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The History of Astronomy in the University of Durham from 1835 to 1939

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The study of astronomy in the University effectively dates from the election of the Rev. Temple Chevallier (1) to the Chair of Mathematics in 1835. Chevallier came to Durham from Cambridge with a reputation as a scholar of wide learning, not only in mathematics but in theology, classics, English Literature and the French and Italian languages. Astronomy was one of his special interests for even when at Cambridge his profound knowledge of this subject had been demonstrated in several of his publications, most notably in one of his Hulsean lectures, entitled, 'The Proofs of Divine Wisdom and Goodness to be derived from a Study of Astronomy'.

In Durham, Chevallier increased the range and raised the standard of the astronomy taught in degree and certificate courses; thus, degree students were required to study large sections of Books I, II, and III of Newton's *Principia*. These courses were, naturally enough, mainly theoretical, for there was at that time in Durham little opportunity for practical work. The possibility of changing this situation by the creation of an Observatory occurred in 1838 when the Bishop of Durham received a letter from a well-known amateur astronomer, the Rev. T.J.Hussey of Hayes Court, Kent, in which he offered to sell his excellent astronomical instruments to the University. This letter was reported to Senate on 1839 January 7, and Chevallier was 'authorised to inspect the instruments with the assistance of the Astronomer Royal and others' (2). The report was favourable (3) and Senate agreed to establish an Observatory to be administered by a Board of Governors and staffed by an Observer and an Assistant Observer (4). In addition it was decided that Chevallier be authorized to open a subscription list to help pay for the instruments and the building. Letters, still in existence (5), show widespread support for the creation of an Observatory. A list of 143 subscribers, given in the University Calendar for 1840, includes the names of many prominent people, among whom may be mentioned: The Lord Bishop of Durham (£105), the Rev. Temple Chevallier (£50), Earl Grey (£25), Archdeacon Thorp (The Warden) (£35), Viscount Dunganon, MP (£25), H.J.Spearman (£25), and W.L.Wharton (£21). The total sum contributed was £1193 15s. A suitable site, at low cost, was made available by the Dean and Chapter.

The *First Report of the Curators*, dated 1840 June 23, indicated that considerable progress had been made towards the completion of the building.

Thus:

> The sums already subscribed for the Observatory, including £200 appropriated by the Dean and Chapter from the University Estate for the purchase of instruments, amounted to £1,411 19s. 0d. The purchase of the instruments, and expenses attending to removal amounted to above £900. The sums already paid towards the building amount to £580 and a further sum will be requisite to complete the building and fix the instruments.

By 1841 a simple building, designed by W.T.Salvin, had been constructed and the instruments installed. A dome, also purchased from the Rev. Hussey, was added in 1842. The principal instruments were a Fraunhofer telescope of 8 ft focal length and aperture 7 inches, mounted equatorially, a transit instrument with an aperture of 3¼ inches and a Sidereal Clock.

The Observatory went into service in 1842 under the direction of Chevallier, officially termed Observer, with the assistance of T.S.Brown, as Assistant Observer. In 1841 Chevallier was created Professor of Mathematics and Astronomy at a salary of £700 p.a. (**6**) and thereafter the name Assistant Observer was discontinued. The Observer was required to live at the Observatory and be an unmarried man, a restriction removed in 1866–7. A complete list of Observers is given in Note (**7**); several achieved distinction in astronomy in Durham or elsewhere most notably, Carrington, Rümker and Marth. Rümker became an important astronomer at Hamburg Observatory, and Marth did fine work on Saturn, Uranus and Neptune. Other notable observers were Plummer, (F.C.H.) Carpenter and Sargent.

The first work carried out at the Observatory was concerned with what may be described as the Astronomy of Position, that is, the accurate determination of the latitude of the Observatory and the checking of the instruments against known astronomical objects. The concentration on latitude was undoubtedly a consequence of the considerable interest at the time in the problem of polar wandering. The mean value of the latitude in 1843 was found to be N 54° 46′ 6·423″. The value adopted by the NA in 1850 was N 54° 46′ 6·2″ which is identical with that found by the Observer in 1848 by Bessel's Method (**8**).

Much observational work was also carried out on the limbs of the Moon and the Sun, on stars close to the N Pole, on Jupiter's satellites and the planet Neptune, discovered in 1846. News of the discovery reached Durham on 1846 October 2 and it was first seen on the following day. It is worthy of note that the early Durham observations of Neptune were supplied to a South African Observatory in the 1920s for a new calculation of the orbit of this planet.

