encyclopedia.com

# James Bradley | Encyclopedia.com

Complete Dictionary of Scientific Biography COPYRIGHT 2008 Charles Scribner's Sons
14-18 minutes

---

(*b*. Sherbourne, Gloucestershire, England, March 1693; *d*. Chalford, Gloucestershire, England, 13 July 1762)

*astronomy*.

The Bradley family has been traced as far back as the fourteenth century at Bradley Castle, near Wolsingham, Durham, but a branch to which James Bradley's father belonged had moved south to Gloucestershire. James, the third son of William Bradley and his wife Jane Pound, was intended for the Church. His father's income was limited, however, and his education was helped financially by his uncle, the Reverend James Pound, rector of Wanstead, Essex, who was then one of the ablest amateur astronomers in England and who fostered his nephew's fondness for astronomy. Bradley was educated at Northleach Grammar School and at Balliol College, Oxford, which he entered in 1711 and from which he received his B.A. in 1714 and his M.A. in 1717; upon his appointment as astronomer royal in 1742, Oxford awarded him an honorary D.D.

Bradley was ordained in 1719 and installed as vicar of Bridstow, near Ross, Monmouthshire, by the bishop of Hereford, who also presented him with an additional sinecure living and soon after made him his chaplain. A distinguished career in the Church seemed in prospect for the clever young scholar; but Bradley, whose parochial duties were very light, was able to continue his visits to Wanstead and to take part in his uncle's astronomical observations.

Pound had introduced his nephew to a friend of his, the eminent astronomer Edmund Halley, and in 1716 Bradley had made accurate and prompt observations of Mars and certain nebulae at Halley's request. A year later Halley drew the special attention of the Royal Society to Bradley's erudition, ability, and industry, predicting that he would advance astronomical studies. In 1718 Bradley was elected a fellow of the Royal Society. Three years later he was appointed to the Savilian professorship of astronomy at Oxford and resigned his livings and gave up his prospects in the Church, since he did not believe he could do full justice to two different employments; his Oxford appointment made astronomy no longer a spare-time hobby. Many years later, for the same reason, he refused the living of Greenwich as a means of supplementing his meager salary of £100 per year as astronomer royal.

When Halley died in 1742, Bradley was appointed—as Halley had wished—to succeed him as astronomer royal; and he held that office with great distinction for twenty years until his death. In 1744 Bradley married Susannah Peach of Chalford, Gloucestershire. There was one daughter of the marriage, born in 1745. Bradley's wife died in 1757. Bradley was humane, benevolent, and kind; a good son and an affectionate husband and father. He was very abstemious. Apart from an attack of smallpox in 1717, he seems to have enjoyed excellent health for most of his life. A hard worker, he was able to endure long hours of observing and intensive calculating with no apparent ill effects. In the last few years of his life, partly through overwork, Bradley's health gradually deteriorated, and he began to suffer from severe headaches. By 1761 he became unfit for regular work, and was obsessed by the unfounded fear that his brain was giving way. He was cared for by his deceased wife's family until he died of an abdominal inflammation.

Bradley was a fellow of the Royal Society for over forty years, and by 1748 his brilliant discoveries and work at the Royal Observatory brought him preminence among both English and foreign astronomers. He was elected a member of the Acadèmie Royale des Sciences and of the academies of Berlin, Bologna, and St. Petersburg.

Bradley's celebrated discovery of the aberration of light is a good example of the way in which his accuracy, industry, and clarity of perception could extract an unforeseen success from an apparent failure. Since the stars should appear to be very slightly displaced in direction because of the earth's annual motion round the sun, these parallactic displacements would, if measurable, reveal the distances of the stars. Robert Hooke had unsuccessfully attempted this in 1669, and in 1725 Samuel Molyneux, a wealthy amateur astronomer, tried to better Hooke's effort to measure the parallax of the star Gamma Draconis by means of an improved twenty-four-foot zenith sector, made by George Graham and erected at Molyneux's house at Kew. He invited his friend Bradley to join in the observations. Gamma Draconis, passing almost through the zenith, was chosen to avoid refraction and to have the telescope fixed vertically, so that it could easily be checked. Within a few days Molyneux and Bradley detected a small but increasing deviation of the star, a displacement too large and in the wrong direction to be due to its parallax. Having verified the accuracy of the instrument, they carefully measured the deviations of Gamma Draconis, finding that they went through a cycle in the course of a year and that a similar effect occurred with other stars.

