7. Astronomy at the universities

New cosmological ideas kept creeping into the universities, too. Ptolemy's system was increasingly dismissed in favour of that of Tycho Brahe. The elliptical orbits were upheld in the work of Ravensberg and Holwarda, as well as by the philosopher Renerius. Two convinced Copernicans – Hortensius and Holwarda – occupied academic chairs. In this section, we will deal with the universities in the pre-Cartesian epoch. The changes brought about by Cartesianism will be dealt with in the following section. Of course, there is no clear chronological boundary between the pre-Cartesian and the Cartesian era. Rather than establishing a fixed time limit, our division will be determined by whether the various authors show any awareness of the new situation as created by the advent of Cartesian philosophy. This will include quite a number of contemporaries of Descartes among the pre-Cartesian philosophers. By 1650, however, nearly everybody had lost his or her innocence. The debates on Cartesianism of the 1640s made it virtually impossible not to take sides on the issue.

As we have seen, outside the universities the philosophical implications of the new discoveries were quickly recognised. The universities, however, were much more traditional and did not allow for daring speculation. Academic discussion on the system of the world still remained very much the affair of astronomers and mathematicians. Even so, physical issues do turn up in their works. The Aristotelian world-view was no longer a self-evident background. Moreover, by 1640 the system of Ptolemy had run completely out of favour. It simply did not match the astronomical phenomena. On the other hand, the system of Tycho Brahe became a serious alternative. So, gradually, a situation arose whereby a choice between Tycho and Copernicus had to be made.

Tychonians

As stated, the first adherent of the system of Tycho Brahe in the Dutch Republic was Johannes Isacius Pontanus. His was rather an exceptional case. His personal acquaintance with Tycho will surely have been of influence. On the whole, it was only in the 1640s that Tycho's system was seriously considered by Dutch astronomers.

One rather curious figure is Antonius Deusing. He is mainly remembered as a physician, but he started his career as a professor of mathematics and physics at Harderwijk University. He later claimed to have been a student of Golius. [49] Deusing was a rather ambitious scholar, and he published a large number of works. In 1640-1641, he presided over a series of nine physical disputations, which provide some information on the background to his ideas. He found the principles of natural philosophy in the history of Creation as told in the Bible: matter, spirit and light. Having discussed these extensively, he argued that the principles of Aristotle agreed marvellously with those of Scripture. [50] The remainder of the disputations consisted largely of an exposition of the works of Creation, in the classical form of a hexahemeron. (It appears that he encountered some problems because he, a philosopher, had discussed the Creation. [51]) In the corollaries to the fifth disputation, Deusing upheld the Tychonian system and rejected the celestial spheres. [52] Meanwhile, in an elementary work on cosmography and astronomy he published the following year, he simply stuck to the Ptolemaic order. [53]

However, Deusing's ambitions went further. Another corollary of the fifth physical disputation was: 'Having rejected the Tychonian motion, we may demonstrate, saving the phenomena, the simple planetary motion around the sun by epicycles and epicyclepicycles of the orbs.' [54] A few years later, in 1643, he devoted a full-length treatise to the planetary orbits. It had the promising title *De vero systemate mundi* ('The true system of the world'). As it appears, Deusing felt much admiration for Copernicus' simplification of astronomical theory by having the planets revolve round the sun, but he had big problems with the motion of the earth. In particular, he considered the immense cosmic distances this would require as absurd. Consequently, he aimed at transposing Copernicus' theories to an immobile earth. [55] This results in, of course – as Deusing himself acknowledges – a Tychonian system. One should remember that Tycho himself had given only an outline of the geoheliocentric system, and had not formulated the exact theories. This is exactly what Deusing now undertook to do. The whole thing is rather tough reading, as nearly the whole

[49] Deusing (1642) 199. On Deusing as a physician, see Ebels-Hoving (1997).
[50] Deusing, disp. Harderwijk, June 1640, quaestio 1 & 2. Cf. Verbeek (1992) 8.
[51] Deusing (1650) preface.
[52] Deusing, disp. Harderwijk, 25 Feb. 1641, coroll. 1, 2.
[53] Deusing (1642).
[54] Deusing, disp. 25 Febr. 1641, coroll. 3.
[55] Deusing (1643) 6-7.

book consists of mathematical calculations. Delambre, who in his days was famous as a diligent astronomical arithmetician, commented on the book: '...this work is tiring [*pénible*] to read. One finds a horrible multitude of lemmata, theorems and corollaries, the quiries of which are long and obscure, and the demonstrations difficult to follow.' [56] Moreover, Deusing nowhere uses observational data or numerical values. His only concern is the construction of geocentric theories which are equivalent to Copernicus'.

