The Antiquarian Astronomer

Journal of the Society for the History of Astronomy

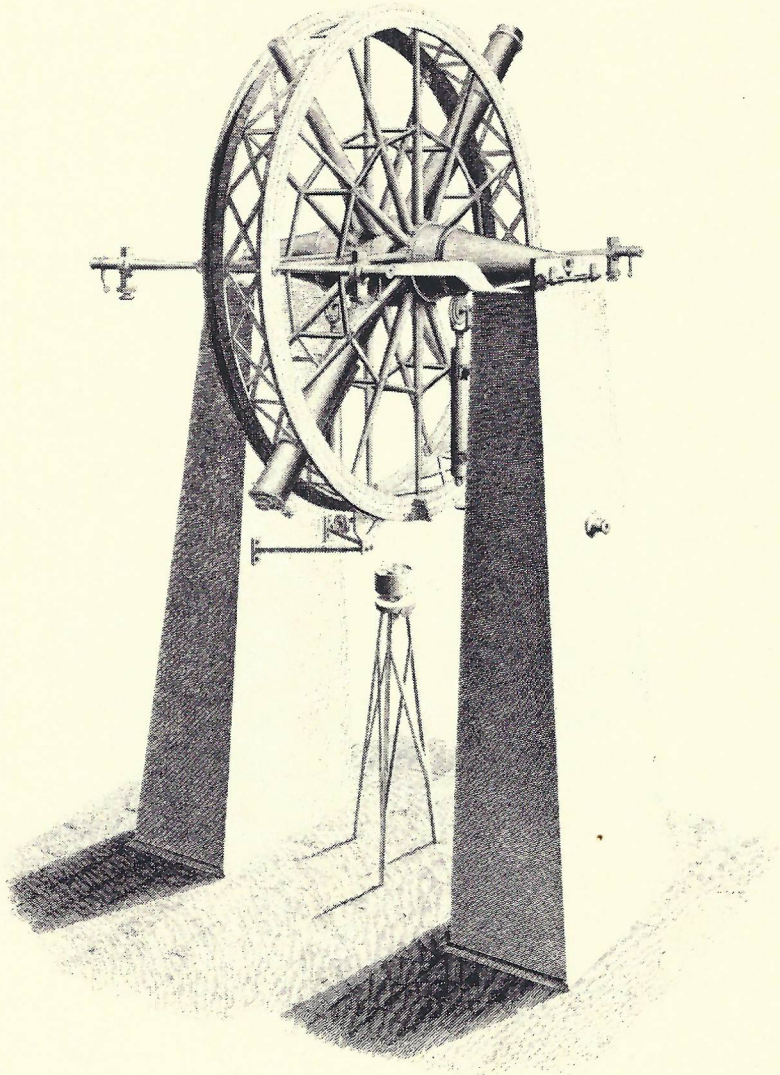

Image by courtesy of the Royal Astronomical Society

Issue 2

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Foreword

The Society for the History of Astronomy, now in its fourth year, continues to build on the good start outlined in my Foreword to Issue 1. A very successful Spring Conference and A.G.M. took place at Greenwich in May 2005 followed, for many of those attending, by an enthralling visit to the 28-inch refractor in the company of Dr Derek Jones and Dr Robert Massey. Our Autumn Conference in October was again held at the Birmingham and Midland Institute. In April our reference library at the B.M.I. was inaugurated as the *Sir Robert Ball Library* by Professor Peter Willmore. The Council of the Society has decided to name its lending library the *Sir Patrick Moore Library*, not only in recognition of his support during the formative years of the Society, but also because it was felt singularly appropriate that our gratitude should be permanently recorded by naming the second library after one who has done even more for all aspects of our science in the twentieth and twenty-first centuries than even Sir Robert Ball achieved in the nineteenth century. Sir Patrick, our Honorary Vice-President, has expressed himself very flattered by this decision.

Sir Patrick Moore receiving his copy of *The Antiquarian Astronomer,* Issue 1, from Gilbert Satterthwaite (right) and Ken Goward. Selsey 2 April 2005.

Issue 1 of *The Antiquarian Astronomer* was very well received, and I am proud to introduce Issue 2, produced by our new Editorial Team of Reg Withey and Kevin Johnson. We are very grateful to them for their efforts, and to all the contributors. The members of the Society's Council have also contributed a great deal of hard work, often in unsung ways, and I would like here, on behalf of all our members and readers, to express our gratitude to all of them.

Gilbert E. Satterthwaite
Chairman
Society for the History of Astronomy

A Message from the Editorial Team

We are very pleased to present to members of the Society for the History of Astronomy, Issue 2 of *The Antiquarian Astronomer*. Coming as it does within nine months of the distribution of Issue 1, it represents the very considerable efforts of a large number of people. We wish to thank in particular four groups of special people: all the authors, who have had to cope not only with learners at the helm, but also with our efforts to get the most efficient processes in place; our external reviewers, who gave us their expert opinion on each paper; members of the S.H.A. Council for their unstinting support in guiding us through to production; and our Printers, Parchment (Oxford) Ltd. (especially Mrs Helen Comely) for their speed, efficiency and goodwill in dealing with our requirements.

Issue 2 consolidates the excellent start made by the previous Editor, Callum Potter, and his team. There are no startling changes, nor do we think any are required. We hope that the content, layout and format of the Journal have set the style for a long time to come. However, we are always anxious to improve, so comments from readers will be received with enthusiasm.

It is axiomatic that a Journal such as this can succeed only if it receives papers to publish. We have some for Issue 3, but need many more. These should be submitted at any time, using the Guidelines for Authors contained on page xx. If you cannot follow the Guidelines, please contact the Editor to discuss your requirement. The ethos of *The Antiquarian Astronomer* is that Council and the Editorial Team is committed to provide the opportunity for every member to contribute something of lasting value to the Society, and to the annals of the history of astronomy.

Please bear in mind that identifying the research opportunity and then doing the research are only the first two of a three-stage process; the third, and most important stage, is interpreting and writing up the material for the benefit of others. Research done is incomplete unless it is published. To those experienced at writing articles, preparing a paper for *The Antiquarian Astronomer* will pose no difficulties. To those less experienced, there is no reason at all why writing a paper should present any problems. The Editorial Team will support you in any way you need; please do not hesitate to ask.

Our experience with Issue 2 shows that the single area where close attention is needed is in the correct referencing of sources of information. It is imperative that each fact, each illustration and source is supported by a complete note of where the information was found. This note must be sufficiently complete and accurate that any reader of a paper can trace that same information using the author's notes alone. The Guidelines for Authors include preliminary guidance on how to reference books, research papers in learned journals and unpublished sources such as document archives. Please use them until more complete guidelines appear of the Society's website.

In the meantime, we hope you enjoy Issue 2, and find something that excites you; something that encourages you to continue researching, and to continue publishing your findings in *The Antiquarian Astronomer*.

K.L.Johnson and W.R.Withey
Editorial Team

The Penllergare Observatory

John L. Birks
Past Chairman, Swansea Astronomical Society

This rather picturesque and historically important Victorian observatory was built by the wealthy John Dillwyn Llewelyn near to his mansion, some four miles north-west of Swansea, Wales. He had many scientific interests, in addition to astronomy, and was a notable pioneer of photography in Wales. Together with his eldest daughter, Thereza, (who married the grandson of the fifth Astronomer Royal, Nevil Maskelyne), he took some early photographs of the Moon from this site. This paper describes the construction of the observatory, and some of those primarily involved with it. Despite its having undergone restoration work in 1982, the state of the observatory is again the cause for much concern.

The Penllergare Observatory (nowadays spelt Penllergaer) and its adjoining laboratory was built by John Dillwyn Llewelyn (J.D.L.), in 1851, on his large country estate some four miles north-west of Swansea, Wales. The historic photograph (Figure 1) showing the observatory in the grounds of his mansion was taken by J.D.L., soon after the building was completed, using the calotype photographic process. It is one of only two nineteenth century astronomical observatories in Wales, the other being at Hakin, Pembrokeshire.

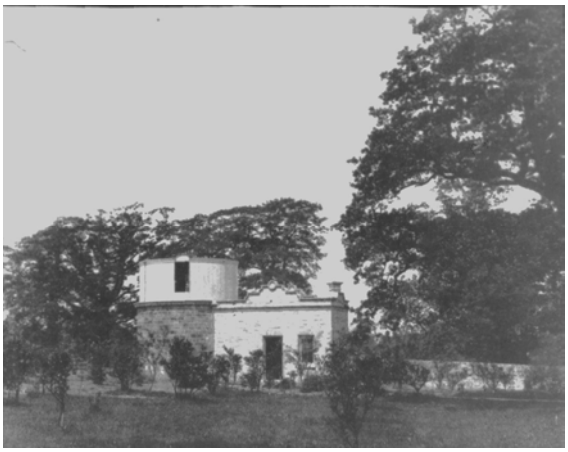


Figure 1

The Penllergare Observatory in 1852, soon after construction

Photograph taken from slightly east of south.

Photograph supplied by, and reproduced courtesy of, Mr R. Morris.

The observatory is now situated in the grounds of the Neath/Port Talbot Borough Council Civic Centre, at grid reference SS 622991, just off junction 47 of the M4 motorway[1]. The original Llewelyn family mansion on this site, dating from the early eighteenth century, eventually fell into decay and was demolished in the mid 1960s, but the observatory was superficially renovated by the Lliw Valley Borough Council, assisted by members of the Swansea Astronomical Society, in 1982, when the Council built their new offices on the 14-acre site. A contemporary newspaper article described the restoration work done on the old observatory, with the assistance of youngsters on a Manpower Services Commission scheme[2].

John Dillwyn (1810-1882) was the son of Lewis Weston Dillwyn, who was the Member of Parliament for Swansea from 1834 to 1841 and owner/manager of the famous Swansea Cambrian Pottery. John inherited the Penllergare estate from his grandfather, Colonel John Llewelyn, in 1817,

Figure 2

John Dillwyn Llewelyn with photographic equipment, circa 1850

Photograph supplied by, and reproduced courtesy of, Mr R. Morris.

when he was only seven years old, and lived there with his parents and brothers until he was 21 years old, when he came into his inheritance. His parents

then moved to Sketty Hall on the western outskirts of Swansea. John Dillwyn became the local squire, taking on the additional surname Llewelyn, and was both a magistrate and High Sherriff of Glamorgan. Figure 2 portrays him with his bulky camera and darkroom tent, essential components for photographic work in the 1850s.

J.D.L.'s wife (Emma Thomasina Talbot) was sister to the very wealthy Mr C.R.M.Talbot, who owned land at Margam Abbey in Glamorgan and also at Penrice Castle in Gower. She was a cousin of William Henry Fox Talbot, the pioneer of photography, of Laycock Abbey, Wiltshire. The Llewelyns, together with their cousin Fox Talbot and another distant relative, the Reverend Calvert Richard Jones, developed from the1840s the art of photography, and initiated improvements in early photographic techniques, around the Swansea area.

As a typical Victorian gentleman, J.D.L. had wide interests, which encompassed the subjects of botany, geology, physics and chemistry, and he made some of the earliest experiments concerned with the electrical propulsion of small boats on his estate lakes. He also assisted Professor Charles Wheatstone in 1844 with experimental under-sea telegraphy in Swansea Bay. He was a Fellow of the Royal Society (elected in 1837), a founder member of the Photographic Society of London (now the Royal Photographic Society), and a Fellow of the Linnaean Society (he was a pioneer in the cultivation of exotic orchids and tropical epiphytes in his heated greenhouses at Penllergare). He was elected a Fellow of the Royal Astronomical Society on 13 February 1852, following his proposal on 26 November 1851 by several Fellows, including the President, Admiral W H Smyth R.N., John Couch Adams and Richard Sheepshanks.

J.D.L. built an observatory of the rotunda (or 'drum') type, with a rotating, top-hat-shaped cupola some 19 feet[3] in diameter, originally made of wood with a copper cladding (the smelting of copper ores made Swansea the 'copper capital' of the world in those days). The outer surface was coated with white lead paint to reflect sunlight and so keep the interior from becoming too hot. The cupola rotated on a metal rail, which encircled the top of the observatory wall, and had doors in the roof and on its side to permit the telescope to be pointed at any part of the sky. A large wheel, similar to that used to steer a ship, was fixed to the observatory wall and used to rotate the cupola.

The lower part of the circular observatory tower wall was built of dressed masonry and was about 32 inches thick. On the north and south sides, diametrically opposite each other, two holes, 6 inches square and about 18 inches apart, penetrate the base of the wall; their purpose is unclear. They might have been part of a ventilation system or a floor-supporting structure. The upper part of the wall was reduced to a thickness of some 12 inches. Excavation of the decayed internal contents in 1981 revealed a substantial, cone-shaped, brick-built pillar of some 7½ ft maximum diameter and about 12 ft high with fragments of cast-iron reinforcements, some brass pulleys, etc.

At the top of the pillar was fixed a capstone, which had three, iron levelling screws to support the telescope mounting. It is thought that this massive, supporting pillar was designed to prevent vibrations from the railway line which ran nearby, or from the passing of horse-drawn carts on the road outside, affecting the long refractor telescope at high magnifications, and when photography was being undertaken. There was almost certainly a cast-iron telescope support fixed at the top of the pillar capstone, as such an object, about 5 feet in length, was lying broken in the overgrown shrubbery near the ruined building in the 1940s, but this has since disappeared[4]**.** The wooden observation platform would have been reached by steps from ground level inside the building, but this woodwork had completely disintegrated by the time the 1981 excavation started.

The outside wall of the observatory consists of solid, coursed stonework. The inner skin of the wall shows another of the observatory's unusual features: It is built from specially-designed, hollow, clay bricks which were interspersed with wooden blocks set in a regular pattern, and onto which were fixed 4- by ½-inch tongued and grooved wall cladding set on battens. This construction was probably intended to provide thermal insulation, and so promote temperature stability inside the observatory.

Figure 3

Penllergare Observatory in 2005

Photograph from the north-east by the author.

The photographic laboratory, attached to the east side of the observatory, is some 10 feet wide and 20 feet long, and has an interesting type of construction. It consists of two skins of hollow, glazed bricks of specially-designed, triangular shape. A nineteenth century German publication[5] states that such bricks, or tiles, were made by Claytons of 21 Upper Park Place, Dorset Square, Lon-

don, and examples were displayed at the Great Exhibition in London in 1851. Their purpose seems to be to provide temperature stabilisation, and thus limit convection currents that might affect the clarity of viewing at the telescope, which was at a higher level. The building has a vaulted roof fitted with iron tie rods, and each side of the building is finished with an ornamental, Dutch-style gable of specially-moulded bricks. There is an entrance door and a window on the south side, and another window (formerly a door) on the north side. The single room has a fireplace and chimney at the east end, and there is evidence of a wooden floor, and of wooden steps that led up to the telescope room on the western side. The building unfortunately has again deteriorated since the renovations of 1982, and as it is judged to be unsafe the Council forbids entry to the interior. Figure 3 shows the observatory as it appears today.

