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CHRISTOPH CLAVIUS, S. J. ON THE REALITY OF PTOLEMAIC COSMOLOGY: *EX SUPPOSITIONE* REASONING AND THE PROBLEM OF (DIS)CONTINUITY OF EARLY MODERN NATURAL PHILOSOPHY[*]

1. Introduction and overview

This paper aims at indicating, very cursorily, some ways in which the work of Christoph Clavius (1538–1612), influential Jesuit mathematician, astronomer, calendar–reformer and professor of the famous Collegio Romano[1], may bear on the long–standing debate about continuity or discontinuity between medieval and early modern natural philosophy which I shall call simply *science*. It should be noted, from the outset, that this debate is at the heart of the very question of whether there really was anything like a *Scientific Revolution* or whether it should be regarded more as a disciplinary affirmation of academic history of science, a question that has been looming over the field for more than half a century now[2]. It is far from my intention in the brief remarks that follow to significantly delve into these far–reaching questions, which deserve much lengthier treatment. My hope is just to argue that the examination of the scientific activity of early–modern Jesuits, Clavius in particular, may lead, after more work on the subject has been completed by investigators in the field, to useful insights into the continuity/discontinuity problem and, by extension, into the character – be it revolutionary or not – of the transformations that natural knowledge passed through from mid–16th to late 17th centuries.

Of course, it would be hardly new to point out the importance of taking into account the Society of Jesus as a relevant actor in several aspects of the enterprise of early–modern science, at least if we keep in mind the large body

[*] I am very grateful to Michał Kokowski and Elżbieta Jung for stimulating discussions, as well as to Sabine Rommevaux for pointed criticism. Also, I wish to express my deepest gratitude to Carlos H. B. Gonçalves, whose generous collaboration and friendship have made this work possible.

[1] For the sake of brevity of presentation, it is not possible, in this paper, to elaborate upon biographical information on Clavius, descriptions of his many works or the institutional setting of which he was part. Details on these matters can be found, for instance, in the entry on Clavius in the *Bibliothèque des Ecrivains de la Compagnie de Jésus* by Augustin and Aloys de Backer (7 vols., Liége, 1853–1861, new ed. by C. Sommervogel, 12 vols., Brussels, 1890–1960) or in E. Knobloch, *Sur la vie et l'œuvre de Christophe Clavius (1538–1612)* and U. Baldini, *Legem impone subactis ...* , pp. 19–73.

[2] See a fine collection of essays on the subject: D. C. Lindberg & R. S. Westman (eds), *Reappraisals of the Scientific Revolution*.

of work on the subject that has been produced in the last three decades, roughly[1]. What I intend is just to present a *concrete* instantiation of this point, specifically one that may be fruitful for further research about the continuous or discontinuous nature of that very enterprise – namely, the logical weaving of Clavius' arguments against non–Ptolemaic cosmologies, as presented in his *Disputationem perutilem de orbibus Eccentricis et Epicyclis contra nonnullos philosophos*[2]. My main point is that amid the several logical constructs employed by Clavius in this late–16th century text, which went through a series of revisions till finding its definitive form in 1611, one in special bears a neat resemblance to Galileo's peculiar breed of *ex suppositione* logics, characteristic of his 1638 *Discorsi*[3]. The important matter is that his usage of this kind of reasoning has been singled out by historians of science as bearing heavily on the continuity/discontinuity problem, as discussed below.

