The Life and Work of James Bradley: The New Foundations of 18th Century Astronomy, by John Fisher (Oxford University Press), 2023. Pp. 531, 24 × 16 cm. Price £ 83 (hardbound; ISBN 978 0 19 888420 0).

James Bradley was the third Astronomer Royal, following John Flamsteed and Edmond Halley but, despite his achievements — including discovery of aberration and nutation — and widespread recognition in his own life-time, is not as well known today. In comparison with his predecessors, he has been neglected by biographers, so this comprehensive biography by John Fisher is very welcome. His *Life and Work of James Bradley* is embedded in context: astronomical and social, especially networking and patronage. It was an exciting time for astronomy: Rømer had shown that the speed of light was finite, but annual parallaxes in confirmation of the heliocentric system had yet to be convincingly demonstrated. In Chapter 1, Fisher covers the work and tribulations of Flamsteed, as a comparison and contrast with Bradley. Bradley's own introduction to astronomy was *via* his maternal uncle, James Pound, who took him under his wing. Pound's influence on Bradley's career was so significant that Chapter 2 is devoted to his activities prior to taking on his nephew. Pound had entered the service of the English East India Company as a chaplain and had, over a few years, sailed between various company stations in the South China Sea. He was also a skilled astronomer and was provided with a quadrant by Flamsteed to make observations for him. At some time in 1702–03, Pound was posted to the island settlement of Pulo Condore, close to the mouth of the Mekong Delta. There he took up residence in a wooden dwelling situated about 400 yards outside the fortified settlement — which was fortuitous because this saved his life during the massacre which took place in the settlement on the night of 1705 March 3. According to Fisher, the best account of the massacre is that given by Pound in his letter to the Court of Managers of the Company. Along with 14 others, he escaped on a sloop and after a harrowing voyage reached Batavia. Pound returned to England in 1706 July and a year later was offered the lucrative living of Wanstead, near London.

In 1711, James Bradley took up residence with Pound and entered Oxford University in preparation for a career in the Church of England, as desired by his father. He also began assisting Pound in his astronomical observations. From examination of the Wanstead observing books, Fisher shows that Bradley's first recorded observation in 1715 indicated that he had by then become a very capable observer. Bradley's day-to-day observing record is included in the detailed, often day-by-day, chronology of his life and work presented in Appendix 1. This chronology includes a great deal more information, making it a valuable resource. Many of the observations were of the Galilean satellites of Jupiter on behalf of Halley, who had become his mentor. Bradley was eventually given the credit for the observations when they were published by Bevis in 1752, but we are not given a reference for this. Nor is a reference given for the tables for Jupiter's satellites published by Hodgson in 1749 which "studiously avoided all mention of Bradley" (p. 94). This is unfortunate. It would have been interesting to read — or find out using the references — how the observations compared. Fisher returns briefly to the satellites on pp. 150–151, reporting Bradley's recognition that the three inner satellites were interacting gravitationally with one another, effectively laying the ground for the Laplace Resonances. I would like to have read more about this. Halley had hoped to use timing of the Galilean satellite eclipses to solve the longitude problem but such observations were impractical from the deck of a ship at sea. On the other hand, Bradley was able to use them to determine the longitudes of Lisbon and the fort of New York relative to London.

For the first half of 1719, Bradley continued observing vigorously; but then he was ordained and received a living at Bridstow. Through the efforts of Samuel Montagu, private secretary to the Prince of Wales, he also received half a divided living in Pembrokeshire in 1720. Fisher reports that Pound laid out over £18 in fees in connection with the latter. As he took up his duties, Bradley's observing ceased — but not for long. In 1721 he was elected to the Savilian Chair of Astronomy at Oxford. It had been initially offered to Pound, who declined it because holders of the chair were not allowed to hold ecclesiastical benefice, with the consequence that he would have to give up his livings. Once Pound had declined, Bradley's candidature was supported by Lord Chancellor Thomas Parker, and Pound paid the costs of the election. Bradley's church sinecures were sufficiently modest that giving them up was an acceptable sacrifice.

