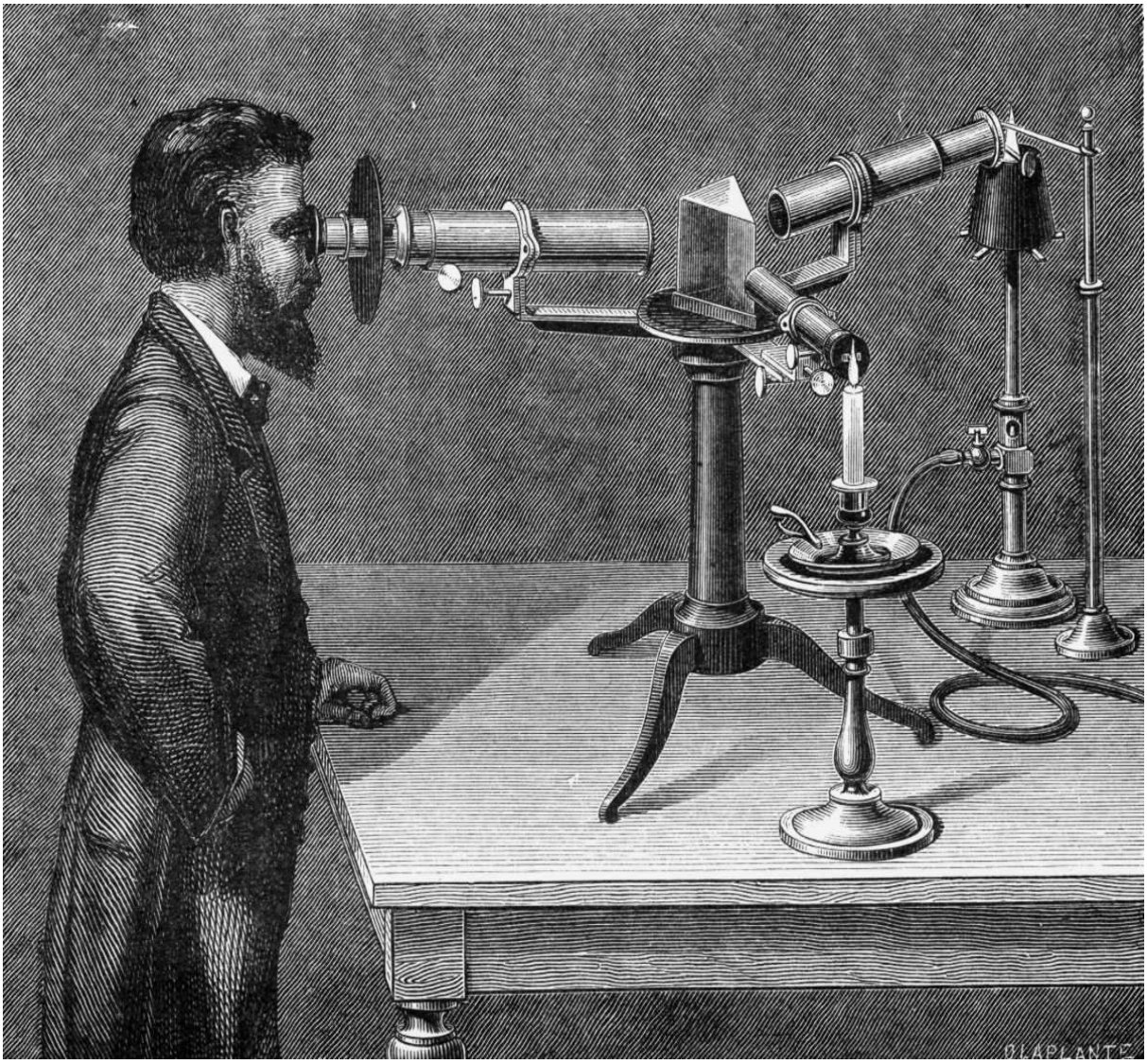
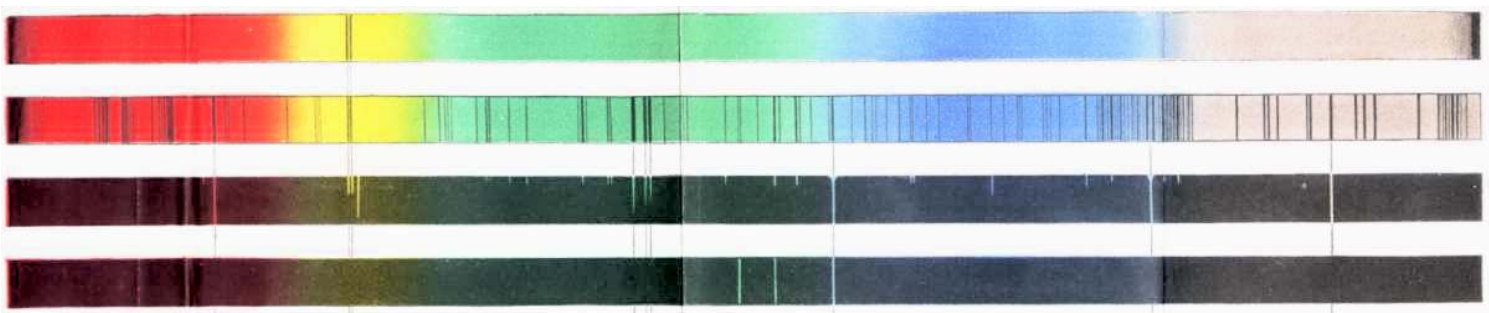
The Antiquarian Astronomer

Journal of the Society for the History of Astronomy





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The cover illustration: Spectroscope: Bunsen-Kirchhoff type

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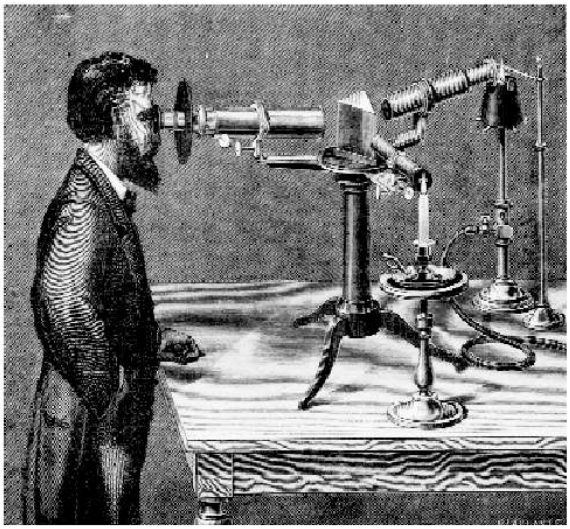

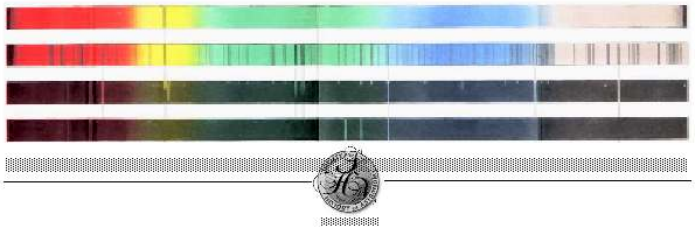

THE cover marks a significant recent astronomical anniversary—the publication 152 years ago (in 1859) of the fundamental principles that underpin spectroscopy and hence our material view of the Universe. These discoveries were the joint work of Robert Wilhelm Bunsen (1811-1899) and Gustav Robert Kirchhoff (1824-1887) at the University of Heidelberg, now in the state of Baden-Württenburg, Germany. The illustration is thought to show Kirchhoff himself and a period spectroscope incorporating the features necessary for chemical analysis in the laboratory. The form of the instrument would be recognisable even today by older chemists.

First published in a German work, the illustration was re-used by Joseph Norman Lockyer (1836-1920) in his volume, *The Spectroscope and its Applications.*[1, 2] Beneath the engraving are parts of a lithograph, also from this work, showing a series of chemical spectra and that of the Sun (second line from the top). Our cover therefore encapsulates the progress made by the work of Bunsen and Kirchhoff.

These advances did not happen suddenly, but were the culmination of a series of discoveries made in the preceding fifty years. When following up the work of Isaac Newton (1642-1727) on the solar spectrum, William Hyde Wollaston (1766-1828) observed dark lines in the spectrum when sunlight passed through a prism via a slit. The lines were first mapped in detail by Joseph von Fraunhofer (1787-1826) to use as reference points when determining the refractive and dispersive powers of optical glass. David Brewster (1761-1868) used equipment having greater dispersion than that of Fraunhofer, and concluded that the lines could be explained by absorption in the solar atmosphere. Another pioneer, Anders Jonas Ångström (1814-1874), recognised that spectra from sparks indicated the composition of the electrodes used to create them. Likewise, Julius Plücker (1801-1868) realised that spectra produced from Geissler discharge tubes depended on the composition the gas within them.

It was against these innovations that Kirchhoff undertook his experiments using a prism spectroscope.[3] From his observations he made the following inference:

> "I conclude furthermore that the dark lines of the solar spectrum which are not produced by the Earth's atmosphere result from the presence of the substance in the luminous solar atmosphere which produces in the flame spectrum bright lines in the same place…The dark D lines in the solar spectrum allow one therefore to conclude, that sodium is to be found in the solar atmosphere."[3]

This led to the conclusion that light emitted or absorbed by any solid body or gas was related to both its wavelength and temperature. The implication of this insight for astronomy was immense. A method was now available to astronomers to analyse remotely the material nature of the Universe. The seemingly impossible had been achieved, a mere few decades after the French positivist philosopher Isidore Marie Auguste François Xavier Comte (1798-1857), referring to stars, infelicitously wrote that:

> "...we would never know how to study by any means their chemical composition, or their mineralogical structure, and, even more so, the nature of any organised beings that might live on their surface…"[4]

Applying such principles, Kirchhoff went on to map the solar spectrum and to identify some of the elements present. For this work he used a four-prism spectroscope designed by the Munich instrument maker Carl August von Steinheil (1801-1870). His work led to a seminal paper *Investigation of the solar spectrum and the spectra of the chemical elements*, which outlined the identification of iron, calcium, magnesium, sodium, nickel and chromium in the Sun.[5] Kirchhoff's achievement is significant in that it marks a shift in the research of classical astronomy to the modern discipline of astrophysics.

Notes and references:

1. Schellen, Heinrich., *Die Spectralanalyse in ihre Anwendung auf die Stoffe der Erde und Natur der Himmelskörper* (Braunschweig: Westermann, 1870).

2. Lockyer, J. Norman., *The Spectroscope and its Applications* (London: Macmillan and Co., Second Edition 1873), p.29.

3. Kirchhoff, G., *Uber die Fraunhofer'schen Linien* (Monatsberichte Akademie Wissenschaft, Berlin, 1859), 662-665. Translated into English by George Gabriel Stokes (1819-1903). *On the Simultaneous Emission and Absorption of Rays of the Same Definite Refrangibility, Philosophical Magazine*, 21 (Fourth Series, 1860), 195-96.

4. Compte, Auguste., *Leçon dix-neuf, Cours de Philosophie Positive, Tome II* (Paris: Bachelier, 1835), p.8.

5. Kirchhoff, G., *Untersuchungen über das Sonnenspektrum und Spektren der chemischen Elemente, Part I* (Abhandlungen der Berliner Akademie, 1861), 63-95; (1862), 227-40; *Part II*, (in the same journal 1863), 225-240.

Compiled by K.L. Johnson and W.R.Withey

The Antiquarian Astronomer

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Foreword

THIS is the fifth issue of *The Antiquarian Astronomer* and the first for which I am wholly responsible, so on behalf of the Society I welcome you as a reader and hope that you will enjoy this issue. The Society has a good website www.shastro.org.uk for you to browse. There you will see that one of the principal aims of the Society is to facilitate the rediscovery of local astronomical history in England, Ireland, Scotland and Wales by running a Survey of Astronomical History (arranged by county, links via the website), and to publish relevant research.

Since not all members can manage to attend meetings, the journal is clearly a fundamental benefit of membership, as well as adding to our knowledge of the history of astronomy in these isles. We aspire to produce one substantial issue each year. Dr Reg Withey, a founding member of the Society, edited the last three issues of *The Antiquarian Astronomer* and set such a high standard that it attracted institutional memberships to the Society. Issue 4 was distributed in January 2008. Very unfortunately, while advancing Issue 5, Reg was beset by both health and family problems. The Society's Council has thanked Reg warmly for all he has achieved and for the precedent set. We have heard that he is now recovering and feeling much better. Meanwhile, I was appointed Editor, and now equally sincerely thank the contributors to Issue 5 for their patience along with the reviewers and copy-proofers on the editorial team for their support.

Issue 6 is planned for publication towards the end of 2011. The Society and the history of astronomy thrive according to the numbers who participate. We welcome all who attend meetings, and are delighted when people share their research by offering a talk at our friendly gatherings, and then offer it for publication. For the past two years timely information, particularly notice of forthcoming meetings, has been distributed via the quarterly eNews, while the flagship *The Antiquarian Astronomer* remains scholarly, the range of the less formal and twice yearly *SHA Bulletin* has been expanded (see Scope, at the back of this issue). This provides a much broader, but more focused quality publication, welcoming shorter contributions on any astronomical subject or period (the next *Bulletin* is intended for March/April 2011). Therefore as the SHA regains its publishing momentum, we will be even more able to consider your early drafts and to support your work through to publication for everyone to enjoy. So please do consider offering a talk, writing for the society, and do not be shy of making an early contact to discuss your intention.

Kevin L. Johnson (Editor)

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Objectives

The Society for the History of Astronomy was formed in June 2002 with three main aims:

> To provide a forum for those with an interest in the history of astronomy and related subjects;
> To promote interest in the history of astronomy by academics, educators and amateur astronomers and local historians;
> To encourage research into the history of astronomy, especially research by amateurs, and to facilitate its collation, interpretation, preservation, publication and dissemination.
> To implement these aims, the Society organises regular meetings and publishes its twice yearly SHA *Bulletin* and its annual Journal, *The Antiquarian Astronomer*.

Council established *The Antiquarian Astronomer* to provide a medium to publish research by members and others into any aspect of the history of astronomy and related subjects. Council recognised that because most members were amateur astronomers and amateur historians, most of their research would be about local history, which though of lasting value, was unlikely to fall within the scope of professionally-published journals. *The Antiquarian Astronomer* therefore provides a means by which the results of that research can be shared with other individuals and organisations having interests similar to those of the Society, and be made available for posterity. The Society will publish a decennial Index to *The Antiquarian Astronomer* and the *Bulletin*. Papers for *The Antiquarian Astronomer* need not be restricted to local history, but should contain original research, new interpretation or insight of material already in the public domain, or description that brings to a wider audience material of limited availability, or that is available only in dispersed locations. Papers offered to *The Antiquarian Astronomer* should not have been previously published. Papers submitted to *The Antiquarian Astronomer* are subject to external peer review.

Timely information, particularly about forthcoming events, both SHA and other, is now communicated to members via the quarterly eNews, which most members will receive by email. The Society also publishes the *Bulletin* (Editor Clive Davenhall; newsletter@shastro.org.uk), which usually appears twice per year. The next issue is scheduled for Spring 2011. The scope of the *Bulletin* includes, but is not necessarily limited to: news and developments in the history of astronomy, meeting reports, articles, obituaries, book reviews and members' letters.

Contributions for the *Bulletin* are welcome. Articles can be on any aspect of the history of astronomy and are usually up to 2000 words in length. They normally do not contain significant new research (such research should be published in *The Antiquarian Astronomer*) and are not peer reviewed. Contributions for the *Observatory Scrapbook* series are particularly welcome. These items consist of a brief description (typically 500 words or fewer) and an illustration of some historical observatory. It is prudent to discuss contributions for the *Bulletin*, particularly book reviews, with the Editor in advance to avoid duplication.

Hector Copland Macpherson (1888-1956), Clergyman, educator, lecturer and writer on astronomy and its history

Mary T. Brück
Former senior lecturer in astronomy, University of Edinburgh
David M. Gavine
Director of the Aurora Section of the British Astronomical Association

Hector Macpherson was the author of several well-known books on astronomy during the first half of the last century, his magnum opus, a *Biographical Dictionary of Astronomy* (1940), was for various reasons not published in his lifetime, and was not widely distributed. Now, after a long lapse of years, it has achieved its due recognition, having served as a core element in the recent *Biographical Encyclopedia of Astronomers* (2007), to which Macpherson himself thus becomes a posthumous contributor. In this paper we recall the career of this energetic promoter of astronomy and significant recorder of its history and personalities.

HECTOR Copland Macpherson, usually known as Hector Macpherson Junior, was born in Edinburgh on 1 April 1888 and spent most of his life there. He was the son of Hector Carsewell Macpherson, famous editor of the *Edinburgh Evening News* and writer on literary subjects. Because of a serious illness, rheumatic fever in childhood, he did not attend school but was educated at home until the time he entered university. His intellectual father encouraged his studious nature, and when the young Hector began to take an interest in astronomy and to ask for information, he was provided with the books of Agnes Giberne and with Sir Robert Ball's *Starland,* and Proctor's *Half hours at the Telescope*. In October 1901 he was also given a 1-inch aperture telescope and later set up a little observatory in the garden of their home where he used a 2-inch telescope, thus beginning, at the age of 13, his lifelong interest in astronomy and in observing the heavens. In 1911 he was elected a Fellow of the Royal Astronomical Society, having been proposed by Sir Frank Dyson while he was Astronomer Royal for Scotland.

Fig. 1. Rev. Dr Hector Macpherson in 1953 (photographer unknown).
By courtesy of the Astronomical Society of Edinburgh.

Fig. 2. The former Guthrie Memorial Church of Scotland, Easter Road, Edinburgh.
By courtesy of D. Gavine.

His chosen career, however, was not astronomy. At Edinburgh University, he studied theology and trained at New College for the United Free Church ministry, winning academic honours such as the Cunningham Fellowship on the way. He served the first five years of his ministry in Louden in Ayrshire and in war service, and thereafter, from 1921 until his sudden death on 19 May 1956, was Minister in the Guthrie Memorial Church in Edinburgh where he was well-known as a forceful preacher and a dedicated youth worker.[1] In 1929 the United Free Church and the Established Church reunited so that Hector became a minister of the Church of Scotland.[2] In addition, he was a distinguished historian and a recognised expert on the seventeenth century Scottish Covenanter Movement, the subject of a major study that earned him a PhD from Edinburgh University in 1923, and was published as a book. It was a field which continued to occupy him and about which he wrote and researched copiously throughout his life. He was elected a Fellow of the Royal Society of Edinburgh in 1919. On 15 September 1917 he married Catherine Anne Chisholm. Their children were Hector (b.1919), Fergus (1921), Mari Margaret Anne (1923) and Catherine Isabel (1927).

Macpherson's books and articles on astronomy

Hector Macpherson may be truly described as a man of great intellectual ability and wide learning; this showed itself too in his astronomical writings. His astronomical writing career, actively encouraged by his father, began at the precociously early age of 14 with an article entitled 'Is Mars Inhabited?' in *The North British Advertiser,* a local Edinburgh weekly paper edited by a friend of his father's. This was followed by a series of short biographies of living astronomers in the same paper. His first book, *Astronomers of Today and their Work*,[3] published in 1905 when he was only 17, was a set of 32 of these biographies, all

Fig. 3. Astronomical Society of Edinburgh Council members at the City Observatory on the occasion of the presentation of the Lorimer Medal to Sir Harold Spencer Jones, October 1953. Left to right back: J. Gibson Kerr, Mrs. Matthew, Norman Matthew (Director of the Observatory), J. C. Johnston (Past President). Front: Sir Harold Spencer Jones FRS (Astronomer Royal), Dr Hector Macpherson (President), Prof. W. H. M. Greaves FRS (Astronomer Royal for Scotland), Prof Sir Edmund Whittaker F.R.S.
By courtesy of the Astronomical Society of Edinburgh.

but two of which had already appeared in the newspaper. He explains in the Introduction that he owed his astronomical knowledge to Agnes Clerke's famous books and writings, and to the Royal Astronomical Society's *Monthly Notices*. Agnes Clerke herself was the subject of one of his articles, and he corresponded with her (and is likely to have visited her) before publishing his account. In fact, again encouraged by his father, he corresponded with all his subjects, who supplied him with biographical details and with their portraits, and took 'a kindly interest in the work', to the extent of reading and correcting the finished articles. He paid a visit to the octogenarian Sir William Huggins and 'his gracious wife' at their observatory home in London, and established a warm correspondence with Giovanni Schiaparelli of Milan, the famous observer of Mars whose description 'canali' of what he took to be natural 'channels' became misinterpreted as 'canals'. Another correspondent was Percival Lowell who discussed with him the question of Martian photography.[4] He paid a visit to the great asteroid finder and celestial photographer Max Wolf in Heidelberg who, initially taken aback at the youthfulness of his admirer, became a dear personal friend and supplied him with material for the beautiful lantern slides for which his lectures were renowned.[5] Another of his correspondents, Camille Flammarion, the highly popular French astronomer and writer, proposed him for Membership of the Societé Astronomique.

Astronomers of Today was published by Gall and Inglis, well-known publishers of *Norton's Star Atlas*, a firm of Edinburgh origin that had always been associated with books of astronomical and geographical interest. It was quickly followed by two more books, *A Century's Progress in Astronomy* (1906) and *Through the depths of space* (1908), a primer in Astronomy, the author being still only twenty years of age. In all, over his lifetime, Hector Macpherson was to write ten books on astronomy and two which dealt with the question of science and religion – *Church and Science: a study of the relationship of theological and scientific thought* (1927) and *Heavens declare* (1937).[6]

In 1907 Macpherson began to contribute regularly to *Observatory* magazine and to the American journal *Popular Astronomy*, providing 23 articles to *Observatory* between then and 1932 (and one in 1940), and 14 to *Popular Astronomy* up to 1925, the period during which Ralph Elmer Wilson was editor.[7] A few of the early articles were biographical, but for the most part they expounded topics of current interest. In the course of time, obituaries of favourite astronomers such as Camille Flammarion (1925) and Max Wolf (1932) were also included. He also wrote a short biography, the only one in existence, of the Edinburgh amateur astronomer Dr Thomas Anderson (1853-1932), the discoverer of Nova Aurigae (1892), Nova Persei (1901) and many variable stars. Under the title 'Thomas David Anderson: Watcher of the Skies', *Publication no. 2 of the Astronomical Society of Edinburgh* (1954), it was his Presidential Address.

Lectures in Astronomy

Hector Macpherson also exercised his talent as an expositor of astronomy through lectures to various audiences, and was an influential encourager of amateurs in Scotland. He was a founder member in 1924 of the Astronomical Association (now Society) of Edinburgh, and the deliverer of their first lecture (*Pioneers in astronomical science*).[8] He was the Society's first President in 1924-26 and held office in the Society for many years, being President again in 1952-54, during which period the Society's Lorimer Medal was awarded, no doubt on his recommendation, to the Astronomer Royal of the day, Sir Harold Spencer Jones.[9]

He also delivered lectures to schools under the Royal Society of Edinburgh's Robert Cormack Bequest scheme, instituted in 1942 by Robert Cormack, benefactor of astronomy and an old personal friend. Very little is known about Cormack, he does not seem to have been active in amateur astronomy although it was obviously an interest. When he died in 1942 he bequeathed a fortune for promoting astronomy in Scotland, through research scholarships, instruments for Scottish university observatories, public lectures, and talks to school children.

On an academic level, Macpherson held the appointment of Thomson Lecturer on Natural Science at Aberdeen Theological College in 1925-26, and was Lecturer in Astronomy at the Royal Technical College (now Strathclyde University), Glasgow, from 1928 to 1938. He delivered the prestigious Elder Lectures at the Royal Technical College in 1930-31 and 1931- 32. These Lectures were established in 1904 with an endowment by the philanthropic Mrs Isabella Elder for the maintenance of "Lectures on Descriptive Astronomy" in honour of David Elder, father of her late husband, a famous Glasgow engineer and shipbuilder. Macpherson's lectures over the two sessions were published in 1933 under the title *Makers of Astronomy*, his longest and most scholarly book.[10] It is a non-technical, highly readable account of the lives and work of the astronomers chiefly responsible for the evolution of the modern view of the universe, beginning with Copernicus and ending with Harlow Shapley and his contemporaries. *Makers of Astronomy*'s special value today is as a portrait of the astronomical universe as perceived by the author's (*i.e.* pre World War II) generation.

The Macpherson Gregorian telescope

According to the late Norman Matthew, for many years Secretary of the Astronomical Society of Edinburgh and Director of the City Observatory, his life-long friend Dr Macpherson acquired a 14.4 inch (365 mm) aperture Gregorian reflector by Andrew Barclay (1814-1900) which he presented to New College, Edinburgh. It stood on a pillar mount in the College garden but disappeared many years ago and the College has no record of its presence. Some 35 years ago a Barclay telescope of this exact description was offered for sale at a huge price in a Paris auction house. Barclay, the Kilmarnock locomotive engineer, was an eccentric, a bigamist and an irascible character who continued to make speculum-metal Gregorians long after they had become obsolete.[11] The connection between him and Macpherson is not known.

The *Biographical Dictionary of Astronomers*

Macpherson's major work in astronomical history was his *Biographical Dictionary of Astronomers* completed in 1940 but unfortunately never published. It consisted of short biographies (typically 100 to 400 words) of 500 astronomers from the ancients to his own day, the vast majority being what he called 'modern' (15th Century onwards), of whom 100 were still living. The Astronomical Society of Edinburgh possesses a bound typescript of the Dictionary presented by the compiler in September 1940, and it would appear from the Society's minutes that it was intended to have it published and that it had been refereed by Mrs Mary Evershed of the British Astronomical Association (and Director of its Historical Section).[12] The Society's minutes refer to delays, which would not be unexpected as World War II was occupying most minds at that time.

In 1950, Macpherson submitted the manuscript to the British Astronomical Association, with a request to have it published as a Memoir, which would be issued free to members.[13] The Memoirs Committee in its report pointed out that the manuscript was out of date and would have to be revised in consultation with the Historical Section. The matter of cost was looked into, and it was agreed that the Dictionary should be published subject to satisfactory arrangements being reached. At a Council meeting in 1952 the question came up of the inclusion of living astronomers in the Dictionary, and it was decided that living astronomers should not be included. This proved to be a stumbling block. Macpherson's suggested solution was to put the entries on astronomers living at the time of publication in an appendix. He also insisted that he alone should be responsible for the selection of all names, both living and deceased. There were 69 astronomers on Macpherson's list still living in 1952 (including Einstein, Hubble, Oort, Shapley and others), and the Dictionary would have been very much poorer without them. It is understandable that the inclusion or exclusion of living astronomers would have caused difficulty for the BAA, and also that Macpherson could not accept any censorship of his selections. The *Biographical Dictionary of Astronomers* was thus never published, though a few copies of the typescript were evidently produced. At that time, before the introduction of universal photocopying, typescripts were not readily reproduced.

Macpherson's *Biographical Dictionary* was the first ever (at least in English) compilation devoted exclusively to astronomers, and is of additional interest in that it represents traditional optical astronomy, before the advent of radio astronomy and later new techniques. Fortunately, after the lapse of more than sixty years, the Dictionary has at last fulfilled its purpose. It has been used as a basis for the huge *Biographical Encyclopedia of Astronomers* (BEA) published in 2007 which documents the lives and work of more than 1500 astronomers from antiquity to those born before 1918.[14] The team of editors, in preparing the list of names to be included, was provided with a copy of Hector Copland Macpherson's unpublished *Biographical Dictionary of Astronomers* (1940) by Brenda Corbin, librarian at the United States Naval Observatory, Washington.[15] They write: 'We hope that its use in assembling the BEA is similar to what Dr Macpherson had wished to achieve'. They also state that many, though not most, of the shorter entries were paraphrased from Macpherson's work.[16] All but 35 of Macpherson's 500 entries appear in BEA, an indication of the thoroughness and usefulness of his labours. Though a number of writers and popularisers of astronomy are to be found in BEA, Macpherson himself is not among them.

Conclusion

Hector Macpherson's many contributions to astronomy spanned an entire half a century, beginning in 1905 with his delightful *Astronomers of Today and their Work*, a rare collectors' item but now available in reprint.[17] The enthusiasm and love of astronomy which inspired that first youthful work never waned. He was a superb lecturer and a leading promoter of astronomy for its educational value and as an amateur pursuit. His informative well written books remain of value today, while his historical researches have amply proved their worth to his successors.

Acknowledgements

We would like to thank Anthony Kinder of the British Astronomical Association, London, and Graham Rule, secretary and former President of the Edinburgh Astronomical Society, for providing material from their respective archives. We are also very grateful to Brenda Corbin, emeritus librarian at the US Naval Observatory, Washington, and Connie Carter of the Science and Technology Division, Library of Congress, for tracking down the master bound typescript of Macpherson's Dictionary held in the latter library. Sally Bosken, present librarian at the US Naval Observatory, kindly sent us a photocopy of the American copy of the Dictionary for comparison with the Edinburgh one (they are identical). We have deposited this copy in the library of the Society for the History of Astronomy.

Notes and References

1. Seager, James, *Hector Copland Macpherson*, Obituary Notice with contributions from N.G. Matthew and Hector Macpherson III., *Year Book of the Royal Society of Edinburgh* 1955-56 (Edinburgh: 1957), pp. 27-31; Ellison, M.A., *Henry Copland Macpherson*, *Observatory*, 117 (1957), pp. 254-56.

2. Lamb, J.A. (Ed.), *The Fasti of the United Free Church of Scotland 1900-29* (Edinburgh: 1956), p. 10; *Fasti Ecclesiae Scoticanae*, 9, (Glasgow: 1961), p. 16.

3. Macpherson, Hector Junior, *Astronomers of Today and their Work* (London and Edinburgh: Gall and Inglis, 1905).

4. Lowell's letter is quoted in Macpherson, *Makers of Astronomy* (reference 10), p. 199.

5. Personal communication from his son Reverend Fergus Macpherson in 1994.

6. Macpherson, Hector C., *The Church and Science: a study of the interrelations of theological thought* (London: James Clarke and Co. Limited, 1927), was one of 'The Living Church' series published under the auspices of the United Free Church College, Glasgow. It deals with the three great scientific revolutions – Copernican cosmology, Genesis and Geology, and the Descent of Man – and discusses how a harmonious understanding is reached between theology and science by the serious study of science on the part of the Church. This very interesting book did not reach the usual astronomical libraries. In the 19th and early 20th Centuries the Free Church laid great emphasis on natural science and taught it to their students. Many more Free Church clergy were involved in public lectures and the practice of astronomy and other sciences than were those of the Establishment.

7. Marche, Jordon, D., II., *Popular journals and community in American astronomy 1882-1951*, *Journal of Astronomical History and Heritage*, 8, 1 (1961), pp. 49-64.

8. The Society, first known as the Edinburgh Astronomical Association, came into being following a WEA (adult education) astronomy class given by Professor Ralph Sampson, Astronomer Royal for Scotland. (Archives of the Astronomical Society of Edinburgh).

9. The Lorimer medal is named after John Henry Lorimer (1856-1936), sometime Vice-President of the Astronomical Society to which he left a substantial legacy. He was a brother of the architect Sir Robert Lorimer and was himself a well-known artist. One of his paintings, donated to the Society, hangs in the background of the photograph.

