

science, religion, and astronomy to better understand the depth and details of Carolingian intentions in producing the *Handbook of 809*. A fundamental problem that made the convening of the council necessary was the need to calculate time accurately throughout all areas of the empire. The intimate connection between art and science is discussed throughout the two parts of the publication which consists of two chapters in each part. Chapter 2 discusses the history of celestial iconography in general and the Drogo *Handbook* in particular. He takes a new look at early Frankish painting and the former classifications of various 'schools of manuscript production'. Chapter 3 investigates his thesis that teams of talented artists traveled through the Frankish area spreading their ideas and artistic styles while copying classic pagan astronomical scrolls and manuscripts and at the same time editing them into more acceptable Christian illustrated texts.

One of Ramirez-Weaver's intentions was to demonstrate how the traveling Carolingian artists and scribes were not mere copyists of classical exemplars but added their own creativity in the selection of textual material and inserted their own version of the illustrative traditions into Carolingian manuscripts. He presents examples where traditional constellation images included particular items and the *Handbook* images excluded them. But since few manuscripts from antiquity used as exemplars survive for comparison, we have no sure way of knowing that their choices were not directly copied from manuscripts. He also assumes that the traveling artists and scribes in the Frankish empire during the ninth century were that well educated and qualified, which is questionable: there is no assurance that these traveling artists and scribes were even fluent in Latin. Their main subject matter would certainly have been directed toward religious manuscripts, bibles, gospel books, psalters, and sacramentaries in which changes from Church dogma were forbidden. It is more probable that the educated composer or designer of the manuscript or head of the scriptorium dictated the final product, not the scribes and artists who were always considered craftsmen, not scientists. There is innovation in artistic styles among talented artists. Certainly, their skill in writing text and creating artwork varies with each person but it seems doubtful that they would make individual selections of astronomical script or illuminations; such changes would have been minimal. Unfortunately, we will never know who made the choices to eliminate offensive pagan imagery from antique models. The surviving astronomical manuscripts from the ninth-century published so far maintain the traditional depictions of Greek and Roman mythology seen in surviving frescoes, vases,

medals and statuary with no insertion of Christian iconography.

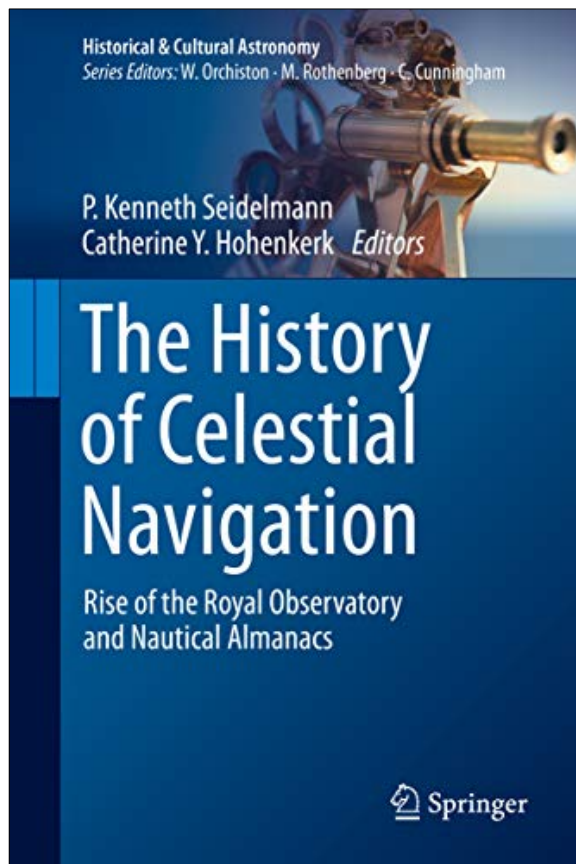
The final chapter of the study discusses the spiritual benefits derived from studying and understanding astronomy in the struggle for salvation and shows how Carolingians saw astronomy as 'a saving science', thus the chosen title. Accurate knowledge of the heavens served not only educational purposes for medieval readers but also liturgical purposes. Knowledge of the heavens was thought to bring one closer to God and his creation. He explains that through understanding the *Handbook of 809* we gain knowledge of early medieval conceptions of astronomy and its cultural implications. Costly illustrated astronomical manuscripts were not written merely to pass on their essential knowledge to future generations but acted as functional tools for educating clerics and to assist in the advancement of the developing Carolingian culture. The convoluted and opaque language of the book sometimes render his explanations too encumbered and less illuminating rather than elucidating the intentions of the medieval mind. Overall, the text is very well researched in its historiography and iconology and its images are of very high quality. Unfortunately, the study includes no details or discussion of the astronomical contents of the *Handbook* or the computus procedures or directions to clerics in determining the date of Easter. The inclusion of Carolingian astronomical innovations or perceptions would be helpful for historians of astronomy if the *Handbook* contains more than the standard works of Pliny, Bede and Macrobius. The astronomical material in the manuscript awaits further study. This is the first comprehensive study of Drogo's copy of the *Handbook of 809* and the result reveals that the manuscript is correctly considered an astronomical masterpiece.

