nomical treatises in the Middle Ages included a full cycle of constellation illustrations as well as a celestial map and planetary diagrams. Most illuminated manuscripts were quite labor-intensive and extremely costly to produce when considering the cost of parchment, precious minerals and plant substance for paints, and sheets of gold for enhancements. Of course, the more elaborate the manuscript presentation, the better were its chances for survival. In contrast astronomical manuscripts did not require precious minerals or costly pigments but were still a product requiring significant material and human resources.

Although by far the most popular astronomical treatise in the later Middle Ages, the *de Sphaera* of Sacrobosco (ca. 1195–1244), the English monk, scholar and astronomer, does not appear in this work. His composition was one of the most influential and widely-used textbooks throughout Europe for almost 500 years, remaining popular until its astronomical information became outmoded at the start of the scientific revolution in the seventeenth century, but his manuscripts do not include an illustrated constellation cycle. Sacrobosco's surviving texts are often embellished with astronomical diagrams that helped to clarify his descriptions of solar, lunar and planetary motions; hundreds of medieval manuscripts of Sacrobosco's *de Sphaera* survive, but they are not included.

Among the essays published in this book is a discussion and partial explanation of an outburst of production of illuminated manuscripts containing the Aratea of Germanicus in the fifteenth century. They reveal a fascinating story of an early Germanicus manuscript that had been discovered in Sicily between 1465 and 1467 which was transferred directly to the Kingdom of Naples where King Ferdinand d'Aragon (or Ferrante) then reigned after a contentious takeover by his father Alfonso d'Aragon. A document survives that demonstrates that the ancient astronomical manuscript was copied there almost immediately, in either 1467 or 1468; it was copied at least three more times by humanist scholars and scribes at the court of Naples. A copy of this Germanicus manuscript was then taken to Florence where it was reproduced for the Medici court, Francesco Sassetti and for Frederico da Montefeltro. Unfortunately the original 'newly discovered' manuscript is now lost, but text scholars have determined that it was based on a manuscript now in Madrid, which itself had an earlier exemplar. Thus the twelfth century manuscript was regarded as an extraordinary find, leading to antiquity; it was reproduced multiple times, accounting for many of the twenty-six Germanicus Aratea surviving from the fifteenth century. The explosion of illuminated astronomical manuscripts during the fifteenth century Italian Renaissance was also inspired in part by the rise of humanism.

This set of volumes encompasses the highest peak of medieval manuscript production as well as its conclusion, for the appearance of less-expensive printed books initiated the elimination of those handmade. *Sternbilder des Mittelalters* … provides new and invaluable research assistance for scholars investigating not only the transmission of medieval astronomy and astrology, but also mythology, classicism, history, historiography, education, science and medicine. The authors will be greatly thanked for their efforts many times over.

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### ***The Complex Itinerary of Leibniz's Planetary Theory* by Paulo Bussotti (Birkhauser/ Springer, 2015; Science Networks Historical Studies 52). Pp. x + 188. ISBN 978-3-319-21236-4 (hardback), 240 x 163 mm, €103.99.**

This informative study provides illuminating new insight into an otherwise somewhat dark corner of Leibniz's physical theory.

Leibniz had no problem with the mathematics of Newtonian planetary theory. But he was dissatisfied with its metaphysics. For Newtonian gravitation was at odds with his own conception of the fundamentals of natural philosophy. And so Leibniz wanted a planetary theory very different from Newton's. Along with many other contemporaries he was committed to the idea that all explanation of the processes of physical nature must proceed on mechanical principles. He rejected gravitation and action at a distance because he saw it as fundamentally at odds with his Law of continuity. Accordingly he, like Descartes and others before him, wanted to explain the phenomena of planetary theory by means of vortex theory. This led him to a Kepler-inspired process of 'harmonic circulation' (*circulatio harmonica*). As Leibniz worked out the mathematics needed to implement these physical interactions he developed a neo-Keplerian planetary physics whose 'complex itinerary' is set out by Bussotti with great detail and in close coordination with the Leibnizian texts and with extensive heed of the relevant literature.

