Rommevaux, Sabine (ed.) ***Mathématiques et connaissance du monde réel avant Galilée*** **(Montreuil: Omniscience, 2010). 351 pp. pb. EUR 45. ISBN 978-2-916097-26-8.**

It is a commonplace that Galileo inaugurated the mathematization of physical science when claiming the universe to be a book written in the language of mathematics. Less commonplace, but well-known all the same, is the mathematization of natural philosophy by Bradwardine and other fourteenth-century philosophers.

The insightful contributions to the present volume go beyond these traditional understandings, as its notion of the 'real world' goes (somewhat) beyond the limits of natural philosophy. All concentrate on particular questions and actors.

Three contributions deal with discussions around the continuum. Aurélien Robert treats of 'atomism and geometry in fourteenth-century Oxford', concentrating on the atomists Catton, Crathorn and Wyclif and their arguments. He observes that their finitist arguments are often geometrically wrong (namely, one may add, because they cannot avoid presupposing aspects of Euclidean geometry and thus the continuum); however, since their interest was the world of existing things – and, behind that, theology, with a long-standing interest also in the continuity or discreteness of qualities such as charity, and, according to the atomists in question, its teaching that only God, not his creation could be infinite – this was no decisive problem: mathematics could be argued not to describe existing things. The article offers a thorough analysis of the often sophisticated arguments of the three authors.

Sabine Rommevaux deals with Bradwardine's *De continuo*, of which she produced a partial translation in 2005. Here, she discusses whether the treatise is justly seen as a primarily mathematical investigation of the continuum (John Murdoch's position) or as a treatise dealing fundamentally with natural philosophy, with a hidden layer of theology (Edith Sylla's reading). Since Bradwardine does not take up those arguments of his opponents which touch on theology, Rommevaux dismisses the theological layer. Further, as Bradwardine is shown by close analysis of his argument to take as his basic premise that all continua (physical as well as mathematical) are similar, Rommevaux concludes that Bradwardine *combines* physical and geometrical arguments, while pointing out that his *purpose* – to refute the finitist arguments of Grosseteste, Harclay and Chatton – puts physics in the privileged position.

Stephen Clucas investigates Thomas Harriot's atomism, in particular the belief that it is borrowed from Giordano Bruno. This belief, held by Hilary Gatti and others, is argued (convincingly, in the reviewer's opinion) not to hold water. One argument in favour of influence was a passage in a manuscript, shown however by John Henry already in 1982 to be misread (Clucas has now identified the real reference of the passage). Others build on supposed similarity between Harriot's and Bruno's texts; but the similarities are always generic and better explained by the common background of both – Harriot was indeed an interested reader of medieval philosophical manuscripts. In conclusion, Harriot's atomism appear to derive from his mathematical studies, whose consequences were carried over to his physical views.

Two contributions deal with (fourteenth-century) musical theory. Dorit Tanay 'studies the relations between Jean de Murs' revolutionary musical theory and contemporary mathematical works belonging to the calculators' tradition of Merton College'. Jean's theory deals with rhythm, not with harmonics, and the 'quantification of qualities' provides the link to the calculators. Quantification, as Tanay emphasizes, was not an idiosyncratic Merton interest, and since Jean wrote his *Notitia artis musicae* in 1321, Merton influence is indeed not plausible (Bradwardine's *Tractatus de proportionibus* is from 1328); Tanay suggests parallel developments on a common background, mentioning Gerard of Brussels' *De motu* and Archimedes' *De mensura circuli*. The relevance of the quantification of qualities (unexpected both from the perspective of later notations and, say, Augustine's *De musica*) is that interaction with Aristotelian metaphysics had caused the length of a note to be understood as *a quality*: depending on circumstances a *longa* note, like any Aristotelian nature, might be perfect (three time units) or imperfect (two units), and so might a *brevis* (one respectively two units); finally, a *semibrevis* might be $^2/_3$ or $^1/_3$. So, the rhythmic possibilities were very restricted, and more so because the actual length of notes was not determined freely by the composer (a *longa* followed by a *brevis* had to be imperfect, etc.). Jean did not give up the idea that length was a quality, and did not get rid of ambiguity in the naming of lengths; but by quantifying this quality he allowed the production of a much wider range of rhythmic patterns – according to Tanay *before* these had come to be used in musical practice.

Matthieu Husson's paper on Jean de Boen's *Ars* and *De musica* (1350s) takes up the traditional core topic of musical theory: harmonics. De Boen's innovations with respect to the Pythagorean-Boëthian tradition were based on a sensualist approach to dissonance and consonance, according to which harmony is determined by what turns out to be pleasant to the ear, and further on his notions of consonance *per se* (the octave and the quint, perfect, and the third and the sixth, imperfect) and consonance *per accidens*, that is, harmony achieved through the 'accidental' vicinity of a consonance *per se*. This division and widening of the realm of consonance was apparently taken over from Jerome of Moravia, so what is really new in de Boen was his use of arguments derived from natural philosophy for what was consonant (e.g., optical imagery, and considerations regarding the movement of air). In this way, as argued by Husson, de Boen contributed to transferring musical theory from the quadrivium (that is, Boëthian non-demonstrative mathematics) to the domain of 'intermediate sciences', dependent on demonstrative mathematics as well as natural philosophy.