10. Macpherson, Hector, *Makers of Astronomy* (Oxford: Clarendon Press, 1933).

11. Gavine, D. M., *Astronomy in Scotland 1745-1900*, unpub. Ph.D. thesis, Open University 1982, volume 2.

12. Information provided by Graham Rule, secretary and archivist of the Astronomical Society of Edinburgh.

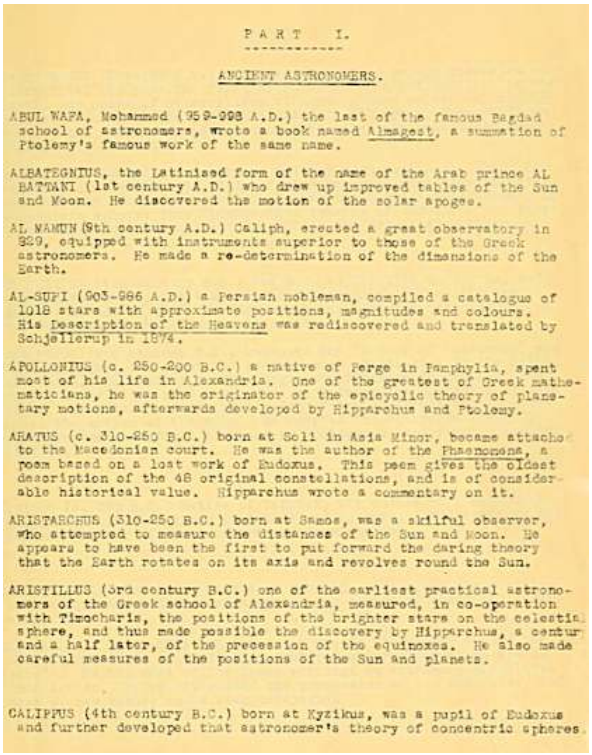
13. Details from the Minutes of the meetings provided by Antony Kinder, Librarian and former Director of the Historical Section, British Astronomical Association.

14. Hockey, Thomas (Editor-in-chief)., *Biographical Encyclopedia of Astronomers* (New York: Springer Science and Business Media, 2007).

15. The master document from which this copy (a photocopy) was made is a typescript in a stiff cover, preserved at the Library of Congress. Its previous ownership is not recorded. Connie Carter, Library of Congress, confirms that it is a typescript, not a mimeograph (stencil), the only known method in 1940 of making copies in any numbers. One assumes that Macpherson re-typed his manuscript more than once. He had many contacts in the USA to whom he might have sent this particular copy.

16. Editors' Acknowledgements, volume 1 of the *Encyclopedia*.

17. A digital reprint has been published (2007) by Kessingen Publishing, Whitefish M.T., U.S.A., which also publishes reprints of four more of Macpherson's books.



PART I.

ANCIENT ASTRONOMERS.

ABUL WAFA, Mohammad (959-998 A.D.) the last of the famous Bagdad school of astronomers, wrote a book named Almagest, a summation of Ptolemy's famous work of the same name.

ALBATEGNIUS, the Latinised form of the name of the Arab prince AL BATTANI (1st century A.D.) who drew up improved tables of the Sun and Moon. He discovered the motion of the solar apogee.

AL MAMUN (9th century A.D.) Caliph, erected a great observatory in 829, equipped with instruments superior to those of the Greek astronomers. He made a re-determination of the dimensions of the Earth.

AL-SUFI (903-986 A.D.) a Persian nobleman, compiled a catalogue of 1018 stars with approximate positions, magnitudes and colours. His description of the Heavens was rediscovered and translated by Schjellerup in 1874.

APOLLONIUS (c. 250-200 B.C.) a native of Perge in Pamphylia, spent most of his life in Alexandria. One of the greatest of Greek mathematicians, he was the originator of the epicyclic theory of planetary motions, afterwards developed by Hipparchus and Ptolemy.

ARATUS (c. 310-250 B.C.) born at Soli in Asia Minor, became attache to the Macedonian court. He was the author of the Phaenomena, a poem based on a lost work of Eudoxus. This poem gives the oldest description of the 48 original constellations, and is of considerable historical value. Hipparchus wrote a commentary on it.

ARISTARCHUS (310-250 B.C.) born at Samos, was a skilful observer, who attempted to measure the distances of the Sun and Moon. He appears to have been the first to put forward the daring theory that the Earth rotates on its axis and revolves round the Sun.

ARISTILLUS (3rd century B.C.) one of the earliest practical astronomers of the Greek school of Alexandria, measured, in co-operation with Timocharis, the positions of the brighter stars on the celestial sphere, and thus made possible the discovery by Hipparchus, a century and a half later, of the precession of the equinoxes. He also made careful measures of the positions of the Sun and planets.

CALIPPUS (4th century B.C.) born at Kyzikus, was a pupil of Eudoxus and further developed that astronomer's theory of concentric spheres.

Fig. 4. First page of Part I of Macpherson's hand-typed manuscript of the* Biographical Dictionary of Astronomers *(Edinburgh, 1940).
From http://www.archive.org/

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Charles Frederick Butterworth: The man with stars in his eyes

Gary Kewin
Isle of Man Astronomical Society

Charles Butterworth was a prolific variable star observer from 1897 to 1947, an early amateur spectroscopist who also experimented with photography. Honoured by British and French associations, his known observatories were in Cheshire 1910-27, and the Isle of Man 1927-41.

IN a quiet corner of the cemetery of the parish church of the Holy Trinity, in Rushen on the Isle of Man, is a simple grave.[1] The grave is that of Charles Frederick Butterworth and his first wife,

Fig. 1 Charles Butterworth's gravestone.
Photograph by author.

Margaret Anna.[2] It is the resting place of a remarkable, yet almost forgotten, amateur astronomer—Charles Frederick Butterworth. During his time as an observer he made more than 130,000 estimates of the visual magnitudes of variable stars, and photographed many stellar spectra. He has been largely forgotten for reasons that probably have more to do with a modest personality than with wilful neglect by his peers. Indeed, his contemporaries held him in high esteem. In addition to being elected to Fellowship of the Royal Astronomical Society, he was twice given prestigious awards by French astronomers, and was an early recipient of the Goodacre Medal and Gift of the British Astronomical Association (BAA). Yet within two generations of his death, he was forgotten, even by most amateurs who specialise in observing variable stars. The author knows of only a limited number of published sources of information about Butterworth's life and astronomy; all are short and contain no specific references to the origin of their content.[3, 4, 5] This paper is written to present the main results of preliminary research on Charles Frederick Butterworth. Facts are sparse; the search continues for reliable information about him, his family and his astronomical work.[6] It will be limited to outlining his life, achievements and for convenience is given broadly in chronological order.

Family beginnings

Charles Frederick Butterworth was born on Tuesday 29 November 1870, the first child of Joseph Francis Butterworth and Jessie Eleanor, née Parry.[7] At the time of his birth, the couple had been married for nearly three years, and had made a home at 4 Dudley Grove, Stretford, Lancashire.[8] His father was a 'Grey Cloth Salesman', his mother, a 'Wife'.[9, 10] In the United Kingdom census held on Sunday 2 April 1871, it is recorded that the Butterworth household included 13-year old Ellen Arrowsmith, a 'Domestic Servant (Nurse)', born in Manchester.[11] It is highly improbable that she could have been a wet-nurse, but perhaps her domestic duties included caring for the infant; or perhaps she was there to ease Jessie Eleanor's postnatal recovery. Butterworth's younger siblings were Joseph Francis (junior) born in November 1872; Harry Clement in May 1875; and Eleanor Emma, in July 1877.

Sometime during the period May 1875 to July 1877, the Butterworth family moved home to Glebeland Road, Ashton-upon-Mersey in Cheshire, where they were still living at the time of the 1881 census.[12] Butterworth was then 10 years old and a 'Scholar', although where his school was located, has so far eluded discovery. His 32-year old father was described as 'Salesman Grey Cloth' with the words 'Cotton Dealer' added to the record at some stage. A general domestic servant was also in residence. Here are clues that the Butterworth household was, perhaps, no longer typically working class—a move away from the back-to-back, terraced housing of the southern Manchester suburbs to a much more desirable residential area a few miles away in north-west Cheshire. It is also possible that Joseph Francis Butterworth, although described as a salesman was by then self-employed.

On Christmas Eve 1884 seven-year old Eleanor Emma died from diphtheria after a short illness, her father registering the death on Boxing Day, Friday, 26 December.[13] Thereafter, the coming of Christmas must have been a sad time for the Butterworth family; the grieving and mourning surely lasted for many years. Apparently increasing family affluence caused another move of home. The census of 1891 recorded Joseph Francis and Jessie Eleanor Butterworth and two of the three sons living at Mayfield, 20 Alexandra Road South, in the parish of Withington, in the Whalley Range district of

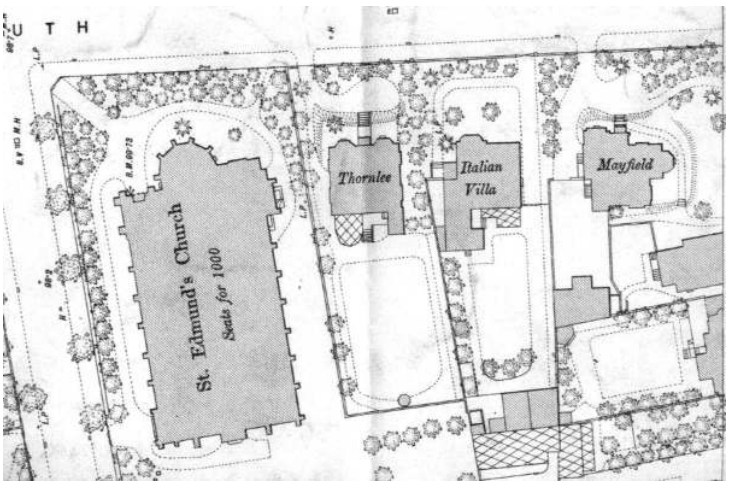


Fig. 2 Alexander Road South.
Image supplied by Tony Cross, Manchester Astronomical Society

Fig. 3. Italian Villa next to Mayfield Mansions, in background.
Photograph by Tony Cross, Manchester Astronomical Society.

present-day Greater Manchester.[14] The house no longer stands, the site now being occupied by Mayfield Mansions, a block of flats erected in the 1930s, but it is clear from the map that the size of the plot was considerable. The type of house that once stood on it can be imagined from the house next door, the Italian Villa, which retains its imposing Victorian exterior. Apart from the prestigious address, the 1891 census gives further evidence of the apparent growing affluence of the Butterworth family. Joseph Francis (head of the family) is now recorded as being an employer – a 'Grey Cloth Agent'. The 20-year old Butterworth is a 'Grey Cloth Salesman', his 18-year old brother, Joseph Francis (junior), is a 'Grey Cloth Warehouseman', both are recorded as employees.[15] It is tempting to think of the sons working for the father, but no evidence has been found to substantiate this. The household included a 26-year old 'Nurse Housemaid' and a 35-year old 'Cook', Annie Waterson, born on the Isle of Man.

The Butterworth family changes

After census day in 1891, the family started to disperse – the start of a decade of change for Jessie Eleanor. First it was due to Butterworth himself, who was married on Sunday 29 August 1894, in St Paul's the parish church of Withington. His wife, Margaret Anna Clarke, a spinster one year his senior, was born in the terraced housing of Lower Broughton, a mainly residential district less than one mile north-west of Manchester city centre, but was living before her marriage in Withington. At the time of his marriage, Charles Butterworth was living less than three miles south of the family home in Alexandra Road South, at 6 Northen Grove, Didsbury. It was probably here that the newly-weds set up their first home together. They were destined to have a long, but childless marriage; they were together for nearly half a century.

On Sunday 16 August 1896, Joseph Francis (senior) died from pneumonia.[16] He was just 47-years old.[17] Even in a time when adult life-expectancy was shorter than it is today, the loss of a husband of 27 years, the head of the family and principal breadwinner must have dealt an enormous blow to Jessie Eleanor. Up to this point, Joseph Francis has been painted as successful and prosperous (but not ostentatiously so). It therefore comes as a surprise to find that the place of his death is given as 'Union Workhouse Withington'.[18] This is mitigated when we realise that in addition to their statutory task of administering the provisions of the Poor Law Amendment Act 1834, by caring for the needy of the community, workhouses cared for the sick—they were hospitals.[19]

Fig. 4. Waterloo.
Photograph by the author.

Move to Waterloo and the setting up of his first observatory

In 1897 Charles Butterworth acquired a 999-year lease on a property named Waterloo in the rural village of Poynton-with-Worth in north Cheshire, about 7 miles (12km) south-east of his Didsbury home. Waterloo was a substantial dwelling, converted in the early 1870s from its former role as a pump-house for nearby coal mines.[20] Although he was the lease-holder, he did not live there immediately. We know that on Sunday 31 March 1901, the date of the census, he was living about half a mile from Waterloo in a house named Fellerigge. At this time, presumably having sold Mayfield after her husband's death, his widowed mother and youngest brother, Harry Clement, were living (with a domestic servant) in Cheadle Hulme. His other brother, Joseph Francis was living in Didsbury to where he had moved after his marriage to Dora Peters a few months previously, in September 1900.

Butterworth was still at Fellerigge when the 1902 edition of Kelly's Directory of Cheshire was published. However, by the time of the publication of next edition in 1903, he had taken up residence at Waterloo. The house was described in 1920 as '…built of Brick with Rough-Cast Exterior and Slated Roof, and contains about ten Rooms with Bathroom and W.C.' The area of the house and 'Garden and Orchard', which he rented separately, amounted to 0.700 English acres.[21] He also rented separately, some farmland about half a mile away, at Sprink Farm. At some point after he took up residence at Waterloo, his mother came to stay, for she died there on Saturday 13 April 1907, aged 60 years.[22]

Waterloo is situated on the south-eastern edge of Poynton village, on ground that gave him open views to the east, south and south-west. It is at Waterloo that the story of Butterworth's serious observing really begins, for here, in 1910, '…he put up a 6-inch Grubb equatorial refractor…', with which he made the vast majority of over 106,000 visual estimates of the magnitudes of variable stars.[23] He was now 40 years of age, married with no children, and it may be assumed with the means (perhaps inherited from his late mother) and space at his disposal to indulge himself in his hobby.

His astronomy can be considered as comprising two distinct phases. The first was in the period before he acquired the Grubb equatorial in 1910; the second, from then until 1941, when he stopped making formal observations.

Butterworth's astronomy before 1910

Both F. J. Sellers, president of the BAA in 1941 when Butterworth was given the Goodacre Medal and Gift of the BAA and W. M. Lindley, his Royal Astronomical Society obituarist, describe circumstances that place his interest in astronomy as starting before he

was 16 years old.[24, 25] He is said by both to have been a foundation member (*membre fondateur*) of the *Société Astronomique de France*, which was formed in January 1887 by Nicolas Camille Flammarion (1842-1925).

This begs the question: How did a boy who had just left school, or was about to do so have the contacts and language skills necessary to do this? We don't know where he was educated, but circumstantial evidence suggests that he and his siblings may have had private tuition. In the absence of evidence, conjecture may be allowed limited liberty. It may be relevant to our question that his family home, Mayfield was adjacent to St. Bede's College, a Roman Catholic school that had moved into the premises of the former Manchester Aquarium in 1877. Next door to the College was St. Gertrude's (Roman Catholic) Convent, which numbered amongst the sisters several of French nationality (see Fig. 7). The order to which the nuns belonged was not closed; that is, the nuns were not confined to the convent but were able to undertake suitable duties outside its walls. It is possible that through one or other, or both of these neighbours, Charles Butterworth was introduced to astronomy and to French connections.[26]

The BAA's Variable Star Section was founded in 1891 and until 1910 had 10-15 members, but until 1900 was chiefly concerned with a search for novae and new variables. It was apparently only after 1900 that a programme was organised to observe about 35 long period and interesting irregular variables. Perhaps Butterworth's early interest in the French society had been complemented by his own interests evolving beyond those early ones of the BAA section before 1900.

However his interest came about, it is axiomatic that to progress in competence and knowledge, an amateur astronomer in Victorian times, as now, needed guidance, training and mentoring. In 1887 and before, Butterworth's choice of colleagues and his access to astronomical information and equipment, was somewhat limited. The Liverpool Astronomical Society (LAS) had been formed in 1881 and by 1890 had a membership from a very wide geographical range, not only in the north-west but as far afield as the Isle of Man and South America. Its success was in fact its temporary undoing, when financial difficulties forced the society into an hiatus during 1890, a void filled almost immediately by the formation of the British Astronomical Association in that same year. Two years later in 1892, the BAA encouraged the formation of the North West Branch of the society in Manchester, but there is no record that Butterworth joined at that time. However, he may have established communications with other members of the LAS living in the Manchester area from which his skill in variable star observation may have been acquired.[27]

Observations after 1910

The scarcity of information about Butterworth was mentioned in the opening paragraphs of this paper. The author is aware of no autobiographical material. Furthermore, only the two items mentioned in Notes 3 and 4 contain biographical material whose audit trail, though implicit, can be taken as reliable. However, a third source originating from the *l'Association Française d'Observateurs d'Étoiles Variables*, which he joined in 1923, contains plausible content that we shall utilise, despite the source unidentified. He was a very active member of the Association, contributing 30,000 observations beyond the stars within the prescribed programme of the BAA Variable Star Section. For this he was awarded in 1927 the Abbott Silver Medal from the University of Lyons and in the following year the *Palmes d'officier de l'Academmie* by the President of France.[28]

In 1936, *l'Association* published an article about him and three other recipients of the Abbot Silver Medal. Part of it reads:

> 'We have been able to collect some information about the scientific activity of the individuals concerned, but in Butterworth's case there were problems because of his extreme reluctance to speak about himself, or to let others do so. Chronic insomnia from his youth onwards led Butterworth to carry out astronomical observations during night-time cycle rides, beginning with meteors. This led him to observe variable stars, enabled by his favourable situation 26 km from Manchester and 130 m above sea level…His only regret was that he didn't start 20 years earlier.'

Fig. 5. Butterworth—Stonyhurst July 1921.
Image supplied by Kevin Kilburn, from Manchester Astronomical Society archives.

The inference we draw is that it was at Poynton, perhaps when he was still living at Fellerigge that his serious interest in astronomy and variable stars in particular, began. The earliest Butterworth observation in the database of the Variable Star Section of the BAA is of R Aquilae on 16 June 1911. Having established his home at Waterloo, Butterworth set up a 6-inch Grubb refractor in a small observatory. He says that he chose the eyepieces with care to match the optics of the instrument and to minimise chromatic aberration. With the instrument, later augmented at times by 10¼-inch and 15-inch Newtonian reflectors, he made what was for the time, the longest and most continuous series of magnitude estimates of variable stars of any observer.

Although Butterworth was an unassuming man and we can only glean limited details of his private life, as a prolific observer of variable stars, he was a regular contributor to the astronomical societies of which he was a member. Much of what we know is taken from his obituary in the Monthly Notices of the Royal Astronomical Society, to which he had been elected a Fellow on 13 December in 1918. His other affiliations to United Kingdom societies included the British Astronomical Association, in which he was a member of the Variable Star Section and the Spectroscopic Section and the Manchester Astronomical Society. While it is not known when he first submitted observations to the BAA, it is clear that after 1910 he was active, and also attended meetings of the Manchester Astronomical Society (MAS). By 1914 his technical ability is evident from papers submitted to the BAA from 1913 to 1920.

At the Manchester Astronomical Society he would have met Rev. A.L. Cortie, S. J., F.R.A.S., MAS President and one of the most respected authorities on stellar spectra. At the opening meeting of the 1914 session, 7 October 1913, Butterworth exhibited some photographs of the spectra of Delavan's Comet and a comparison star, taken with a lens of 25.8mm diameter in conjunction with a mirror of size 26mm and focal length of 650mm, the flint glass prism having an angle of 21°.[29] On 4 March 1914, he exhibited a number of spectrograms of Mira (o Ceti) and β Aurigae.[30] At the Thirteenth AGM of the MAS, on 1 November 1916 Butterworth drew attention to the magnitude of Mira as being 4.5 and remarked that on 18 October, with a two hours exposure, no Hydrogen-β line was visible in the spectrum. He also exhibited a light curve of SS Cygni made during the previous two years and called for observations to be made by more observers.[31] His later spectrograms were taken with a 6½-inch prismatic camera, his work being described in his lecture, 'Nova Aquilae', which he gave to MAS on 2 October 1918. The instrument he then used, was a prismatic chamber whose aperture and focal length were respectively 6⅓ and 42½-inches; the prism had an angle of 21°, thus allowing the recording of spectra from Hydrogen-α to H without inclining the plate. A summary of the information obtained by these spectrograms was published in the *Journal of the Manchester Astronomical Society*, 1917-20, pp. 32-3, with two plates as its frontispiece showing a reproduction of the negatives.

Butterworth was one of those rare variable star observers who had the opportunity to measure his own vision as regards spectral sensitivity. During 1911, with three experienced spectroscopists, he examined the rays of the solar spectrum in a Rowland system (grating) spectroscope and found that he was more than usually sensitive towards the violet end of the spectrum. This may explain a notably consistent personal equation seen in his variable estimates. His observations of Long Period and Irregular Variables communicated to the Variable Star Section of the BAA between 1911 and 1941 amounted to just less than 80,000. This series is equally noteworthy for the uniformly high proportion of early morning observations, perhaps driven by his chronic insomnia, when most amateur observers find it difficult to be active owing to work commitments the next day. As a result, Butterworth was able to achieve in his observations, made with the same instrument, a higher consistency and continuity in method than most.

In 1927, aged 57, Charles Butterworth retired to Port St. Mary, Isle of Man, buying Beach Villa (now Balla Maria) for £900 and later described 'as a beautifully situated, commodious detached residence fronting Main Street and with views over Port St.Mary Bay'.[32, 33] He built a wooden observatory for the 6-inch Grubb refractor and resumed his variable star observations. The reflecting telescopes were not used again after his retirement and were sold. For the remaining twenty years of his life, he apparently lived comfortably on the proceeds of his career in the Lancashire textile industry. Astronomy was not his only interest, he was a keen cellist and pianist and spent a great deal of time on chamber music, especially string quartets, having acquired a very fine set of old Italian instruments to ensure balanced tone in the ensemble. In an amusing anecdote related by Simon Butterworth, his great-nephew, on the outbreak of World War II Charles Butterworth took his Steinway piano out into his garden along with his German music and burned the lot.[34] 'It fell to my father to explain to Uncle Charles that Steinways were not made in Germany but in the USA!' Ornithology, botany and geology also interested him as did his yacht and the growing of roses.[35]

Yet in comparison with this apparently idyllic lifestyle, the last few years of Charles Butterworth's personal life were quite extraordinary for a man who had lived privately during his most productive time as a variable star observer and held such ideals against Germany. On Friday 14 March 1941, his wife Margaret Anna died from heart failure, after suffering a cerebral haemorrhage. At about the same time he stopped observing. Eleven months later, aged 71, he married a German woman, over thirty years his junior, who had been interred at the women's camp at Rushen. Scandal ensued as Erica Fruhling had been released from the camp under a Home Office order and had nursed Margaret until her death. Butterworth had attempted to get permission for Erica to become his housekeeper, but was unsuccessful because the village was a protected area.[36, 37] In June 1941, Erica went to live in England, and there married Charles on 12 February 1942 at Brentford, Middlesex.[38, 39] The couple returned to the Isle of Man, but Erica was barred entrance into Port St. Mary under the orders of the chief constable, as it was still a protected area. The newly-weds initially decamped to a hotel in Douglas and, until they could return to Beach Villa , from 4 March 1942 took up lodgings with a friend, Mr. Harry Corrin at his home, Avondale, at Colby a small village a couple of miles from Port St. Mary.[40]

Charles Butterworth, now an elderly man, was very upset about the affair and declined to say anything more about it except that his health had suffered. He died 22 September 1946. Erica sold Beach Villa for £3000 in 1950 and moved to Morcombelake in Dorset.[41] She died in 1981 having not remarried.[42] According to her wishes she was cremated.

Conclusion

During 30 years of observing Charles Frederick Butterworth made on average of more than ten magnitude estimates a night, a remarkable achievement and one which put him in the fore-front of English variable star observers with a total of 106,000 magnitude estimates submitted between about 1911 and 1941. He was the first British observer to exceed 100,000 observations, and in 2008 only one other has exceeded his achievement. On his retirement as the most prolific variable star observer, in 1941 he was awarded the Walter Goodacre Medal and Gift of the British Astronomical Association. In 2006, John Toone of the Variable Star Section of the British Astronomical Association proposed the creation of a special, occasional award, the Butterworth Award, for outstanding service in the field of variable star astronomy. It was first awarded to Dr. Arne Henden, the director of the American Association of Variable Star Observers (AAVSO) during his visit to the United Kingdom that year. The second recipient was Gary Poyner on 12 April 2008 in recognition of becoming the first European to accrue 200,000 visual observations of variable stars.[43, 44]

Fig. 6. Beach Villa as it is today and inset showing observatory.
Photograph by author.

Fig. 7. Erica Butterworth. *Photograph supplied by the author.*

Acknowledgements

It is a pleasure to acknowledge assistance for this article from Mr. Simon Butterworth, great-nephew of Charles Frederick Butterworth; John Qualtrough; Tony Cross of the Manchester Astronomical Society; John Toone and Roger Pickard of the BAA Variable Star Section; Emile Schwitzer of the French Variable Star Association; The staff at the Manx Museum; *The Dorset Echo*; *The Manx Independent*; Debbie Winters, education and liaison officer, Dorset Family History Society; The Society for the History of Astronomy—especially Dr. Reg Withey, Roger Jones and Kevin Kilburn

Notes and References

1. The church is dedicated to the Holy Trinity, but is commonly referred to as 'Rushen Church' and spoken of as 'Kirk Christ'. The grave is in the north east corner of the section of the southern cemetery nearest the road.

2. Her second forename on birth certificate is given as 'Anne'; but on her marriage and death certificates as 'Anna'.

3. 'La Médaille Abbott', *Bulletin de l'Association Française d'Observateurs d'Étoiles Variables*, 1936, 5, 2 (1935), 33–38, pp. 33–34.

4. The award to Butterworth of the Goodacre Medal was made at the meeting of the BAA held on Wednesday 25 June 1941, 'Report of the Ordinary General Meeting of the Association', Journal of the British Astronomical Association, 51, 7 (August 1941), p. 7. The record of the award to his representative on 29 October, which contains biographical and astronomical detail, is 'Report of the Annual General Meeting of the Association', Journal of the British Astronomical Association, 52, 1 (December, 1941), pp. 4–6.

5. Lindley, W. M. ,'Charles Frederick Butterworth', Monthly Notices of the Royal Astronomical Society,107,1 (1947), pp. 40–41; William Lindley (1891–1972) was Secretary of the Variable Star Section of the BAA from 1934 to 1939, then Director until 1958. This was the time of great activity by C. F. Butterworth.

6. Some of the facts in this paper have appeared in the *British Astronomical Association Variable Star Section Circular*, 134 (December, 2007), pp. 24–27; and from a presentation by the author in *Nebula: Newsletter of the Leeds Astronomical Society*, 36, 1 (April, 2008), pp.12–13.

7. The marriage took place on Saturday 30 January 1869 in the cathedral in Manchester.

8. Stretford was then a township of about 2000 lying a few miles to the south-west of Manchester, on the northern side of the River Mersey. It later became an increasingly larger dormitory suburb for 'white collar' Mancunian workers. In 1974 it became part of the unitary Authority of Greater Manchester.

9. Grey-cloth was the name given to unbleached cotton cloth. The industrial north-west of England was, in Victorian times, the major centre for cotton weaving and for the manufacture of garments and other items from that cloth. For context see: Rose, Mary B. (Ed.)., *The Lancashire Cotton Trade: A History Since 1700* (Manchester: Lancashire County Books, 1996).

10. From Charles F Butterworth's Birth Certificate.

11. It is difficult to judge the financial status of the Butterworth household. Working-class families quite often had living-in servants; of the six households recorded on the same page, three had live-in servants.

12. Information is taken from the 1881 Census.

13. Her death certificate records 'Diphtheria. 5 days.' At this time, the three commonest fatal diseases of children were diphtheria, pneumonia and tuberculosis; all bacterial lung infections, for whose prevention or treatment there were no vaccines or antibiotics.

14. The 1891 census records the 15-year old youngest son Harry Clement Butterworth (and one other boy) as a 'Scholar' and 'Visitor' respectively in the home of Miss Mary Beatrice Stooke, employed as a 'Governess in School' in the Fairfield parish of Buxton, then as now, a fashionable Georgian spa town in the Peak District of Derbyshire, about 20 miles south east of Manchester. It is unclear if the house, number 1 Elleslee Villa, was a school, or merely a house where two scholars happened to be visiting a school governess on census night. The indications are that the house was semi-detached with its immediate neighbour, 2 Elleslee Villa: if it was a school, it must have been a small, possibly privately run one.

15. C. F. Butterworth is said to have left school when 15 years old.

16. Information from his death certificate.

17. Having reached the age of 45 years, Joseph Butterworth could have expected to live for about another 22 years. This information is calculated and promulgated by organisations such as the Department of Health. A convenient, independent historical analysis on life expectancy (from the year 1841) has been prepared by the Office of Health Economics – www.ohe.org.

18. The word 'Union refers to the practice of several adjacent civil parishes being united to administer the requirements of the Poor Law Amendment Act 1834. Until this time, individual parishes had been responsible for care of the poor and needy. The Chorlton upon Medlock Poor Law Union comprised twelve parishes of northern Cheshire. In 1844-1845 a new building for 1,500 inmates was erected—the Withington workhouse. An aerial photograph and information about it is given in: Peter Higginbotham, *Images of England: Workhouses of the North* (Stroud, Gloucs., Tempus Publishing, 2006). The author's excellent website at www.workhouses.org.uk gives a history of the Chorlton Union workhouses, extensive modern photographs of the buildings, a map and a 'bird's-eye view' of the Withington workhouse, which in 1915 became Withington hospital. The formation of the National Health Service in 1948 led to the integration of many former workhouse hospitals (infirmaries) into the newly-created NHS.

19 Workhouses were not the only infirmaries at this time. Charity-supported hospitals were present in most cities. The Manchester Royal Infirmary was built in 1755 on the site of the present-day Piccadilly Gardens. Why Joseph Francis Butterworth was not taken here is unclear. His death certificate states that he was a 'Commission Agent of Hulme, Manchester'. If he lived in Hulme, then the Manchester Royal Infirmary was the natural place for him to be taken. If, however, he still lived in Alexandra Road South, then the Royal Infirmary was more distant than the infirmary of the Withington workhouse. It may be significant that C.F.B. lived just a few minutes' walk from the Withington workhouse.

20 For a discussion of coal-mining in the Poynton area, see: Shercliffe, W. H., Kitching D. A., and Ryan, J. M., Poynton, *A Coalmining Village; Social History, Transport and Industry 1700-1939* (Stockport: W. H. Shercliffe, revised edition 1990).

21 This description appears in the 'For Sale' catalogue of Poynton Estate, which was held on Friday 19 March 1920. See Lot 33 on pages 24-25, and Lot 34 on page 25. A detailed map accompanied the sale catalogue. The map has a scale of about 12.7 inches to 1 mile, and was inscribed, '…based upon the Ordnance Survey Map…'. It was probably a half-scale (1:5000) copy of the 1:2500 Ordnance Survey sheets covering the Estate. A copy of the catalogue and its coloured map of the Estate is held in Poynton Library, SK12 1RB.

22 The date and place of death are taken from her death certificate, on which her age is erroneously given as 62 years.

23 Lindley, W. M., 'Charles Frederick Butterworth', *Monthly Notices of the Royal Astronomical Society*,107, 1 (1947), pp. 40-41.

24 See Note 4. Francis John Sellers (1875-1959) was Secretary of the BAA 1928-1938, from 1939 to 1951 Director of the Solar Section, and President 1940-1942; see Newbegin, A. M., 'Francis John Sellers' *Journal of the British Astronomical Association*, 70, 5 (May, 1960), pp. 235-37; Newton, H.W., 'Francis John Sellers' *Quarterly Journal of the Royal Astronomical Society*, 1, 2 (December, 1960), pp. 242-44.

25 See note 5.

26 Kelly, Howard L., The British Astronomical Association, the First Fifty Years, BAA Memoirs, vol. 42, 1 (London: BAA, 1948), p.117.