Dr Marion Dolan
Independent Scholar
Deerfield Beach, Florida
Email: mdolan79@hotmail.com

***The History of Celestial Navigation: Rise of the Royal Observatory and Nautical Almanacs*, edited by P. Kenneth Seidelmann and Catherine Y. Hohenkerk. (Cham (Switzerland), Springer Nature, 2020). Pp. xvii + 332. ISBN 978-3-030-43630-8 (hardback), 155 × 235 mm, UK 109.99 pounds (also available as an e-book).**

As its somewhat cumbersome title suggests, this edited collection ranges over three related but distinct topics: the long history of celestial navigation, the astronomical observatory at

Greenwich, and nautical almanacs. Originally intended to commemorate the foundation of *The Nautical Almanac* by Nevil Maskelyne in 1767, just over 250 years ago, the project expanded, although remaining within largely Anglo-American constraints. For example, consideration of the important institutions in Berlin and Paris was excluded on the grounds that their information was not designed for navigators. Arranged chronologically, nine papers cover diverse topics, beginning in Babylon around five thousand years ago, and culminating in a prediction that the vulnerability of the Global Positioning System (GPS) will lead to a resurgence of computerised celestial navigation in the future.



The contributors are all distinguished in their fields, and they bring a great deal of experience as well as expertise to this book. Their papers are magnificently detailed, with extensive references to both the primary and the secondary literature, thus making each one stand independently as a valuable summary of its subject and a useful starting point for future research. At the same time, they have been editorially united by being identically structured in numbered sections with clear abstracts and conclusions, although they do vary greatly in length (from 12 pages to 76). Evidently instructed to assume no prior knowledge, the authors start with basic definitions, including explanations of the old dating system and the difference between treatises and tables. Intriguingly, at least three his-

torians draw contrasts between ephemerides and almanacs (on pages vi, 2, and 145–146), but they do not match each other (I infer that ephemerides are shorter but more technical).

The volume opens with a highly condensed but lavishly illustrated survey of astronomy's past, covering not only some familiar Greek innovations, but also systems developed by Chinese, Mayan, and Indian observers. Attention then shifts first to the foundation of the Greenwich Observatory and then to the controversies arising over the 1714 Longitude Act. Both these episodes have already been meticulously picked apart by multiple scholars, yet they take up well over a third of this new book.

It is only at this stage that *The Nautical Almanac* makes its appearance. A short account of Maskelyne's initiative is followed by a chapter on the nineteenth century that opens in Greenwich and then switches to Cambridge, Massachusetts, for the establishment of the American Nautical Almanac Office in 1849, which was partly motivated by a patriotic desire for independence from foreign countries. Following that turning-point, the story switches to computer-based methods and is inevitably more global, technical and packed with acronyms. Although the rest of the world does feature occasionally, the account of international cooperation conveniently glosses over any disputes, leaving the UK and the USA in charge. Yet a later chapter on computerised almanacs suggests that the path was not always smooth: one collaborator was praised for being willing to spend hours negotiating centre/center or metre/meter, but he obstinately refused to budge when it came to mathematical techniques (page 228).

Although there is no separate list, many of the illustrations are in full colour (including one of each author), a luxury that presumably contributes to the prohibitive cost of this edition. Unfortunately, portraits are treated as if they were passport photos rather than being in themselves political statements and thus sources of historical information. For instance, James II carefully advertised his military prowess by commissioning several versions of the image on page 70, which shows him fully armed and in uniform; and in Pierre Mignard's picture of Louise de Kéroualle (one among several lovers of Charles II; page 33), she has her arm round a small African girl who is paying tribute to this privileged European by offering her imperial treasures of pearls and coral. Such iconographic considerations might have helped to incorporate aspects of the current academic interest in globalisation.