Three contributions deal with mechanics and architecture. Walter Roy Laird takes up Blasius of Parma's *Questiones super tractatum de ponderibus* and *Tractatus de ponderibus*. As he quotes earlier discussions, these treatises have been judged, from Pierre Duhem to Marshall Clagett and Joseph Brown, to be at best an unoriginal repetition of what had been done by Jordanus and his followers in the thirteenth century, at worst (Brown) 'a thoroughly Aristotelian exercise with a decided preference for the paradoxical over the rigorous'. Laird admits that these characterizations seem adequate *if* the treatises are read simply as steps toward later statics, but then concludes reasonably that better understanding of Blasius's intention may change them. He suggests that in the *Questiones* 'Blasius was concerned not so much with advancing the science of weights as with examining the foundations in the light of fourteenth-century natural philosophy', and finds one of the 'main purposes [of the *Tractatus* to be] to suggest a way around what he saw as the failure of the science of weights to take into account the buoyancy and resistance of the medium'. These claims are vindicated through analysis of Blasius's treatises in relation to the thirteenth-century founding works – the *Liber de canonio*, the *Liber Archimedis de insidentibus in humidum*, and the various treatises written by or attributed to Jordanus – as well as the fourteenth-century *Aliud commentum*. It is concluded that 'in the light of the later attempts by Benedetti and Galileo to establish an Archimedean science of falling bodies through buoyant and resistant media, the scholastic mechanics of Blasius of Parma does not seem so backward'.

Sophie Roux deals with the way Galileo, his predecessors (Leonardo, Guidobaldo del Monte, Baldi) and Torricelli approached the problem of percussion – the hammering of nails into wood, of sheet piles into the ground, etc. Even today, the reviewer remembers from having taught building engineers' physics, such problems can only be treated semi-empirically, by means of an adaptable model for the behaviour of the receiving medium; at a moment when the preferred mathematical tool was proportion theory, even Descartes' rule $v(m_1+m_2) = v_1m_1+v_2m_2$ could not be expressed. The usual approach (not that of Leonardo, who proposed semi-empirical methods) was to think in terms of the simple machines of Hero, Pappus and the (ps.-)Aristotelian *Mechanics* (and thus ultimately of the lever) and to ascribe (in the paradigmatic case of vertical percussion) to the falling body an extra 'acquired weight', whose ratio to the 'natural weight' was to be found. This (with more explicit reference to the machine model) was also Galileo's approach in *Le mechaniche*, which however only leads to a promise to elucidate the matter in another treatise that never saw the light. In the 'Sixth day' intended to be added to the *Discorsi*, an ingenious real experiment, together with a thought experiment, lead Galileo to conclude that the force of percussion is 'infinite, or rather indeterminate and indeterminable' and thus not reducible to an equivalent weight (an unpublished experiment related by Torricelli confirms the conclusion very directly). He then tries an analogy with the infinitely repeated 'impression of force' in a free fall, which merely leads him to the problem (which he tries to explain away) that the actual effect of a percussion does not seem to be infinite. Torricelli, when taking up the idea in a series of lectures for the literary *Accademia della Crusca*, tries a solution which contradicts Galileo's fundamental insight in the law of free fall (a contradiction he may not have noticed). He saves himself with an unsubstantiated reference to Cavalieri; as observed by Roux, mathematics has taken over from physics and rhetoric from mathematics.

Samuel Gessner's concluding paper approaches the relation between architecture and mathematics through Daniele Barbaro's commentary (1556/67) to Vitruvius, which proclaims the importance of mathematics for architecture as the criterion determining its being 'scientific' and 'liberal'. Gessner examines whether the amount of mathematics really used in the core part of the commentary (that is, leaving aside hydraulics, gnomonics and machines, also dealt with by Vitruvius, and concentrating on building) really justifies this claim, and finds very little: in only two passages of book III are mathematical arguments applied to architectonic questions by Barbaro: a discussion of the just proportions of the *eustylos* colonnade, which serves as a pretext to introduce the Boëthian names for ratios and other pieces of elementary proportion theory, which however do not serve much in the unconvincing discussion (nor elsewhere in the commentary); and when he 'saves the letters' of Vitruvius opaque explanation of how to make the dimension sketch for the volute of a columnar capital – that is, to interpret Vitruvius's words as referring to a geometric construction that justifies Palladio's way to make this sketch. In both cases, as summarized by Gessner, mathematics is not applied to building practice but to the theory of architecture. Asking in the end whether the references to the importance of mathematics are mere commonplaces corresponding to what certain readers would expect from the genre, Gessner proposes as an alternative that Barbaro's view of the role of mathematics in architecture might be more sincere, but the commentary genre not apt to bring this view to fruition.

All essays are thoroughly argued from primary texts. They do not produce a unified picture, but apart from the interest each one offers by itself, the totality is a useful reminder that 'mathematics *and* understanding of the real world' is a question with more facets than the mathematization *of* this understanding.

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