27 Butterworth is listed as one of the 122 members of Manchester Astronomical Society in its *Journal of the Session 1916-1917*, and it may be significant that several other names are known to have been members of the Liverpool A.S. and North West Branch of the BAA in the last decade of the 19th century.

28 With a view to encouraging the observing of variable stars at the Lyon Observatory, one of the members of the French Association of Variable Star Observers, M.W.N. Abbott, generously provided a gift of Fr.1000 in 1926 for the establishment of a prize. The interest from this sum would enable a silver medal to be given to a deserving and diligent observer whose observations would constitute a complete and permanent record.

29 *Manchester Astronomical Society Journal of the Session 1914-1915*.

30 *MAS Journal of the Session 1913-1914.*

31 *MAS Journal for the Session 1916-1917.*

32 Thus implying that his income and likely inheritance to that date was sufficient to allow retirement and the continuation of his observations in the manner he had enjoyed at Poynton.

33 Gary Kewin in the article, *'Charles Butterworth... man who had 106,000 stars in his eyes'*, *Manx Independent* [newspaper], Friday 14 September, 2007.

34 Personal communication to the author.

35 Lindley, W. M., 'Charles Frederick Butterworth' *Monthly Notices of the Royal Astronomical Society*, 107, 1 (1947), pp. 40-41.

36 Erica Johanna Henriette Fruhling, b.16 December 1902 at Gr. Fluttbeck [?], Germany arrived at Dover on June 10 1937; UK Registration Card 622179 dated June 11 1937. She is described as a cook. This document suggests that she was only allowed to stay in the UK for 12 months but she may have been joining relatives already settled in Middlesex, possibly to escape Nazi extremes in Germany.

37 In 1939 she was working for him looking after his wife who was dying. He tried to adopt her to help her avoid returning to Germany, which she did not want to do. Upon his wife's death he probably discovered that if he married her the authorities would not be able to deport her. Personal Communication from Simon Butterworth to the author.

38 Interred at Rusden December 19 1939 as an enemy alien, 'until further orders', Erica was initially released to live in the Isle of Man on 30 May 1940 and again released 19 June 1941 to reside at 7 Charlbury Grove, Ealing, London W5. Ref: Release document date stamped 19 June 1941.

39 The witnesses to the wedding were Erica's sister, L.B.H. [Louise Beate Hermane] Cockshutt and Joseph Cockshutt, presumably Erica's brother-in-law.

40 Letter dated 4 March 1942 from Inspector J. G. Kneal [?], Castletown, to Major J. W. Young O.B.E. Chief Constable of I.O.M.

41 Advertised for sale with vacant possession by public auction in the, *Isle Of Man Examiner*, 6 January 1950, p. 8

42 According to her Will, Erica left most of her estate to her sister Hildegarde Cornelia Brann of Kingston-on-Thames, with proceeds from the sale of her house being equally shared between her sister Louise Cockshutt and Clive Butterworth, Charles Butterworth's nephew.

43 As of 2008 the only observers to have accomplished this amazing feat of over 100,000 variable star brightness estimates include Albert Jones with over 500,000 and still observing; Danie Overbeek with around 285,000 and Wayne Lowder who made some 209,000 observations. From Britain only two other observers have achieved 100,000, John Toone with 128,000 observations and still counting and, of course, Charles Butterworth who made some 106,000 measurements and was the first to achieve the goal.

44 'Out of London Meeting, 2008 12 April held at New Hall, University of Cambridge, jointly with the meeting of the BAA Variable Star Section and the American Association of Variable Star Observers', *Journal of the British Astronomical Association*, 119, 2 (2009), 96-99, p. 99.

Warren De La Rue— Pioneer astronomical photographer

David Le Conte
Past President, La Société Guernesiaise

Warren De La Rue (1815-1889) was the quintessential Victorian wealthy amateur astronomer, operating at the centre of the astronomical scene in England in the third quarter of the nineteenth century. He stands pre-eminent in that country and period in the development and application of astro-photography. His achievements include improvements to the figuring of mirrors, the construction of a superb equatorial reflector and photoheliograph, detailed observations of the Sun, Moon and planets, photography of the Moon and of solar prominences, an extended series of photographic observations of the Sun over a solar cycle, and support for others engaged in the science of astronomy. He achieved all this while making innovations to mechanical systems, carrying out chemical and electrical research, and running a major company.

Fig. 1. Warren De La Rue.
Portrait by Maull & Polyblank. Courtesy of National Portrait Gallery.

Introduction

The January 2008 issue of *The Antiquarian Astronomer* contained a paper by the present author on the observations of the total solar eclipses of 1860 and 1870 by Warren De La Rue (1815-1889) and Paul Jacob Naftel (1817-1891),[1] respectively, both born in the Channel Island of Guernsey.[2] This paper deals in more detail with De La Rue's life generally, and his astronomical achievements in particular. He was a foremost pioneer in the application of the new art of photography to the science of astronomy, a researcher in chemistry, electricity and printing processes, and an outstanding Victorian businessman. James Nasmyth referred to him as the 'father of celestial photography'.[3] Agnes Clerke, the chronicler of nineteenth century astronomy, stated: 'To Mr Warren De La Rue belongs the honour of having obtained the earliest results of substantial value'.[4]

Family

Warren De La Rue was the eldest son of Thomas, founder of the De La Rue printing company. He was born in St Peter Port, Guernsey, in the Channel Islands, on 18 January 1815.[5] Being the son of a famous father implies a privileged head-start, but the circumstances of his birth were far from privileged. It would be several years before Thomas founded the business which still bears his name as a multinational company, and many more years before it became a successful one, and then only with the able assistance of his first-born son, Warren.

Indeed, Warren's grandfather, Eleazar, an unsuccessful farmer, had, twelve years previously, moved from the Guernsey countryside into the town of St Peter Port in a vain attempt to improve his lot. He fell considerably into debt, and it was left for Thomas to find his own way in life. By the time of Warren's birth, Thomas, then almost 22 years old, had established his own small printing business in the island, publishing the *Mirroir Politique*, following a short-lived venture in publishing the *Publiciste* with Thomas Greenslade, a relative of his Devonshire bride, Jane Warren (after whose family, Warren De La Rue was named). This new venture was financially supported by another relative, his brother-in-law, Jean Champion. But that too was short-lived, and in 1816, his father having died, Thomas moved his young family to Devon, and thence to London, leaving behind a number of debts.[6, 7]

Hence before his second birthday, Warren had left Guernsey for good. Throughout his life, however, he kept in contact with the island of his birth, visiting it at least once, having relations with whom he kept in touch, property interests, and, indeed, a Guernsey-born wife.[8]

In Guernsey Thomas had appeared to be more interested in improving the printing process and the paper quality than in editing newspapers. By 1819 he had established himself in Finsbury as a manufacturer of straw hats. This was not such a radical departure from printing as might first appear, as Thomas became interested in the use of straw in the manufacture of paper, and in paper bonnets. He experimented with the use of talc to make paper brighter, and with colour printing, and by 1830 had set up business as a manufacturer of playing cards. His subsequent development of uniformly patterned backs for the cards, so that marks caused by handling them did not give players an indication of the card face, led eventually to security printing of stamps and then bank notes. Security printing is still a major business of the Company.

The early years

Warren grew up in this background of investigation, experimentation and implementation. Through his printing interests, Thomas undoubtedly had contacts with France, and he sent the 15-year-old Warren to be educated in Paris, at the Collège Ste Barbé, where, unlike English public schools the emphasis was on science.ix Warren appears to have appreciated this, writing to his father: 'I perceive now that the French education is much superior to the English'. He appears to have shown intelligence, coped well with

French, Mathematics and Drawing, demonstrated more maturity than other children of his age, showed stable behaviour and a good character, was sensitive, honest with his teachers, and kind to his friends, but may have been too light-hearted outside the classroom.[10]

His French education, however, was cut short by the unrest of the July Revolution of 1830 and the abdication of Charles X, and he was brought back to London to enter his father's firm.

Business abilities and character

No doubt Thomas's motives in providing such a good education for his son were not entirely altruistic; he could undoubtedly see the benefits for the family business. It was a good investment, for in the subsequent years, scientifically-minded, multi-lingual Warren developed new processes which established the printing quality of the firm as second to none. As partner from 1839 to 1858, senior partner to 1869, and company Chairman from 1872 to 1880, he promoted the Company's interests internationally. Indeed, he can be credited with the majority of the firm's success during this period.

Warren had a profound knowledge of the scientific background to the printing process, and pioneered in the development of printing surfaces and inks, all of which expertise was applied to the benefit of De La Rue Press. To this day the Company retains in its archives a 'bible' in which he recorded his undoubtedly secret recipes for colourings.[11] He also had an outstanding business sense, as demonstrated by the huge advances made by the firm during his leadership, and the development of international markets all over the world. These were not easy times, and it took an astute man to steer the Company through a difficult course. He was clearly a 'formidable character', a hands-on leader, being the 'brains' of the business, involved directly in the engraving processes (he held the title of Engraver to the Board of Inland Revenue), voluminous correspondence, much foreign travel, and international negotiations, at a time when the firm had huge contracts for printing stamps, not only for the British Government, but also for India, Italy, Belgium, Australia, New Zealand, and Africa.[12] 'The points which really mattered were the scientific knowledge which was the very being of the De La Rues: the quality of the personal supervision … and finally the advantage that any firm who had devoted its mind to one highly specialised branch of printing, and could point to efficient service as well as results, must have over its rivals.'[13]

Fig. 2. Thomas De La Rue and Company building at Bunhill Row, London, 1856.

Easton, John., The De La Rue History of British & Foreign Postage Stamps, 1855 to 1901 *(London: Faber, 1958), p. xxii.*

The death of his father, in 1866, was followed soon after by what must have been an even greater loss, the death of his younger brother and business administrator, William, in 1870, putting even greater strain on Warren's energies.

An undoubted advantage was afforded by Warren's character. Time and again, he appears as a sympathetic person, with a good sense of humour, a caring attitude towards the workforce, an eye for opportunity, and a meticulous attention to detail. He is recorded as being 'a man of order and energy, on cordial terms with everyone'.[14] 'Warren … appears as a genial person with a strong sense of humour, howbeit exceedingly shrewd'.[15] His business correspondence dispels 'once and for all the idea that those in charge of the Bunhill Row factory had little but brains and cold blooded efficiency to commend them. Warren appears as a genial companion, clearly the 'boss', but combining humour with shrewdness – the kind of man who would meet trifling disaster with a chuckle rather than an oath'.[16] In giving advice to his brother over some particularly difficult negotiations in Italy, he said: 'Don't shut the door quite close against the foe; it may stop our chance of bleeding him'.[17]

His RAS Obituary records 'the wisdom and good sense of his counsel, his generous and disinterested devotion, and the charm and geniality of his manner'.[18] He used his increasing wealth to good effect, not only in the creation of innovative astronomical instrumentation, but in such personal gestures as providing RAS Fellows with copies of his astronomical drawings and photographs,[19] and financially supporting astronomical endeavours by others. 'He was always ready to assist important astronomical work with his purse and his influence'.[20] 'He was a man invaluable for his intelligence, for his persevering energy, for his promptness of resource, and for a generosity, princely, but discriminating'.[21]

It is astonishing that with all the business activity necessary to a rapidly growing, successful firm, Warren found time to extend his scientific researches into the field of astronomy. Having embarked on this course, however, he embraced it, as with everything in his life, with dedication. The President of the RAS, in presenting him with the Society's Gold Medal in 1862, said: '… for many years Mr. De La Rue has devoted the energies of his mind, a large expenditure, and such leisure as he could abstract from the complicated cares of an extensive and well-known commercial concern, to the earnest cultivation and systematic pursuit of practical Astronomy'.[22]

Marriage

There are few clues as to how Warren came to marry a young Guernsey-born lady, Georgiana Bowles, in London in 1840. He was just 25; she was 20. I have found no evidence that he revisited Guernsey after leaving it in 1816. She was the daughter of Thomas Bowles, who was from London, and his wife, Guernsey-born Marie-Marthe Bardel. There is evidence for a family relationship between the Bowles and the Greenslades, so that provides a possible explanation for a meeting between Warren and Georgiana.[23]

Georgiana, nicknamed Georgie, was to present Warren with a girl and four boys. She may well have assisted Warren in his photographic endeavours.[24] She lived to be 98, having survived her husband by 29 years, and is buried in the same grave as Warren, in Kensal Green, London.

Early researches

De La Rue embarked on scientific researches at an early age, demonstrating an eclectic approach, but focusing primarily on electricity and chemistry. His first papers, on the subject of the Daniell Battery, were published in 1837, when he was 22.[25] He was a founder member of the Chemical Society (1841).[26] With Charles Button, a wealthy chemist whose financial support had saved Thomas De La Rue's company during difficult times in 1837-8[27], he published *A Series of Tables of the elementary and compound bodies systematically arranged, in the form of labels*.[28] His chemical expertise was undoubtedly material in helping the Company at this time, and probably led to his being made a partner in 1839. He pub-

lished a number of papers on chemistry in the 1840s, especially on cochineal, showed a passing interest in entomology, and briefly dabbled in microscopy.[29] When the College of Chemistry was established in 1845, he studied under its Director, August Wilhelm Hofmann,[30] and in the 1850s assisted Michael Faraday with studies on the optical properties of gold film.[31]

He showed a particular aptitude for invention, again especially that related to his father's printing business. He was granted no less than 14 patents between 1844 and 1866, mostly for mechanical devices.[32]

First steps in astronomy

It was, indirectly, his chemical pursuits and his father's firm which were responsible for the kindling of De La Rue's interest in astronomy. A major influence in the Company's improved fortunes had been the development of a white lead coating for playing cards, for which his father had been granted a patent. De La Rue engaged James Nasmyth, the engineer, astronomer and inventor of the steam hammer, to work on a new process for making the pigment, and he visited Nasmyth in 1840 to discuss this work. During his visit Nasmyth was casting a thirteen-inch mirror of speculum metal by a process of his own.[33] Reportedly, Nasmyth was also using another speculum to project an image of the Sun, and De La Rue pointed out what he assumed were defects in the mirror, but which were actually sunspots.[34] De La Rue became curious, and commissioned Nasmyth to cast a similar speculum for him, which he then ground and polished with a machine based on William Lassell's, but with improvements which he, De La Rue, had devised. He gave the speculum a rotating motion independent of the sliding plate, and cranked the polisher on its axis, so that it also had a rotating motion.[35]

With this mirror De La Rue created a superb 13-inch reflecting telescope,[36] with a focal length of 10 feet. Later in life, he was to acknowledge his debt to Nasmyth in sending him one of his astronomical photographs: 'No one has so great a claim on the fruit of my labours; for you inoculated me with the love of star-gazing'.[37]

He set up the telescope at his home in Canonbury, and proceeded to develop observing techniques with the meticulousness characteristic of all his work. He soon gained a reputation as an excellent and accurate observer. He was elected a Fellow of the Royal Astronomical Society in 1851, and in 1852 he commenced a long series of astronomical publications with a drawing of Saturn in the Monthly Notices.[38] There followed papers on detailed observations of Mars, Saturn and Jupiter, with particular emphasis on micrometric measurements of their diameters, and timings of occultations. *The Monthly Notices* contain numerous references to his generosity in making copies of his engravings, some of them coloured, for Fellows of the Society. These were, no doubt, the beneficial result of his ready access to printing facilities.

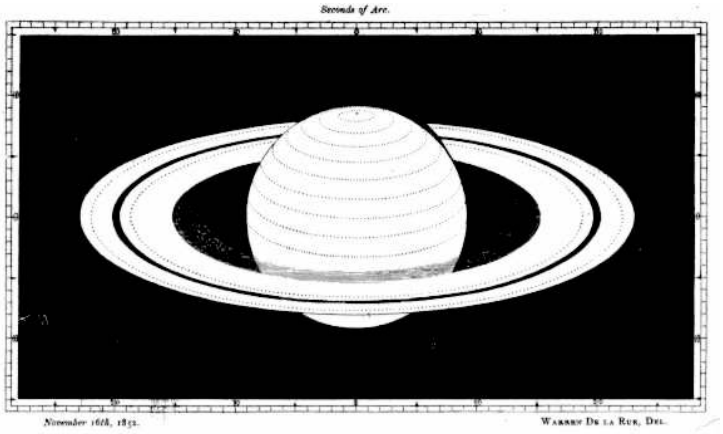


Fig. 3. Warren De La Rue's drawing of Saturn, 1852.
MNRAS, *13, 1, (1852), p. 31.*

His meticulous approach to observation is recorded in a lengthy letter to Sir John Herschel, which describes how it was his practice to observe Saturn over a long period of time, and take micrometrical measurements before making a final drawing in colour, and even then comparing the tints over and over again. Furthermore, 'I always etch the outline of the planet and all its details myself on the steel plate, as I do not find any of the engravers sufficiently skilful or rather I ought to say careful to undertake it." Even so, "I have been so long accustomed to doubt the results of my own observations, and even to delay their publication for an unreasonably long period, notwithstanding the risk of being forestalled, that I am neither surprised nor hurt when others do not immediately adopt them as correct'.[39]

First attempts at astronomical photography

In 1850 Warren was elected a Fellow of the Royal Society on the basis of his chemical researches.[40] The following year he his father Thomas were very much involved in the organisation of the Great Exhibition at Crystal Palace, sitting on several of the committees and acting as Jurors. De La Rue and Company had a stand at the Exhibition, the centrepiece of which was an envelope-making machine, capable of producing no less than 2,700 envelopes an hour.[41] The machine had been invented by Warren De La Rue and Edwin Hill, the brother of Rowland Hill, the postal reformer, and proved significant to the fortunes of the Company because of the advent, a decade earlier, of the penny post and the consequent demand for envelopes. Previously letters had been simply folded and sealed, and charged by the number of sheets.

Fig. 4 The De La Rue stand at the Great Exhibition, with the envelope-making machine.
Colour lithograph print published by Lloyd Brothers & Co., London, 1851 (Victoria and Albert Museum, 19538:7).

At the Great Exhibition was a large photographic display, and it was there that Warren saw a daguerreotype print of the Moon, taken with the 15-inch equatorial refracting telescope at Harvard College Observatory.[42] Although the daguerreotype process had been in existence for a dozen years, this was the best-defined astronomical image so far obtained. It stimulated the development of astronomical photography, and inspired Warren De La Rue to apply the newly-invented wet collodion process to the art.

Compared with later photographic processes, the wet collodion process, introduced in 1851 by Frederick Scott Archer, seems extremely cumbersome.[43] It involved adding cadmium iodide to a solution of cellulose nitrate (collodion), coating a glass plate with this mixture, sensitising it with silver nitrate in a darkroom, and then exposing the plate while still wet. After exposure the plate had to be

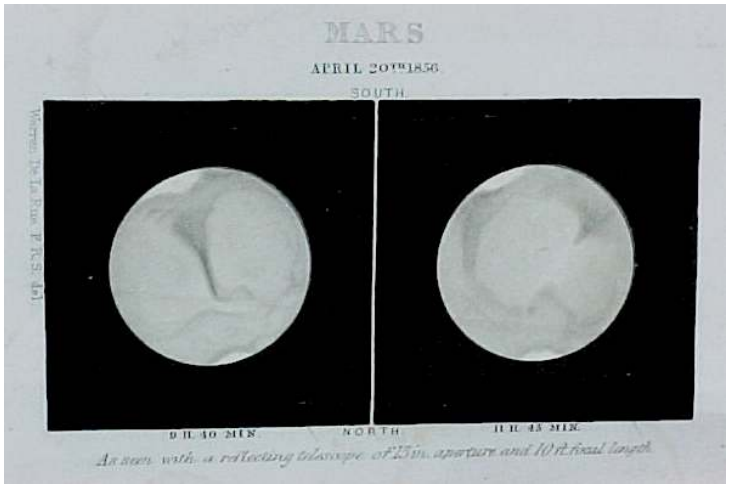


Fig. 5.1 (left) & 5.2 (below). The front page of the De La Rue diary for 1861, and a page showing Warren's sketches of Mars.
Courtesy of the archives of De La Rue plc, Basingstoke.

developed with pyrogallic acid, and fixed with a strong solution of sodium hyposulphite before the collodion dried, then washed, dried and varnished. So it was necessary that photographers carry a darkroom around with them.

Nevertheless, the wet collodion process had considerable advantages over the daguerreotype. It was more sensitive, so exposures could be much shorter, and it enabled reproductions on paper to be made of the image on the glass plate. It produced highly detailed photographs, and was the most popular method of photography until the dry-plate method was invented some 30 years later. Warren was the first person to use the wet collodion process for celestial photography, and it was this process which he used throughout his astronomical career.

The long exposures needed for daguerreotypes necessitated the telescope to be driven accurately to counteract the rotation of the Earth. By contrast, De La Rue, using the wet collodion process, was able in 1852 to produce his first successful photographs of the Moon with exposures of just a few seconds, driving the telescope by hand.[44] This, however, required an assistant 'and it was not easy to find a friend always disposed to wait up for hours, night after night, probably without obtaining any result'.[45] According to Norman Lockyer: 'He soon found that he was working against nature ? that nature refused to be wooed in this way, the moon in quite a decided manner declined to be photographed'.[46] He developed a sliding plate-holder, and, by viewing the image through the collodion film, was able to keep the telescope guided on the Moon. But the continued need for an assistant made him discontinue further photographic experiments for a while.

De La Rue diaries

There appears to have been considerable overlap between De La Rue's scientific and business interests. He undoubtedly made good use of the Company's engineering workshops, produced prints of his photographs for distribution to fellow astronomers, and made a number of business trips to the continent, during which he took the opportunity of visiting observatories and consulting with colleagues. Of interest is the annual publication by De La Rue & Company of diaries, edited by astronomers, and containing much astronomical information and reproductions of sketches by De La Rue and others.

For example, De La Rue's improved indelible Diary and Memorandum Book for 1859, edited by Norman Pogson, Assistant Observer of the Radcliffe Observatory, Oxford, contains not only Moon phases and sunrise and sunset times, but also: solar and lunar eclipses, occultations, eclipses of Jupiter's satellites, times of the Sun's southings, planetary risings, settings and transits, the difference between local and Greenwich time for a number of places, an explanation of astronomical terms, planetary phenomena, a detailed description of Saturn, and his sketch of the planet. The diary for 1861, also edited by Pogson (by then Director of the Hartwell Observatory, Aylesbury), included two of his sketches of Mars. In 1869 an article by Warren De La Rue about the Orion Nebula was included, illustrated with a sketch of the nebula as seen through Lord Rosse's telescope. That for 1871, edited by William Godward (Nautical Almanac Office) and Edward Thelwall (Trinity College, Cambridge), included sketches of solar prominences.[47]

The scientific journal *Nature* was moved to say, with respect to the De La Rue pocket and desk diaries for 1882:

> If possible all these are more beautiful examples of the printer's art than those produced in past years, and especially interesting from *Nature's* point of view, at all events is the fact that the amount of scientific facts packed into the closely-printed page is greater than ever. The mechanical equivalent of heat, the present magnetic elements, the mean distance of the sun, and such like data, are all to be found in their proper place, while the astronomical portion is so full that the amateur astronomer will be spared many references to his *Nautical Almanac*.[48]

Mounting of Huygens' object-glass

By 1854 De La Rue's reputation in the fields of mechanics, optics, and astronomy was well-enough established that the Council of the Royal Society asked him to superintend the remounting of an objective lens which had been made by Christiaan Huygens (1629-95), and presented to the Society by Sir Isaac Newton. Huygens had pioneered the development and use of aerial telescopes, that is tubeless instruments with extreme focal-length object-glasses mounted in short tubes held by cables, the image being observed with a handheld eyepiece, the observer being guided to the position of the objective by a 'bull's-eye lantern'. The Society's purpose in re-creating Huygens's telescope with his own object-glass was to resolve a theory proposed by Otto Struve that the rings of Saturn might be collapsing towards the planet, and that the change which had taken place since Huygens' observations two centuries earlier was measurable.[49] The rings were to appear at their extreme open position in 1855—the best alignment for this purpose for 15 years, and the opportunity was to be taken to make the observations and measurements.

In a detailed report for the Council De La Rue said that he had examined four object-glasses at the Kew Observatory,[50] of which at least two (focal lengths 122 feet and 170 feet) had been made and/or used by Huygens. He prepared proposals for the remounting of the 122-foot one, first examining whether it was possible to use the Kew Gardens Pagoda for its support, then using a pole, and concluded that the only practical method was to build a 120-foot tower in the form of a pyramid, on land adjacent to the Kew Observatory. He proposed a modern improvement on the guiding light: a platinum wire ignited by a voltaic battery. He had a model of the con-

Fig. 6. Huygens' 170-foot focal length object glass. *Royal Society MO/1/1/3 and No 23 of I/010. The object glass appears to have a diameter of about 10 inches.*

struction made (by De La Rue Company engineers) and, having an initial grant from the Society of £500, went so far as to rent the area of land needed, fencing it off from cattle, engaging an architect, and obtaining two estimates.[51] The estimated total cost was over £900 (£70,000 at today's values).

Having put forward his technical solution, De La Rue refrained from actually advocating the erection of the telescope, 'and more especially according to the plan that I have ventured to propose, as I wish to be considered merely as a willing agent to do that which I have been requested to do, in the manner seeming best to my humble judgment'.[52]

In the event, the object-glass selected for the project was the 170-foot one. It exists in the scientific instrument collection of the Royal Society, and is inscribed with Huygens', Newton's and De La Rue's names. It is not clear, however, whether the observations were actually carried out successfully, as no report on them has been identified. The inscription on its mount, however, which includes the date 1856, implies that it was in fact used.

The Royal Society Philosophical Club

In 1855, the same year of his report on the Huygens object-glass, De La Rue suffered an embarrassment involving the Royal Society Philosophical Club. The Club had been founded in April 1847, its stated purpose being to promote the Society's scientific objectives, to facilitate what we would today call networking amongst active Fellows, to increase attendance at meetings, and to encourage the contribution and discussion of papers. It was limited to 47 members who had to have published a scientific paper, and appears to have been something of an inner circle within the Society.

The Club had a curious set of rules. Meetings, which appear to have included a dinner, were held monthly from October to June, including the Anniversary Meeting held in April each year, at which new members were elected. They started at 5.00 pm 'precisely', and finished at 8.15 pm, members then being expected to attend the Society meeting which started at 8.30 pm 'unless unavoidably prevented'. Members chaired meetings in turn, in alphabetical order. There was a Committee of six members, and candidates for membership had to be proposed by three members who were not Committee members. The names of candidates thus proposed waited their turn for up to five years, and were dealt with in order of the date of their nomination. However, if the number of candidates exceeded the number of vacancies the Committee put forward the names of those (already proposed) candidates which they considered the most eligible. Those candidates recommended by the Committee had priority of ballot. At least 15 members had to be present at the election. Voting was carried out by secret ballot, a ballot box with black and white balls being used (or a box with partitions for 'yes' and 'no' into which balls could be dropped; such a box still exists in the Royal Society archives). The rules stated 'one black ball in three to exclude'. In other words, for a candidate to succeed two-thirds of those present had to vote in his favour.

Fig. 7. Royal Society ballot box.
Royal Society archives; photograph by author.

De La Rue had been elected a Fellow of the Royal Society on 6 June 1850, and in due course was nominated as a candidate for membership of the Philosophical Club. At the Anniversary Meeting held in April 1855 there were six vacancies and six candidates, including De La Rue, who was by then a member of the Council. However, there being only 14 members present the election was postponed to the meeting held on 10 May. At that meeting 18 members were present,[53] and the election proceeded. One candidate succeeded without a vote, having previously been a member, but having been abroad for a while. Of the other five candidates four were successful, but De La Rue failed to be elected; at least six members must have voted against him. It appears from a perusal of the Club Minutes that he may have been the only candidate not to be elected in the history of the Club.

The reasons for his non-election are not recorded. It might perhaps have reflected a prejudice of some members to a perception of 'trade'. A clue may be found in a letter by Charles Darwin, who had been elected to the Club the previous year, but who was not present at the meeting of May 1855. He wrote: 'I am glad to hear of the elections for the Club, but very sorry about De la Rue: he does not appear like a gentleman, but all that he says at the Council seems very gentlemanlike & nice: I would not have the blackballing of such a man on my conscience for a couple of hundred guineas: what a mortification for him'.[54]

De La Rue had to wait nearly thirty years to become a member of the Philosophical Club. He was finally elected, unanimously, on 28 April 1884, having been recommended by the Committee for priority of ballot. By then he was a prominent and respected Fellow of the Society, having been awarded the Royal Medal (1862), serving twice as Vice-President (1869-70 and 1883-5), and chairing the Society's Kew Committee. He remained a member of the Club for the remaining five years of his life, but rarely attended meetings. The Minutes of the Meeting held on 16 May 1889, held shortly after his death, record the unanimous wish that 'the deep regret of the members at the loss of a colleague so distinguished as the late Dr Warren de la Rue' be conveyed to his widow.[55]

Cranford Observatory

By 1857 he had moved his telescope to the darker, clearer and steadier skies of a substantial estate at Cranford in Middlesex, 15 miles outside of London, where he had built a new house, and entered into

the life of the community, being Chairman of the Sewerage Committee at a time of major development of public sewers.[56] At Canonbury the telescope had been in the open air in his small garden. He now installed it in a purpose-built observatory, together with a small transit circle by Simms, and a clock by Condliffe of Liverpool. The telescope was mounted on a pier 15 feet high, and had a photographic laboratory beneath it.[57]

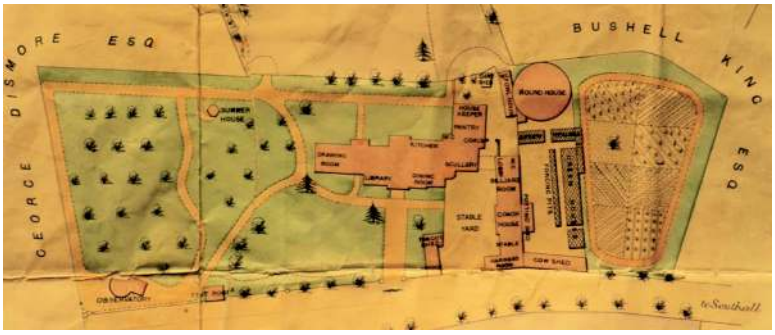


Fig. 8. Warren De La Rue's Cranford Estate in 1873. The observatory is shown at the lower left of the plan.
Hounslow Public Library, Q728.3/927.

Fig. 9. Warren De La Rue's house at Cranford in 1873.
Hounslow Public Library, Q728.3/927.