Another interesting early calotype photograph of the observatory and laboratory during its construction, taken by J.D.L., is reproduced in the book *Penllergare: a Victorian Paradise*, by Richard Morris, a distant descendant of the family[1]. In addition to containing a general description of the estate, it has a chapter devoted to the observatory.

J.D.L. was a graduate of Oriel College, Oxford, and had an extensive knowledge of chemistry. He was one of the pioneering amateurs in the application of photography to astronomy, and it was his enthusiasm for improving photographic techniques that led to the building of the photographic laboratory adjoining the observatory. It was only in March 1840 that Dr J.W.Draper of New York had produced the first photographic image of the Moon on a Daguerreotype plate using a 20-minute exposure[6], and over the next 20 years several notable pioneers began to apply photography in astronomy[7].

In Britain, Warren de la Rue[8] first photographed the Moon in 1852 using Daguerreotype plates, exposed using a 13-inch reflector telescope, and achieved good success after 1857 when he acquired a motor drive to control the telescope during the long exposures required[9]. Henry Scott Archer published details of the wet collodion photographic process in 1851, which made faster exposures possible onto glass plates, and it was this technique that J.D.L. adopted in the early 1850s. With the assistance of his eldest daughter Thereza, J.D.L. produced an image of the Moon (referred to below) using this collodion process. However in 1856, following the example of his more-famous relative W.H.Fox Talbot, who in 1841 had patented the calotype process in which negatives are first produced from which true positive prints could be made, J.D.L. developed the oxymel photographic process[10]. This process stabilised the photographic image on dry plates, utilising a solution derived from a mixture of honey and vinegar. It was considerably more light sensitive than the daguerreotype process and made 'instantaneous' photography in daylight possible[11]. Oxymel dry plates would have been considerably easier to use in a camera attached to a telescope than dripping wet ones, and once prepared they could be used up to a week later, in contrast to wet plates that had to be used soon after they had been prepared.

These early photographic techniques often involved the use of some rather more hazardous chemicals such as mercury, bromine, iodine, chlorine and other volatile substances, and it was their use which probably exacerbated the asthmatic condition which seriously affected J.D.L.'s health as he grew older. He retired from his mansion at Penllergare to Cornwall Gardens in London in 1871, leaving his son John T.D.Llewelyn in occupation, and later moved to Atherton Grange in Wimbledon, where he died in 1882.

It is known that in 1846 J.D.L. purchased a 4¾-inch Dollond refractor telescope (presumably George Dolland), but the size of the observatory suggests that it probably housed a longer refractor having an aperture of 6 to 8 inches. The details and whereabouts of these telescopes is now unknown, although it is on record that the object glass of the main telescope was of fine quality, and cost over £100. J.D.L.'s son, John T.D.Llewelyn recounted that the objective was procured by J.D.L. after he had made a long coach journey to Gloucester and then a train journey on to London[12].

It is almost certain that J.D.L. constructed the observatory mainly for his astronomically-minded daughter, Thereza, as a 16th birthday present. In an unpublished letter to her father, Thereza refers to her grandparents, Lewis and Mary Dillwyn, and her younger sisters, Emma and Elinor, being present on the occasion of the laying of the observatory foundation stone on 7 July 1851.

> 'I laid the foundation stone of the observatory today, July 7th. When Grandpa and Grandmama were here on Saturday we told them about it and they were so very kind as to come over here today to see the first stone laid; so we went in procession to the place; they had got some stone already and after I had laid the first stone Emma laid the second and Elinor the third, which she was very much delighted to do'.[13]

These foundation stones may have been at the base of the central pillar, and have not been identified during the renovation work.

Thereza, following in her father's footsteps, was very interested in astronomy, as well as many other sciences. The photograph of Thereza (Figure 4), taken in the early 1850s, was staged outdoors to represent an indoor scene (because of the requirement for maximum light) and the edge of the background screens can just be seen. The photo portrays her interest in astronomy, books, and the globe of

Figure 4

Thereza Llewellyn with small telescope

Photograph supplied by, and reproduced courtesy of, Mr R. Morris.

the world. She was a particularly capable botanist, but also was very familiar with the night sky and is said to have noticed Donati's comet in August 1858 (whilst on her honeymoon in Europe) before the Italian astronomer had announced its discovery. Her diary records on another occasion:

> 'This westerly wind has brought clouds along with it, otherwise I should have been looking at Jupiter or the Moon'.[14]

She was always eager to show visiting guests the splendours of the night sky through the observatory telescope, and she enthusiastically assisted her father with experiments in astrophotography, producing early pictures of the Moon around 1855. A copy of the collodion photograph of the Moon they took in the mid-1850s is in the possession of the Swansea Astronomical Society (Figure 5). If the original still exists, its location is unknown; finding it would obviously be of great historical interest.

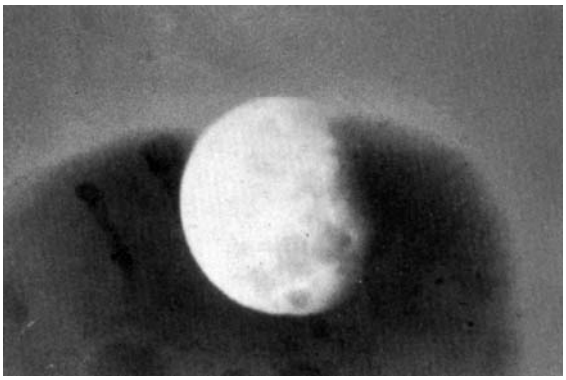


Figure 5

Collodion photograph of the Moon taken by John Dillwyn Llewelyn in the 1850s

Photograph supplied by, and reproduced courtesy of, Mr R. Morris.

Later, Thereza wrote in her diaries:

> 'In 1857 N [then her fiancée, later her husband] sent me the photo of the Moon taken with Mr de la Rue's telescope - Dec. 27th. About this time, if not earlier, my father and I made like photos at Penllergare - without clockwork motion.' [15]

Many years later she recalled:

> 'About 1855 my father made a photo of the Moon, and as moonlight requires much longer exposure it was my business to keep the telescope moving steadily as there was no clockwork action. That photograph was one of the first ever made of the Moon. In 1869 a photograph now historical and described as being taken 'at a time when the art of photography was in its infancy' was made by Sir David Gill, and is now at the Royal Astronomical Society in London.' [16]

Thereza eventually married Professor Nevil Story Maskelyne (1823-1911), a notable chemist and mineralogist, and the grandson of the famous Astronomer Royal, Nevil Maskelyne. He later became Keeper of Minerals at the British Museum as well as occupying the Chair of Mineralogy at Oxford University. Initially J.D.L. invited Maskelyne down from Oxford because of his interest in early photographic techniques and the chemistry of photographic processing, and he afterwards became a frequent visitor. The romance of Maskelyne with Thereza Llewelyn, initiated by their mutual interest in science, particularly astronomy and photography, blossomed in and around the observatory at Penllergare[17]. They married in 1858, and thenceforth Thereza had to tear herself away from the family paradise in Wales to set up home in London.

Despite the best efforts of several interested persons, it has not been possible to trace more completely the work that J.D.L. contributed to astronomy, other than the early collodion image of the Moon, and it is somewhat doubtful if original records of his work in astrophotography still exist[18]. However, further information on their early work in astrophotography and their equipment may emerge if the journals of Thereza Dillwyn Llewelyn, which are in private family archives, are eventually made available to researchers.

J.D.L.'s son, Sir John T.D.Llewelyn, succeeded his father and he also had scientific interests. He was President of the Swansea Scientific Society and instrumental in encouraging that Society to purchase a telescope for erection at the Royal Institution of South Wales, which later became Swansea Museum. A newspaper article[12] records him hosting the visit of the Committee of the Swansea Scientific Society to the Penllergare observatory on the previous Wednesday evening to see the telescope, during which they made observations of the Moon, Mars, and Jupiter with its four prominent moons.

From the late 1920s the Penllergare estate declined. It was once owned by the Bible College of

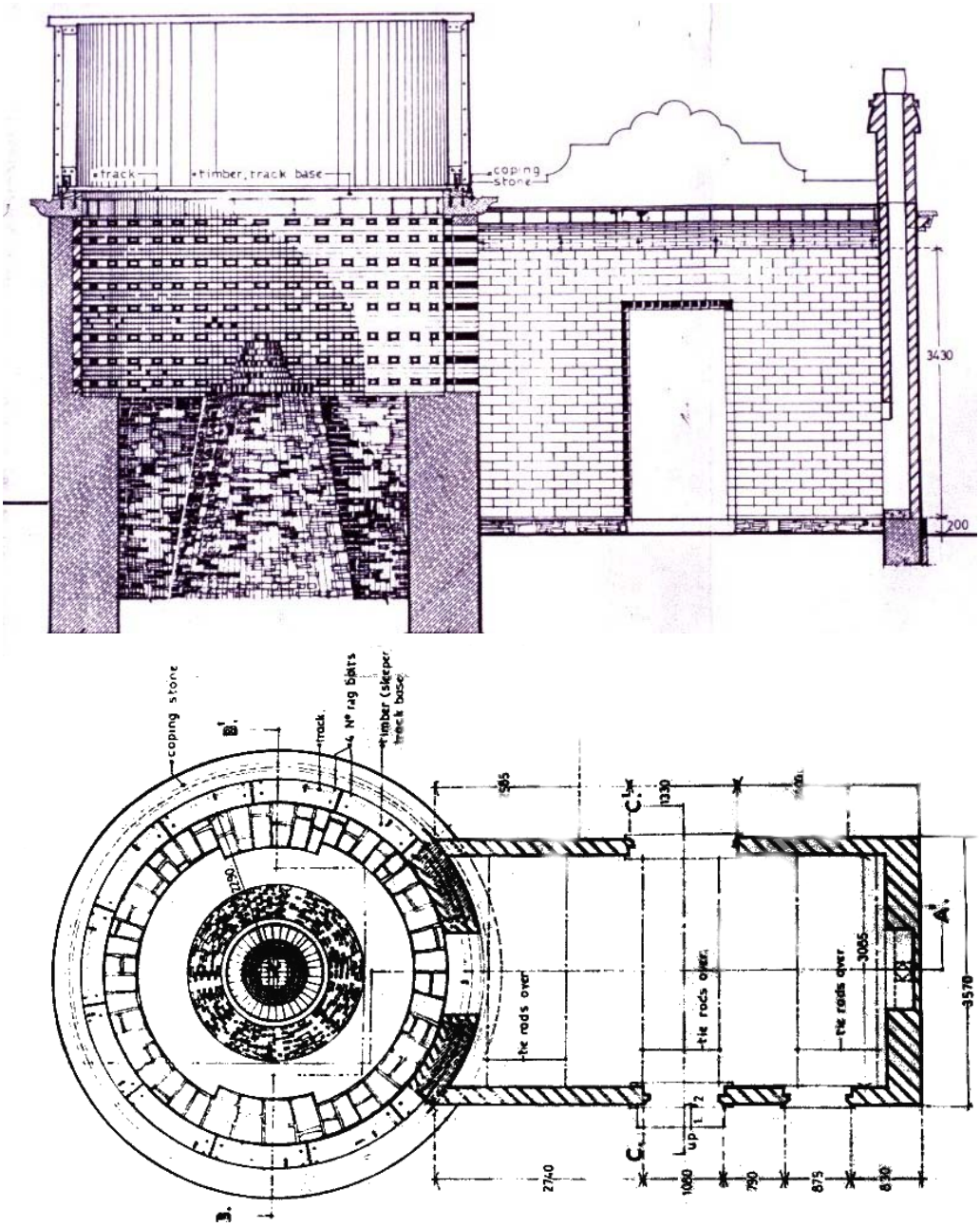


Figure 6

Architect's drawing of the Penllergare Observatory

Upper view: North elevation. Lower view: plan.

Reproduced by courtesy of the City and County of Swansea.

Wales, and during the Second World War was occupied by U.S. marines. The old mansion was eventually demolished in the 1960s as unsafe. The observatory was gradually swallowed up by encroaching yew, birch, azaleas and rhododendrons, and camouflaged by a dense covering of ivy .

During the restoration work undertaken by the Lliw Valley Borough Council, a reproduction cupola was designed and constructed by local engineer Mr Ray Carlisle of Pontardulais. This was made to reproduce as far as possible the appearance and working of the original, but was made of steel rather than the former materials. It was placed into position on a wheel and rail track and has a removable roof section and 'stable door' opening similar to the original (see Figure 1). Architectural drawings were made by the Council at that time, based on the excavation findings, to reproduce the original observatory and laboratory as closely as possible, and a copy of these is also in the possession of the Swansea Astronomical Society

Figure 6 shows the north elevation and the plan. Another set of drawings is in the Archives Department of the City and County of Swansea.

Unfortunately, despite widespread enquiries, it has not been possible to trace the original telescope with its German Equatorial mounting or J.D.L.'s 4¾-inch Dollond telescope, which it is believed were sold at auction when the contents of Penllergare Mansion were disposed of in 1936.

It had been hoped, following the restoration work in 1982, that the old observatory and its adjacent laboratory would be used as an exhibition centre for J.D.L.'s photographic and astrophotographic work. However lack of funds, and the death of some of the enthusiasts in the Swansea Astronomical Society who had worked hard on the project, has allowed the building once again to fall into disrepair. The building, the second oldest astronomical observatory in Wales, is obviously of national historic importance as a scientific site and therefore it is hoped that a more complete and lasting restoration of the observatory may be made at some future time.

Acknowledgements

The late Mr Gerry Lacey, Secretary of the Swansea Astronomical Society at the time, worked untiringly to discover as much as he possibly could about the Penllergare observatory and encouraged its renovation in 1981-1982. Together with other members of the Astronomical Society, and the Lliw Valley Borough Council, he rescued this historically important building from long-standing neglect and what might have been total loss. Many of his papers are kept by the Swansea Astronomical Society and have been an important resource for this article.

It is a pleasure to acknowledge the willing assistance I have received from Dr S.J.Wainwright, F.R.A.S., who collected and made available to me the most important papers relating to the observatory.

The continuing interest of Jenny Ayers, Michael Norman, and others of the Penllergare Trust is also gratefully recognised.

The antique photographs in Figures 1, 2, 4 and 5 were supplied by, and are reproduced with the kind permission of, Mr Richard Morris.

Permission to print portions of the drawings made in June 1980 by the Planning Department of the then West Glamorgan County Council, which are now the copyright of the City and County of Swansea, is also gratefully acknowledged.

Thanks are also due to the archivists of the University of Wales in Swansea, West Glamorgan Archives at County Hall, and the Swansea Museum, for their assistance in attempting to find more information on the astronomical activities of John Dillwyn Llewelyn.

Notes and References

1 The history of the site, and information about its Victorian environment, can be found in the main reference to the Penllergare estate: *Penllergare; a Victorian Paradise*. Morris, Richard. Llandeilo: The Friends of Penllergare, 1999. This can be obtained from: The Friends of Penllergare, Coed Glantawe, Esgairdawe, Llandeilo, SA19 7RT, U.K.

2 Jones,P. Youngsters Restore Observatory. Article in *Western Mail*. Friday 26 September 1981. Page number unknown.

3 All measurements in this paper are in imperial units, the units in use at the time when the observatory was built and used.

