

Despite the Clouds:

A History of Wales and Astronomy

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Wales has seen diverse astronomical activity through its history, including the early use of the telescope in Carmarthenshire, the first observation of the galaxy M64, and pioneering theoretical research into magnetic fields in astrophysical plasmas. This article aims to provide a broad overview of historical astronomy in Wales and by people from Wales. It covers the period from the 7th century to the current era. It describes the extensive work of enthusiastic amateurs and the growth of academic research in astronomy in Welsh universities in the 20th century.

Introduction

Wales has conventionally been portrayed as a country where intellectual activities were directed to the humanities, arts, religion and politics, rather than to the sciences. In reality, Welsh people through the ages showed considerable interest in science, including astronomy.¹

Throughout history it is possible to find individuals in Wales who studied astronomy, and many people from Wales contributing to the science while living elsewhere. Among these are some examples of work at the cutting edge of international research, such as Sir William Lower's early use of the telescope in Carmarthenshire, the Pigotts' telescopic observations in the Vale of Glamorgan, the long-exposure photography of Isaac Roberts, and Thomas Cowling's research into astrophysical magnetic fields at University College Swansea. There was, however, a much greater amount of more mundane astronomical activity that included observation, publication and education. Before the 20th century these activities were mostly the work of amateurs.

The study of the history of astronomy in Wales, however, has been a relatively neglected subject until comparatively recently. An overview of the subject (in Welsh) was given at a popular level by Silas Evans in his general book on astronomy *Seryddiaeth a Seryddwyr* ('Astronomy and Astronomers').² This has often served as a useful starting point to the history of astronomy in Wales, although much of the text is a

catalogue of early 20th century Welsh amateur astronomers.³ More recent contributions include sections within the account of 19th century British amateur astronomy by Dr. Allan Chapman.⁴ Articles about some individual figures have appeared in biographical dictionaries.⁵ Only one Welsh observatory was listed in the *Greenwich List of Observatories* – at Hakin, near Milford Haven – and that was abandoned before opening.⁶

A basic modern, but patchy overview of the history of Welsh astronomy is available online.⁷ A critical modern summary has not, however, been available. The aim of this article is to provide a new, broad overview, which can serve as a starting point for more in depth analyses. It describes historical astronomical activities in Wales and activities carried out by people from Wales who worked elsewhere.

Ancient events

A small number of references to astronomical phenomena can be found in medieval manuscripts from Wales. One of the earliest surviving examples of Old Welsh is the *Computus Fragment*, a single page dating from c.850–920 about calendar calculations and the 18.6-year lunar cycle, bound with other, unrelated, manuscripts in a volume held in Cambridge University Library.⁸

The Latin chronicles known as the *Annales Cambriae* record events between the 5th and 10th cen-

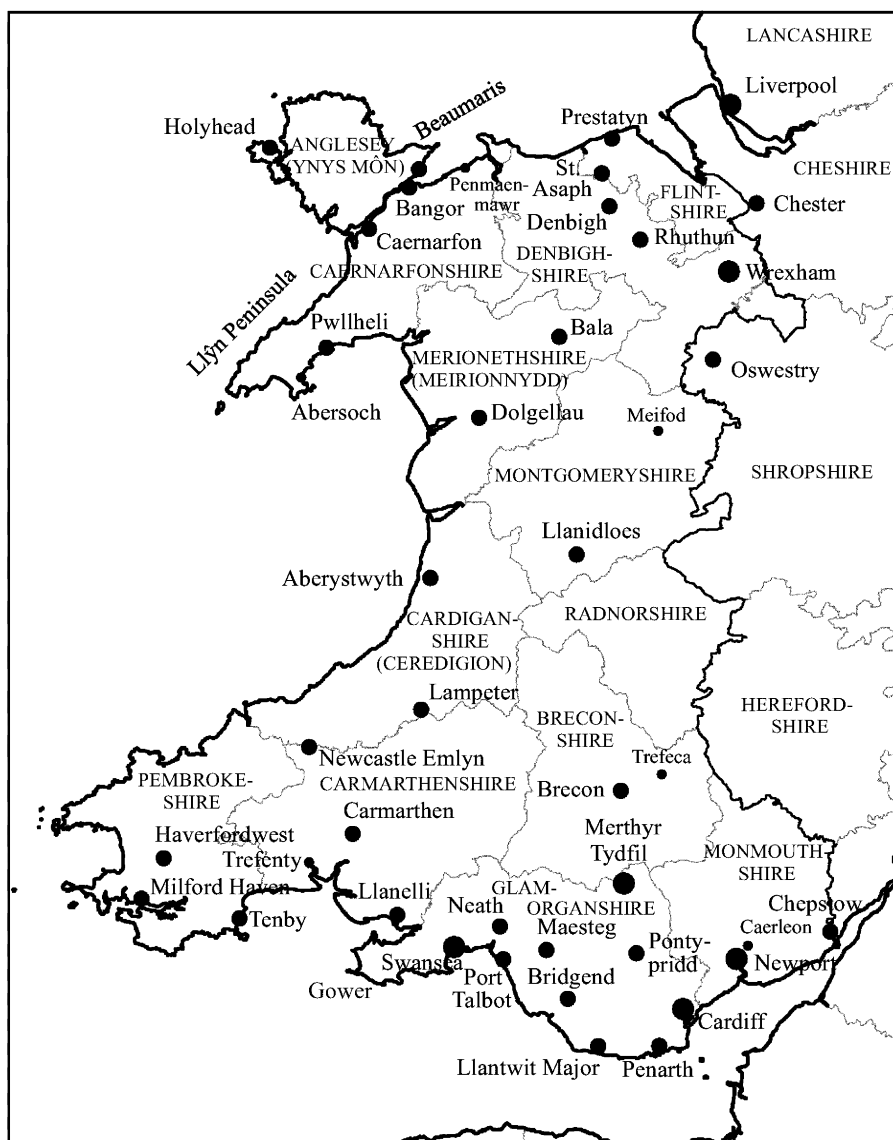


Fig.1 A map of Wales showing locations mentioned in the text. Historic (pre-1974) counties are outlined.

The map was plotted using coastline data from the Global Self-consistent, Hierarchical, High-resolution Geography (GSHHG) Database & old (pre-1974) county boundary data from the Historic County Borders Project

By the author

tures, largely from a Welsh perspective. The version in the British Library Harley 3859 manuscript includes references to what can be identified as the partial solar eclipse of 21 June 624 and as a comet in 676.⁹ There are also references to ‘a rising of a star’ in 650 and to night being as bright as day in 714.

The *Brut y Tywysogyon* chronicle incorporates some of the *Annales Cambriae* text in translation into Welsh and continues with significant new material through to the early 14th century.¹⁰ The *Brut* mentions

several astronomical events, including the solar eclipses of 11 February 807 (partial in Wales), 20 March 1140 (total), 1 May 1185 (partial) and 23 June 1191 (partial). The total lunar eclipse of 25 December 809 is recorded, as is a lunar eclipse in 830, but the stated date does not closely match candidate eclipses. A reference to the Moon turning the colour of blood in 691 could be interpreted as the total lunar eclipse of 7 May 691. There also is a short description of the Great Comet of 1106.¹¹

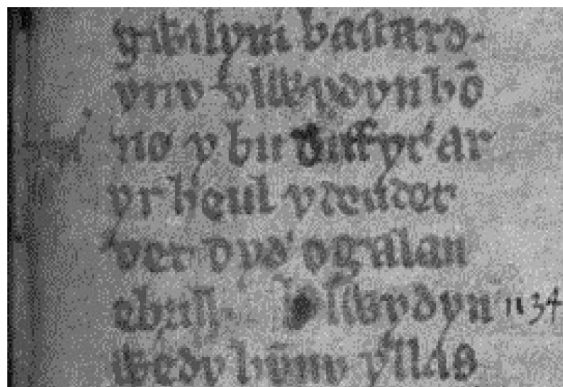


Fig.2 *Yn y vlwydyn hono y bu diffyc ar yr heul y deudecvet dyd o galan ebrill.*

(‘In that year there was an eclipse of the Sun on the twelfth day from the Calends of April.’)

A reference to the total solar eclipse of 20 March 1140 in the *Brut y Tywysogion* chronicle (Peniarth MS.20 version of the chronicle, page 153). From the Digital Mirror on the website of the National Library of Wales

By permission of Llyfrgell Genedlaethol Cymru/National Library of Wales

Late medieval learning

Welsh-language poetry of the 14th and 15th century occasionally made reference to astronomical phenomena, such as comets, although these were usually interpreted uncritically as omens of future events.¹²

In this same period, some Welsh scholars produced works on astronomical subjects. Walter Bryt (or Brytte) was a 14th century astronomer of Welsh origin who wrote a book about planetary motions called the *Theorica Planetarum*. He was associated with Merton College, Oxford, but the precise location and date of his birth are not known.¹³

The late 15th century mathematician, astronomer, physician and teacher, Lewis of Caerleon, produced a number of Latin books about eclipses. He studied and taught first in Cambridge, and later in Oxford. He became involved in political intrigues in England during the Wars of the Roses, with some of his astronomical works being written while he was detained in the Tower of London until the arrival of the Tudor dynasty.¹⁴

Renaissance figures

Some 16th century Welsh scholars noted in other fields made some minor contributions to astronomy. The scholar and royal administrator William Thomas (d.1554), probably a native of Breconshire, translated Johannes de Sacrobosco’s 13th century *De Sphaera Mundi* into English, although it was not printed. He was later executed for treason against the English crown during the early reign of Mary Tudor.¹⁵ William

Salesbury (c.1520–c.1580) from Denbighshire studied at Oxford where he developed his skills as a linguist. He became noted as the author of an English-Welsh dictionary and the translator of the New Testament into Welsh. His astronomical contribution was a translation into English, of Thomas Linacre’s Latin translation, *De Sphaera*, of the 5th century Greek text by Proclus.¹⁶

Humphrey Llwyd (or Lhuyd, Lluyd or Lloyd) (1527–1568) of Denbigh attained prominence in several fields, including as an antiquary, geographer, map maker and as the member of parliament who did most to support legislation for the translation of the Bible into Welsh.¹⁷ Llwyd made one contribution to astronomy as the author of a book about the apparent positions of the Moon and planets, which was partly an almanac, but the work has not survived.¹⁸ An acquaintance of Llwyd, Sir Richard Clough (d.1570), was reputed to have an enthusiasm for astronomy and to have used a cupola on the roof of his home, Bach-y-graig near St. Asaph, for astronomical observations.¹⁹

The mathematician Robert Recorde (c.1512–1558) is celebrated today as the originator of the equals sign (=).²⁰ Born in Tenby, Pembrokeshire, he studied at Oxford where he subsequently taught mathematics, before studying medicine at Cambridge. He served the crown as comptroller of local mints and surveyor of mines in Ireland, although Recorde continued to have some connections with Tenby.²¹ He died in prison, probably detained for debt after he lost a libel action.