De La Rue provided the telescope with a clockwork drive, regulated by a governor, obviating the need for an assistant. This kept the object in the field for over an hour, and he constantly experimented with ways to improve it. It was not easy to adjust the drive to the accuracy required for photography, even at a sidereal rate, let alone that required for the Moon: 'we can fidget at it, and fidget at it, and at last get it; but … the moon is going in a reverse motion to the motion of the heavenly bodies … and it is going with a variable motion; and if we set the clock tonight, it will not follow to-morrow'. Even a dust particle or hair on the drive wheel could affect the accuracy of the drive.[58]

Sometimes, however, the drive did keep the object exactly on the cross-hairs for up to a minute. He was, therefore, able to resume his photographic experiments. He developed cameras for use at the Newtonian and prime foci. By November 1857 he was able to exhibit 'a great variety of beautiful photographs of the Moon.' His lunar pictures "brought to light details of dykes, and terraces, and furrows, and undulations on the lunar surface, of which no certain knowledge had previously existed'[59] and bore magnifications of 400 times. He changed from using positive photographs to negative ones, which not only enabled paper reproductions to be made but also had finer grain. By improvements to the development process he was able to reduce the exposure times to between 3 and 7 seconds, not only of the Moon but also of Jupiter, the latter showing the planet's belts. The short exposures assisted the photography by reducing the effects of irregularities in the drive and changes in the Moon's declination, and atmospheric disturbance. He foresaw that photography would supersede hand-drawing for mapping the Moon[60] and produced photographic enlargements of the Moon over three feet in diameter.[61] In later years (1866-9) he was to take part in a Moon-mapping project, serving on the lunar mapping committee of the British Association for the Advancement of Science (BAAS).[62]

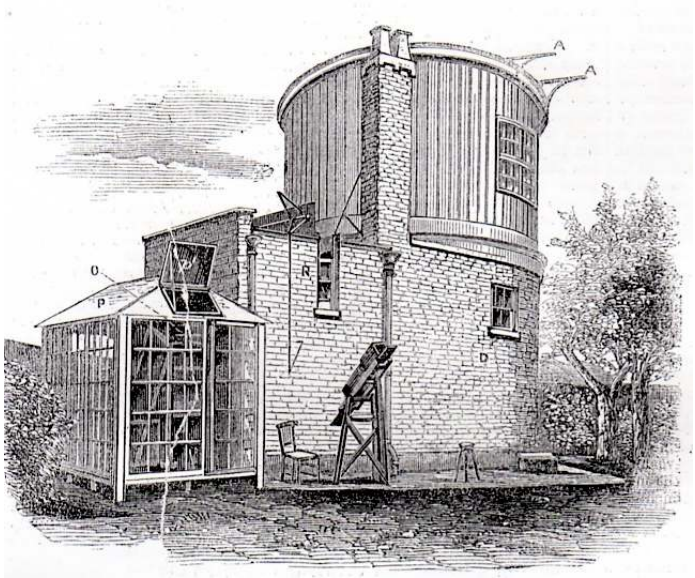
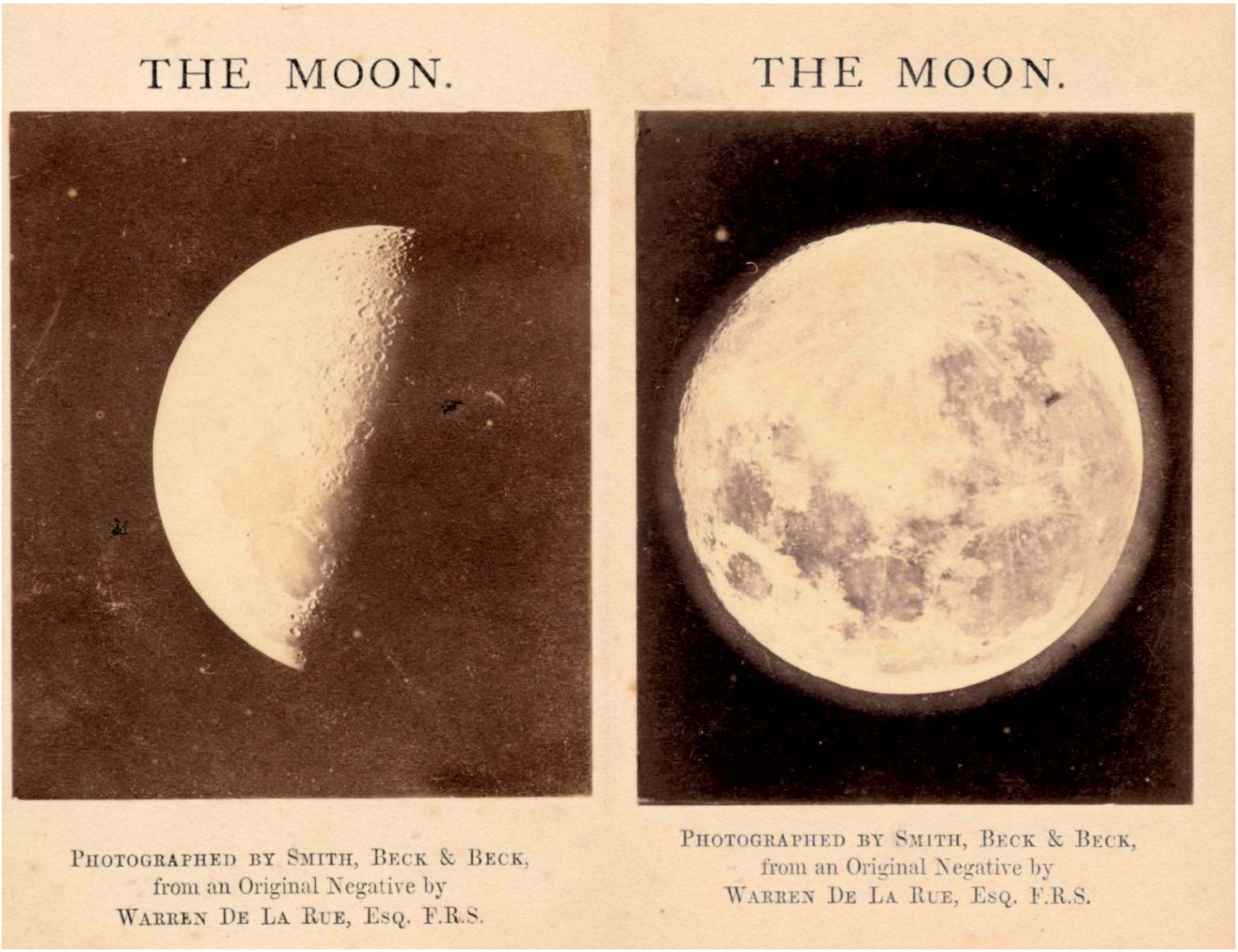


Fig. 10.1 and 10.2. Warren De La Rue's observatory and 13-inch equatorial (with De La Rue) at Cranford.
The Engineer *(May 22, 1868), pp. 374-6), reproduced in* The British Journal of Photography*, 15, May 29, 1868, pp.256-7 and June 5, 1868, pp.270-1. The observatory was eventually used as living accommodation, and came to an unfortunate end on 21 April 1966, when it burned down just before it was due to be demolished.* Middlesex Chronicle*, Hounslow and Brentford edition, 29 April 1966; RGO 6/172 534.*

He also exhibited photographs of Saturn and Castor 'of great beauty and promise', and studied the relative illuminations of areas of the Moon, Jupiter, and Saturn, comparing the photographic and visible intensities, observing that oblique rays and the mare produced less 'photogenic power' than the direct rays and the mountains. His meticulous observations, however, were not matched by



***Figs. 11.1 and 11.2. Two images from* Photographs of the Moon.**
Photographs of the Moon *by Smith, Beck & Beck, from negatives taken by Warren De La Rue, published 1862. The set comprises 12 pictures taken at successive lunar phases. These two pictures are from the author's collection. They show the Moon at ages of 7 days and 15 days, and are telescope views, i.e. inverted and reversed. 'Mr De La Rue has made a series which shows the moon in all her different phases. They are remarkable …', Lockyer, J Norman.,* Stargazing: Past and Present *(London: Macmillan and Co.,1878), p. 464.*

his deductions: 'he inclines to the view that the Moon is surrounded by a comparatively dense atmosphere of small extent, and that vegetation exists on the lunar surface, particularly in those portions generally called seas'.[63] This opinion was noted by Jules Verne.[64] Having acquired a large number of pictures of the Moon, De La Rue was able to publish a compendium showing it at every phase.

In 1864 he briefly contemplated carrying out a systematic survey of nebulae, a project for which he felt his equatorial telescope was well suited, but decided that since that was being undertaken by Heinrich d'Arrest with an 11-inch refractor; it would be a waste of his time to do so. His 13-inch reflector had, until then, been enclosed in a wooden tube, but he decided to convert it into a skeleton structure, using four gas tubes. He carefully designed it with torsion wires, and reported that 'it is very rigid and looks an elegant piece of apparatus. It is a manifest improvement on the old tube as regards definition'. The new design was also of considerable benefit for solar observation and photography.[65]

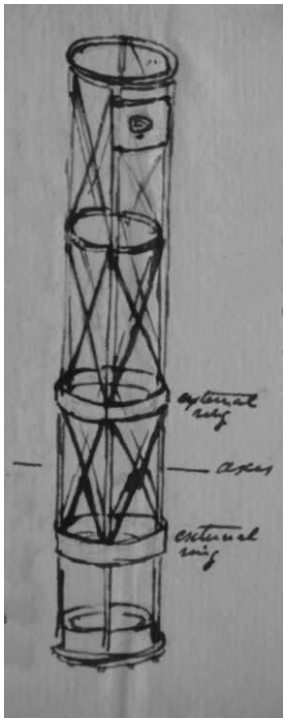


Fig. 12. De La Rue's drawing of his new tube.
Letter from De La Rue to Herschel, 25 October 1864; Royal Society HS6.D.161.

Stereoscopy

De La Rue used his many lunar images to produce a number of stereoscopic pictures, by grouping pairs of photographs taken at different stages of lunar libration. This was a complex process, requiring the selection of pictures taken at similar phases but at extremes of libration in longitude only, often months apart. They were published in 1858, and created much interest. Sir John Herschel expressed his 'admiration of their transcendent and wonderful effect. It is a step in nature but beyond human nature as if a giant with eyes some thousands of miles apart looked at the Moon through a binocular. What surprises me most is the extraordinary difference in the two pictures as seen by either of the eyes separately not only in form but in shadow & light & the way in which they blend into one is something quite astonishing'.[66] These pictures were not only wonderful to look at, but also, De La

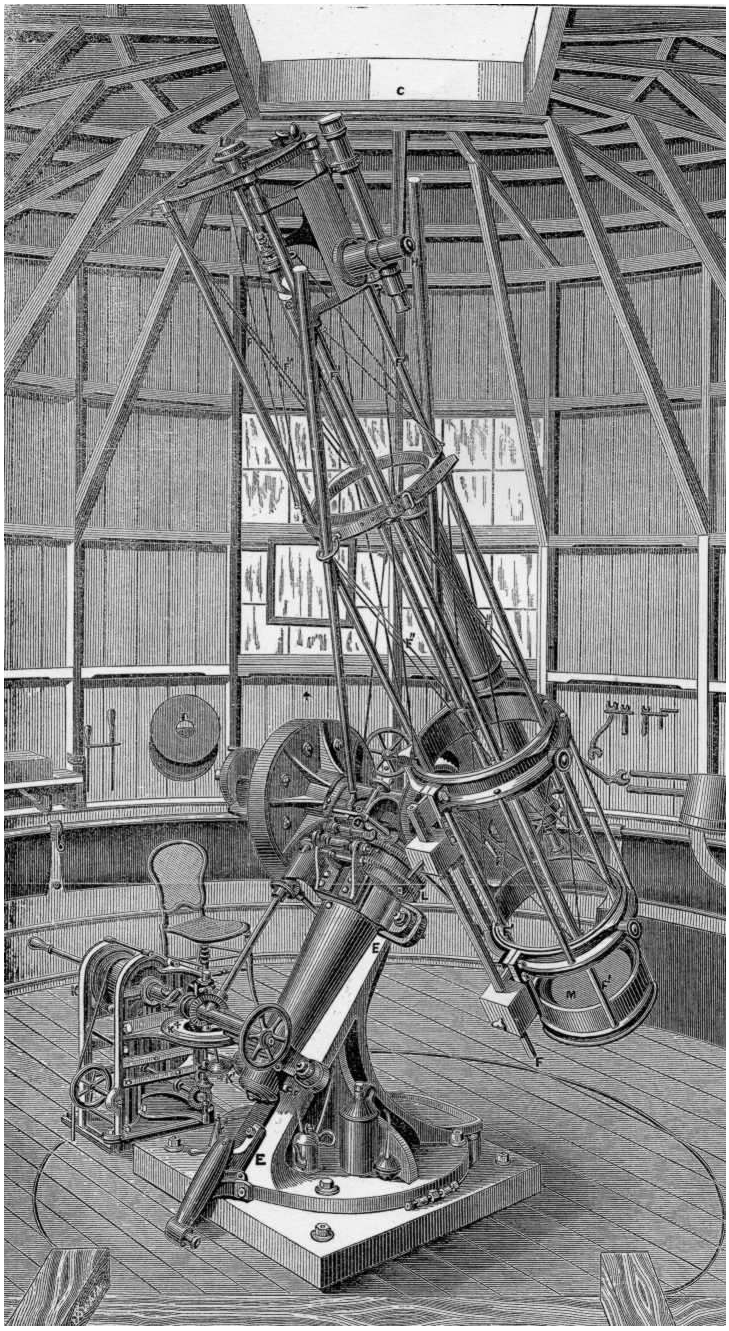


Fig. 13. The completed telescope.
'Mr Warren De La Rue's apparatus for photographing the Moon', The Engineer *(22 May 1868), p.374.*

Rue observed, revealed altitude differences, showing, for example, that Tycho's rays consisted of ridges and furrows, overlaid with craters.[67]

He described the production of the stereoscopic photographs in a comprehensive report which he presented to the BAAS meeting held in Aberdeen in 1859. Entitled *The present state of Celestial Photography in England*, it included a detailed account of his photographic techniques and manifold successes.[68] He somewhat immodestly, although undoubtedly truthfully, stated: 'In bringing before the Association the present Report it will be only necessary, after referring briefly to the labours of others, to confine myself to an account of my personal experience; for, although other observers have occasionally made experiments in Celestial Photography, there has not been any systematic pursuit of this branch of Astronomy in England, except in my Observatory, and under my immediate superintendence in the Kew Observatory'.[69]

His *Report* pointed out that his success was largely due to his use of a reflecting telescope, rather than the refractors used by others, as well, of course, as his persistent dedication to the task. The fact that his telescope was equatorially mounted was, of course, also highly beneficial. He gave an extremely detailed description of the very laborious preparation of the collodion plates, the development of the pictures, and his telescope driving mechanism, as well as the effects of atmospheric disturbance and lunar libration, together with simplified diagrams showing the stereoscopic technique. He noted that his lunar images of 1.1 inches diameter, and which he enlarged to 8 inches, could be examined at a magnification of over 16, showing details as small as two arc-seconds (one-thousandth of an inch on the original plate), or two to three miles on the surface of the Moon. He described in some detail the crater Copernicus, the Apennines and the ray system of Tycho.

De La Rue explained that, while he occasionally took pictures of the fixed stars, particularly the double star Castor, he generally left them to the Harvard Observatory, while he concentrated on the Moon. He did, however, take photographs of the planets when the atmospheric conditions were favourable, often several images on a single plate, by briefly disconnecting the drive from the telescope, allowing the next image to fall on a different area of the plate. Calculating that the optimum stereoscopic angle was 15.8º, and observing that the maximum lunar libration in longitude provided just this angle of parallax, he conjectured that it would be possible to use the rotations of Jupiter (26 minutes) and Mars (69 minutes) to produce stereoscopic images of those planets. He further surmised that the apparent opening and closing of Saturn's rings would afford a means of obtaining a stereoscopic picture. He stated that he had obtained a stereoscopic effect by pairing two drawings of Saturn which he had made in November 1852 and March 1856, but there is no record that he made stereoscopic photographs of other planets.

He did, however, succeed in making stereoscopic pairs of photographs of the Sun by using displacement of successive images by solar rotation. He found that any two photographs taken at intervals of about a day sufficed to produce satisfactory stereoscopic images. These confirmed Alexander Wilson's view of nearly a century earlier that sunspots were indentations in the solar photosphere, while solar faculae were high above it.[70]

Always busy, De La Rue was to be even more active in 1858 and the years immediately following. He tried to photograph the century's most spectacular Comet, Donati, but a 60-second exposure failed to produce an image. He attributed this to the low altitude of the comet at the time.[71] He did, however, send his sketch of it to Sir John Herschel.[72]

Fig. 14. Stereoscopic views of the Moon by Warren De La Rue, 1858.
Published as a stereoscopic slide by R & J Beck, London, 1858, author's collection. 'The appearance of rotundity over the whole surface of the Moon is perfect; and parts which are as plain surfaces in the single photograph in the stereoscope present the most remarkable undulations and irregularities',. MNRAS, 19, 1 (1858), p. 40.

Business and family developments

Further attempts at photography of Comet Donati were cut short by a 'severe domestic calamity'. His mother died in September, and two weeks later he left for a two-month business trip to Russia.[73] Soon afterwards his father remarried and retired from the firm, leaving Warren De La Rue, as senior partner, to run the business with his younger brother, William. While the two of them worked well together, William's considerable administrative expertise complementing Warren's technical abilities, their acrimonious relationship with their father, and the severe financial terms which he imposed upon them, must have made things very difficult for a while.[74] It must indeed have been hard for him to balance his major business responsibilities with his research interests.

Nevertheless, he continued research in astronomy and chemistry, and publishing papers. In addition to presenting his 1859 BAAS report on celestial photography, he was also preparing for the expedition to Spain to observe and photograph the 1860 solar eclipse, an event which was to occupy much of his analytical energies for the next two years.

Solar granulation

The first few years of the 1860s saw considerable debate about the nature of solar granulation. It started in 1861 when James Nasmyth reported seeing what he called 'willow-leaf shaped objects' on the Sun.[75] These lenticular bodies, he said, covered the entire photospheric surface, and were particularly noticeable against the dark umbrae of sunspots.[76]

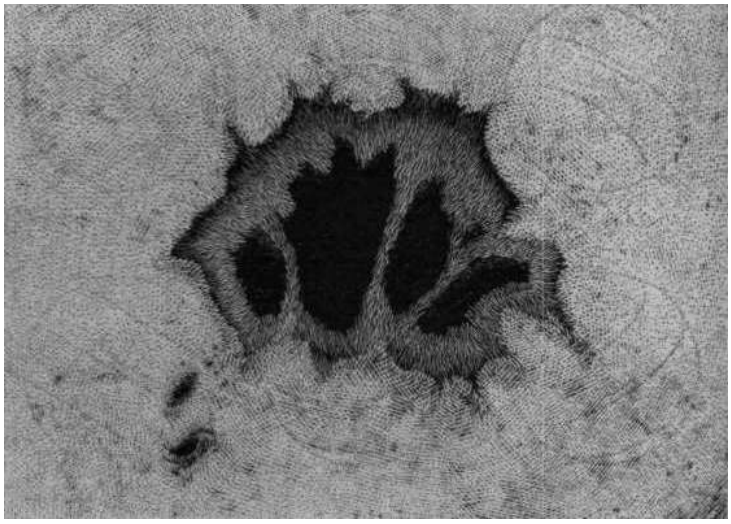


Fig. 15. Sunspot, by James Nasmyth.
Guillemin, Amédée., The Heavens *(London: Richard Bentley, 1868) p. 32.*

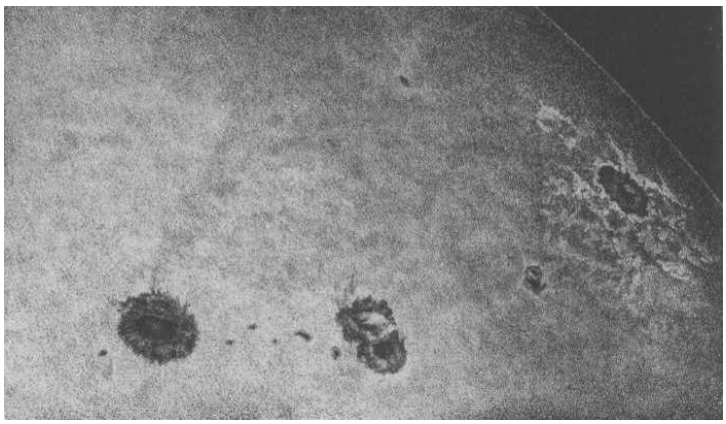


Fig. 16. Details of sunspots and faculæ, from a photograph by Warren De La Rue, 20 September 1861.
Sir Robert Ball, The Story of the Heavens *(London: Casell & Company, 1892) Plate III, opp. p. 41.*

Anxious that his discovery should be recognised and acknowledged, Nasmyth consulted a number of astronomers, including the Astronomer Royal, George Biddell Airy, Sir John Herschel and Warren De La Rue. Herschel endorsed the observations, noting that they supported the theory that the solar radiance must be produced by solid bodies, rather than gases. De La Rue also found evidence of the willow leaves, especially when examining an enlarged photograph of the Sun. In sending his first attempt at such an enlargement to Herschel in 1861 he wrote: 'An attentive examination without a magnifier or simply an amplifier will enable you to trace a little of Jas Nasmyth's willow leaf pattern in the fringing of the umbræ and penumbræ'.[77]

Others, however, notably the Rev. W. R. Dawes, did not subscribe to the willow leaf idea. In 1863 De La Rue himself confessed to some early scepticism, later dispelled by his own observations. He informed Herschel that he was convinced of their existence,[78] and expressed the following enlightening comments to Charles Pritchard, Secretary of the RAS. Note particularly his problems with solar observing:

> Mr Nasmyth sent to me as he did to many other persons a photographic reduction of a drawing he had made of a solar spot observed under particularly favourable circumstances with an (eight inch?) achromatic by Cook in which he noticed that the photosphere of the sun appeared to be made up of a conglomeration of spindle shaped components very uniform in size – and that on the edge of a spot they appeared to overhang the chasm and sometimes to bridge it over in parts – to explain to me his views he sent me a model made up of pieces of paper cut in the willow leaf form overlaying each other.
>
> I had and have a great confidence in Mr Nasmyth's power of delineating of any thing he observes—he has a wonderful eye and hand:- and when I received the drawing and model I believed in them, with a mental reservation however;- the markings as depicted seemed to me too uniform in size and too distinctly made out to be absolutely correct & I thought that Mr Nasmyth's artistic skill had too markedly outlined the peculiar kind of phenomenon he was desirous of calling attention to.
>
> I had never noticed any such markings on the Sun's surface but, at the same time, I felt that I was no authority on such a subject for, having injured one eye by an inadvertence in observing the Sun I had abstained from making the Sun's surface my particular study.
>
> Such, as I have described, were my feelings with respect to the willow leaves when I happened to call upon you at Clapham; you casually mentioned that you had been looking through your Cook's object glass at the Sun and I expressed a desire to have an opportunity of judging his productions as I had never observed with one of his glasses. We entered your observatory which we had recently left, so that the shutter was still open and therefore the conditions were so far favourable:- you had on the telescope a Dawes' eye-piece. As soon as I looked into the telescope I immediately exclaimed "you have a splendid object glass!- here are Nasmyth's willow leaves unmistakably brought out – have you an eye-piece with a diagonal glass reflector for I do not like this small field". The eye-piece was changed and the diagonal employed instead of Dawes', and the spot was severely scrutinized – it happened to be near the limb and I was surprised to see the spindle shaped markings end on, they resembled the fingers of one's hand held loosely together and viewed on

end. The markings were observed to be extremely alike both in size and dimensions and very much as Nasmyth had represented them—whether or not they are quite so uniform in size as he has depicted them will be a matter for further investigation, but that the photosphere is composed of an aggregation of components having a well defined form cannot be disputed. I mentioned to you that I had not seen these markings with a splendid 4in of Dallmeyer's—since then however I have on two or three occasions fully confirmed the existence of these markings with that object-glass and have, if I remember rightly, shown them to Carrington. It requires the very finest atmospheric conditions to permit of this phenomenon being seen and I should deem it useless to attempt the observation with any but an instrument of the greatest excellence.[79]

Pritchard clearly had great respect for De La Rue as an observer of detail, saying: 'Of all men's eyes in the matter of telescopic vision, De La Rue's are peculiarly trustworthy', and advocated Nasmyth's claims.[80]

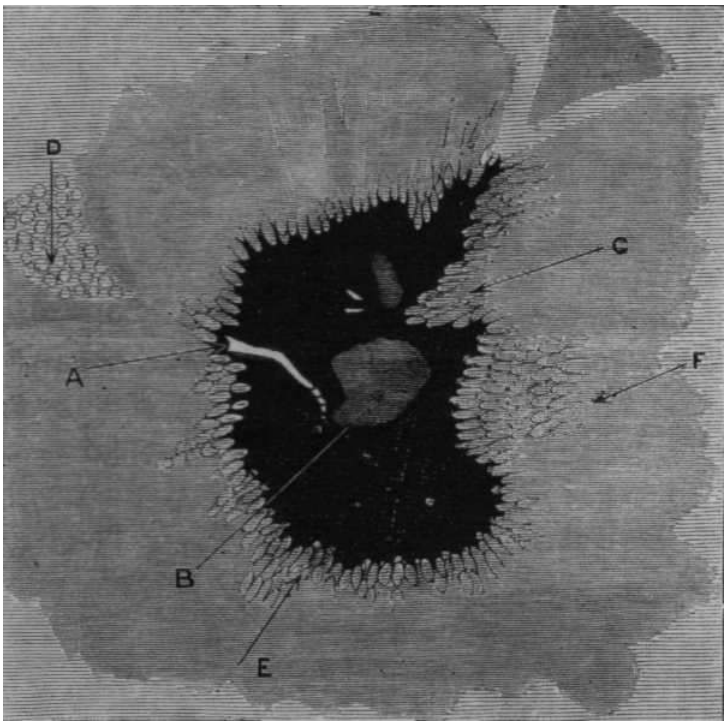


Fig. 17. Sunspot by Norman Lockyer, showing the 'willow leaves'.
Guillemin, Amédée., The Heavens (London: Richard Bentley, 1868) p. 42.

Encouraged by support from such respected astronomers as Herschel and De La Rue, Nasmyth persisted in his contention that the willow leaves existed, going so far as to say that: 'the grand fact of their existence is now proved beyond all doubt'.[81] Nevertheless, the dispute continued. It appeared to be agreed that there was some kind of nodular appearance to the solar surface, the main differences of view being whether the nodules were of uniform size and shape. No doubt the problem arose because, being only about an arc-second in size, they could be seen only with the highest quality instruments under the most favourable seeing conditions, and even then at the limit of visibility.

The disagreement was eventually settled in 1865 by a detailed description by William Huggins, who referred to them as granules or granulations, the term by which the small-scale structures of the photosphere are now known.[82] It is interesting to note that De La Rue had himself referred to them as granulations as early as 1861, and was probably the first to do so.[83]

Solar photographic survey

De La Rue's reputation as a pioneer astronomical photographer could certainly have been based solely on his early photographs of the Moon and the planets. But he is best known for his success in solar photography, and especially for his observations of the 1860 total eclipse of the Sun, which, as has already been described in some detail by this author,[84] demonstrated that prominences were genuine features of the Sun. De La Rue's development of the Kew photoheliograph was briefly described in the same paper.

Fig. 18. The Kew Observatory building today.
Photograph by author. The observatory is now an office building.

The proposal for a daily photographic survey of sunspots had been made by Sir John Herschel in 1854: 'I consider it an object of very considerable importance to secure at some observatory, and indeed at more than one, in different localities, daily photographic representations of the sun, with a view to keep up a consecutive and perfectly faithful record of the history of the spots'.[85] He provided specifications for the instruments, which would have apertures of 3 inches, their locations, and recording schedules.

De La Rue advised that such an instrument could be built for £150. This was provided by the Royal Society, and De La Rue proceeded to design it and have it constructed for the BAAS. By 1856 the resulting photoheliograph had been completed by the instrument maker Andrew Ross, and installed in the dome at the top of Kew Observatory, where it commenced operations in March 1858.

The brightness of the Sun's image required considerable experimentation in order that satisfactory photographs could be obtained. The object glass was stopped down from 3.4 inches to 2 inches, the image was enlarged by secondary optics within the instrument from 0.466 inches to 4 inches diameter (decreasing the light intensity 64 times), a filter was introduced in the light path, and experiments were conducted with different forms of collodion. Nevertheless, the over-exposure of images persisted. The solution was eventually found in the design of a spring-loaded shutter with an adjustable aperture, placed near the plane of the primary focus.[86]

With such very short exposures, it was found unnecessary to drive the telescope. A finder telescope mounted on the clamped telescope projected an image of the Sun onto a brass plate on which were inscribed lines corresponding to the Sun's diameter. When the Sun moved into the central position, a lighted match was used to burn a thread holding the spring-loaded shutter, whose aperture then flashed across the field. Wires fixed across the field were used to determine the positions of sunspots. Possible image distortion was checked by photographing a 15-foot scale mounted on the Kew Gardens pagoda, 1466 yards away.[87]

Fig. 19.1. The Kew Observatory, with the Kew Gardens Pagoda. The Observatory in Richmond Gardens*, by T Cadell, London, 1792 (British Library).*

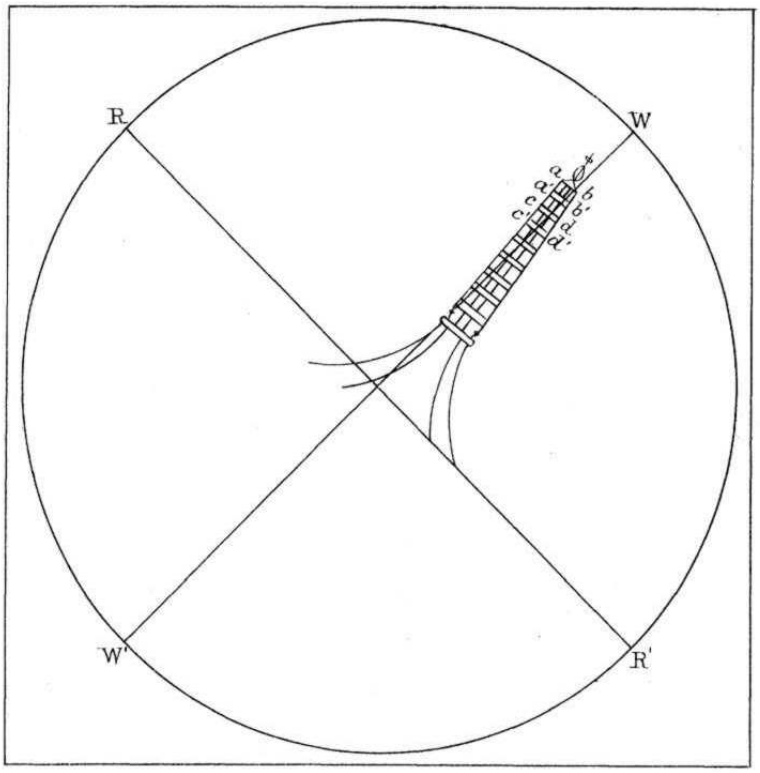
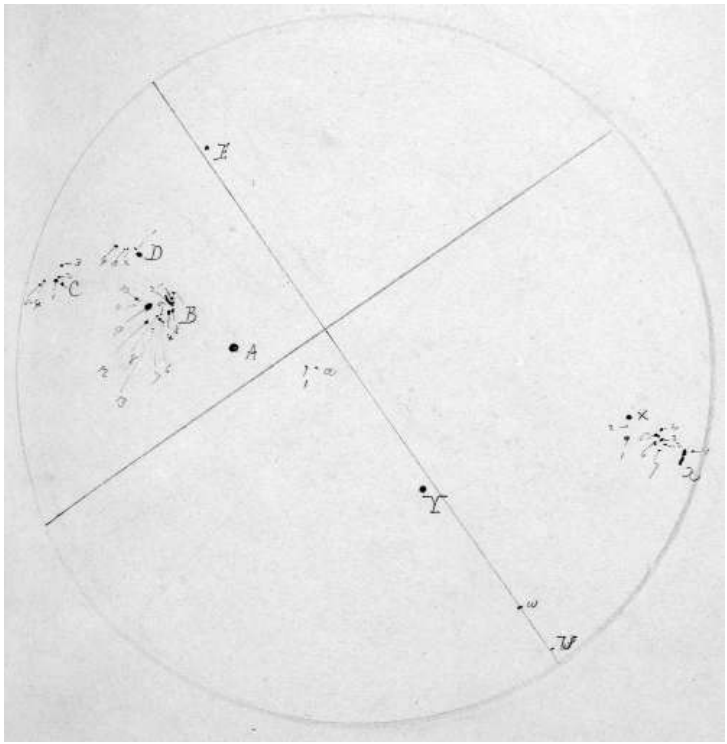


Fig. 19.2. View of the Kew Pagoda with photoheliograph. Phil.Trans. *159 (1868), Plate II, No 2.*

The programme of daily solar photographs was interrupted for the 1860 solar eclipse, when De La Rue, largely at his own expense, took it to Spain. There was then a delay in returning it to Kew because of a dearth of assistants to operate it. During this time it remained at De La Rue's Cranford Observatory. Operations at Kew were recommenced in February 1862, and continued until March 1872, so that essentially a complete solar cycle was covered. Several photographs were taken daily, whenever weather permitted.[88] In addition to sunspot numbers, the position (heliographic latitude and longitude) and area of each spot were measured.[89]

The results were reported at length in several series of reports, some by De La Rue alone, but most by him jointly with Balfour Stewart (Superintendent of the Kew Observatory) and Benjamin Loewy (Observer and Computer to the Kew Observatory). These reports were initially published for private circulation at De La Rue's expense, and then by the Royal Society.[90] They included an analysis of Hofrath Schwabe's records (1832-1854), and those of Richard Carrington (1854-1860 and 1868), as well as those of Kew, and conformed to an average sunspot cycle of just over eleven years.[91]



The published reports of sunspot areas from the Kew photographs start with observations made on 7 February 1862,[92] and do not, therefore include the major solar storm observed by Carrington and Hodgson on 1 September 1859.[93] They do, however, include the areas from Carrington's own observations, and show that the mean sunspot coverage area for the relevant two weeks (August/September), at 0.3365% the area of the solar disc, was a maximum.[94] Hodgson reported that a photograph taken at Kew the previous day showed that the sunspot group was about 60,000 miles in diameter.[95]

By the conclusion of the Kew observations in 1872 supervision of the Observatory had passed from the British Association to the Royal Society. The photoheliograph was moved to the Royal Observatory Greenwich, where it was used from April 1874 to September 1875.[96]

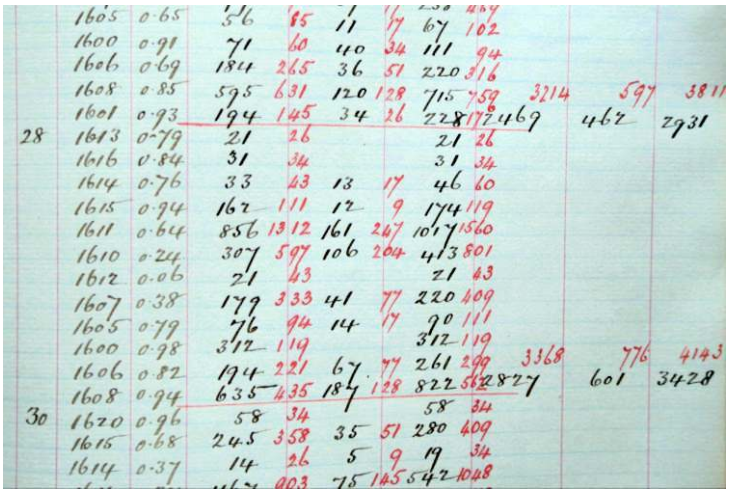


Fig. 20.1 & 2. Record of sunspot observations, 28 March 1871. *Royal Society MS265. The columns show the sunspot group number, its radial distance, the areas of the penumbra, umbra and whole spot, and the totals for the day.*

Sunspots and planets

In their second report series, in 1865, De La Rue, Stewart and Loewy explored the idea that the pattern of growth and decline of sunspots showed that some external influence might be at work, and they suggested that this could be the planets. Their initial analysis led them to the conclusion that the behaviour of spots might be influenced by Venus, without, however, suggesting that Venus was the cause of the solar cycle.[97] They felt that spots attained their maximum size when on the side of the Sun away from Venus, and their minimum size when on the side facing Venus.