4 Correspondence of G.P. Lacey with G.R. Redman, dated 22 September 1982. Archives of the Swansea Astronomical Society. Penllergare box file/envelope 7(a).

5 Archives of the Swansea Astronomical Society. Penllergare box file/envelope 5(b).

6 Article on Photography, Celestial . In: *Encyclopaedia Britannica. Micropaedia VII*. Chicago: Encyclopaedia Britannica Inc., 1976. 968.

7 Lankford, John. The Impact of Photography on Astronomy. Chapter 2 in: *Astrophysics and 20th Century Astronomy to 1950*, 4A. Ed. Gingerich, Owen. Cambridge: Cambridge University Press, 1984. 16-39.

8 Warren de la Rue, one-time President of the Royal Astronomical Society, was a family friend of the Llewelyn family, and a notable British amateur astronomer and pioneer astrophotographer. He photographed the 1860 total solar eclipse in Spain, thereby showing that the prominences seen at totality are emissions from the Sun, rather than from the Moon (see Hingley,P.D. The First Photographic Eclipse? *Astronomy and Geophysics*. 2001. 4**2**(1). 1.18-1.22). His photographs of the Sun and Moon, including stereoscopic images of sunspots and surrounding faculae, received sensational acclaim at the 1862 International Exhibition in London.

9 Clerke, Agnes. *A Popular History of Astronomy During the Nineteenth Century*. London: A & C Black, 4th edition 1902. 152-154.

10 www.welshwales.co.uk/images.htm accessed on 21 November 2005.

11 Morris, Richard. The Oxymel Process. *The Photohistorian*. 100. Spring, 1993. Page numbers unknown.

12 An evening at Penllergare astronomical observatory. *The Cambrian*. 15 June 1888. Page number unknown.

13 Unpublished letter from Thereza Dillwyn Llewelyn to her father John Dillwyn Llewelyn, who was attending a British Association for the Advancement of Science meeting in Ipswich. Quoted in Morris, Richard [Reference 1]. 32.

14 Quoted in a leaflet entitled *Penllergare Equatorial Observatory,* which was published by Lliw Valley Borough Council in 1986. A copy is held in the Archives of the Swansea Astronomical Society, Penllergare box file/envelope 1(a).

15 Archives of the Swansea Astronomical Society, Penllergare box file/envelope 1(a).

16 Morris, Richard [Reference 1 above]. 32.

17 Morton, Vanda. *Oxford rebels: the life and friends of Nevil Story Maskelyne, 1823-1911, pioneer Oxford scientist, photographer and politician.* Gloucester: Alan Sutton, 1987. 130-135.

18 Some of the J.D.L. papers are, however, still in the possession of his family, and some are held in archives of the Royal Institution of South Wales and the Swansea Scientific Society, held by the West Glamorgan Archive Service, County Hall, Swansea.

The Observers Observed: Charles Dickens at the Royal Observatory, Greenwich, in 1850

Allan Chapman
Wadham College, Oxford

As far as I can tell, Charles Dickens had no especial interest in science in general or in astronomy in particular. There is no science in his novels, short stories, or articles beyond occasional comic parodies, such as Mr Pickwick's fame as an explorer, 'The Mudfog Association for the Advancement of Everything', ridiculing the newly-founded British Association for the Advancement of Science, in *Sketches by Boz* (1836-37),[1] narrow-minded Mr Gradgrind's obsession with 'Facts' in *Hard Times* (1854), and Ebenezer Scrooge's remarks about political economy in *A Christmas Carol* (1843). And while Dickens was undoubtedly familiar with the massive impact that science-related technology had had on the western world during his lifetime (1812-1870), what seems to have concerned him most were the dire human consequences that science and technology had (Dickens himself had been a fortunate survivor of the horrendous railway accident at Staplehurst, Kent, in June, 1865) especially for the poor and vulnerable. In particular, he detested those scientifically-inspired political economists, social theorists, and economic 'bean-counters', who advocated that a 'Utilitarian' approach to society should be enshrined in government legislation as a way of dealing with the poor, in accordance with the seemingly 'Newtonian' laws of supply and demand. The Poor Law Amendment Act (1834), and the hated new system of Workhouse management that it ushered in, was one of Dickens's most famous targets, attacked with especial savagery in *Oliver Twist* (1837-38).

Charles Dickens was a quintessential English pragmatist, who distrusted theory of all kinds, associating it with narrow-mindedness, ideology and oppression. What fascinated him, as his novels so abundantly testify, was the infinite diversity of human peculiarity. For in his mind, a scientific approach standardised and killed the very eccentricity that lay at the heart of all human vitality. Indeed, how different he was from the French writer he in part inspired: Emile Zola (1840-1902). For Zola's 'realist' novels, with all their wonderful Parisian local colour and often bizarre characters, are rooted in a scientifically-inspired belief in human degeneracy, as Zola drew heavily on the ideas of contemporary medical and scientific men.) So why did Charles Dickens either write or edit three articles about the Royal Observatory (Figure 1) and the Royal Navy Compass Observatory in the May, June, and July numbers of his widely-read magazine *Household Words* in 1850?

Figure 1

Royal Observatory, Greenwich, *circa* 1883

The photograph show the Time Ball and an array of meteorological instruments on the roof of Flamsteed House.
Courtesy of the Royal Astronomical Society.
(R.A.S. Manuscript Dreyer 7, page 18)

These articles, of around 3,500 words apiece, were entitled 'The Planet-Watchers of Greenwich' (May), 'Greenwich Weather Wisdom' (June), and 'Swinging the Ship. A Visit to the Compass Observatory' (July). Their composition seems to have been stimulated by an article on the Royal Observatory which had been published in the April number of *The Edinburgh Review*, though an article on the Royal Observatory's Magnetic and Meteorological department had been published in the *Illustrated London News* on 16 March 1844.[2] Yet this magisterial, albeit unsigned, *Edinburgh* article of 57

pages, which spared the reader no technical details, appeared in one of the leading and most intellectually authoritative review journals of the age. And while the *Household Words* articles cover a good bit of the same ground, they do so in a much briefer and more light-hearted style, for this magazine, unlike the formidable *Edinburgh*, was aimed, by its homely title and Charles Dickens's editorial Preface made abundantly clear, not at an intellectual salon readership, but at ordinary people gathered around the family fireside. Its clearly-marked twopence (5 pence) selling price also placed it firmly in the popular mass market.

Annoying, from our point of view, is the convention of anonymity found in Victorian magazines and newspapers, where authors did not to sign articles; so all that we know of the authorship of the *Household Words* Royal Observatory pieces is that they were written by 'one of "our own contributors"'. Precisely who this contributor may have been is not made clear. It could, of course, have been Charles Dickens himself, or perhaps one of his editorial assistants on *Household Words*. But very clearly, the author was a professional writer, for as the article says, the Observatory's doors were readily opened to 'the press and its *attachés*' in the noble cause of informing the public.[3] Nor is there any clear reference to the identity of the person who showed Dickens or his deputy around, though there are several allusions to 'Mr Airy', the Astronomer Royal, and to 'Mr Glaisher', who superintended the Magnetic and Meteorological Departments of the Observatory under Airy's overall command.

At the time when the *Household Words* articles were published, George Biddell Airy (Figure 2) had been Astronomer Royal for 15 years, and over that time had transformed the Observatory. When he took up office in 1835, the Royal Observatory had been in the doldrums. Its staff had been inefficient and ill-disciplined, many of its instruments were either out of date or out of adjustment, and the deteriorating health of John Pond, Airy's precedessor as Astronomer Royal, had made the institution leaderless in practical terms. Since entering office, however, Airy had overhauled every aspect of the Observatory's operations, from transforming staff efficiency to the designing and building of a new set of major instruments. The Magnetic and Meteorological Departments, with which the *Household Words* author was so clearly fascinated, were Airy's original creations; while on 4 January 1851 the new Transit Circle which would define the Greenwich Meridian down to our own time, and global time zones after 1884, was about to come into operation.[4] And like Dickens himself, Airy was the son of a middle-ranking civil servant. Dickens's father, John, was an established clerk in the Admiralty Pay Office and at Somerset House[5] who, in spite of a good and guaranteed salary (he retired in 1825, after 20 years' service, on a pension of £145 p.a.), was always in debt, for which he had been imprisoned in the Marshalsea; while the Astronomer Royal's father, William Airy, had been an officer in the Excise Service. And as Dickens's unstable family finances obliged him to win early fame as a journalist and writer – after an interlude working in a shoe-blacking factory – Airy's focused determination and mathematical brilliance saw his meteoric ascent via scholarships at Colchester Grammar School and Trinity College, Cambridge.[6] James Glaisher, though coming from a humbler family background, first rose within the Ordnance Survey of Ireland and obtained an Assistantship at the Cambridge University Observatory before commencing a career at Greenwich which would win him an F.R.S. by the age of 40 in 1849 and an international reputation as one of the founding fathers of scientific meteorology. Glaisher was also the driving force behind the founding of the Royal Meteorological Society.[7]

Figure 2

Sir George Biddell Airy, F.R.S. (1801-1893), Astronomer Royal 1835-1881

No other Astronomer Royal had anything like the impact upon the Royal Observatory as Airy did.

Courtesy of the Royal Astronomical Society. (R.A.S. Additional Manuscripts 90/98)

Two things about the Royal Observatory that impressed Dickens at the outset were its utilitarian character and its unpretentiousness. Unlike the great observatories of continental Europe, such as Paris, and Russia's Pulkova near St Petersburg, Green-

wich had no opulent architecture or vast imperial funds.[8] Its buildings, clustered around Wren's domestic-looking Flamsteed House, were modest and wholly functional. Their purpose was not state aggrandisement, but usefulness to the nation. With its superb published tables and almanacs, along with other services rendered to both the Royal and Merchant Navies, the Observatory was strictly for the benefit of the public at large, to make the world a safer and better place. For Dickens was a committed believer in progress, trade, and prosperity, and was the great champion of those burgeoning middle-class values of hard work, unpretentiousness, peace, and social justice. He – like Airy – also believed strongly in constitutional government, where the state did no more than was absolutely necessary to ensure the smooth running of the realm, and the modest, practical, non-imperial character of the Royal Observatory was exactly what he believed a department of state should be.

Charles Dickens's belief in the British virtues of hard work and practicality, as opposed to a centralised state's imperial pomp and wastefulness, and France's preference for theory, also shone through his remark that France had failed to produce practical navigational tables as good as those of Great Britain, because:

> 'The French are bad observers. They have no such proofs of unremitting patient toil in search of facts, as those afforded in the records of the Greenwich Tables of the Moon.'

A little extreme, one might say, considering the brilliance of French mathematical analysis and achievements in celestial mechanics, but Dickens had a point. The French in the nineteenth century produced no solid meridian astronomy of a quality that matched the British, German, and Russian (really expatriate German) work.[9]

Dickens says that most Londoners thought of the Royal Observatory as a 'sealed book', within which complex and arcane procedures were practised.[10] It was his intention to inform them otherwise. For though Dickens was clearly fascinated by the Observatory and its 'planet-watching', it was also his aim to correct several local myths of the time. One of these myths, for instance, concerned the tall mast that stood in the grounds of the Magnetic and Meteorological part of the Observatory. A lamp always burned at the top of this 80-foot mast, and folk mythology held that its light, high up on Greenwich Hill, was lit to guide ships up the river! Yet as Dickens said, the masthead lamp served no other purpose than 'to keep warm and dry a body of glass that cuts off all communication between the conductor and the machinery which supports it'.[11] In scientific parlance, the lamp kept dry a glass electrical insulator, which ensured that all the aerial electricity collected found its way into the self-recording electroscope and Leiden jars within the building, and did not leak away. Nowadays, however, one might marvel at the obvious lack of light pollution prevailing in Greenwich in 1850, for who today, coming up the Thames at night, could hope to see the light of a small oil lamp burning in the Observatory grounds?

Dickens was also struck by the contrast between the simplicity of the Observatory buildings and the exquisite perfection and delicacy of the instruments contained within them, displaying as they did 'the perfection of mechanical skill in their construction and finish'.[12] Wisely, considering his general readership, Dickens tells us nothing about the details of the astronomical instruments, beyond relating that: 'They are fixed on solid piers of masonry, deeply embedded in the earth, to secure freedom from vibration'.[12] They were used to watch the stars, while the 'clock stars' in particular were observed to tell the time (Figure 3).[13] These were the bright stars, often circumpolar, such as Capella, the meridian transits of which were used to establish exact sidereal time.

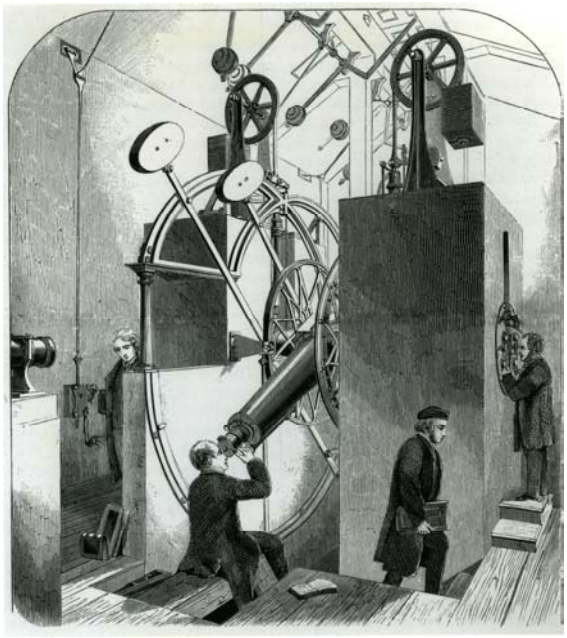


Figure 3

The Transit Circle, designed by Airy and built by Troughton and Simms, and Ransome and May

The first recorded observation using this instrument was on 4 January 1851. Its meridian still defines the Prime meridian of the Earth, and Greenwich Mean Time. The last recorded observation was made by Gilbert Satterthwaite on 30 March 1954.

Image from Dunkin, E. *The Midnight Sky*. London: The Religious Tract Society, 1891. Page 156. Courtesy of the Royal Astronomical Society.

Of the astronomical parts of the Observatory, it was the Time Department which Dickens treated most thoroughly. In particular, the Time Ball (first installed by Airy's predecessor John

Figure 4

Royal Observatory, Greenwich, 1883, looking west

Notice the Time Ball and the gate clock by Charles Shepherd. Its movement of 1852 was an electromagnet, which was activated by 'galvanic' pulses from a master clock within the Observatory.

Courtesy of the Royal Astronomical Society.
(R.A.S. Manuscript Dreyer 7, page 7. 'R.O.G. 'E' view, 1883')

Pond in 1833) captured his imagination. He describes the rituals for making the Ball ascend its pole, and the Assistant's 'practised hand upon a trigger, and a practised eye upon the face of the [clock] dial', and his release of the mechanism, at one o'clock to the tenth of a second, to make the Ball begin its five-second-long descent.[14] The Ball's descent gave a time-signal to all the shipping anchored along the Thames, and ensured that Merchant Navy captains could regulate their chronometers before sailing, and thereby add to the navigational safety of their voyages.

