AUGUSTUS DE MORGAN, POLYMATH

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Karen Attar, Adrian Rice and Christopher Stray (eds), *Augustus De Morgan, Polymath: New Perspectives on his Life and Legacy*. Cambridge, UK: Open Book Publishers, 2024, https://doi.org/10.11647/OBP.0408

ISBN Paperback: 978-1-80511-326-3
ISBN Hardback: 978-1-80511-327-0
ISBN Digital (PDF): 978-1-80511-328-7
ISBN Digital eBook (EPUB): 978-1-80511-329-4
ISBN HTML: 978-1-80511-330-0
DOI: 10.11647/OBP.0408

Cover image: Portrait of Augustus De Morgan, in Sophia Elizabeth De Morgan, *Memoir of Augustus De Morgan (1882)*, https://commons.wikimedia.org/wiki/File:Augustus_De_Morgan_1850s.jpg. Background: Nico Baum, White round light on gray textile (2020), https://unsplash.com/photos/white-round-light-on-gray-textile-xZroI5V_dxc.
Cover design: Jeevanjot Kaur Nagpal.

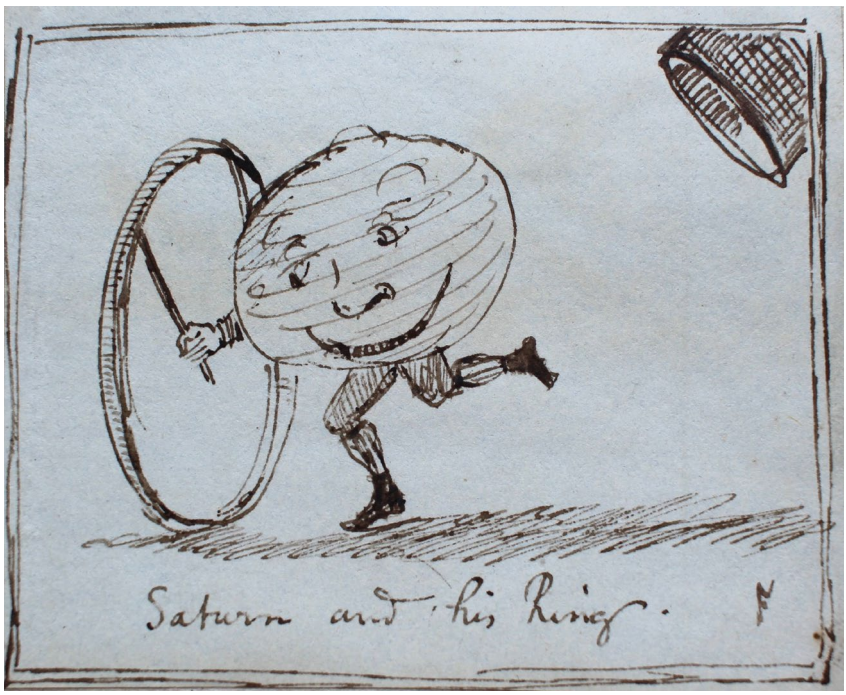

Fig. 5 De Morgan's personal copy of a volume containing his twelve biographies of eminent scientists, originally published in *The Gallery of Portraits: with Memoirs* (1833–37), features several witty and whimsical drawings, including this cartoon of 'Saturn and his Ring'—further evidence of his playful and somewhat eccentric sense of humour. (RAS MSS De Morgan 3, reproduced by permission of the Royal Astronomical Society Library and Archives.)

3. Augustus De Morgan, Astronomy and Almanacs

Daniel Belteki

> Astronomy signifies the *laws of the stars* . . .
> If we except general terms, such as *science*, there
> is perhaps no single word which implies so many
> and different employments of the human intellect.
>
> — Augustus De Morgan[1]

Introduction

How can an individual contribute to astronomy? Is it only by making observations of celestial bodies, or are there other means? Augustus De Morgan's contributions to astronomy raise precisely these questions. De Morgan never identified himself as an astronomer, and blindness in one eye rendered him unable to make reliable observations with astronomical instruments.[2] Yet he participated actively in the astronomical community during the mid-nineteenth century, becoming involved as Secretary of the Royal Astronomical Society in major events and controversies that shaped both British and international astronomical practice during the 1840s, and making himself through his

1 Augustus De Morgan, 'Astronomy', *Penny Cyclopaedia*, vol. 2 (London: Charles Knight, 1834), pp. 529–38 (p. 529).

2 Sophia Elizabeth De Morgan, *Memoir of Augustus De Morgan* (London: Longmans, Green, 1882), p. 5.

 https://doi.org/10.11647/OBP.0408.03

writings an authoritative 'expounder and historian' of astronomy and its instruments.[3]

Therefore, any examination of De Morgan's contributions to astronomy is best achieved not by counting the number of planets, comets or stars he discovered, but by analysing how he shaped the fabric of the astronomical community during the middle of the nineteenth century, and how he wove new and forgotten threads into the history of the field. This chapter revisits the origins of De Morgan's interest in astronomy and his close relationships with leading astronomers of the nineteenth century. It discusses his activities as a writer, arguing that while he raised awareness of history's forgotten and overlooked astronomers, his publications also reaffirmed the contemporary and historical boundaries of the astronomical community. Finally, it examines De Morgan's writings about calendrical reforms and an apparent paradox regarding the determination of the date of Easter, to demonstrate how he combined his interests in antiquarianism, ecclesiastical and legal history with his knowledge of mathematics and astronomy to participate in a debate of interest to the wider public.

Early Interest in Astronomy

Augustus De Morgan's interest in astronomy arose through his studies in mathematics. During the early part of the nineteenth century, astronomers began to place an increasing emphasis on the use of mathematics to solve astronomical problems. For instance, observations made by previous astronomers were recalculated on the basis of revised astronomical values with new mathematical techniques.[4] The discovery of the planet Neptune was seen as a culmination of the achievements of this new approach.[5] When De Morgan entered Trinity College, Cambridge

3 S.E. De Morgan, *Memoir*, p. 50.

4 David Aubin, Charlotte Bigg, and H. Otto Sibum, eds, *The Heavens on Earth: Observatories and Astronomy in Nineteenth-Century Science and Culture* (Durham and London: Duke University Press, 2010).

