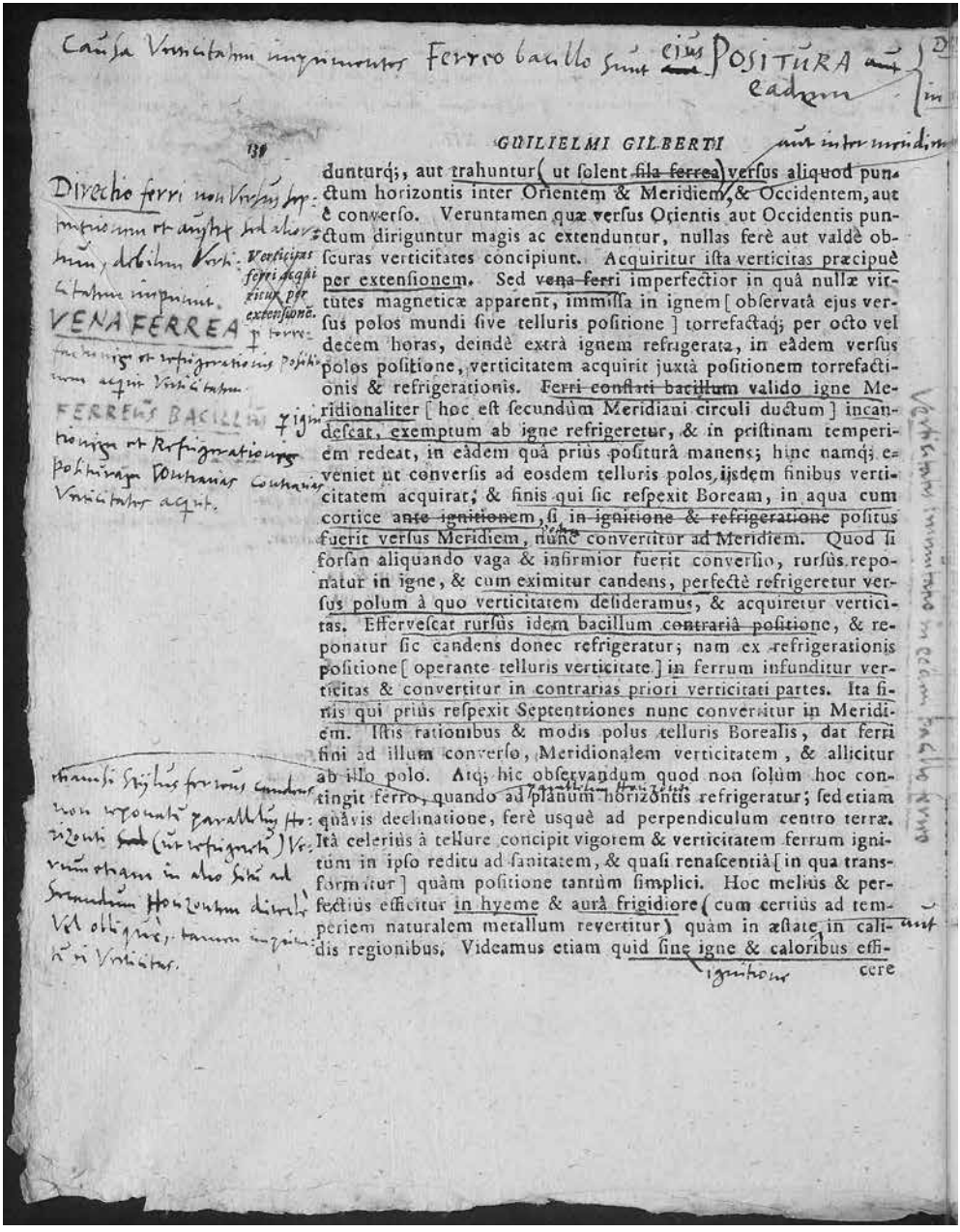


Fig. 4: Title page of William Gilbert: Tractatvs, siue Physiologia nova de magnete, magneticisqve corporibvs et magno magnete tellure sex libris comprehensus, Sedini: Hallervord 1628, copy owned and annotated by Nikolaus Andreas Granius. Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46, http://diglib.hab.de/drucke/nc-4f-46/start.htm [01.03.2023]