A considerable improvement in observing became possible in 1846 with the gift from the Duke of Northumberland of an excellent refracting telescope of focal length 7 ft.

Late in the 1840s Chevallier initiated the regular and continuous observation of sunspots, pioneer work of great importance, later to be taken up by Durham's most distinguished observer, R.C.Carrington, who came from Cambridge in 1849 and left in 1852. Carrington and Chevallier established the main features of sunspots, and their work was basic to the later advancement

of the subject. Carrington also published in 1855 extensive observations on the minor planets and comets. A piece of work of particular note was his accurate determination of 1851 of the longitude of the Observatory by measuring the difference in time between Durham and Greenwich. This he did by transporting three accurate box chronometers supplied by Messrs. Reid & Sons of Newcastle upon Tyne, between the two places. The chronometers were a Hardy, a Reid and a Harrison. Two journeys were made and a weighted mean of the readings was taken, chief weight being given to the Reid chronometer. The chronometers were taken to London by train and then 'in a spring carriage by Hyde Park and Lewisham to avoid the pavement of London' (**9**). The difference so obtained was 6m 19·75s W a value adopted by the NA as standard. A fine stone obelisk, the gift of W.L.Wharton, Esq., a Curator, was erected in 1850, 1200 yards north of the Observatory, to mark the Meridian.

Carrington was so devoted to his subject that he soon became dissatisfied with the instruments in the Observatory, which by 1852 needed repair and renovation. A detailed plan to upgrade the Observatory and his own post was therefore submitted to the Curators but was rejected because of shortage of money. Carrington left, and being by that time a man of means, established his own observatory at Redhill, Surrey, where he enhanced his reputation by further detailed observations of sunspots and stars within 9° of the pole star. This latter work was subsequently published as *The Redhill Catalogue of Stars* and was rewarded by the award of the Gold Medal of the Royal Astronomical Society.

After Carrington's resignation sporadic observations were made but little of note appeared in the astronomical journals for several years until Plummer observed the transit of Mercury on 1868 November 4 and a fine display of the Aurorae Borealis on 1869 April 2. Plummer also wrote a number of well-known books among which may be mentioned *The Introduction to Astronomy* (1872), *The Zodiacal Light* (1881) and *The Origin of Typhoons* (1910).

Chevallier retired from his chair in 1871 and died in 1873 at the age of 79. Few men made a greater impact on Durham or simultaneously held so many university posts, for in addition to his Professorship of Mathematics and Astronomy he was Reader in Hebrew and Registrar. Moreover, he was for 35 years the much-loved pastor of the Parish of Esh, six miles from Durham, and noted for his diligent and caring ministry.

Chevallier believed strongly in the importance of science and engineering in university education and did everything possible to encourage the introduction and growth of both in Durham. In this he was only partially successful; indeed, the difficulties and disappointments in Durham led him late in life to support strongly the foundation of the College of Science (Armstrong College) in Newcastle.

In astronomy he published some 30 papers most of which were based on observations made at the Observatory he created. He also devised some simple methods of calculating orbits and determining parallax. In the context of his other responsibilities he achieved much, but the very width of his interests severely curtailed his astronomical work. As his biographer in the *Monthly Notices of the Royal Astronomical Society* remarked (**10**),

> . . . astronomers may perhaps feel disposed to regret that Mr Chevallier's talents were too much occupied by clerical and professional work to admit of the full development of his prowess in the field of original research.

After 1871 the Professorship of Mathematics and Astronomy was changed to the Professorship of Mathematics and for the next 20 years or so little was reported to the astronomical societies: indeed, one pathetic report from this period cast doubt on the usefulness of the Observatory for serious astronomical work (**11**).

A notable feature of the Observatory was the recording of meteorological observations, at first somewhat sporadically and then twice daily from 1850 to the present day. After Oxford, Durham has probably the longest continuous run of observations on the same site in the UK, a site almost free from topographical change.

In 1888 a real effort was made to reawaken interest in astronomy in Durham through the President of the Durham University Association (**12**), Gainsford Bruce, QC, Chancellor of the County Palatinate who gave an address at the Association's General Meeting, held on 1888 December 12, entitled:

> The History of Astronomical Discovery in connection with the Durham Observatory, and the observers there, and an attempt to present some reasons in favour of the encouragement by the University of Systematic Astronomical Observation.