5 For an overview of the controversies surrounding the discovery of Neptune, see Robert W. Smith, 'The Cambridge Network in Action: The Discovery of Neptune', *Isis*, 80:3 (1989), 395–422; Nicholas Kollerstrom, 'An Hiatus in History: The British Claim for Neptune's Co-Prediction, 1845–1846: Part 1', *History of Science*, 44 (2006), 1–28.

in 1823, he was surrounded by men of science widely advocating such an approach. He counted among his teachers at least three such figures in George Peacock, William Whewell and George Airy. Peacock was a founding member of the Analytical Society devoted to reforming mathematics at Cambridge.[6] Whewell became the Master of Trinity College and remains known as a polymath due to his contributions to various fields of science.[7] Airy was appointed Astronomer Royal in 1835 and remained the director of the Royal Observatory at Greenwich until 1881.[8]

Although there is no clear evidence of De Morgan's engagement in astronomy during his years in Cambridge, his wife, Sophia Elizabeth De Morgan, recalled his exceptional knowledge of Eastern astronomy at the time of their first meeting in 1827.[9] The first major milestone in De Morgan's involvement in astronomical matters occurred in 1828, when he was elected a Fellow of the Royal Astronomical Society.[10] The Society had been founded only eight years earlier by individuals who were interested in the applications of the mathematical methods used in astronomy to matters of business. Its founding members promoted an 'astronomical book-keeping' reliant on the use of mathematics as it could be found in the offices of accountants and insurance companies.[11] This approach to astronomy through mathematics suited De Morgan. The community also welcomed De Morgan's mathematical investigations, as they were linked to the profit-seeking motive of the Society's members. Such interests were exemplified by the Society's successful efforts to shape the *Nautical Almanac*, a key publication for the purposes of navigation at sea (for example, for the shipping of goods) and for providing astronomical data to astronomers.

6 Kevin Lambert, 'A Natural History of Mathematics: George Peacock and the Making of English Algebra', *Isis*, 104 (2013), 278–302.

7 Richard Yeo, *Defining Science: William Whewell, Natural Knowledge and Public Debate in Early Victorian Britain* (Cambridge: Cambridge University Press, 2003).

8 Allan Chapman, 'Science and the Public Good: George Biddell Airy (1801–92) and the Concept of a Scientific Civil Servant', in *Science, Politics and the Public Good: Essays in Honour of Margaret Gowing*, ed. by Nicolaas A. Rupke (Basingstoke: Macmillan, 1988), pp. 36–62.

9 S.E. De Morgan, *Memoir*, p. 21.

10 At the time, it was still known as the Astronomical Society of London. The Society did not receive its royal charter until 1831.

11 William J. Ashworth, 'The Calculating Eye: Baily, Herschel, Babbage and the Business of Astronomy', *British Journal for the History of Science*, 27 (1994), 409–41.

Members of the Society included eminent men of science such as Francis Baily and John Herschel. Baily would later influence the development of De Morgan's interest in the history of astronomy.[12] Herschel, as well as becoming a lifelong friend and correspondent, would later recommend De Morgan for the presidency of the Society.[13] De Morgan's close acquaintances from his Cambridge years were also members of the Society. Richard Sheepshanks (a Trinity College graduate, a patron of the Cambridge Observatory and the son of a wealthy textile manufacturer) served as its Secretary. Airy was its president and received the Gold Medal of the Society for his various scientific achievements. Sophia De Morgan characterised the Airy-De Morgan-Sheepshanks triangle as an 'intimate friendship'.[14] The three men and their families frequently congregated at the Sheepshanks residence and spent the afternoons playing music together. Such encounters were initially easy to organise as Sheepshanks lived near De Morgan.[15] Recalling these visits, Sophia De Morgan wrote: 'All were fond of music, and Mrs. Airy's and her sister's ballads, sung with a spirit that gave them a character equal to Wilson's,[16] were sometimes accompanied by Mr. De Morgan's flute, and are still among my pleasantest remembrances'.[17]

12 Rebekah Higgitt, *Recreating Newton: Newtonian Biography and the Making of Nineteenth-Century History of Science* (London and New York: Routledge, 2015).

13 For an overview of John Herschel's life, see Stephen Case, *Making Stars Physical: The Astronomy of Sir John Herschel* (Pittsburgh: University of Pittsburgh Press, 2018).

14 S.E. De Morgan, *Memoir*, p. 48.

15 Unfortunately, Sheepshanks' personal correspondence is scattered around archival collections in small numbers. Sheepshanks is the most prolific correspondent in RAS MSS De Morgan at the Royal Astronomical Society, with 68 letters, 1842-1852 (RAS MSS De Morgan 1; subjects covered include, alongside matters discussed in this chapter, whether or not Maria Mitchell should be elected as an honorary member of the Society). Letters exchanged between Airy and De Morgan survive in the Royal Greenwich Observatory Archives at Cambridge University Library (see Chapter 11 of this volume). Another key source is De Morgan's correspondence with Herschel, held in the archives of the Royal Society (also discussed in Chapter 11). Together, these letters provide a window into the dynamic between core members of the Royal Astronomical Society.

16 This is probably a reference to John Wilson's *Cheerful Ayres or Ballads: First Composed for One Single Voice and Since Set for Three Voices*, first published in 1660.

