had focused on Galileo. Édouard Mehl contributes a paper on Kepler's failed search for annual stellar parallax in his noble efforts to publicly oppose theology's ongoing penchant to restrict the search for truth. Finally, Rienk Vermij and Steven Vanden Broecke, respectively, discuss the post-1616 Copernican debates in the Dutch Republic and in Paris.

Summing up, the nine authors have provided rich scholarly accounts of many intricate dimensions of the conceptual maelstrom that enveloped the Copernican works, and which, in some lasting ways, silenced Galileo.

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***Arithmetic in the Thought of Gerbert of Aurillac*, by Marek Otisk. (Berlin, Peter Lang, 2022). Pp. 242. ISBN 978-3-631-85816-5 (hardback), 150 × 215 mm, US$56.95.**

If you are not familiar with the name Gerbert of Aurillac (946–1003), you may know him by the name he took in the year 999 when he became Pope Sylvester II. As the year 1000 is generally taken as marking the beginning of the High Middle Ages, most of Gerbert's life was spent in the Early Middle Ages, more popularly termed the Dark Ages. Far from being dark, Gerbert's life was filled with knowledge of the musical arts and mathematics, which was just then being transformed by the use of Arabic numerals.

This book is Volume 10 in the Philosophy and Cultural Studies Revisited series by the publisher Peter Lang. It is by Marek Otisk, Professor of Philosophy at the University of Ostrava in the Czech Republic.

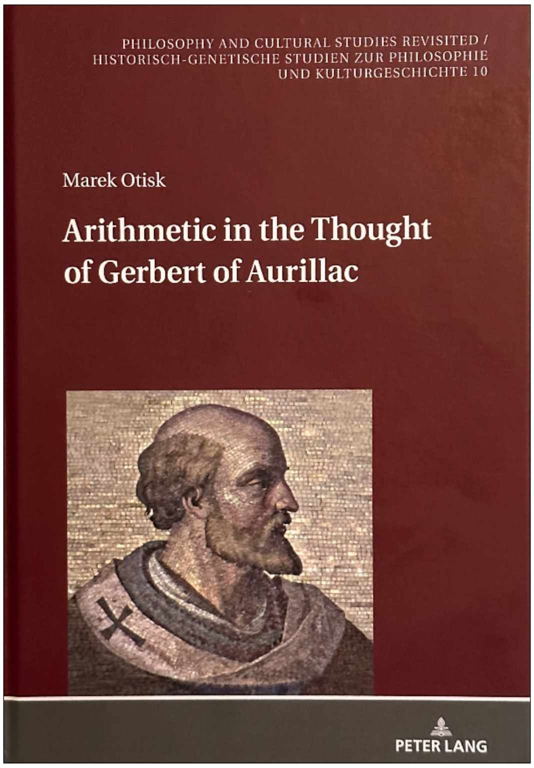
In 970, Gerbert met Pope John XIII, and later the Holy Roman Emperor Otto I, and

> Both were attracted to his knowledge of music and astronomy, as neither of these sciences was deeply developed in Christian Europe at this time. (p. 70).

This book looks closely at the arithmetical knowledge of Gerbert which was closely linked to his interest in music, as "… music is concerned with the relative properties of a number, i.e. numerical ratios." (p. 70). Gerbert's commentaries on *Introduction to Music* by Boethius (died 524 CE) influenced other scholars; for Marchetto of Padua, Otisk writes

> Proportional mathematical foundations (the determining aspect of music) form the order of the universe, cosmos and humankind. (p. 80).

In the early Middle Ages mathematics was "… situated at the centre of theoretical philosophy." (p. 19). It was placed there by the leading early Medieval authority on the subject, Boethius, and "Without arithmetic, Boethius writes, there could be no geometry, music, astronomy or any other kind of human knowledge at all." (p. 21). He associated astronomy with 'magnitudes in motion.' This is the framework within which Gerbert worked five centuries later.



Perhaps surprisingly, letters that Gerbert wrote to a monk named Constantine of Fleury are still extant. In a text written around the year 979,

> Gerbert attempts to clarify a process, not fully explained by Boethius, in which unequal ratios between numbers are converted to equality and identity. (p. 35).