The paper is organized as follows: in the next section, I present a bird's eye view of the relation between Galileo's *ex suppositione* arguments and the problem of continuity or discontinuity between medieval and modern science, according to the views of its major proponent, American scholar William Wallace. In Section 3, the reader will find a sketch of the logical contriving of Clavius' cosmological *Disputationem*, with emphasis on his usage of the so–called *ex sufficienti partium enumeratione* argument. In the same Section it is suggested how Clavius' use of this kind of logical device is, in fact, a brand of *ex suppositione* reasoning, and a very innovative one, given that cosmology tended to be the realm of a different kind of logical expedient (namely, the so–called *ex hypothesi*). I also indicate how Clavius' adoption of this type of logical scheme is tied to his realist standpoint. In the concluding Section I reinstate that Galileo's and Clavius' usage of *ex suppositione* reasoning are fully connected, both from the evident, structural point of view, given by their common logical nature – or yet, by what was perceived in the 17th century as being their common nature –, as well as from an *external* one, given by both authors' appropriation and reworking of a logical tradition characteristic of the Jesuit Collegio Romano and their very similar conceptions of the nature of scientific knowledge points also made by Wallace long ago[4]. Finally, I put forward the argument that, similarly to Wallace's Galileo, and keeping in

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[1] From an already large bibliography, one may pick up relevant examples (without any pretension of exhaustiveness) such as L. Giard, *Le devoir d'intelligence ou ...* , which presents am overview of several tendencies in the historiography of Jesuit science, A. Carugo & A. C. Crombie, *The Jesuits and Galileo's Ideas of Science and Nature* on the relationship between Jesuits and Galileo, P. R. Dear, *Jesuit Mathematical Science and ...* on mathematics and experience in the Jesuit intellectual tradition. See also several studies of the scientific and mathematical culture of the early–modern Society of Jesus, its networks of exchange of ideas, shared practices and its place on the *republic of letters*, e.g. M. Feingold (ed.), *Jesuit Science and the Republic of Letters*, A. Romano, *La contre–reforme mathématique ...* , F. Laplanche, *Réseaux intellectuels et options confessionnelles ...* or R. Feldhay, *The Cultural Field of Jesuit Science*. One cannot fail to mention the penetrating essays of Ugo Baldini (collected in U. Baldini, *Legem impone subactis ...* and U. Baldini, *Saggi sulla Cultura ...*).

[2] As explained below, this text is part of Clavius' famous commentary on the medieval astronomical treatise of Johannes de Sacrobosco.

[3] Galileo Galilei, *Discorsi e dimostrazioni matematiche intorno a due nuove scienze* (1638) in: A. Favaro (ed.), *Edizione Nazionale dell' Opere di Galileo Galilei*, G. Barbera, Firenze 1934, vol. 8.

[4] See W. A. Wallace, *Galileo and His Sources ...* is entirely devoted to these issues.

mind the obvious differences in scale, Clavius may be of interest to a fuller understanding of the continuity/discontinuity problem.

2. Continuity, discontinuity and Galileo's appropriation of logical traditions

In a seminal paper of 1976, William Wallace presented a fresh perspective on Galileo's role in the history of science[1]. Previously, the field seemed dominated either by Galileo's *detractors* or by his *unconditional admirers*. The former could be well typified by Pierre Duhem and his followers, who saw on the Italian's work nothing but the strict continuity of a centuries–old tradition of mathematical natural philosophy, deeply rooted in 14th century Paris and Oxford. The latter were, by their turn, convinced of the radical break represented by Galilean science, but would not agree on the exact nature of this discontinuity: one school, led mainly by Alexandre Koyré, saw in Galileo a neo–Platonic thinker, staunchly contrary to the peripatetics of the day, attracted to a mathematical description of the universe, who could even, as it were, sacrifice reality in favor of theoretical cogency. Yet, another school, very much associated with the likes of Stillman Drake, preferred to locate Galileo's break with tradition in the methodological domain: he would be the true founder of a modern, hypothetico–deductive way of experimentally inquiring nature through the formulation of empirically testable hypotheses and the actual carrying of those tests[2].