Recorde wrote several mathematics textbooks in English, some elementary, some advanced, which became noted for their clarity.²² These books used material from a wide range of sources, including from contemporary continental mathematicians. His astronomical book *The Castle of Knowledge* (1556) concerned planetary motions, building on the works of classical and medieval scholars. The book also referred to Copernicus’s heliocentric model (published in 1543), but fell short of a clear endorsement.²³ It has often been represented as the introduction of Copernican principles into Britain.

Sir William Lower and John Prydderch

Sir William Lower (c.1569–1615) a Carmarthenshire landed gentleman, was among the first people to use the telescope for astronomy.²⁴ Originally from St. Winnow, Cornwall, he was educated at Oxford and at the Middle Temple in London.²⁵ He was elected to represent Bodmin in the English parliament in 1601 and around this time he married Penelope Perrot of Carmarthenshire, moving to the Perrot estate at Trefenty near St. Clears, Carmarthenshire.²⁶ His wife’s stepfather was the Earl of Northumberland, patron of

the noted scientist and mathematician Thomas Harriot, who lived at the Earl's estate at Syon House, west of London.



Fig.3 A cartoon depicting Sir William Lower & John Prydderch observing in Carmarthenshire, c.1609. Lower is shown using a telescope and Prydderch holds a cross-staff. The artist was Joseph Morewood Staniforth (1863–1921), cartoonist to the Western Mail group of newspapers

Seryddiaeth a Seryddwyr by J. S. Evans (ref. 2), page 265
Picture by the author

Lower and Harriot began a friendship, becoming collaborators in science and mathematics, which is evident from Lower's surviving letters to Harriot. Lower made a series of observations of a bright comet in 1607, subsequently identified as Comet Halley. He first saw the comet while on board a ship crossing the Bristol Channel towards Wales. He followed it for nearly three weeks, measuring its position relative to stars using a cross-staff.²⁷

Thomas Harriot learnt of the development of the telescope in the Netherlands in 1608 and before mid-1609 experimented with telescopes of his own construction. He provided Sir William Lower with an example which Lower used to observe the night sky from Trefenty, aided by a friend, John Prydderch (or Protheroe, Pretherch or Rytherch), of the nearby Nantyrhebog (or Hawksbrook) estate.²⁸ Prydderch had been born in about 1582 in Carmarthenshire, son of the very wealthy landowner James Rytherch. He was probably educated at Jesus College, Oxford, and attended Lincoln's Inn, London. He subsequently inherited the Nantyrhebog estate.²⁹

Lower described the appearance of the Moon through his telescope, which he called a cylinder, in a letter to Harriot dated 6 February 1610. This included

the words, 'In the full she appears like a tart that my cooke made me last weeke; here a vaine of bright stuffe, and there of darke, and so confusedlie all over. I must confess I can see none of this without my cylinder'.³⁰ Harriot provided Lower with the news of Galileo's telescopic discoveries shortly after the publication of *Sidereus Nuncius*. They were able to repeat Galileo's observations of the satellites of Jupiter together from Syon House in December 1610.³¹ However, neither Harriot nor Lower published their results and the significance of their activities came to light only in the late 18th century. Lower died in April 1615, aged 45 years.

The 17th and early 18th centuries

The mathematician William Jones (c.1675–1749) was born in the hamlet of Maenaddwyn, Anglesey.³² After working in London, he travelled to the West Indies and subsequently taught mathematics and navigation on board ships. On returning to Britain, he wrote a book about celestial navigation, *A New Compendium of the Whole Art of Practical Navigation*, published in London in 1702 that included, 'the most Useful and Necessary Problems in Astronomy'.³³ Jones became a private tutor, particularly of mathematics, later becoming tutor to the family of the Earl of Macclesfield. He became a friend of Newton, a council member of the Royal Society and served briefly as a vice-president. Like Robert Recorde, Jones is however best known for introducing a mathematical symbol: he first used π (π) for the ratio of the circumference to diameter of a circle.

Joseph Harris (c.1704–1764), brother of the famous Methodist religious leader Howel Harris, was born in Trefeca, Breconshire.³⁴ He received education and training from his uncle, the local blacksmith, before moving to London. Harris went to sea, where he contributed to navigation and attempted to improve navigational instruments. He visited Veracruz on the Gulf coast of modern-day Mexico from where he observed solar and lunar eclipses in an attempt to improve knowledge of the port's longitude, sending the results to Edmond Halley, the Astronomer Royal, who presented them to the Royal Society.³⁵ Harris subsequently used these experiences to write a book, *A Treatise of Navigation* (1730), which was soon followed by a second, *The Description and Use of the Globes and the Orrery* (1731).³⁶ His name also appeared as the author of a single-page chart of the southern celestial hemisphere published by Thomas Bowles as *Stellarum Fixarum Hemisphaerium Australe*.³⁷

Harris next left Britain to sail for Jamaica where he was employed by Colin Campbell (d.1752) to establish

an astronomical observatory.³⁸ Ill health limited Harris's activities and he returned to Britain, making magnetic observations during the return.³⁹

Harris obtained employment in 1736 at the Royal Mint in London, where he continued working for the rest of his life, subsequently becoming an assay master. He published a paper about terrestrial globes.⁴⁰ Harris observed the 1761 transit of Venus at Trefeca during a visit.⁴¹ He died in 1764 without completing a book on optics.⁴²

Nathaniel and Edward Pigott

Nathaniel Pigott (1725–1804) and his son Edward (1753–1825) were noted observers of the late 18th century, who lived near Llantwit Major in the late 1770s.⁴³ Nathaniel Pigott was born into a Catholic family at Whitton, west of London. He was educated, like many English Catholics, at Douai in northern France. His life was peripatetic, marrying in Brussels then living in various locations in Britain and on the continent, including Louvain (Leuven) and Caen. He had the financial means to support his astronomy interests by purchasing instruments of quality from noted London makers. He made observations at Caen which were submitted to various academies, including to the Royal Society which elected him a fellow in 1772.⁴⁴ He returned to Britain in 1775 in an attempt to benefit from the estates of his relations in the Fairfax family.

The Pigott family, including Edward, took up residence at Frampton House in the Vale of Glamorgan in 1777. Their observatory included a Dollond achromatic refractor of six feet focal-length, a Sissons transit instrument with a Dollond telescope of two-inch aperture and three feet focal-length, two mural quadrants and a five-inch aperture reflector by Heath and Wing.⁴⁵

Observing from Frampton, Edward found a nebula in the constellation Coma that he could not identify with any in Charles Messier's Catalogue or mentioned by J. J. Lalande. He sent an account of the new nebula, dated 3 September 1779, to the Astronomer Royal, Nevil Maskelyne giving the date of his first observation as 23 March 1779. Pigott had determined the position using the transit instrument and a mural quadrant. Maskelyne read the account to the Royal Society. The positions subsequently published in the *Philosophical Transactions* match those of the spiral galaxy M64.⁴⁶ The discovery of M64 was once attributed to Johann Elert Bode who first observed it on 4 April 1779 and independently to Messier who first saw it on 1 March 1780.⁴⁷ It is now clear that it was independently discovered by the three astronomers and first seen by Edward Pigott.

Nathaniel Pigott reported the discovery of three double stars from Frampton in a letter to Maskelyne which was read to the Royal Society on the same day as was Edward's discovery of M64.⁴⁸ One of these stars was γ Delphini, a binary.⁴⁹ Nathaniel used astronomical measurements, including timing the motions of Jupiter's satellites, to determine the position of Frampton and therefore the position of the northern shore of the Bristol Channel. He also observed occultations of stars by the Moon.⁵⁰ Edward Pigott measured the position of Mercury in the daytime sky, but these observations were not published.⁵¹

The family relocated to York in 1780 in further hope of succeeding to family estates.⁵² The instruments from Frampton were installed in a two-storey observatory building, constructed for the purpose. At York Edward collaborated with his neighbour and relative, John Goodricke, particularly in the discovery of variable stars.⁵³ Edward discovered a comet.

Nathaniel Pigott died in York in 1804. Edward subsequently lived in Louvain, York, London and Bath, although he was detained in France for a period during the hostilities between France and Great Britain. He died in 1825 in Bath.