Aside from Boethius, the other major influence on Gerbert was the early fifth century polymath Martianus Capella. In addition to elucidating one of the three definitions of numbers that Otisk surveys in his Introduction, his allegorical compendium of the Seven Liberal Arts still set the agenda five centuries later:

> During Gerbert's times, the practical approach to geometry was dominant, as described by Capella … Geometry describes celestial phenomena and the orbits of the heavenly bodies; hence it is also cosmography. (p. 59).

Additionally, Otisk delves into the work of Gerbert's contemporary Abbo of Fleury, who was bold enough to discuss cosmological origins. According to Abbo,

> In the beginning there could not have existed anything other than a unit, which is the principle and origin of all numbers. In addition, as it has no parts, it is therefore identical to being and necessity, and thus it is the divine foundation of the universe. (p. 42).

All this feeds into Gerbert's worldview. In a letter, "… he explicitly states that he wishes to follow in the footsteps of Cicero, and combine usefulness with nobility." (p. 82). This explains his approach to astronomy, "… a field that Gerbert's intellectual renown is deeply tied to." (ibid.). Rather than taking a theoretical approach, as we might have expected him to do with just arithmetic, he chose "… the applied aspects of this discipline." (ibid.). On that choice rests the action he is most famous for, before he ascended to the papacy: Gerbert re-introduced the astrolabe in the Latin West.

As a teacher in Reims, he employed a celestial globe, an observational hemisphere and two armillary spheres, some of which he constructed himself. As

> … they are supposed to represent the movement of stars, planets, or the Sun in the sky, we may say that these aids acted as a complete introduction to astronomy. (p. 83).

Otisk suggests that Gerbert's approach to astronomy derived from his studies in Catalonia, a centre of Arabic astronomical teaching. He also posits that Gerbert had at hand a treatise on astronomy by Boethius, which has not survived; other sources would have been the ancient authors Pliny, Hyginus and Manilius (who created the numerical stellar magnitude system).

Otisk actually "… reconstitutes the specific framework for a Latin introduction to geocentric astronomy, as presented by Gerbert." (p. 85). This forms the core of the book, and much of it based not on speculation but on letters Gerbert wrote. In response to a letter asking for the principles necessary for timekeeping, Gerbert created horological tables (given on page 105) for two locations, one where daylight lasts for 15 hours, the other for 18 hours. This takes Otisk into an extended discussion of the dual definitions of an hour, the five divisions of the Earth that were understood in the tenth century, and why Gerbert chose those two locations.

With the celestial globe, Gerbert showed his students that different stars could be seen from various locations:

> Such practical application of the globe is very surprising, since night sky observations and horizon modifications according to the place of observation were unknown in contemporary Latin Europe. (p. 91).

The author tells us Gerbert conducted regular observations of the night sky, and he primarily used the astrolabe as a device to measure time. The actual construction of the 'observational hemisphere' is described in an extant letter by Gerbert, and is examined in detail by the author:

> It is beyond doubt that anybody could use this observational hemisphere to see where a specific star or a constellation was located at any particular moment and place it in accordance with its equatorial coordinates. (p. 97).

Gerbert also created, with the help of a shield manufacturer, an abacus to teach geometry; 50 pages of the book are devoted to the abacus. Since this is a small-format book, the presentation of figures is sometimes problematic. Numbers and letters on such things as a board game (p. 54), The Bern abacus (p. 139) and the Oxford abacus (p. 147), are so small or faint as to be unreadable. The use of a magnifying glass merely reveals that the print, which I estimate to be in 4pt type or even less, is too blurry to distinguish what is there. The figures needed a rotation of 90° and printed full page. However, most of the tabular data and diagrams are just fine. The text is replete with more than 450 footnotes, a 27-page bibliography, an Index locorum and dual Indexes of personal names both before and after 1700.

This is a book of great importance for our understanding of early Medieval astronomy.