Wallace's primary aim was to show how both ways of construing Galileo's alleged discontinuity with previously prevailing approaches to natural philosophy missed the point. At the same time, though, he did not subscribe to a plain continuity thesis, with its insistence on *precursors* and on lack of originality by the part of the Italian. As to the neo–Platonic Galileo of Koyré and his followers, Wallace was blunt: Simply by considering plenty of new or previously overlooked documentary evidence, the view of Galileo as dismissive of empirical compromise could be deemed untenable. On the other hand, questioning the idea of the methodological revolution purportedly carried on by Galileo with his adherence to the hypothetico–deductive program is what drove Wallace to the heart of his argument. This consists on the insight that Galileo, exactly like the Jesuits of the Collegio Romano, especially Clavius, was fully attached to a tradition that viewed the primary aim of natural knowledge as the establishment of true and certain knowledge of causes in a squarely Aristotelian fashion, that is, Galileo sought produce *scientia* in its full medieval and Renaissance sense[3].

As it is, the hypothetico–deductive method, with its reliance on *ex hypothesi* reasoning, cannot result in such kind of certain knowledge. This happens because reasoning *ex hypothesi* is simply a way of affirming the consequent and can only lead to probable knowledge. It is codified by an expression of the

[1] See W. A. Wallace, *Galileo and Reasoning Ex Suppositione ...* .

[2] This familiar picture is given by W. A. Wallace, *Galileo and Reasoning Ex Suppositione ...* , pp. 79–81.

[3] But let us not fail to note that scholars such as E. McMullin, *Galileo on Science and Scripture* are not so sure of Galileo's commitment to producing *scientia* in this way.

kind 'if *p*, then *q*', where *q* is a verifiable proposition, pertaining to the order of appearances, and *p* is an unverifiable one, pertaining to the order of causes. The verification of *q* cannot, from a strictly logical point of view, assure one that *p* is certainly true, only that it is *probable* to a certain degree. But the aim of *scientia* and Galileo's, according to Wallace, was exactly to ascertain without any doubt the necessary truth of propositions belonging to the causative order.

But there is a different brand of argumentation, reasoning *ex suppositione*, which, as refined in the second half of the 16th century from its Scholastic and especially Thomist sources, was widely regarded as conducive to *scientia*[1]. This kind of reasoning also proceeds in the logical form 'if *p*, then *q*', but now *p* is the contingent proposition, pertaining to the order of appearances, and *q* is the necessary condition to the causation of *p*. It can lead to *scientia* if one establishes that *q* is the *only* possible way of obtaining *p*, that is, if all other causal explanations can be ruled out. This is accomplished in classical syllogistic form by *modus ponendo ponens*: 'if *p*, then (if *p* then *q*), then *q*'. This operation is logically consistent and, from the point of view of the internal structure of the complete proposition, the reasoning is rendered entirely deductive. The obvious problem is how one can be sure that one has ruled out all but one cause or a set thereof without once again affirming the consequent. Wallace is confident, though, that the Jesuit thinkers of the Collegio Romano, as well as Galileo, did not regard this as such a problem and believed in the power of *ex suppositione* argumentation to produce true and certain knowledge[2]. The take–home lesson then is: even if this kind of reasoning is evidently prone to the same fallacy of *ex hypothesi* argumentation, *it was not regarded as so*.

Galileo's use of *ex suppositione* reasoning is documented by Wallace in several passages of the *Discorsi*. What is relevant, however, is how Galileo confers his own *twist* to such a methodology that was already well known – and here resides his true innovation, according to Wallace: the insertion of mathematical arguments in the very propositions and the eventual interchange of *p*'s and *q*'s (in what reminisces of a different, Archimedean tradition). Being neither a *revolutionary* neo–Platonic nor an empiricist of a radically new hypothetico–deductive brand, Wallace's Galileo is not as well a slavish continuator of *precursors*. He was deeply immersed in Aristotelian tradition as regards his high esteem for *scientia* and also as regards the logical apparatus with which he forcibly convinces the reader of his conclusions in the *Discorsi*. At the same time, however, he stretches the boundaries of this tradition that he shares with the Roman Jesuits and, in a certain way, creatively uses it against itself to produce a new science. In Wallace's view, Galileo was aware of the strengths and limitations of the Aristotelian and Archimedean traditions that had preceded him, and he had the genius to wrest from those traditions the combination of ideas that was to prove seminal for the founding of a new era.