It is not quite clear how far Deusing took these theories, which involved complicated models for the various motions, as mere mathematical hypotheses, or as physically true descriptions. In a work on the Creation two years later, he still appears to vacillate between a Tychonian and a Capellan world system. Speaking on the meaning of the word *mundus* (world), he explained that it could refer not just to the whole universe, but also to separate parts: 'So, there is the sublunary world, wherein the moon is rotating; the Solar world, wherein at least Venus and Mercury are turning round; the Jovial world, wherein the stars which are turning round Jupiter...' [57]

Anyhow, all theories should be in accordance with the immobility of the earth. However, having dismissed the annual motion of the earth, Deusing is still prepared to accept its daily rotation. The decisive argument is taken from the immense velocities the revolving heavens should have. [58] The assumption of the earth's daily rotation leads him to an elaborate discussion of the phenomenon of free fall, largely in opposition to Ismaël Boulliau. He even arrives at some quantitative relations, but he keeps to Aristotelian theory and appears unaware of the work of Galileo. None of this is of great scientific importance. Deusing does not make a single effort to match his theories with observations and, as Delambre dryly remarks, 'nobody, I think, will take the trouble'. The astronomers seem to have completely ignored the book. It is preserved in the important libraries, but one is hard pressed to find a single reference to it in contemporary literature. [59]

So, the various discoveries of recent times moved Deusing to enrich his world-view with new elements, but he continued to understand the world in biblical terms. To him, mathematics was a gateway to truth. Astronomy, the contemplation of the heavens, in particular led man to the knowledge of the divine. [60] Like Lansbergen and Mulerius before him, he aimed to reduce

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[56] Delambre (1821) II 146. Deusing is dealt with on pp. 144-146. Deusing is also succinctly dealt with by Dunin Borkowski, IV, 500-501.

[57] Deusing (1645).

[58] Deusing (1643) 125.

[59] Lipstorp (1653) is one of the few authors to refer to Deusing.

[60] Cf. his orations on these disciplines in Deusing (1642) 181, 219.

all heavenly motions to uniform circular movement. He knew of Kepler's innovations, but deliberately opted for the simplicity of Copernicus' circles.[61] We may conclude that Deusing was a scholar in the Leiden tradition who did his best to grasp in traditional notions a world ever more complex and bewildering.

At Utrecht University (founded 1636), physics and mathematics were taught by Jacob Ravensberg.[62] He had been a student of Mulerius at Groningen, where he obtained his doctorate in philosophy in 1639 on a collection of miscellaneous theses. One thesis was devoted to the question whether the earth was moved or not. He gave a long list of both the ancient and the recent proponents of the earth's motion, and summarised their opponents in a single line (peripatetics, Ptolemaeans, Tychonians). Finally, he simply stated: 'It is difficult to refute the motion of the earth by natural reasons; still, one cannot deny absolutely the motion of the sun.'[63]

After his graduation, Ravensberg moved to Utrecht, where in 1640 he defended a disputation on the system of the world, wherein the Copernican question was tackled much more seriously. Disputations 'on the system of the world' would be rather popular in the second half of the century, when they discussed the question in a set way. Ravensberg's disputation, however, was the first of its kind, and not at all a standard one. In fact, the work is rather puzzling. At the outset, he states that there are only two serious claimants for the true system of the world, viz. the Copernican and the Tychonic. One of them has to be true. He will lay out the system of the world according to the Copernican theory. The theory may seem rather absurd, but it makes astronomy easier, even if it may be wrong in other respects. So he will accommodate his exposition to it. 'So far as it disagrees with the Tychonic system, it will suffice to have it qualified here once.'[64] A similar qualification is also to be found in the dedication of the disputation to the Utrecht rector Schotanus, professor of law. Ravensberg explains that he may seem to be rather too fond of Copernicus; but then he does not strive after strict accuracy, but proposes these things for disputation's sake. He is only concerned with matters fit for a disputation, not with exact astronomical descriptions of motions and magnitudes.

The disputation can be divided into several parts. After a few theses about the world in general, Ravensberg first explains the various motions of the earth according to the Copernican theory (th. 12-19). Still, whereas Coperni-

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[61] Deusing (1643) 6.
[62] Or Ravensperger. See on him Dibon (1954) 211-214.
[63] Ravensberg, disp. Groningen Feb. 1639, th. 48.
[64] Ravensberg, disp. Utrecht 25 Nov. 1640, th. 2.

cus himself had acknowledged only three motions, Ravensberg came up with nine. He also counted such phenomena as the anomaly of the obliquity of the Zodiac and the variation of the eccentricity as motions. In the end, however, he reduces the whole lot to three again. Next, he devotes a number of theses (19-24) to the magnetic nature and other properties of the earth. The final part (th. 25-36) is devoted to special phenomena which could be derived from the theory of Copernicus, such as stellar parallax, the phases of the planets, their variety in magnitude in different places in their orbits, retrograde motion and other properties of the planets' courses, Galileo's theory of the tides, etc. In some cases, such as stellar parallax, Ravensberg acknowledges that the phenomenon cannot be observed because of the dimensions of the universe, in others he confirms their existence; some phenomena, such as the influence of the earth's motion on falling bodies, he regards as probable, but unproven as yet. Without Ravensberg's warning at the start, the whole could very well be read as an extensive argument in favour of Copernicanism.