It is worth noting, however, that had Dickens produced his article a mere three years later, he would have found even more technical wonders in the Time Department to report. For by 1853, the Greenwich Time Ball had been fitted with sophisticated electrical contacts, so as to send a 'galvanic current' through freshly-laid cables in the Park to Deal, Kent, where it not only made another Time Ball fall in perfect synchronicity, but when the Deal Ball reached the bottom of its pole, it relayed an electrical current back to Greenwich to confirm the signal.[15] Figure 4 shows the continued use of galvanic impulses more than 30 years after installation. Surprisingly, Dickens says nothing about 'galvanic chronometry' in his articles, for though it was in its infancy at Greenwich in 1850, it was certainly being tried out in the Observatory, as Airy was experimenting with the 'American method' of recording star transits electrically, and it is hard to imagine that 'our own contributor' did not see the wires, batteries, and electromagnets.[16] Perhaps he may not have understood them, and even if he had, still felt them to be too complicated for a popular article. (By the mid-1850s, moreover, not only would Airy's 'galvanic chronometry' be sending a Greenwich Mean Time signal through the railway telegraph system, which was burgeoning across the country, but the 1851 submarine telegraph beneath the English Channel would be exchanging star transit signals with several European observatories to establish their exact global longitudes.[17])

Another aspect of the Royal Observatory's time-keeping and distributing function that deeply interested 'our own contributor', were those rooms devoted to the testing and warranting of marine chronometers. For this was the place, where 'during the first three Mondays in the year, the chief watchmakers of London send in their choicest instruments for examination and trial'. These trials included variable temperature environments, where the timepieces would be subjected to the most severe winter weather, with the natural January cold being forced yet further down by 'freezing mixtures'. After some weeks spent thus, the trial chronometers were next sent to a room rendered so hot by means of gas burners as to simulate an 'artificial East India or Gold Coast' climate.[18] During the many months of trial, the watches, arranged 'like so many watch-pies in a baker's dish', were carefully monitored for their daily rates of time-keeping, and

at the end certificates and financial rewards were tendered to their makers, with the best watches bought for the Queen's Ships by the Royal Navy.

What Dickens did, as a good journalist, was to convey the wonder of what went on in the Astronomical Department of the Royal Observatory, while at the same time avoiding anything remotely technical. But in addition to his pursuing his themes of usefulness and economy, he tried to encapsulate what scientific precision meant for the average magazine reader. And perhaps he did this most appropriately when he told the readers of *Household Words* that some instruments were so delicate that even the warmth of the human body could disturb their adjustment.[19] While he specified no particular instruments in this respect, it is likely that he was referring either to the old Transit Instrument (Pond's 1816 Transit Instrument by Edward Troughton, which would be superseded by a new Circle in January 1851, Figure 3), or to the Lunar Altazimuth of 1847 (Figure 5), the delicate stone and gunmetal piers of which could absorb sufficient heat from an adjacent person's body as to momentarily distort collimation, and induce an arc-second inaccuracy into the resulting observation.[20]

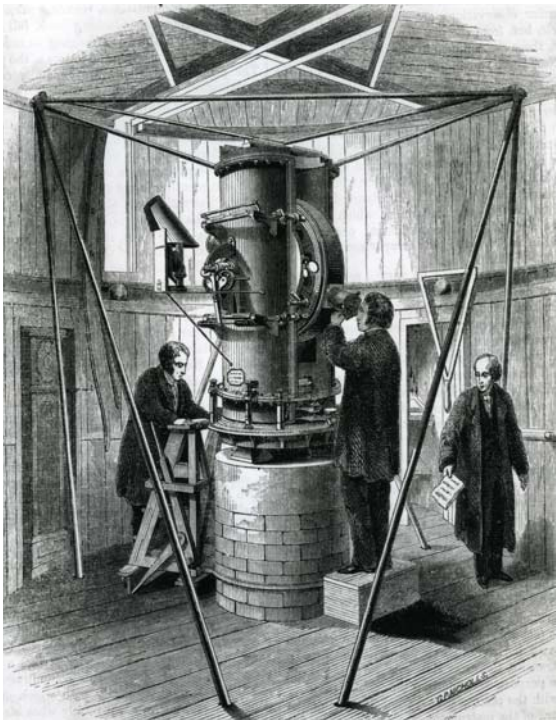


Figure 5

The Altazimuth Instrument, designed by Airy

The main fabric of this instrument was built by Ransome and May of Ipswich. The optics and divided circles were provided by Troughton and Simms. It incorporated the vertical motion of a Transit Instrument to measure altitude, with a capacity to measure azimuth angles. Its purpose was to secure positions of the Moon in any part of the sky, not just on the meridian.

Image from Dunkin, E. *The Midnight Sky*. London: The Religious Tract Society, 1891. Page 167. Courtesy of the Royal Astronomical Society.

Of particular fascination to Dickens, however, were the new self-recording instruments at the Royal Observatory. Indeed, Airy and Glaisher (Figure 6) had been pioneers in the practical development of self-registering instruments in the wake of Airy's almost obsessive concern with the purity of primary scientific data, and his attempts to protect them from human error. It is true that Dickens, in a popular article, does not describe the meticulous routines whereby each individual astronomical observer's 'personal equation', or split-second nervous response time, was quantified for correction purposes, though the space he devotes to self-registering instruments certainly reflects the Observatory's concern with relentless accuracy.[21] But as the self-registering electrical Transit apparatus mentioned above, with its circuit tappers and impersonal, chronograph drum recorders, was not yet in regular use by May 1850, Dickens devoted himself primarily to those pieces that he saw in the Magnetic and Meteorological Departments.

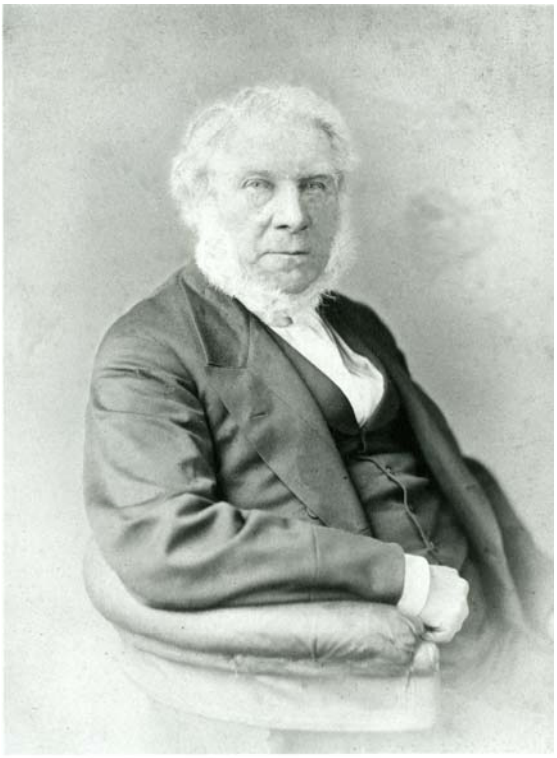


Figure 6

James Glaisher, F.R.S. (1809-1903)

Glaisher's formidable personality is evident from this photograph, and one can understand that his relationship with the equally-formidable Airy was not without tension. Both men, however, had great respect for each other's talents.

Courtesy of the Royal Astronomical Society. (R.A.S. Additional Manuscripts 94. No.36)

These last two Departments, which ran in conjunction with the Astronomical Department, and were accommodated within the precincts of the Observatory on top of Greenwich Hill (Figure 7),

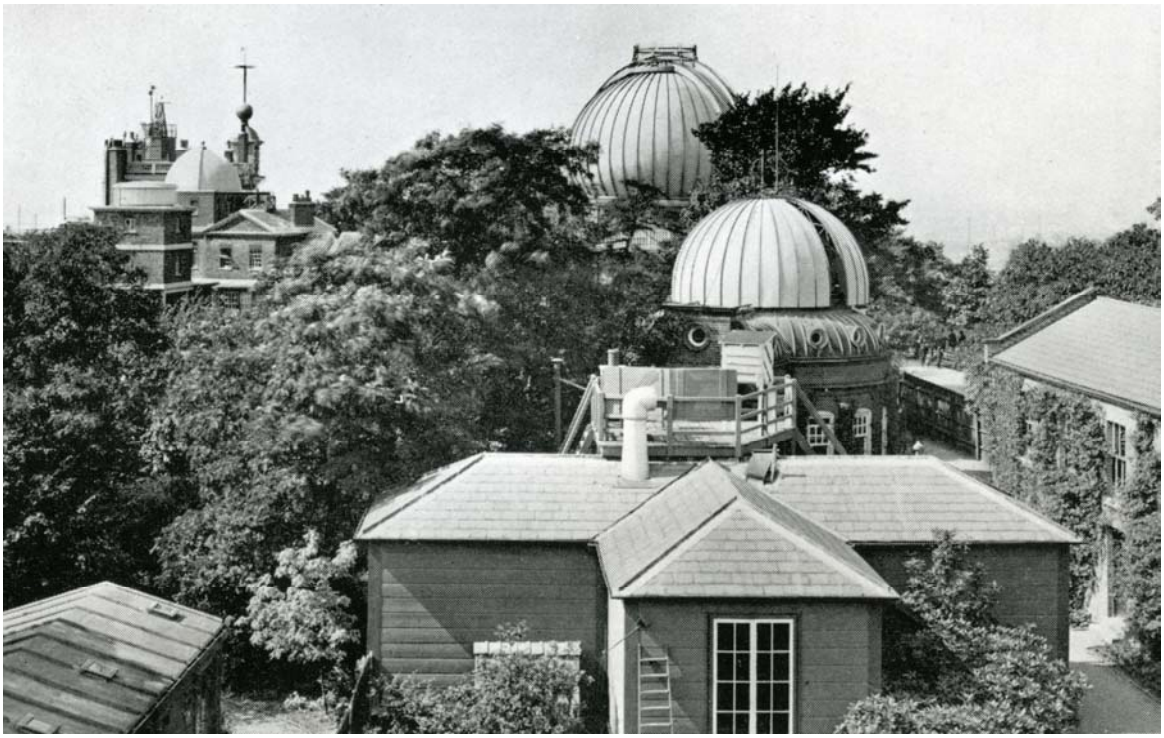


Figure 7

The Royal Observatory, Greenwich, *circa* 1880

Notice the Time Ball and the meteorological instruments on the roof of the distant Flamsteed House.
In the immediate foreground is the wooden, cruciform Magnetic Building.
Image from Forbes, G. *The Wonder and Glory of the Stars.* London: Ernest Benn Ltd., 1926. Plate 5.
by courtesy of the Royal Astronomical Society.

were really Airy's own creation. For while Astronomers Royal back to Flamsteed had kept meteorological journals, and Fahrenheit's scale of temperatures had come into widespread use by about 1770, meteorology at Greenwich before 1838 had been peripheral. It is true that since 1750 James Bradley and his successors had recorded temperature and barometric pressure readings each day, after it had been realised that variations in pressure and temperature, and later in humidity, affected the refractive index of the atmosphere, and had to be applied as a correction factor to the declination angles read with the great quadrants, but that had really been all. By the 1830s, however, several scientists in Great Britain and Europe were coming to the conclusion that if climate could be accurately observed from many stations across the Earth's surface, then the collected data, after mathematical analysis, might reveal climatic laws that would make the weather predictable. Likewise, carefully-monitored fluctuations of the Earth's magnetic field from many separate stations may unlock the secrets of the magnetic variation. In each case, pure science stood to gain, while at the same time enormous practical benefits might follow. A better knowledge of geomagnetism offered obvious benefits to navigation, making it safer and more reliable. And a more exact knowledge of meteorology was seen as promising enormous advantages to medicine. For before Louis Pasteur's discovery of the disease-inducing power of germs in 1865, most physicians believed that contagious diseases were caused by 'miasmas', atmospheric thickening and thinning or poisons present in the air. The new disease of Asiatic cholera had ravaged the poorer districts of London and many other cities in Britain and Europe between 1832 and 1848, and medical opinion firmly associated it with bad air. And the same could be said, argued Dickens, for 'a national insatiable disease – consumption'.[22] A large meteorological database drawn from across Britain, Europe, and North America was deemed to be one way of predicting epidemics, by establishing which configurations of pressure, temperature, humidity and wind direction were present when an epidemic broke out.

Indeed, Glaisher presented Dickens with some fascinating statistics in which Greenwich meteorological data were interpreted in the context of the birth and death statistics collated by the Registrar General. For instance, it had been calculated that when the air temperature of London fell from 45 ºF to 32 ºF, 300 more people would die than if the temperature had stayed as it was.[23] Glaisher, who had conducted a minute analysis of some 70 years of weather records, had come to two remarkable conclusions. First, that there were cycles of

warm and cold years and that these cycles seemed to follow a 15-year pattern. And second,

> 'The indications are that the climate of England is becoming warmer, and consequently healthier; a fact to be partly accounted for by the improved drainage, and the removal of an excess of timber from the land.'[24]

No doubt what Glaisher had in mind here were the vast tracts of the Fens, which had been drained over the previous century, with the consequent increase in land surface temperature. It was not for nothing that Glaisher is now seen not only as a pioneer meteorologist, but as a founder of the integrated study of the earth sciences, with his acute perception not only of long and short cycles, but of the role of changing land usage, micro-climates and pollution in creating the bigger picture. Indeed, Glaisher even saw connections between weather patterns and wider national and political events. Cold cycles since 1771, for instance, had synchronised with greater mortality, dearer food and a tendency to political discontent![25] Glaisher was also, perhaps, the first to notice 'temperature inversions', or the relationship between air and river temperatures, in the production of London's notorious fogs, pointing out to Dickens that at night the Thames was often 10 ºF to 17 ºF warmer than the ambient air above it, whereas in the daytime it was 8 ºF to 10 ºF colder.[26]

And all of these conclusions were based on the accumulation and analysis of thousands of individual observed statistics. These statistics were gathered not only at Greenwich, but from a wide range of stations around the British Isles, from 'Glasgow to Guernsey, and Cornwall to Norwich', largely by amateur volunteers who owned the necessary instruments, for 'Many a quiet country gentleman amuses his leisure by noting day by day the variations of his thermometer and barometer,[27] and these readings Glaisher was now collating.

Good as these provincial observations were, however, they were generally made only once or twice a day, whereas the professionally accumulated Royal Observatory observations, made by Glaisher and his two or three assistants, were recorded much more frequently. At first these weather observations had been made manually every hour or so each day, but the sheer tedium and labour cost of this enterprise was to act as a stimulus to ingenuity. And this was how those self-registering instruments – early prototypes of which had been devised by Sir Christopher Wren and Robert Hooke in the 1660s – which so fascinated 'our own correspondent' came to take pride of place in Dickens's account.