Late-18th century astronomers

The philosopher, statistician and political radical, Richard Price (1723–1791), originally from Llangeinor near Bridgend, made a minor contribution to astronomy through a paper about the effect of the aberration of light on the observed times of transits of Venus.⁵⁴

John Lloyd Williams (1745–1838) of the Gwernant, or Alderbrook Hall, estate at Troed yr Aur, Ceredigion, worked as a physician for the British East India Company in the 1790s.⁵⁵ He collated reports of the fall of a meteorite in 1798, near Varanasi in Uttar Pradesh, India – also known as Benares.⁵⁶ Williams had previously written an account of the historic observatory at Varanasi, with its monumental naked-eye instruments, which was published by the Royal Society, and was elected a fellow in 1801.⁵⁷

John Lloyd (1750–1815) of the Wigfair and Hafodunos estates near St. Asaph became renowned for his library and collection of scientific instruments.⁵⁸ A lawyer by profession, he was elected member of parliament for Flintshire but served only two years. His scientific interests were wide, including natural history and astronomy, with Sir Joseph Banks being a good friend. Other correspondents included Sir William Herschel and Nevil Maskelyne, while a number of scientists visited Wigfair. Indeed, the astronomer Alexander Aubert (c.1730–1805) died at Wigfair while visiting Lloyd.⁵⁹ Lloyd was elected to the Royal

Society in 1774, but his publications in its journals related to terrestrial natural phenomena and not astronomy. Lloyd purchased a reflector, of seven feet focal length and seven-inch mirror, from Sir William Herschel for £105.⁶⁰

Lloyd died in 1815 without children. His library and scientific instruments were sold at a celebrated auction that lasted 13 days: the auction catalogue provides a picture of the collections.⁶¹ The scientific books included works by Copernicus, Brahe, Galileo, the 1726 edition of Newton's *Principia*, and a complete run of the *Philosophical Transactions* from 1665 to 1814.⁶² The Herschel reflector was sold for £99 10s and a Dollond telescope for £84.⁶³

A native of Caerleon near Newport, Monmouthshire, Lewis Evans (1755–1827) attended the University of Oxford before being ordained in the Church of England.⁶⁴ He became a vicar at Froxfield in Wiltshire, prior to being appointed a mathematical master at the Royal Military Academy in Woolwich in 1799, where he remained until 1820. He erected a well-equipped observatory first at Froxfield and then at Woolwich. He published on astronomy and mathematics in journals that included the *Philosophical Magazine* and the *Mathematical Repository*.

Peter Roberts (1760–1819) from Ruabon, near Wrexham, studied at Trinity College, Dublin. He remained in Dublin as a private tutor where he was noted for his knowledge of astronomy, but his hopes of succeeding Henry Ussher (1741–1790) as Andrews professor of astronomy came to nothing. He later returned to Wales, serving as an Anglican vicar in Flintshire.⁶⁵ Rev. Thomas Jones (1756–1807) from Berriew, Montgomeryshire became an academic at Cambridge where he lectured in mathematics, natural philosophy, astronomy, and moral philosophy.⁶⁶

18th and 19th century authors and lecturers

The late-18th and 19th centuries saw the publication of books in Wales that included some considerable discussion of astronomy, with many of them written in Welsh.⁶⁷ Simon Thomas (d.c.1743), a Presbyterian minister, published *Hanes y Byd a'r Amseroedd* ('History of the World and the Ages') around 1718, subsequently revised in 1724 as *Llyfr Gwybodaeth y Cymro* ('The Welshman's Information Book') and reprinted several times after his death, including a newly revised edition in 1824.⁶⁸ Although a general book mostly about history and geography, Thomas gave some emphasis to astronomy, which is likely to have introduced many general readers in Wales to the subject.

A Carmarthenshire land surveyor named Mathew



Fig.4 Rev. Lewis Evans (1755–1827), astronomer, mathematical master at the Royal Military Academy Woolwich, and native of Caerleon, near Newport
Courtesy of the Royal Astronomical Society

Williams (c.1732–c.1819) wrote books in Welsh about religion and practical arithmetic for workmen.⁶⁹ One book, *Speculum Terrarum et Coelorum neu Ddrych y Ddaear a'r Ffurfafen* ('Speculum Terrarum et Coelorum or Mirror of the Earth and Heavens'), consisted of two parts, the first a lengthy introduction to geography while the second was a shorter introduction to astronomy that also included atmospheric phenomena.⁷⁰ The book was first published in 1784 with revised editions in 1804 and 1826.

Mathew Williams also produced annual almanacs, a popular type of publication in the 18th and 19th centuries. Almanacs were usually soft-bound booklets listing each day of the year with information about the day of the week, sunrise and sunset times. They often included some astronomical information, particularly about eclipses, although the accuracy depended on the publisher. Some included astrological speculation, others were strictly rational. Among the most celebrated almanac publishers were John Lewis Roberts (1731–1806), also known as Siôn Robert Lewis, and his son Robert Roberts (1777–1836) of Holyhead.⁷¹ Robert Roberts ran a private academy and developed a reputation for his public lectures in Welsh about astronomy at venues across Wales.⁷² He published a lengthy book, *Daearyddiaeth* ('Geography') in 1816 that described in detail with maps, the countries of the

world over 548 pages, but which started with a 96-page section about astronomy, physics and astronomical geography.⁷³

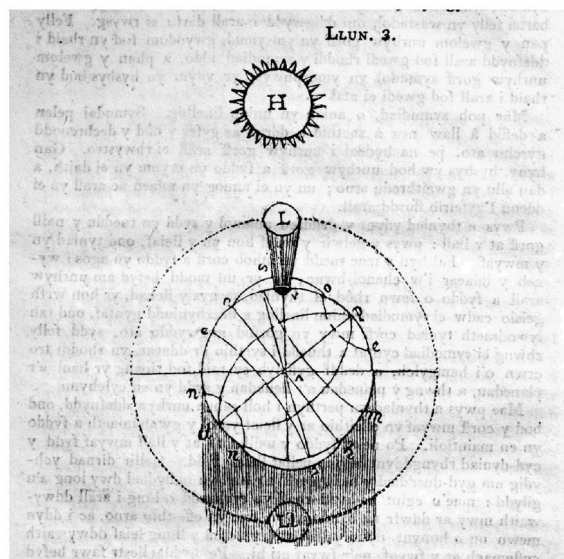


Fig.5 An illustration in the astronomical section of Robert Roberts's book *Daearyddiaeth* explaining the causes of eclipses
Picture by the author

Astronomy found a place in formal education beyond the academy of Robert Roberts. For example, John Evans (1796–1861) ran a renowned school in Aberystwyth and used various apparatus to explain the science, even a large umbrella painted with constellations. He constructed his own telescope.⁷⁴

John William Thomas (1805–1840), a native of Llandygai near Bangor, better known by the nom-de-plume Arfonwyson, briefly attended Robert Roberts's academy in Holyhead. He moved to London where eventually he gained employment as a computer at the Royal Observatory, Greenwich, ultimately becoming superintendent of the computing staff.⁷⁵ In Welsh, he published almanacs, educational works, mathematical publications, articles in magazines and posthumously, a lecture about astronomy.⁷⁶

Edward Mills (1802–1865) of Llanidloes, Montgomeryshire lectured on astronomy across Wales and was reputed to have built a large orrery.⁷⁷ He published a book about astronomy, geography and geology called *Y Darluniadur Anianyddol* ('The Illustrator of Natural Science') in 1850, illustrated with woodcuts made by himself and his son.⁷⁸ In doing this, he repeated the practice of Robert Roberts and Mathew Williams of placing descriptive astronomy alongside geography, something that had also been done by Josiah Thomas

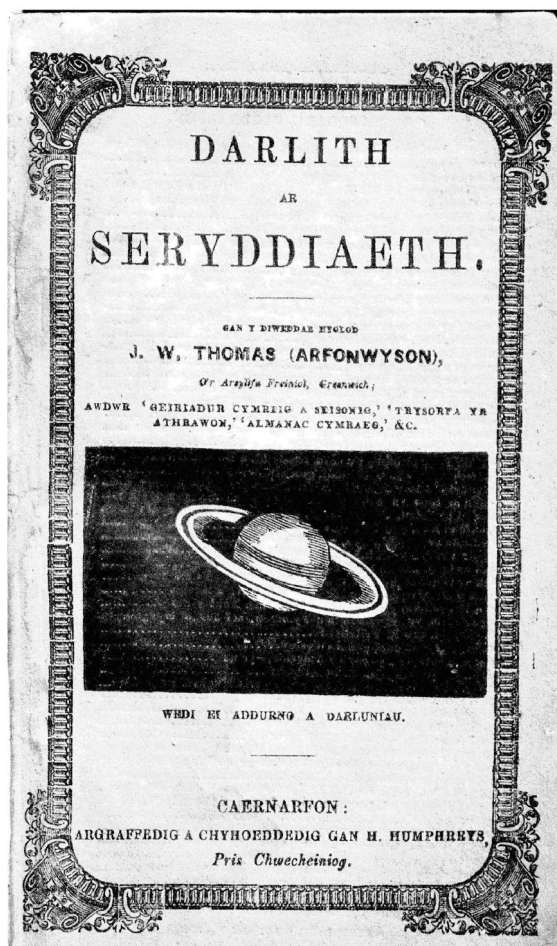


Fig.6 Cover of the booklet *Darlith ar Seryddiaeth* ('A Lecture on Astronomy') by John Wm. Thomas, superintendent of the computing staff at Greenwich. Written c.1835, but published posthumously in 1840
Picture by the author

Jones (1799–1873) in his *Hanes y Nef a'r Ddaear* ('History of the Heavens and the Earth') of 1848.⁷⁹

The 19th century saw some translations of books written in English into Welsh. A version of R.A. Locke's infamous 'Moon Hoax' appeared around 1840, demonstrating that not always were the most reliable texts chosen for translation.⁸⁰ A translation by Griffith Parry (1827–1901) of Thomas Chalmers's *A Series of Discourses on the Christian Revelation Viewed in Connection with the Modern Astronomy* appeared as *Pregethau Seryddol* ('Astronomical Sermons') in 1846.⁸¹ The renowned publisher Thomas Gee produced a translation of the astronomical volume of Jeremiah Joyce's *Scientific Dialogues*, under the title *Elfenau Seryddiaeth* ('Principles of Astronomy').⁸² *The Solar System* by the Scottish author Thomas Dick was translated by Eleazar Roberts (1825–1912), appearing as *Y Dosparth Heulawg*.⁸³

Roberts was born in Pwllheli, Caernarfonshire, but spent almost all his life on Merseyside, where he worked as chief clerk to a court of law.⁸⁴

The 19th century saw a vigorous publishing industry in Wales which produced many newspapers and magazines in both Welsh and English. These sometimes included articles about astronomy of a general nature to educate a broad audience.⁸⁵ However, despite the appearance of a fairly appreciable body of astronomical material in print, the Welsh words adopted for astronomical terms varied considerably between authors.