Ravensberg was well acquainted with the astronomical literature. Among others, he refers to Kepler, Galileo, Gilbert, Boulliau, Blaeu, Lansbergen and Mulerius. His arguments are indeed largely mathematical. Most of them can be accommodated to the theory of an unmoving earth, as happens in the Tychonic system. On the other hand, Ravensberg does not have a physical view of the universe which would support heliocentrism. His cosmology is a mixture of old and more recent elements. His view that the world (in the sense of the whole cosmos) is spherical is traditional. As such, it must have a centre, where either the sun or the earth is located (th. 1, 3). Still, he argues that the fixed stars may be like suns, each of them with its own planets. The stars were not created primarily for the benefit of man (th. 7). He adheres to Gilbert's theory that the daily rotation of the earth is caused by its magnetic virtue (thus implicitly acknowledging the daily rotation). He supplements this theory, however, with Galileo's idea of inertia (th. 21-22). Thus, he was clearly aware of the physical difficulties of Copernicanism and these may well account for his doubts. Ravensberg certainly was not an adamant adversary of Copernicanism, but in the end, he refused to advocate it openly.

As to the further developments of his ideas, in 1642 Ravensberg published, in the form of disputations, his *Encyclopedia mathematica*, which dealt with the whole of mathematics. The work was a collection of unconnected, for the most part rather short theses, grouped under such headings as spherics, astronomy, 'planetaria', astrology and statics, as well as 'medica' and 'physica'. In some respects, Ravensberg appears more advanced by now: he not only rejects the existence of celestial orbs, but accepts that the planets do not move in circles but in ellipses. He still regards the theory of epicycles and excentres as useful, but he no longer holds, as he had done in 1640, that they really exist.[65] Among Dutch astronomers, he seems to have been the first to defend elliptical orbits in print. However, he had been forestalled by a philosopher, Henricus Renerius, who had recommended Kepler's ellipses in a disputation in 1635.[66] As Renerius was closely connected with Descartes, he will be more fully discussed in a later chapter. He taught at Utrecht University, where Ravensberg defended his theses, but it does not seem very probable that he influenced the latter directly, since he died at about the time Ravensberg arrived there.

Other elements in Ravensberg's 1642 work probably were influenced by his new academic environment. He devoted a rather long section to a discussion of the vortex theory of planetary motions – remarkably, as this theory would not be published until two years later, in Descartes' *Principia philosophiae* of 1644[67] (the *Discours de la méthode* does not discuss it). On the other hand, Ravensberg had become more cautious with regard to cosmographic speculation. On the whole, he stressed the insufficiency of the arguments in favour of Copernicus, while he appears to regard Tycho's work rather favourably. But by now, Ravensberg also was aware of theological restrictions: 'I leave the Copernican, that is, daily and annual motions of the earth, to the theologians in order to investigate them.'[68] Theological pressure was rather heavy at Utrecht, as we will see in a later chapter.

In Ravensberg, Utrecht had a competent mathematics professor with a special interest in astronomy, who seems to have transmitted both his astronomical learning and his predilection for Tycho to a number of students. His influence can be discerned in several doctoral disputations. The later Amsterdam professor of mathematics Alexander de Bie obtained his degree in philosophy at Utrecht on 25 August 1642 on a thesis on spontaneous generation, the sun's motion, and usury. (Utrecht doctoral disputations were triple at this time, each part dealing with a separate part of philosophy – normally physics/metaphysics, mathematics and ethics.) In the second part, De Bie agreed that Kepler's ellipses saved the phenomena, but like Ravensberg, he maintained that the theory of excentres and epicycles remained of practical value.[69] As

[65] Ravensberg, disp. Utrecht 1642, planetaria, th. 32. Ravensberg, disp. Utrecht 25 Nov. 1640, coroll. 18.

[66] Renerius, disp. Utrecht 10 June 1635, th. 36.

[67] Ravensberg, disp. Utrecht 1642, statica th. 4.

[68] Ravensberg, disp. Utrecht 1642, Geographia th. 8: '*Motus vero Terrae Copernicanos, seu diurnum & annuum, Theologis hac vice examinandos relinquo.*'

[69] De Bie, disp. Utrecht 24 Aug. 1642, *De motu Solis*, th. 6.

for Copernicus' theory, 'To investigate it would require an opinion like the one Copernicus had. But although we presuppose from Holy Writ that his hypotheses and his system recede from truth, it will be allowed for us to hear and consider the arguments of the philosophers against Copernicus.' [70] De Bie, too, expressed his preference for Tycho's system.