De La Rue was clearly enamoured of this idea, and must have spent considerable time in following it up. He is attributed as saying: 'solar activity, as shown in the phenomena of sun-spots, would not exist but for planetary motion, any more than certain physical phenomena of the planets would be produced without solar influence'.[98]

In a subsequent paper (1870), however, the authors expressed more caution, stating: 'We were induced to imagine from our preliminary researches that the amount of spotted area may possibly be influenced by the positions of the planets in such a way as to exhibit excessive solar action when two influential planets are together at the same ecliptical longitude'.[99] They proceeded to test this hypothesis by an analysis of conjunctions of Venus and Jupiter, and of Venus and Mercury, and relate them to their own and Carrington's observations. They drew no specific conclusions, but felt that their results lent some support to the idea, and that it warranted further investigation.

Clearly, this hypothesis must have drawn some critical comments, for in a further paper they defended the idea that sunspots may be subject to external influences, there being no evidence for a mechanism within the Sun which could cause the observed changes in sunspot appearances.[100] They carried out a much more detailed analysis, the results of which, they suggested, appeared to indicate that Mercury and Venus (but not Jupiter) had such an influence.

The 1874 transit of Venus

De La Rue proposed to photograph the transit of Mercury on 12 November 1861 at Cranford, and requested that the Kew photoheliograph attempt it also.[100] However, we must assume that this was unsuccessful, as no report of a Cranford or Kew observation appears in the collection of reports on the transit published in the *Monthly Notices* of the Royal Society.[102] The transit occurred at sunrise, and it could well have been cloudy, although it was observed in some other parts of the country.

By the late 1860s planning was engaged in earnest for observations of the transits of Venus across the disc of the Sun in 1874 and 1882, in order to determine the elusive solar parallax, and hence an accurate measure of the scale of the solar system. This was to be a major international undertaking, with expeditions being sent by many countries all over the world. The contribution by Britain to this enterprise was, therefore, considered to be of much importance, and the Astronomer Royal, Airy, who was strongly supportive of the application of photography to astronomy, asked De La Rue to give thought as to how it might be used for the transits.[103]

In 1868 De La Rue responded by submitting a paper to the Royal Astronomical Society suggesting that if two or more timed photographs were taken during the transit, and the distance between the centre of the Sun and that of Venus measured by a micrometer similar to that which he had devised for measuring the 1860 eclipse plates, the solar parallax could be determined with high precision. Furthermore, the photographs did not need to be taken at the exact contacts of the planet with the solar limb, as with the optical methods. A series of such photographs could be taken at intervals of a few minutes, and multiple measurements obtained, thereby increasing the accuracy of the method. He calculated that it could provide an accuracy of 0.185 arc-seconds in parallax, and possibly much better. He advocated that six such instruments be used at various locations, and concluded by saying: 'no strain on the nerves would occur [compared with that of observing a solar eclipse] … All the operations could be conducted with that calm so essential for such a problem as the determination of the Solar Parallax'.[104]

De La Rue was able to convince Airy of the reliability of the photographic method[105] and five instruments, being a modified design of the Kew photoheliograph, were duly built by Dallmeyer, and sent with expeditions to their respective locations around the world (the Sandwich Islands, Egypt, Rodriguez Island, Kerguelen Island, and New Zealand) for the 1874 transit. The instruments incorporated a form of shutter facilitating the making of multiple exposures on a single plate, devised by Jules Janssen and modified by De La Rue and Dallmeyer, called the '*Révolver Photographique*'.[106]

Fig. 21. The photoheliograph used for the 1874 transit of Venus. *Royal Astronomical Society ADD MS 93/105.*

In the meantime, however, there had been some dispute about whether to use Halley's method (which relies on observers at sites far north and far south to record accurate times of the contacts of Venus with the limb of the Sun, in order to compare the lengths of the transit chords), or Delisle's (which relies on accurate knowledge of the observers' longitudes). In 1868 Airy had announced his selection of observing sites for the 1874 transit, based on the view that Halley's method was unsuitable for this transit.[107] This view, together with the sites selected, was challenged by Richard Proctor, then Secretary of the RAS, and became the subject of a public and acrimonious correspondence between Proctor and De La Rue in the pages of *The Times* in early 1874. Proctor accused De La Rue of making an attack upon him at a meeting of the RAS, in his absence, for a paper he, as (temporary) Editor, had inserted in the *Monthly Notices*. De La Rue defended his action, referring to what he viewed as improper remarks contained in the paper, pointing out

that the paper had not been sanctioned by the RAS Council, and that the Council had passed a Resolution 'expressing their strong disapprobation' of Proctor's remarks.[108]

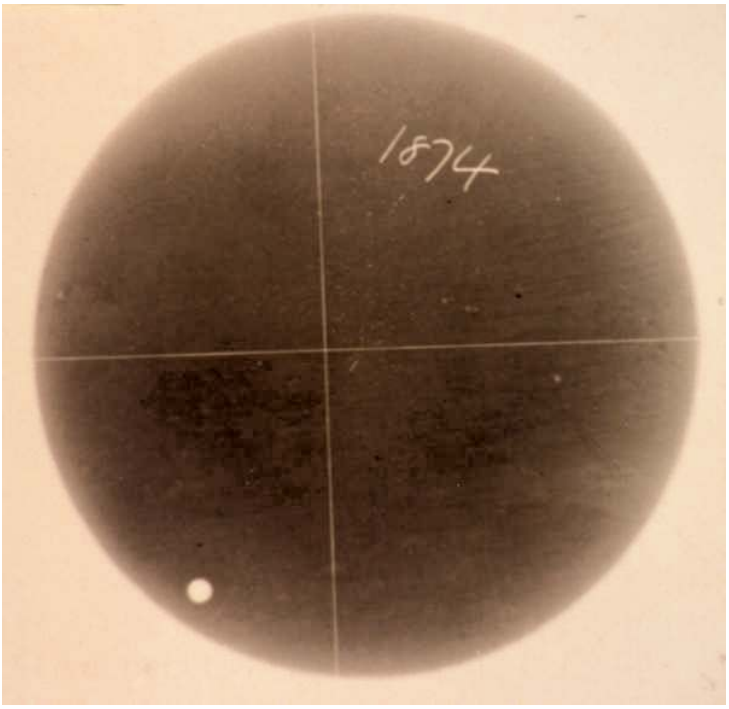


Fig. 22. Photograph of the 1874 transit of Venus, taken with the photoheliograph.
Royal Greenwich Observatory archives.

In the event, the photographic method devised by De La Rue and used by the British expeditions, in common with other European attempts, proved a complete and costly failure. The small solar images had to be enlarged before measurement, and it was found impossible to determine the limbs of the Sun and Venus with sufficient accuracy. Airy did not blame De La Rue, but rather the human computers carrying out the measurements.[109] Nevertheless, it seems clear that the method was unsuited to its task; the American expeditions, with long focal-length telescopes, faired rather better.[110] De La Rue publicly held himself 'responsible for having sanctioned so much expense and labour'.[111] Needless to say, the British expeditions for the 1882 transit abandoned photography as a method.

Endowment of scientific research

In 1872 a heated debate within the scientific community led to the resignation of De La Rue from the RAS Council. The matter had commenced in 1868, when Council member Lieut.-Colonel Alexander Strange had presented a paper to the BAAS, advocating State endowment of scientific research.[112] This led to the establishment of a Committee within the BAAS. Two years later, on the recommendation of the BAAS Committee, there was established the *Royal Commission on Scientific Instruction and the Advancement of Science*, chaired by the scientifically qualified William Cavendish, Duke of Devonshire, with Norman Lockyer as Secretary. The Devonshire Commission met for six years, took evidence from 150 people, including De La Rue, and produced eight reports.

In his evidence to the Commission De La Rue advocated the appointment of a Science Minister, assisted by secretaries, and advised by a Board 'of men eminent in different departments of science. … Then we should get prompt action, instead of questions being allowed to drag over years and years without any practical solution being come to'. He contrasted the poor progress in English science, especially chemistry, with that of Germany, where science enjoyed considerable patronage. He stressed the need for a major chemical laboratory, as well as a physical laboratory. With regard to the physics of astronomy, he recommended that the State provide support for physical observations, especially those that 'require the devotion of so long a time and are so expensive that private individuals can hardly be expected to carry them on for a sufficiently long period', such as large-scale solar photography. He further proposed that, in order to ensure daily photographs of the Sun, there should be one or two observatories in India and another at the Cape of Good Hope. Lunar libration and stellar motions were also considered worthy of study. He concluded: 'We want science really cared for in England by the State, and we want all State questions relating to science properly considered by a body capable of dealing with them. … There is great difficulty in fact under existing circumstances in the State dealing at all with science or with scientific men. There is no department of the Government, so far as I know, which is able to fully appreciate the advantages that science confers on the State'.[113]

In the meantime, Strange had read a paper to the RAS, in 1872, on the need for official observatories to carry out fundamental research. He argued that the relatively narrow research focus of the Royal Observatory at Greenwich (which concentrated on observations necessary for navigation, including time-keeping and time distribution), meant that there was a dearth of research into the physics of astronomy by official institutions.[114] He received support from De La Rue, who pointed out the need for solar studies to establish any connection between activity on the Sun and meteorological changes on Earth. The Astronomer Royal, Airy, however, took the view that observatories had to have objectives which were of practical use. At a subsequent RAS Council meeting Strange and De La Rue attempted, unsuccessfully, to get a resolution passed supporting the establishment of an observatory for basic research, and for several branch observatories in British territories overseas for solar photography.

Leading the opposition to this proposal was Richard Proctor, and the dispute became very personal. There appears to have been particular animosity between Proctor and Lockyer, which had been simmering for some time. The outcome was the resignation of Strange, De La Rue and Lockyer from the RAS Council in November 1872, because of its deference to Airy's opposition to a specialist observatory independent of his control. The dispute did not stop there, however, since there were disagreements over the award of the Gold Medal in 1873, with Strange proposing an alternative list of candidates for Council. It continued into 1881 when a further proposition was considered opposing the granting of public money for basic research, and specifically the establishment of a physical observatory, and that the Government grant to Lockyer's South Kensington Solar Observatory should be discontinued. The endowment of research debate clearly polarised views within the scientific community, and specifically within the RAS. While De La Rue appears to have been on the losing side for a time, the situation had started turning by 1881, and, following a rather spirited session, the proposition failed to be carried, no doubt to the relief of De La Rue, Strange, and especially Lockyer. In due course there was a gradual acceptance of the principle of endowment, and government support resulted in the establishment of a number of scientific institutions.[115]

Oxford University Observatory

In 1873, at the age of 58, his health and eyesight lessening, De La Rue retired from active observing, sold his estate at Cranford, and moved back to London, settling at 73 Portland Place, between the Langham Hotel (where he had often stayed) and Regents Park.[116] He presented his equatorial telescope and the contents of his obser-

vatory to Oxford University, where his friend Charles Pritchard had become Savilian Professor of Astronomy. His generosity was in response to the welcome news that the University would build a new University Observatory, and his desire to find a home for his telescope where he could be sure that it would be applied to worthwhile research. The recognition which the University had given to him by awarding him an honorary DCL three years earlier, and the obvious trust which he placed in Pritchard, clearly also played a role.[117]

Pritchard put the telescope to good use as a core instrument for the development of the Observatory into one appropriate for a major university. Indeed, it appears that the gift of De La Rue's equatorial reflector hastened the progress of a development which the University was already embarking upon, and the University readily committed to the additional building works necessary to house the instrument. The original plan was thereby transformed, and De La Rue was thus a co-founder and vital on-going benefactor of the new observatory (since the University did not itself provide adequately for assistants or research). His donation, indeed, accorded with the need he had expressed to the Royal Commission the previous year, and led to what Pritchard himself referred to as 'the first foundation [in England] of an observatory for astronomical physics'. Pritchard gave full credit for this achievement to De La Rue, and supported him in his dispute with Proctor by writing to *The Times*, pointing out De La Rue's role with respect to the Observatory.[118] De La Rue modestly responded in a further letter, stating that the discussions in the RAS Council which had influenced the foundation of the new Observatory arose out of resolutions proposed by Lieut-Col. Strange, which he had seconded, and were based on Strange's 1872 paper to the RAS on the subject of national observatories.[119]

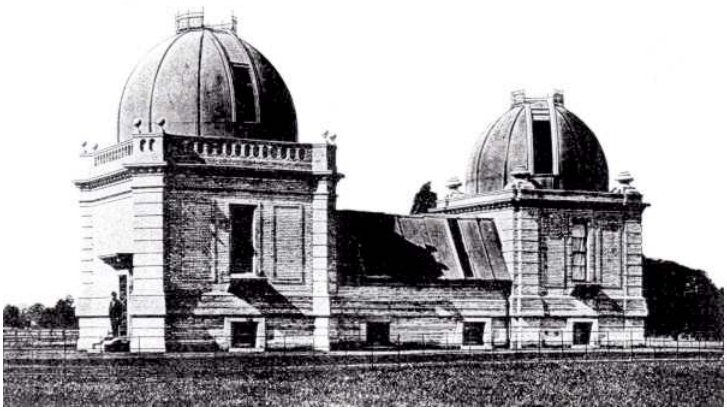


Fig. 23. The Oxford University Observatory in 1875. The De La Rue dome is on the right.
MNRAS*, 36, 1 (1875), cover page.*

The only condition which De La Rue placed on his gift was that it was to be usefully employed. He further urged: 'One use [to] which I should like to see my reflector applied is the determining whether or not the moon has a physical libration; for this purpose, photograms of this planet would have to be taken as often as practicable, and the original negatives measured by means of a properly constructed micrometer, so as to determine the apparent distance of selected craters from the moon's limb — after allowance for the shifting produced by the optical (latitude), the orbital (longitude) and terrestrial station librations, the residue would be the true libration due to the centre of gravity not coinciding with the centre of figure ...'.[120]

To this end, De La Rue met the cost of an assistant for four years, provided a plate measuring machine, and continued to support and advise the Observatory. However, despite the dedication of the assistant to the task, hundreds of lunar pictures being taken annually, their micrometrical measurement, and a statement, in 1880, that the lunar libration work had been completed, it was never published in a complete form. In January 1881 Pritchard stated that he hoped 'speedily to lay the results before the RAS, but he only reported: 'There does exist a real, but inconsiderable, [physical] libration in Longitude, less than five minutes of arc, and probably not ascertainable within some decades of seconds'.[121] His biographer does know why the work was laid aside.[122] Pritchard did, however, carry out a considerable amount of work on stellar parallax and photometry.

In 1887 the Observatory agreed to participate in a collaborative photographic survey for the production of an international chart of the heavens, but lacked a suitable refracting telescope. De La Rue not only provided two 15-inch mirrors of different focal lengths, in order to test whether wide-field photography was feasible,[123] but also provided £600 for the purchase of a 13-inch Grubb astrograph to be mounted coaxially on the 12-inch refractor, asking only that an inscription be affixed to it, saying 'The gift of Warren De La Rue in honour of Professor Pritchard'.[124]

Fig. 24 The Oxford Observatory building in 1994, showing the De La Rue dome.
Photograph by the author.

The Observatory is now a cluster of buildings no longer having an astronomical function. The De La Rue reflectior is stored in a dismantled state at the Museum of the History of Science in Oxford. The Museum also has several of his cameras, two of the 13-inch specula, and a box of eyepieces.[125]

Cape Observatory telescope

In 1880 De La Rue, now aged 65, was heavily involved in a proposal for a major new telescope at the Cape of Good Hope Observatory. A year earlier David (later Sir David) Gill had been appointed Her Majesty's Astronomer at the Cape. The Observatory at that time had only a transit-circle, a 7-inch equatorial, and one of the Dallmeyer photoheliographs which had been made for the 1874 transit of Venus. Gill was eager for the Observatory to possess a large equatorial refracting telescope, of the order of 20 inches aperture and 30 feet focal length, and sought support from the Government. Correctly anticipating difficulties with Airy, he enlisted De La Rue's assistance and influence.[126] Airy was very lukewarm about the project, saying that Gill had to decide whether to be a meridian observer or an equatorial one, and bemoaning how little had come out of the 48-inch Great Melbourne Telescope.[127] He suggested that Robert Newall's instrument be obtained on loan.[128]

Not one to turn down anyone asking for help, De La Rue took up the cause. There ensued a round of correspondence between Gill, De La Rue and Airy. De La Rue and Gill felt that a loan instrument

Fig. 25.1 & 2. De La Rue's 13-inch telescope and cameras, at Museum of the History of Science, Oxford.
Telescope photographed by author; cameras by Museum of the History of Science.

was not desirable for a Government observatory, and that either Newall's telescope be purchased, if he was willing to sell, or that an object glass which Grubb already had be purchased immediately. Their idea was that the telescope would be paid for by public subscription (£6,500 or £7,640 depending on which option was adopted), and that the Government assist with its transport.

In an attempt to press the matter towards an early resolution, Gill suggested that the approaching transit of Venus in 1882 would require a large telescope in South Africa, to match those in the northern hemisphere. He asked De La Rue to lay the matter before the Royal Society, and for the Society to approach the Government.[129] De La Rue responded by setting up a Cape Telescope Committee within the Royal Society, in order to raise the money needed. Although there was some response,[130] De La Rue soon expressed despair of reaching the required sum. He advised Gill to apply direct to the Government, while he (De La Rue) left for a two-month trip to the Continent. This Gill did, by writing to the Secretary to the Admiralty, but Airy expressed the view: 'I greatly fear that Mr. Gill is preparing for himself much disappointment'. This was evidently the case, and by the end of 1880 the support of the Cape Telescope Committee appears to have been withdrawn. Gill had to wait a further two decades before he got the telescope he wanted, and only then after many more difficulties, and the intervention of a major gift by Frank McClean – the Victoria Telescope.[131]

His final years

In his later years, his position as a serious and accomplished scientist firmly established, Warren De La Rue continued to play a significant part in Victorian business and astronomy, in England and in international circles. He served on the Melbourne telescope committee, the design of this giant 4-foot reflector and its photographic equipment being based on his celebrated 13-inch equatorial.[132]

He made further experiments to determine whether it would be possible to photograph the prominences without the Sun being eclipsed, using prisms with gold-coated faces and fluid filters. These produced negative results, although he felt it would be possible to photograph them as dark markings against the bright background of the photosphere. Philosophically, he said: 'The progress of scientific discovery may be promoted by the record of one's failures, for it tends to prevent the same paths from being trodden by future explorers'.[133]

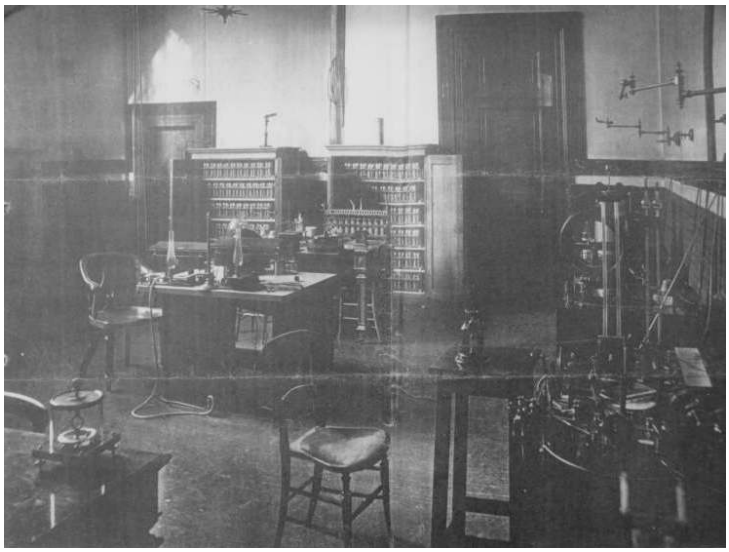


Fig. 26. Warren De La Rue's laboratory.
Science Museum, London (Inv. No. 1876-63).

He set up a laboratory near his house in Portland Place, and, with his chemist friend Hugo Müller, renewed with vigour researches on what must have been spectacular electrical discharges using thousands of silver chloride batteries, and published a large number of papers on the subject.[134] Their studies included electrical discharge through gases, which Balfour Stewart had suggested might explain aurorae as solar-terrestrial phenomena. Indeed, one of their

papers drew conclusions about the height of the aurora borealis (37.67 miles, visible for 585 miles) at its maximum brilliancy, and its various colours at different heights.[135]

De La Rue apparently did not neglect his chemical studies entirely, and it is recorded that he was of assistance to Louis Pasteur when the latter visited London in September 1871, probably not least because Whitbread's Brewery, which Pasteur visited, was in Chiswell Street, just around the corner from the De La Rue factory in Bunhill Row.[136]

Although appearing generally to have a robust constitution, he occasionally suffered from health problems, and clearly increasingly found it difficult to maintain the energy and mental capacity which characterised his life. Nevertheless, despite his expressed profound dislike of lecturing,[137] he gave a memorable discourse at the Royal Institution on electrical discharge with 14,000 Sodium Chloride batteries, complete with demonstrations.[138] That was in early 1881, but by December of that year his letter of resignation as Secretary of the Royal Institution gave some insight into his difficulties:

> With great emotion I write this letter to let you know that it is essential to my health and to the interests of the Institution that I should resign the Secretaryship. It is possibly due to my age combined with past brain work that I am unable to do without worry to myself the work which tougher men could do easily.… I ought to be able to get through the work without strain; but somehow or other, work which has to be accomplished at particular times is always present before and worries me.[139]

The end came quickly. He attended the Royal Institution Managers meeting on 1 April 1889,[140] but some two weeks later, on Good Friday, 19 April, died from pneumonia at his house in Portland Place. He left an estate worth over £300,000 (over £20 million at today's values). In his will he remembered his family and servants, but the bulk of his estate went to his widow, who presented his laboratory apparatus to the Royal Institution.[141] In his memory his son, Warren William, presented to the Victoria and Albert Museum a painting of the opening of the 1851 Great Exhibition, which includes Warren and his father amongst the guests.

Tributes

Warren De La Rue was lauded in many obituaries which recorded his character, his business acumen, his expertise and contributions in a number of scientific fields. Books on the history of astronomy invariably give due recognition to his pre-eminent role in early astronomical photography, especially solar photography, in which, in the words of the address given on the presentation of the Royal Astronomical Society's Gold Medal, 'he stands almost alone'. That same address summarized his astronomical achievements: 'the perfecting of the figures of mirrors, the graphic observations of the planets, the incomparable photographs of the Moon, the invention of the photoheliograph, the observations of the solar eclipse, the invention of the new method of obtaining numerical data, the application of the stereoscope to the examination of the surface of the Moon, and afterwards to that of the Sun'.[142]

The scientific journal *Nature*, in a lengthy obituary, stated that his efforts during the 1860 eclipse 'laid the foundation of that wonderful structure of solar physics which is daily enlarging our knowledge of the true nature of the sidereal universe', and went on to conclude:

> The space which can be here afforded to the memoir even of an illustrious man precludes more than a passing allusion to the honours and social distinctions which always accompany the efforts of a life such as Warren de la Rue's; and upon him they were accumulated in abundance. The abiding honour lies in the contemplation of the man. A career like his dignifies the daily life of a manufacturer, giving it an aim and an object apart from the accumulation of wealth; it humanizes, warms and illuminates the absorbing abstraction of the solitary student; and it illustrates the fact of an Aristocracy of Nature.[143]

An equally lengthy RAS obituary stated: 'In the history of celestial photography in this country Mr. De La Rue stands pre-eminent'.[144] *The Observatory* praised 'his wise and liberal assistance to science by presence and sympathy as well as by gifts', and his skill in committee. 'His insight, his judgment, his ready tact, his conciliatoriness – combined to make him a power in council and committee. Conciliatoriness he regarded as a most valuable quality. "I am the man with the oil-can," I have heard him say; and the description was as true as it was graphic'.[145] He was also remembered in Guernsey, the island of his birth, the *Star* and *Comet* newspapers recording his death and publishing brief accounts of his life's work.[146]

Fig. 27. Warren De La Rue's grave, Kensal Green, London. *Photograph by the author.*

Conclusion

Warren De La Rue is not now a household name, even amongst astronomers. Unlike his contemporaries and colleagues, Airy, Faraday and Carrington, for example, there is nothing named after him. There is no De La Rue disc, De La Rue effect, or De La Rue

Fig. 28. De La Rue crater.
The De La Rue crater is the large one surrounding the small bright one in the centre of the picture. From Clementine Lunar Map (Deep Space Program Science Experiment), U.S. Naval Research Laboratory (1994).

rotation. He does, however, deserve to have his name listed amongst these more familiar scientists. For it is clear that he was an important and talented figure, highly regarded by everyone, welcomed especially for his technical skill and his genial character. A consummate amateur scientist, inventor and successful businessman, he made significant contributions to astronomy, chemistry, electricity, physics, printing, and particularly to the development of astronomical photography. His one 'discovery', however, was perhaps really a demonstration—that solar prominences emanated from the Sun.

He made some errors of interpretation of his observations. He expressed the view that the appearance of the solar corona was the result of light from solar prominences.[147] He persisted in claiming that the solar chromosphere was nothing more than a continuous encirclement of prominences,[148] and that Baily's Beads were caused by defects in the telescopes used to observe solar eclipses.[149]

It has been suggested that his early publications show that 'he was very adroit at self-promotion'.[150] The implication is that he gave insufficient credit to the work of others. I do not believe this to be the case. His motives in publishing thorough accounts of his work were, in my view, genuine attempts to inform the scientific community of the rapid developments of the third quarter of the nineteenth century, especially those of astro-photography and its contribution to astronomical knowledge. His scientific publications are, quite properly, replete with references to others, and many of his papers were of joint authorship. At times he shows deference surprising in a man of such eminent achievements. He himself said that he 'knew something of manufactures, and had also dabbled a little in science'.[151]

There is a lasting tribute to him in the form of the lunar crater which bears his name. Its appearance and position, however, reflects his position in history. It is not prominent, and few would be able to pinpoint it. Although sizeable (135 km diameter), it is indistinct, and non-central, lying on the northern edge of the Moon, best visible when libration carries it into a favourable aspect.

Warren De La Rue was not only Britain's leading exponent of the emerging technology of astro-photography, but was a meticulous observer and experimenter, with a gift for mechanical and optical innovation. His holding of many influential offices, and his extraordinary achievements suggest that he is deserving of much further recognition than he has heretofore been granted.

Awards and positions

Juror, Class XXIX (Miscellaneous manufactures), Great Exhibition, 1851; Juror, Class X (Chemical manufactures, including paper), Exhibition Universelle, Paris 1855. (He also exhibited products of cochineal, and his model of the mounting of Huygens's lens); Founder Member, Chemical Society (1841-89), President (1867-9 and 1879-80); Fellow, Royal Astronomical Society (1851-89), Secretary (1855-63), Council Member (1862-72), Gold Medal (1862), President (1864-66); Fellow, Royal Society (1850-89), Royal Medal (1864), Vice-President, (1869-70 and 1883-85); Chairman, Royal Society Kew Committee; Member, Royal Society Grants Committee; Member, Meteorological Council (1881); Member, BAAS Committee for lunar mapping (1866-9); President, BAAS Section 'A' (1872); President, London Institution; Secretary, Royal Institution (1879-82); Vice-President, Royal Institution; Honorary D.C.L., Oxford (1870); Master of Arts, Oxford; Commander of the Legion of Honour; Commander of the Order of St Maurice and St Lazarus; Knight of the Order of the Rose, Brazil; Member, The Photographic Society; Medal, French Photographic Society; Member, The Microscopical Society; Engraver to the Board of Inland Revenue (1888); Society of Arts (1847-; Council Member and Committee Member); Member, International Electrical Congress (Paris, 1881); Juror, Electrical Exhibition, Paris, 1881; Member, Consulting Council, Electrical Exhibition, Crystal Palace, Sydenham, 1882.

Acknowledgements

A number of people have assisted in this research. I am particularly grateful to Peter Hingley (Royal Astronomical Society), Adam Perkins (Cambridge University Library), and Kevin Johnson (Science Museum).

Notes and References

1 The literature contains various permutations of upper and lower case D and L in the name De La Rue, but Warren always signed with upper case for both letters.

2 Le Conte, David: 'Two Guernseymen and Two Eclipses', *The Antiquarian Astronomer*, **4** (January 2008), 55-68.

3 Nasmyth, James, and Carpenter, James., *The Moon considered as a planet, a world, and a satellite* (London: John Murray, third edition 1885), p. 62.

4 Clerke, Agnes., *A Popular History of Astronomy during the Nineteenth Century* (London: Adam & Charles Black, third edition 1893), p. 190.