By 1889 March a special committee of the Association had been set up to consider the best steps to be taken for improving and adding to the instruments at the Observatory. It was realized that a large sum would have to be found and a subscription list was opened to which Senate expressed its willingness to contribute. Support for the Association's activities came from the Professor of Mathematics, Professor R.J.Pearce, FRAS, who had been responsible since 1871 for the running of the Observatory and had himself tried unsuccessfully to revive the post of Professor of Astronomy. By 1891 the Fraunhofer Equatorial Telescope had been replaced by one of equal aperture, designed and built by Sir Howard Grubb of Dublin, whose firm was later to become Messrs. Grubb and Parsons Ltd, of Newcastle upon Tyne. Correspondence from this period shows that the University had considerable advice and help from a remarkable local amateur astronomer, the Rev. T.E.Espin (**13**), Vicar of Tow Law, who had built and equipped his own observatory – the Wolsingham Observatory. It seems that Espin had read in a local paper of the efforts of Gainsford Bruce and the Durham University Association to revive astronomical work in Durham and he wrote to the University offering his services and suggesting that a closer association of the two observatories would be of benefit to astronomical research. Professor Pearce was very interested and there was even a suggestion of a university appointment for Espin, but nothing came of it, partly it seems, because the University thought astronomy should be under the control of a Professor, and partly because of the difficulty of finding a suitable post. Nonetheless, Espin checked carefully the Observatory instruments and examined critically the Grubb Report and his suggestions for further work in Durham. On Espin's advice the instrument already mentioned and a 6 inch Transit Circle were bought and the decision taken that a suitable line of research would be

the study of variable stars, a study that became an important part of the observational programme of the Observatory until the outbreak of World War II in 1939.

A major development took place in 1895 when Professor Pearce retired and R.A.Sampson agreed to move from Newcastle to Durham as Professor of Mathematics and Director of the Observatory. The appointment began in 1896 (**14**) and was held until 1910 December, when Sampson became the Astronomer Royal for Scotland. In 1908 he was given the title of Professor of Mathematics and Astronomy.

In many ways Sampson was the right type of person for Durham for he was a gifted mathematician, an outstanding theoretical astronomer and a practical astronomer with a keen appreciation of the importance of high quality astronomical instruments.

Sampson had had a brilliant career at Cambridge where he graduated as third wrangler in the Mathematical Tripos of 1888. He then went to King's College, London, as a lecturer in mathematics, specializing in hydrodynamics, and while there was elected a Fellow of St John's College, Cambridge. He returned to Cambridge in 1891 as the first Isaac Newton Student in Astronomy and Physical Optics during the tenure of which he produced a long paper of considerable importance entitled 'On the Rotation and Mechanical State of the Sun' in which he developed the theory of the radiative equilibrium in a star's interior. This paper was typical of the pioneering side of his researches. Another side of his research interests, which undoubtedly had its origin in the influence of his former tutor, J.C.Adams, was dynamical astronomy, and it was this which led to his concentration, in Durham, on the Four Great Satellites of Jupiter, the theory of which had engaged the attention of some of the greatest dynamical astronomers of the eighteenth and nineteenth centuries. The importance of the Jupiter system is that it can be studied in great detail because of the shortness of the orbital periods of the satellites and the high accuracy with which their motions can be determined. This means, as de Sitter pointed out in his George Darwin Lecture to the Royal Astronomical Society (**15**), that secular and long-term perturbations can be measured with high accuracy for comparison with theory. To make observations of the same statistical weight as 300 years of satellite observations would require 18 000 years for the four inner planets or 1 000 000 years for the four outer planets of the solar system. Unfortunately, in spite of intense effort to perfect the theory many of the theoretical results did not accord well with observations from the eclipses probably because of the visual uncertainty of determining the precise times of disappearance and reappearance of the satellites at the rim of Jupiter. In 1878 Professor Pickering of Harvard replaced the visual method by a photometric method and made a series of observations extending over 20 years, observations which when examined critically by Sampson so impressed him that he decided to reopen the whole subject. Thus began his monumental work on the Satellites of Jupiter ultimately to be recognized by the Royal Astronomical Society in 1928 with the award of its highest honour, the Gold Medal. Sampson's treatment of the experimental results and later the theory was thorough and professional. From 'ancient' (**16**) and 'modern' observations he deduced a

new set of elements by comparison with a theory which was based on Souillart's development of a theoretical treatment due to Damoiseau. The discrepancies between theory and observation were, however, still substantial in many cases. With characteristic patience, therefore, Sampson made extensive changes and additions to the existing theory, a work completed before he left Durham but not published until 1921 (**17**). The tables based on the theory were published by the University of Durham in 1910 under the title *Tables of the Four Great Satellites of Jupiter*, a volume of some 350 pages. Since 1910 these tables have formed the basis for computing the phenomena for the National Ephemerides; the tables give the positions of the Satellites from the year 1850 to the year 2000.