17 S.E. De Morgan, *Memoir*, p. 47.

De Morgan as the Secretary of the Royal Astronomical Society

De Morgan was elected a member of the Council of the Royal Astronomical Society in 1830, and the following year he became its Honorary Secretary.[18] This position had been created in 1824 to assist the work of the Society's Secretary in the increased number of clerical duties.[19] As Honorary Secretary, De Morgan drew up documents relating to the Society's operations, arranged meetings, helped to edit the Society's two journals (*Monthly Notices of the Royal Astronomical Society* and *Memoirs of the Royal Astronomical Society*), corresponded with members, and edited—and in some cases also wrote—obituaries of its deceased fellows. Dreyer and Turner in their history of the Society even state that the detailed summaries of papers published in the *Monthly Notices* became the publication's characteristic feature through De Morgan's efforts.[20] In addition, his frequent interactions with the members of the Society enabled him to demonstrate his mathematical and tutoring skills. For example, the astronomer George Bishop (who would become President of the Society in 1857) even took lessons in algebra from De Morgan.[21]

As an active member of the Society, De Morgan became involved in various debates that rippled through the astronomical community during the mid-nineteenth century. An example of this was the infamous *Troughton & Simms* v. *South* court case, a legal battle and subsequent controversy which historian Michael Hoskin later labelled the 'Astronomers at War' saga.[22] It concerned the performance of a

18 S.E. De Morgan, *Memoir*, pp. 41–42. For De Morgan's correspondence in connection with this role, see London, Royal Astronomical Society, RAS Letters 1831–1866, De Morgan. These are mainly letters about forthcoming meetings and publications and are addressed to the Society's Assistant Secretary. Letters from De Morgan to other astronomers are included in other RAS MSS series, such as correspondence relating to the asteroid discoveries of John Russell Hind in RAS MSS Hind.

19 John Louis Emil Dreyer and Herbert Hall Turner, eds, *History of the Royal Astronomical Society 1820–1920* (London: Royal Astronomical Society and Wheldon & Wesley, 1923), p. 44.

20 Dreyer and Turner, p. 79.

21 S.E. De Morgan, *Memoir*, p. 49.

22 Michael Hoskin, 'Astronomers at War: South vs Sheepshanks', *Journal for the History of Astronomy*, 20 (1989), 175–212; Michael Hoskin, 'More on "South v.

telescope constructed by the instrument makers Troughton & Simms for the wealthy astronomer James South. South considered the performance of the telescope subpar, while the instrument makers argued that South did not allow the construction to be finished. The astronomical community (including members of the Royal Astronomical Society) was divided in its support for the two sides. Airy and Sheepshanks supported the instrument makers, while Charles Babbage came to the support of South. South lost the ensuing legal battle, which included a back-and-forth of letters and opinion pieces published in newspapers. The final decision in favour of Troughton & Simms did not calm the sensibilities of the losing side, and both Babbage and South continued their attacks in the ensuing years.[23]

In the decades-long conflict, De Morgan sided with his intimate friends, Airy and Sheepshanks. His association with them made him a target for the wrath of their opponents, most notably when South publicly demanded to know on what basis De Morgan had been elected a Fellow of the Society in the first place.[24] South explicitly asked the Assistant Secretary of the Society to see the letters of recommendation that had testified to De Morgan's contributions to the field and his suitability to be a member of the Society. This was a serious and potentially threatening development. As De Morgan neither made astronomical observations nor published scientific articles in the Society's journals, South was attacking De Morgan from a very delicate angle and questioning both the legitimacy of his role and the evaluations of the astronomers who had supported his election. Luckily for De Morgan, other members of the Society rallied round to dismiss the request, and it had no effect on his involvement within the Society nor with the astronomical community at large. Indeed, what South's futile attack ultimately demonstrated was how deeply De Morgan was embedded within the Society's core group, to the extent that accusations by his enemies failed to affect his reputation within it.

Sheepshanks"', *Journal for the History of Astronomy*, 22 (1991), 174–79; Anita McConnell, 'Astronomers at War: The Viewpoint of Troughton & Simms', *Journal for the History of Astronomy*, 25 (1994), 219–35.

23 Doron David Swade, *Calculation and Tabulation in the Nineteenth Century: Airy versus Babbage* (Unpublished Ph.D. Diss., University College London, 2003).

24 S.E. De Morgan, *Memoir*, pp. 63-64.

In addition to participating in debates, De Morgan was able through his active role in the Society to witness the impact of major astronomical discoveries at close quarters. One of these was the discovery of Neptune, which provoked a controversy about the circumstances surrounding the breakthrough.[25] Both Urbain Le Verrier and John Couch Adams worked on the challenge of predicting the path of a new planet. Le Verrier's calculations and predictions were verified in 1846. The British astronomical community later showed that Adams had sent similar predictions to Airy to be verified by observations but that Adams had failed to respond to Airy's follow-up letter, which had led to delays in the search for the planet. The ensuing debates pitted claims of national, personal and scientific interests against each other. De Morgan contributed to the discussion with two articles in the *Athenæum*, a weekly magazine aimed at a middle-class audience with a growing appetite for scientific news,[26] to which his friends, like Airy, also regularly contributed.

In De Morgan's first piece to the magazine about the new planet, he summarised a recent meeting of the Society, during which Airy had presented the chronology of his correspondence with Adams. Even at this early stage De Morgan predicted that the controversy surrounding the discovery would be discussed by future historians of science. In addition, he claimed that England missed out on the discovery because 'the mathematicians of this country had not faith enough in their own science'.[27] In his next article he defended Airy's scepticism about the possibility of a new planet on account of Adams's lack of response.[28] De Morgan further argued that as soon as Le Verrier communicated similar findings to Airy, the Astronomer Royal initiated the search for the planet precisely because of Adams's previous communications. De Morgan also defended the actions of James Challis (the director of the Cambridge University Observatory, who aided Adams's investigations)

25 See Smith, 'The Cambridge Network in Action'; Kollerstrom, 'An Hiatus in History'; Allan Chapman, 'Private Research and Public Duty: George Biddell Airy and the Search for Neptune', *Journal for the History of Astronomy*, 19 (1988), 121–39.

26 Susan Holland and Steven Miller, 'Science in the Early *Athenæum*: A Mirror of Crystallization', *Public Understanding of Science*, 6 (1997), 111–30.