5. Curiously, his baptism in the St Peter Port Town Church is omitted from the register, a fact recognised in a letter from Matthew Gallienne of Guernsey to Warren De La Rue on 31 January 1856. The priest did, however, furnish a certified extract of a registry entry in 1882. (University of Reading Special Collections MS937, 9/7, 9/35 and 9/50). It has been suggested that registry details were sometimes written on pieces of paper for later entry into the register, and that occasionally these pieces may have been lost. (Gregory Stevens Cox, historian, and Amanda Bennett, Guernsey Priaulx Library, personal communications.)

6. Houseman, Lorna., *The House that Thomas Built* (London: Chatto & Windus, 1968), p. 18.

7. Thomas owed £254-8s-6d to Jean Champion, £25 to Thomas Lenfestey, £34 to George Lucas, and £25 to Henri de Garis (Greffe, Guernsey: Décrets, 1816-1820, p. 27).

8. It is recorded that Warren visited Guernsey early in 1834 (*Autobiographical Twaddle*, Samuel Elliott Hoskins, Guernsey Archives AQ 0843/02), and was clearly close to some of his Guernsey relations. A letter to him dated 28 November 1882 from his cousin, Rachel Aubert (daughter of John Champion and Thomas's sister Rachel), then living at Vine Grove, Mount Durand, St Peter Port, about his grandparents' headstone is written in terms of close endearment (Reading University Special Collections MS 937 9/7). His property interests in Guernsey derived from an 1850 contract of 'délaissance' of property owned by his father-in-law, Thomas Bowles (Guernsey Greffe, *Contrats pour la date*, book 60, p. 41), and appear to have included properties in the High Street and Hauteville, St Peter Port (Reading University Special Collections MS937 9/48, 9/50 and 9/52).

9. The lack of science educators, and therefore science education, in England was an issue to scientists like Michael Faraday, who is reported to have told a Royal Commission: 'If you want science, you must begin by creating science teachers'. (G.M. Young, 'Portrait of an age', in *Early Victorian England*, II, Chapter 27 (Oxford: OUP,1934), p. 498).

10. Houseman (1968), p. 23, and school report (Paris Archives).

11. Archives of De La Rue plc, Basingstoke.

12. For a detailed description of Warren De La Rue's role in the business see Easton, John., *The De La Rue History of British & Foreign Postage Stamps, 1855 to 1901* (London: Faber and Faber, for the Royal Philatelic Society, 1958).

13. Easton (1958), pp. 91-92.

14. Newall, H.F., 'The decade 1860-1870', in *History of the Royal Astronomical Society*, I, Chapter 5 (J.L.E. Dreyer and H.H. Turner, eds., (London: RAS, 1923, reprinted 1987), p. 165.

15. Easton (1958), p.xvii.

16. Easton (1958), pp. 766-7.

17. Letter from Warren De La Rue to William Frederick De La Rue, 4 January 1864, De La Rue Company Correspondence Books. Quoted by Easton (1958), p. 777.

18. Knobel, Edward., 'Warren De La Rue', *Monthly Notices of the Royal Astronomical Society* [hereafter *MNRAS*], 50, 4 (1890), 155-64, p. 163.

19. *MNRAS,* 17, 1 (1856), p. 19; *MNRAS*, 17, 1 (1857), p. 221: 'Mr. De La Rue exhibited finished engravings of the planets Jupiter and Saturn, the latter printed in colours, copies of which he most handsomely offers to Fellows of the Society'.

20. Knobel (1890), p. 163.

21. 'Warren De La Rue', *Nature*, 40 (9 May 1889), 26-28.

22. *MNRAS*, 22, 4 (1862),131-40.

23. A godmother of one of Georgiana's sisters, Henrietta, was a Marie Bardel Greenslade (ref. St Peter Port Church baptism records 1812-1832, p. 144). The Greenslades were related to Warren's mother's family. Thomas Greenslade, who came from the same Devon village (Bishop's Nympton) as Warren's mother, had briefly been Warren's father's publishing partner in Guernsey. It seems probable that one of Georgiana's mother's family had married a Greenslade, and that there was, therefore, a loose family link between the Bowles and the De La Rues. This appears to be supported by the reference to an Osborne Greenslade as having an interest in the estate of Marie Bardel Bowles (ref. Guernsey Greffe: *Contrats pour la date*, book 75, p. 494). It is also probable that Thomas Bowles and his family had reason to visit London, or perhaps move there, as he originated from Cripplegate.

24. In a letter of 1 May 1860 the Astronomer Royal refers to the possibility of Mrs De La Rue 'who I believe aids her husband in photography', accompanying Warren on the eclipse expedition. In the event she did not go. (Royal Greenwich Observatory – hereafter RGO - 6/123 22).

25. De La Rue, Warren., 'On the effects of a battery charged with sulphate of copper' *Journal of the Franklin Institute*, 19, S (1837), pp. 229-31. Also De La Rue, Warren., 'Ueber die Wirkungen einer mit schwefelsaurem Kupferoxyd geladenen Voltaschen Säule', *Annalen der Physik und Chemie*, 116, 4 (1837), pp. 628-31.

26. *Memoirs of the Chemical Society of London*, 1841-43, *Proceedings*, p. 1, House of the Society of Arts, John Street, Adelphi, 23 February 1841.

27. Houseman (1968), 48-51. The Company was in such a bad state of affairs that Warren's salary was in arrears.

28. Published by De La Rue & Co., London, 1843.

29. De La Rue was a founder member of the Microscopical Society of London (1839). He published a paper on microscopic observations of a butterfly: 'On the Markings of the Scales of the Amathusia Horsfieldii'*, Transactions of the Microscopical Society of London*, 3, (1852), pp. 36-40.

30. Hoffman and De La Rue jointly edited the first two volumes of the *Annual Report of the Progress of Chemistry and the allied sciences, Physics, Mineralogy and Geology*, by J Leibig and H Kopp (London: 1847-8). They also contributed a paper in one of the Jurors' Reports of the Great Exhibition, 1851.

31. Martin, Thomas, (ed)., *Faraday's Diary* (London: G Bell & Sons, 1936) contains many references to De La Rue.

32. De La Rue's first patent was for a machine to apply colour to the surface of paper. He had three patents for the manufacture of envelopes, and even one for a method of treating printers' rags so that they could be re-used. (British Library, Business and IP Centre: patent nos. GB 10436 (1844), GB10565 (1845), GB12084 (1848), GB12904 (1849), GB1123 (1852), GB1051 (1854), GB2719 (1854), GB843 (1855), GB2002 (1855), GB890 (1856), GB1860 (1859), GB1248 (1866), GB1381 (1866), GB 1383 (1866)). He is also widely credited on Internet websites with inventing the first light bulb, a platinum fila-

ment lamp, but this is almost certainly a misattribution, as I have found no primary evidence. This claim is discussed by Edward J Covington at http://home.frognet.net/~ejcov/delarue.html, where it is suggested that it may be traced to a statement by Edwin J. Houston, *Electricity in Every-Day Life*, 2 (New York: P. F. Collier & Son, 1905), p. 247.

33. Warren De La Rue's visit to James Nasmyth is recorded in Samuel Smiles (ed)., *James Nasmyth, Engineer; An autobiography*, (London: John Murray, 1897), chapter 18.

34. Edwards, Ernest., *Portraits of Men of Eminence in Literature, Science, and Art, with Biographical Memoirs: The Photographs from life,* 3 (London: A. W. Bennet, 1865), p. 37.

35. De La Rue, Warren., 'On the Figuring of Specula', *MNRAS*, 13, 1 (1852), 44-51. See also Lockyer, J Norman., *Stargazing: Past and Present* (London: Macmillan and Co., 1878), p. 134.

36. De La Rue's telescope was 'designed by himself and constructed in his own workshops', Natural History Museum, L MSS HUN/4, 26 January 1866. This document is an account of his astronomical work, written in his own hand, 'as the justification to be read at the "Academie des Sciences" for the Lalande prize of Astronomy'.

37. Letter from De La Rue to Nasmyth, 26 October, 1864 (quoted in *Nasmyth* (1885), Chapter 21).

38. The first mention of De La Rue in the *MNRAS* was a note that his 'very beautiful drawing of Saturn' would be exhibited at the Royal Astronomical Society meeting in January 1851, *MNRAS* 11, 1, (1850), p. 22.

39. Letter from De La Rue to Herschel, 12 October 1856 (Royal Society, HS.6.D.137). The letter includes a number of detailed sketches of Saturn's rings.

40. De La Rue's nomination as a Fellow of the Royal Society referred to him as a 'Card maker and engineer', the inventor of 'the envelope machine and other mechanical contrivances', and cited his paper on cochineal. It was signed by 16 Fellows, including Faraday. (Roy. Soc. EC/1850/10).

41. *Great Exhibition of the Works of Industry of All Nations, 1851: Official Descriptive and Illustrated Catalogue*, Vol. 2, Section 3, *Manufactures*, Class 17 *Paper, printing, and bookbinding*, exhibit 76, pp. 541-3. Edwin Hill and Warren De La Rue took out a patent for cutting and folding machinery in 1845. Previously, envelopes had been folded by hand, an experienced workman achieving 3,000 a day. The machine still exists, in working order, and is housed at the Company's headquarters in Basingstoke.

42. *Report of the 29th meeting of the British Association for the Advancement of Science* (1859), p. 131.

43. Frederick Scott Archer first published his description of the wet collodion process in 'On the use of collodion in photography', *The Chemist* (March 1851), p. 257.

44. Harvard's 15-inch refractor required exposures of 20 minutes to produce a Daguerreotype image of the Moon, whereas De La Rue's 13-inch reflector produced a strong collodion image of the Moon in 4 seconds. (King, Henry C., *The History of the Telescope* (New York: Charles Griffin & Co. Ltd., 1955, Dover Edition 2003), p. 249). In 1853-4 De La Rue exhibited his photographic apparatus to the RAS, and had obtained a good collodion picture of the Moon in 30 seconds (*MNRAS* 14, 1 (1853), p. 134).

45. *MNRAS,* 18, 1 (1857), 16-18, p. 16.

46. Lockyer, J Norman., *Stargazing: Past and Present* (London: Macmillan and Co., 1878), p. 464.

47. Archives of De La Rue plc, Basingstoke.

48. *Nature*, 25 (15 December, 1881), p. 161.

49. Clerke (1893), p. 366.

50. De La Rue, Warren: *Report of Warren De La Rue FRS on the proposal to remount the Object Glass of Huyghens* [sic], 22 January 1855, Royal Society MM11, 27.

51. The model was displayed at the 1855 Exhibition Universelle in Paris (*Catalog des Objets Exposé dans le Section Britannique de L'Exposition*, Class VIII, Section 3, item 393, p. 23), and at the South Kensington Museum's 1876 exhibition of the Special Loan Collection of Scientific Instruments (catalogue, 1877, p. 421, item 1852a).

52. De La Rue, Warren., 'Report of Warren De La Rue FRS on the proposal to remount the Object Glass of Huygens [sic]', 22 January 1855 Royal Society MM11, 27, p. 11.

53. One of the members present was geologist David Thomas Ansted, a founder member of the Club, and later co-author of the comprehensive book *The Channel Islands* (Wm H. Allen & Co., London, 1862), which he wrote following a four-year residence in Guernsey, De La Rue's birthplace. The list of contributors of information contained in the book includes George Busk, who was a successful candidate at the election at which De La Rue failed.

54. Letter from Charles Darwin to J.D. Hooker, 18 May 1855 (Burkhardt *et al*., *The Correspondence of Charles Darwin, vol. 5: 1851–1855* (Cambridge; CUP, 1985, letter 1681).

55. The prime sources of information about the Philosophical Club appear in T.G. Bonney, *Annals of the Philosophical Club of the Royal Society* (London: Macmillan and Co. Ltd., 1919), and the Club's Minute Books (Royal Society MS721 and MS722) and Rules. The Club was disbanded in 1901 through decreasing interest.

56. University of Reading Special Collections MS937.

57. *MNRAS,* 18, 4 (1858), pp. 110-12.

58. *The Photographic Journal*, 15 January 1861, 80-85, p. 83. This paper, entitled 'Lunar Photography' by Samuel Fry is followed by a detailed discussion by De La Rue, not only of his telescope drive, but also the chemicals used and the method of obtaining stereoscopic image pairs.

59. 'Address delivered by the President, Dr Lee, on presenting the Gold Medal of the Society to Mr Warren De La Rue'*, MNRAS*, 22, 4 (1862), 131-39, p. 136.

60. The description of these developments appears in an account of the meeting of the RAS held on 13 November 1857, *MNRAS,* 18, 1 (1857), 16-18.

61. *MNRAS,* 25, 1 (1864), p. 116.

62. Hutchins, Roger., 'John Phillips, "Geologist-Astronomer", and the Origins of the Oxford University Observatory, 1853-1875', in Peter Denley (ed.), *History of Universities*, 13 (Oxford: OUP, 1994), 194-249, p. 220.

63. *MNRAS,* 18, 4 (1858), pp. 110-2. See also *MNRAS* 18, 1 (1857),16-18, p. 18, and *Report of the 29th meeting* of the *British Association for the Advancement of Science* (1859), 145-6.

64. 'Are these plains composed of arid sand, as the first astronomer[s] maintained? Or are they nothing but immense forests, according to M Warren de la Rue's opinion, who gives the moon an atmosphere, though a very low and a very dense one? That we shall know by and by. We must affirm nothing until we are in a position to do so'. Jules Verne: *Around the Moon*, chapter 12, translation by Lewis Page

Mercer and Eleanor E King (Sampson Low, 1873) of *Autour de la Lune* (1870).

65. Letter from De La Rue to Herschel, 25 October 1864 (Royal Society HS6.D.161).

66. Letter from Herschel to De La Rue, 10 October 1858 (Royal Society HS.6.D.143).

67. *MNRAS,* 18, 4 (1858), 110-2, p. 111, and *Report of the 29th meeting* of the BAAS (1859), p. 146.

68. De La Rue, Warren., 'The present state of Celestial Photography in England', in *Report of the 29th meeting* of the *British Association for the Advancement of Science* (1859), 130-53. It also appears in the *Photographic Journal*, 1 October 1859, and in a reprint by Taylor and Francis, London, 1860. See also *MNRAS,* 19, 10 (1859), 353-8.

69. De La Rue, Warren., *The present state…*, p. 130. De La Rue emphasised the dedication needed in the following terms: 'to photograph the moon continuously is a laborious undertaking, and affords full occupation for one observer, who must not fail to pay unremitting attention to the condition of the various chemicals employed, so as to be always prepared for a fine night with such as will work. I would therefore strongly urge the claims of this new branch of astronomical science to a more extended cultivation than it has hitherto received, with the conviction that it will require the ardent co-operation of many astronomers to develop fully its rich resources', p. 149.

70. *MNRAS,* 19, 10 (1859), 353-8, p. 357; *MNRAS*, 22, 4 (1862), 120-1, p. 121; *MNRAS* 22, 4 (1862), 131-40, p. 137; *MNRAS* 25, 1 (1865), 115-6. De La Rue, Warren., *The present state…*, p. 153. Proceedings of the Royal Society 16 (1868), 447. I have been unable to find any examples of these stereoscopic pictures of the Sun; De La Rue probably did not mount the pictures permanently together.

71. *MNRAS,* 19, 4 (1859), 138-9. Had he succeeded, De La Rue would have been the first to photograph a comet, a feat accomplished by Mr Usherwood ('an artist residing on Walton Common', reportedly with an exposure of just 7 seconds, and G.P. Bond of Harvard, with an exposure of 6 minutes (Olsen and Pasachoff, *Fire in the Sky* (Cambridge: CUP, 1999), 250-4.

72. Letter from De La Rue to Herschel, 15 September 1858 (Royal Society HS6, D142). The sketch, however, is not with the letter.

73. Letter from De La Rue to Airy, 5 October 1858 (RGO 6/169, 563).

74. Houseman (1968), pp. 89-90.

75. Nasmyth, James., 'On the Structure of the Luminous Envelope of the Sun', *Memoirs of the Literary and Philosophical Society of Manchester*, 3rd series, I (1862), 407-11.

76. A detailed account of the willow-leaf controversy appears in Bartholemew, C.F., 'The Discovery of the Solar Granulation', *Quarterly Journal of the Royal Astronomical Society*, 17 (1976), 263-89. There is also an account in Rothermel, Holly., 'Images of the sun: Warren De la Rue, George Biddell Airy and celestial photography', *British Journal for the History of Science* [hereafter *BJHS*], 26 (1993), 137-69, especially pp.160-2.

77. Letter from De La Rue to Herschel, 24 August 1861 (Royal Society HS.6.147).

78. Letter from De La Rue to Herschel, 24 October 1863 (Royal Society HS.6.D.152).

79. Letter from De La Rue to Pritchard, 24 October 1863 (Royal Society HS.6.D.151). Twelve years later De La Rue, when referring to the installation of his instruments at the University of Oxford, mentioned that his eyesight had improved: 'While making observations for the preliminary adjustments I inadvertently used my left eye, and was surprised and delighted to find that I had recovered perfect vision with it, the granulations in the centre of the retina having disappeared', *MNRAS*, 35, 8 (1875) p. 376.

80. Letter from Charles Pritchard to Sir John Herschel, 19 October 1863, cited by H.H. Turner, in Ada Pritchard, *Charles Pritchard - Memoirs of his life* (London: Seeley & Co. Ltd., 1897), pp. 240 & 243.

81. *Astronomical Register*, 3 (1865), pp. 81-82.

82. Huggins, William., 'Results of some Observations on the Bright Granules of the Solar Surface, with Remarks on the Nature of these Bodies', *MNRAS*, 26, 5 (1866), 260-65.

83. In a letter to Herschel on 26 August 1861, De La Rue said: 'perhaps more than all in importance is peculiar granulation which comes on the surface and which betokens a great amount of activity in the photosphere', Royal Society HS.6.148.

84. Le Conte, see note 2 above, p. 56.

85. Letter from Sir John Herschel to Colonel Edward Sabine, 24 April 1854, *MNRAS*, 15, 4 (1855), 158-9.

86. The shutter mechanism is fully described in De La Rue, Warren: *The present state…*, p. 151.

87. *Philosophical Transactions of the Royal Society* [hereafter *Phil.Trans.*], 159 (1868),17-20.

88. The photographs were initially taken by B. Loewy, Chief Observer (Jacobs, L., 'The 200-years' story of Kew Observatory', *Meteorological Magazine*, 98 (1969), p. 165). By 1866, however, they were taken by Miss Beckley, the daughter of the mechanical assistant. De La Rue reported that 'it seems to be a work peculiarly fitting for a lady. During the day she watches for opportunities for photographing the Sun with that patience for which the sex is distinguished, and she never lets an opportunity escape her'. She also carried out some analysis of the sunspot pictures *MNRAS*, 26, 1 (1866), 74-77.

89. The results for 7 February 1862 to 31 December 1863 appear in *Phil.Trans.,* 159,1-110, which also contains a detailed description of the methodology and reductions. Results for 1864-5 are in *Phil.Trans* 160 (1870), 389-496 (abstract in *Proc.Roy.Soc*. 18 (1870), 263-4, which includes an analysis of the records of Hofrath Schwabe (for 1832-1853 and 1861), Richard Carrington (for 1854-1860), as well as those of Kew (1862-1865). These conformed with an average sunspot cycle of just over 11 years. See also Proc.Roy.Soc.20, 1871, pp.82-87 and 1872, p.289.

90. 'Researches on Solar Physics: On the nature of sunspots', by Warren De La Rue, Balfour Stewart and Benjamin Loewy (London: Taylor & Francis, 1865). 'Researches on Solar Physics: Area Measurements of the Sun Spots observed by Carrington during the seven years from 1854-1860 inclusive and deductions there from', by the same authors and printer, 1866. 'Tables for the Reduction of Solar Observations, No. 2: Table giving the values of log sin ? and log cos ? corresponding to the values of r/R, r being the measured distance of the spot from the centre and R the radius of the sun's disk, while ? is the heliocentric angle between the spot and the earth', by Warren De La Rue (London: Taylor & Francis, 1878). 'Researches on Solar Physics: On the Distribution of the Heliographic Latitude of the Sun Spots observed by Carrington, 1868', *Proc.Roy.Soc*., 14 (1865), 37-39. Phil.Trans., 14 (1865), 59-63. *Proc.Roy.Soc*., 16 (1867) p.336. *Proc.Roy.Soc*., 16 (1868), p. 447. *Proc.Roy.Soc*., 18 (1870), 263-64. *Proc.Roy.Soc*., 20 (1871), 82-87. *Proc.Roy.Soc*., 20 (1872), 198-9. *Proc.Roy.Soc*., 20 (1872), 210-8. *Proc.Roy.Soc*., 20 (1872), p.289. *Proc.Roy.Soc*., 21 (1873), 399-402. *Phil.Trans*. 159 (1869), 1-110. *Phil.Trans*., 160 (1870), 389-496. *MNRAS* 25, 1 (1864), p. 76. *MNRAS,* 26, 1 (1866), 74-77. *MNRAS,* 27, 1 (1866), 12-14. *MNRAS,* 27, 1 (1866), p. 91. *MNRAS,* 27, 8 (1867), p. 286. *MNRAS,* 28, 1 (1867), 44-45. *MNRAS,*

29, 1 (1868), 3-4. *MNRAS,* 29, 3 (1868), p. 95. *MNRAS,* 30, 3 (1870), p. 60. *MNRAS,* 31, 3 (1871), 79-80. *MNRAS,* 32, 5 (1872), 225-6. *MNRAS,* 33, 3 (1873), 173-174. *American Journal of Science*, 43 (1867), 179-92 and 322-30. *Philosophical Magazine*, 29 (1865), 237-9. *Phil.Mag*., 29 (1865), 390-4. *Phil.Mag*., 31 (1866), 243-4. *Phil.Mag*., 33 (1867), pp.79-80. *Phil.Mag*., 40 (1870), 53-54. *Phil.Mag.,* 43 (1872), 385-90.

91. *Phil.Trans*., 160 (1870), 389-496, p. 393. The sunspot records have been reviewed by Vaquero, J. M., Sánchez-Bayo, F., and Gallego, M.C., 'On the reliability of the de la Rue sunspot area measurements', *Solar Physics*, 209, 2 (October 2002), 311-9, and 'Periodicities of the de la Rue sunspot area measurements', *Solar Physics*, 218, 1-2 (December 2003), 307-17).

92. *Phil.Trans*., 160 (1870), 389-496.

93. *MNRAS,* 20, 1 (1859), 13-16.

94. *Phil,Trans*., 160 (1870), p.404 & plate XXXI.

95. *MNRAS,* 20, 1 (1859), 15-16.

96. Howse, Derek., *Greenwich Observatory, Volume 3: The Buildings and Instruments* (London: Taylor & Francis, 1975) p. 93. The photoheliograph is now in the collections of the London Science Museum.

97. *Proc.Roy.Soc*., 14 (1865), 59-63. *MNRAS,* 25, 4 (1865), 115-16; *MNRAS* 26, 1 (1866), 74-77.

98. Letter from "Athenæum", published in the *Daily News*, 5 January 1867 (Royal Society archives).

99. *Phil.Trans*., 160 (1870), 394-6.

100. *Proc.Roy.Soc*., 20, 1872, pp.210-8.

101. Letter from De La Rue to Herschel, 10 November 1861, Royal Society HS.6.D.149.

102. *MNRAS,* 22, 1 (1861), 38-42.

103. Airy saw great potential for the application of photography to solving astronomical questions, and consistently encouraged De La Rue in his photographic endeavours. As early as 1857, in a letter to De La Rue, he said: 'In due time we may make Astronomy self-acting', by which he meant avoiding the human equation which adversely affected the achievement of consistency. (24 September 1857, RGO 6/169, 549/50.)

104. *MNRAS,* 29, 2 (1868), 48-53. The paper was followed by constructive comments by Major Tennant *MNRAS,* 29, 7 (1869), 280-2, and a response by De La Rue *MNRAS* 29, 7 (1869), 282-4.

105. The deliberation between De La Rue and Airy over the application of photography to the transit of Venus has been discussed in Rothermel, Holly., 'Images of the sun: Warren De la Rue, George Biddell Airy and celestial photography', *BJHS*, 26 (1993), 137-169, especially pp. 163-8.

106. The shutter is described by De La Rue in *MNRAS* 34, 7 (1874), 347-53, and by Françoise Launay and Peter Hingley in *Journal for the History of Astronomy*, 36, 1 (February 2005), 57-79.

107. The debate within the RAS about the preparations for the 1874 transit of Venus is covered by Hollis, H.P., 'The decade 1870-1880', in Dreyer, J.L.E., and Turner, H.H. (eds)., *History of the Royal Astronomical Society*, Vol. 1, 1820-1920, (London: RAS, 1923, reprinted 1987), Chapter 6, p. 168 and pp.178-85.

108. Letter to the Editor by Richard A Proctor, *The Times*, 30 December, 1873, p. 9. Letter by Warren De La Rue, *The Times,* 31 December, 1873, p. 8. Letter by 'C.P.' [Charles Pritchard], *The Times*, 3 January, 1874, p. 8. Letter by Warren De La Rue, 5 January 1874. Letters by Richard A Proctor and Alex Strange, *The Times*, 6 February 1874, p. 7. The first two letters and a further letter to *The Times* by E.B. Denison, were also published in the *Astronomical Register*, 134 (February 1874), 39-43. It is interesting to note that, despite the acrimony between Proctor and De La Rue, the former 'respectfully Dedicated' to the latter his 1873 book about the Moon, 'in recognition of those important additions to our knowledge of the celestial bodies, and especially of the Sun and Moon, which have resulted from his photographic and other scientific researches', Proctor, Richard A., *The Moon: Her motions, aspect, scenery, and physical condition* (London: Longmans, Green, and Co., 1873).

109. Rothermel, Holly., 'Images of the sun: Warren De la Rue, George Biddell Airy and celestial photography', *BJHS*, 26 (1993), 137-69, especially pp. 166-8.

110. Clerke (1893), pp. 291-2.

111. *Astronomical Register*, 18 (1878), p. 174.

112. Strange, Lieut-Col. Alexander., 'On the Necessity for State Intervention to Secure the Progress of Physical Science', *Report of the British Association* (Norwich, 1868), pp. 6-8.

113. *Royal Commission on Scientific Instruction, etc.: – Minutes of evidence*, 22 (1874), 300-6. De La Rue was examined by the Commission on 12 July 1872.

114. Strange, Lieut-Col. Alexander., 'On the insufficiency of existing national observatories', *MNRAS,* 32, 6 (1872), 238-41. See also *Astronomical Register*, 10 (1872), 113-20, and *Nature,* 5 (April 25, 1872), p. 497.

115. A general account of the endowment of research debate appears in Macleod, Roy M., 'Resources of Science in Victorian England: The Endowment of Science Movement, 1868-1900', in Peter Mathias (ed.), *Science and Society* (Cambridge, CUP, 1972). An account of the debate and dispute within the RAS appears in Hollis, note 107, 173-78 and 207-11.

116. 73 Portland Place suffered damage during the World War II blitz, and the present building on this site dates from after that time. De La Rue's house appears to have been similar to those extant in the neighbouring terrace. (London County Council Bomb Damage Maps 1939-1945, published by London Topographical Society, 2005; Guildhall Library, London, personal communication.)

117. Turner, H.H., note 107, 263-67, p. 272, and 308-309. De La Rue's role in the development of the Oxford University Observatory, is addressed in detail by Hutchins, note 62, 193-249. He also gained an MA, reportedly an honorary one from Oxford University, but the University has no record of it.

118. Letter from 'C.P. Oxford, Jan. 1' to the Editor of *The Times*, published 3 January 1874, p. 8, under the heading 'The New Observatory at Oxford'.

119. Letter from Warren De La Rue to the Editor of *The Times*, published 5 January 1874, p. 11.

120. Turner, note 107, pp. 266-7.

121. *MNRAS*, 41, 5 (1881), 306-9.

122. Turner, note 107, 281-2.

123. Pritchard, Charles: 'Remarks on some of the present Aspects of Celestial Photography', *MNRAS,* 47, 6 (1887), 322-4.

124. Turner, note 107, p. 309. The fate of the astrograph is not known.

125. Cameras inventory nos 63460, 73104, 81324 and 81544, eyepieces inventory no. 22368, Museum of the History of Science, Oxford.

126. Letter from Gill to De La Rue, 22 March 1880, Royal Society MM12.99: 'Regarding the Telescope. Dr. Huggins tells me the only man who can manage the matter is yourself, and I need hardly say how greatly indebted I shall be to you if you can arrange it.'.

127. Letters from Airy to De La Rue, 13 April 1880, Royal Society MM12.100, and from Airy to Gill, 19 April 1880, Roy.Soc. MM12.103.

128. Letter from Airy to De La Rue, 15 April 1880, Royal Society MM12.102. Newall had a 25-inch refractor, Hollis, note 107, p.189.

129. The lengthy correspondence is at Royal Society MM12.94 to MM12.134.

130. The largest donation was from Nasmyth, in the amount of £1,000. Others gave lesser amounts, and Airy also subscribed, but the correspondence does not record the amount.

131. Gill, Sir David., *A History and description of The Royal Observatory, Cape of Good Hope* (London: HMSO, 1913) p. xliii.

132. *Proc.Roy.Soc.* 16 (1868), 434-7.

133. Letter from De La Rue to George Stokes, 17 December 1868 (Exeter University archives), and letter from De La Rue to Airy, 6 June 1872 (Royal Greenwich Observatory 6/17 40-41). *MNRAS,* 30, 1 (1869), 22-24; *MNRAS*, 30, 2 (1869), 36-37; *MNRAS*, 30, 4 (1870), p.98.

134. *Journal of the Chemical Society* 6 (1868), 488-95. *Acad.Sci.Compt.Rend*., 67 (1868), 794-8. *Deutsch.Chem.Gesell.Ber*. 1 (1868), 276-82. *Proc.Roy.Soc.,* 23 (1875), 356-61. *Proc.Roy.Soc.,* 24 (1876), 167-70. *Acad.Sci.Compt.Rend*., 81 (1875), 686-8 and 746-9. *Annalen der Physik und Chemie*, 233, 2 (1876), 290-4 & 294-7. *Proc.Roy.Soc*., 25 (1876), 258-9. *Journ. Chem.Soc*., 29 (1876), p. 334. *Proc.Roy.Soc*., 26 (1877), p.227, 324-5 and 519-23. . *Phil.Trans.,* 169 (1878), 55-121 and 155-241. *Acad.Sci.Compt.Rend*., 85 (1877), 791-4. *Acad.Sci.Compt.Rend*., 86 (1878),1071-5.

135. *Proc.Roy.Soc*., 30 (1880), 332-4.

136. Letter from Louis Pasteur to Jean-Baptiste Dumas, 8 September 1871 (Marie Claude Fortier of Arbois, France, personal communication). See also Redman, Nick., 'Louis Pasteur and the Brewing Industry', *The Brewer* (September, 1995), 369-380.

137. Letter from De La Rue to Airy, 24 April 1861 (RGO 6/123 346). This apparently refers to a lecture about the 1860 eclipse observations, given to the Royal Institution , in L. Pearce Williams, Rosemary Fitzgerald, and Oliver Stallybrass (eds.), *The Selected Correspondence of Michael Faraday*, Volume 2, 1849-1866, letter 530, pp.996-7. De La Rue's 1862 Bakerian lecture to the Royal Society, about the 1860 eclipse, 'was illustrated most brilliantly by apparatus, reproducing some of the phenomena of a total eclipse', (Edwards, note 34, p. 39).

138. *Royal Institution Managers' Minutes*, xiv, 181 (6 May 1889).

139. Letter from De La Rue to John Tyndall, 3 December 1881, *Roy.Inst. Managers' Minutes*, xiii, 284, 5 (December 1881).

140. *Royal Institution Managers' Minutes*, xiv, 172 (1 April 1889).

141. *Nature* , 10, (16 May 1889), pp.60-63.