Fig.7 John Dillwyn Llewelyn (1810–1882), amateur astronomer and pioneering photographer, of Penllergaer, near Swansea

Flickr gallery of the National Library of Wales

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The Dillwyn-Llewelyn Family

Lewis Weston Dillwyn (1778–1855) was born in Hackney, London, the son of an American-born Quaker who purchased the Cambrian Pottery in Swansea.⁸⁶ Dillwyn relocated to Swansea to run his father's businesses. His main scientific interests were in natural history, but his diaries show that they also extended to astronomy, including casual observations of comets, eclipses and the aurora.⁸⁷ Among Dillwyn's acquaintances were Sir James South, whose obser-

vatory he visited in London. South, W. H. Smyth and other astronomers visited Dillwyn at his Swansea home, Sketty Hall.⁸⁸ Dillwyn's son, John Dillwyn Llewelyn (1810–1882) pursued various scientific and technological interests at his Penllergaer estate near Swansea.⁸⁹ He has been celebrated as a pioneering photographer of the 1840s and 1850s.⁹⁰ Llewelyn built an observatory on his estate, equipped with a 4¾-inch equatorial refractor, commencing its construction in 1851.⁹¹

Llewelyn's daughter, Thereza Mary Llewelyn (1834–1926), later Thereza Story-Maskelyne, shared her father's scientific interests and made extensive use of the Penllergaer observatory. Her journal entries show her enthusiasm for observing the Sun, Moon, planets, stars, clusters and nebulae, whilst clearly possessing an excellent knowledge of the objects within reach of her telescope.⁹² Thereza worked with her father to photograph the Moon in the mid-1850s when she operated the telescope, including driving it to



Fig. 8 Thereza Mary Llewelyn (1834–1926), later Thereza Story-Maskelyne, amateur astronomer and daughter of J. D. Llewelyn

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compensate for the Earth's rotation, while her father operated the camera.⁹³ Their most successful lunar photograph dated from 1858.⁹⁴ She later married the mineralogist and chemist Nevil Story-Maskelyne, grandson of the Astronomer Royal Nevil Maskelyne.⁹⁵

Clock Makers and Time Services

In the early and mid-19th century, major ports often had local time service providers for shipping. One example was John Jenkins (1802–1868), a Swansea watch and chronometer maker elected to the Royal Astronomical Society in 1842.⁹⁶ Jenkins had an observatory at his premises at Wind Street, Swansea although he subsequently moved to live on the Gower.⁹⁷ A Swansea competitor, John T. Owen was elected to the RAS in 1855.⁹⁸ Clock and chronometer makers frequently described their premises as ‘observatory’. For example, Solomon Marks (c.1801–1883), a prominent member of the Cardiff Jewish community, gave his address as ‘Bute Dock Observatory’.⁹⁹ Similarly, T.J. White of Haverfordwest, Pembrokeshire, gave his address as ‘The Observatory, Market-street’.¹⁰⁰

19th Century Amateur Astronomers

The 19th century saw many amateur astronomers in various localities across Wales, spanning the social spectrum from the manual working class to the aristocracy. Many pursued their studies in isolation. Some did so in collaboration with others locally or in contact with scientists further afield.

One example was Benjamin Hill (c.1801–1888), a businessman, physicist and engineer of Cwmdwr, Clydach, near Swansea, who possessed an astronomical observatory.¹⁰¹ Another, Thomas Norbury (c.1807–1872) was a Worcestershire-born shopkeeper in Merthyr Tydfil who built an observatory above his premises.¹⁰²

William Rees (1802–1883), a prominent Independent Methodist minister, editor, Welsh-language poet and political radical based in Liverpool, maintained an interest in astronomy. Rees, often better known by the nom-de-plume Gwilym Hiraethog, frequently lectured in Wales on the science.¹⁰³

William Owen Williams (1818–1888), a native of Anglesey, became a prominent Calvinistic Methodist minister and an amateur astronomer.¹⁰⁴ He observed with a 4-inch refractor, specialising in observing the Moon to monitor the lunar surface for possible changes.¹⁰⁵ Williams served chapels in Pwllheli, Penmaenmawr, Liverpool and, in the 1850s at Trem-eirchion near St. Asaph in an attempt to strengthen Protestantism, given the presence of St. Beuno’s Catholic college nearby. Among the temporary students at St. Beuno’s were astronomers from Stonyhurst College, Lancashire, such as Stephen Joseph Perry (1833–1889), Walter Sidgreaves (1837–1919) and Aloysius Cortie (1859–1925). The Stonyhurst

astronomer Alfred Weld (1823–1890) served as rector of St. Beuno’s College from 1871 to 1873.¹⁰⁶

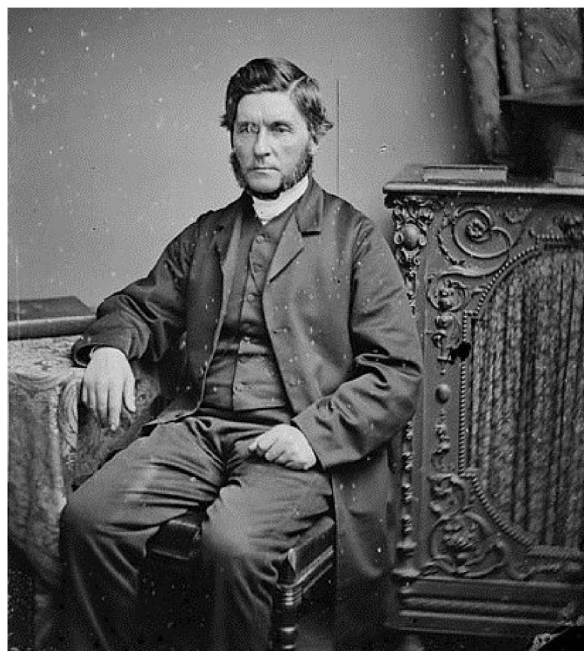


Fig.9 Rev. Wm. Owen Williams (1818–1888), an amateur astronomer who specialised in observing the Moon

John Thomas photographic collection at the Digital Mirror on the website of the National Library of Wales
By permission of Llyfrgell Genedlaethol Cymru/
The National Library of Wales

Several wealthy English amateur astronomers retired to Wales and erected private observatories. Murray Gladstone (1816–1875), a Manchester businessman, moved to Penmaenmawr near Conwy where he built a residence and observatory.¹⁰⁷ The Liverpool architect George Williams (1814–1898), a friend of William Lassell, retired in 1880 to his brother’s residence at Dolmelynlyn, north of Dolgellau, Meirionnydd. He built an observatory equipped with a 4-inch refractor.¹⁰⁸ Edward Joseph Lowe (1825–1900) of Nottingham moved in 1882 to Shirenewton Hall, near Chepstow.¹⁰⁹ A Lancashire engineer, Thomas Thorp (1850–1914) built a bungalow for his retirement in Prestatyn with an observatory dome on a tower in the roof.¹¹⁰

The Royal Astronomical Society had a number of fellows with strong Welsh connections in the middle-19th century, mostly from among the wealthy Anglo-Welsh gentry. One such was William Coffin (c.1790–1866) of Llandaf, Cardiff, who joined the Astronomical Society of London (subsequently the Royal Astronomical Society) in December 1820, months after its formation.¹¹¹ Among the society’s founder members was Thomas Frederick Colby (1784–1852), an army

officer, military surveyor and cartographer.¹¹² Born in Kent, Colby spent much of his childhood at his aunt's home Rhos-y-gilwen, near Newcastle Emlyn, Carmarthenshire.¹¹³ The surveyor and cartographer Sir George Everest (1790–1866), after whom a mountain was named, was elected a fellow in 1823 and came from a Breconshire family.¹¹⁴ John Crichton Stuart (1793–1848), the Second Marquis of Bute, owned extensive lands in the South Wales coalfield which he developed commercially. Bute was a fellow of the RAS for 21 years.¹¹⁵ He appointed the astronomer William Henry Smyth (1788–1865) in 1839 to supervise the construction of new docks in Cardiff, where Smyth also worked on the writing of his book *A Cycle of Celestial Objects*.¹¹⁶ Smyth lived with his family at Spring Garden House, Crockherbtown (now Queen Street).¹¹⁷