27 Augustus De Morgan, 'The New Planet', *The Athenæum*, 21 November 1846, p. 1191.

28 Augustus De Morgan, 'The New Planet', *The Athenæum*, 5 December 1846, pp. 1245–46.

by claiming that Challis was in no position to give up his other duties and to devote his entire attention to Adams's claims. The article then lashed out at François Arago (the director of the Paris Observatory), who proposed naming the new planet Le Verrier without waiting for the Royal Astronomical Society to present the historical circumstances of the discovery. According to De Morgan, this demonstrated that Arago's judgement was 'subjected to his distorting mirror of national bias'.[29]

As Secretary of the Society, De Morgan's activity extended beyond participation in the debate to mediation of the discussions surrounding the award of the Society's Gold Medal for the discovery of Neptune.[30] Members faced a conundrum that arose from trying to acknowledge the contributions of both Le Verrier and Adams, even though Le Verrier could claim to be the first who made his discovery public. At a Council meeting of the Society in February 1847, in the absence of the required three-to-one majority during voting relating to the medal, no agreement was reached. Babbage (a supporter of South and a critic of the De Morgan-Airy-Sheepshanks triangle) was one of the majority who supported awarding the medal to Le Verrier only. He summarised the events in a letter sent to *The Times*,[31] claiming that there was a two-to-one majority in support of awarding the medal to Le Verrier: ten votes in support and five against (the five against including Airy). As a result, a motion by Airy was adopted after the vote, which called for an extraordinary meeting to discuss awarding two or more medals. Babbage submitted a letter to the extraordinary meeting (as he was unable to attend), which supported the Gold Medal being awarded to Le Verrier and an extraordinary medal awarded to Adams. However, his letter was not read out at the meeting. Somewhat surprisingly, Babbage's suggestion was not radical. Even Sheepshanks, despite his previous clashes with Babbage, supported a similar approach: Le Verrier should be awarded a medal first in the usual manner, and Adams could be awarded a medal decided on by a special meeting. In contrast, Airy argued that if no

29 Augustus De Morgan, 'The New Planet', *The Athenæum*, 5 December 1846, pp. 1245–46.

30 For a summary of the debates surrounding the awards, see S.E. De Morgan, *Memoir*, pp. 132–36.

31 Charles Babbage, 'The Planet Neptune and the Royal Astronomical Society's Medal', *The Times*, 15 March 1847, p. 5.

medals were awarded this time, then it would be impossible to award any medal in the future.

Ultimately though, it was De Morgan whose proposed solution was adopted. He stated that the established procedure for awarding a medal was to obtain a three-to-one majority at the relevant meeting of the Council. The consequence of failing to reach this threshold, he argued, should not be the creation of a new by-law (i.e. awarding extra medals), but rather a decision to refrain from awarding any medal. On the basis of this argument, the Society refused to award any medals, and decided to acknowledge the contributions of Le Verrier and Adams through testimonials instead.

That De Morgan's views directly influenced the steps taken by the Society reflected his integral role within it. It may be seen as a natural consequence that, parallel to the discovery of Neptune, discussions arose about the possibility of electing him as the President of the Society: discussions which clearly demonstrate that, despite not being a 'practical astronomer', he was held in high esteem and was seen as a fitting leader of the astronomical community. His refusal to take on the role shows that he continued to view himself as a non-practising astronomer, albeit as an active participant within the community. In a letter to another member of the Society, Captain William Smyth, De Morgan argued that only a 'practical astronomer' was suitable to become the president of the Society: 'the President must be a man of brass—a micrometer-monger, a telescope-twiddler, a star-stringer, a planet-poker, and a nebula-nabber'.[32] Similarly, in a letter to John Herschel, De Morgan described himself as 'a person who has never promoted astronomy otherwise than as promoting mathematics is indirectly doing so'.[33] At the same time, his refusal of the Presidency was motivated by his interest in promoting Herschel to the same role: he stated that he would only take on the role of Vice-President or Secretary if Herschel were willing to become President.

De Morgan also directed some of his prodigious energy to the Society's library. He volunteered his expertise in bibliography to assist with the arrangement and cataloguing of the Society's hitherto 'literally inaccessible' library, working with the Assistant Secretary, James Epps,

32 S.E. De Morgan, *Memoir*, pp. 153–54.
33 S.E. De Morgan, *Memoir*, p. 155.

on an eighty-five-page catalogue published in 1838.[34] And when the old Spitalfields Mathematical Society was dissolved in 1845, he co-signed the report on the absorption of its members and its library into the Royal Astronomical Society,[35] and supervised appraisal of incoming texts, as acknowledged by Assistant Secretary John Williams in a report of 1848.[36]

Given De Morgan's uncompromising stance on issues of importance to him, it is perhaps appropriate that his long period of service on the Society's Council came to an end over a matter of principle. In 1861, the wealthy amateur astronomer and philanthropist John Lee was elected President of the Society, and although De Morgan was not opposed to Lee's election per se, the manner in which he perceived it had been conducted, which departed somewhat from the usual conventions, was to him distasteful. And despite the fact that this same election saw him elected to the position of Vice-President, he declined to serve, promptly resigning as a member of the Council on which he had served for over three decades.[37]

The Astronomical Publications of Augustus De Morgan

De Morgan's publications on astronomy can be categorised into three distinct areas: articles on the history of astronomy and astronomers; reviews of published books on astronomy; and contributions to almanacs, particularly on matters relating to calendrical reckoning and the determination of the date of Easter.

History of Astronomy

In the first category, De Morgan's editorship of obituaries of deceased fellows of the Royal Astronomical Society, combined with his antiquarian interests, led him to write extensively about the lives of astronomers. In addition, his interest in the underdogs and forgotten contributors

34 *Catalogue of the Library of the Royal Astronomical Society* (London: printed by James Moyes, 1838). See Dreyer and Turner, p. 64.