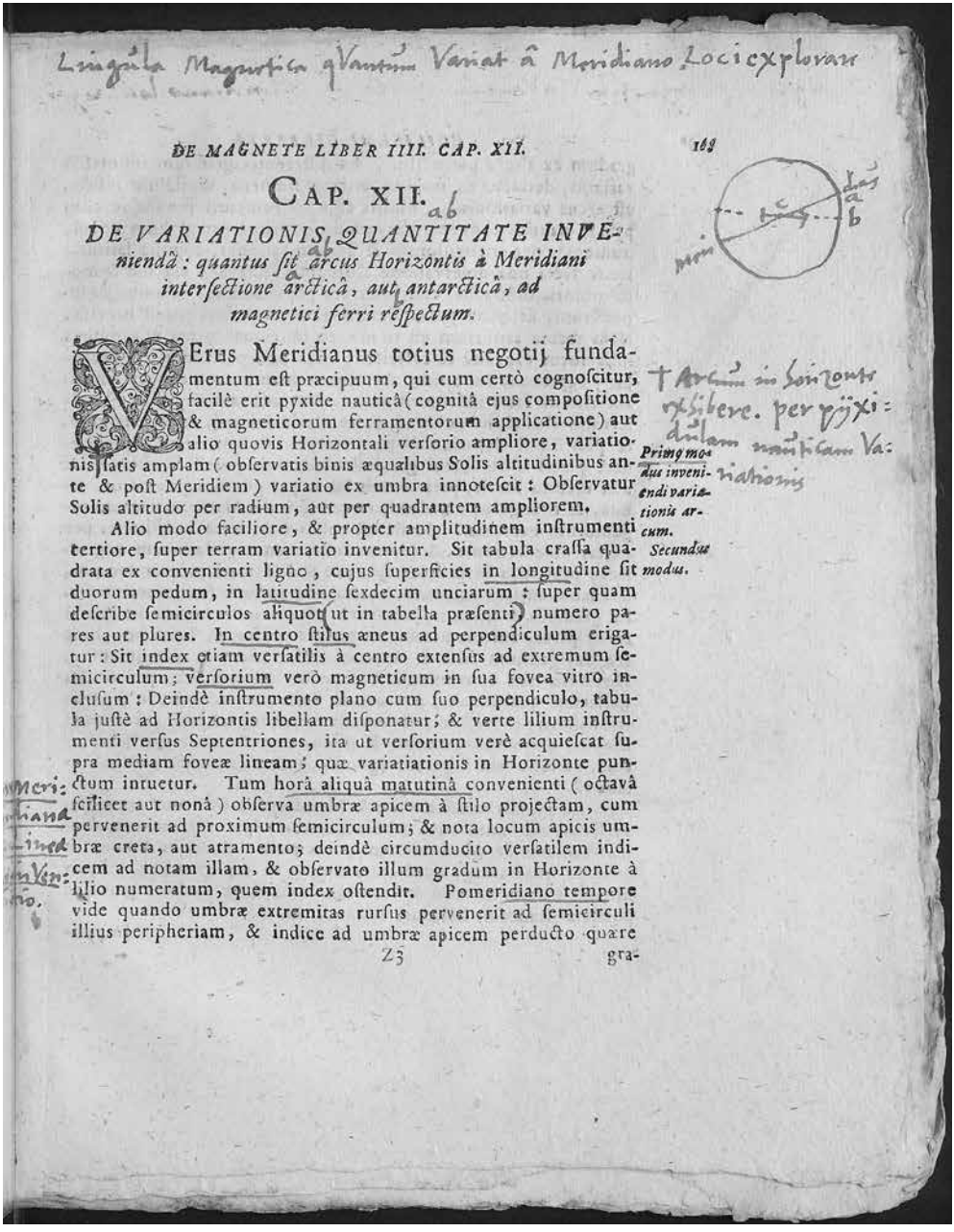


GVILIELMI GILBERTI

dunturq;, aut trahuntur (ut ſolent ~~fila ferrea~~) verſus aliquod punctum horizontis inter Orientem & Meridiem, & Occidentem, aut è converſo. Veruntamen quæ verſus Orientis aut Occidentis punctum diriguntur magis ac extenduntur, nullas ferè aut valdè obſcuras verticitates concipiunt. Acquiritur iſta verticitas præcipuè per extenſionem. Sed ~~vena ferri~~ imperfectior in quâ nullæ virtutes magneticæ apparent, immiſſa in ignem [obſervatâ ejus verſus polos mundi ſive telluris poſitione] torrefactaq; per octo vel decem horas, deindè extrà ignem refrigerata, in eâdem verſus polos poſitione, verticitatem acquirit juxtà poſitionem torrefactionis & refrigerationis. ~~Ferri conflati bacillum~~ valido igne Meridionaliter [hoc eſt ſecundùm Meridiani circuli ductum] incandeſcat, exemptum ab igne refrigeretur, & in priſtinam temperiem redeat, in eâdem quâ priùs poſiturâ manens; hinc namq; eveniet ut converſis ad eosdem telluris polos, ijsdem finibus verticitatem acquirat; & finis qui ſic reſpexit Boream, in aqua cum cortice ~~ante ignitionem~~, ſi ~~in ignitione & refrigeratione~~ poſitus fuerit verſus Meridiem, nunc convertitur ad Meridiem. Quod ſi forſan aliquando vaga & infirmior fuerit converſio, rurſus reponatur in igne, & cum eximitur candens, perfectè refrigeretur verſus polum à quo verticitatem deſideramus, & acquiretur verticitas. Effervescat rurſus idem bacillum contrariâ poſitione, & reponatur ſic candens donec refrigeratur; nam ex refrigerationis poſitione [operante telluris verticitate] in ferrum infunditur verticitas & convertitur in contrarias priori verticitati partes. Ita finis qui priùs reſpexit Septentriones nunc convertitur in Meridiem. Iſtis rationibus & modis polus telluris Borealis, dat ferri fini ad illum converſo, Meridionalem verticitatem, & allicitur ab illo polo. Atq; hic obſervandum quod non ſolùm hoc contingit ferro, quando ad planum horizontis refrigeratur; ſed etiam quâvis declinatione, ferè usquè ad perpendiculum centro terræ. Ità celeriùs à tellure concipit vigorem & verticitatem ferrum ignitum in ipſo reditu ad ſanitatem, & quaſi renaſcentiâ [in qua transformatur] quàm poſitione tantùm ſimplici. Hoc meliùs & perfectiùs efficitur in hyeme & aurâ frigidiore (cum certiùs ad temperiem naturalem metallum revertitur) quàm in æſtate in calidis regionibus. Videamus etiam quid ſine igne & caloribus efficere

Fig. 5: William Gilbert: Tractatvs, siue Physiologia nova de magnete, magneticisqve corporibvs et magno magnete tellure sex libris comprehensus, Sedini: Hallervord 1628, p. 139, annotations by the hand of Nikolaus Andreas Granius. Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46, http://diglib.hab.de/drucke/nc-4f-46/start.htm [01.03.2023]

Fig. 6: William Gilbert: Tractatvs, siue Physiologia nova de magnete, magneticisqve corporibvs et magno magnete tellure sex libris comprehensus, Sedini: Hallervord 1628, p. 155a, annotations by the hand of Nikolaus Andreas Granius. Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46, http://diglib.hab.de/drucke/nc-4f-46/start.htm [01.03.2023]



Lingula Magnetica qVantum Variat â Meridiano Loci explorari

DE MAGNETE LIBER IIII. CAP. XII. 169

CAP. XII.

DE VARIATIONIS QUANTITATE INVEniendâ: quantus sit arcus Horizontis à Meridiani intersectione arcticâ, aut antarcticâ, ad magnetici ferri respectum.

VErus Meridianus totius negotij fundamentum est præcipuum, qui cum certò cognoscitur, facilè erit pyxide nauticâ (cognitâ ejus compositione & magneticorum ferramentorum applicatione) aut alio quovis Horizontali versorio ampliore, variationis satis amplam (observatis binis æqualibus Solis altitudinibus ante & post Meridiem) variatio ex umbra innotescit: Observatur Solis altitudo per radium, aut per quadrantem ampliorem.

Primo modus inveniendi variationis arcum.