Also in 1642, Barthold van Wesel graduated at Utrecht on a thesis on prime matter, the celestial orbs, and the affects. In the second part, after providing a historical overview of the several theories, he concluded that it is highly doubtful whether such orbs really exist. The sphere of the fixed stars is known to exist for biblical, not philosophical reasons. Planetary spheres are rather superfluous; according to Kepler, one can use ellipses instead of excentres with epicycles. Meanwhile, Van Wesel does not seem to have been very fond of the more mathematical parts of astronomy. This is not the case with Bernard de Moor's doctoral disputation, which he defended at Utrecht in 1643. It deals with the continuum, the new planets and the Stoic errors concerning the affects. De Moor was well acquainted with the astronomical literature of the day, including Galileo's work and Kepler's *Epitome*. In the corollaries, he expressed his preference for the Tychonic system, as best according with the heavens, and his dislike of the celestial spheres.

Copernicans

Probably the first full-fledged Copernican to hold a Dutch chair was Martinus Hortensius, whom we met before as the champion of Lansbergen. [71] He was one of the most outspoken Copernicans in the Dutch Republic. He was clearly interested in astronomy at an early date; born in 1605, he regularly made astronomical observations from 1625 onwards. [72] In 1634, he was appointed professor of mathematics at the Amsterdam Athenaeum. In 1634 he taught astronomy, in 1635 optics and in 1636 navigation. According to Varenius, who later set his sights on this chair, he had hardly any auditors. [73] It need not have been Hortensius' fault. 'This city has many followers and ob-

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[70] *Ibidem*, th. 5: '*Haec inquirere ingenium requirebant, quale fuit illud Copernici, Quamvis vero ex sacris praesupponamus ejus hypothesis & ejus systema à veritate aberrare, licebit nobis philosophorum argumenta contra Copernicum audire & expendere*.'

[71] On Hortensius, van Berkel (1997). See also de Waard in NNBW I, 1160-1164; van Berkel (1983) 143-145, 150; Rademaker (1981) 247-250.

[72] Lansbergen (1632), *Thesaurus*, 124, 144, 162, 164, 171, 175, 177, 183. Pingré (1901) 57, 62, 64-66, 68, 72-75, 77-78, 83, 86-90, 103, 105, 114, 123. Pingré (p. 55) also mentions an observation at Dordrecht on 20 May 1621, but this appears doubtful.

[73] Varenius to Jungius, 24 Dec. 1647 and 12 April 1648, Jungius (1850) 379, 381; German translation in Jungius (1863) 328, 331.

servers of Mercury, but none of the other stars,' as Varenius remarked caustically on another occasion.[74] In 1639, Hortensius was appointed professor of mathematics at Leiden, but he died on 17 August, before he could start his courses.

Hortensius was not really an original thinker, although he did contribute to the propagation of Copernicanism in several respects. He made Latin translations of Lansbergen's *Bedenckingen* and of Blaeu's *Twee-voudigh onderwijs*, both of which had a clear Copernican tenor. Hortensius seems also to have advocated Copernicanism in a more private way. In 1635, in the aftermath of the Galileo affair, Gerard Vossius, by that time Hortensius' colleague at the Athenaeum, was asked for his opinion on the Copernican issue by his friend Abraham van der Myle. Vossius did not want to commit himself on the subject and he passed the request on to Hortensius, who apparently was only too pleased to state his views. There is a manuscript known wherein he discusses and refutes some objections Van der Myle had brought forward against the Copernican system. Among other things, Van der Myle thought it improbable that the radius of the earth's orbit would be 'quite nothing' compared to the distance to the fixed stars.[75]

Moreover, he published an extensive introduction with his translation of Lansbergen's book. This introduction was principally an attack on the astronomy of Tycho Brahe. It aimed not so much at Tycho's world system, however, as at his observations. Hortensius made it quite clear that only Lansbergen could claim to have restored true astronomy. As it seems, he regarded Tycho as a rival claimant for this honour. Hortensius did his utmost to show that Tycho's astronomy was built on rather shaky foundations. The points dealt with seem rather trivial to the modern reader – in fact, not just to the modern one. Kepler spoke of 'minute things which are controverted among specialists'. Finally, Hortensius asserted that Lansbergen had discovered the two pillars upon which he was to restore astronomy: the motion of the earth, and the true measure of the celestial spheres.

This introduction provoked a vehement reaction from the Danish astronomer Peder Bartholin Kierul, who came out in defence of Tycho Brahe's honour.[76] Kepler, too, made some rather disdainful remarks about Hortensius' preface, in an appendix to his ephemerides for 1624.[77] In the latter case, Hortensius answered with an entire booklet, in which he replied to Kepler's ob-

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74 Varenius to Jungius, 16 June 1647. Jungius (1850) 378, cf. Jungius (1863) 326.