35 London, Royal Astronomical Society, RAS Papers 37.

36 London, Royal Astronomical Society, RAS Papers 45.

37 De Morgan's lengthy letter of resignation is reproduced in full in the RAS minutes: see London, Royal Astronomical Society, RAS Papers 2.2 (Council minutes for March 1861). See also S.E. De Morgan, *Memoir*, pp. 272–77.

to the field led him to examine the lives of lesser-known individuals. Such texts were usually published as articles in the *Penny Cyclopaedia*, as contributions to biographical collections, and as obituaries in the *Monthly Notices of the Royal Astronomical Society*.

De Morgan's earliest writings about astronomy were written for the *Companion* to the *British Almanac*. These discussed the nature of eclipses (1832), comets (1833, 1835), and the moon's orbit (1834).[38] His desire to contribute to the dissemination of knowledge and to the education of the public is further demonstrated by his explanation of the *Maps of the Stars*.[39] Titled *An Explanation of the Gnomonic Projection of the Sphere* and published in 1836, this book devoted an entire chapter to the historical analysis of gnomonic projections, i.e. charts that depict the great circles of a sphere as straight lines.[40] De Morgan's work as the Secretary of the Royal Astronomical Society editing the detailed obituaries in *The Monthly Notices of the Royal Astronomical Society*, already noted, helped to shape his biographical research skills and widened his knowledge of the lives of astronomers. These obituaries still serve as essential starting points for historians of astronomy. De Morgan's most popular contributions relating to astronomy, however, were his large number of entries about astronomers and astronomical concepts for the *Penny Cyclopaedia*.[41] The entries bear witness to De Morgan's skills in historical research. They include entries on the various Astronomers Royal at the Royal Observatory, Greenwich (James Bradley, John Flamsteed, Edmond Halley, Nevil Maskelyne and John Pond). De Morgan also wrote the entry on the celebrated discoverer of the planet Uranus, William Herschel, and his entry on Jeremiah Horrocks contributed

38 These appeared in *The British Almanac of the Society for the Diffusion of Useful Knowledge* for the years 1832 to 1835. The relevant sections can be found in the part of the *Almanac* titled *The Companion to the Almanac; or Year-Book of General Information*.

39 Also published by the Society for the Diffusion of Useful Knowledge.

40 Augustus De Morgan, *An Explanation of the Gnomonic Projection of the Sphere* (London: Baldwin & Cradock, 1836). Great circles are the largest circles that can be drawn on a sphere. Such projections usually result in circular charts centred around a single point where the great circles intersect. Furthermore, only one hemisphere is depicted on such charts.

41 The *Penny Cyclopaedia* was also a publication of the Society for the Diffusion of Useful Knowledge. See Chapter 4 of this volume.

to efforts to raise the historical reputation of this relatively unknown seventeenth-century astronomer.[42]

Another strand of De Morgan's biographical research activities consisted of his contributions to *The Gallery of Portraits: with Memoirs*, published by Charles Knight between 1833 and 1837.[43] De Morgan wrote twelve 'portraits' in total about astronomers, mathematicians, and instrument makers for the publication: James Bradley, Jean-Baptiste Delambre, René Descartes, John Dollond, Leonard Euler, Edmond Halley, John Harrison, William Herschel, Joseph-Louis Lagrange, Pierre-Simon Laplace, Gottfried Leibniz and Nevil Maskelyne. The Royal Astronomical Society retains a collection of De Morgan's contributions bound together in a single volume, annotated by De Morgan, with additional information and corrections relating to the various mini-biographies.[44] While the style of most of the portraits in Knight's *Gallery* is dry, De Morgan's manuscript includes various cartoons illustrating events from the written accounts, which are characteristic of his sense of humour. The annotations exhibit his playful writing style, which is best showcased by his play on the word 'Uranus' ('you're an ass').

De Morgan's biographical research led him to analyse the life and work of Isaac Newton, following early-nineteenth-century efforts to examine Newton's life more critically than had previously been the case.[45] Francis Baily had pioneered this approach with a collection of texts about the life of John Flamsteed and his quarrel with Newton. A key point of the debate was Flamsteed's unwillingness to fund the publication of his observations, which meant limited access to the astronomical data he gathered. Although Newton helped to procure assistance from the Crown and the Royal Society to publish the results, he also altered the final publication in places without Flamsteed's consent. By showcasing part of the injustice done to Flamsteed, Baily's collection of texts was unflattering toward Newton. De Morgan wrote several accounts of

42 For a full list of his contributions to the *Penny Cyclopaedia*, see S.E. De Morgan, *Memoir*, pp. 407–14.

43 Sian Prosser, 'From the Collections: Illustrating Scientific Lives', *Astronomy & Geophysics*, 59 (2018), 4.11.

44 London, Royal Astronomical Society, MSS De Morgan 3.

45 For a more detailed discussion of De Morgan's contribution to the study of the life of Newton, see Adrian Rice, 'Augustus De Morgan: Historian of Science', *History of Science*, 34 (1996), 201–40; Higgitt, *Recreating Newton*.

Newton's life that followed Baily's critical approach, possibly influenced in his views (as Sophia De Morgan claimed) by his friendship with Baily.[46] He also aimed to demonstrate that there was a clear distinction between the image of Newton that survived and the Newton who lived at the time. This did not mean a devaluation of Newton's skills, talent, and contributions; instead, De Morgan argued that just because a person's work was highly valued, it did not immediately follow that his character was flawless.

As demonstrated by William Whewell's famous *History of the Inductive Sciences*, historical research based almost exclusively on secondary sources was considered perfectly acceptable at this time. But De Morgan and Baily shared an approach to historical research that emphasised a reliance on primary rather than secondary sources, thereby breaking from the established ways of examining the lives of astronomers and the history of astronomy. As Rebekah Higgitt has demonstrated, De Morgan was able to practise his writing in an intellectual community and among a circle of friends who shared the same approach towards collecting and consulting original sources.[47] Although De Morgan was not an ardent collector of letters and manuscripts, this antiquarian spirit was partly responsible for his accumulating a large collection of books.[48] Another factor was his willingness to write book reviews.