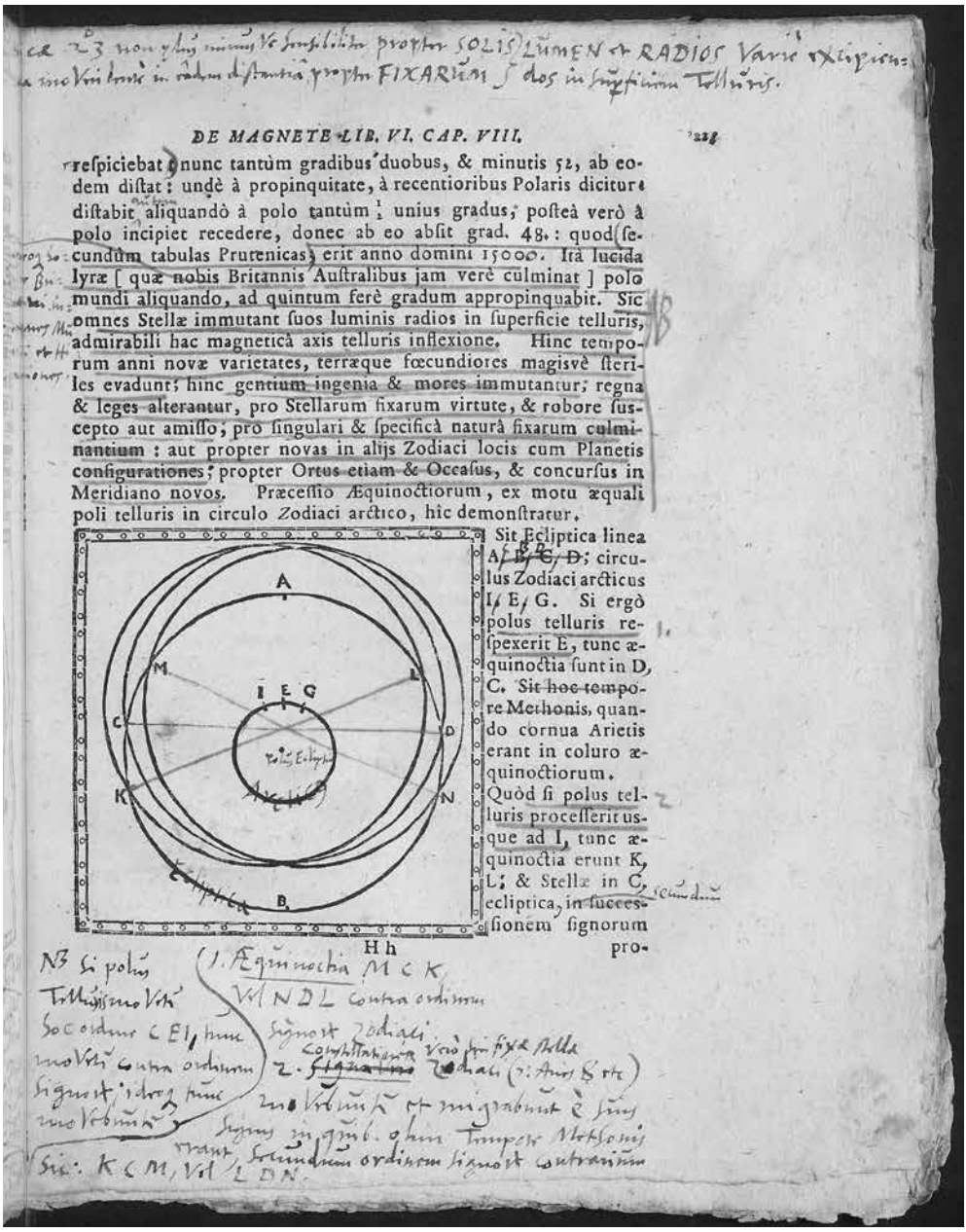
Alio modo faciliore, & propter amplitudinem instrumenti tertiore, super terram variatio invenitur. Sit tabula crassa quadrata ex convenienti ligno, cujus superficies in longitudine sit duorum pedum, in latitudine sexdecim unciarum: super quam describe semicirculos aliquot (ut in tabella præsenti) numero pares aut plures. In centro stilus æneus ad perpendiculum erigatur: Sit index etiam versatilis à centro extensus ad extremum semicirculum; versorium verò magneticum in sua fovea vitro inclusum: Deindè instrumento plano cum suo perpendiculo, tabula justè ad Horizontis libellam disponatur; & verte lilium instrumenti versus Septentriones, ita ut versorium verè acquiescat supra mediam foveæ lineam; quæ variationis in Horizonte punctum intuetur. Tum horâ aliquâ matutinâ convenienti (octavâ scilicet aut nonâ) observa umbræ apicem à stilo projectam, cum pervenerit ad proximum semicirculum; & nota locum apicis umbræ creta, aut atramento; deindè circumducito versatilem indicem ad notam illam, & observato illum gradum in Horizonte à lilio numeratum, quem index ostendit. Pomeridiano tempore vide quando umbræ extremitas rursus pervenerit ad semicirculi illius peripheriam, & indice ad umbræ apicem perducto quære

Secundus modus.

† Arcum in Horizonte exhibere. per pyxidem nauticam Variationis

Z 3 gra-

Fig. 7: William Gilbert: Tractatvs, siue Physiologia nova de magnete, magneticisqve corporibvs et magno magnete tellure sex libris comprehensus, Sedini: Hallervord 1628, p. 168, annotations by the hand of Nikolaus Andreas Granius. Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46, http://diglib.hab.de/drucke/nc-4f-46/start.htm [01.03.2023]

