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John M. Steele

Ancient Astronomical Observations and the Study of the Moon's Motion (1691–1757)

Springer

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To F. Richard Stephenson in honour of his pioneering work in the scientific use of ancient eclipse records

Preface

The end of the seventeenth and the first half of the eighteenth century witnessed a revival of interest in ancient astronomy among astronomers. The investigation of "secular accelerations" of heavenly bodies—gradual changes to their mean velocities—relied upon the comparison of ancient and contemporary observations. These secular accelerations are extremely small, changing the mean velocities of the moon and planets by only arcseconds per century, but their cumulative effect can be detected from even crude observations made over very long timescales. In order to examine the secular accelerations in detail astronomers were forced to use the small number of lunar, solar, and planetary observations made by ancient and medieval astronomers. Knowledge of the secular accelerations was important both for constructing accurate astronomical tables (of particular significance for the moon because of its use in longitude determination) and because the existence of secular accelerations provided a crucial test of the power of the gravitational theory in explaining the motion of heavenly bodies. But the historical astronomical observations available to the seventeenth- and eighteenth-century astronomers were few in number and of doubtful reliability.

Until the middle of the seventeenth century ancient astronomy was still a living tradition, understood in detail by most astronomers, even if its basic theories had been superseded by Kepler's new astronomy. But by the end of the seventeenth century, only 50 years later, ancient astronomy had become a foreign land: its methods all but forgotten except in the most general terms. The astronomers who needed to use ancient astronomical observations to investigate the secular accelerations were faced with the task of extracting the observations from the original texts, understanding how they were observed and the terminology used in recording them, evaluating their reliability, and developing a methodology for their use. This book investigates the use of ancient and medieval observations by astronomers to investigate the moon's secular acceleration during the period from about 1691 to 1757. Although the secular accelerations of Jupiter and Saturn were discovered somewhat earlier than that of the moon, the moon's secular acceleration was the most actively studied during the eighteenth century because of the greater number of ancient observations available, allowing the magnitude of the acceleration to be determined with greater confidence and precision. In a little under a decade starting in 1749, three estimates of the size of the moon's secular acceleration were published: first by Richard Dunthorne, then by Tobias Mayer, and finally by Jérôme Lalande. Mayer and Lalande are fairly well known to historians of science, but the same cannot be said of Dunthorne. He does not appear in the *Dictionary of Scientific Biography*, for example, and only short (and not fully accurate) biographies of him are given in the *Biographical Encyclopedia of Astronomers* and the *Dictionary of National Biography* (in order to rectify the lack of published information on Dunthorne's life, I have included a detailed biographical account in the beginning of chapter 7). Dunthorne, Mayer, and Lalande investigated the secular acceleration using largely the same historical data. They differed, however, in how they analysed the ancient and medieval observations, and, in particular, in the relative trust they placed in the different historical sources.

My aim in this book is twofold. First, I try to tell the story of how the secular acceleration of the moon was discovered, the reception of its discovery, and attempts to determine its size from historical data in the period up to about 1757. After this date, the study of the secular acceleration switched from investigating whether the acceleration existed and determining its size from the ancient data to attempting to account for the acceleration theoretically. Secondly, I attempt to address the wider question of how ancient and medieval astronomy was viewed in the eighteenth century. In particular, I investigate European perceptions of astronomy from different cultures: Ancient Greek, Arabic, Babylonian, and Chinese. It will be clear, for example, that biases against contemporary cultures in the far and near east influenced views of the ancient and medieval astronomy of those regions.

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Documents from the seventeenth and eighteenth century, both manuscript and print, are remarkable for their inconsistency in the use of personal and other names. Differences in spelling are common, as are the use of Latinized names alongside vernacular forms. These issues are even more apparent with attempts to render Arabic and Chinese into Latin script. Except within direct quotations, I have chosen to use the commonly accepted modern forms of names (for example, Delisle not De l'Isle, al-Battānī not Albategnius). In a few instances I have given both the transcription used at the time and the modern transcription in order to avoid confusion; this is particularly the case with the names of works in Chinese which, as rendered in the eighteenth century, may be hard for the non-specialist reader to identify with the modern Pinyin form (for example, 竹書 was transcribed by Gaubil as "Tchou chou" but is rendered in Pinyin "Zhushu").

Another complication in dealing with the eighteenth century is the use of different calendars in Great Britain and on the continent. Britain adopted the Gregorian calendar in 1752. "Old style" Julian dates were used prior to 1752 in which the year began on 25 March. Dates from 1 January to 24 March were usually accompanied by a double year number, for example 1750/1 meaning that the date was in the last part of the year 1750. Astronomical tables, however, always employed "new style" dates in which the year began on 1 January. I have retained "old style" dates for events in Britain. Dates relating to continental Europe, where the Gregorian calendar was adopted much earlier, and British dates after 1752 are given in the Gregorian calendar.

Unless otherwise noted all translations are my own.

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This book has its origin in an invitation to speak on the topic of the use of ancient eclipses in early studies of the moon's secular acceleration at the conference "Ptolemy in Perspective" organized by Alexander Jones and hosted by the California Institute of Technology in 2007. That I knew anything about this topic was due to F. Richard Stephenson, who supervised my PhD on ancient eclipse records at the University of Durham during the period 1995–1998. He first introduced me to the problem of the moon's secular acceleration and the variability in the Earth's rate of rotation, and encouraged me to explore the history of astronomy across a variety of cultures. In undertaking the research for this book I have been fortunate to be able to discuss aspects of it with many colleagues including the late John Britton (whose own study of Ptolemy and the history of the secular acceleration provided a framework for my own work), Steven Wepster (who generously pointed me towards the relevant manuscripts of Tobias Mayer), Alexander Jones, Noel Swerdlow, Jed Buchwald, and Len Berggren. I gratefully acknowledge the libraries and archives that have allowed me to consult and discuss books and manuscripts in their collections: the Museum of the History of Science, Oxford; the Niedersächische Staats- und Universitäts-Bibliothek, Göttingen; the University Library, Cambridge; the British Library; the Crawford Library, Royal Observatory in Edinburgh; the John

Hay Library, Brown University; Palace Green Library, University of Durham; the library of the Royal Society. I also wish to thank William S. Monroe for help reading work in eighteenth-century Dutch. Finally, my biggest thanks go to my wife Rebecca for her support during the writing of this book and her help reading tricky passages in French.

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