Edwin Wyndham-Quin (1812–1871), Third Earl of Dunraven and Mount Earl, was elected a fellow of the Royal Astronomical Society in 1831. His main residence was at Dunraven Castle, west of Llantwit Major. He had studied at Trinity College Dublin and carried out the routine observations at Dunsink Observatory, but abandoned observational astronomy for other interests, particularly archaeology, due to declining eyesight.¹¹⁸ The medic John Jesse (1801–1863), a fellow of the RAS from Manchester, inherited the Llanbedr Hall estate near Rhuthun, Denbighshire in 1848, which then became his residence.¹¹⁹

The second half of the 19th century saw fellowship of the RAS extend across the comfortable middle classes. William Evans (1828–1904), a local medic in Llannerchymedd, Anglesey, built an observatory on a stone tower at the back of his house.¹²⁰ A Cambridge-educated London solicitor, Harry Samuel Williams (1840–1921) retired to Swansea.¹²¹

Some people born in Wales became amateur astronomers after moving to England. For example, William James Lewis (1847–1926), born in Llanwyddelan, Montgomeryshire became an academic mineralogist in Oxford, later London and then professor of mineralogy in Cambridge. He travelled to observe total solar eclipses in Spain in 1870 and in Ceylon in 1871.¹²² Originally from Llanddulas, Denbighshire, Robert Pritchard Davies (1823–1905) became an Anglican cleric and amateur observer, serving as a vicar in Gloucestershire, where he erected an observatory.¹²³

John Jones, *Y Seryddwr* (1818–1898)

Of all 19th century Welsh amateur astronomers, perhaps the figure to attract most attention was John Jones, commonly known as *Y Seryddwr* ('The Astro-

nomer'). Jones was born into a poor family near Brynisiencyn, Anglesey. He received a modest education until becoming a farm labourer at the age of 12 years, following the death of his father. He also carried out some part-time work for a local minister of religion, which gave illicit access to the minister's library when he was out. Here, Jones read the Welsh translation of Thomas Dick's *The Solar System*.¹²⁴

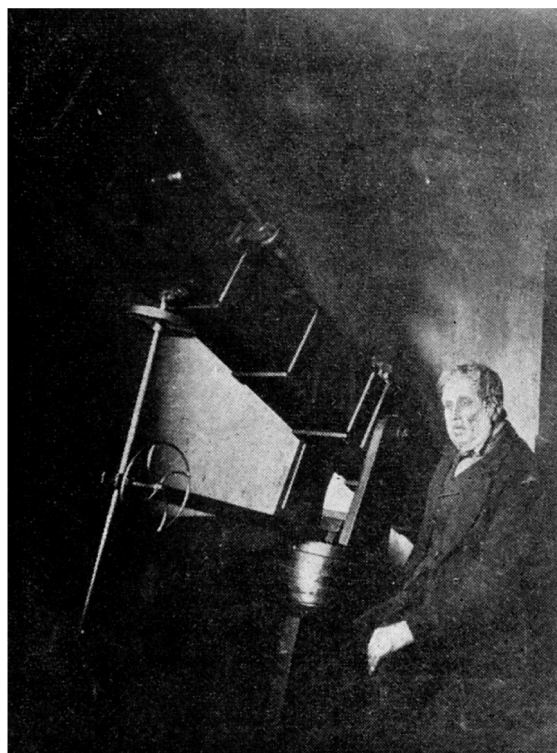


Fig. 10 John Jones (1818 – 1898), *Y Seryddwr*, of Bangor, & his home-made 8-inch reflecting telescope
Journal of the Astronomical Society of Wales, vol.1, no.4, facing page 36, 1895
Picture by the author

Ill health forced Jones to abandon heavy manual labour. He moved to Bangor and became a slate counter at Penrhyn Port, educating himself further in his spare time. Although he had diverse intellectual interests, the greatest of these was astronomy. He constructed a small, simple refracting telescope in the early 1860s. Dissatisfied with its performance, he started in 1868 to build an 8-inch silver-on-glass reflector. Jones ground the glass blank to a spherical surface himself, sending the mirror to George Calver for parabolising and silvering. He constructed a large wooden tube and mount from wood. He also constructed a 6-inch reflector and a spectroscope, grinding a prism from a ship's skylight.

John Jones attracted considerable notoriety for his accomplishments, particularly given his working-class

background. Most notably, Samuel Smiles used Jones's example of an individual transcending difficult personal circumstances in his writings.¹²⁵ The Bangor astronomer should not be confused with a John Jones (c.1827–1900), born in Rhesycae, Flintshire, who worked for a time on compiling almanacs, nor with the amateur astronomer Lieutenant-Colonel John Jones (1800–1875) who lived near Llyswen, Breconshire, in the 1860s.¹²⁶

Isaac Roberts (1829–1904)

The Welsh person most celebrated for his contributions to astronomy in the 19th century was undoubtedly Isaac Roberts, born in Y Groes in the hills west of Denbigh. His family relocated to Liverpool while he was still a child, where he subsequently became an apprentice builder. He progressed through the building trade, becoming a manager, then a partner in a successful company of builders. He devoted much of his spare time to educating himself, developed an interest in geology and then astronomy. He set up a private observatory with a 7-inch refractor and experimented with astronomical photography using camera lenses of various sizes attached to the telescope's mount. He retired from business, having amassed sufficient wealth to pursue his astronomical interests.¹²⁷

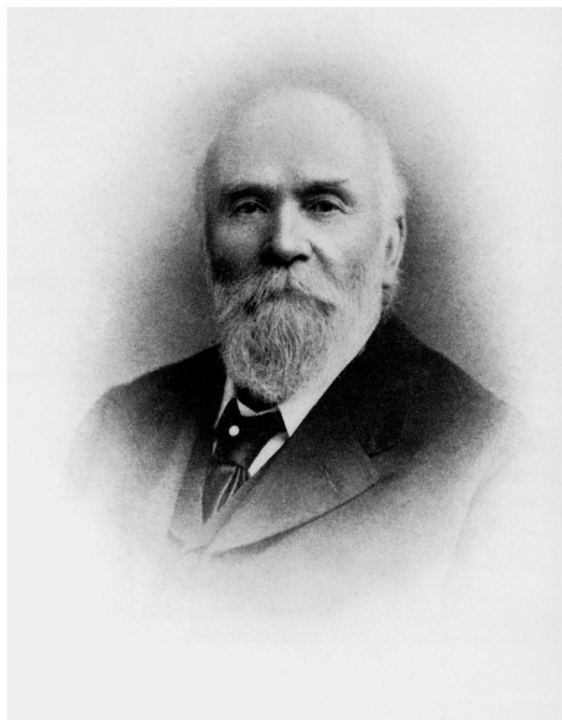


Fig. 11 Isaac Roberts (1829–1904), pioneer of long-exposure astronomical photography
Courtesy of the Royal Astronomical Society

PHOTOGRAPH OF THE GREAT NEBULA IN ANDROMEDA.
BY
ISAAC ROBERTS, F.R.A.S., F.R.S.
ON OCTOBER 1ST 1888, AT MAGHULL, LIVERPOOL.
EXPOSURE 2 HOURS.



Fig.12 A two-hour exposure of the Andromeda Galaxy, M31, by Isaac Roberts. The photograph was taken on 1 Oct. 1888 from Maghull, near Liverpool, and was among Roberts's first images to reveal spiral structure

SSPL Image No. 10415880

Courtesy of the Science Museum, London

Encouraged by his results from small portrait lenses, he ordered a 20-inch aperture reflecting telescope from Howard Grubb, Dublin, to perform long-exposure photography at its prime focus. Roberts recorded a series of exposures of nebulae, star clusters and star fields from his observatory at Maghull outside Liverpool. He relocated in 1890–1891 to a better observing site at Crowborough, Sussex, from where he continued his research projects, in collaboration with his assistant William S. Franks (1851–1935).¹²⁸ Roberts published reproductions of many of the better photographs in two volumes in 1893 and 1899.¹²⁹ The aspect of this work that attracted most attention was the realisation that the bright and dark lanes in the great Andromeda Nebula (Messier 31) followed a spiral structure and that the object was therefore the largest and brightest of the spiral nebulae. Roberts however, interpreted the object as a planetary system undergoing formation, rather than as an independent system beyond the Galaxy.¹³⁰

Organising an Amateur Community

Some 19th century Welsh philosophical societies, mechanics' institutes and scientific organisations on occasion showed an interest in astronomy.¹³¹ For example, the Usk-born naturalist Alfred Russel Wallace (1823–1913) wrote in his memoirs of his experiences living in Neath in the 1840s when the local philosophical society purchased a telescope 'with a four- or five-inch object glass'.¹³² Wallace's one major contribution to astronomy was his rational consideration of the possibility – or improbability – of life elsewhere in the Universe and on Mars in particular.¹³³ The Cardiff Naturalists' Society formed an astronomical section in 1881, but it was disbanded the following year.¹³⁴ The Swansea Scientific Society established a short-lived astronomical section in 1889, but requests for the society to establish an observatory were dismissed.¹³⁵

In 1892 a journalist, author and amateur astronomer called Arthur Mee moved from Llanelli to Cardiff to work for the *Western Mail* group of newspapers. Born in Aberdeen in 1860, he had spent part of his childhood in Llanelli where his father had been a newspaper editor. Mee had developed an interest in astronomy and observed with his 8½-inch Calver reflector.¹³⁶ He wrote books and pamphlets on astronomy and a range of other subjects.¹³⁷ He was in 1890 a founder member of the British Astronomical Association, serving on its large (49-strong) provisional committee.¹³⁸



Fig.13 Arthur Mee (1860–1926) using his 8½-inch Calver reflecting telescope to observe the Sun from his Cardiff home
Evans, J.S., *Seryddiaeth a Seryddwyr* (Ref.2) page 7.
Picture by the author

Mee made the acquaintance of amateur astronomers in the Cardiff area, with whom he discussed the possibility of forming a local organisation dedicated to amateur astronomy. Taking the initiative with Norman Lattey (1864–1941) of Dinas Powys, Mee called a meeting in Cardiff in December 1894 to discuss establishing an all-Wales association which led to the formation of the Astronomical Society of Wales.¹³⁹ Mee was elected president and editor of the journal, Lattey as secretary and treasurer. The society had at the outset as many as 18 vice-presidents, intended to provide representation from across Wales. It published its journal, monthly at first, containing reports of meetings, various articles and Mee's reports of members' observations. The journal was replaced in 1898 by a quarterly magazine, the *Cambrian Natural Observer* which supplemented the astronomical material with reports of other natural phenomena, particularly weather reports. The magazine was produced, annually at some times, up to 1910. The society held regular meetings in Cardiff, featuring lectures. Indeed, most of its activities were concentrated in the city.