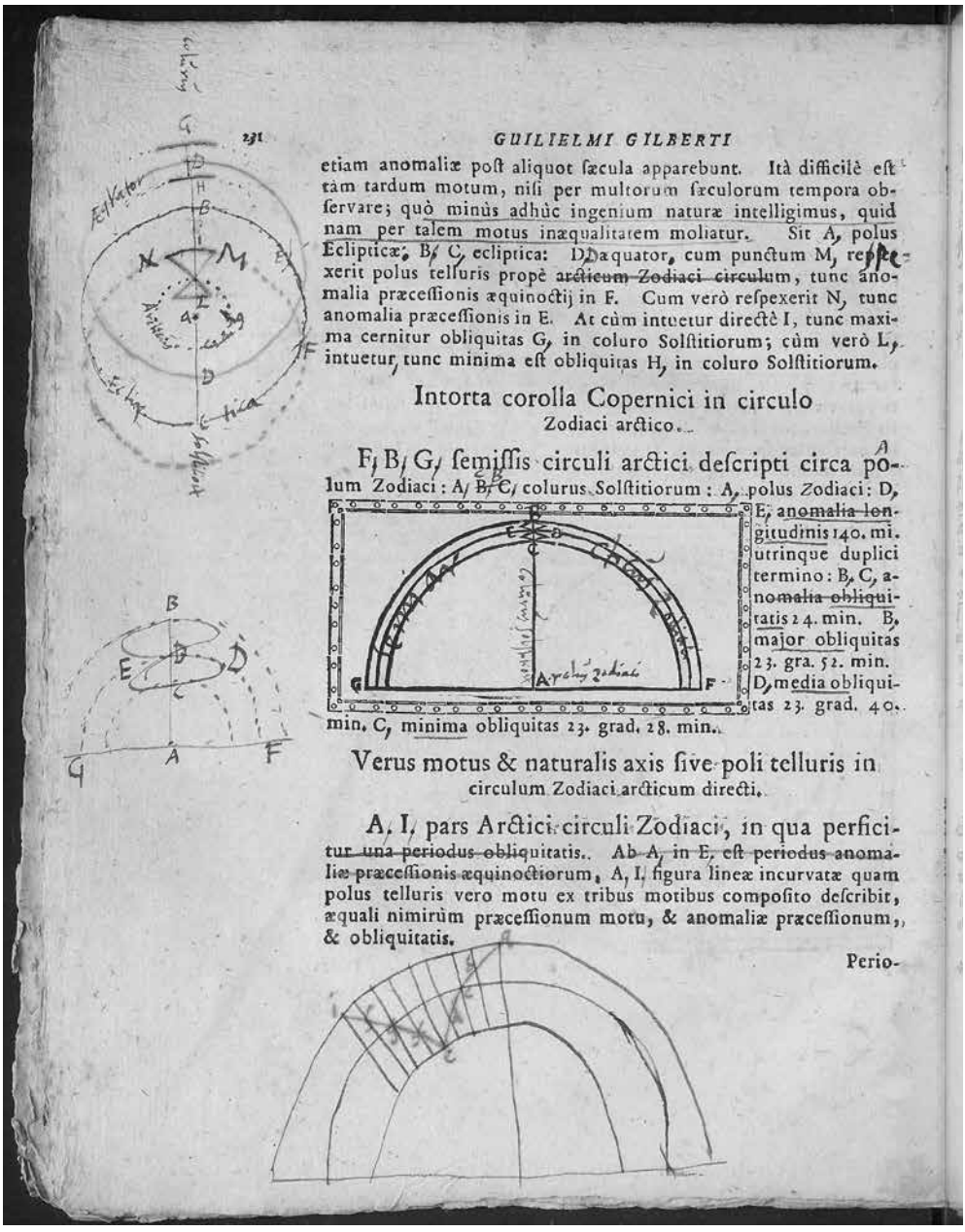


DE MAGNETE LIB. VI. CAP. VIII. 228

respiciebat, nunc tantùm gradibus duobus, & minutis 52, ab eodem distat: undè à propinquitate, à recentioribus Polaris dicitur: distabit aliquandò à polo tantùm ½ unius gradus, posteà verò à polo incipiet recedere, donec ab eo absit grad. 48.: quod (secundùm tabulas Prutenicas) erit anno domini 15000. Ità lucida lyræ [quæ nobis Britannis Australibus jam verè culminat] polo mundi aliquando, ad quintum ferè gradum appropinquabit. Sic omnes Stellæ immutant suos luminis radios in superficie telluris, admirabili hac magneticâ axis telluris inflexione. Hinc temporum anni novæ varietates, terræque fœcundiores magisvè steriles evadunt; hinc gentium ingenia & mores immutantur; regna & leges alterantur, pro Stellarum fixarum virtute, & robore suscepto aut amisso; pro singulari & specificâ naturâ fixarum culminantium: aut propter novas in alijs Zodiaci locis cum Planetis configurationes; propter Ortus etiam & Occasus, & concursus in Meridiano novos. Præcessio Æquinoctiorum, ex motu æquali poli telluris in circulo Zodiaci arctico, hic demonstratur.

Sit Ecliptica linea A, B, C, D; circulus Zodiaci arcticus I, E, G. Si ergò polus telluris respexerit E, tunc æquinoctia sunt in D, C. Sit hoc tempore Methonis, quando cornua Arietis erant in coluro æquinoctiorum. Quòd si polus telluris processerit usque ad I, tunc æquinoctia erunt K, L; & Stellæ in C, ecliptica, in successionem signorum pro-

Hh



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etiam anomaliæ post aliquot sæcula apparebunt. Ità difficilè est tàm tardum motum, nisi per multorum sæculorum tempora observare; quò minùs adhùc ingenium naturæ intelligimus, quid nam per talem motus inæqualitatem moliatur. Sit A, polus Eclipticeæ; B, C, ecliptica: D, æquator, cum punctum M, respexerit polus telluris propè arcticum Zodiaci circulum, tunc anomalia præcessionis æquinoctij in F. Cum verò respexerit N, tunc anomalia præcessionis in E. At cùm intuetur directè I, tunc maxima cernitur obliquitas G, in coluro Solstitiorum; cùm verò L, intuetur, tunc minima est obliquitas H, in coluro Solstitiorum.

Intorta corolla Copernici in circulo Zodiaci arctico.

F, B, G, semissis circuli arctici descripti circa polum Zodiaci: A, B, C, colurus Solstitiorum: A, polus Zodiaci: D, E, anomalia longitudinis 140. mi. utrinque duplici termino: B, C, anomalia obliquitatis 24. min. B, major obliquitas 23. gra. 52. min. D, media obliquitas 23. grad. 40. min. C, minima obliquitas 23. grad. 28. min.

Verus motus & naturalis axis sive poli telluris in circulum Zodiaci arcticum directi.

A, I, pars Arctici circuli Zodiaci, in qua perficitur una periodus obliquitatis. Ab A, in E, est periodus anomaliæ præcessionis æquinoctiorum, A, I, figura lineæ incurvatæ quam polus telluris vero motu ex tribus motibus compositio describit, æquali nimirùm præcessionum motu, & anomaliæ præcessionum, & obliquitatis.