75 Rademaker (1981) 249. Leiden University Library, Pap. 2. The attribution of this piece to Hortensius is based on a marginal annotation; van der Myle appears as 'Milius'.

76 Bartholin (1632). Cf. Moesgaard (1972) 133.

77 Kepler, *Werke*, IX-1, 204-205.

jections point by point. Behind the discussion of astronomical details stands the question: who is the true restorer of astronomy? Especially the fact that only Lansbergen holds all ancient observations in esteem, whereas Tycho, Longomantanus and Kepler tend to neglect them, is regarded by Hortensius as a clear sign of superiority. [78] In fact, Hortensius points out that he decided to answer Kepler's objections because of Lansbergen's exhortations. 'For he has no other wish than to see, while he is still alive, the security of his hypotheses, which I put forward in my preface, publicly asserted, and confirmed by certain and convincing arguments.' Although Kepler had died in the meantime, the book was still published. [79]

His defence of Lansbergen led Hortensius to attack the work of the greatest astronomers of his age, but he was not in all cases so offensive. As indicated above, he supported the publication of Boulliau's *Philolaus*, although this book contained a rather critical evaluation of Lansbergen's argument from the moon's motion. He also appears to have genuinely admired Galileo. Hortensius played a prominent role in the plan to get Galileo to the Dutch Republic after his condemnation, and in the discussions on the project of determining longitude thereafter. When he died, he was about to go to Italy on a special embassy to Galileo to settle this affair. He was also instrumental in getting two copies of Galileo's *Dialogo* to the Republic, in 1634. [80] As the book had been banned in Italy, it was rather difficult to obtain. Hortensius seems to have welcomed the Latin translation that Matthias Bernegger was about to make at the behest of Galileo and his friends. Bernegger, a German from Strasbourg, was urged by the Leiden professor Boxhorn, on behalf of Hortensius as well, to produce this translation. [81] It appeared in 1635 under the title *Systema cosmicum*.

In a dissertation, dated 1636, explaining the project of a full course in mathematics, Hortensius announced his intention to publish shortly a book on astronomy, *Controversiae astronomicae*. [82] His death, however, left the project unfinished. The fundamentals of his astronomy are however pretty clear. To the end, he remained a firm defender of Lansbergen's calculations. When he published a reaction to the book the French astronomer and philosopher Pierre Gassendi wrote on his observation of Mercury's conjunction with the

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[78] Hortensius (1631) 9-10, 12.
[79] Hortensius (1631) 4; see also preface. Extracts from the debate were published by Frisch in: Kepler (1858-1871) VIII, 543-547.
[80] Van Berkel (1989) 104-105.
[81] Bernegger to Diodati, 14 April 1635: '*Verum enim est... Leydensem illum Boxhornium suo et Hortensii nomine ad versionem Systematis me adhortatum esse*.' *Briefe* (1889) 936.
[82] Hortensius (1645) 591.

sun, he used Gassendi's observations as confirmation of the accuracy of Lansbergen's tables.[83] In his determination of the diameter of the planets, he based himself on the values for cosmic distances in Lansbergen's *Uranometria*. In his cosmological ideas, he probably also remained strongly influenced by Lansbergen. He dismissed Kepler's speculations regarding cosmic harmony. Astronomy, he stated, should be based on observations and mathematical demonstration, not on speculation.[84] Although he rejected the vain prognostications of the astrologers, he firmly believed in the influence of the celestial bodies on the earth.[85]

The second Copernican to occupy a Dutch chair was a more important astronomer than Hortensius. Jan Fokkes ('Fokkes' is not a family name; it simply means 'son of Fokke') was born in the village of Holwerd (province of Friesland) in 1618. As he entered an academic career, he Latinised – or rather Graecised – his name as Johannes Phocylides Holwarda. He studied at Franeker, took his doctorate in medicine there in 1640, and then taught there as a professor. In 1639, a year before he was awarded his medical doctorate, he had already been appointed professor *extraordinarius* of logic. He became an ordinary professor in 1647, and died just four years later.