Dickens tells us that in one of the Observatory turrets (in Flamsteed House) was the self-recording wind gauge. The wind turned a special weather vane, the motion of which was relayed by shafts and gears to a room below (Figure 8). Then,

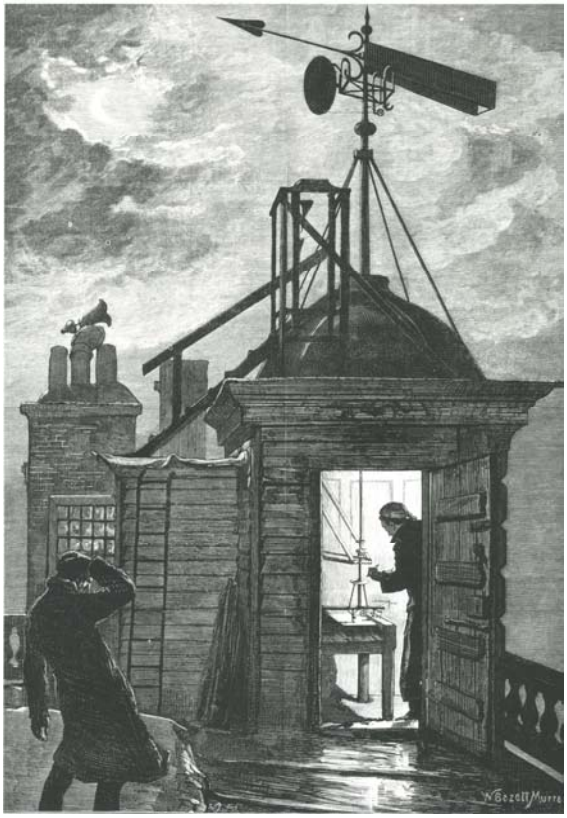


Figure 8

The self-registering anemometer

This instrument wrote its own 'Aeolian Autobiography' in the west Tower of Flamsteed House. (The device on the central chimney pot was probably nothing more than a fire-draught cowl.)

Image from Illustrated London News 31 January 1880 by courtesy of the Royal Astronomical Society.

by means of a spring, 'the wind is made to write down the direction in which itself is blowing' via the mechanism of a pencil trace up a piece of paper moved at a precise speed by a clockwork motor, to produce an 'Aeolian autobiography'.[28] Nearby was a self-registering rain gauge, where drops of water were made to leave a permanent mark on a specially-prepared scale calibrated to decimals of a single inch. Sensitised photographic paper was used to bear the trace of a reflected ray from a controlled light source afloat in the mercury thermometer tube to record changes in temperature.[29] Though not discussed in detail, an automatic device was also used for recording changes in barometric pressure.

Yet the Department of the Royal Observatory, and its self-registering instruments that most captivated the *Household Words* author, was that which monitored slight changes in the Earth's magnetic field. One suspects that this fascination derived from the seemingly mysterious nature of what was being observed, for unlike astronomy or meteorology, there was absolutely nothing for the unaided human senses to behold. Yet those strange

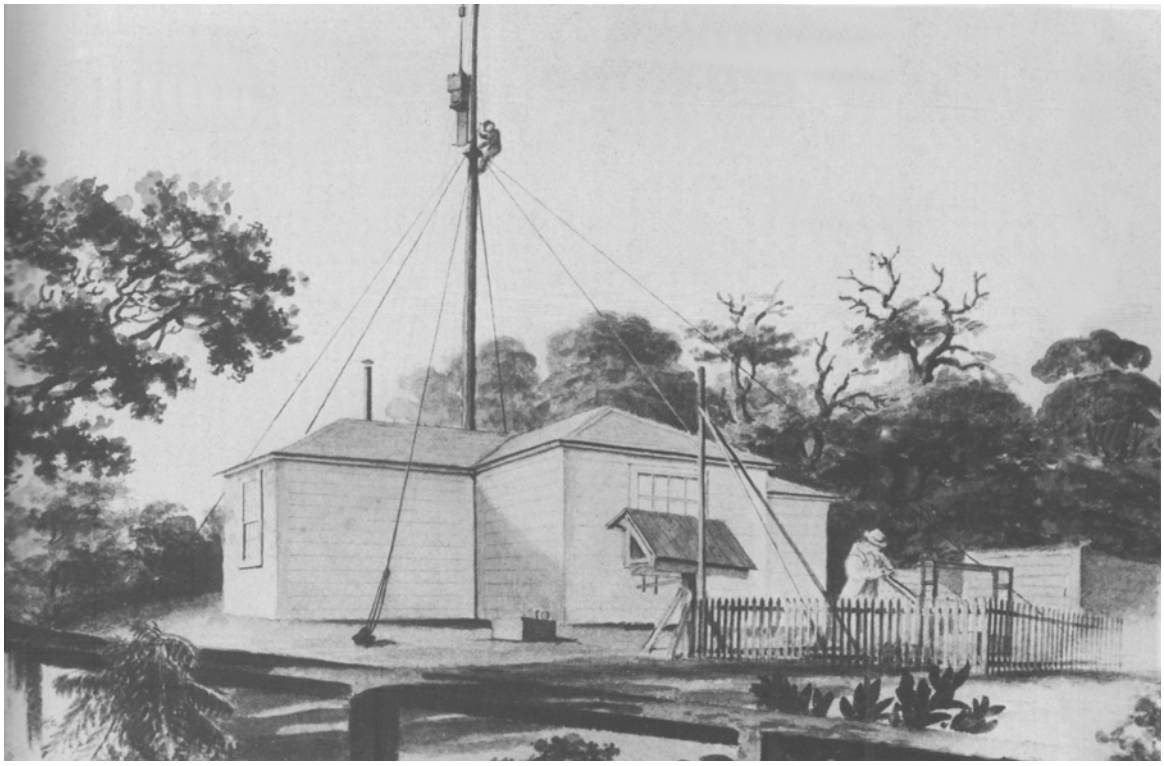


Figure 9

The Magnetic Department, looking north-east, *circa* 1870

Notice the '80-foot' (actually 79-foot) electrometer mast, the lamp on top of which was said by popular legend to guide ships up the river Thames at night.

Image from Howse, H.D. *Greenwich Observatory. Volume 3. The buildings and instruments.* London: Taylor and Francis,1975.

magnetic forces, which could make delicate Observatory needles quiver, which guided great ships across the oceans and which seemed somehow to emanate from the depths of our planet as it spins through space, constituted an elegant link between astronomy, physical science and making the world a safer and more prosperous place.

Though the Earth's magnetic field had been subjected to increasing scrutiny since William Gilbert's *De Magnete* (1600), it was only since about 1820 that its study had become the subject of global scientific concern. It is true that Pond had set up a short-lived magnetic observatory at Greenwich between 1817 and 1824,[30] but it had been the great German mathematician and physicist, Johann Karl Friedrich Gauss (1777-1855), who had called for a detailed monitoring of the Earth's magnetic field, and Airy had been quick to recognise the importance of the call. As Astronomer Royal, Airy came to see his duty at Greenwich as not simply to monitor the heavens, but also to monitor any other forces of nature that might prove themselves to be subject to quantifiable physical laws, and which might in turn be useful to the practical business of making the world a safer place. Meteorology was one such force and geomagnetism another – leading to the establishment of the Magnetic and Meteorological Departments of the Royal Observatory between 1838 and 1840.[31] In consequence, the Earth's magnetic field was to be constantly monitored along with the ambient aerial static electricity: hence the 80-foot-high mast in the magnetic ground and the myth about its light.

What first fascinated Dickens about the Magnetic Department was the plain, single-storied, unpainted, cross-shaped, wooden building in which it was housed, with not so much as a single iron nail in its entire construction (Figure 9). Copper and zinc seem to have been the only permitted metals, and these had even been used to make the door locks, for the tiniest piece of iron had been found capable of distorting the instruments. In three arms of this wooden building – so plain to look at that one might mistake it for a 'collection of emigrant's cottages' (sic)[32] – hung three delicate magnets suspended on untwisted silk threads, while inside the fourth arm were the electrical instruments connected to the 80-foot mast outside. Each magnet was suspended in a zinc casing, which had the job of protecting it from all sunlight and extraneous interference. The magnets could be read only by the controlled light of a specially prepared lantern with a yellow glass.[33]

Yet, to observe the behaviour of these instruments manually, at every even hour of the day, around the clock, as the wider magnetic research

programme demanded, turned out to be both a cumbersome and a time-consuming exercise, not to mention expensive in terms of staff time and wages. And this is what led to the devising of a technique of continuous self-registration that was not only extremely ingenious, but which provided perhaps the first example of the use of photography for routine scientific recording purposes. This was, said 'our own contributor' (as the *Edinburgh Review* writer had said before him), due to the ingenuity of Mr Charles Brooks, a medical man with a flair for invention.[34] For in the mid-1840s, Mr Brooks had devised an apparatus whereby a controlled ray of light from a lantern could be reflected from a polished spot on each of the three suspended magnets, inside their dark cases, and the resulting beam made to fall upon a piece of photographically sensitised paper, to leave a trace. Whenever the magnet moved, no matter how slightly, the weightless pointer of light would accentuate that motion, and move the reflected beam to a new place on the sensitised paper. If, therefore, one had a way whereby the movement of the light ray could be recorded in time (presumably by placing the sensitised paper inside a clockwork-driven slide), then one could monitor changes in the Earth's magnetic field for every single minute of every single day.

Though Brooks probably did not invent the principle of using the 'weightless pointer' of a reflected light ray to measure and magnify an angular displacement – I think Henry Cavendish had been the first to hit upon that idea in his torsion balance experiments to measure 'Big G' (the universal gravitational constant) in 1798 – he nonetheless was the first to adapt the principle to the photographic recording of physical data. And in the mid-1840s, photography itself was a brand new science, having only been brought into practical use for taking pictures by Louis Daguerre, William Henry Fox Talbot, and Sir John Herschel only in 1839. Dickens waxed lyrical about the ingenuity and usefulness of Mr Brooks's invention, mentioning that the Government had given Brooks a reward of £500, while nonetheless pointing out that this sum 'seems small when we see every year millions voted for warlike sinecures, and other worse than useless purposes'.[35] All of this apparatus was very new when Dickens produced the *Household Words* articles, and while he himself gives us no date for these innovations, beyond telling us that Airy's present Magnetic and Meteorological Departments date from 1838, we know from internal Royal Observatory sources that self-registration using Brooks's instrument began only in 1847.[36]

The Magnetic Department at Greenwich was intended to work closely with the Admiralty Compass Observatory at Charlton, which stood 2½ miles away from the Royal Observatory, in Blackheath. At Greenwich, Admiralty compasses were once again meticulously checked – in a wooden building in which there was not so much as an iron nail – before commissioning into Men-o'-War. This is all described in the third *Household Words* article, 'Swinging the Ship', as Dickens shows the sheer usefulness of geomagnetism to safety at sea: the scientific work done ashore, the calibration of shipboard compasses against on-shore standards prior to a ship sailing, and the importance of 'swinging' or rotating a ship of the line through a precisely marked circle in a wide part of the Thames, so that her compasses could be corrected against magnetic and fixed, terrestrial marker points, to compensate for the magnetic deviation, and all the iron contained in her guns and fittings.[37]

For a magazine that set out to entertain and instruct its readers, the three Royal Observatory articles in *Household Words* set a remarkably high standard, adroitly combining easily-conveyed scientific detail with strategic insertions of what we might call 'human interest' stories. Yet even these stories fill in many gaps in what was subsequently to become the 'historical record' when approached from our perspective, 155 years later. Let us take, for example, the staff working conditions in the Royal Observatory. We are told that Airy, the Astronomer Royal, was in receipt of a salary of £800 a year. (He also had a residence provided, which was part of the Flamsteed House section of the Observatory, and a £300 *per annum* Civil List pension for his wife, Richarda, though this information was not included in the article.) He had six full-time official Assistants, enjoying salaries of £470, £290, £240 and £150, with two men on £130.[38] These sums were not bad for the period, and many a city clerk or country curate would have given his eye teeth for an officially-guaranteed salary of £130, rising by increments during his working life, followed by a pensioned retirement. For instance Nicholas Nickleby (a gentleman's son) in Dickens's novel of that name, believed himself to be in clover when in receipt of an annual £120, working for good employers in a City of London office in 1838.[39] James Glaisher, F.R.S. received £240 a year and lived in a handsome rented house in Dartmouth Terrace, Lewisham,[40] on the edge of Blackheath, a 20-minute walk from the Observatory. There was also a staff of 'short term contract' calculators or 'Computers' who did much of the routine computation, employed for between 6d and 10d an hour, whose lives and working conditions were described in detail in the manuscript *Auto-Biographical Notes* of Edwin Dunkin, F.R.S., F.R.A.S. (Figure 10), who later rose to become Chief Assistant in 1881.[41]

The silence of the interior rooms of the Observatory mentioned in the article was kept so as to enable these 'scientific clerks' to do their computations undisturbed, though the six Assistants only put in a desk-work day of 9.00 a.m. to 2.00 p.m.[42]

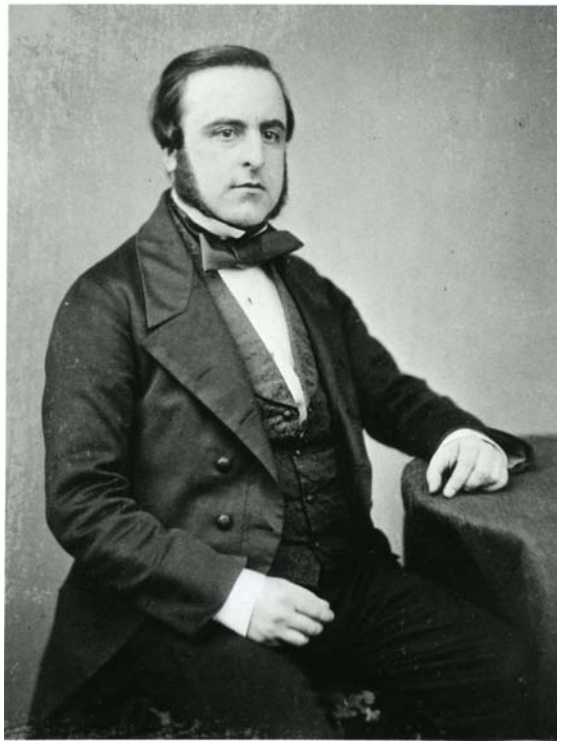


Figure 10

Edwin Dunkin, F.R.S. (1821-1898)

Dunkin is shown here in early middle age. It is not clear whether the *Household Words* writer met Dunkin in 1850, but it is very likely, as he was one of the Senior Assistants in the Astronomical Department of the Royal Observatory, Greenwich, and would later become a prominent, popular astronomy writer.

Image by courtesy of the Royal Astronomical Society.