Perio-

Fig. 9: William Gilbert: Tractatvs, siue Physiologia nova de magnete, magneticisqve corporibvs et magno magnete tellure sex libris comprehensus, Sedini: Hallervord 1628, p. 231, annotations by the hand of Nikolaus Andreas Granius. Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46, http://diglib.hab.de/drucke/nc-4f-46/start.htm [01.03.2023]

many diagrams printed in the book by inscribing them so that they relate more closely to their textual explanations (see fig. 6 and 8).

How Granius assessed Gilbert's cosmological thoughts is difficult to tell from his annotations, since they are not judgmental. From his library holdings it can be inferred that he was familiar with Copernicanism.[81] However, his *Disputatio cosmographica* (1622) reveals him clearly to be a supporter of a geocentric cosmology.[82] But at least at one point Granius seems to contradict the text of *De magnete* (p. 221, see fig. 10), namely with regard to Gilbert's counter-argument to the critics of Copernicanism, namely that a body falling from high above could not fall strictly vertically downwards on a rotating earth. Gilbert had developed his own theory of gravity to address this, but Granius, who in his *Disputatio cosmographica* had also dealt with the Aristotelian theory of gravity, did not agree, as an *objectum* at the margin seems to indicate.[83] Gilbert's critique of Ptolemy on the same page, saying that refuting his explanations (*rationes*) is needless, is commented by Granius with a certain amount of irony: »He [i. e. Gilbert] solved the Gordian knot most convincingly in this way« (*gordium nodum sic certissime solvit*).

The numerous notes and commentaries on *De magnete* suggest that, although the study of magnetism does not seem to have played any important role in Helmstedt's university, Granius as professor of natural philosophy still had a good grip on contemporary developments in the field of experimental science and non-Aristotelian natural philosophy, such as Gilbert's work.

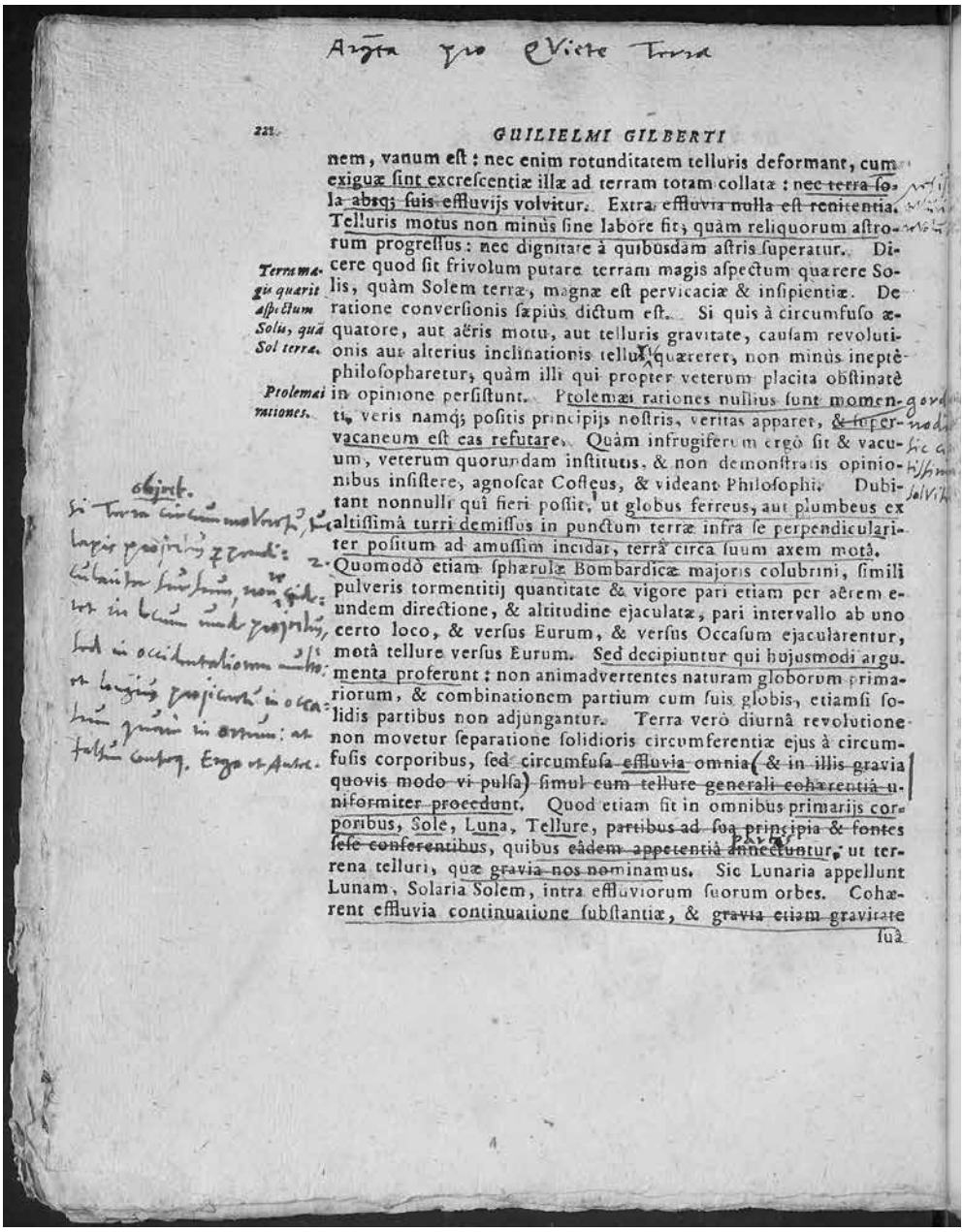
Conclusion

Magnetism had no place in the *Corpus Aristotelicum*, neither as object of causal explanation nor as object of natural history. Interest in magnetism among ancient and medieval Aristotelians existed but remained occasional and never grew into in-depth studies. This changed in the 16th century.

81 He owned, for example, Copernicus's *De revolutionibus*, Kepler's *Ephemerides Novae Motuum Coelestium* and his *Epitome astronomiae Copernicanae*. For Kepler see the copies in Wolfenbüttel, Herzog August Bibliothek: A: 21.1 Astron. 2°, H: N 121b.4° Helmst, and H: N 89.8° Helmst. (1). There are many astronomical works by Granius in the Herzog August Bibliothek. On Granius's comments on *De revolutionibus*, see OWEN GINGERICH: An Annotated Census of Copernicus' De Revolutionibus (Nuremberg, 1543 and Basel, 1566) (Studia Copernicana 2), Leiden – Boston 2002, esp. pp. 96 – 99 who however fails to attribute them to Granius.

