butions would have dealt with purely practical subjects, but they were both on Olber's Paradox. This led him to believe the Universe was both infinite in extent but finite in time:

> He went on to argue (incorrectly) that if the Universe were infinite in extent, the light from more distant stars would not mean ever-increasing levels of light arriving at the Earth because these stars were individually so small. (pages 114–115).

However, he was the first (in 1718) to realise the reason three bright stars had changed their positions since ancient Greek times was because "… they were probably relatively close by." (page 109). The concept of 'fixed stars' was proven wrong, a major advance in astronomy.

Just about the only person who wrote anything nasty about Halley was his predecessor as Astronomer Royal, John Flamsteed: "Flamsteed's letters from the mid-1690s on are overflowing with vitriolic complaints about Halley." (page 67). Flamsteed also was the source of religious attacks: "I pray God give him grace to see his follies and repent …" Flamsteed wrote (page 68). Widely thought of as a "… dangerous freethinker …" (page 69), Halley in 1691 was denied the plumb academic job in astronomy—the Savilian Professorship of Astronomy at Oxford University.

Love provides a concise look at the total solar eclipse of 1715, and another solar eclipse in 1724, both visible in England. And one of the most endearing things about Halley is that he looked to the future. In 1716 he wrote about the transits of Venus in 1761 and 1769 as a means of measuring the distance to the Sun; and in 1705 he most famously asked astronomers to look for the periodic comet in 1758 that now bears his name. As he died in 1742, Halley never made any of these observations himself, but his spirit of scientific excitement was with everyone who did.

The book concludes with seven appendices (including a family tree, a time line of his life, Julian vs Gregorian dates, and the Coriolis Effect), 13 pages of notes and a concise bibliography and index. As the contributions of Halley are quite inspirational, this little book would make a fine gift for a teenager interested in science.

Reference

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***The Life & Work of James Bradley: The New Foundations of 18th Century Astronomy*, by John Fisher. (Oxford, Oxford University Press, 2023). Pp. xxvii + 531. ISBN 978-0-198-88420-0 (hardback), 160 × 240 mm, US$110.**

This book on Great Britain's third Astronomer Royal is an outgrowth of the university studies done by Dr. John Fisher. His Master's dissertation was on James Bradley's discovery of the aberration of light, and he followed this with a PhD on the work of Bradley.

The prose is a mix of academic and conversational. The only downside of this is that when he enters conversational mode, the reader often encounters issues that have already been mentioned. The repetition is only mildly annoying, but it does sometimes devolve into a rambling account that disrupts the flow of reading. For example, the account on page 92 begins with a paragraph on family matters; the next paragraph is about Bradley's observations of the satellites of Jupiter from January to June 1719; and the third paragraph starts with the fact that Bradley was 25 years old in 1717, and thus qualified to take holy orders. Page 93 reverts to his satellite observations, which were made on behalf of his mentor, Edmond Halley. I found the continuation of this on page 94 to be utterly confusing. It appears Halley published Bradley's observation in the *Philosophical Transactions* …, but a footnote gives the volume and page number, but no date. Then we are told Halley also inserted them into his own collection of tables for his personal use. They finally were published, after Halley's death, in 1752: "John Bevis was in regular communication with Bradley translating them from Latin to English." (page 94). No reference is given for the 1752 publication: I give the missing reference below. Tacked onto the end of this paragraph is the following sentence:

> Hodgson of Christ's Hospital published tables of Jupiter's satellites in 1749, 'studiously ignoring all mention of Bradley whose previous labours he must surely have been acquainted.' (page 94).

Fisher does not give us the first name of the afore-mentioned Mr. Hodgson (it is James), nor does he even list Hodgson in the Index! By this aside, which quotes from an old book about Bradley, Fisher implies Hodgson was a *parvenu* who suddenly came onto the scene in 1749. Actually, he had been publishing accounts of his Jupiter satellite observations in the *Philosophical Transactions* … since at least 1736. And to top off the missteps here, Fisher does not give a reference for Hodgson's 1749 publication; I also give this missing reference below. The use of subsections in his chapters would have given his prose some much-needed structure. Even though the text of the book clearly does not meet high academic standards, I found no obvious errors, so if one can get past such glitches, the book represents a very fine testament to the life and work of Bradley.

Very few personal details about Bradley are known, as it appears his surviving family destroyed nearly everything to make sure the proverbial skeletons stayed locked in the closet forever. Even his registers and working documents were retained by the family until 1776, and were not fully published until 1805, more than half a century after the observations were made. This goes a long way to explaining why Bradley has fallen into near obscurity, despite the fame (and royal favouritism from King George II) that he experienced while alive.

Bradley's fame derived from two major discoveries. The first was the aberration of light:

> What is so remarkable about Bradley's achievement is that he quicky perceived that the phenomenon he began to observe in December 1725 was *not* annual parallax … It was the clarity of Bradley's mind, and the discipline of his astronomical practice, rather than the precision and accuracy of his instrument that led to the discovery. (page 115).