142. *MNRAS,* 22, 4 (1862), 131-39, p. 136 and p. 139.

143. *Nature* (9 May 1889), 28.

144. Knobel, Edward.,'Warren De La Rue', *MNRAS,* 50, 4 (1890), 155-64, p. 161.

145. Huggins, Margaret., 'Warren De La Rue', *The Observatory*, 150 (1889), 244-50.

146. *The Star, Guernsey*, 25 April 1889, and *The Comet*, 24 April 1889.

147. Note from De La Rue to Airy, 18 July 1860, Royal Greenwich Observatory 6/123 284.

148. Letter from De La Rue to Lockyer, 26 November 1868, and from De La Rue to Stokes, 17 December 1868, University of Exeter archives.

149. *Phil.Trans*., 52, (1862), 333-16, p. 358.

150. Hutchins, *note 62*, p. 213.

151. *Journal of the Society of .Arts*, 26 July 1872, p. 733.

The Author

David Le Conte was born in the Channel Island of Guernsey. After working briefly at the Royal Observatory Edinburgh and the University College of Wales in Aberystwyth, he went to the United States to work at the Smithsonian Astrophysical Observatory. He became Executive Director of the Smithsonian Research Foundation in Washington DC, and has worked as a department manager at Kitt Peak National Observatory in Arizona. Returning to Guernsey in 1978, he joined the local astronomical society and led the creation of the island's observatory in 1991. He has served as President of La Société Guernesiaise, the island's local studies and natural history society. In 2005 he was elected to the position of Jurat of the Royal Court of Guernsey. He is a founder member of the Society for the History of Astronomy. He has been researching the life of Warren De La Rue for some years, his interest being sparked by the fact that De La Rue was also born in Guernsey, and is the island's most famous astronomer.

The Telescopes of John Henry Reynolds of Harborne, Birmingham, England: An Outstanding Grand Amateur

Dr Ron Maddison

Past President, Antique Telescope Society[1]

This contribution was stimulated by a list that appeared in the *Newsletter of the Society for the History of Astronomy* issue **16** for July 2008. The list, on page 21, under the heading of 'Grand Amateur British Observatories' does not include the name of J.H. Reynolds, although his contribution to that area of interest was truly remarkable.

JOHN Henry Reynolds (1874–1949) was a contemporary of George Ellery Hale and, indeed, he also shared a similar lifestyle. However, I have chosen to start the story in 1935 because, for me, that was a particularly significant year. In that year, for example, the 74-inch reflecting telescope by Grubb Parsons at the David Dunlap Observatory in Toronto was completed and saw first light. That instrument is now seriously threatened by deteriorating observing conditions around that huge city, and its future is uncertain, but it has had a distinguished career in astrophysical research and is housed in a very impressive Observatory that remains a rare example of architectural beauty that is well worth visiting on that score alone. Also, at the beginning of 1935, the 200-inch Pyrex disc had just been successfully cast and had started the long annealing process that culminated in the Hale Telescope at Palomar. That instrument initiated, and dominated for several decades, the new era in deep sky studies which have become the basis of modern astrophysics. Another event in that year was that I also saw first light! I came out of the annealing oven in January of 1935, and although you won't see any connection between that fact and the other two events, you might with the last one, namely that in that year J.H. Reynolds, a remarkable amateur astronomer in England, was elected as President of the Royal Astronomical Society. For me that had implications which would not emerge for some years.

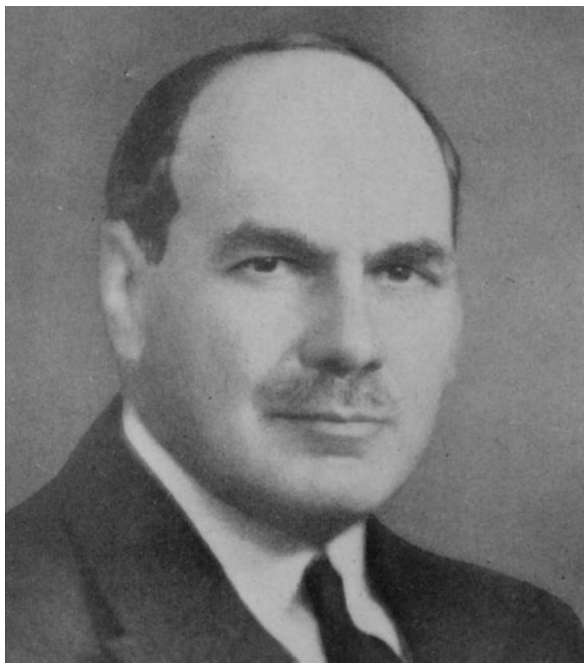


Fig. 1. John H. Reynolds, President of the RAS, 1935-39. *Courtesy of the Royal Astronomical Society–Presidential portrait.*

J.H. Reynolds was the son of a very prominent citizen of Birmingham, England. His company was a major producer of metals in a city that was proud of its thousands of small engineering businesses, and by any standards he was a very successful and wealthy industrialist. Ironically, today he is remembered mainly for the valuable contributions he made to astronomy in the first half of the twentieth century which were generated by his all consuming fascination with telescopes and nebulae.

My interest in Reynolds was aroused just after the Second World War when I was about 12 years old. I had acquired a science textbook at school, written by F. Sherwood Taylor, which featured a beautifully detailed photograph of Jupiter. The picture credit was to 'J.H. Reynolds, taken with a 28-inch telescope in his observatory in Harborne'. That took me completely by surprise because I lived in that small suburban village of Harborne and knew nothing of this observatory! So, like anyone would, I started a 'dome search' and soon located the Reynolds dome less than a mile from my home. It was in the back garden of an imposing three-story Victorian house and was surrounded by flowers and rose bushes. I soon discovered that it had been empty for 21 years. In fact it was actually being used to breed rabbits, and I was more than a little disappointed to find that I had missed the primary activity by such a clear margin. However, I also discovered that the doctor who had been present at my birth, and who was our respected family practitioner, was the son-in-law of J.H. Reynolds – so there was a tenuous connection after all. As I grew during the next few years I became increasingly aware of the fact that when I asked him astronomical questions, they were always answered in depth and in detail, as one would expect from such a close association with such an authority as the recent President of the Royal Astronomical Society (RAS).

The reason why the old observatory had closed was that, even in the 1920s, the street lighting had begun to encroach on seeing conditions and the telescope had to be moved to a more effective site. Even though observation was abandoned from the Harborne observatory J.H. Reynolds continued to analyse photographs from other observatories in all parts of the world by installing a Hartmann Microphotometer in his house. As an amateur he followed in the tradition of Hale and acquired personal equipment that would have done credit to any professional observatory. While he was President of the RAS he hosted many international guests in the house called Low Wood and it became a meeting place for many of the big names in astronomy of that period.

Reynolds' principal work in astronomy began in 1902 when he made his first visit to Egypt. It was a particularly good summer and he was most impressed by the clear air and fine seeing conditions. No doubt he was also keenly interested in the archaeological work of the time – as was George Willis Ritchey (1864-1945) who was also visiting Egypt at about that time. I do not know whether the two actually met in Egypt but it is clear that they did meet at some time during this period while Ritchey was visiting Europe; Reynolds never visited the United States.

At this time very little work had been done on nebulae in the southern hemisphere and the advantage of Cairo is that observations can be made from that latitude as far South as declination minus 40°. This observational potential so impressed Reynolds that he decided to design and build a suitable large telescope which he would then present to the Egyptian government. It happened that an unused 30-inch mirror and cell made by Dr. Andrew A. Common

(1841–1903), and a matching flat, were in the possession of an electrical engineer in Leeds by the name of F.W. Dickinson and both were available for such a project.[2] This had been a matching mirror to the 30-inch Thompson equatorial telescope made for Greenwich and Reynolds bought the complete system for the princely sum of eighty pounds. In those days the exchange rate was about five dollars to the pound, so the total cost in United States currency was in the region of four hundred dollars. While designing the telescope, Reynolds had clearly consulted the paper by Ritchey that describes much of the design work for the 60-inch Mount Wilson reflector that would be completed in 1908.[3] I now have Reynolds' personal copy of this paper, which contains a few notes of his own, and the similarities between the two instruments are very clear. Both telescopes have unperforated primary mirrors in heavy cells which allow the use of short-arm forks. They can both be used at the prime and Newtonian focus positions and were frequently used in what Dr. Donald Osterbrock called the folded Cassegrain configuration. This combines the classical Cassegrain secondary with a tertiary flat mounted just in front of the primary mirror to divert the converging beam of light to the side of the tube. In England we still prefer to call this the Cassegrain-Newtonian System.

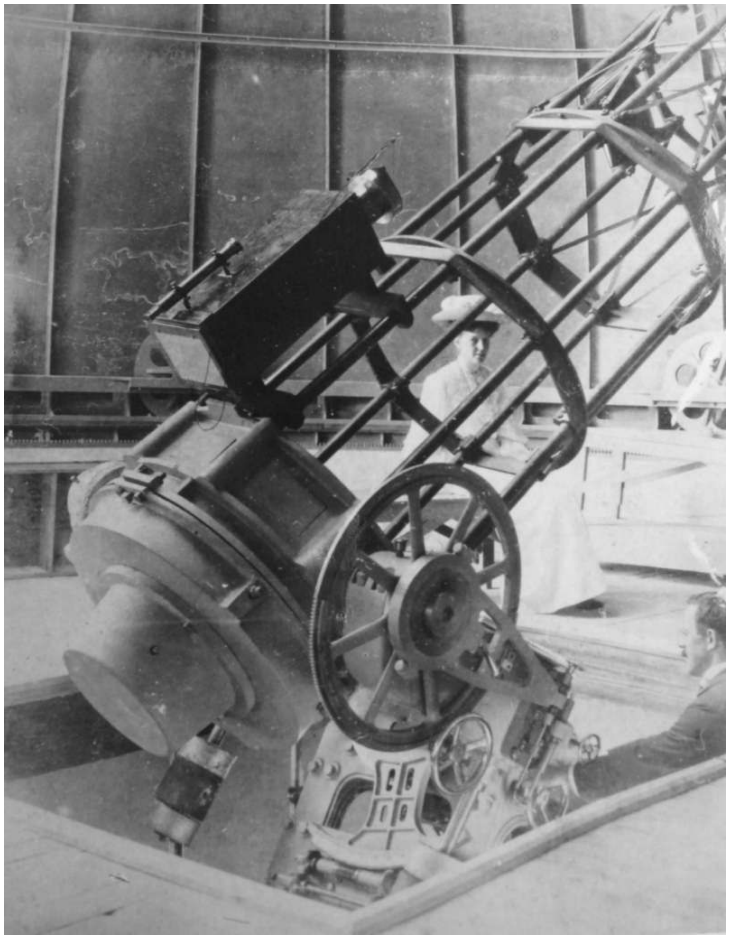


Fig. 2. The 30-inch Reynolds reflector at Helwan, Cairo. Mrs Reynolds is seated on the far side.
Courtesy of Miss Elizabeth Morton, from personal collection – Reynolds family.

By August 1905 the new 30-inch reflector had arrived for installation in an existing dome at the Helwan Observatory which is a few miles south of Cairo, and it became the first large modern telescope capable of observing a considerable part of the southern sky. The first photographs were exposed in 1907. The value of the work that was carried out in the next few years, much of it by Reynolds himself, was highlighted by Paul Hodge in a recent review article on 'The Andromeda Galaxy'. He wrote:

> A remarkable study by J.H. Reynolds in 1913 provides an interesting lesson – that more complete and accurate data do not necessarily lead to more accurate understanding. Reynolds did a rather modern-sounding analysis of the structure of Andromeda by measuring the plate density of an image as a function of distance from the centre. He found that the resulting curves showed that the image was made up of a central bulge and wings. Reynolds used this piece of evidence, remarkably advanced for its time, to support the hypothesis that M31 was a reflection of gas and dust illuminated by a central star, with the nucleus being the star. Several years later he published a discussion of the structure of M31 that recognized its true nature.[4]

It was this first survey work from Helwan by Reynolds that gave rise to the notion of a 'zone of avoidance' where spiral nebulae, as they were then called, did not appear to exist close to the plane of the Milky Way. Reynolds suggested that this may be an illusion caused by obscuring material in the plane of the Milky Way, but he did not make the distinction between galaxies and nebulae since the true distance scale had not been determined at that time.

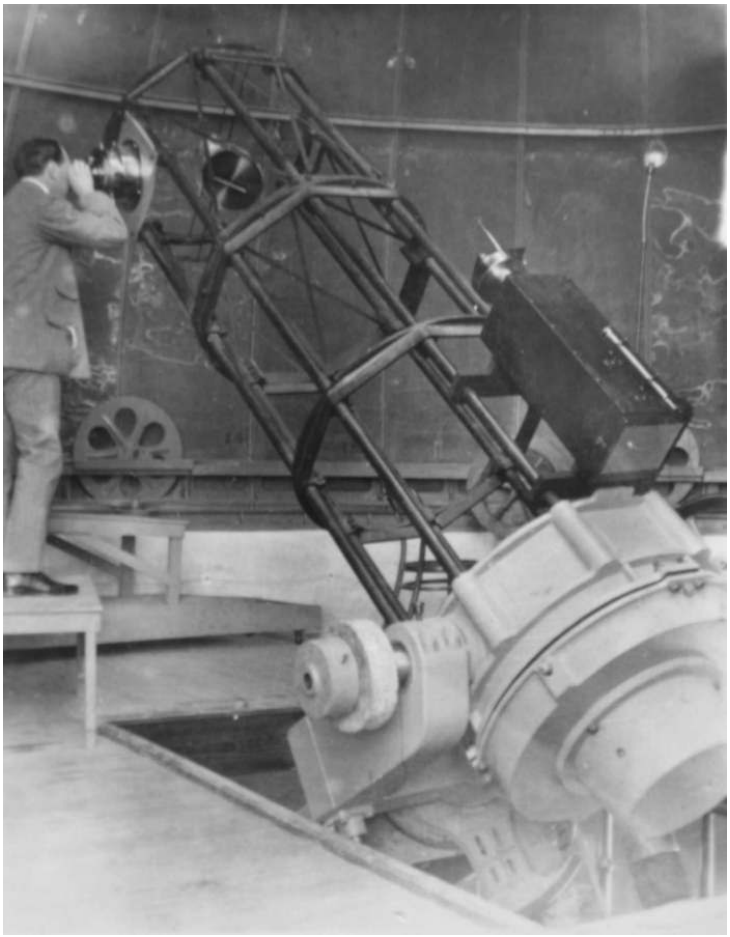


Fig. 3. J.H.R. at the Newtonian eyepiece, Helwan.
Courtesy of Elizabeth Morton.

However, it is gratifying that Paul Hodge recognized the contribution that Reynolds as an amateur made to this work.

The field of astrophysics has since been professionalized and the chances of an amateur making such an enormous contribution today are relatively very small – as are the chances of an amateur ever again being elected President of the Royal Astronomical Society! The last amateur to serve as President was the equally remarkable Dr W.H. Steavenson in 1955 – more than half a century ago!

By 1910 it was realized that the Helwan mirrors needed upgrading and a new flat was ordered from George Willis Ritchey.

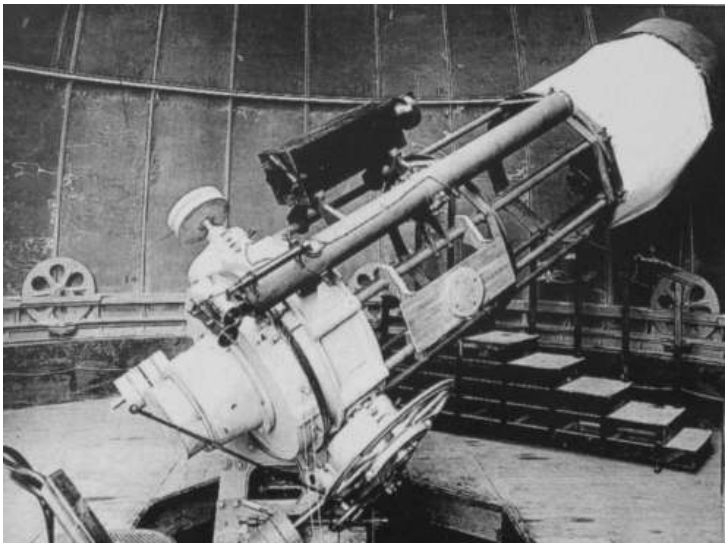


Fig. 4. 30-inch Reynolds Telescope at Helwan. The 5-inch Tulley refractor is the finder telescope.
Courtesy of Elizabeth Morton.

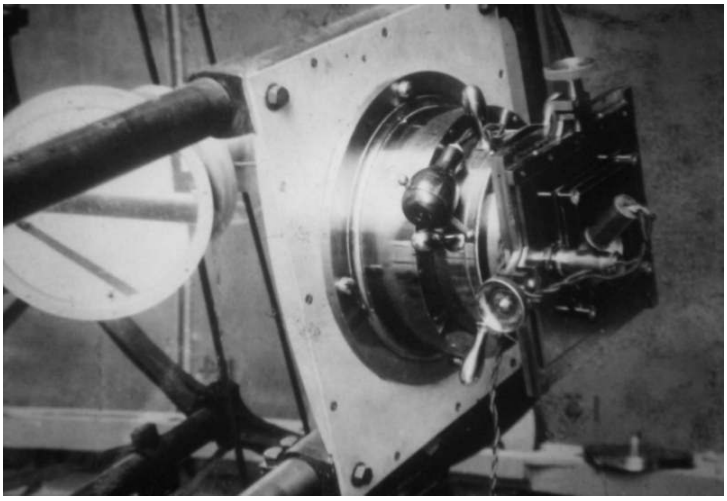


Fig. 5. The double-slide plate-holder on the 30-inch Reynolds Telescope.
Courtesy of Elizabeth Morton.

This secondary mirror was made and fitted in early 1911 while Ritchey continued to work on the new 30-inch primary. This was ready in 1914 and further engineering improvements were made as the new primary was fitted. The fork system was modified so that the cell and counterweights would clear the base, thus allowing the instrument to be aimed directly at the North Polar Region. The original Common mirror was returned to Birmingham.[5]

An interesting feature of this first Reynolds telescope is its finder which can clearly be seen in Figure 3. This was a fine 5-inch refractor made by Charles Tulley (1761-1830) in about 1825. Henry King quotes Sir James South (1785-1867), who commissioned the telescope from Tulley, as writing that 'it is the finest in existence'.[6] Unfortunately, I have not been able to verify that this refractor still exists and would be grateful for any further information anyone might have about it. One of the most useful accessories fitted to the 30-inch was a double-slide plate-holder similar to the one that had been made for the 40-inch refractor at Yerkes by G.W. Ritchey in 1900.[7] This was a device invented by A.A. Common at the end of the Nineteenth Century for improving the accuracy of guidance during long photographic exposures. Rather than moving the whole telescope to correct image drift, fine guiding could be achieved using two fine micrometer hand screws, in right ascension and declination, to move just the photographic plate and eyepiece to keep the image centred and stable.[8]

After the Helwan telescope had been successfully set up in 1907, Reynolds began to make plans for his own observatory at Harborne.[9] The dome was to be 24 feet in diameter and would house a 28-inch reflector based on the Helwan design. Reynolds ground and figured the 28-inch mirror himself, drawing on his own extensive experience as a young man when he had made several smaller mirrors that were of acceptably good quality and were much admired by his colleagues in the Royal Astronomical Society. Telescope maintenance at Harborne involved the whole family. Mrs. Kennerley, Reynolds' second daughter, wrote: 'My father used to silver the mirror of his 28-inch telescope himself with the help of the gardener, my mother and any of his family available, quite an occasion! A white apron and rubber gloves were worn'.[10]

Fig. 6. The observatory at Low Wood, Harborne, Birmingham.
Courtesy of Elizabeth Morton.

Fig. 7. The 28-inch reflector at Low Wood began work in 1911.
Courtesy of Elizabeth Morton.

The drive mechanism for the 28-inch was weight driven and regulated by means of a classical expanding governor similar to those made by Warner and Swasey Co. for their large instruments in the late nineteenth century and which were adopted by so many later manufacturers. Since the telescope was frequently used at the Newtonian focus a heavy observing platform was fitted to the inside of the rotating part of the dome so that access to the eyepiece ceased to be a problem. This arrangement is similar to that used with the Crossley 36-inch reflector at Lick Observatory and also the 74-inch David Dunlap reflector in Toronto, Canada.

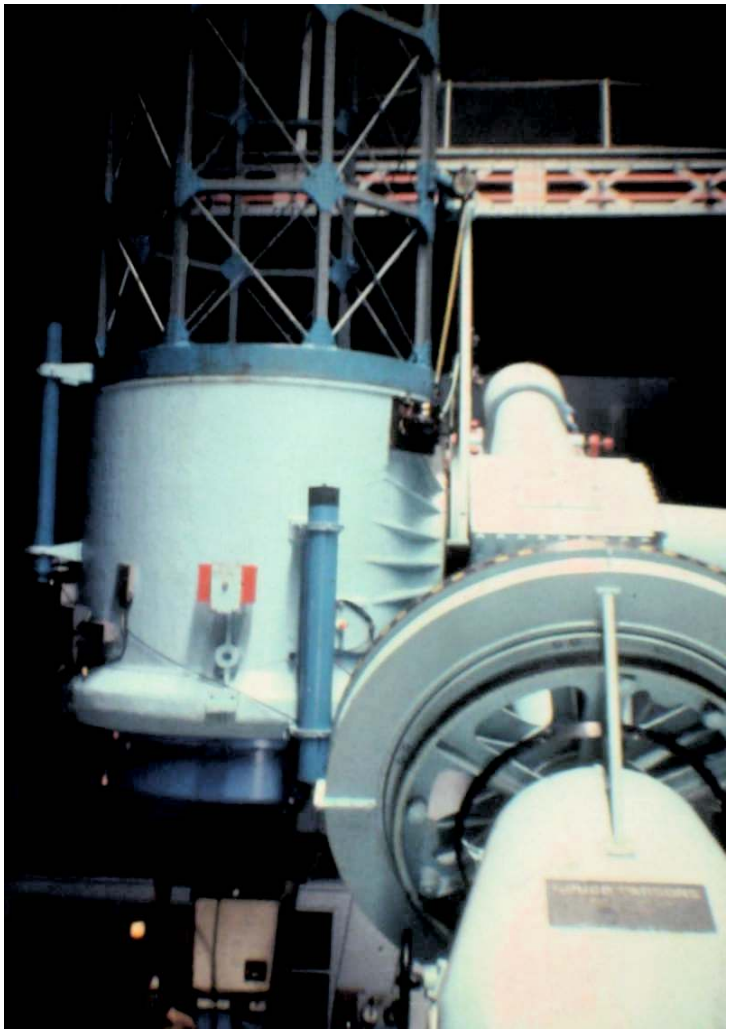


Fig. 8. The 30-inch at Mount Stromlo in the 1970s. Sadly it was destroyed by fire in 2003.
Courtesy of Prof. A.W. Rodgers, Mount Stromlo and Siding Springs Observatories, Canberra, Australia.

Eventually, in 1920, Reynolds replaced his own 28-inch primary with the 30-inch Common mirror which had been brought back from Helwan. However by 1924, as mentioned earlier, the City of Birmingham had expanded to the point where light pollution prevented much of the highly sensitive photographic work that Reynolds was doing from the Low Wood site, so with characteristic generosity he decided to donate the telescope for use at a better place. He chose the young Commonwealth Solar Observatory, which later became the Mount Stromlo and Siding Spring Observatories, near Canberra in Australia. At that time there was no big telescope in the southern hemisphere. Set up in 1927-30, and applied to photoelectric photometry, the 30-inch was to dominate that field until the 74-inch Grubb-Parsons instrument, that matched the David Dunlap reflector, was set up at the same site in 1956.

The Mount Stromlo Reynolds Telescope brought the original Common mirror back into service and the instrument was in steady use

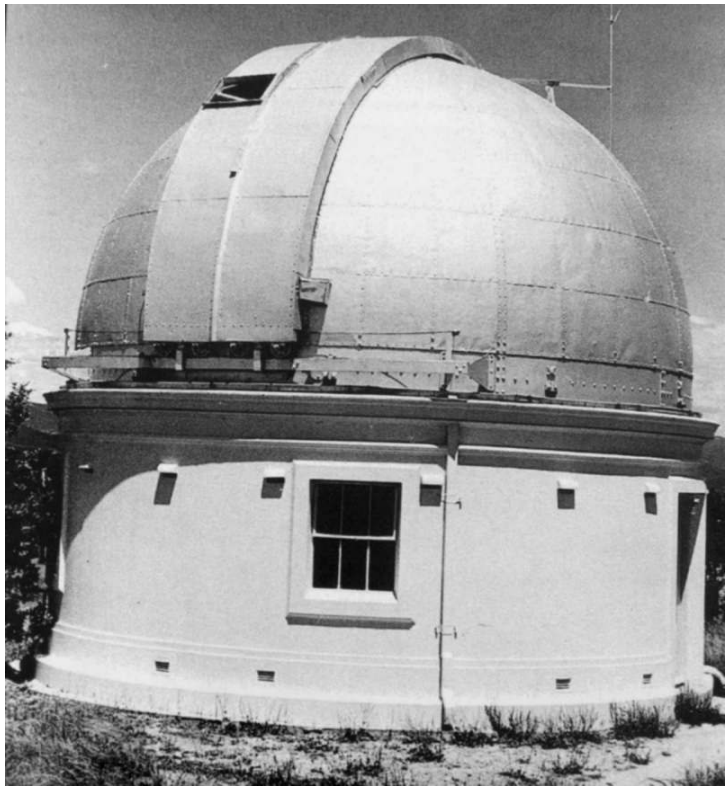


Fig. 9. Dome of the 30-inch Reynolds Telescope at Mount Stromlo.
Courtesy of Elizabeth Morton.

for almost a quarter of a century, after which it was extensively refurbished in 1979. Most of the open parts were covered with protective panels and major improvements were made to the drive.[11] Sadly this part of the story was brought to an abrupt end on the18th of January 2003 when a forest fire severely damaged the whole facility. The list of instruments destroyed is depressing. It includes the 74-inch Grubb reflector, the 50-inch Great Melbourne reflector, the 30-inch Reynolds reflector, the 9-inch Oddie refractor and the 26-inch Yale-Columbia refractor.[12]

The Low Wood Observatory in Birmingham closed in the mid-twenties and the 28-inch Reynolds mirror languished there for the next 30 years until it was bought by the Dunsink Observatory near Dublin to be used by Michael Smyth for a photometric project on certain variable stars. That mirror was made from ordinary plate glass and was only about three and a half inches thick. Its original cell was not capable of preserving a high resolution figure, but the set-up was quite adequate as a flux collector for photometric work. After being refigured by Cox, Hargreaves and Thompson in London, England, it was reattached on an old Grubb equatorial mounting on top of the old Observatory building and used to complete the project. There it remained for about a decade until deterioration of the dome led to its disuse and eventual closure. The telescope was dismantled and, I believe, the old mirror remains in the observatory. Who knows what may lie ahead for this interesting relic of a bygone age? Maybe, one day, a new active support system might give it new life.

Not only did J.H. Reynolds provide and use these pieces of expensive hardware to help solve some of the most intriguing problems in astronomy, but he also played an important part in the social activity of a prestigious scientific society and brought together many minds whose combined power was formidable.

In 1950, in his Obituary notice for J. H. Reynolds, Dr. Martin Johnson, Reader in Astrophysics at the University of Birmingham, wrote:

> Astronomers from many countries came to Birmingham to visit the Reynolds at the house called Low Wood. It is easy to recall scenes, grave and gay [I should remind the reader that

this was the vocabulary current in 1950!] over many years. Eddington, in Birmingham to give a lecture, ill and only kept on his feet by the skilled ministrations of Mrs Reynolds, who is never dismayed by anything; Jeans, more engrossed in testing the fine organ in the house than in the lecture he was to give; Dyson, the Astronomer Royal, Jackson of the Cape, and many others occasioning the familiar call from Reynolds; 'We have a visitor here from a great Observatory, will you come along and be introduced?'. Perhaps the most vivid picture is of de Sitter from Leiden, most fascinating of astronomers, arguing in the Low Wood music room about relativistic cosmology and his dislike of nineteenth-century music, until Reynolds set out to convert him by playing the organ chorale preludes which Brahms had written at the end of his life.[13]

Reynolds was indeed a man who attracted affection, and the last duty he undertook was to attend one of the regular lectures which were endowed at the University of Birmingham, of which he was a governor. Martin Johnson recalls:

> When Professor Dingle, an old friend (and a relativistic cosmologist) came to give the Norman Lockyer Lecture in Birmingham on November 22nd 1949 Reynolds demanded medical permission to accept the University's invitation to honour the gathering, and in discussion at the end of the lecture he attacked with exhilarating vigour the uncertainties about galactic distribution ... he still had a knack of throwing out questions and challenges to the theoreticians of the day... he sat down having, as usual thrown a sobering and unanswerable problem into the arena, and as the audience dispersed, a few of them noticed that he was apparently tired and dozing off to sleep where he sat. No-one realized for some minutes that he had actually spoken his last word.

When Dr. Hugh Morton, Reynolds' son in law, died in 1980, I received a little package from his widow. It contained a few items that belonged to her father. One that I cherish most is an 1814 print (with the original frame and glass from the period) of William Herschel. I am very proud to have had this tenuous acquaintanceship with Reynolds, a gentleman I regard as one of the unsung heroes of our subject.

Although this paper was first published in 1995, a new book by David Block and Kenneth Freeman entitled *Shrouds of the Night* (2009) has an entire chapter devoted to the work of John Reynolds. This chapter clearly gives credit to Reynolds for the important contributions that he made to the study of the morphology of galaxies. His correspondence with Edwin Hubble shows that the inspiration behind the famous 'tuning fork classification' was clearly due to suggestions made by John Reynolds.

My original intention with this paper was to review the contributions to instrumental astronomy that were made by this remarkable man. However, having done a little of that, I feel I should add something about some of the other aspects of his influence upon national astronomy. John Reynolds was a Fellow of the Royal Astronomical Society for fifty years and a member of its Council for thirty years. His very successful career in business qualified him perfectly to assist in the running of the RAS and he became its Treasurer for seventeen of those years, which included steering the society through the rigours of the Second World War. He was elected President of the RAS from 1935 to 1937. It is clear, from his obituary notice by Harold Knox-Shaw, who knew him very well, that he was regarded by contemporaries as the 'doyen of British amateur astronomers' and 'was a kindly man, calm and dependable, the very best of companions'.[14] And yet, even though he was an amateur, his own personal observations and analyses of his own photographic, photometric and spectrographic measurements put him squarely in the same category as most active professional astronomers of the time.

His philanthropic support of astronomical research at Oxford University matches that of Warren De la Rue of half a century earlier. De la Rue gave his famed 13-inch photographic reflector to Oxford University Observatory in 1849. In 1904 Reynolds had originally offered the 30-inch reflector to Prof H.H. Turner at Oxford – but circumstances prevented the acceptance of the offer at the time and thus it went to Helwan instead. In the late nineteen twenties Reynolds paid for a new spectroscopic instrument for Cambridge University in order to enhance their, by then, dominant astrophysical work.

In short, John Henry Reynolds was one of the very last Grand Amateurs in Britain whose influence was felt around the world. Not only did he inspire the work of such practitioners as Edwin Hubble (1889-1953) in his study of the Nebulae, he even inspired an impressionable teenager who was just entering the world of science, by means of one of his beautiful photographs that had been printed in a school textbook!