[1] For a critique of this assumption, which is essential to Wallace's thesis, see W. L. Wisan, *On argument ex suppositione falsa*. I will, nevertheless, cling to Wallace's view.

[2] See W. A. Wallace, *Galileo and Reasoning Ex Suppositione* ... , pp. 81–85.

In the next Section, I will sketch Clavius' usage of this same logical tradition and what is, in my view, his own creative *twist* of it.

3. Logical underpinnings of Clavius' presentation of rival cosmologies

Christoph Clavius' *In Sphaeram Ioannis de Sacrobosco Commentarius* is, arguably, the most successful introductory astronomy textbook of the last three decades of the 16th century and first two decades of the 17th century, being disseminated widely in Catholic Europe – especially, of course, through the Jesuit network of colleges and universities – but also meeting fair acceptance in Protestant centers of learning[1]. First published in Rome in 1570, the book appeared in at least three other Roman editions (1581, 1585 and 1606), one in Lyon (1593), three in Venice (1591, 1596 and 1601), one in Geneva (1602) and, finally, in the third tome of the luxurious, in–folio edition of the author's complete works (*Opera Mathematica*, 5 vols), published in Mainz in 1611–1612. Several reimpressions were also issued in each of these cities and the book can be found, in one form or another, in virtually any library with a reasonable early–modern general collection.

The size of the book grew steadily between 1570 and 1611, but its structure was quite stable: a commentary, paragraph–wise, of Johannes de Sacrobosco's hugely influential 13th century *De Sphaera*[2]. Besides hundreds of extant manuscripts, this slim work, barely reaching 9,000 words, found its way into some 90 printed editions from 1472 up to the end of the 17th century, many of which were accompanied by commentaries – Clavius' being one among several. The amount of original material inserted by Clavius amid the meager lessons of Sacrobosco makes his oeuvre, however, absolutely unique in this commentary tradition and turns it into an unmatchable testimony of the state of astronomical research and training from 1570 to, roughly, 1620 when the Society of Jesus itself starts endorsing the Tychonic world–system, thus rendering Clavius' staunch Ptolemaic views difficult to cling to.

Naturally, the presentation of the material follows Sacrobosco's original, four–chapter structure: the first one presents a general view of the structure of the universe, the second presents the static geometry of the celestial sphere (that is, its several constituent circles and notable points) and its earthly counterpart (the doctrine of climates), the third purports to explain the daily motion of the stars, and the fourth tackles planetary movements and eclipses. Clavius' extensive commentaries introduce mathematical tools, digressions into the relation of each subject with Aristotelian natural philosophy, notices of important recent observational results (even the telescope, of which Clavius was an early user, is mentioned in the last, Mainz edition) and several other types of excursions.

It is in the fourth chapter that one finds the most remarkable comments by Clavius pen. As said, the chapter is devoted to planetary motions, the explanation of which was, certainly, one of the main driving forces behind

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[1] For a thorough and unique study of the whole book, see J. M. Lattis, *Between Copernicus and Galileo ...* .

[2] On Sacrobosco's text and the long history of its reception, see O. Pedersen, *In Quest of Sacrobosco*.