(R.A.S. Additional Manuscript 55, facing page 184)

They were, however, required to take their turn as observers at the Transit Instrument, the Lunar Altazimuth, and other telescopes and measuring instruments on what must have been gruelling 24-hour, continuous observing shifts. Even so, 'On cloudy days, the observer is idle', as he often was in winter, when he could rest, though he was more likely to be busy in summer, when the Greenwich skies were clear. And as one can take meridian star transits in broad daylight, an Assistant might find himself doing 17 hours of daylight and 7 hours of dark observing on a 24-hour shift on a clear June day. An interesting sky-clarity statistic, which Dickens recounts, and which had no doubt been told him by a Greenwich astronomer, is that 'in our climate the nights, on the whole, are clearer than the days, and evenings less cloudy than mornings'.[43]

The reader of the articles is also given some fascinating titbits about spiders and astronomy, and here one sees that Dickensian passion for idiosyncrasy. While spiders sometimes spun their webs inside telescopic tubes and thereby caused a nuisance, astronomers nonetheless 'rob spiders for the completion of their choicest instruments', by using spider's web strands for the eyepiece and micrometer reticules.[44] For 'No fabric of human construction is fine enough to strain across the eye-piece of an important telescope, and opticians preserve a particular race of spiders, that their webs may be taken for that purpose'.[45] On the other hand, spiders were the bane of the Magnetic and Meteorological Departments. Their fine webs, or even their tiny body weight, could be enough to upset the perfect balance of one of the suspended magnets, while the surviving webs of long-dead spiders were sometimes found short-circuiting the electrical instruments: deceased spiders that had 'paid the penalty of such daring with his life', and been electrocuted! [46] Another ironic touch, of the kind that appealed to Charles Dickens's imagination, was the story, related by Glaisher, about his experiments to quantify water evaporation from a given surface area. For three years, inexplicable, erratic figures for the evaporation of water from a 6-inch-diameter dish kept coming from the experiment. And then, Glaisher noticed 'an irreverent bird! – a sparrow was scattering from his wings the water left to be drunk by the winds of Heaven'.[47]

And also on the theme of 'human interest', we are told of the entrenched myth that the Royal Observatory is:

> 'the head-quarters, not only of Astronomy, but of Astrology ... [and is] a manufactory of horoscopes, and a repository for magic mirrors and divining rods'.[48]

People occasionally turned up at the Observatory gates seeking occult advice on how to recover lost property, while 5-shilling postal orders sometimes came with a request to the Astronomer Royal for a personal horoscope. Yet this was not peculiar to 1850. John Flamsteed, the first Astronomer Royal, who was appointed in 1675, was also pestered by horoscope-seekers; while Airy, in an interview given for the 'Celebrities at Home' column appearing in an unspecified magazine in the late 1870s, of which an isolated cutting is preserved in the R.A.S. Library, mentioned the continuing flow of postal orders and requests for fortunes to be told, one of which was addressed to 'Mr Hairy Extrollinger Grinage Park'.[49] Indeed, some such letters sent to Airy are now preserved in Cambridge University Library, in the Airy RGO6 archive.[50] As a point of historical curiosity, it would be interesting to know when the Astronomer Royal ceased to receive such astrological requests. My own suspicion is that it still goes on!

As noted at the beginning of this article, we have no clear indication of the identity of the author of the *Household Words* articles of 1850. Airy never mentions them – nor the pieces in *The Edinburgh Review* that inspired them – in his *Autobiography* for the year 1850, and my notes from the manuscript 'Astronomer Royal's Journal' for April 1850 do not refer to such a visit.[51] I must admit,

however, that when I went through this 'Journal' some years ago I was not looking for Dickens or *Household Words* in particular, and I could have missed it. A more thorough search in the relevant section of the RG06 (Airy) archives than I have yet had time to do may provide a name and a visit date.

Yet even if 'our own contributor' was not Charles Dickens himself, it is clear that, as editor and conspicuously-denoted 'Conductor' of *Household Words*, he would have laid down the ground rules for house style and content. These would certainly have included the rule of not being technical (unlike *The Edinburgh Review*) and concentrating instead upon usefulness, curiosity, wonder, progress, and 'human interest', all of which features shine through the three articles. The very style of the English, moreover, has a direct, lively tone, of the kind found in Dickens's novels and signed works. For when the articles appeared in 1850, the 38-year-old Charles Dickens was a front-rank Victorian celebrity with an international reputation not just as a novelist and journalist, but also as a social reformer, actor and pundit. Were he alive today, he would be hosting a prime-time T.V. chat-show, writing blockbuster film scripts and having bodyguards to protect him from bands of hysterical fans such as those who, on his first visit to America in 1842, besieged hotels where he was staying and mobbed him wherever he went.[52]

One cannot help wondering how far the *Household Words* articles gave the Royal Observatory a new profile within the wider public consciousness, carrying its twopenny-per-number message into thousands of British homes. This in itself could be a topic for future historical research.

Acknowledgements

I wish to thank the irrepressibly learned Peter D. Hingley, Librarian of the Royal Astronomical Society, for his amplifying comments on my original article, and his kind location of illustrations from the R.A.S. archives. I also wish to thank Kevin Johnson and Reg Withey for their generous assistance in the editorial and physical production of this article.

Notes and References

Throughout these Notes, I use the following abbreviations to identify the three articles in *Household Words (H.W.)*:

P.W. The Planet-Watchers of Greenwich. *H.W.* May 1850. 200-204.

W.W. Greenwich Weather Wisdom. *H.W.* June 1850. 222-225.

S.S. Swinging the Ship. A Visit to the Compass Observatory. *H.W.* July 1850. 414-418.

Copies of the original issues of *Household Words* containing these articles have been acquired by Library of the Royal Astronomical Society. Members of the Society for the History of Science wishing to consult them are welcome to do so by appointment.

1 Pickwick was 'the man who had traced to their source the mighty ponds of Hampstead', (a skit on contemporary efforts to find the source of the Nile), and who had 'agitated the scientific world with his Theory of Tittlebats'. Dickens, Charles. *Pickwick Papers* (1837). Chapter 1, The Pickwickians. Also, Dickens, Charles *Sketches by Boz* (1836-37). See 'Miscellanies', 'Full Report of the First Meeting of the Mudfog Association for the Advancement of Everything'. The 'Reports' of the different parts of the Association, for Medicine, Statistics and such, followed and parodied those of the real British Association for the Advancement of Science.

2 *The Edinburgh Review*. April 1850. **XCL**, Number CLXXXIV. A group of six anonymous articles on the Royal Observatory, Greenwich, covering pages 299-356.

3 *P.W.* 200.

4 Howse, Derek. *Greenwich Observatory. Volume 3: The Buildings and Instruments*. London: Taylor and Francis, 1975). 43-48. The best and most authoritative study on the Airy Circle is Satterthwaite, Gilbert. Airy's Transit Circle, *Journal of Astronomical History and Heritage*. 2001. **4**(8). 115-141.

5 Ackroyd, Peter. *Dickens*. London: Minerva, 1991. 101.

6 Airy, George Biddell. *Autobiography*. Ed. Airy, Wilfred. Cambridge: Cambridge University Press, 1896. 17-19.

7 E.[llis], W.[illiam]. James Glaisher. Obituary. *Monthly Notices of the Royal Astronomical Society*. **LXIV**. 1904. 280-287. Also, Glaisher, James. *New Dictionary of National Biography*. Oxford: Oxford University Press, 2004.

8 *P.W.* 201-202, 203.

9 *P.W.* 203.

10 *P.W.* 200.

11 *P.W.* 222-223.

12 *P.W.* 201.

13 *P.W.* 201, 202.

14 *P.W.* 201. Howse, D. *Greenwich Observatory. Volume 3.* [Reference 4 above]. 134-135.

15 Airy, G.B. *Autobiography.* [Reference 6 above]. 213, 216, etc. Also, Chapman, A. Standard Time for All: The Electric Telegraph, Airy, and the Greenwich Time Service. *Semaphores to Short Waves*. Ed. James, Frank A. J. L. London: Royal Society of Arts, 1998. 40-59: 48.

16 Airy, G.B. *Autobiography.* [Reference 6 above]. 203. See also, Chapman, A. [Reference 15 above] for a fuller bibliography.

17 Airy, G.B. *Autobiography*. [Reference 6 above]. 214-219. Also, Chapman, A. [Reference 15 above]. 49-55.

18 *P.W.* 203. Airy, G.B. *Autobiography*. [Reference 6 above] explicitly records that the room 'had a chronometer-oven with gas-heat, erected in 1850'. 205.

19 *P.W.* 203.

20 All of these instruments are discussed in Howse, D. *Greenwich Observatory. Volume 3.* [Reference 4 above]. 38-40, 43-48, 53-54.

21 Schaffer, Simon. Astronomers Mark Time: Discipline and the Personal Equation. *Science in Context*. 1998. **2**. 115-145.

22 *W.W.* 222, 225. For Bradley's realisation of the awareness of atmospheric temperature and pressure on refraction, see: Chapman A. *Dividing the Circle: The Development of Critical Angular Measurement in Astronomy 1500-1850.* Chichester: Praxis-Wiley, 1990. 95, 187-188.

23 *W.W.* 222.

24 *W.W.* 224.

25 *W.W.* 224.

26 *W.W.* 225.

27 *W.W.* 224. See also, Wallace, Gordon. Meteorological Observations at the Radcliffe Observatory. In, Burley, Jeffrey and Plenderleith, Kristina. *A Short History of the Radcliffe Observatory Oxford. The Biography of a Building.* Oxford: Green College, 2005. 103-128. Meteorological observations have been made in Oxford since 1767.

28 *P.W.* 201.

29 *W.W.* 224.

30 Howse, D. *Greenwich Observatory. Volume 3.* [Reference 4 above]. 123-124, 158-159.

31 Howse, D. *Greenwich Observatory. Volume 3.* [Reference 4 above]. 123-124.

32 *W.W.* 222.
33 *W.W.* 222-223.
34 *The Edinburgh Review*. April 1850. [see Reference 2 above]. 353. Also, *W.W.* 223-224.
35 *W.W.* 224. Also, Cavendish, Henry. Experiments to Prove the Density of the Earth. *Philosophical Transactions.* 1798. **88**. 469-526.
36 Howse, D. *Greenwich Observatory. Volume 3.* [Reference 4 above]. 123. The extreme sensitivity of the magnetic instruments, their tendency to be disturbed by new (1891), suburban electric railways by 1891 4½ miles away, and even an accidentally magnetised umbrella brought to work by a member of the Observatory staff, are recounted in various sources. See Meadows, A.J. *Greenwich Observatory. Volume 2: Recent History (1836-1975).* London: Taylor and Francis, 1975. 99-101.
37 *S.S.* 414-418. See Fanning, A.E. *Steady As She Goes: A History of the Compass Department of the Admiralty.* London: Her Majesty's Stationery Office, 1986. 14-27, for a technical account of 'swinging a ship'.
38 *P.W.* 202.
39 Dickens, Charles. *Nicholas Nickleby* (1838-39). Chapter XXXV.
40 James Glaisher lived at 13 Dartmouth Terrace from some time before 1850 until 23 September 1861, then moved around the corner to 1 Dartmouth Place. Both elegant houses stand on the edge of the open expanse of Blackheath: RGO6 Manuscript 43/358. Airy's Memorandum, 23 September 1861.
41 Dunkin, Edwin. *Auto-biographical Notes*, Royal Astronomical Society Additional Manuscripts 55. This manuscript has been published in a limited edition of 30 copies under the title *A Far Off Vision: A Cornishman at Greenwich Observatory. Auto-Biographical Notes by Edwin Dunkin F.R.S., P.R.A.S., P.R.I.C. (1812-1898)*. Ed. Hingley, Peter D. and Daniel, Tamsin C. Truro: Royal Institution of Cornwall, 1999. 71. (Pagination in the printed text is the same as that in the manuscript.)
42 *P.W.* 202. *The Edinburgh Review* (Reference 2. 349), describes the monotony of an Observatory Assistant's life, as does Dunkin [Reference 41 above, 71].
43 *P.W.* 202.
44 *P.W.* 200.
45 *P.W.* 200-201. For the historical study of spiders' webs in telescope eyepiece manufacture, see Hingley, Peter D. Arachnophobes Need Not Apply. *Astronomy and Geophysics*. June 2002. **43**(3). 7.
46 *W.W.* 223.
47 *W.W.* 225.
48 *P.W.* 204.
49 Celebrities at Home. No. LX. The Astronomer Royal At Greenwich. Undated cutting from an unspecified magazine. (Post-1874 – as it mentions the recent transit of Venus, 1874 – yet before 1881 when Airy retired.) Cutting in R.A.S. Additional Manuscript 88. 77. Airy's favourite journal, for which he occasionally wrote articles, was *The Athenaeum*. I have examined the Bodleian Library set for 1874 to 1881, without finding it. But the R.A.S. cutting is in a different type-font and page layout from that used in *The Athenaeum*.
50 A few of these items were preserved privately by Airy, and kept amongst his papers. When the Airy family generously donated these private papers to join the official Airy RGO6 archive in the 1990s, they were given under the title *Enid Airy Papers.* As the Airy family had loaned the *Enid Airy Papers* documents to me to work on privately in Oxford before donating them to Cambridge, I do not know their current classification numbers in the RGO6 collection.
51 Airy, G.B. *Autobiography.* [Reference 6 above]. 202-205. For Airy's manuscript *Astronomer Royal's Journal*, see Cambridge University Library Manuscript RGO6 21/1ff.; by date order.
52 Dickens, Charles. *American Notes* (1842). Various modern reprints.

J. Norman Lockyer: The Early Years

Mike Frost
Past Chairman, Coventry and Warwickshire Astronomical Society

Joseph Norman Lockyer was born in 1836 in Rugby, where his father was a surgeon-apothecary and a leading member of the Literary and Scientific Institution. In the 1840s the family moved to Leicester, where his father became a manufacturer of matches. After his mother's death, he lived with an uncle and attended school in Kenilworth. His main interests then were classical and modern languages, which he taught in a Somerset school before going to Switzerland in 1856-57. On his return, the patronage of Lord Leigh of Stoneleigh helped him to become a clerk in the War Office. He developed an interest in astronomy that led to his election as a Fellow of the Royal Society, and to the editorship of the science journal, Nature.

The great Victorian solar astronomer, Joseph Norman Lockyer (1836-1920), was born in Rugby, the town where I live. Lockyer's life contained an extraordinary range of achievements[1]. He pioneered the use of spectroscopy to study the solar spectrum, identifying the spectral lines of an unknown new element, which he named 'helium'. William Ramsay confirmed the terrestrial presence of this element in 1895. Along with the French physicist Jules Janssen, Lockyer produced the first spectrum of solar prominences other than during a solar eclipse. He carried out a series of solar eclipse expeditions around the world, and founded a solar observatory in London on the site now occupied by the Science Museum. Lockyer was a prolific writer and lecturer. He founded the science journal *Nature*, which has risen to become the world's pre-eminent scientific journal. He argued for a greater inclusion of science in education and government, and founded the British Science Guild to press the case. He also made important contributions to meteorology. In his later years he became interested in the astronomical alignments of the ancient monuments in Britain and abroad, principally Egypt: his book *The Dawn of Astronomy* is taken as the seminal work on archaeo-astronomy. The observatory he founded in Sidmouth, Devon, after his move from London, exists to this day and is named for him.

Two biographies of Lockyer have been written. The 'family biography'[2] was published in 1928, eight years after his death. Lockyer's second wife, Thomazine Mary, and his daughter, Winifred Lucas, are listed as the principal authors. The assistance of Professor H. Dingle of the Royal College of Science is acknowledged, but it is likely[3] that he actually wrote the general biographical chapters, which contain few personal details, as well as two of the technical chapters. Professor A.J. Meadows of Leicester University wrote a second biography[4] in 1972.