Notes and References

1. This is an updated version of an article that appeared in the *Journal of the Antique Telescope Society*, 8 (Spring- Summer 1995), pp. 12-16
2. Dickenson, F.W., private letter to J.H. Reynolds, May 1902. From the collection of Elizabeth Morton (Reynolds family).
3. Ritchey, G.W., 'On the Modern Reflecting Telescope and the Making and Testing of Optical Mirrors', *Smithsonian Contributions to Knowledge,* vol. 34 (1904, Smithsonian, Washington), pp. 10-11.
4. Hodge, Paul, 'The Andromeda Galaxy', *Mercury,* 22, 4 (July-August 1993), pp. 99-108.
5. Knox-Shaw, H., 'Helwan Observatory, Egypt', *Monthly Notices of the Royal Astronomical Society*, 75, 4 (Feb., 1915), p. 297.
6. King, H.C., *History of the Telescope* (Charles Griffin and Co., London, 1955), pp. 194 and 200.
7. Ritchey, G.W., 'On the modern reflecting telescope and the making and testing of optical mirrors', *Smithsonian Contributions to Knowledge*, 34, 3 (1904, Smithsonian), p. 51.
8. Common, A.A., 'Note on an Apparatus for correcting the Driving of the Motor Clocks for large Equatorials for long Photographic Exposures', *Monthly Notices of the Royal Astronomical Society*, 49, 5 (March 1889), pp. 297-300.
9. [Knox-Shaw, H.], 'The Late Mr. John Henry Reynolds', *Royal Observatory Helwan, Special Notice* (Cairo University Press, 1950), p. 3.
10. Kennerley, J., (daughter of J.H.R), personal communication, September 7, 1993.
11. A.W. Rodgers – Director of Mount Stromlo and Siding Springs Observatories, personal communication, August 22, 1991.
12. Orchiston, Wayne., 'The Mount Stromlo Fires', *News Report*, Feb. 21, 2003, Australian National University (http://www.mso.anu.edu.au/info/fire/orchiston).
13. Johnson, M. C., 'John Henry Reynolds', *Monthly Notices of Royal Astronomical Society*, 110, 2 (1950), pp. 131-33.
14. Knox-Shaw, H., 'John Henry Reynolds', *Observatory*, 20, 854 (Feb. 1950), pp. 30-31.

The author

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Personal links with astronomers of the USSR and Eastern Europe, 1970-1989

George A. Wilkins
Norman Lockyer Observatory Society. Honorary Fellow, University of Exeter

During my career in H.M. Nautical Almanac Office within the Royal Greenwich Observatory I developed links with several astronomers of the USSR and Eastern Europe. Some of these links arose directly from the cooperation between the Office and other organisations in the publication of almanacs for international use in astronomy, while others arose from my personal participation in the activities of the International Astronomical Union (IAU). These activities gave me opportunities to visit the USSR and some of the countries of Eastern Europe for meetings and conferences in unusual locations. Consequently, my career as a scientist and the activities in which I was engaged were enriched by the links with astronomers from these countries that developed during these visits.

Introduction

The aim of this article is to describe aspects of my career that would not feature in any formal report of my scientific activities, but which I hope will show that personal relationships played an important role in the development of those activities. They illustrate how science depends on an international exchange of information and ideas and of how significant advances come from international cooperation. It is based largely on my links with astronomers in the USSR and some countries of Eastern Europe as I was privileged to have more opportunities to visit these countries than other members of staff of the Royal Greenwich Observatory (RGO) during my career.[1]

These visits arose in two ways from my varied activities. Firstly, from the work of H.M. Nautical Almanac Office (NAO, which shared with the ephemeris offices of other countries the task of preparing almanacs and related publications for international use.[2] One such office was the Institute of Theoretical Astronomy in Leningrad (as St Petersburg was known at that time). Secondly, from my personal participation in the activities of the International Astronomical Union (IAU), and of other international organisations with which it was associated. The International Astronomical Union is unusual in that the membership is made up of individual astronomers as well as of countries. Most of the activities are organised by specialist Commissions of interested members that meet during the triennial General Assemblies. Most of the Commissions have working groups that are also active between assemblies. The Union arranges conferences on topical subjects proposed by Commissions at and between the assemblies.[3]

My visits are described in chronological sequence following a brief review of my early involvement in international activities to provide the context of the visits. Further details of the organisations concerned are given in the endnotes. It is, however, appropriate to start by recognising my debt to Donald H. Sadler (DHS) who nurtured my career in the Office and supported my early appointments within the IAU.[4] He had played a major role in developing international cooperation in the context of the Office, but also more generally as he served as the General Secretary of the IAU from 1958 to 1964, including the period when V.A. Ambartsumian from Armenia was the President. Sadler's wife, Flora M. McBain (FMS),[5] had been, when a student, on an eclipse expedition to Siberia and had a working knowledge of the Russian language. She was on the staff of the Office and held office within the IAU. When I joined the RGO in 1951 the Astronomer Royal was Sir Harold Spencer Jones (HSJ).[6] He had been President of the IAU from 1944 to 1948 and was still strongly involved in international activities, such as the International Council of Scientific Unions (ICSU) and the International Geophysical Year (IGY). The ICSU was formed in 1931 to encourage international scientific activity for the benefit of mankind. Its members are international scientific unions, national members, and various national and scientific associates. It has many committees for special topics and it organises major international multi-disciplinary projects. The International Geophysical Year took place during 1957-1958 and included world-wide campaigns of observations on various aspects of Earth sciences and solar-terrestrial relations as well as the launches of Sputnik 1 in October 1957 and of Explorer 1 in February 1958. The project for my own Ph.D. thesis had been dependent on international cooperation in the making of geomagnetic observations around the world and so it was natural that I should come to regard participation in IAU activities as an integral part of my job.

Early international activities

I attended the IAU General Assembly (GA) in 1955 in Dublin as 'young astronomer' and so was able to attend some of the meetings of the many commissions that each dealt with a specialised aspect of astronomy. In particular, I was able to meet in Commission 4 on Ephemerides the members of other offices that shared in the preparation of almanacs for general use. I was also able to listen to the invited discourses given by the leading astronomers at that time on the latest research.

The next major event in my career was my secondment to the U.S. Naval Observatory (USNO) in Washington D.C. and then to the Yale University Observatory in New Haven, Connecticut, from February 1957 to February 1958. This had three purposes: firstly to learn more about the USNO work for the almanacs that we prepared jointly; secondly, to gain experience in computer programming and in the organisation of computer operations prior to the acquisition of a computer by the RGO; and thirdly, to learn more about celestial mechanics and the analysis of orbital data. In addition to developing good relations with the staffs of these two organisations I met other American astronomers at meetings of the American Astronomical Society. Quite unexpectedly, I was offered a post at the Adler Planetarium in Chicago, but I did not accept the offer! My work with the staff in Washington proved to be invaluable afterwards when I was editing the joint publication *Explanatory Supplement to the A.E.*[7] My computer project was to analyse observations of the satellites of Mars and this subsequently led to papers at international conferences and to lectures at a summer school in the Italian Tyrol.[8]

I did not attend the IAU GA in Moscow in 1958, but I did go to the next GA in Berkeley, California in 1961, as well as to the symposium on Space Age Astronomy that preceded it. At the GA I presented a short paper about the computation of the lunar ephemeris at a Joint Discussion and this led to an invitation by Professor W. Fricke to give a lecture in 1962 at the Astronomisches Rechen-Institut (ARI) in Heidelberg, West Germany. This institute no longer published a separate astronomical almanac in German, but it took over the publication of A*pparent Places of Fundamental Stars*. The following year I attended IAU Symposium 21 in Paris on the system of astronomical constants and I was appointed as the secretary of a working group under the chair-

manship of Fricke to prepare a report for the next GA in Hamburg in 1964. The system specified new and consistent values for the many fundamental constants that are used in almanacs and in the reduction of observations of many kinds. For the first time, the value of the solar parallax, which specifies the mean distance between the Earth and the Sun was based on radar observations of the planets instead of on optical observations of minor planets. Our report was adopted, but I was then appointed secretary of a working group on space ephemerides. I was also elected as Vice-President of Commission 4 for 3 years. At about this time I also became secretary of IAU Commission 20 on the motions of minor planets, comets and satellites.

The next IAU GA was held in Prague in 1967 and I was elected President of Commission 4. The following year I was back in Prague for a meeting of the working group on space ephemerides that was held during the ICSU Committee on Space Research (COSPAR) meeting. At this time the General Secretary of the IAU was Lubos Perek, who lived in Prague. He had become a good friend of Donald Sadler and I had met him when he came to Sussex. Then in 1969-1970 I was the chairman of the scientific organising committee of IAU Colloquium 9 on a further revision of the system of astronomical constants. This was held in Heidelberg just before the IAU GA in Brighton in 1970. At the beginning of 1970 I became the Acting Superintendent of the NAO since Sadler was seconded to organise on a full-time basis the IAU General Assembly. He did not resume his position afterwards.

The IAU GA at Brighton gave my wife and me the opportunity to entertain some of the members of Commission 4 (of which I was then President) at our home. Professor G. A. Chebotarev and Victor Abalakin of the Institute of Theoretical Astronomy (ITA) in Leningrad were amongst our guests. We did not then realize that I would visit Leningrad the following year. During the Assembly I was asked to become the chairman of a working group on numerical data that reported to the Executive Committee rather than to an individual commission as it was to cover all types of data used in astronomy. In this capacity I would represent the IAU on CODATA – the ICSU Committee on Data for Science and Technology which was concerned with data for science and technology in general.[9] I was also asked to replace Sadler as the IAU representative on the Council of FAGS – the Federation of Astronomical and Geophysical Services. It was formed by ICSU in 1956 and included 11 'permanent services' that collect and analyse data for astronomy and geophysics. They are operated by national organisations, but receive some international financial support through FAGS.[10] I accepted both requests as the functions clearly overlapped although I did not then realize the role that they would play in my future career.[11]

Fig.1. IAU members with my wife and son in our garden during the IAU General Assembly in Brighton in August 1970.
From left to right: T. Lederle (ARI, Heidelberg), Mrs J. Duncombe (NAO, USNO), Betty and Michael Wilkins., G. Chebotarev, (ITA, Leningrad), R. Duncombe (NAO, USNO), V. Abalakin (ITA, Leningrad). Photograph by author.

Visit to Leningrad and Moscow, August 1971

The main reason for my first visit to the USSR was to attend the meeting of the Council of FAGS, which was to be held in Moscow during the General Assembly of the IUGG (the International Union of Geodesy and Geophysics) that consists of seven associations covering geodesy and different aspects of geophysics,[12] when most of the Directors of the Services would be present. In further justification of the journey, I also visited the Institute of Theoretical Astronomy in Leningrad to better understand their position and to discuss ways in which we might cooperate further. I took my teen-age son along as he was learning Russian for his School Certificate – this was very helpful as he could read the signs and buy tickets etc. We travelled on a Saturday and spent the next day walking around Leningrad with Chebotarev (the director of the Institute) and his son. In the evening we had a very enjoyable supper in his home to celebrate his birthday. I spent much of the next two days in discussions at the ITA. I was able to have discussions with Dr. V. Shor, who was also interested in the satellites of Mars and had access to more data. My son and I were taken on visits to the Pulkovo Observatory and to the Summer Palace at Petrodvorets.

The IUGG meeting was held at Moscow University, with its typical central tower; even from the forecourt there was a good view over the city. Apart from the meeting of the Council of FAGS I was able to attend various scientific meetings. We also went to the space exhibition, including the Space Obelisk and the Vostok rocket, within the Exhibition Park for the Economic Achievements of the USSR. We also went to a football match at the Lenin stadium as tickets were available from the IUGG tours desk.

Visit to Tsachadzor in Armenia, June 1974

There can be very few people in England who have been to the place where CODATA held its General Assembly and Conference in 1974 – a little village, high up in the mountains of Armenia where the USSR athletes trained before the Olympic Games in Mexico City. There were the usual conference facilities and basic living accommodation, but also gymnastic and swimming facilities! I had flown to Moscow and then changed airports and planes to fly to Yerevan, the capital of Armenia, but unfortunately, my luggage continued on the flight to Tokyo and I did not see it again until several weeks later. Even more regrettably, there were no shops in Tsachadzor at which I could buy new clothes, so I had to borrow and wash for a week. Apart from the meetings we had an afternoon coach excursion to Yerevan and I was also invited by an Armenian scientist to go on a short tour in his car with two other participants, including Paul Melchior, who was a director of the service on Earth Tides in FAGS.

When I attended my first CODATA meeting I realized that the main concern was with the data of physics and chemistry and so at the following meetings I and others had argued that it should extend its activities to a wider range of data. In 1974 I was appointed

chairman of an Advisory Panel on the Geosciences. We met at the Royal Society in London in the following year and later produced guides to the presentation of such data.[13] This experience proved to be useful later when I revised the IAU Style Manual.[14]

Visit to Kiev in Ukraine, May 1977

My third visit was directly connected with my work at the RGO and I was accompanied by N. O'Hora of the Time Department, for which I had been given administrative responsibility. We stayed overnight in Moscow and had to spend most of the evening at the hotel trying to recover our passports as we were due to leave the hotel at 6am the next morning to catch our plane to Kiev. I found that the main details from our passports were copied in longhand into large ledgers.

We attended IAU Symposium 78 on Nutation and the Earth's Rotation, which was held at the Kiev Observatory and in the Physics Department of the University.[15] I was on the Scientific Organising Committee for the meeting and acted as co-chairman with Abalakin of the sessions for the general discussions that preceded the adoption of the resolutions. I later prepared the report on those discussions.

We were taken to the theatre one evening for a concert, with folk dancing, singing, and so on. I had hoped to visit the circus that was just opposite the hotel, but I could not get a ticket – I since wonder whether an offer of a little 'commission' would have helped. We had only a short

Fig.2. Victor Abalakin (ITA, later Director of the Pulkovo Observatory) during IAU Symposium 78 on Nutation & Earth's Rotation at Kiev in May 1977.
Photograph by author.

tour of Kiev, but on the Saturday after the Symposium had ended, we were taken on a hydrofoil down the River Dnieper. This gave further opportunities to talk to other participants, who included many from the USSR, about technical and social matters. As we were going through a lock I was told that it would be inadvisable for me to take photographs as such constructions were of military significance. In 1974 one scientist had had the film taken out of his camera at Yerevan airport as he had been seen taking photographs from the aircraft.

The Director of the Kiev Observatory was Yaroslav Yatskiv, who subsequently became a member of the IAU/IUGG Working Group on the Determination of the Earth's Rotation. This was set-up in 1978 after IAU Symposium 82 at San Fernando, Spain and I was appointed as its chairman.[16] The group organised Project MERIT,[17] which afterwards recommended the establishment of the International Earth Rotation Service (IERS).[18] Project MERIT was an international campaign to 'Monitor Earth Rotation and Intercompare the Techniques of observation'. The original IAU Working Group was extended by geodesists from IUGG. The project led to the replacement of classical optical astrometric techniques by new radio and space techniques for determining the variations in the rotation of the Earth and for establishing terrestrial and celestial reference systems.

Visit to Warsaw, Poland, in 1980

IAU Colloquium 56 on Reference systems for Earth dynamics provided an early opportunity for me to publicise the proposals for Project MERIT and seek wide participation in the Main Campaign that was being planned for 1983.[19] One of the co-chairmen was Barbara Kolaczek, from the Polish Academy Sciences, who was herself a member of the working group. She had a particular interest in the motion of the Earth's pole of rotation within the Earth, for which the classical astrometric measurements were not adequate but which could be determined more accurately by new techniques, such as laser ranging and VLBI.

In 1983 I arranged to hold a meeting of the group at Herstmonceux Castle to complete the preparations for the Main Campaign. Since I knew that Yatskiv would be short of funds I invited him to stay at our home for a few days. It was just before the General Election and he was fascinated by the television coverage, and I am sure that he enjoyed seeing the sights of Eastbourne and the surrounding area, such as Beachy Head.

Visits to Prague, Czechoslovakia, in 1984 and 1986

In March of 1984 I went to Prague for a meeting of the organising committee of a laser ranging workshop that was to be held at the RGO in the following October. The RGO was then operating successfully a satellite laser ranging system (SLR) as its contribution to Project MERIT. The chairman of the committee and of the workshop was Professor Karel Hamal from the Technical University at Prague, and one of the members was Carol Alley, who had proposed that retro reflectors should be left on the surface of the Moon by the Apollo 11 astronauts. At dinner one evening, he produced from his pocket a reflector of the type that has been used successfully for lunar laser ranging. We took the opportunity to visit the Ondrejov Observatory to see, in particular, the SLR system.

I returned to Prague in September 1986 to present a report on Project MERIT at an international symposium on the figures and dynamics of the Earth, Moon and planets.[20] On this occasion I travelled (on annual leave!) by car with my wife and on the way we stayed for the weekend with Lubos Perek and his family at their country cottage and visited them at their house in the city.

Visit to Moscow, October 1987

My next visit to the USSR did not come until 10 years after the Kiev meeting, but in the meantime I had met Yatskiv regularly and I continued to meet Abalakin from time to time at IAU meetings. In the spring of 1987 I was surprised to receive a telex message inviting me to attend a 'Space Future Forum' in Moscow in the October. I did not know the person who sent the telex, nor had I had any previous contacts with his

Fig. 3. An astronomical clock in the National Library in Prague in March 1984.
Photograph by author.

Fig.4. At the final session of the Space Future Forum in Moscow in October 1987 to mark the 30th anniversary of the launch of Sputnik 1.
The Chairman was Professor Sagdeev. Photograph by author.

organisation. I was not asked to give a paper, and yet I was offered free flights and hotel accommodation in Moscow! I sought and obtained clearance to go and I used my annual leave allowance to cover the time that I would be away.

The Space Future Forum was timed to celebrate the 30th anniversary of the launching of Sputnik 1, the first artificial satellite of the Earth, on 4 October 1957. It was intended to stimulate greater cooperation between the USSR and the West, and in particular the emphasis was on the proposed flights to Mars. The meetings were held in the Sovincentre, which was clearly designed for international trade exhibitions and conferences, and had its own American-style hotel. One surprising name amongst the speakers was that of Susan Eisenhower, a niece of the former President. All was explained a few years later when I saw that the chairman of the conference, Professor Sagdeev, had married her!

Another surprise was that the delegates were listed in groups and a guide was assigned to each group to show us around Moscow and to arrange any visits that we would like to make. Apart from the initial walk around the city, I seemed to be only one in the group to take advantage of this offer. Our guide was a lady research chemist, and we went to the circus, and a ballet, and on the last day she arranged for an official car to take us to the Space Exhibition and then to take me to the airport. What more could you ask? Yaroslav Yatskiv arrived on about the second day of the Forum, and then the penny dropped – it was he who had suggested that I should be invited to the Forum! I was not able to make any contribution to the discussions, but it was a very interesting experience.

The highlight was, however, the visit to Star City, where, amongst other space-related activities, Russian cosmonauts are trained. We started with formal meeting at which no less than 41 Russian cosmonauts and American astronauts were gathered on the platform; they included Valentina Tereshkova, the first lady in space. We then went on a tour to the museum and to some of the training facilities, such a large centrifuge and a replica of the MIR space laboratory. After an animated discussion between two guides we were taken to another building in which there was a water tank containing another replica of MIR. Surprisingly, we were allowed to take photographs of some cosmonauts in training in the tank. A space enthusiast at the RGO claimed that such photographs had not been published and he sent a print from one of my slides to the USA.

Fig. 5. A general view of the Space Exhibition in Moscow in 1987.
Photograph by author.

Visit to Potsdam, August 1988

I presented a report on the development and activities of the IERS at an international conference on geodesy and the physics of the Earth in Potsdam during the following year. By this time the IERS was in operation and, as I was soon to retire from the RGO, I had handed over the chairmanship of the Directing Board to Yatskiv, who was a principal speaker at the conference. I was delighted to meet again Margarita Petrovskaya, from the Institute of Theoretical Astronomy in Leningrad; she had been our guide during our visit in 1971. By chance, I sat at a concert with Wolfgang and Galina Dick, who lived in Potsdam and both worked at ZIPE (Central Institute for the Physics of the Earth). We became good friends and in the following years we were interested to hear from them about the changes in Eastern Germany. Wolfgang has a major interest in the history of astronomy. He has published regularly an Electronic Newsletter for the History of Astronomy and also jointly prepared a volume containing bibliographical information on 16,000 persons whose activities relate to astronomy.[21]

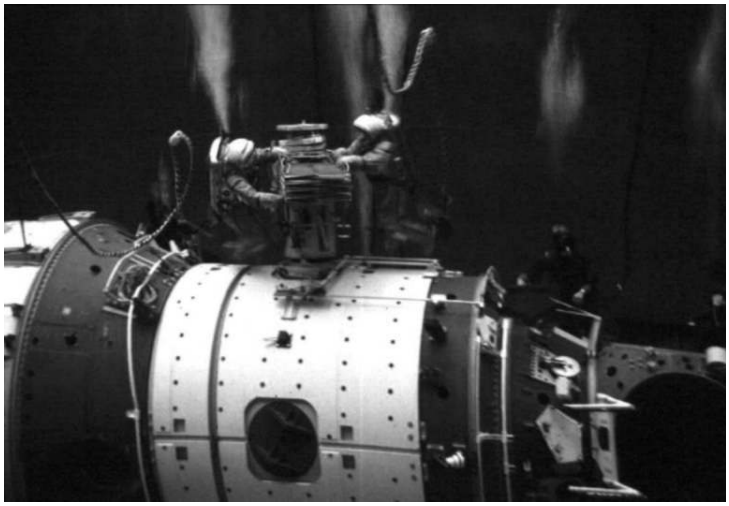

Fig. 6. Cosmonauts training on a MIR space laboratory in a water tank at Star City, near Moscow, in October 1987.
Photograph by author.

Visit to Leningrad and Moscow, October 1989

My final visit to the USSR came after my retirement when I attended IAU Symposium 141 on the Inertial Coordinate System of the Sky in Leningrad.[22] I was particularly pleased to be able to go as it was attended by many of the persons from other countries with whom I had worked during my career. I had prepared a review paper on reference systems for astronomy and geodesy that I had expected to give in the opening session, but I found that I was expected to give a general review at the end of the conference, and so I had to make many last minute revisions to take account of the discussions during the meeting.

Many of the western astronomers were accommodated in a new hotel where the conference took place and found that on our first evening the hotel restaurant was being used for a wedding reception. We were even more surprised to find that we were treated to a free cabaret that was performed by a group from East Germany. We were also able to get cheap tickets for the ballet – we paid Russian prices rather than western tourist prices. We had some time for sightseeing and I was disappointed to see how much Leningrad had deteriorated since my first visit – many of the city streets were in an appalling state of repair, with large potholes.

Some of us were invited to an evening meal at the home of Victor Abalakin, who had been made the Director of the Pulkovo Observatory. I was also invited to supper at the home of a lady from the Observatory to whom I had chatted to on the boat trip down the River Dnieper at Kiev. Her daughter's room had all the characteristics of that of a western teenager.

After the conference in Leningrad I travelled by train to Moscow – in this case I failed in my attempt to buy the ticket at the Russian rate – I paid the tourist rate and travelled in complete isolation in the carriage for tourists. I did manage to get a drink at the buffet.

My main aim in Moscow was to hand over responsibility for an IAU Task Group on the revision of UDC 52, the class for astronomy in the Universal Decimal Classification system which is used in some libraries and abstracting journals.[23] I also took the opportunity to visit the HQ of the Astronomical Council of the USSR, to learn about their data centre as at the time I was President of the IAU Commission 5 on Documentation and Astronomical Data. I was very surprised to be presented with a commemorative medal by the Head of the Centre, Olga Dluzhnevskaya, who later became the President of Commission 5. According to the Diploma, the medal was for my 'significant contribution to international cooperation'. I would like to feel that my contributions matched the satisfaction and enjoyment that I gained from my participation in international activities.

Fig. 7. Yaroslav Yatskiv speaking at the opening of the conference on Geodesy and Geophysics at Potsdam in August 1988.
Photograph by author.

Acknowledgement

This paper is based on a talk entitled 'Glimpses of the USSR, 1971-1989' that I gave to the Torquay Natural History Society at the Torquay Museum on 1998 February 10 as the result of a request by the programme secretary to give a talk to the Society about a personal aspect of my career. My notes for that slide-talk contain more details of people and places than are given here. The official correspondence and notes about these visits are in the files of the NAO in the RGO archives in the Cambridge University Library.

Fig. 8. George Wilkins speaking during IAU Symposium 141 on the Inertial Coordinate System on the Sky at Leningrad in October 1989.
Photograph by Wolfgang Dick.

Notes and References

1. Wilkins, G.A., 'A personal review of the history of the Royal Greenwich Observatory at Herstmonceux Castle, 1948-1990', *Antiquarian Astronomer*, 4 (2008), 69-80.

2. Wilkins, G.A., 'The expanding role of H. M. Nautical Almanac Office', *Vistas in Astronomy*, 20 (1976), 239-43.

3. The IAU has played a dominant role in my career – I have been to 14 of its General Assemblies and to many conferences and meetings of working groups. The structure and activities of the IAU up to 1969 are described by Adriaan Blaauw in *History of the IAU* (Kluwer Academic Publishers, 1994).

4. D.H. Sadler was the Superintendent of H.M. Nautical Almanac Office from 1936 to 1971. See the obituary Wilkins, G.A., 'Donald Harry Sadler, O.B.E. (1908-1987)', *Quarterly Journal of the Royal Astronomical Society*, 32 (1991), 59-65. Much interesting information about activities and persons is given in *A personal history of H.M. Nautical Almanac Office, 1931-1972*, written by Sadler and edited by Wilkins on the NAO website at *http://www.hmnao.com/nao/history/*.

5. F.M. McBain was on the staff of the NAO from 1937 to 1973. See the obituary, Wilkins, G.A., 'Flora Munro McBain 1912-2000', A*stronomy and Geophysics*, 42 (2001), page 4.34.

6. H.S. Jones was Astronomer Royal from 1933 to 1971. See the obituary by Sadler, D.H., 'Harold Spencer Jones', *Quarterly Journal of the Royal Astronomical Society*, 4 (1963), 113-25.

7. *Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac* (London, H.M.S.O., 1961). Chapter 1 gives a brief account of the history of International cooperation as well as details of the publications of the two offices; Seidelmann, P. K. (editor), *Explanatory supplement to the Astronomical Almanac* (California, University Science Books, 1992)

8. Wilkins, G.A., 'The analysis of the observations of the satellites of Mars', in: Colombo, G. (ed.), *Modern Questions of Celestial Mechanics* (Rome, Centro Internationale Matematoco Estivo, 1968), 223-40. Wilkins, G.A., 'The motion of Phobos', *Nature*, 224 (1969), page 789.

9. I was the IAU delegate to CODATA from 1970-1979. I reported on what we were doing in astronomy, and I also learnt about what was happening in other fields of science so that I saw new developments before they had been widely publicised.

10. I was the IAU representative on the Council of FAGS from 1970-1975 and its Secretary from 1975-1979. Most of the annual meetings involved one-day journeys to Paris.

11. Wilkins, G.A., 'The genesis of the IAU Working Group on Astronomical Data' in: Heck, A., (ed.), *Organisations and strategies in astronomy* (Springer 2006), vol. 7, 355-66.

12. I was mainly concerned with the International Association of Geodesy and had the honour to be the chief UK delegate to its GA in Hamburg in 1983, when I was the chairman of the Royal Society's subcommittee on geodesy.

13. Wilkins, G.A., 'Presentation in the primary literature of data derived from observations in the geosciences', *CODATA Bulletin*, 32 (1979).

14. Wilkins, G.A., 'The IAU Style Manual (1989): the preparation of astronomical papers and reports', *Transactions IAU* (1989), vol. 20B, chapter 8.

15. Wilkins, G.A., 'The specification of Nutation in the IAU system of astronomical constants', in: Federov, E.P., et al. (eds.), 'Nutation and Earth's Rotation', *Proceedings of IAU Symposium No.78* (Dordrecht, Holland: Reidel, 1980), 17; Wilkins, G.A., 'Report of general discussions at IAU Symposium No.78 on Nutation and the Earth's Rotation', *Ibid.*, 247-55.

16. McCarthy, D.D. & Pilkington, J.H. (Editors), 'Time and the Earth's Rotation', *Proceedings of IAU Symposium No.82, Cadiz*, 1978 (Dordrecht, Holland: Reidel, 1979)

17. The project was one of the most satisfying of my international activities. It spawned many papers and the results and recommendations of the Working Group are summarised in the following paper that was also printed in geodetic publications: Wilkins, G.A. and Mueller I.I., 'Joint Summary Report of the IAU/IUGG Working Groups on the Rotation of the Earth and the Terrestrial Reference System', in: Swings, J-P. (ed.), *Highlights of Astronomy* (IAU, 1986), vol. 6, 771-88. The report was adopted by the IAU at its GA in Delhi in November 1985 and subsequently by the IUGG.

18. IERS was set up on the basis of the recommendations of the MERIT group. I chaired the first meeting of the new Directing Board in 1988, but then I handed over to Y. Yatskiv as I was to retire from the RGO the following year. I reviewed the 10-year programme at a conference in 1999; Wilkins, G.A., 'Project MERIT and the formation of the International Earth Rotation Service', in Dick, S., McCarthy, D. and Luzum, B. (eds), 'Polar motion: historical and scientific problems', *Proceedings of IAU Colloquium 178, Cagliari, Sardinia, Italy, 27-30 September 1999* (ASP Conference Series, 2000), vol. 208, 187-200, pages 187-198.

19. Wilkins, G.A., 'A note on the origin, objectives and programme of Project MERIT', in: Gaposchkin, E. M., and Kolaczek, B. (eds.), *Reference Coordinate Systems for Earth Dynamics* (Dordrecht, Holland: Reidel, 1981), 275-76.

20. Wilkins, G.A., 'Report on recent developments in international collaboration in monitoring the rotation of the Earth and in establishing new terrestrial and celestial reference systems', Invited paper; abstract only in: *Proceedings of International Symposium on the Figures and dynamics of the Earth, Moon and planets (Prague, 1986 Sept. 15-20,* (1987), part 3, 713-14.

21. The *Electronic Newsletter for the History of Astronomy* contains information about current meetings etc and is at www.astrohist.org; Bruggenthies, Wilhelm, and Dick, Wolfgang R., *Biographischer Index der Astronomie* (Frankfurt: Verlag Harri Deutsch, 2005).

22. Wilkins, G.A., 'The past, present and future of reference systems for astronomy and geodesy', in: Lieske, J.H., & Abalakin, V.K. (eds.), 'Inertial coordinate system on the sky', *Proceedings of IAU Symposium No. 141 (Leningrad, 1989)* (Kluwer Academic Publishers, 2000), 39-46.

23. UDC 52 – I continued to work on the much-needed revision after my retirement but, far as I am aware, my proposals were not implemented. It is a multi-lingual system and its uses are described on the website of the UDC Consortium at www.udc.org.

The Author

George A. Wilkins, B.SC., Ph.D., F.R.A.S., carried out research in geophysics before joining H. M. Nautical Almanac Office (N.A.O.), a department of the Royal Greenwich Observatory (R.G.O.) at Herstmonceux Castle in Sussex, in 1951. He was superintendent of N.A.O. in 1970–1989 and Head of the Almanacs and Time Division of R.G.O. in 1974–1989. He has taken part in a wide variety of international activities, especially in the International Astronomical Union. He was the President of its Commission 4 on Ephemerides in 1967–1970 and of Commission 5 on Documentation and astronomical Data 1985–1991. In 1970–1979 he was chairman or secretary of groups on astronomical and geophysical data. In 1978–1988 he was chairman of an international working group on the determination of the rotation of the Earth. It organised Project MERIT and its recommendations led to the establishment of the International Rotation Service in 1988. He was the chairman of the Subcommittee on Geodesy in 1982–1984 and a Vice-President of the Royal Astronomical Society in 1986–1987. After retirement in 1989 he moved to Sidmouth. He participates in the activities of the Norman Lockyer Observatory (N.L.O.) and gives talks about astronomy to local organisations. He was president of the Devon Astronomical Association in 1991–1996. He has been an Honorary Fellow (mathematics) in Exeter University since 1990. His main scientific activities are now on the histories of the R.G.O. and N.L.O. He was a founder member of the Society for the History of Astronomy.

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