Although neither mathematics nor astronomy was part of Holwarda's charge, astronomy was certainly the field he took most interest in. He observed various eclipses and remains known for his discovery of *Mira Ceti*, a variable star in the constellation of the Whale.[86] Moreover, he published two astronomical books. A third one, as well as a book on physics with a large astronomical section, was published posthumously.[87] The *Friesche sterre-konst* ('Friesian astronomy') is a handbook of mathematical astronomy. Its core is a series of astronomical tables with which one can calculate stellar positions. These are accompanied by extensive theoretical explanations of the motions of the various planets. Although by this time many similar books had been published, Holwarda felt justified in writing it for two reasons: he writes in the vernacular, which nobody had undertaken before in the Dutch Republic, and he had new astronomical data. In particular, Holwarda accepts Kepler's innovations of putting the sun as the centre of motion and making the orbs of the planets elliptical rather than circular.[88] Holwarda was one of the first ad-

[83] Hortensius (1633) 16-23, 79-81.
[84] Hortensius (1633) 68; see also 65.
[85] Hortensius (1633) 67-68.
[86] Pingré (1901) 122, 128, 142, 148-149.
[87] On Holwarda, see Galama (1954) 91-100; a bibliography of his works on 291-293. Also Terpstra (1981) 65-74.
[88] Holwarda (1652), preface; cf. 237-240.

herents in the Dutch Republic of Kepler's theories. On the other hand, he was highly critical of Lansbergen's work.

He took from Kepler not only the theories we now regard as 'modern'. 'The sun, being the centre of the whole world, causes, by its rotation on its axis and the emanation of its strong rays (as if it were a big magnet), the motion of all further celestial bodies, in proportion to their distances and their particular properties.' The idea of the sun as moving force of the heavens is clearly Keplerian. Holwarda, after some hesitation, declares that the fixed stars, too, are moved by this central force. Their immobility would contradict nature, which is never idle. Precession, then, is a real motion of the fixed stars, not just of the earth's axis. Holwarda's ideas here are akin to Lansbergen's. He, too, thinks that the velocity of the heavenly bodies decreases with their distance from the centre, that is, the sun. [89] On the other hand, Holwarda ridicules the idea of solid celestial spheres. [90]

Holwarda represents the transition to a new era. By the time he occupied his chair, not only had the old Aristotelian system been discredited, but the outlines of a new world-view had become visible. Descartes had published his *Discours de la méthode* in 1637. But if Holwarda was acquainted with Descartes' ideas, there are few traces of them in his work. Although his view of nature appears to have been influenced by the new mechanical philosophy, another mechanical philosopher seems to have been more important to him: Pierre Gassendi, whose work Holwarda praised highly. Like Gassendi, he defended the view that nature consists of atoms. On the other hand, there is also the influence of Renaissance philosophers, such as Julius Caesar Scaliger. Holwarda's atoms are endowed with sympathy and antipathy. He remains a transitional figure and certainly cannot be called a mechanical philosopher.

We might conclude this section on academic Copernicans with a mathematician who remained outside the universities, Bernard Varenius. He was, however, a scientist of note who worked in the academic sphere. Varenius came from Germany. He had studied at Hamburg with the famous Joachim Jungius before starting an academic pilgrimage which brought him first to Koenigsberg and finally to Leiden. Apparently, the scientific climate in the Dutch Republic was much to his liking. He settled in Amsterdam and set his hopes on obtaining the chair of mathematics at the Athenaeum, which had been vacant since the departure of Hortensius and his successor, John Pell, some time before. Despite his poor living conditions, he turned down an offer

[89] Holwarda (1652) 230-231; cf. (1640) 218.
[90] Holwarda (1640) 232-233.

from his teacher Jungius to return to Hamburg. His hopes, however, came to nothing. Soon afterwards he died, in 1650.[91]

In order to qualify himself for the chair of mathematics, Varenius undertook the composition of a book on geography, then regarded as a practical application of mathematics. Shortly before his death, it appeared as *Geographia generalis*. The book is considered a milestone in the development of the geographical sciences. Here, however, we are concerned only with Varenius' contribution to the discussion on Copernicanism. The book opened with a general description of the earth, wherein he discussed not only its shape and size, but also its motion. He rather elaborated on this subject, as 'there is no affection of the earth on which there is a greater or harsher dispute, as not long ago it suffered from the censorship of the Roman Church.'[92]

The fifth chapter is devoted to the annual rotation of the earth, and the sixth to its course around the sun. Varenius argues elaborately in favour of the Copernican system, rehearsing the well-known arguments for and answering the common objections against it.[93] He has clearly been impressed by the new cosmological discoveries. Aristotelianism is dismissed and he rejects the traditional distinction between heaven and earth, although he feels that one might still maintain it for practical reasons.[94] However, he makes no use of the newly developed Cartesian physics. He is familiar with Descartes' vortex theory, to which he refers in a section on ocean currents and the tides, but appears rather critical. He promises a further consideration on Cartesian physics, but this never appeared.[95]

Varenius' book immediately became popular and was reprinted many times in the seventeenth and eighteenth centuries. It was exactly what the educated public needed at the time: a thorough but readable overview of an extensive subject, presented in a new scientific spirit. One should not call it a mere book of popularisation, although it certainly helped to spread scientific insights. Its discussion of Copernican theory must have reached a far wider audience than most other books on the subject, in the Dutch Republic as well as abroad. In the eighteenth century, it was even translated into Turkish and so became one of the sources from which knowledge on Copernican theory reached the Ottoman empire.[96]

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[91] His biography in Günther (1905).
[92] Varenius (1650) 48.
[93] Varenius (1650) 48-62.
[94] Varenius (1650), dedication.
[95] Varenius (1650) 180-190.
[96] Ihsanoglu (1992) 86-87.