During its lifetime, the presidents of the Astronomical Society of Wales included Arthur Mee, Charles T. Whitmell (1849–1919), George Carslake Thompson (1843–1906), James Waugh (1852–1910), Rev. William Edward Winks (1842–1926), Henry Herbert Lee (1838–1920), James A. Kidd (d.1915), Albert Taylor (1865–1930) and Dr. Percy Billups (1859–1938).¹⁴⁰ Of these, Whitmell and Taylor were inspectors of schools, but Welsh astronomy lost Whitmell when he relocated to his native Leeds in 1897.¹⁴¹ Taylor had earlier worked as a demonstrator in astronomical physics at the Royal College of Science (now Imperial College) in London, as a research assistant to A.A. Common in west London and as an assistant to Sir Howard Grubb in Dublin.¹⁴² Waugh was a prominent Cardiff secondary school headteacher.¹⁴³ Thompson was a barrister and supporter of educational causes.¹⁴⁴ Winks was a Baptist minister in Cardiff, while Major-General Lee of Dinas Powys was a retired army officer and Billups a prominent medic in Barry.¹⁴⁵ Kidd was a local councillor in Cardiff.¹⁴⁶ Several had private observatories. Besides Lattey, the position of secretary was filled by Miss E. Graham Hagerty (c.1856–1944), Miss Annie Rule, C.D.R Andrews, Arthur Mee and John Rees (1862–1949). Lattey had been born in India, later moved to Bristol and died in Birmingham in 1941.¹⁴⁷ Elizabeth Graham Hagerty and Annie Rule were teachers, Hagerty of secondary school science.¹⁴⁸ John Rees was a company secretary and accountant.¹⁴⁹

JOURNAL

OF THE PROPOSED

Astronomical Society for Wales.

VOL. I.] JANUARY, 1895. [PRELIMINARY NUMBER.

The formation of an Astronomical Society for Wales and Monmouthshire was suggested in conversation amongst a few friends at Cardiff, towards the close of last year. Enquiry quickly showed that such a Society would be welcome, and letters and paragraphs in various newspapers and periodicals, both English and Welsh, combined with the efforts of friends of the movement, as well at Cardiff as at Newport, in North Wales, and other parts, has resulted in a membership already of some sixty persons, of whom some have long been practical observers, others take a general interest in astronomy, and others again are desirous of forming an acquaintance with the science. As soon as it was seen that the support received justified further action, a Preliminary Meeting of Members was called for December 14th, at St. Paul's Schoolroom, Neville Street, Cardiff, kindly lent for the occasion. Mr. Arthur Mee was voted to the chair and stated what had already been done towards forming a Society, and read selections from a mass of correspondence relating to the subject. Discussion took place on the name of the Society, and the following suggestions were made—

"The Astronomical Society of Wales."

"The National Astronomical Society of Wales and Monmouthshire."

"The Cambrian Astronomical Society."

The constitution and rules of the Society were partly considered and adjourned to the next meeting. The following were appointed Provisional Committee, with power to add to their number:—Messrs. Arthur Mee, N. Lattey, J. Rees, W. H. Burrows, G. H. Gunn, and S. Forsdike. Mr. R. W. Atkinson, B.Sc. (President of the Cardiff Naturalists' Society), attended the meeting by invitation and assured it of the goodwill of that Society. Thanks were accorded for the loan of the Meeting Room.

At a second meeting of the Committee, fully attended, on December 20th, the Rules of the Society were drafted and a list of Officers drawn up.

The minutes of the Meetings of the Committee, of which the foregoing is an abstract, will be submitted to the First General Meeting of Members, to be held at the Hotel Metropole (opposite the T.V.R. Station), Cardiff, on Wednesday, Jan. 9th, at 7.30 p.m. Members who are unable to attend on that night are requested to forward their suggestions (if any), as to the Rules or List of Officers, or otherwise, not later than Monday, January 7th, to Mr. N. Lattey, Provisional Secretary, Eastbrook House, Dinas Powis, Cardiff.

Fig.14 The first page of the preliminary edition of the *Journal of the Astronomical Society of Wales*, January 1895, announcing the formation of the society

Picture by the author

Others contributors to the society included the businessman Thomas Edward Heath (1849–1918) of Cardiff, later of Tenby, and Griffith Parry Jenkins (1860–1940), a bank employee originally from Ceredigion.¹⁵⁰ Jenkins emigrated to Canada in 1902

the Cardiff area, offered his observatory and instruments to the local corporation.¹⁵⁷ Evans had purchased the telescope and observatory from William Conybeare Bruce (1844–1919), Anglican vicar of St. Nicholas in the Vale of Glamorgan, for whom it had originally

and was replaced as manager of a Colwyn Bay bank by the brother of Rhishard Llewelyn Jones (1865–1932), professor of physics in Madras and deputy director of the Kodaikanal and Madras Observatories.¹⁵¹

The Astronomical Society of Wales's membership list for 1910 had as many as 222 named members.¹⁵² However, the Society published the last edition of its journal – the edition for 1912 – in 1913 and appears to have gone into decline after this time. During the period 1910–1917, Arthur Mee published his summaries of amateur observations in local newspaper *Astronomical Notes* columns, rather than in publications of the society. For this, Mee was dependent on the work of some stalwart observers, such as Owen John Owen (1867–1960) of Abergavenny, Taliesyn Kenwin Jenkins (1879–1936) of Nantyglo near Ebbw Vale, William John Waters (b.1875) of Abercynffig, H. Percy Wilkins (1896–1960) and Thomas Harries (b.1871) of Llanelli.¹⁵³ Silas Evans quoted Mee as stating that the society came to an end with the war.¹⁵⁴ Billups however, was still describing himself as president as late as November 1917.¹⁵⁵

The early burst of activity by the Astronomical Society of Wales coincided with the donation of a Calver 12-inch reflecting telescope and observatory to the city of Cardiff. A letter-writing campaign to editors of local newspapers in 1896 called for a public observatory for the town.¹⁵⁶ In response, Franklen Evans (1826–1904), a medic from



Fig.15 The cover of the Journal of the Astronomical Society of Wales, October 1895. The artwork was by Joseph Morewood Staniforth (1863–1921), cartoonist to the Western Mail group of newspapers
Picture by the author

been manufactured.¹⁵⁸ Progress by the local council following the gift was very slow. Eventually a site was found at the council's waterworks at Penylan, and the new Cardiff City Observatory was formally opened in 1906.¹⁵⁹ The facility was used for public education and by the local amateur astronomy community but not for research. Daniel James Jones (1876–1965) was subsequently employed as the curator.¹⁶⁰ The observatory continued to function until the late 1970s when it closed and was demolished.

Though impressive, the Cardiff telescope was not the largest in Wales. Silas Evans awarded that distinction to the 18-inch Cooke reflector owned by David Evans (1858–1910), Anglican vicar of Cynwyl Elfed, Carmarthenshire.¹⁶¹

The first local astronomical society in Wales was established in Barry in 1910, with Percy Billups serving as president.¹⁶² Arthur Mee donated his 8½-inch

Calver reflecting telescope to the new organisation. The members built an observatory overlooking Barry Docks, which was opened formally in May 1914.¹⁶³ In December 1921 the Barry society was joined by a Llynfi Valley Astronomical Society around Maesteg and in May 1922 by a Cardiff Astronomical Society, though neither seems to have lasted in the long term. Silas Evans noted that a majority of the Llynfi Valley members were miners, which Allan Chapman has contrasted with the mostly middle-class membership of the former Astronomical Society of Wales.¹⁶⁴

Several local amateur organisations were set up in Wales during the middle of the 20th century, such as a Cardiff and District Astronomical Society (1940s–1950s) and a Cambrian Astronomical Society.¹⁶⁵ However, only the Swansea Astronomical Society (1948–present) succeeded in the long term. A number of societies appeared in the later 20th century, including the Cardiff (established 1975), the Gwynedd (1974) and Bridgend (1982) astronomical societies. A new Astronomical Society of Wales was established in 1981, which operated as an all-Wales organisation for a few years, issuing a quarterly journal.¹⁶⁶ The society subsequently reduced its geographical ambitions to the area around Port Talbot, when it was led by B. E. Featherstone (1913–1995), and eventually (1994) became the Port Talbot Astronomical Society.¹⁶⁷

A Society for the Astronomical Study of Ancient Monuments in Wales was established in 1908 by Rev. John Griffith (b.1860) with the support of Sir Norman Lockyer.¹⁶⁸ Griffith published some enthusiastic, but very uncritical, interpretations of prehistoric monuments.¹⁶⁹