Bradley's observations leading to his discovery of aberration and nutation began in a campaign led by Molyneux at his house at Kew, where he had installed a zenith sector built by George Graham. The aim was to repeat Hooke's experiment of 1669 from which he claimed to have measured the parallax of γ Draconis. Bradley's observations of this star showed movement, but not in the sense expected of annual parallax. Fisher brings out well the progress of the experiment, and the consideration of alternative explanations. To test the possibility that they were observing nutation, Bradley and Molyneux began observing another bright star separated by 12 hours in right ascension, whose movement soon enabled them to rule out that possibility. To increase the number of stars observable, Bradley commissioned from Graham a new zenith sector having a larger field of view. After Pound's death, Bradley no longer had access to the Wanstead parsonage but was able to continue observing from the nearby house belonging to Elizabeth Pound, his aunt. The new sector was installed there and Bradley was able to measure motions of stars having a range of right ascension. In April 1728, a pattern became apparent: the stars' motions ceased when they were observed at times when the Earth was moving directly towards or away from them. Later that year, he deduced the cause in terms of the Earth's motion in its orbit round the Sun and the finite velocity of the light from the stars — a new, unexpected phenomenon that confirmed the heliocentric view. Fisher sets out Bradley's argument in full. There are three versions of his report written in letters to Halley: Fisher identifies Bradley's 'final' version and presents this in Appendix 2, together with the differences between it and the version read by Halley to the Royal Society and published in the *Philosophical Transactions*.

In 1729, Bradley accepted the post of lecturer in experimental philosophy at Oxford for which he delivered two or three courses of 20 lectures a year for over 30 years. This lay outside the duties associated with the Savilian Chair and provided valuable additional income. His principle was that the laws of nature could be discovered only "by experiments and observation & examining the Phaenomena & finding from them by what laws their motions are ordered and regulated which is properly the Business and scope of Natural and Experimental Philosophy". Bradley's course notes are not available, but the author gives us (in Chapter 6) an account of the content from the note book of one of the students. In 1732, the increased demands on his time in Oxford prompted him to move from Wanstead to the Oxford dwelling that came with the Savilian chair. His aunt Elizabeth Pound accompanied him to Oxford, but he was able to continue observing with the zenith sector at her house in Wanstead. This he did until 1747, when he completed his investigation of the residuals from his observations of aberration suggesting the existence of another, distinct phenomenon. This was the nutation of the Earth's axis caused by the Moon. Bradley had suspected this early in his study but continued observing to cover a whole period, 18·6 y., of the precession of the Moon's orbital nodes — not only was he a meticulous observer, but also a very patient one, willing to continue a campaign long enough to make certain of a result. Besides these and many other observations (Appendix 1), and his teaching, he was active in other projects: studying the shape of the Earth from isochronal pendulum observations in collaboration with Graham, helping the Earl of Macclesfield set up his well-equipped observatory in Shirburn Castle, and beginning his tenure at the Royal Observatory.

Bradley was appointed Astronomer Royal on the death of Halley in 1742. Fisher gives an illuminating picture of the networking behind this appointment. Bradley's earliest years at Greenwich were taken up with testing and rectifying the instrumentation, which had been neglected during the final years of Halley's life, often with the aid of observations made at Shirburn Castle. In 1749 he requested funding to remedy the dire state of the instruments and facilities at the observatory. This was supported by the Board of Visitors, Royal Society, and Admiralty with the result that George II agreed an award of £1000. He constructed the New Observatory (Transit House) building to house the quadrants and new transit instrument. The prime meridian defined by the latter became the origin for the Ordnance Survey. In 1750, he began observations for a Catalogue of 3222 stars, each star being observed 20–30 times, together with ancillary data including atmospheric pressure and temperature to allow correction for refraction. He was not satisfied with possible treatments of atmospheric refraction and the data remained unreduced.

Any biographer of Bradley has to contend with the fact that, after his death, all of his Greenwich observations (shades of Flamsteed!), correspondence, and other items passed to the executors of his estate. Fisher gives a good account of the long battle with the Board of Longitude for the papers followed by their subsequent poor handling by Bradley's successor at Oxford, Thomas Hornsby, with the result that some were lost. Eventually, Bradley's comprehensive observations for his Catalogue of 3222 stars were reduced by Bessel and published only in 1818.

This is a substantial work, based on abundant primary sources with endnotes to each chapter. Some of the references are not easy to decipher owing to the misuse of the abbreviation '*ibid*' where there is no connection with the immediately preceding references. Altogether, the book would have benefitted from the help of an editor, who could also have removed some of the repetition and re-ordered some of the material to improve the flow. That being said, the author has successfully restored Bradley to his rightful place with the fullest ever account of his scientific life and legacy. Along the way, we can learn much about the practice of astronomy at the time, giving another reason to recommend this book heartily. — PEREDUR WILLIAMS.

Power Laws in Astrophysics. Self-Organized Criticality Systems, by Markus Aschwanden (Cambridge University Press), 2025. Pp. 264, 25 × 18 cm. Price £125/$160 (hardbound; ISBN 978 1 009 56293 5).

The concept of self-organized criticality was introduced only in the late 1980s but its validity covers an enormous range of physical phenomena. One of the most familiar is the 'sandpit' model in which avalanches occur according to some instability. The result is often power laws in size distributions. This book