Both biographies contain scant detail about Lockyer's early life. The family biography does have a brief family history and a number of anecdotes, but is by no means a complete history of his childhood and adolescence. Meadows's biography is more concerned with Lockyer's often stormy interactions with the government and the scientific establishment, and has no more than a perfunctory account of Lockyer's early days.

Following a talk I gave in 1999 to Rugby Historical Association on Lockyer, I resolved to attempt to fill in some of the gaps in the Lockyer biographies, with the assistance of Chris Hicks, a member of Rugby Local History Research Group. In Spring 2003 I presented a summary of the work so far to the Society for the History of Astronomy; this article records what I presented then and what I have discovered subsequently.

The Lockyer Family in Rugby

Joseph Norman Lockyer was born in 3 Sheep Street, Rugby, on 17 May 1836 (Figure 1). A small plaque marked Lockyer's birthplace for many years, but in 2004, Rugby Borough Council replaced it by a new 'blue plaque' (Figure 2) as part of their programme to honour famous Rugbeains (including Frank Whittle; Dennis Gabor, the inventor of holography; Rupert Brooke; and William Webb Ellis, who founded the game of Rugby football).

Lockyer's father, Joseph Hooley Lockyer, was the local surgeon-apothecary[5] at Sheep Street, the family premises. The shop remained a pharmacy (Fleet's chemist) until 1965[6] but is now the premises of the Household Bank. Lockyer's mother, Anne Norman, was born in Cosford, a hamlet 4 km north of Rugby. She was the daughter of the squire of Cosford. In Lockyer's day Cosford was a tiny farming community - it remains so, although it is now sandwiched between a large industrial estate and the M6 motorway.

J.H. Lockyer was a founder member, then Secretary and Treasurer, of Rugby's Literary and Scientific Institution. A fellow member was Thomas Arnold, the famous headmaster of Rugby School (and recipient of another blue plaque). I have spent some time trying to find out more about the Institution, but without much success. The Warwickshire County Archive does contain material on

Figure 1

Sheep Street, Rugby

Lockyer was born at No. 3, which is the first 4-storeyed, red-brick house after the white, 3-storeyed buildings on the left side (west) of the street.

Photograph by the author 2005.

Figure 2

Lockyer's birthplace, with the blue plaque marking the event

Photograph by the author 2005.

the organisation, unfortunately from later in the nineteenth century. The family biography[7] lists lectures by J.H. Lockyer entitled: *An Outline of Chemistry*, *First Principles of Chemistry*, *Oxygen Gas*, *History of Chemistry*, *Electro-Magnetism*, *Magneto-Electricity* and *Electricity*.

One interesting snippet from J.H. Lockyer's days was that he owned one of the first printing presses in Rugby, on which he printed material for the Scientific and Literary Institution. On 11 March 1839, he registered this press[8]. The registration still exists (Figure 3):

> 'To the Clerk of the Peace for the County of Warwick. I, Joseph Hooley Lockyer do hereby declare that I have a Printing Press and Types for Printing which I propose to use for Printing within the Town of Rugby and which I require to be entered for that purpose in pursuance of an Act passed in the thirty ninth year of his majesty King George the Third entitled 'an act for the more effectual suppression for societies established for seditious and treasonable purposes and for better preventing treasonable and seditious practices'. Witness my hand this eleventh day of March in the year of our Lord one thousand eight hundred and thirty nine.'

The witness is Matthew H. Bloxam, a well-known antiquary in Rugby. Amusingly, a directory of printing press registrations[9] mentions Bloxam, but says 'nothing is known about Lockyer'. Other members of the Bloxam family have astronomical connections,[10] which I am hoping to research.

Another, undated, document[11] from about this time, gives an interesting insight into commercial life in a small Warwickshire market town. J.H. Lockyer added his name to a petition to H.J. Gibbs Esq. (Figure 4).

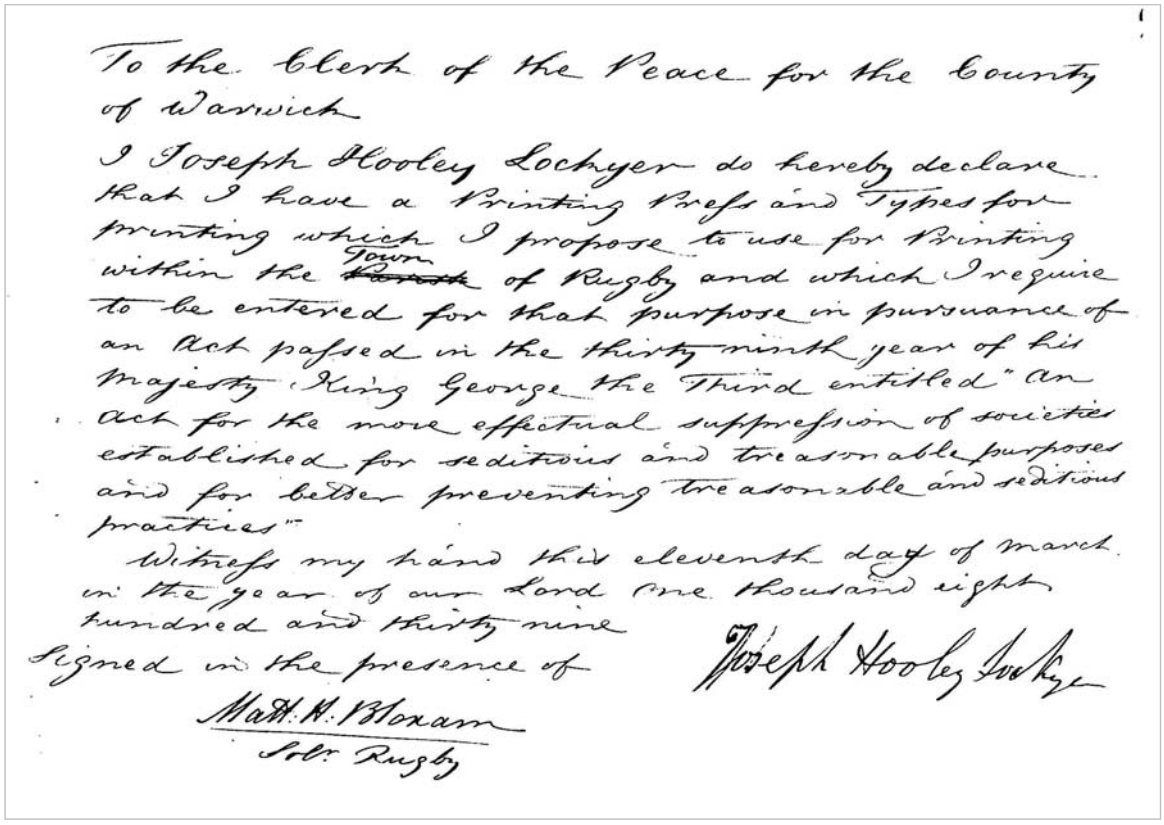
> 'We the Undersigned Inhabitants and Shop Keepers of Rugby do find the Bazaar now standing near the George Inn in the Said Town very injurious in Trade & should be much obliged by you useing [sic] your endevours [sic] to remove them from this town. We are your Most Humble Servants.'

A move to Leicester

At some time in the 1840s, Lockyer's father decided to move closer to his family in the Leicester area. Neither biography sheds much light on the family's life in Leicester, but an examination of *White's Leicestershire Directory* for 1846[12] yields some interesting information. Joseph Hooley Lockyer is listed as owning a 'congreve match and cake blacking manufacturer', with premises in Leicester Market Place. There is also a family home listed in King Street. Congreve matches, developed during the 1830s, were named for William Congreve, who developed rockets in the early 1800s. Congreve rockets were fired relentlessly by British forces in their siege of Fort McHenry, Baltimore during the Anglo-American war of 1812; 'the rockets' red glare' is immortalized in the national anthem of the United States of America.

It is possible that J.H. Lockyer's business in Leicester may shed light on Norman Lockyer's later accomplishments. Can it have been a co-incidence that Norman Lockyer, one of the first people to realise the potential of the spectroscope, had a father who ran a match making business? It is tempting to suppose that the young Lockyer visited his father's manufactory, and saw at first hand the results of burning sulphur, phosphorous, etc, with their distinctive-coloured flames. When, years later, he encountered the spectroscope, he must have instinctively relished the opportunity to look for the same distinctive colours in the spectrum of the Sun.

Norman Lockyer himself remembered one incident from Leicester[13], which records his introduction to astronomy. Lockyer's father owned a small telescope of 2 or 2½-inch aperture.



To the Clerk of the Peace for the County of Warwick

I Joseph Hooley Lockyer do hereby declare that I have a Printing Press and Types for printing which I propose to use for Printing within the ~~Borough~~ Town of Rugby and which I require to be entered for that purpose in pursuance of an Act passed in the thirty ninth year of his Majesty King George the Third entitled "An Act for the more effectual suppression of societies established for seditious and treasonable purposes and for better preventing treasonable and seditious practices"

Witness my hand this eleventh day of march in the year of our Lord one thousand eight hundred and thirty nine

Signed in the presence of

Joseph Hooley Lockyer

Matt. H. Bloxam
Solr Rugby

Figure 3

J.H. Lockyer's printer registration

From the Ernest W. Timmins archive (see Note 8).

> 'One day, about mid-day, he [J.H. Lockyer] was observing Jupiter with the telescope fixed to a tripod, and he showed the planet to Norman. Then, saying 'I must fetch your mother, don't move the telescope on any account' he left the room. It had happened that on the previous day that the telescope had been turned to the church spire to examine something which in the end turned out to be a sparrow, and the boy, now being in sole possession of the instrument, felt that it was a grand opportunity to inspect the spire once more, thinking it would be a very simple business to find Jupiter again afterwards. He moved the telescope. But alas, when Jupiter was sought again he was not to be found. The boy's parents came to the telescope to find nothing visible, nor could the planet be hit upon again that day.'

The skill needed to locate Jupiter, even once, during broad daylight, suggests that his father had more than a passing interest in observational astronomy.

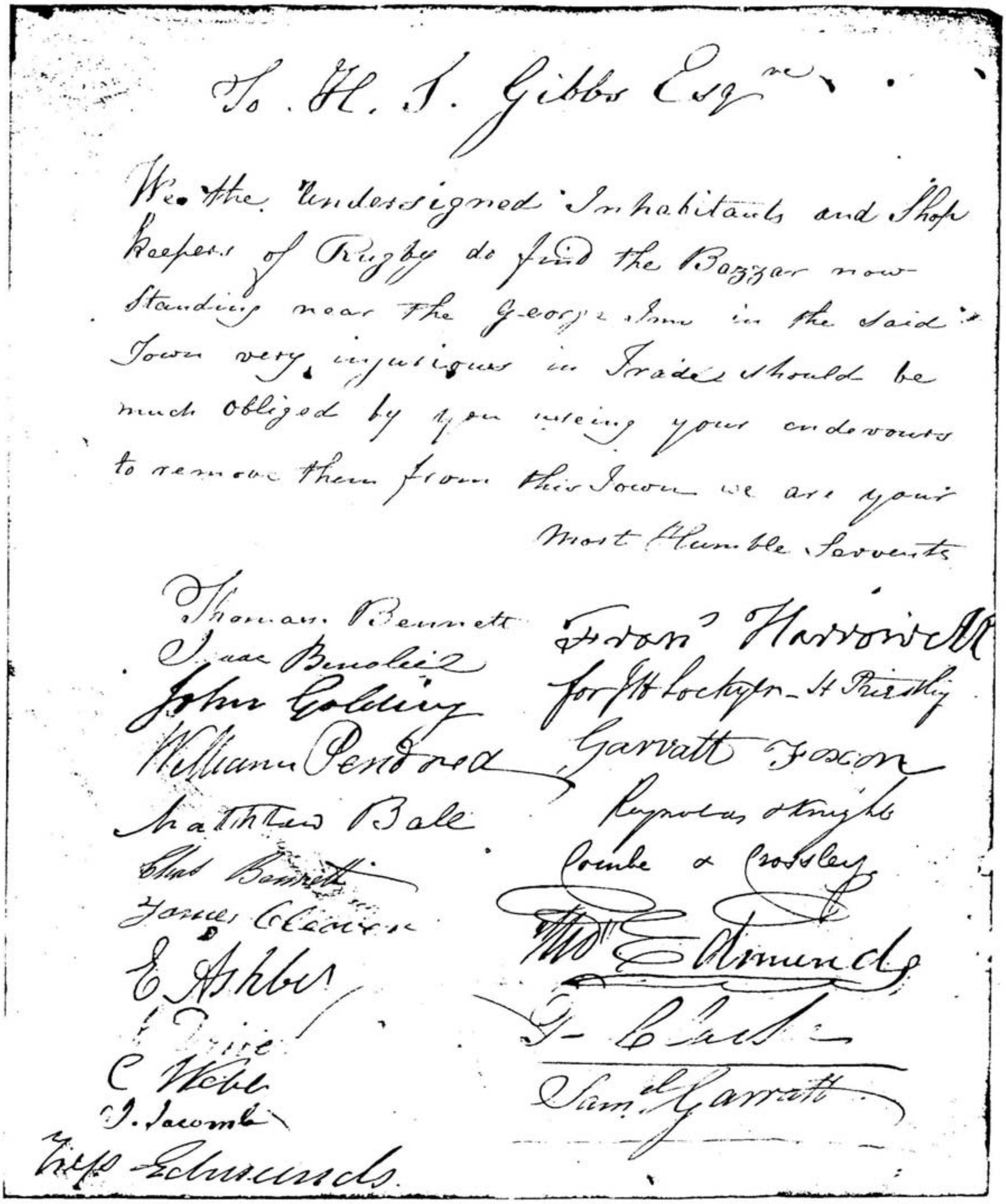
Lockyer's education

Anne Norman Lockyer died in 1845.[14] J.H. Lockyer may well have found it difficult to bring up two children on his own whilst running a business. In addition, both biographies tell us that Norman Lockyer's health was not good. In 1849, Norman and his younger sister, Lucy were sent to live with their maternal uncle, William Norman, a farmer living at Grange House in Ashow, a village on the River Avon north of Leamington and 3 km south-east of Kenilworth.

The Lockyer children went to school in Kenilworth, where Norman Lockyer began to show academic talent. The family biography[15] relates that Lockyer's application to the War Office was supported by R.C. Adams, 'of Kenilworth School'. Meadows's biography reproduces Adams' testimonial[16], dated 31 March 1856, and refers to him as the Master of Kenilworth School. There is, and was, no such establishment as Kenilworth School. However, *White's Warwickshire Directory, 1850*[17] resolves this issue. A number of small educational establishments are listed in the town, among them one run by Richard Charles Adams in Castle End (to the south-east of the town centre). By 1875[18], Mrs R.C. and Miss Adams are listed as running a boys' preparatory school in Castle End. Lucy Ann Lockyer, Norman's sister, was at another educational establishment in Castle End. The 1851 census[19] lists her as a pupil of Elizabeth Cattell.

R.C. Adams's signed testimonial reads:[16]

> 'Mr Lockyer is 20 years of age, and has lately been Tutor at a school in Somersetshire: he had previously resided in my school, as student and


To H. T. Gibbs Esqre.