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***William Herschel: Discoverer of the Deep Sky*, by Wolfgang Steinicke. (Norderstedt, Germany: Books on Demand, 2021). Pp. 568. ISBN 978-3-754-397374 (hardback), 210 × 297 mm, US$87.65.**

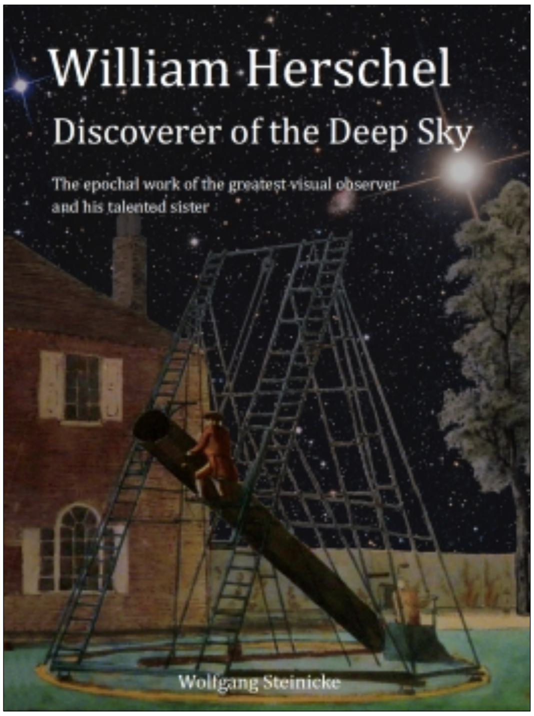
Over many years Dr Wolfgang Steinicke has been fascinated with the 'deep sky', meaning observing and studying faint objects requiring the best amateur equipment. This led him to write *Observing and Cataloguing Nebulae and Star Clusters: From Herschel to Dreyer's New General Catalogue* (Cambridge University Press, 2010). The present volume, weighing in at a whopping 3.6 kg with 568 glossy pages, is a labor of love describing major aspects of the observational career of William Herschel (1738–1822; hereafter WH), who, with his son John (1792–1871), first discovered most of the objects listed in the New General Catalogue (NGC, published in 1888). The book also discusses Caroline Herschel's (1750–1848) observations and her other contributions to WH's success.

The book has 374 Figures, 150 Tables, 1124 footnotes, and 14 very complete Indexes covering 50 pages. It is self-published and shows unfortunate evidence of same. Copy editing on the whole is substandard, including entire words missing. Citations and credits are often incomplete or absent, the most egregious example being the single statement that all historical images are "author's collection"! In many cases Steinicke cites secondary sources rather than the original, although he always does cite original sources with regard to astronomical observations (logbooks, compilations, etc. made by WH and Caroline). Non-standard English also frequently occurs, for example, wrong or missing prepositions. Sometimes this leads to ambiguity: what are we to make of: "The discovery of [the non-circularity of Uranus' image] is actually attributed to Herschel"? (p. 262).

The book's organization is clear and contains many notable 'extras'. For example, there are three valuable Appendices, covering: Visitors to the Herschel's home in Slough; WH's trips away from home; and a timeline of his life.

The strength of Steinicke's contribution to Herschelian scholarship is first in his painstaking analysis of the Royal Astronomical Society's archives containing original logbooks and data reductions for the many WH surveys of thousands of stars, star clusters, and nebulae. He then typically compares WH's results with modern images and other data for these same objects. Herschel's surveys were mostly conducted over several decades after he turned 40 and gave up his successful career as a musician.

Steinicke provides many insights into how exactly WH used his giant reflectors—especially his '20-foot' with its 19-inch (48-cm) speculum mirror—often with new diagrams. He also for the first time (Section 5.1) has thoroughly analyzed exactly how WH's



'sweeps' across the sky worked (previously always a puzzle to this reviewer). The basic sweep method was to keep the telescope in the meridian at a certain declination and let the sky sweep across his 15'-diameter field of view. He also continually 'nodded' the telescope up and down by ± ~1.0 degree (with the aid of a worker) so that effectively more sky could be covered in one night. This, however, meant that any new object was in view for a very short time, not long enough to shout out a short description to Caroline acting as recorder for the description, time, nearby reference stars, etc. Meanwhile, the sky kept steadily marching on and one thus invariably had gaps in sky coverage as WH interrupted the sweep to track the object for