changes in cosmological theory during the 16th century. Clavius analyzes each of the main proposals available at the time: homocentric systems (the most compatible to orthodox Aristotelianism, championed mainly by Girolamo Fracastoro) and eccentric–epicycle–based systems (in Ptolemaic, Copernican and Tychonic versions). He fully subscribes to the epistemological stance of *saving the phenomena*, but, and this is a key point, he does so in a strongly realist guise, that is, the *best explanation* entails reality, not simply instrumentality[1], in other words, Clavius is fully committed to pursuing astronomy as an integral *scientia*, productive of true and certain knowledge of necessary causes. One consequence of this epistemology is that he is led to weight each one of those alternative views of the geometry and kinematics of planetary motions against the standard of fitness to the phenomena, but, also, that he must ascertain that the *best fit* is also true in reality, not just hypothetically so. This means that Clavius is not content to demonstrate the *reasonability* of the Ptolemaic system *ex hypothesi*, as was the rule in cosmological discussions of the time. He must show its *necessity* and, in order to do so, he must appeal to different logical schemes, as I will argue.

The chapter is, for the most part, organized as *disputatio* on the relative virtues of each system in its capability of *saving the phenomena*. This is the text known as *Disputationem perutilem de orbibus Eccentricis et Epicyclis contra nonnullos philosophos*, which was referred to in the introductory section above[2]. The victor of the dispute, as it emerges, is the Ptolemaic system. Clavius follows a traditional, Scholastic structure of argumentative dispute: he must convince the reader of the truth of the proposition that the Ptolemaic system better saves the phenomena and that its constituent devices (eccentrics and epicycles) are real. In this way, he must not only show that the Ptolemaic system indeed fits the appearances, but also that the alternative explanations, even if they seem to fit them as well, cannot be true for some reason or other. As usual, he also enlists arguments against his own position and show they are not valid. Very schematically, this structure is something like: *proposition (eccentrics and epicycles in the Ptolemaic arrangement save the phenomena and are really existent) → arguments in favor → objections → refutation of the objections → necessary conclusion*.

In this way, he first presents a series of phenomena that can be *saved ex hypothesi* by eccentrics and epicycles, showing at the same time that homocentrics cannot do the job. Then he presents current objections against eccentrics and epicycles and refutes each one of them. To this end, he occasionally has to appeal to scriptural authority, Aristotelian physics which could be as well used against his own Ptolemaic choice, or even *ad hominem* attacks, not devoid of some elegant irony. It is, however, somewhere between these two moments – defense of eccentrics and epicycles and refutation of the objections against them – that is inserted what is, to my view, the main thrust of the chapter: given his realist stance, Clavius evidently must not only defend

[1] On Clavius' realism, see N. Jardine, *The Forging of Modern Realism ...* , *passim*, and W. A. Wallace, *Galileo and Reasoning Ex Suppositione ...* , p. 88.

[2] Full reference of the edition employed is at the end of this paper.

eccentrics and epicycles *ex hypothesi*, but he must also (1) prove their *real* existence and (2) exclude the rival systems that also employ these devices, but not in Ptolemaic arrangement (namely, the Copernican and Tychonic systems). It is at this point that an interesting kind of *ex suppositione* reasoning enters the scene.

What Clavius does is to try and convince the reader that there are *only* three ways of saving the celestial appearances: homocentrics, eccentrics–epicycles, and the proposition of *fluid* heavens[1]. Then he proceeds with an argument called *ex sufficienti partium enumeratione*, which amounts to saying that if he can show that two of those alternatives, namely homocentrics and fluid heavens, are false, the third one is *necessarily* true[2]. The key passage is this:

> *Si planetae in orbibus eccentricis non deferuntur ab occasu in ortum, devehentur utique aut per orbes concentricos, aut certe per sese movebuntur in caelis, ut pisces in mari, vel aves in aere: Sed hisce duobus modis non moventur. Igitur in eccentricis feruntur. Consecutio manifesta est: Maior quoque propositio patet ex sufficienti partium enumeratione. Minor vero probatur, quoad utramque partem.*[3]

Well, but this is nothing short of a very elaborate kind of *ex suppositione* argument, with a higher order *modus ponendo ponens* structure. For, if Clavius is able to rule out all but one of the only possible explanations for heavenly phenomena, he will succeed in construing a neat *ex suppositione* argument exactly of the form described in the last Section and which, it should once again be stressed, was considered, in the intellectual tradition in which he was immersed, conducive to true and certain knowledge, that is, *scientia*.