Sampson's thorough work reduced the discrepancies in many cases by an order of magnitude but errors of the order of 10 sec in time remained and these were a source of great disappointment to him. From the fact that the margin between observation and theory was greater than could be ascribed to the effects of both he concluded that Jupiter has an atmosphere and perhaps from time to time can emit cloud-like protuberances, a view in accord with modern observations, for example, those of the *Voyager* spacecraft.

Sampson chose the Harvard eclipse observations because his analysis convinced him that they were a reliable and homogeneous set of data. Nonetheless, other types of observation not dependent on the sharpness of the limb of Jupiter were available, and in retrospect it is surprising that he did not make use of them. Typical of these observations were those begun in 1891 at Cape Observatory by Gill, using an instrument known as a Heliometer by which could be determined the mutual distances and position angles of the satellites in pairs. The probable error of this type of observation was small, of the order of $\pm 0{\cdot}075$ arcsec, much smaller than a typical eclipse error of about 10 sec in time. De Sitter was in Gill's observatory from 1897 to 1900 and therefore knew of the heliometer measurements. In 1908, 1918 and 1931 he made new analyses in which he incorporated the best of Sampson and the more refined Gill measurements and in consequence was able to reduce many of the discrepancies by almost a further order of magnitude. For this remarkable result he was presented with the Gold Medal of the Royal Astronomical Society – three years after Sampson! Two features of the Durham work should be stressed; firstly, the Sampson work was a necessary stage in the de Sitter analysis and, secondly, quantities derived from 'ancient' observations were the same from both analyses.

In addition to his great work on the Galilean Satellites, Sampson contributed in 1899 a long article entitled 'A Description of Adams' Manuscript on the Perturbations of Uranus' as part of the collected scientific papers of J.C.Adams. This article was published in the *Memoirs of The Royal Astronomical Society* (**18**).

On the practical side Sampson continued to improve observing facilities in Durham and on the advice of Professor Turner and Dr Common introduced a new instrument called the Almucantor, invented by S.C.Chandler of Cambridge, USA, in 1884. The almucantor was a transit instrument in which transits were taken across a horizontal circle instead of across the

meridian. Adjustment and correction of the axis of rotation of the telescope were not needed because it was mounted on a tray floating in mercury. When the tray was rotated in azimuth the telescope always pointed to the same horizontal circle in the sky and transits were taken across this circle in the usual way. Two of the corrections applied to the usual transit circle, azimuthal error and level error were eliminated, as also were errors due to the flexure of the telescope tube and those associated with the use of a divided circle. The Durham instrument was built by Messrs. T.Cooke and Sons of York and paid for by sums raised by Sampson from private sources. A full description of the instrument appeared in the *Monthly Notices of the Royal Astronomical Society* (**19**). The almucantor attracted much attention and was the chief observing instrument in Durham for a number of years. Its performance was described in a number of publications and it was used mainly for measuring latitude variation (**20**). A new sidereal clock and a printing chronograph for use with the almucantor were purchased in 1901.

Sampson received a number of academic honours apart from the Gold Medal of the Royal Astronomical Society. He was elected a Fellow of The Royal Society in 1903 and was President of the Royal Astronomical Society from 1915 to 17. The University of Durham conferred the degree of DSc on him in 1904.

After leaving Durham Sampson continued to make important contributions, particularly to the measurement of time and the distribution of energy in the continuous spectra of stars. He died in Bath in 1939 at the age of 73.