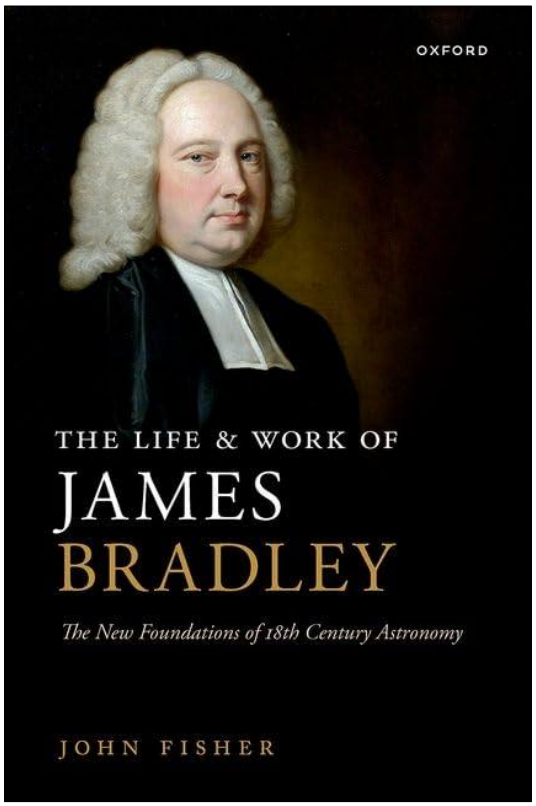
The first astronomer Royal, John Flamsteed, infamously claimed the discovery of stellar parallax more than a century before Friedrich Bessel finally did measure it in 1838. Thus, Bradley was very circumspect about making claims that would damage his reputation. Even so, Bradley faced widespread opposition on the Continent.

> The hypothesis of the new discovered motion met with resistance from many devout Roman Catholics. It was also rejected by various upholders of Cartesian theory, particularly in France. (page 132).

Thus, the same reactionary cliques who rejected Newton's theory of gravity also disparaged Bradley. In the case of aberration, it appears this rejection hinged on one point in particular.

> Acceptance of Bradley's hypothesis was contingent on the acceptance that the velocity of light was finite. (page 132).

A particularly harsh critic was Eustachio Manfredi, an astronomer so reactionary that he wrote "The Copernican system is totter-



ing." (page 171). Manfredi based his attack in part on his own observations of the stars, which he completely misunderstood. In one of the great ironies of astronomy,

> … *they were observing the same phenomenon*. Manfredi was observing 'aberrations' in right ascension. Bradley was observing motions in declination. Manfredi was observing these abnormal 'aberrations' in order to disprove all prior claims to the discovery of annual parallax, in order to invalidate the Copernican system. Bradley was observing these counter-intuitive motions precisely *because* they con-

> tradicted the theory of annual parallax. (page 172).

Bradley came to welcome Manfredi's observations, as they supported his own! The controversy, however, was not confined to Continentals. Samuel Molyneux, a Fellow of the Royal Society, was adamantly against Newton's discoveries as well. Fisher traces a main reason for this being Molyneux's friendship with Flamsteed. The first Astronomer Royal got along with almost nobody, but he had a particular antipathy towards Newton and his colleagues Halley and Bradley. The extraordinary tale of Molyneux's psychological attacks against Newton, made all the more galling as it was Newton who proposed him for election as an FRS, is related with aplomb by Fisher.

Ultimately, the opponents of Newton were adherents of Rene Descartes. "Many Cartesian natural philosophers," Fisher writes, "thereby interpreted Newton's *Principia* as a brilliant exercise in geometry rather than an account of 'the real world.'" (page 184). As the Savilian Professor of Astronomy, Bradley taught lectures based on Newtonian physics. His attitude is succinctly expressed in one of his lectures, which was kept for posterity by notes taken by one of his students.

> To know anything of the Nature of a Body we must not guess and suppose, but make trials and experiments which diligently pursued have led Men to discover many Articles of Natural Knowledge, which the most ingenious Hypothesis could never have brought to Light. (page 186).

Bradley must surely have been referring to himself when saying this: as the most diligent and accurate observer of the heavens, it was Bradley himself who made a second great discovery: nutation. Even though his own mentor Halley did not believe an accuracy of better than 2 seconds of arc was possible, Bradley had to measure with an accuracy of a half second over a period of 20 years (1727–1747) to provide definitive proof of a stellar motion no hypothesis had ever anticipated. Fisher goes into great detail about his methods of observation, often quoting from him directly. Before his demise in 1762, Bradley had also put the Royal Greenwich Observatory on a firm basis, so that his successor Nathaniel Bliss was able to continue observations without the long break that had hampered the work of Halley and Bradley when they took over as Astronomers Royal.

This rather heavy book on James Bradley is certainly the finest one ever written to explore his career and legacy. Fisher has accomplished his goal of rescuing Bradley from relative obscurity.

There are 3 typos: I'm not sure what a sentence on page 277 is meant to say, but it includes the words "it was obvious astute that he was"; on page 311, "first notice" should be "first took notice; and on page 327, "unable undertake" should be "unable to undertake".

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The Big Bang Revolutionaries: The Untold Story of Three Scientists Who Re-enchanted Cosmology, by Jean-Pierre Luminet. (Seattle, Discovery Institute Press, 2024). Pp 254. ISBN 978-1-63712-040-8 (paperback), 152 × 229 mm, $19.00.

This book opens with laudatory endorsements from outstanding experts in astrophysics, cosmology and quantum gravity, two of them Nobel Laureates. It will surely engage the curious with its vivid and lucid account of how in the 1920s–1940s a trinity of theoreticians transformed thinking on the nature of the Universe. Distinguished cosmologist Jean-Pierre Luminet displays his creative talents as a poet, an artist, and a musician, in the artful crafting of this delightful scientific adventure story. A world authority on black holes and cosmology, Luminet has published twenty science books in French and a further five in English.

The three revolutionaries in Luminet's case study are Alexander Friedman (1888–1925), Georges Lemaître (1894–1966) and George Gamow (1904–1968). As individualistic scholars they enunciated the three essential features of relativistic cosmology: the expansion of the universe; a singular origin for the universe; and the existence of the fossil signature of its origin. The singular origin is now known as the Big Bang, the