His reasoning thus goes roughly like ‘if p (phenomena), then {[if p then q_1 (homocentrics)] or (exclusive) [if p then q_2 (eccentrics and epicycles)] or

[1] It is important to note that, for Clavius and his contemporaries, the last alternative represents the Tychonic system, whose eccentrics and epicycles were considered of immaterial nature. On this issue, see M.–P. Lerner, *Le problème de la matière céleste après 1550 ...* .

[2] Interestingly, such kind of argument traces back to Basil of Caesarea, who, in his Homily IX on the Six Days of Creation (*Hexaemeron* 9, 84D) considers how a dog is able to decide which path to follow when pursuing a hunt that may have taken one out of three roads. I quote Basil from the 1894 Schaff–Wace edition (*A Select Library of the Nicene and Post–Nicene Fathers of the Christian Church*, Second Series, vol. VIII, p. 104), translated from the Greek by Blomfield Jackson: *The dog is not gifted with a share of reason; but with him instinct has the power of reason. The dog has learnt by nature the secret of elaborate inferences, which sages of the world, after long years of study, have hardly been able to disentangle. When the dog is on the track of game, if he sees it divide in different directions, he examines these different paths, and speech alone fails him to announce his reasoning. The creature, he says, is gone here or there or in another direction. It is neither here nor there; it is therefore in the third direction. And thus, neglecting the false tracks, he discovers the true one. What more is done by those who, gravely occupied in demonstrating theories, trace lines upon the dust and reject two propositions to show that the third is the true one?* Plutarch had said something along the same lines in the *Moralia* (XII, 66, *De sollertia animalium*), but denied that the dog indeed reasons.

[3] Clavius [1611], p. 299 [*If the planets are not carried by eccentric orbs from the west toward the east, either they must be dragged by concentric orbs, or they must move by themselves in the skies, like fishes in the oceans and birds in the air. But they do not move in those ways, so they must be carried by eccentrics. This consequent is clear: the major proposition is patent from a sufficient enumeration of parts, while the minor may be proven according to each part.*].

(exclusive) [if *p* then q_3 (fluid heavens)]}, then [q_1 or (exclusive) q_2 or (exclusive) q_3]'. Clavius then shows the impossibility *ex hypothesi* of homocentrics and fluid heavens and what we are left with is the *real necessity* of eccentrics and epicycles. This still leaves the problem of deciding between Ptolemy and Copernicus, but he gets rid of the latter with a different set of arguments. Indeed, Clavius is very explicit in saying that, from the strict point of view of fitness to appearances, Copernicus' and Ptolemy's eccentric–epicycle systems are perfectly equivalent. This amounts to conceding that, *ex hypothesi*, it is not possible to choose one over another. But, and here his strict realism is in full operation once again, Clavius rejects the Copernican hypothesis as unphysical and abhorrent[1], what finally leaves him with one and only one *real* cosmological possibility – the Ptolemaic system.

What does all this amount to? In my view, it shows that, like Galileo in the realm of mechanics, Clavius is able to present a convincing case for his Ptolemaic cosmology that is compelling and fully intelligible for contemporaries that shared in the tradition which viewed *scientia* (i.e. true and certain knowledge, not just hypothetical) as the aim of natural philosophy – the same contemporaries who were convinced that *ex suppositione* reasoning schemes were able to lead to such knowledge. Once again, it does not matter if from *our* logical standpoint this was doomed to failure: the point is that not a few people, Galileo among them, were convinced that this project could be successful.

4. Conclusions

What we have seen, hopefully, is that Clavius, in his urge to produce a *scientia* of cosmology, must seek for certitude, not just reasonability. He is not content with just *saving the phenomena ex hypothesi*, which seemed to be a prevailing attitude among astronomers. In the same way, Galileo wants a *scientia* of movement: he is not satisfied with, say, showing that the quadratic law of fall is a satisfactory hypothesis. He must show it is real and that any deviation from it is due to the famous *impedimenti*[2], not to any degree of incertitude.