Molyneux gave up the observations but Bradley continued, using a smaller and more convenient sector made by Graham that would take in a greater number of stars; this was erected at Wanstead in 1727. Bradeley tested numerous hypotheses to explain the effect, but none of them would fit. One story tells that he obtained the clue when on a pleasure trip on the Thames by noticing that every time the boat put about, the vane at the masthead shifted slightly; the sailors assured him that the wind direction had not changed—the shift of the vane was due to the boat's change of direction. Bradley concluded that the phenomenon he had observed in the stars was due to the combined effect of the velocity of light and the orbital motion of the earth. He verified this by calculation, and presented an account of the work and his discovery of the aberration of light to the Royal Society in 1729, in the form of a long letter to Halley, then astronomer royal. In this paper Bradley stated that if the parallax of any of the stars he observed had been as great as one second of are, he would have detected it, and concluded that their parallaxes were much smaller than had been hitherto supposed. He was quite correct: there are only twenty-one stars with parallaxes exceeding 0″.25, and that of Gamma Draconis is approximately 0″.017. The discovery not only provided an essential correction for star positions but was also the first direct observational proof of the Copernican theory that the earth moves round the sun.

In 1727 Bradley had noticed a small "annual change of declination in some of the fixed stars" for which neither precession nor aberration completely accounted, so he continued to observe the stars involved with his zenith sector. He found that stars of the right ascension near 0 hours and 12 hours were affected differently than were those near right ascension 6 hours and 18 hours. By 1732 he had guessed the real cause, suspecting "that the Moon's action upon the equatorial parts of the earth might produce these effects...." He felt confident that a complete cycle of these displacements of the stars due to the moon's action would correspond to the period (nineteen years) of the revolution of the nodes of the moon's orbit, so he continued the observations for twenty years, finding at the end of nineteen "that the stars returned into the same positions again, as if there had been no alteration at all in the inclination of the earth's axis...."

Since this effect on star positions arose from a slow nodding of the earth's axis due to the moon's attraction, Bradley called it "nutation." In 1748 he announced the results to the Royal Society in a very long letter to his patron and friend the Earl of Macclesfield, himself a keen amateur astronomer. The paper contained much geometrical discussion and tables of precession, aberration, and nutation for several stars for the years 1727–1747. (At current values, aberration ranges from zero to 20″.4958, nutation from zero to 9″.210.) Bradley further improved the exact determination of star positions by deriving practical rules for refraction from elaborate calculations, introducing corrections for air temperature and barometric pressure.

On becoming astronomer royal, Bradley tested, adjusted, and had repairs made on the astronomical equipment at Greenwich Royal Observatory. Then, with one assistant, he embarked on an intensive program of star observations. He found, however, that Halley's instruments had developed defects that caused observational errors. He managed to obtain a grant of £1,000 from the Admiralty, and by 1750 had thoroughly reequipped the observatory; the chief additions were two mural quadrants and a transit instrument, all made by John Bird, a pupil of Graham's. As a result, the massive program of observations (at least 60,000) made at Greenwich from 1750 to 1762 attained a very high standard of accuracy, sufficient to make them useful to modern astronomers.

Throughout his adult life Bradley made many observations of bodies in the solar system as well as of stars. With his uncle, in 1719 he had derived an improved value for the solar parallax from observations of Mars. He observed and calculated the elements of several comets, and published short papers on three. In one paper (1726) Bradley derived the longitudes of Lisbon and New York from differences in the observed times of eclipses of one of Jupiter's bright satellites. He was the only astronomer to record the reappearance of Saturn's ring in 1730 from the edgewise phase. He made laudable attempts at the very difficult feat of measuring the diameters of Venus, Mars, Jupiter, and of Saturn and its ring system, a task that taxed the resources of astronomers with much larger and better telescopes a century and a half later.

As befitted an astronomer royal, Bradley was keenly interested in the accurate measurement of time. In the early 1730's Graham experimented in London with a clock whose pendulum beat sidereal seconds, and gave Bradley the results. The clock was then sent to Jamaica and tested on the transits of certain stars, with the times and temperatures recorded. From these data Bradley worked out a correction for the higher temperatures in Jamaica and deduced a slowing of the clock by 1 minute, 58 seconds per day due to lower gravity near the equator. From Newton's theory of the relation between latitude and gravity, Bradley derived the same slowing. He then worked out a table, for each five degrees of latitude, of the lengths required for pendulums that would keep the same time as one 39.126 inches long in London, and reported the results of the investigation to the Royal Society in 1734. One use Bradley made of his new quadrants at the observatory after 1750 was to determine accurately the latitude of Greenwich. His value,+ 51° 28′ 38 1/2″, exceeds the current one by only 1″.3, and is closer than those derived by two of his successors.