Athenæum Book Reviews

It is difficult to overstate the importance of *The Athenæum* in the nineteenth-century periodical world: established in 1828, it was the century's best-selling weekly, and its reviews were influential, renowned for their disinterestedness.[49] De Morgan was an avid book reviewer there, publishing anonymously almost one thousand reviews in *The Athenæum* over many years.[50] Many of the books he reviewed

46 Adrian Rice, 'Vindicating Leibniz in the Calculus Priority Dispute: The Role of Augustus De Morgan', in *The History of the History of Mathematics*, ed. by Benjamin Wardhaugh (Oxford: Lang, 2012), pp. 89–114.

47 Higgitt, *Recreating Newton*, pp. 106–10 and 116–24.

48 See Chapter 10 of this volume.

49 See Leslie A. Marchand, *The Athenæum: A Mirror of Victorian Culture* (Chapel Hill: University of North Carolina Press, 1941).

50 For an overview of the variety of subjects that De Morgan reviewed, see Sloan Evans Despeaux and Adrian C. Rice, 'Augustus De Morgan's Anonymous Reviews

were astronomical, and De Morgan used his reviews to reflect on the field and on its developments. Alongside major works within the field, the books reviewed included privately published volumes written by individuals unknown within the established astronomical community, thereby reflecting De Morgan's fascination with the contributions of 'underdogs' and individuals at the boundaries of the field. Mistakes in publications allowed him to exercise his playful writing style for his own enjoyment, and reviews became springboards for De Morgan to reflect upon more contemporary issues by criticising or praising the actions of astronomers that led to the publication of their books. His judgements of books ranged from scathing criticism, through simple summary, to genuine praise. A good example of the sharp edge of his critical style is the last line of his review of *A Theory of the Structure of the Sidereal Heavens*: 'as we cannot argue either for or against pure speculation, we stop here, wishing the author had expended his time, money, and very neat copper plates in something more likely to do him and others good.'[51]

De Morgan rarely engaged in detailed criticism of the content of the books, especially when reviewing observations published by observatories. In a review of the observations made at the Toronto Observatory he noted: 'it is not the province of our journal to enter upon the details of such a work'.[52] Instead, he gave a short description of the larger magnetic project in which the Observatory participated. Similarly, when the first volume of observations made at the Naval Observatory at Washington was published, De Morgan marked it as a historical moment in the development of astronomy: 'This is the first large volume of observations, that we have ever seen, emanating from a fixed observatory in the United States.'[53] Thereby, De Morgan used his reviews not only to reflect on the contents of books but also on the contexts of their production.

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for *The Athenæum*: A Mirror of a Victorian Mathematician', *Historia Mathematica*, 43 (2016), 148–71. A selection of his reviews from *The Athenæum* was later reproduced in Augustus De Morgan, *A Budget of Paradoxes* (London: Longmans, Green, 1872).

51 [Augustus De Morgan], Review of *A Theory of the Structure of the Sidereal Heavens*, *The Athenæum* (25 March 1843), p. 284.

52 [Augustus De Morgan], Review of *Toronto Magnetical and Meteorological Observations*, Vol. I. 1840–42, *The Athenæum* (5 April 1845), p. 332.

53 [Augustus De Morgan], Review of *Astronomical Observations made at the Naval Observatory*, Washington, *The Athenæum* (9 January 1847), p. 45.

As a historian of astronomy, De Morgan also found pleasure in noting mistakes and misconceptions about Newton in astronomical publications. In a review of *Astrology As It Is, Not As It Has Been Represented*, he remarked on the author's claim that Newton was an astrologer: 'this we never heard before, and we never found any trace of it in his writings. We hope the author will tell us how he makes this out'.[54] In another review, he mentioned the mistaken belief that 'Newton [had suppressed] the manuscript of the Principia for many years, lest the savans [of the Royal Society] should be offended', and noted the involvement of Halley and others in the publication of Newton's work.[55] And while his review of *The Wonders of Astronomy* was on the whole laudatory, he noted that '[i]t is startling to see that the law of gravitation was "revealed to Newton by the fall of an apple."'[56] These examples indicate how book reviews served partly as an outlet for De Morgan to engage in historical commentaries about the lives of scientific practitioners such as Newton.

The above-mentioned reviews were relatively short and were included within the 'Our Literary Table' section of the magazine devoted to brief reviews. In addition, De Morgan wrote substantial reviews of major publications within the field of astronomy. The focus of these reviews, several columns in length, was rarely the works themselves. A salient example was a review of John Herschel's astronomical observations made at the Cape of Good Hope from 1834 to 1838.[57] Herschel's project was to survey and catalogue the double stars and nebulae visible from the Cape. De Morgan's review began with an overview of Herschel's initial aims and how the project was an expansion of his father's (i.e. William Herschel's) research. It then explained how the younger Herschel had not intended to publish the observations separately but that the Duke of Northumberland had offered to fund their individual publication. De Morgan also gave a brief overview of the content and noted the minute

54 [Augustus De Morgan], Review of *Astrology as it is, not as it has been represented*, *The Athenæum* (14 February 1857), p. 213.

55 [Augustus De Morgan], Review of *The Solar System as it is, not as it is represented*, *The Athenæum* (18 July 1857), pp. 908–09.

56 [Augustus De Morgan], Review of *The Wonders of Astronomy*, *The Athenæum* (26 December 1846), p. 1324.

57 [Augustus De Morgan], Review of *Astronomical Observations…*, *The Athenæum* (21 August 1847), pp. 885–86.

descriptions of nebulae found in the volumes. He found the importance of the publication in its being a 'mass of observations, deductions, and results as has rarely appeared at one time from one individual'. In addition, he praised the 'undivided labour of twelve years' that yielded the work. In brief, the review functioned as an encomium in order to communicate to the readers the accomplishments of an astronomer. We see the same technique in De Morgan's review of Ormsby Mitchel's *The Planetary and Stellar Worlds*. The review began by praising Mitchel for being an excellent popular writer on astronomy, and for creating a work that has 'intrinsic merit [... in] the freshness of its illustrations and [...] newness of its language'.[58] The rest of the review retold the story of the establishment of the Cincinnati Observatory. De Morgan noted Mitchel's involvement in its founding, his visit to European observatories, subsequent financial troubles, and the fire that burnt down the Observatory, which resulted in Mitchel's transformation into an itinerant lecturer. De Morgan used this story to build up a half-joking and half-serious proposal that the Cincinnati Observatory should be renamed the Mitchel Observatory. These two reviews demonstrate how De Morgan used his lengthier articles to contextualise the circumstances of their production. In this light, his longer book reviews also served as commentaries on contemporary developments within the astronomical community.