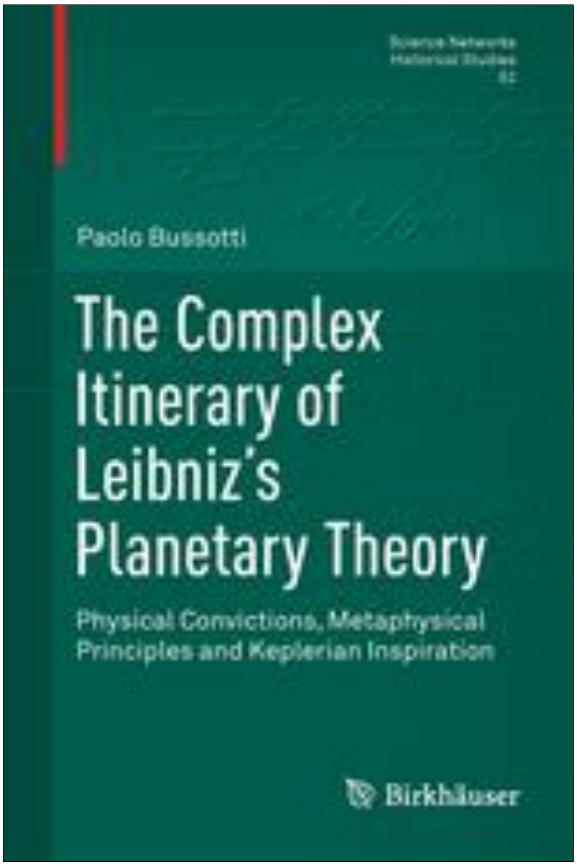
As Bussotti sees it, when Leibniz worked out his theory of planetary motion in the so-called *zweite Bearbeitung*, this led him to maintain: "(1) that 'harmonic circulation' is due to a [global] aether spread throughout the whole solar system; (2) Gravity on earth is due to the [local] aether surrounding our planet. And there are two possible hypotheses as to how gravity acts [viz. either by a 'radiation' due to an expansive impetus (*conatus explosivus*) or by a centrifugal force of an aetherial fluid]; (3) the difference between the specific weights of materials is due to yet a third aetherial fluid, more tenuous than the second [local] one, which, in its turn; is yet more tenuous than that [global] aetherial fluid responsible for harmonic circulation." (Bussotti, p. 98).

The cogency of its mathematical articulation does not altogether compensate for the physical cumbersomeness of Leibniz's planetary mechanics. Why was Leibniz willing to pay this price?

As Bussotti sees it, "… if action at a distance were true, the whole metaphysics of Leibniz would collapse, and not only his physics." (p. 152). Bussotti's reasoning to this conclusion is left somewhere between obscure and missing. But I think it can be supplied. Leibniz and Kepler alike were both influenced by and deeply sympathetic to a neo-Platonic view of cosmic order and harmony which included a commitment to principles like harmony, continuity, and economy. Now contact interaction can be accounted for lawfully via action/reaction, continuity conservation of energy etc. But if there were action at a distance, no reason could be given why it should take this form or that (inverse square rather than inverse cube). And this would violate the most fundamental principle of Leibnizian metaphysics: the Principle of Sufficient Reason.

In the end, Leibniz is prepared to accept the cumbersomeness of his aether-based cosmology because for him the complexity of nature's phenomena (of process) can be more than offset by the elegance of nature's laws (of processuality).

What Bussotti has given us is a highly instructive example of the interplay of technical science and theoretical metaphysics in the rare case of a thinker who was a master-mind in both domains.




In concluding, I give reluctant voice to one minor caveat. It would have been good to have a native English speaker go over the text. Such a helper would have revised such passages as "… the inertia principle in his theory is a significant subject to catch the features of Leibniz's physics, inside which planetary theory is inscribed." (p 32). It is regrettable to have such avoidable infelicities mar so excellent a work of scholarship.

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