82 On Granius's *Disputatio*, see NICOLAUS ANDREAS GRANIUS, JOHANNES MEIERUS: Disputatio cosmographica, quam deo duce, Helmstedt: Lucius 1622.

83 The note, with the help of Stefano Gulizia, can be transcribed as follows: »object. Si turri circummoventi tunc lapis projectus perpendiculariter sursum non se distet in locum unde projectus, sed in occidentaliorum mundis[?] et longius projectus in occasum quam in ortum. At falsum conseq. Ergo et autore.«



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nem, vanum est: nec enim rotunditatem telluris deformant, cum exiguæ sint excrescentiæ illæ ad terram totam collatæ: nec terra sola absq; suis effluvijs volvitur. Extra effluvia nulla est renitentia. Telluris motus non minùs sine labore fit, quàm reliquorum astrorum progressus: nec dignitate à quibusdam astris superatur. Terræ magis quærit aspectum Solis, quàm Solem terræ, magnæ est pervicaciæ & insipientiæ. De ratione conversionis sæpiùs dictum est. Si quis à circumfuso ætquatore, aut æris motu, aut telluris gravitate, causam revolutionis aut alterius inclinationis tellu[ris] quærerer, non minùs ineptè philosopharetur, quàm illi qui propter veterum placita obstinatè in opinione persistunt. Ptolemæi rationes nullius sunt momenti, veris namq; positis principijs nostris, veritas apparet, & supervacaneum est eas refutare. Quàm infrugiferum ergò sit & vacuum, veterum quorundam institutis, & non demonstratis opinionibus insistere, agnoscat Cosleus, & videant Philosophi. Dubitant nonnulli qui fieri possit, ut globus ferreus, aut plumbeus ex altissimâ turri demissus in punctum terræ infra se perpendiculariter positum ad amussim incidat, terrâ circa suum axem motâ. Quomodò etiam sphærulæ Bombardicæ majoris colubrini, simili pulveris tormentitij quantitate & vigore pari etiam per aërem eundem directione, & altitudine ejaculatæ, pari intervallo ab uno certo loco, & versus Eurum, & versus Occasum ejacularentur, motâ tellure versus Eurum. Sed decipiuntur qui hujusmodi argumenta proferunt; non animadvertentes naturam globorum primariorum, & combinationem partium cum suis globis, etiamsi solidis partibus non adjungantur. Terra verò diurnâ revolutione non movetur separatione solidioris circumferentiæ ejus à circumfusis corporibus, sed circumfusa effluvia omnia (& in illis gravia quovis modo vi pulsa) simul cum tellure generali cohærentiâ uniformiter procedunt. Quod etiam fit in omnibus primarijs corporibus, Sole, Luna, Tellure, partibus ad sua principia & fontes sese conferentibus, quibus eâdem appetentiâ annectuntur, ut terrena telluri, quæ gravia nos nominamus. Sic Lunaria appellunt Lunam, Solaria Solem, intra effluviorum suorum orbes. Cohærent effluvia continuatione substantiæ, & gravia etiam gravitate suâ

Terræ magis quærit aspectum Solis, quàm Sol terræ.

Ptolemæi rationes.

Fig. 10: William Gilbert: Tractatvs, siue Physiologia nova de magnete, magneticisqve corporibvs et magno magnete tellure sex libris comprehensus, Sedini: Hallervord 1628, p. 221, annotation by Nikolaus Andreas Granius. Wolfenbüttel, Herzog August Bibliothek: Nc 4° 46, http://diglib.hab.de/drucke/nc-4f-46/start.htm [01.03.2023]

Magnetism became an increasingly important topic, as object of empirical and experimental investigation, as object of natural philosophy, and as object in practical and technological applications. It may not have been the Aristotelians of the time who induced and drove this increased research, but they caught up quickly. The first detailed early modern study on magnetism was authored by the Jesuit and college teacher Leonardo Garzoni. He adjusted Aristotelian natural philosophy to better tackle the notorious action-at-a-distance of magnetic attraction, the oddity of polarity, and the miraculous ability of a magnetic needle to point north. Although his work was never printed and probably never informed actual university teaching, it impacted on other Jesuits such as Niccolò Cabeo, whose printed study spread more widely and was read in many schools and universities.

Magnetism as a topic of scientific and natural philosophical investigation reached Central European universities on a public and a private level. In the public sphere, dozens of university disputations prove that magnetism was no longer neglected but given considerable attention in the education of the students. These disputations, as far as their printed records go, show that universities were up-to-date with the relevant literature in the field. They engaged in natural philosophical explanations that, at least before 1650, mostly remained within an Aristotelian framework, offering an immaterial explanation and invoking ›qualities‹ and ›substantial forms‹. With the advent of the ›new philosophies‹ à la René Descartes' corpuscularianism, universities partly re-adjusted again. Mostly without openly criticizing Aristotelian principles, professors and their students often opted for different ways to explain magnetism in the second half of the 17th century.

This development, tangible in printed university disputations in institutions that generally were following an Aristotelian curriculum, is also mirrored, and was perhaps prepared, by private engagement with magnetic studies on the part of the university teachers. Already Garzoni's study should be seen as a private undertaking, leading to a novel way of thinking about magnetism within Peripatetic philosophy. Two rather exceptional but highly telling case studies have been presented in this article. The first case discussed Kaspar van Baerle, who wrote a natural philosophical study based on the more experimental Dutch-language study by Laurens Reael. Van Baerle, at the time, was affiliated to a university-like school in Amsterdam and considered himself a Peripatetic philosopher. His study, however, shows how far he was willing to deviate from typical patterns to explain magnetism in an Aristotelian framework. He openly, albeit not always consistently, proposed materialistic types of explanation, involving *effluvia* being emitted by the magnet.