To prove the certain reality of what they are talking about both men make maximum use of an argumentative logical toolkit that was fully at their disposal. Their uses of the potentialities of this shared tradition are evidently different: Galileo must prove the certainty of a *law*, Clavius must demonstrate the reality of *material heavenly entities* in a certain arrangement. The pursuit of his goal leads Galileo to push the boundaries of this tradition to an extreme that was to find its way into 17th century science and beyond – mathematization – and here resides his historical success as well as the diffic-

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[1] Says Clavius [1611], p. 301: *Sed quoniam multa absurda, et erronea in Copernici positione continentur, ut quod terra non sit in medio Firmamenti, moveaturque triplici motu, quod qua ratione fieri possit, vix intelligo, cum secundum philosophos uni corpori simplici unus debeatur motus, et quod Sol in centro mundi statuatur, sitque omnis motus expers. quae omnia cum communi doctrina Philosophorum, et Astronomorum pugnant, et videntur iis, quae sacrae literae plerisque locis docent, contradicere.*

[2] See, for instance, p. 276 of the *Discorsi*, in the edition referred to in note 3, p. 196.

ulty of classing him under any simple *continuator*/*revolutionary* dichotomy. He revolutionizes by dragging tradition to a limit point, by folding and stretching, in a movement much more resembling of a convolution.

In his own way, Clavius also pushes the edges. He brings *ex suppositione* reasoning to the very heart of his cosmological inquiry. He also folds upon tradition and creatively reworks it to his ends, which are proving the certain reality of Ptolemaic eccentrics and epicycles. Even if, on a very short run, the contents of his views were to be discarded as the *ancient* ones in the 17th century intellectual battles, he is far from being a simple continuator of ancient ways of defending these views. On the contrary, he brings to their defense a reasoning style that was to be the very source of scientific modernity.

References

Main source

Clavius Ch., *Disputationem perutilem de orbibus Eccentricis et Epicyclis contra nonnullos philosophos* in: Ch. Clavius, *Opera Mathematica*, t. 3, chapt. 4: *In Sphaeram Ioannis de Sacrobosco Commentarius*, pp. 290–307 (text compared to the Venice, 1596, and Rome, 1606 editions of the *Commentarius*)

Secondary

Baldini U., *Legem impone subactis: Studi su filosofia e scienza dei Gesuiti in Italia,1540–1632*, Bulzoni Editore, Rome 1992

Baldini U., *Saggi sulla Cultura della Compagnia di Gesú (secoli XVI–XVIII)*, CLEUP Editrice, Padova 2000

Carugo A. & Crombie A. C., *The Jesuits and Galileo's Ideas of Science and Nature* in: *Annali del'Istituto e Museo di Storia della Scienza de Firenze* 8, 2/1983, pp. 3–68

Dear P. R., *Jesuit Mathematical Science and the Reconstitution of Experience in the Early Seventeenth Century* in: *Studies in History and Philosophy of Science* 18, 1987, pp. 133–175

Feingold M. (ed.), *Jesuit Science and the Republic of Letters*, MIT Press, Cambridge (Mass.) 2002

Feldhay R., *The Cultural Field of Jesuit Science* in: J. W. O'Malley *et al*. (eds), *The Jesuits: Cultures, Sciences and the Arts, 1540–1773*, University of Toronto Press, Toronto 1999, pp. 107–130

Giard L., *Le devoir d'intelligence ou l'insertion des jésuites dans le monde du savoir* in: G. Luce (ed.), *Les jésuites à la Renaissance: système éducatif et production du savoir*, PUF, Paris 1995, pp. xi–lxxix