20th century amateurs

The 20th century saw considerable activity by amateur astronomers in Wales and by individuals born in Wales working elsewhere. Arthur Philip Norton (1876–1955), author of *Norton's Star Atlas* was born in Cardiff, but only lived in Wales as an infant.¹⁷⁰ Carmarthenshire-born Hugh Percy Wilkins (1896–1960), one of Arthur Mee's correspondents in the 1910s, became a noted observer of the Moon, director of the British Astronomical Association's Lunar Section and the author of several books, including a Moon map with a diameter of 300 inches.¹⁷¹ Detailed lunar drawings were also made by Miss Evelyn Whitehead (b.c.1867; fl.1911) of Linda Vista, Abergavenny, formerly of Deighton Grove, near York.¹⁷²

In his 1923 book *Seryddiaeth a Seryddwyr*, Silas Evans devoted 33 pages to his survey of contemporary Welsh amateur astronomy, listing over 50 individuals alive at that time.¹⁷³ Curiously, as Chapman has point-

ed out, all were male.¹⁷⁴ These figures ranged from casual hobbyists, through dedicated observers to amateur telescope makers such as William John Waters and Taliesyn Kenwin Jenkins. One remarkable case was that of John Alun Lloyd (b.1895) of Rhewl, Denbighshire who had a 12½-inch reflecting telescope mounted on a trolley that moved on rails.¹⁷⁵



Fig.16 Silas Evans (1864–1953), Anglican cleric, amateur astronomer and author of the popular book *Seryddiaeth a Seryddwyr* about astronomy
Picture by the author

Silas Evans himself was born in Pencarreg, Carmarthenshire, near Lampeter in 1864. After gaining a degree from Saint David's College, Lampeter, he entered the Anglican church and served ministries in north and mid Wales. In 1909 he was appointed vicar of Llanrhaeadr-ym-Mochnant, between Bala and Oswestry, which he served subsequently as a canon until 1938. He retired to Aberystwyth and later to his home village of Pencarreg, where he died in 1953.¹⁷⁶ Evans wrote several books besides *Seryddiaeth a Seryddwyr*, including *Marvels of the Sky*.¹⁷⁷

Evans was not the first 20th century author to write a general introduction to astronomy in Welsh. Caradoc Mills (1883–1950), sometimes spelled Caradog, published *Y Bydoedd Uwchben: Llawlyfr ar Seryddiaeth* ('The Heavens Above: A Handbook on Astronomy') in 1914.¹⁷⁸ Born in Llanrwst in North

Wales, Mills received his university education in Bangor and regularly contributed scientific articles to Welsh-language magazines, often using the nom-de-plume Sigma.

The amateur observer John Richards Owens (1899–c.1977), sometimes spelled Owen, of Llanrhystyd near Aberystwyth took possession of the meteorite which fell at Pontllyfni near Caernarfon.¹⁷⁹ The meteorite fragments that fell in Beddgelert in Snowdonia in 1949, in contrast, found their way more speedily into scientific collections.¹⁸⁰

Kenneth Glyn Jones (1915–1995), originally from New Tredegar, became a well-known amateur observer of star clusters, nebulae and galaxies.¹⁸¹ An amateur called Gordon Ellis, observing from near Llandudno, attracted considerable notoriety when he independently discovered a nova in the southern constellation Puppis in 1942, within a few days of it first being recognised, despite its very low altitude from Britain.¹⁸²

20th Century Researchers

A number of people of Welsh origin pursued academic research elsewhere in the world during the 20th century. The pioneering meteorologist, Montgomeryshire-born Sir David Brunt (1886–1965), who used fluid mechanics to model the Earth's atmosphere, began his scientific career as a research student in astrophysics at the Cambridge Observatories.¹⁸³ Idwal Owain Griffith (1880–1941) contributed to photographic photometry at Oxford.¹⁸⁴ Robert Atkinson (1898–1982) was born near Rhaeadr in Radnorshire. He became chief assistant at the Royal Observatory, Greenwich and later an academic at the University of Indiana. He made contributions widely across astronomy, including stellar astrophysics, nuclear energy generation in stars, positional astronomy and instrumentation.¹⁸⁵

Roger Daniel Hewart Jones (b.1908) from Aberystwyth and later Radyr near Cardiff, performed astronomical research in Cambridge before becoming an academic mathematician in the United States.¹⁸⁶ Hugh Ernest Butler (1916–1978) from Cardiff became a chief assistant at Dunsink Observatory, then principal scientific officer at the Royal Observatory, Edinburgh, where he researched into astronomical instrumentation and photometry.¹⁸⁷

A native of Swansea, Edward George Bowen (1911–1991), became a pioneer of radar before and during the Second World War and was one of the participants in the Tizard Mission to the United States in 1940. He subsequently applied this expertise to radio astronomy in Australia, which led through his efforts to the building of the radio observatory at

Parkes. Bowen had a central role in the creation of the Anglo-Australian Telescope.¹⁸⁸

The stellar astrophysicist David Stanley Evans (1916–2004), from Cardiff, was awarded his PhD for research at Cambridge with Eddington. He later worked at the Radcliffe Observatory and Royal Observatory at the Cape of Good Hope in South Africa. He moved to the University of Texas at Austin, where he became a professor of astronomy and associate director of the MacDonald Observatory.¹⁸⁹ A native of Penarth near Cardiff, Barbara Middlehurst (1915–1995) also contributed to astronomy in the United States, particularly with lunar research and through editing astronomical publications.¹⁹⁰ Another Cardiff-born scientist, the geophysicist Gareth Hubert Stanley Jones (1924–1997) contributed in Canada to research into lunar cratering, in particular in relation to the manned lunar landings in the 1960s.¹⁹¹ David Lunt (1942–2005) from Denbigh became an optical engineer in the United States and developed the mirror for NASA's Orbiting Solar Observatory. He later established the Coronado Technology Group to sell telescopes with narrow-band hydrogen-alpha filters for amateur solar observers.¹⁹²

Pembrokeshire-born Dyfrig Jones (1940–1989), became head of the Space Plasma Physics Group at the British Antarctic Survey, where his research interests extended to the magnetospheres of the outer planets. Unusually, he was awarded PhD degrees by two different universities.¹⁹³

Academies and Universities

A number of religious denominations established academies to train individuals for the ministry. As such, their curricula emphasised theology and the liberal arts, but some academies included the physical sciences and mathematics. In particular, the Presbyterian College in Carmarthen taught science in the later-18th and early-19th centuries. It possessed a number of astronomical textbooks and instruments that were used for instruction, including a telescope, orrery and quadrants.¹⁹⁴ Instruments once owned by Joseph Harris (c.1704–1764) remained in the possession of the Methodist College at Trefeca, Breconshire.¹⁹⁵

St.David's College, Lampeter, which opened in 1827 as an Anglican university college, had a chair of natural philosophy, later of science, but contributions to astronomy extended little beyond an observation of a meteor storm.¹⁹⁶

There were unsuccessful attempts to establish non-denominational private colleges in Wales that would teach a scientific and technical curriculum. Charles

Francis Greville (1749–1809), the second son of the Earl of Warwick and developer of the town of Milford Haven in Pembrokeshire, instigated a scheme to establish a 'College of King George' at Hakin near Milford with an astronomical observatory at the core of the project.¹⁹⁷ He appointed Thomas Firminger (1775–1861), previously assistant to the Astronomer Royal, Nevil Maskelyne, at Greenwich as superintendent.¹⁹⁸ A collection of telescopes and other instruments was assembled, including the noted 'Lee' transit circle manufactured by Edward Troughton and a sizeable observatory building was constructed.¹⁹⁹ However, Greville died in April 1809 and the project was abandoned before opening. The astronomical instruments were sold and the observatory building ultimately fell into ruin.²⁰⁰

An attempt was made to establish a university college specialising in science and technology at the Gnoll, near Neath, as a commercial venture in the 1850s, led by the agent of the Gnoll Estate.²⁰¹ The plans included an observatory under the direction of a Professor of Mathematics with Arthur Cayley (1821–1895) being recruited to the post. Although primarily a mathematician, Cayley had an interest in astronomy and later (1872–1874) served as president of the Royal Astronomical Society.²⁰² The scheme proved over-ambitious and collapsed shortly before the planned opening in 1857.

Non-denominational university education began with the formation of the University College of Wales, Aberystwyth (1872), followed by the University College of South Wales and Monmouthshire in Cardiff (1883) and the University College of North Wales in Bangor (1884). These new institutions did not have degree awarding powers, preparing students instead as external candidates of the University of London. As such, they taught to the London syllabus, which included some component of positional astronomy within mathematics. Consequently, Aberystwyth had a chair of Mathematics, Natural Philosophy and Astronomy (1872–1909), although the position was filled by mathematicians.²⁰³ Similarly, the mathematician Henry William Lloyd Tanner (1851–1915) served as Professor of Mathematics and Astronomy in Cardiff (1883–1909). Tanner maintained an interest in astronomy, becoming a vice-president of the Astronomical Society of Wales, although his academic research was almost exclusively in mathematics.²⁰⁴ The situation changed in 1893 when the three university colleges established the federal University of Wales with its own power to confer degrees and with its own syllabus. Astronomy was consequently lost from the title of the mathematics chairs.