P.J.Heawood succeeded Sampson as Professor of Mathematics and Astronomy in 1911 but in the following year the title reverted to Professor of Mathematics. At the Observatory a restricted programme of work was carried out by the Observer, F.C.H.Carpenter, who had been in post since 1899 and had contributed much to the immense computational work involved in producing the Satellite Tables. The administration of the Observatory was in the hands of the Curators with the President of the Council of the Durham Colleges as Chairman and Professor Heawood as Secretary, supported by many well-known persons several of whom were astronomers of high quality, notably, the Rev. T.E.Espin of Wolsingham Observatory, Major Hills (later Colonel Grove-Hills, FRS), Professor R.A.Sampson, FRS (The Astronomer Royal for Scotland), and Professor H.H.Turner, FRS, of Oxford University. From a perusal of the Minutes it is clear that the Curators were in some difficulty because of the lack of an astronomer of distinction and the financial resources needed to keep the Observatory and its instruments in first-class condition. The solution arrived at was to keep the post of Observer and appoint a distinguished astronomer as Honorary Director. In pursuance of this policy late in 1912 a recommendation to this effect was submitted to Council. Approval was given and Major Hills was appointed Director of the Observatory. In the circumstances it was a good appointment for in addition to being an astronomer of wide experience he was an eminent scholar and an able administrator. In addition he had a long-standing interest in a problem much studied in Durham, namely, polar wandering. Indeed, apart from giving general approval to the on-going routine programme he proposed that a new instrument be built in order to

determine latitude with the highest practicable accuracy. This instrument, designed in 1913–14, determined the position of the vertical by use of a suspended telescope and measured the variation in the vertical by photography against a field of fixed stars. It was known as the Suspended Zenith Telescope but before it could be built and tested World War I intervened and both Hills and Carpenter left Durham.

Hills returned after the war but Carpenter resigned in 1919 and was replaced by the last Observer to hold office, F.Sargent, FRAS. The Zenith Telescope was built by Messrs. T.Cooke & Sons and installed in 1920 initiating a long period of testing which continued until Grove-Hills' death in 1922. It was never intended that the instrument would be used in Durham for serious astronomical work but it was hoped that it would reach an advanced stage of development. The Durham tests indicated that it could be made to work but because of Grove-Hills' death it never became fully operational.

Whilst the design and development of the novel Zenith Telescope must have given some satisfaction to Grove-Hills and the Observer the general state of the Observatory at the end of the war must have given them great concern. Years of neglect had resulted in serious damage to the building and several of the instruments, notably the almucantor and one of the large telescopes, were in such a bad state that they were virtually unusable. Fortunately Grove-Hills was a man of wide connections and in 1921 was able to get on permanent loan, a 6·4 inch refracting telescope the property of the late Sir Wilfrid Peek of Rousden in Devon. Moreover, in Sargent, Durham had a skilled Observer and it therefore became possible to continue to observe variable stars some of which had been under observation in Durham for some years and others by the Peek Telescope for upwards of 40 years. At the time of the transfer of the Peek Telescope to Durham some 4000 variable stars were known and of these some 25 had been assigned for observation by the British Astronomical Association to Durham. The variation in brilliancy with time was seldom less than 2000:1; indeed, one very unusual star varied by a factor of 60 000:1 every 200 days! The telescope was not sufficiently large for all the possible variables to be studied; nor had it a good clock drive. Nonetheless some excellent observations were made over a period of some 15 years, the records being sent up to the British Astronomical Association or the *Monthly Notices of the Royal Astronomical Society*. Some 600–700 observations were made each year. The devotion of Sargent and his work was noted on many occasions by the Curators, a typical comment being: 'the Observer was thanked for the zeal with which he prosecuted his work under unfavourable climatic conditions'.

Grove-Hills was succeeded as Honorary Director in 1923 by a former President of the British Astronomical Association, Harold Thomson, FRAS, of Newcastle upon Tyne, and he encouraged Sargent to continue his work on variable stars. He resigned in 1930 and was the last Director ever to be appointed. The scientific control of the Observatory was then taken over by a Committee of Management.

Besides the Peek Telescope which was housed in the dome of the Observatory building, there was a 10½ inch reflecting telescope and a 5 inch refractor

equatorially mounted, the private property of Frank Sargent. With these instruments Sargent made many other types of observation, for example, the markings and abnormal surface movements of the surface of Jupiter, certain planets, comets, novae and the occultation of stars by the Moon. These observations were published in the *Monthly Notices of the Royal Astronomical Society* up to the outbreak of World War II after which no further reports appeared. The year 1939 marked, therefore, the end of almost a century of serious astronomical observation in Durham. It also marked the end of the teaching of dynamical astronomy in the University which had been initiated by Chevallier in 1835.

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I am most grateful to Dr D.W.Dewhirst of the Institute of Astronomy, Cambridge, for informing me of the existence in the Archives of Cambridge Observatory of some 20 letters from Chevallier and Carrington pertaining to the scientific work of the Observatory and of the interesting account of its contributions to astronomy in the first 30 years in an important early French publication, entitled: *L'Astronomie Pratique et les Observatoires en Europe et en Amérique*, par C.André & G.Rayet, Gauthier-Villars, Paris, 1874, pp. 68–74.