The second case study focused on reading notes by the Helmstedt university professor Nikolaus Andreas Granius, which he left in a copy of William

Gilbert's *De magnete* (1628). Gilbert's work was notoriously anti-Aristotelian and favored a quasi-Copernican cosmology. Given this as a basis, one would expect an Aristotelian university professor to make short work of such a book. Instead, Granius's critique was mostly confined to formal, linguistic issues of the edition and only rarely engaged with the text's content critically. Overall, Granius appears as an eager reader of Gilbert's ideas on geomagnetic phenomena, representing the more empirical and practical parts of the work, and he very closely read the cosmological parts of the books as well.

What does this story of magnetism tell about the status of Aristotelianism and natural philosophy in universities of early modern Central Europe? As far as the research on magnetism is concerned, only a few Aristotelians in this field can be described as actual ›trendsetters‹, coming up with highly original theories and research, while the larger majority are better described as ›broadcasters‹ of the research of others. This is not a shortcoming or an immanent feature of Aristotelianism but follows from what a university or school mainly was in early modern Europe: a place for teaching and educating the youth. The basis of this education was not always cutting-edge, but fairly up-to-date. At the same time, professors in these institutions occasionally incorporated their own empirical research into their teaching and taught students to critically judge existing natural philosophical theories and to adjust and refute them where necessary – even Aristotelian views. In their private time, some professors appear as researchers who have lost almost any bond to university-trained Aristotelianism, following eclectic and even idiosyncratic avenues of research.

On a more general note, these results – confirming research of other studies – also prompt the conclusion that ›Aristotelianism‹, if it ever had any content-based semantic hard core, had become even more vague in the late 17th century. It was an umbrella term, still relating to certain forms of argumentation, certain core convictions, and often a specific institutional background, but none of that was a *conditio sine qua non*. It seems more justified to put the emphasis on the more external connotations of the term than on any doctrinal contents, as the latter were shifting more and more in the late 17th century. The university was still mostly considered a safe haven for inherited forms of Aristotelianism and thus it seemed that some sort of institutionally embedded research or teaching comes closest to what ›Aristotelianism‹ was supposed to mean at that time, both by contemporaries and by modern historians using this term to describe a certain intellectual current. This does not mean to disregard forms of Aristotelianism outside institutions or institutions that were even anti-Aristotelian, but it aims to capture best the entire spectrum of the phenomenon referred to as ›Aristotelianism‹, in a time when its heyday was over and new forms of learning and doing philosophy and science were gaining ground all over Europe.

Tab. 1: Printed disputations on Magnetism up to 1699

Chair/Author	Respondent	Place	Year	Title	Total pages/ Illustrated pages	Gilbert	Cabeo	Kircher	Descartes	Natural history	Natural philosophy	Experiments	Instruments/ Navigation/ Declination	Cosmology	Medicine	Weapon salve	Theology
Christoph Hunnich	Petrus Crüger	Leipzig	1606	*Περί τῆς τοῦ Σιδηρίτου πολοδείξεως, Id est de magnetis ad utrumque mundi polvm conversione, capita disputationis publicae*	24/0	+				++	+		++				
Petrus Crüger	Adrianus Stodertus	Gdańsk	1615	*De motu magnetis disputatio publica ordinaria*	23/2	+				+	+	+	++				
Laurenz Forer	Georg Mai Johannes Marius	Ingolstadt	1618	*Disputatio philosophica, de magnete sive herculeo lapide*	32/0	+				+	++	+			+	++	
Andrzej Żędzianowski		Kraków	1621	*Quaestio de magnete magneticisque corporibus, physiologis, astronomis, geographicis*	12/0	+				+	+	+	+				
Conrad Cellarius	Johannes Beckhius	Tübingen	1625	*Discursus physicus de magnete*	16/7	+					++	++					
Athanasius Kircher	Johann Jacob Schweigkhard von Freihausen	Würzburg	1631	*Ars magnesia: hoc est disquisitio bipartita empeirica seu experimentalis, physico-mathematica de natura, viribus et prodigiosis effectibus magnetis*	71/12	+				+	++	++	++		++	+	+
Johann Christoph Ludecus	Michael Wendeler	Wittenberg	1634	*Exercitatio physica de magnetis nomine principiis, et affectione potissima*	20/0	+	+			++	+	+					
Johann Sperling	Samuel Cramerus	Wittenberg	1636	*Disputatio physica de actionibus magneticis*	12/0						++					+	
Lambert van Velthuysen		Utrecht	1644	*Disputatio philosophica inauguralis, de mundo, de vindicta, et de chalyboclisi seu deviatione versorii magnetici*	6/0		*				+		++				
Daniel Lagus	Johann Walther Lesle	Gdańsk	1646	*Contemplationis physicae de magnete sectio posterior thematis addens proprietates, divisionem cognata et opposita*	28/0	+	+	+			++	+	+		+		+
Heinrich Nicolai		Gdańsk	1646	*Disquisitio magnetica succincta: Syllogen variorum quaestionum, quae de magnete moveri possunt, exhibens, et ferritractionem, verticitatem, ac declinationem eius specialiter deducens. Quae occasionem dare possunt, accuratius de mirabili lapidis natura inquirendi ac disceptandi*	12/0	+	+	+		+	++	+	++					

Chair/Author	Respondent	Place	Year	Title	Total pages/ Illustrated pages	Gilbert	Cabeo	Kircher	Descartes	Natural history	Natural philosophy	Experiments	Instruments/ Navigation/ Declination	Cosmology	Medicine	Weapon salve	Theology
Johann Rudolph Saltzmann	Johann Christian Keck	Stras- bourg	1648	*De lapide herculeo sive magnete*	19/0	+		+		++	+		+				
Samuel Pomarius	Christopho- rus Fickel	Witten- berg	1649	*De magnete disputatio physica*	32/0	+				++	++	+	+				
Michael Watsonius	Paulus Nauclerus	Rostock	1651	*Theses probabiles privato Collegio propositae. quarum portionem quartam de qualitatibus, imprimis occultis, ubi de operationibus magnetis, veneni, unguenti armarii, succini, & similib. quae occ. qual. adscribuntur*	20/0			+			+					+	
Johann Schmidt	Johann Friedrich Heil- brunner	Stras- bourg	1652 1687	*Magnetica divina: dissertatio theologica inauguralis de tractu patris ad filium salutari, ex Joh. VI,44*	43/0												++
Alexander de Bie	Joannes Brandlight	Amster- dam	1658	*Disputatio mathematica de acus magneticæ incon- stanti deviatione*	12/0			+				+	++				
Alexander de Bie	Joannes du Pire	Amster- dam	1658	*Disputatio de magnete, quae est de ejus ὀρθοβορεοδειξει*	13/0		+			+	+	+	++	+			
Alexander de Bie	Sibertus Coeman	Amster- dam	1658	*Disputatio mathematica de acus magneticae deviatione*	12/0		+					+	++	+			
Nikolaus Klein	Johannes Friedrich Kessler	Leipzig	1660	*Disquisitio philologico-physica de magnete*	28/0	+	+	+		++	+						
Johannes Christopho- rus Letsch	Johannes Rihm	Witten- berg	1661	*Disputationem physiologicam, de magnete*	16/0					+	++	+	+		+		+
Jakob Helwig	Heinrich Gröffenius	Berlin	1662	*Disputatio physica, de qualitatibus occultis, magneti praecipue vendicatis*	12/0						++	+					
Johann Christoph Sturm	Johann Mauricius Hoffmann	Altdorf	1671	*De magnorum mundi corporum magnetismo*	20/0			+			+		+	++			
Johann Michael Schwimmer	Georg Frie- drich Cel- larius	Jena	1671	*Ex physicis dissertationem de magnete*	32/0	+		+		++	++	+	+		+	+	