The professor of mathematics in Bangor between 1896 and 1926, George Hartley Bryan (1864–1928), nonetheless was well prepared to teach mathematical astronomy, having been an author of a textbook on the subject while a fellow of a Cambridge college before his arrival in Wales.²⁰⁵ Bryan was an applied mathematician who specialised in fluid dynamics and early aircraft aerodynamics, but did study the retention of atmospheres by the planets of the Solar System by applying the kinetic theory of gases inside gravitational potentials.²⁰⁶

In 1926 the University College of North Wales received a donation of a 6-inch Grubb refracting telescope and a transit circle by the family of Arthur Edwin Brisco Owen (1858–1925), a Berkshire Anglican vicar whose father had come originally from Beaumaris, Anglesey. Brisco Owen had bought the telescope and observatory from a friend in Constantinople where he had served as assistant Anglican chaplain in the 1880s, subsequently erecting them at his home at Ufton Nervet, near Reading.²⁰⁷ The observatory was set up in Bangor in readiness for the total solar eclipse of 29 June 1927, equipped with a spectrograph to photograph the solar flash spectrum, but heavy cloud defeated attempts.²⁰⁸ A permanent concrete observatory building was soon constructed on the college's sports field where the telescope was used for undergraduate teaching.²⁰⁹ The observatory was eventually demolished to allow for the extension of a nearby building.²¹⁰ The telescope remained in storage in Bangor until the 1980s.²¹¹

Gwilym Owen (1880–1940), professor of physics at Aberystwyth, published a number of popular books and articles in Welsh about astronomy and physics.²¹² A few academics had sufficient interest in astronomy for them to stand for election to the RAS. Arthur Laidlaw Selby (1861–1942), professor of physics at the university college in Cardiff, was elected in 1891 and continued as a fellow for the rest of his life. He attempted to use astronomical examples to illustrate his physics lectures.²¹³ George Henry Livens (1886–1950), professor of mathematics in Cardiff, and William Jacob Jones, Professor of Chemistry, also became RAS members.²¹⁴

A fourth institution was added to the University of Wales in 1920 with the establishment of University College Swansea. A young researcher, Thomas George Cowling (1906–1990) was appointed as a junior lecturer in applied mathematics at the college in 1933, having previously worked as a demonstrator under Sydney Chapman at Imperial College, London.²¹⁵ Originally from East London, Cowling had studied mathematics at Oxford where he had stayed to carry

out research for his DPhil with E.A. Milne, who had directed him towards astronomical problems. At Swansea, Cowling pursued research into magnetic fields in stars, particularly in sunspots, and into stellar structure, including convection in stars and the calculation of stellar models. In these he applied theories of electromagnetism, the kinetic theory of gases and plasma physics to astronomical problems. One notable result was Cowling's Antidynamo Theorem which argues that a perfectly axisymmetric star or planet cannot maintain a magnetic field by a dynamo effect.²¹⁶



Fig.17 Thomas George Cowling (1906–1990), theoretical astrophysicist and applied mathematician, lecturer in Swansea (1933–1937) & professor in Bangor (1945–1948)

Courtesy of the Royal Astronomical Society

Cowling moved to University College Dundee in 1937 to take up a lectureship, then moved to the University of Manchester the following year. He returned to the University of Wales in 1945 when he was appointed to the chair of mathematics in Bangor. Cowling continued his theoretical research into the magnetic field of the Sun, including of sunspots, and solar flares. He also published a paper about oscillations of rotating stars in collaboration with his Bangor colleague R.A. Newing (1913–1984).²¹⁷ Cowling was elected to the Royal Society in 1947. In 1948 he moved to the University in Leeds to take up a chair of

applied mathematics and remained there for the rest of a distinguished career. He served as president of the RAS (1965–1967) and was awarded the society's gold medal.

Independently in Bangor, the applied mathematician L.I.G. Chambers performed some research into specialised theoretical cosmological models.²¹⁸

In 1946 University College Swansea appointed a former student, W.J. Granville Beynon (1914–1996) as an assistant lecturer.²¹⁹ Beynon had worked with Sir Edward Appleton in Slough on the transmission of radio waves through the ionosphere of the Earth, following his PhD research in Swansea. He continued these research interests in Swansea, in collaboration with a colleague, G.M. Brown, including the effects of the Moon's shadow during eclipses on the Earth upper atmosphere. In 1958 Beynon moved to the University College of Wales, Aberystwyth, where he was appointed professor of physics and head of department. He built up a strong research group investigating the Earth's upper atmosphere and the Earth's interaction with the interplanetary medium, regularly using sounding rockets and radar, including radar facilities near Aberystwyth.

New staff were recruited to Aberystwyth, including P.J.S. (Phil) Williams (1939–2003) and Lance Thomas.²²⁰ Williams had previously worked in Cambridge on radio studies of quasars and radio galaxies, but changed his research activity to those of Beynon's group, particularly upper atmosphere radar and the solar wind.²²¹ Plans were developed in the middle 1960s to construct a novel low-frequency radio telescope north of Aberystwyth for general astronomical research, but government funding was not forthcoming following a commitment to concentrate British radio astronomy at Jodrell Bank and Cambridge.²²² The research council instead committed itself to funding ionospheric research at Aberystwyth. Beynon was subsequently elected to the Royal Society and was honoured with a knighthood. Williams was elected to the National Assembly for Wales at the time of its establishment in 1999. The Aberystwyth group subsequently extended its research interests to include solar activity and the Solar System more broadly with extensive use of satellite data. This work continues today at Aberystwyth University.

The Nuffield Radio Astronomy Laboratories at Jodrell Bank in Cheshire operated equipment at sites in Wales. Small temporary radio antennae were used from sites in Flintshire and Mid Wales in the early 1960s.²²³ An observing station was set up at Abersoch on the Llŷn Peninsula to photograph meteors using, from 1957, a 12.9-inch diameter optical Schmidt cam-

era to determine heights of meteors using triangulation between Jodrell Bank and Abersoch.²²⁴ Highly ambitious plans were drawn up in the late 1960s and 1970s to extend the Jodrell Bank network with a new 122-metre steerable radio telescope near Meifod, Montgomeryshire, the largest in the world, but proved too costly for available government funding.²²⁵

Astronomical research was occasionally carried out by individuals working alone. Arnold Buxton (1893–1949), a mathematician at Cardiff Technical College, published research articles about the properties of images produced by astronomical telescopes.²²⁶ D.R. Lynn Jones (1931–2000) was a lecturer in mathematics at the Glamorgan College of Technology, later the Polytechnic of Wales, at Trefforest, near Pontypridd. He specialised in celestial mechanics, computing the motions of Solar System bodies, and studied comets.²²⁷

In Cardiff, in the 1960s, Terry L. John, an applied mathematician in the Department of Applied Mathematics and Mathematical Physics at the University College of South Wales and Monmouthshire, used computers to calculate opacities of the ionised gas within stars. The institution subsequently shortened its name to University College Cardiff. Meanwhile, Chandra Wickramasinghe, formerly of the Institute of Theoretical Astronomy, Cambridge, was appointed to a chair and as head of a new department of Applied Mathematics and Astronomy in 1973.²²⁸ Several additional astronomy academics were recruited over the following three years who had interests across modern astrophysics, including the interstellar medium, stellar evolution, observational extragalactic astronomy, the chemical evolution of galaxies and general relativity in astrophysics.²²⁹ Undergraduate degree courses involving astronomy were established. A 16-inch reflecting telescope was purchased for teaching and was housed in a dome on a tall tower block overlooking Cathays Park. Research council grants funded new computing equipment in 1987 to reduce and analyse observational data, particularly Hubble Space Telescope data in advance of the expected launch of the satellite.

University College Cardiff merged with the University of Wales Institute of Science and Technology in 1988, when astrophysics moved to the Department of Physics of the University of Wales College of Cardiff, leaving a small group working on more speculative astronomical ideas in the Institute of Mathematics. Astrophysics research extended into computational simulations of star and galaxy formation, the analysis of Hubble Space Telescope data and the signal processing of data from gravitational radiation observatories.²³⁰ A new astro-

nomical instrumentation group was established in the mid-2000s. This work continues today at Cardiff University.

Analysis

The history of astronomy in Wales up to the late-19th century is mostly a story of individuals pursuing their interests alone, or sometimes in association with a small number of acquaintances. Some of these achieved some notable accomplishments, particularly given the lack of wealth and formal education that many faced. Others found success only when they left Wales for greener pastures elsewhere.

It was only with the development of amateur astronomical societies, starting with the Astronomical Society of Wales in 1895, that amateur astronomers formed organised communities. Hitherto, Welsh astronomers lacked locally the networks available to learned people in many other parts in Europe, although the more wealthy had access to English or broader British structures.

Higher-education institutions – firstly the denominational academies, later the universities – were small until the middle of the 20th century and therefore lacked the concentration of resources that allowed universities in other countries to support a range of specialised branches of science, such as astronomy. No wealthy benefactors came forward to endow chairs in astronomy in established institutions. The attempts to set up an observatory and associated college at Hakin near Milford Haven, by Charles Greville might have produced an institution of significance, but for the ill-timed death of the founder. As a consequence, significant academic research in astronomy began in Wales only with Thomas Cowling's appointment as a junior lecturer in mathematics at University College Swansea in 1933.

The interpretation of the history of science in Wales suffers from certain difficulties. The loss of libraries on the dissolution of the monasteries has left a patchy and inadequate understanding of scholarship before the 16th century. In contrast, the parallel process in England was alleviated to some extent by the presence of two universities. There is a selection in favour of members of the affluent classes in surviving documents, such as the publications of the Royal Society and Royal Astronomical Society, which in the case of Wales means in favour of English-speaking society through to the 19th century. This bias is however, lessened for the 19th century by the development of a vigorous Welsh-language publishing industry. Women are particularly absent from the historical record. One important set of reference

sources in the study of British astronomical history are the obituaries of fellows of the Royal Astronomical Society, but women were excluded from fellowship until 1915.²³¹

Despite these challenges, it is possible to produce a relatively coherent picture of astronomy in Wales and by Welsh people through the ages. However, much historical research is still needed in what has been a comparatively neglected subject.

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