NOTES AND REFERENCES

(1) An impressive portrait in oils of Professor Temple Chevallier hangs in the Great Hall of Durham Castle. It shows him as a large, imposing man, heavily bearded.
(2) Extract from the Senate Minutes of 14.1.1839.
(3) Extract from the Senate Minutes of 28.1.1839. The Professor of Mathematics reported that he had inspected the Astronomical Instruments belonging to the Rev. Dr Hussey, and had also taken the opinion of the Astronomer Royal, Mr Airy, of Mr Simms, an eminent optician and instrument maker, well acquainted with the instruments, and of Professor Peacock, Lowndian Professor of Astronomy in the University of Cambridge: and on their recommendation as well as his own opinion, advised the purchase of the instruments as likely to be of essential service to the University as well as to the progress of Science in general.
(4) Extract from the Senate Minutes of 11.5.1839.
(5) In the Science Library.
(6) University Calendar 1841.
(7) The following names and dates taken from the University Calendars are from a plaque at the Observatory. Unfortunately the Calendars do not always give the

precise dates of appointment and hence some dates may be slightly in error. R.C.Carrington, for example, definitely started work as an observer in 1849 October, and not in 1850.

1840 J.S.Brown	1843 A.Beanlands
1847 R.A.Thompson	1850 R.C.Carrington
1853 W.Ellis	1854 G.Rümker
1856 A.Marth	1863 E.G.Marshall
1866 M.R.Dolman	1868 J.I.Plummer
1875 G.A.Goldney	1886 H.J.Carpenter
1899 F.C.H.Carpenter	1919 (to 1939) F.Sargent

(8) Minutes of a meeting of the Curators held 27.6.1848.

(9) Extracts from the Minutes of a meeting of the Curators held 18.3.1851.

(10) Obituary Notice, *Mon. Not. R. astr. Soc.*, **34**, 137, 1874.

(11) *Mon. Not. R. astr. Soc.*, **35**, 188, 1875.

(12) An association of graduates and others interested in the University.

(13) This clergyman is a fine example of the fascinating characters who appear from time to time in the Church of England. A son of the Chancellor of the Chester Diocese and educated at Haileybury and Oxford, he went to Tow Law in 1888 and was there until his death in 1934. In addition to outstanding work for his parish he was an unusually able amateur scientist, a keen microscopist, a pioneer in the use of X-rays for medical purposes, a keen botanist, a geologist and a fine musician. His astronomical observations were of such quality and extent that he was awarded in 1913 a Gold Medal of the RAS, the Jackson–Gwilt Medal and Gift.

(14) The following extracts from the Senate Minutes will be of interest to readers who know Durham City:

16.10.1896 Estates Committee authorized to build a house for the Professor of Mathematics in Observatory Field at a cost not to exceed £1500.

26. 1.1897 Expenditure on Professor Sampson's house to be £1410 and rent £70.

(15) *Mon. Not. R. astr. Soc.*, **91**, 706, 1931.

(16) Sampson published an analysis of 'ancient' records in *Mem. R. astr. Soc.*, **59**, 199, 1910.

(17) *Mem. R. astr. Soc.*, **63**, 1, 1921.

(18) *Mem. R. astr. Soc.*, **54**, 143, 1899.

(19) *Mon. Not. R. astr. Soc.*, **60**, 672, 1900.

(20) See, e.g., *Mon. Not. R. astr. Soc.*, **63**, 338, 1903, and the DU Observatory Reports published in the *Mon. Not. R. astr. Soc.*, for the years 1903–1913.

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2. Baxter, E.F., 1937. Article entitled 'The Observatory'. In: *The University of Durham*, ed. C.E.Whiting, Centenary Committee of the University of Durham.
3. *Durham University Calendars*, 1835–1937.
4. *Minutes of Senate*, 1839–1909.
5. *Minutes of Council*, 1910–1937.
6. *Minutes of the Curators of the Observatory*, 1840–52 and 1909–1937 (incomplete).
7. *The Monthly Notices of the Royal Astronomical Association*, 1843–1939, RAS, London.
8. *The Memoirs of the Royal Astronomical Society*, 1840–1921, RAS, London.
9. *The Dictionary of National Biography*, Oxford University Press, London.
10. *The Dictionary of Scientific Biography*, Charles Scribner's Sons, New York.
11. *Obituary Notices of Fellows of the Royal Society*, Cambridge University Press, London.