Between 1849 and 1856, there is a gap in De Morgan's reviews on astronomy for *The Athenæum*, a lacuna arising at least partly (1850–1854) from a disagreement between De Morgan and the journal's editor from 1846 to 1853, Thomas Kibble Hervey. He returned in full force in 1856 with a long review of François Arago's *Popular Astronomy*. De Morgan laid out his somewhat sceptical opinion of Arago's achievements in the first paragraphs: 'there are men among the living and the dead who ought to stand far above Arago, but who have never attained any reputation even remotely approaching to the brilliancy and the universality of that obtained by him.'[59] This remark set the tone for the rest of the review. It examined Arago's 'social public character' as well

58 [Augustus De Morgan], Review of *The Planetary and Stellar Worlds*, *The Athenæum* (21 October 1848), pp. 1051–52.

59 [Augustus De Morgan,] Review of *Popular Astronomy*, *The Athenæum* (5 January 1856), pp. 5–6.

as his 'faculty of illustration, both in speaking and writing' as essential components for his rise to fame. De Morgan criticised Arago's book for making erroneous claims about history and about the discovery of Neptune. De Morgan's reaction was unsurprising, given that Arago had sought to exclude John Couch Adams from the claims for the discovery of the planet. Besides the Neptune controversy, De Morgan's friendship with the disgraced Italian mathematician, historian and bibliophile Guglielmo Libri must have also influenced the review, as Arago and Libri were 'implacable enemies'.[60] Nonetheless, the review considered the book to be a useful popular account of astronomy, stopping short at 'being fit to decide nice controversies from original research'.

The change in tone of the longer reviews from praise to criticism was also present in a piece that discussed a pamphlet by James South, in which South continued his attacks against many members of the British astronomical community.[61] The beginning of De Morgan's review brought the readers up to date with the events and introduced the main characters of the 'Astronomers at War' saga described above (Troughton & Simms, Sheepshanks, Airy, Babbage and South). It characterised South as a person who alienated all his friends by his conspiracy theories. It also offered an overview of how his previous attacks were rebutted. The rest of the review countered the allegations made in the pamphlet, which largely centred around an admission by Sheepshanks that during his younger years he had smuggled a foreign instrument into the country by engraving the name of an English instrument maker on it. De Morgan dismissed any criticism of such an act on the grounds that it was 'a thing frequently done' and that it took place in Sheepshanks' youth. Through this commentary we see De Morgan once again using his reviews less to reflect upon the content of the publications than to contextualise their productions and to express his own views on the relevant debates that they concerned.

In summary, De Morgan's reviews of astronomical books within the pages of *The Athenæum* show us three important points about his

60 Rebekah Higgitt, '"Newton dépossédé!" The British Response to the Pascal Forgeries of 1867', *British Journal for the History of Science*, 36 (2003), 437–53 (pp. 446–47).

61 [Augustus De Morgan], Review of *A Letter to the Fellows of the Royal and the Royal Astronomical Societies*, *The Athenæum* (26 April 1856), pp. 513–15.

involvement with astronomy. First, they reflect his interest in astronomy as a historian, as a communicator of recent developments, and also as an educator (in his criticism of poorly written textbooks and publications). Second, De Morgan used his reviews to communicate his opinion about astronomical controversies. Third, the reviews distinguished 'useful' books from books that contained many mistakes, and works that furthered astronomical knowledge from those that were purely speculative. Thereby, even if indirectly, he gave the impression of serving as a gatekeeper to the astronomical community. As Despeaux and Rice argued, 'De Morgan also used *The Athenæum* as a place to debunk fallacious claims made in mathematics and science'.[62] The extent to which his reviews influenced the views of the readers of *The Athenæum* and the members of the astronomical community remains difficult to measure. However, the publication provided the best possible outlet for De Morgan to reach 'the growing middle classes, an audience which had a growing thirst for science'.[63]

Calendrical Reckoning and the Date of Easter

De Morgan's work on calendars combined his varied interests in history, mathematics, astronomy, legal matters and theology. He exhibited this best in his analysis of the confusion relating to the date of Easter Day in 1845. He examined the history of the development of calendars, the mathematical calculations upon which they were based, the astronomical principles underpinning their construction and the history of such calendars being incorporated into ecclesiastical and state legislation.

The core of the debate arose in relation to the ecclesiastical calendar for the year 1845, which denoted 23 March 1845 as Easter Day. This resulted in the appearance of an apparent paradox in the calculation of Easter and confusion about the rules for determining the exact day upon which it should fall.[64] The general rule for finding Easter states that if the full moon that follows 21 March falls upon a Sunday, then Easter Sunday is the one following it. Yet in 1845, Easter Sunday was denoted as falling on a Sunday immediately after 21 March, which was also a

62 Despeaux and Rice, p. 162.
63 Holland and Miller, p. 112.
64 A. De Morgan, *Budget*, pp. 217–30.

full moon. Within the British context there were also further problems, as British law prescribed that the determination of Easter Day rested on the tables and rules provided by the church. Thereby, a mistake in the determination was not only an ecclesiastical issue, but also a legal one.