The Royal Observatory had been founded to assist navigation—to increase the safety of ships on ocean voyages by prescribing better methods of finding longitude at sea. Bradley recognized the importance for navigation of magnetic observations, so he included magnetic instruments among his new equipment. In 1755 the Admiralty asked Bradley to examine and report on the usefulness of Tobias Mayer's new lunar tables for finding longitude at sea. After comparing them with more than 230 Greenwich observations, and doing many calculations, Bradley reported in 1756 that, subject to trials on shipboard, the tables should give the longitude to within 1/2°. Observations made at sea proved less encouraging, however, so in 1759 and 1760 Bradley compared Mayer's tables with many more observations and worked out detailed corrections for them by laborious and intricate calculations. In 1760 he reported that the difficulty of finding longitude by this method was not insuperable, and that the corrected tables should give it with an error of less than 1°.

Bradley was a brilliant original thinker, a very skillful observer, and a thoroughly practical astronomer who exercised unremitting care in examining the errors of his instruments and in insuring their accurate adjustment. The value of his star observations increases with time, for they provide a firm starting point for long-term investigations of stellar motions. Without his two great discoveries and his work on refraction, it is difficult to see how later progress by others in the determination of star positions, distances, and motions would have been possible.

# BIBLIOGRAPHY

I. Original Works. Bradley's writings are collected in *Miscellaneous Works and Correspondence of the Rev. James Bradley, D.D., F.R.S., Astronomer Royal…*, S.P. Rigaud, ed. (Oxford, 1832), and *Supplement to Dr. Bradley' Miscellaneous Works…*, S. P. Rigaud, ed. (Oxford, 1833). The 1832 volume includes all Bradley's papers and memoranda; his zenith star observations of 1725–1747; a selection of his observations of sun, moon, planets, and comets of 1715–1742 and some observations of them made at Greenwich between 1743 and 1748 and in 1759; the best of his astronomical correspondence; and a detailed biography by Rigaud. The 1833 supplement includes a discussion of Bradley's refraction calculations. (A reprint of this valuable collection is in preparation.)

Bradley's papers are printed in the *Philosophical Transactions of the Royal Society* as follows: "Comet of 1723," **33** , No. 382(1723), **41** ; "Longitudes by Eclipses of a Jupiter Satellite," **34** , No. 394 (1726), 85; "Aberration", **35** , No. 406 (1729), 637; "Pendulum Experiments in London and Jamaica", **38** , No. 432 (1734), 302; "Comet of 1737", **40** , No. 446 (1737) 111; "Nutation", **45** , No. 485 (1748), 1; and "Comet of 1757", **50** (1757), 408.

Much of Bradley's work was recorded in *Astronomical Observations Made at the Royal Observatory at Greenwich From the Year 1750 to the Year 1762 by the Rev. James Bradley D.D., Astronomer Royal…*, 2 vols. (Oxford, 1798–1805), the second volume of which includes observations by Bradley's successor, Nathaniel Bliss.

II. Secondary Literature. Writings on Bradley or his work are G. F. A. Auwers, *Neue Reduktion der Bradley'-schen Beobachtungen aus den Jahren 1750 bis 1762*, 3 vols. (St. Petersburg, 1882–1903), a reduction of all the Greenwich observations of 1750–1762 that shows which of the observations were made by the four men who were, in succession, Bradley's assistant; an earlier reduction is F. W. Bessel, *Fundamenta astronomiae pro anno MDCCLV deducta ex observationibus viri incomparabilis, James Bradley, in specula astronomica Grenovicensi per annos 1750–1762 institutis* (Königsberg, 1818), which contains a catalogue of more than 3,000 stars, based on Bradley's observations.

See also the article on Bradley in *Dictionary of National Biography;* G. Abetti, *The History of Astronomy* (London, 1954); A. F. O'D. Alexander, *The Planet Saturn* (London, 1962), and *The Planet Uranus* (London, 1965); and H. Spencer Jones, *The Royal Observatory, Greenwich* (London, 1948), which contains an excellent short account on pp. 10–13, by a recent astronomer royal, of Bradley's outstanding achievements.

A. F. O'D. Alexander