Philosophers

The most interesting development in the academic sphere, however, is not so much the shift from Ptolemy to Copernicus and Tycho Brahe: more far-reaching was the fact that cosmological questions gradually became a matter of concern not just to mathematicians and astronomers, but also to physicists and philosophers. In a sense, this was a result of the shift which had been started by Galileo's discoveries: the main question by now was the constitution of the heavens, not the mathematics of celestial motions. It seems quite natural that philosophers increasingly discovered the relevance of the topic. Still, the new context did not leave the discussions unaffected. By being discussed in philosophy, questions other than those hitherto common came to the fore. Moreover, the old questions were put in a new framework. The order and constitution of the heavens became entwined with the doctrines on nature as a whole.

That the new cosmology was gradually coming to the attention of academic philosophers is illustrated by one of the outstanding academic philosophers of the first half of the seventeenth century, Franco Burgersdijk. In his case, we see the gradual shift from complete disregard to cautious acceptance of the new cosmology. Burgersdijk was the dominating philosopher during the first part of the seventeenth century. He held the Leiden chair of logic and also taught ethics and physics. [97] He was not an original philosopher, but was renowned as a pedagogue. His textbooks were often reprinted and widely read, not just in the Dutch Republic, but also in England. He wrote two textbooks on physics, which appear to be collections of previously held disputations. *Idea philosophiae naturalis* was originally printed in 1622 (the dedication is from December), and *Collegium physicum* in 1632.

Idea philosophiae naturalis is very short, composed of very short theses with little explanation. The text is traditional, commenting on the works by Aristotle, not on current cosmological questions. Speaking on the heavens, Burgersdijk mainly discusses their influence on the sublunary world. Orbs and heavenly motions are simply taken for granted; the references are mainly to the Conimbricenses. [98]

In 1627, however, Burgersdijk presided over a disputation, *De coelo* ('On the heaven'), which did display some awareness of new developments in cosmology. It does not just pose the time-honoured scholastic questions about the goal and form of the heavens, but is largely devoted to more down-to-earth questions regarding its shape, division and substance. His astronomical

[97] On him: Ruestow (1973) 28-32; Bos and Krop (1992); van Bunge (2001) 27-28, 30-32.
[98] Burgersdijk (1635) 31-35.

knowledge is not always up to contemporary standards (he argues that all heavenly bodies, including the moon, are luminescent, although he admits that it is believable that the sun contributes as well), but he does try to account for new insights. Starting from the assumption that stars are denser parts of their orbs (a point he had made in the *Idea*), Burgersdijk explains the occurrence of novae, like the one of 1572, as the result of a temporary thickening of the heavenly substance. He also discusses the motion of the earth, which he rejects with the familiar argument about the behaviour of falling bodies. He still maintains that the heavens consist of solid orbs and, as a simple body can have but one motion at a time, there are as many orbs as there are different motions. In an earlier chapter, we noted his division of the heavens, on scriptural grounds, into three parts. [99]

Burgersdijk appears to have changed his views even more in *Collegium physicum*. [100] In the eleventh disputation ('On ordinary and extraordinary stars'), he still upholds the view that stars are dense spots of heavenly substance. But he has become much more critical about celestial orbs: these are mere figments, invented to describe the motions of the stars. They suffice as hypotheses to save the phenomena, but it should be regarded an error to think that they exist in reality. Several arguments force us to reject them. It seems much more probable that the planets move of their own in a fluid medium. [101]

As to the system of the world, Burgersdijk has become hesitant. As he says, the cases of both Ptolemy and Copernicus are argued with strong reasons. (Tycho Brahe is not mentioned.) As it seems, Burgersdijk's change in attitude has come about mainly under the influence of the works of Lansbergen, to whom he explicitly refers. He is most impressed by Lansbergen's calculation of the velocity which the fixed stars should have if they, rather than the earth, were turning. 'And if the earth moves with a daily motion, it is easier to believe that it moves with an annual motion as well. And if Lansbergen has not hallucinated in his *Uranometria*, we shall have to think about a solution for the arguments, which argue in favour of Ptolemy.' [102] Had death not prevented him, Burgersdijk might well have turned into a full-fledged Copernican. The real innovation in his work, however, is that here is a philosopher, not a mathematician, discussing the system of the world. In his own time he was an exception, but in the second half of the century, the tables would be turned: discussions on the world system would become the near exclusive domain of the philosophers.