Surprisingly, there is virtually no indication of the reasons for requiring increasingly accurate navigational skills. It would be easy to

gain the impression from these essays that patrons and practitioners were dedicated to the pursuit of pure knowledge. Readers are taken in fine detail through several sets of negotiations—the bitter disputes between Isaac Newton and his various adversaries, the manoeuvres of de Kéroualle at the English court—but apart from a passing reference to “... human cargoes ...” (page 106), there is no mention of commerce, warfare or colonial exploitation. The main challenge for winning the Longitude Prize involved sailing from Britain to the West Indies not because the Atlantic happened to be a suitably large body of water, but because that route formed one side of the trading triangle between the Americas, Europe and Africa. A modern parallel is though made clear: funds continue to pour into developing navigational techniques because the GPS signal is constantly under threat from deliberate sabotage.

The History of Celestial Navigation is a fine addition to Springer’s Historical & Cultural Astronomy series (edited by W. Orchiston, M. Rothenberg and C. Cunningham), providing authoritative discussions covering a diverse range of topics.

Dr Patricia Fara
Clare College, Cambridge, UK.
Email: Pf10006@cam.ac.uk

***Celestial Mirror: The Astronomical Observatories of Jai Singh II*, by Barry Perlus. (Yale University Press, New Haven and London, 2020). Pp. xvii + 147. ISBN 978-0-300-24627-8 (hardback), 235 × 275 mm, US \$50.**

If a picture is worth a thousand words, this is a million-word book. The fairly large format of this book is ideal for presenting a series of panoramic photos by author Barry Perlus, Associate Professor of Art at Cornell University. His subjects are the great seventeenth-century observatories built in northern India by a Maharajah named Jai Singh II (1688–1743).

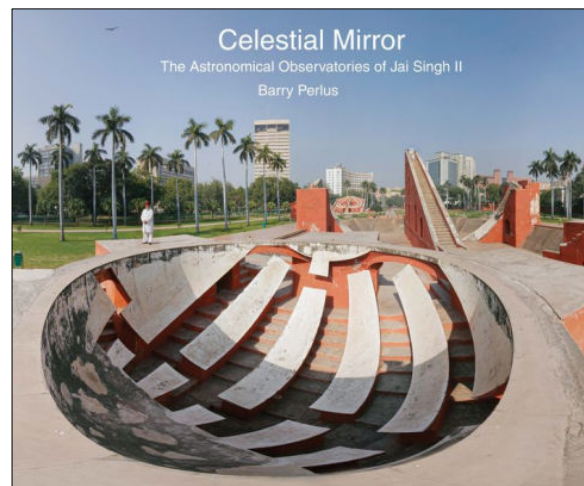
The first of his observatories, in Delhi, was finished in 1724; four others were built in the following 14 years. Of the five, four remain. The most famous are the ones in Delhi and Jaipur; the latter has several instruments not seen at the other sites.

These ‘instruments’ are in fact the most beautiful and evocative examples of outdoor astronomical instrumentation ever built. Even though the telescope had been in use for more than a century, Jai Singh decided to do things the ‘traditional’ way. These measuring instruments expanded the accuracy of the human eye by virtue of their size and precision manufacture.

In Delhi, for example, we find “... a pair of cylindrical structures open to the sky, each with a pillar at the center.” (page 36). It was used to measure the position of any object in the sky, day or night. The instruments have a diameter of 54 feet and a height of 25 feet.

In both Jaipur and Delhi we see the so-called “... king of instruments ...” (page 26), an equinoctial sundial whose gnomon rises 74 feet (22 m). “The marble surface,” writes Perlus, “is inscribed with multiple time scales, with the finest scale indicating intervals of 2 seconds.” (page 26).

Perlus identifies eight instruments at the observatories; each is allotted two or more pages of explanation, which transforms what would otherwise be a bewildering array of architectural fancies into real astronomical workhorses. What we don’t get are any descriptions of real observations, merely the tantalising tidbit that with his observatories Jai Singh and his coterie of observers were able to “... discern errors in the



Tabulae Astronomicae of the French Astronomer Phillip de la Hire.” (page xvi). A footnote tells us this refers to a solar eclipse seen in 1734, but one must hunt down the reference given to learn more (this is found in an introductory chapter by Anisha Shekhar Mukherji).

At Jaipur only, one can find a series of 12 instruments, each dedicated to one of the zodiacal constellations. “Mounted on each is a painting with a representation of the constellation it is based on.” (page 40). Unfortunately only one of these, Leo, is depicted. It would have been most interesting to know the intellectual source of these paintings; were they from Persian, Indian, European ideas of the constellations?

The real value of the book lies in its ‘spherical panoramas’, which Perlus took in 2001 and 2004, the culmination of 30 years of his photography at these sites. He notes with some awe that they incorporate “... astronomy, astrol-