Jardine N., *The Forging of Modern Realism: Clavius and Kepler against the Skeptics* in: *Studies in History and Philosophy of Science* 10, 1979, pp. 141–173

Knobloch E., *Sur la vie et l'œuvre de Christophe Clavius (1538–1612)* in: *Revue d'histoire des sciences* 41, 1988, pp. 331–356

Laplanche F., *Réseaux intellectuels et options confessionnelles entre 1550 et 1620* in: L. Giard & L. de Vaucelles (eds), *Les Jésuites à l'Age Baroque (1540–1640)*, Editions Jérôme Millon, Grenoble 1996

Lattis J. M., *Between Copernicus and Galileo: Christoph Clavius and the Collapse of Ptolemaic Cosmology*, University of Chicago Press, Chicago 1994

Lerner M.–P., *Le problème de la matière céleste après 1550: aspects de la bataille des cieux fluides* in: *Revue d'histoire des sciences* 42, 1989, pp. 255–280

Lindberg D. C. & Westman R. S. (eds), *Reappraisals of the Scientific Revolution*, Cambridge University Press, Cambridge 1990

McMullin E., *Galileo on Science and Scripture* in: P. Machamer (ed.), *The Cambridge Companion to Galileo*, Cambridge University Press, Cambridge 1998, pp. 271–347

Pedersen O., *In Quest of Sacrobosco* in: *Journal for the History of Astronomy* 16, 1985, pp. 175–221

Romano A., *La contre–reforme mathématique: constitution et diffusion d'une culture mathématique jésuite à la Renaissance (1540–1640)*, Ecole Française de Rome, Rome 1999

Wallace W. A., *Galileo and Reasoning Ex Suppositione: The Methodology of the Two New Sciences* in: *Proceedings of the Philosophy of Science Association 1974*, pp. 79–104 (= vol. 32 of *Boston Studies in the Philosophy of Science*, (eds) R. S. Cohen *et al.*, D. Reidel Publishing Co., Dordrecht 1976)

Wallace W. A., *Galileo and His Sources: The Heritage of the Collegio Romano in Galileo's Science*, Princeton University Press, Princeton 1984

Wisan W. L., *On argument ex suppositione falsa* in: *Studies in History and Philosophy of Science* 15, 1984, pp. 227–236

Western philosophy - Western philosophy - Pluralistic cosmologies: Parmenides had an enormous influence on the further development of philosophy. Most of the philosophers of the following two generations tried to find a way to reconcile his thesis that nothing comes into being nor passes away with the evidence presented to the senses.Â This reasoning was also used to explain why some animals see better at night and others during the day. According to Democritus, atoms have no sensible qualities, such as taste, smell, or colour, at all.Â All of these paradoxes are derived from the problem of the continuum . Modern cosmology goes back to the first decade of the 20th century. In 1915â€"1917 the American astronomer Vesto Slipher discovered that the galaxies (called nebulae at that time) do not stay in the same place but move in space, with the majority of them moving away from us.Â We even do not know how the problem of cosmological expansion should be formulated. Even more than that, nothing can be said about what happened before this event; it is not quite clear even what â€œbeforeâ€ here means. Nevertheless, the possibility that the world can expand was predicted by the Russian mathematician Alexander Friedmann, a classic international scholar. Studies in Philosophy and the History of Philosophy. Volume 24. REVOLUTION AND CONTINUITY Essays in the History and Philosophy of Early Modern Science Edited by Peter Barker and Roger Ariew.Â These essays are linked by a concern to understand the content of early modern science in its own context. The ediÂ¬ torsâ€™ introductionâ€"itself a substantial essayexamines several myths about the Copernican revolution perpetuated by the neglect of conÂ¬ text.Â Revolution and continuity. STUDIES IN PHILOSOPHY AND THE HISTORY OF PHILOSOPHY General Editor: Jude P. Dougherty. Studies in Philosophy and the History of Philosophy. Volume 24.