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[99] Burgersdijk, disp. Leiden 16 June 1627.
[100] Burgersdijk (1637). I use the updated second edition, as I have not seen the first.
[101] Burgersdijk (1637) 106-113.
[102] Burgersdijk (1637) 113; see also 112.

Another philosopher of a somewhat later date is Albert Kyper, who was born in Germany. After his studies at Leiden, he was allowed to teach physics privately and even to preside over disputations. In 1646, he became professor of philosophy at the illustrious school at Breda and physician to the stadholder. In 1650 he returned to Leiden, now as a professor of medicine.[103] In 1645-1646, he published in two parts an introduction to physics. Although this work was published after the important work of Descartes, which transformed the face of philosophy, it hardly mentions him.

In the introduction, Kyper announced his programme. His enemies had insinuated that he had introduced new and dangerous opinions into philosophy, which were apt to undermine the foundations of theology and disturb the academic peace. With this publication, he wanted to defend his honour. He admitted that in many respects he was rather critical of Aristotelian philosophy. But that was not to say that he wanted to banish it from the university, or to frame a new system.[104] The hostility Kyper had met may partly have derived, as he supposed himself, from the fact that he had only recently become a member of the Dutch Reformed Church (originally, he had been a Lutheran), and was suspected of having done so just to further his career.[105]

From the text of his book, there appears no reason to regard Kyper as a dangerous modernist. He appears as a man deeply committed to religion, who refers to the Bible much more often than is usual in philosophical textbooks. His deviations from Aristotelian philosophy appear to derive mainly from this biblicism. Biblical arguments support his view that darkness is not a mere privation, as the Aristotelians have it, but something positive. He also ponders the question whether Christians can use in good faith pagan names for the stellar constellations, but admits that it would be very unpractical to have them changed.[106] Kyper rejected Burgersdijk's view that the stars were dense spots of heavenly substance, on the grounds that Genesis teaches us 'that the stars are placed into the heavens, not made from the heavens, by God.'[107] In astronomy, Kyper appears to have been an adherent of Tycho's world system. Perhaps that is why he preferred the view that the heavens are a homogenous, fluid body, to the view that they are made of solid orbs: in this way, they were best suited for the motion of the stars, as well as for the propagation of the stars' influence. As to the fixed stars, because of the uniformity of their motion, he thought it probable that all of them are at the same dis-

[103] On him: Sassen (1962) 323-68; Ruestow (1973) 39-43.
[104] Kyper (1645-1646), preface.
[105] Ibid., dedication.
[106] Ibid., I, 463-464; II, 42. Ruestow (1973) 40.
[107] Kyper (1645-1646) II, 19.

tance from the earth.[108] This argument, of course, presupposes that the diurnal rotation is in the heavens themselves.

Indeed, Kyper rejected the Copernican view that the earth was moving. In accordance with his general stance, his main arguments appear to be biblical. Kyper argues that the Bible expressly teaches that the stars move. Moreover, from the history of Creation in Genesis, it appears that the sun is not the centre of the universe. Physical arguments appear only in the second place; most of them are fairly commonplace. He dismisses the Copernicans' claim that their system is the more 'economic'. The system of the world should be valued according not only to its economy, but also to its necessity and greatness. As long as we do not understand these, we should not make a judgement contrary to Scripture. Interestingly, he also dismisses the argument of 'cosmic harmony', i.e. that the velocity of the spheres should diminish according to their distance from the centre. Kyper argues that the argument is based on a false reading of the original source, viz. Aristotle in his book on the Heavens (*De caelo*, Book 2, Chapter 3). There, Aristotle spoke only about precession. Wondering how the stars are able to make all these complicated motions (earlier, he had rejected not only orbs but also their being moved by intelligences), Kyper looked for a solution in the sympathy of the heavenly bodies both to each other and to the sublunar things.[109]

On the one hand, Kyper's world-view appears rather traditional; on the other hand, however, he is clearly not satisfied with traditional scholastic philosophy. Notably, he feels the need to gain an insight, as a philosopher, into the pressing cosmological questions of the day. Therefore, he starts on new topics and new explanations, although in a much more cautious way than some thinkers outside university. Kyper appears as a kind of belated representative of 'Mosaic philosophy'. The point is, however, that with the shift from a mathematical to a physical consideration of the heavens, the status of the biblical sentences became problematic. No mathematician would turn to the Bible for the solution to a mathematical problem, and no theologian would expect him to. Physics and philosophy, however, traditionally did interfere with theology. It was hard to imagine that the Bible would have no relevance to the explanation of the world. In this sense, Kyper's stance was not just an echo of the sixteenth century, but also a foreshadow of things to come.

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[108] Ibid., II, 56-57, 9-10.
[109] Ibid., II, 104-110; see also 57.