Chair/Author	Respondent	Place	Year	Title	Total pages/ Illustrated pages	Gilbert	Cabeo	Kircher	Descartes	Natural history	Natural philosophy	Experiments	Instruments/ Navigation/ Declination	Cosmology	Medicine	Weapon salve	Theology
Caspar Esaias Siegfried	Ehrenfried Pfundt	Weissenfels	1673	*Disputatio physica de magnete*	28/0	+	+	+	+	++	++	+	+				
Johann Friedrich Scharff	Johann Christoph Viebeg	Wittenberg	1674	*Miraculum naturae magnes*	11/0	+		+		++	+		+				
Burcherus de Volder	Johannes Balthasar Helvetius	Leiden	1677	*Disputatio philosophica de magnete*	14/0		+	+	+	+	++	++			+	+	
Daniel Erici Achrelius	Petter Svensson Ulnerus	Turku	1681	*Contemplationum mundi dissertatio decima tertia, de geocosmi semine, magnetismo rerum naturalium, tum qualitatibus veneni*	6/0			+		+	+	+			++		
Giovanni Francesco Emili		Parma	1682	*Magneticarum motionum investigatio problema physico-mathematicum*	110/2	+	+	+		+	++	++	+	++	+		+
Johann Valentin Scheid	Joannes Joachimus Kast	Strasbourg	1683	*Quaestionum decades duae de magnete*	33/0	+	+		+		++	+	+				
Johann Jakob Waldschmidt	Christian Kursner	Marburg	1683	*Disputatio physica, de magnete*	16/0			+	+	+	++	+	+				+
Johan Bilberg	Ericus E. Odhelius	Stockholm	1683	*Specimen cogitationum de magnetismis rerum*	43/0	+			+	+	+				++	++	+
Theodor Zwinger	Theodor Gernler	Basel	1685	*Disquisitionum physicarum de magnete prima*	36/0	+		+	+	++	+				+		
Theodor Zwinger	Jeremias Gemuseus	Basel	1686	*Disquisitionum physicarum de magnete secunda*	20/0			+	+	+	++	+	+				
Johan Bilberg	Andreas Plaan	Uppsala	1687	*Disputatio physica de magnete*	24/0	+	+	+	+	+	++	+	+	+			
Justus Vesti	Johann Andreas Fischer	Erfurt	1687	*Disputatio physico-medica de magnetismo macro- et microcosmi*	42/0			+	+	+	+	+	+		+	+	+
Johann Spener	Johann Martin Michaelis	Leipzig	1688	*De magnete errores variorum*	24/0	+		+		++		++			+		

Chair/Author	Respondent	Place	Year	Title	Total pages/ Illustrated pages	Gilbert	Cabeo	Kircher	Descartes	Natural history	Natural philosophy	Experiments	Instruments/ Navigation/ Declination	Cosmology	Medicine	Weapon salve	Theology
Daniel Erici Achrelius	Daniel G. Hagert	Turku	1689	*Magnes rerum naturalium*	64/0			+		+	++	+		+	+		+
Theodor Zwinger	Johann Conrad	Basel	1689	*Disquisitionum physicarum de magnete tertia*	20/0	+		+				++	+	+			
Theodor Zwinger	Matthäus Krämer	Basel	1691	*Disquisitionum physicarum de magnete quarta*	20/0	+	+	+				+	++				
Theodor Zwinger	Philipp Adam Brucker	Basel	1692	*Disputationum physicarum de magnete quinta*	36/0	+	+	+			++	+	+				
Theodor Zwinger	Hierony-mus Gemuseus	Basel	1692	*Disquisitionum physicarum de magnete sexta*	36/0				+		++	+	+				
Georgius Christopho-rus Gebhardi	Johannes Fridericus Cellius	Greifs-wald	1692	*De terra magnete*	20/0	+				++	+	+	+	+			
Andreas Riddermarck	Magnus S. Aulaenius	Lund	1692	*Dissertatio philosophica de magnetis ac ferri amoribus et odiis, eorumque interitu*	24/0				+	+	++	+					
Conrad Limmer	Johann Christian Wolff	Zerbst	1693	*Dissertatio philosophica, de magnete ejusque effectibus*	36/0	+			+	+	++	+					
Justus Vesti	Johann Heinrich Spiess	Erfurt	1695	*Disputatio inauguralis physico-medica de magnetismis macro- et microcosmi*	32/0	+		+		+					++	+	
Theodor Zwinger	Daniel Schönauer	Basel	1697	*Disquisitionum physicarum de magnete septima*	24/0		+	+	+		++	+	+				
Petrus Olai Hahn	Christian Procopoeus	Turku	1698	*Dissertatio philosophica de magnetismo polorum cogitatum*	39/0	+		+		+	++	+	+	+			+
Petrus Olai Hahn	Gabriel Procopoeus	Turku	1698	*Disputatio physica amicitiam magnetis cum ferro exhibens*	32/0			+		++	+	+					
Harald Vallerius	Andreas Linnrot	Stock-holm	1699	*Disputatio physico mathematica de pyxide magnetica: sive, ut vocant, compasso nautico*	85/5	+	+	+	+	+	+	+	++				