The problem of establishing the exact day of Easter was neither a new nor an unknown problem, nor was it confined to the annals of history. Mathematicians and astronomers had undertaken the task of solving the challenges posed by the question as recently as the beginning of the nineteenth century. For example, the German mathematician Carl Friedrich Gauss and the French mathematician-astronomer Jean-Baptiste Delambre had each developed their own algorithms for calculating the exact day of Easter.[65] Moreover, the same problem with the calendar had arisen in 1818. Although discussions about the correctness of the calendar had taken place in that year, De Morgan later called them 'useless'.[66]

De Morgan wrote about the issue for four different publications. His first statement appeared as a letter in *The Athenæum*.[67] The next was a detailed examination of the problem, which appeared in the *Companion to the British Almanac*.[68] This was followed by a second paper one year later in the same publication, which discussed the history of the earliest printed almanacs.[69] And, within his *Budget of Paradoxes*, he wrote a shorter account of the debate.[70] This was a re-edited version of his method for finding the date of Easter, which appeared in the *Book of Common Prayer* as published by the Ecclesiastical History Society in 1849.[71] The variety of publication venues once again reflects how De Morgan's varied interests were combined in the Easter question. *The Athenæum* was the publication where he acted as a gate-keeper to astronomical, mathematical and scientific knowledge, and in which

65 See Reinhold Bien, 'Gauss and Beyond: The Making of Easter Algorithms', *Archive for History of Exact Sciences*, 58 (2004), 439–52.
66 Augustus De Morgan, 'Easter-Day, 1845', *The Athenæum*, 13 July 1844, p. 646.
67 Augustus De Morgan, 'Easter-Day, 1845', p. 646.
68 Augustus De Morgan, 'On the Ecclesiastical Calendar', *Companion to the Almanac for 1845*, 1–36.
69 Augustus De Morgan, 'On the Earliest Printed Almanacs', *Companion to the Almanac for 1846*, 1–31.
70 A. De Morgan, *Budget*, pp. 217–30.
71 *The Book of Common Prayer*, vol. 1. (London: Ecclesiastical History Society, 1849), pp. 57–64.

his reviews and articles served as reflections on contemporary political matters. The inclusion of the detailed analysis in the *Companion of the British Almanac* showed it as a mathematical and historical problem that needed to be explained to the public. Finally, the inclusion of a summary of his writings in the *Book of Common Prayer* showcased his interest in ecclesiastical history.

De Morgan's answer to the Easter Day problem rested on his historical analysis of texts. He argued that the terms 'moon' and 'lunations' within the ecclesiastical documents did not relate to actual astronomical objects. Instead, he distinguished between the 'moon of the heavens' and the 'moon of the calendar'.[72] The 'moon of the calendar' was a 'mean' or 'fictitious moon', which closely resembled the movement of the real body, but never precisely replicated it.[73] Similarly, the full moon referenced in ecclesiastical texts to define Easter Day was derived from the mean or fictitious moon rather than the movement of the real body.[74] De Morgan claimed that the lack of clarification about these distinctions was one of the chief causes of the apparent Easter Day paradox. In addition, there was the problem of nomenclature relating to the full moon. The term gradually replaced the wording used by the original makers of the rule for determining Easter: 'fourteenth day of the moon'.[75] The problem was complicated further in Britain, as an Act of Parliament adopted (with a few changes) the definitions provided by the Roman Catholic Church for determining Easter Day. In particular, the Act did not clarify that the term 'moon' in its text refers not to the real body but to the mean moon. The same Act similarly used the term 'full moon' without any explanation that it refers to 'the fourteenth day from the day of the new moon inclusive'.[76]

After explaining the history and the sources of common misconceptions about determining the day of Easter, De Morgan provided the reader with a step-by-step guide to find the exact day of Easter for any given year. For the sake of completeness, he not only provided it for the Gregorian calendar but also for the Julian calendar to illustrate the

72 A. De Morgan, 'Easter-Day, 1845'.
73 This same fictitious motion was reflected by clock time during De Morgan's life. A. De Morgan, *Budget*, pp. 217, 221.
74 A. De Morgan, *Budget*, pp. 217, 221.
75 De Morgan, 'Easter-Day, 1845'.
76 A. De Morgan, 'On the Ecclesiastical Calendar', p. 3.

different results and methods required for the two calendrical systems. Ultimately, the problem of finding Easter never left De Morgan's mind, and he eventually published a separate booklet on how to ascertain Easter Day.[77] This work, *The Book of Almanacs*, allowed its users to convert days between the Gregorian and Julian calendars between the years 1582 and 2000. More importantly, it enabled its readers to find out the days of full moon and new moon in both calendars. The preface also stated that the publication was intended for the use of almanac constructors rather than for the general public. Thus, it was a publication created for a specialist audience as opposed to his other writings about the date of Easter Day, which were communicated in a form accessible to a more general audience. In brief, De Morgan's involvement with the Easter Day question demonstrated how he applied his skills to everyday problems that incorporated aspects of various subjects that he enjoyed and in which he actively engaged.

A Mathematician Among Astronomers

De Morgan matched the intellectual astronomical spirit of the times. His interest in the subject arose through his love of mathematics, and in the Royal Astronomical Society he found a community of astronomers who promoted 'astronomical book-keeping' and thereby acknowledged the value of De Morgan's mathematical skills. Sheer administrative hard work as Secretary of the Society and dutiful editorship of its publications combined with his high intellect to bolster his legacy.

Moving beyond the realm of the Society, this chapter has also shed light on De Morgan's activities as a historian of astronomy and as a reviewer of astronomical books. As a historian of astronomy, he was among the leaders in the field, while as a prolific reviewer of astronomical books in a major periodical, he guided thought. De Morgan combined his interest in astronomy with his love of mathematics and of history to analyse contemporary debates relating to the determination of the date of Easter. At the very beginning, we asked how someone could contribute to astronomy without making a single telescopic observation—and this

77 Augustus De Morgan, *The Book of Almanacs* (London: Taylor, Walton, & Maberly, 1851).

chapter provides an answer. For De Morgan demonstrated that such contributions were possible by weaving his academic interests into the activities and publications of practising astronomers, promoting and publicising the discipline to a general audience, while at the same time upholding and maintaining the fabric of the astronomical community.[78]

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78 Thanks are due to Sian Prosser and Jane Trodd for contributing archival information and references to this chapter.

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