We the Undersigned Inhabitants and Shop keepers of Rugby do find the Bazzar now standing near the George Inn in the said Town very injurious in Trade should be much obliged by you using your endevours to remove them from this Town we are your

Most Humble Servants

Thomas Bennett
John Golding
William Pendred
Matthew Ball
E Ashby
C Webb
J. Jacomb
Edmunds

Francis Harrowell
for JH Lockyer – H Priestley
Garratt Foxon
Reynolds & Knights
Coombe & Crossley
Saml Garratt

Figure 4

A petition by Rugby shopkeepers, including J.H. Lockyer

From the Ernest W. Timmins archive (see Note 8).

> teacher, six years. His stature is about 5ft 6, and his health uniformly good. He is a sound English scholar, and a Classic: a good Accountant and Mathematician, and has a knowledge of French. In a word, his abilities are of the highest order, and his punctuality and perseverance indefatigable.'

The Somersetshire school referred to was in Weston-super-Mare. A second, later-dated version of the testimonial by Adams is in the University of Exeter archives[20], along with a testimonial from a Thomas Atkinson of Dorchester Place, London[21]. Mr Atkinson's relationship to Lockyer is unknown to me (*White's Directory* for Kenilworth does not list him, for example) but the content suggests Lockyer's studies in either Kenilworth or Weston-super-Mare:

> '7 Dorchester Place, Blandford Square, London, Oct^{r}. 28, 1856.
>
> I have great pleasure in certifying that Mr J. Nor-

> man Lockyer was a pupil of mine, & that he evinced a superior knowledge of the higher Latin Authors, especially Virgil & Horace, which he read with fluency & correctness: & that his acquirements in that language are based on an extensive & accurate knowledge of its grammatical structure and analogies. I certify also that Mr Lockyer's acquaintance with the English Language is extensive, accurate, & varied, of which his compositions furnish ample evidence.
>
> Thomas Atkinson M. A. Camb[e].'

Lockyer was able to put his knowledge of French to good use later in 1856 and 1857, when he travelled in Switzerland and France attending lectures at the Sorbonne[22]. A final testimonial[23] from the 'Chef d'Institution, Chateau du Lang, près Genève', dated 22 April 1857, states that Lockyer spent six months at this institution, 'avec la plus grande exactitude et conscience…'. Lockyer's travels and studies may have been made possible by a bequest from his father, who died in 1855.[24]

Stoneleigh and Lord Leigh's patronage

The testimonial by Adams was addressed to William Henry Leigh, the second Lord Leigh of Stoneleigh, whose estates included Ashow and, 4 km upriver, Stoneleigh, and the family seat of Stoneleigh Abbey, situated between the two villages. This lovely old house, now part private apartments, has been renovated following a fire in 1960 and is open to the public at weekends[25]. Famous visitors to the house include Jane Austen (a distant relative of the Leigh family), Queen Victoria and Prince Albert. Lord Leigh acquired a reputation during his lifetime for taking paternalistic care of the tenants on his estate[26]. In this instance his assistance and influence was required to obtain a Government appointment for Lockyer.

The Stoneleigh estate archive is held by the Shakespeare Birthplace Trust in Stratford-on-Avon. There is a large archive of correspondence to and from Lord Leigh dating from the 1850s, but I did not find any correspondence relating to Lockyer. It is possible that most of the relevant extant material (including that quoted above in the biographies) is held in the Norman Lockyer archives at the University of Exeter[27].

In 1856 or 1857, Lockyer applied to the War Office for a post, writing of himself [28]:

> 'Your memorialist is 20 years of age, and has received a most liberal education, he is a sound English scholar and a classic, a good accountant and mathematician, and has a knowledge of French: he can readily produce testimonials of his good moral conduct. The following gentlemen have most kindly appended their names in testimony of his attainments and qualifications for the above appointment; R.C. Adams, Kenilworth School; Wm Boddington, F.R.C.S., Kenilworth; Charles Twistleton, M.A., Rector of Ashow; Arthur A. Fanshawe, S.C.L., Curate of Ashow'

The family biography[29] suggests that internal evidence dates this letter to 1856, before Lockyer visited Switzerland, although the logic for this is not clear. There is no mention of proficiency in the physical sciences; the presence of Ashow clergy is noted as evidence of Lockyer's devout attendance at the Anglican Church.

If Lockyer first applied to the War Office in 1856, it is not clear why he then chose to travel abroad that year; perhaps his first application was rejected, or perhaps he chose to defer entry and improve his language skills. However, he took up a temporary War Office appointment in May 1857, having passed the necessary examination[30]. A permanent position followed, in February 1858, after he had passed further, competitive examinations.

It was during his early career as a civil servant that, through his social connections, he began to take an interest in spectroscopy and solar astronomy[31]. He maintained connections with the Rugby area; in particular with George M. Seabroke of Rugby, who assisted him in his scientific work in his early years, and then, after qualifying as a solicitor, provided legal support during the establishment of the Hill Observatory, near Sidmouth, Devon. After taking up the War Office post, Lockyer never lived in central England again.

However, I have found one final connection to Lord Leigh and Stoneleigh. The Stoneleigh Estate Archive does hold one letter from Lockyer to Lord Leigh[32], dating from 27 April 1869 (five days after Lockyer's election to Fellowship of the Royal Society), and bearing the address of the War Office in Pall Mall.

> To the Right Honourable Lord Leigh:
>
> My Lord, I have forwarded by this post to Stoneleigh my book on astronomy for the Reading Room as I promised you to do. I cannot miss the opportunity w.[hich] this letter gives me of assuring you how deeply I felt your lordship's kindness on saying what you did at the conclusion of my lecture. I ought to have said – but one often forgets what one ought to say – that it was to your kind interest I owed my first step in life.
>
> Believe me, My Lord, Your very obedient servant, J. Norman Lockyer'.

From the family biography[33] I deduce that Lockyer's lecture, referred to in the letter, was delivered at Stoneleigh, at Lord Leigh's invitation[34]. The book is likely to be *Elementary Lessons in Astronomy*, published by Macmillan and Sons in 1868. There may be an element of formal politeness to Lockyer's letter, but I sense gratitude and appreciation from the rapidly rising astronomer to his distinguished sponsor.

Further Work

Lockyer's life in his late teens and early twenties is still not fleshed out in great detail. It would be interesting to know more about his teaching experience in Weston-super-Mare, his visits to Switzerland and France, and particularly his education at the Sorbonne. More detail on Lockyer's applications to, and early career in, the War Office would be useful. I also hope to find out more about the Lockyer family's contemporaries in the Rugby area - in particular, the founders of the Literary and Scientific Institution; the Bloxam family; and Lockyer's collaborator and friend, George Seabroke.

Acknowledgments

I am very grateful to Chris Hicks of the Rugby Local History Research Group for providing material on Lockyer from the collection of the late Ernest Timmins.

The assistance of George Wilkins of the Norman Lockyer Observatory Society is also greatly appreciated. He is a fellow SHA member and he suggested to me some of the themes addressed in this article. He also provided transcriptions of material in the archives of the Norman Lockyer Observatory that are held in the Library of the University of Exeter (E.U.L.).

I also acknowledge the assistance given by the archivists at the Shakespeare Birthplace Trust and the Warwickshire County Archives.

Notes and References

1 See for example, Wilkins, G.A. Sir Norman Lockyer's contribution to science. *Quarterly Journal of the Royal Astronomical Society*. 1994. **35**. 51-57.

2 Lockyer, T.M. and Lockyer, W.L. (with the assistance of Professor H. Dingle). *Life and Work of Sir Norman Lockyer*. London: Macmillan & Co., 1928. In the remainder of these Notes, this source is referred to as *Life and Works*.

3 A letter from Sir Richard Arman Gregory (Imperial College) to H.E. Armstrong states that he (R.A.G.) designed *Life and Work* and he '*got Prof Dingle to do the literary job … Lady Lockyer and Miss Lockyer did not write a word in the book*.' (E.U.L. MS 110 correspondence, R. A. Gregory, dated 5 November 1945).

4 Meadows, A.J. *Science and Controversy – A biography of Sir Norman Lockyer*. London: Macmillan & Co., 1972. In the remainder of these Notes, this source is referred to as *Science and Controversy*.

5 Meadows, A.J. *Science and Controversy*. 4.

6 Anonymous. *Aspects of the Past - 3*. Rugby Local History Research Group. 1991. 9.

7 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 3.

8 The printer registration is from the Ernest W. Timmins archive. Northamptonshire County Archive, index B26.7.1.1.

9 The catalogue of printer registration is an undated document from the Ernest W. Timmins archive.

10 Hingley, P.D. Urania's Mirror - a 170-year old mystery solved? *Journal of the British Astronomical Association*. 1994. 104(5). 238-240.

11 Undated document from Ernest W. Timmins archive.

12 *White's Directory for Leicestershire, 1846*. 148.

13 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 5.

14 Meadows, A.J. *Science and Controversy*. 5.

15 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 6.

16 Meadows, A.J. *Science and Controversy*. 3.

17 *White's Directory for Warwickshire, 1850*. 609.

18 *White's Directory for Warwickshire, 1875*. 701.

19 1851 Census details, provided by Warwickshire Record Office (J. Hogg).

20 E.U.L. MS 110 correspondence, R.C. Adams, dated 27 October 1856. This testimonial reads:

'*Mr. R.C. Adams, of Kenilworth School, has great pleasure in bearing his Testimony to the skill and abilities of Mr. J. N. Lockyer as a teacher: – He resided in this School Six years: Mr. Lockyer is a sound English Scholar & a Classic: – a good Accountant & Mathematician, & has a knowledge of French; his abilities are of the highest order, and his perseverance and punctuality indefatigable. Kenilworth, Oct 27th 1856*.'

21 E.U.L. MS 110 correspondence, T. Atkinson, dated 28 October 1856.

22 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 5,6.

23 E.U.L. MS 110 correspondence, C. Harrius, dated 22 April 1857.

24 Meadows, A.J. *Science and Controversy*. 5.

25 Stoneleigh Abbey web site is www.stoneleighabbey.org

26 *Stoneleigh Abbey – The House, Its Owners, Its Lands*. Ed. Bearman, Robert. Stoneleigh: Stoneleigh Abbey Ltd. 2003. Chapter 7 deals with William Henry Leigh.

27 The Norman Lockyer Observatory archive, University of Exeter, contains two letters to Lockyer, dated 1869, from Lord Leigh and from J.W. Leigh (probably a younger brother); these are noted below. There is also correspondence dating from 1871 about a lecture to the Coventry Institute (E.U.L. MS 110 correspondence, Lord Leigh, dated 27 August 1871); correspondence from September 1871 relating to George Seabroke (E.U.L. MS 110 correspondence, Lord Leigh, dated 22 and 27 September 1871); and a request, dated 9 September 1878, asking Lockyer to give a talk to a new society in Leamington, which could not afford to pay sufficient sums (E.U.L. MS 110 correspondence, J. W. Leigh, dated 9 September 1878).

28 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 6.

29 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 6.

30 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 7.

31 Meadows, A.J. *Science and Controversy*. 6.

32 The letter from Lockyer to Leigh is from the Stoneleigh Estate Archive in the Shakespeare Birthplace Trust. Index DR18/31/786d, F.39. Correspondence to and from Leigh in the 1850s is in DR18/17/57.

33 Lockyer, T.M. and Lockyer, W.L. *Life and Works*. 43.

34 Letter from Lord Leigh to Lockyer (undated, but mentioning that Lockyer is to give a talk on 12 April). E.U.L. MS 110 correspondence, Lord Leigh, 1869. The Norman Lockyer Observatory archive also has a letter dated 3 May 1869, from J.W. Leigh (see Reference 27 above), thanking Lockyer for an 'admirable lecture', and congratulating him on his election to Fellowship of the Royal Society (E.U.L. MS 110 correspondence, J. W. Leigh, dated 3 May 1869).

Sir Robert Ball:
Victorian Astronomer and Lecturer *par excellence*

Roger Jones
Council Member, Society for the History of Astronomy

Between 1875 and 1910 Sir Robert Stawell Ball gave an estimated 2,500 lectures in towns and cities all over the British Isles and abroad. This paper traces his lecturing career from its beginnings in Ireland to the triumphs of the Royal Institution, and on lecture tours in the United States of America. After a period in mathematics and mechanics, he became a populariser of science, especially astronomy, and found fame, and fortune among the working classes and the aristocracy. What motivated him to tireless travels is uncertain, but it might have been that it was rewarding, financially and to his reputation. Whatever his motives, contemporary accounts are clear that Ball's lectures were extremely popular and well-received.

Members of the Society for the History of Astronomy will know that on 30 April 2005 the Society's reference library at the Birmingham and Midland Institute (B.M.I.) was officially opened, and named after Sir Robert Ball (Figure 1)[1]. The library was dedicated to him as he was involved with the B.M.I. for more than 30 years, and lectured there on numerous occasions during the late Victorian era. He will, of course, be remembered by everyone interested in the history of astronomy for his many popular books, such as *The Story of the Heavens*. However, it is his lectures in popular astronomy that are the topic of this paper[2].

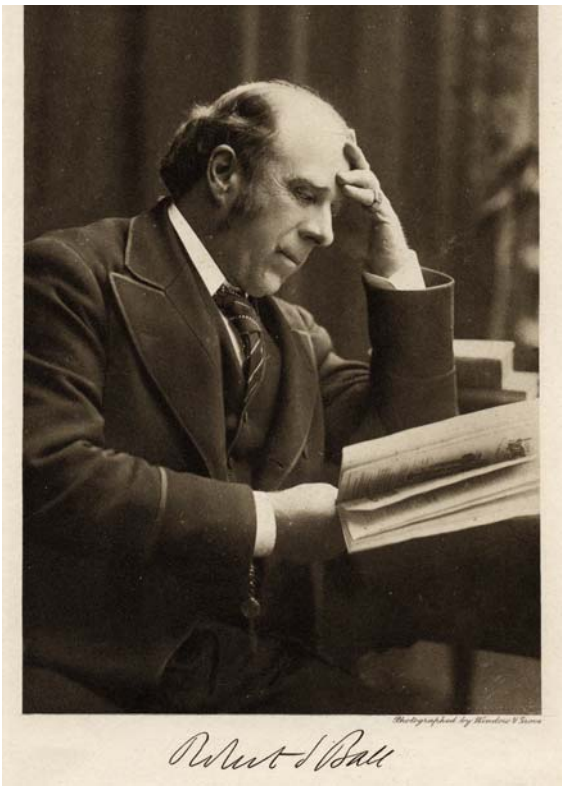


Figure 1

Sir Robert Ball *circa* 1900

Image taken from *Reminiscences* (Reference 2).

Born in Dublin in 1840, Robert Stawell Ball attended Trinity College, Dublin, where he had a brilliant university career, winning a scholarship and gaining honours in mathematics and experimental physics[3]. He graduated in 1865, but nearly a decade passed before he became a professional astronomer. He was influenced early on by many books, especially *Orbs of Heaven*[4] by Mitchell. After graduating he spent two years as tutor in the classics to the sons of the Earl of Rosse at Birr Castle, where he also took charge of the Earl's 72-inch reflector (Figure 2), thus getting his first practical experience in astronomy.

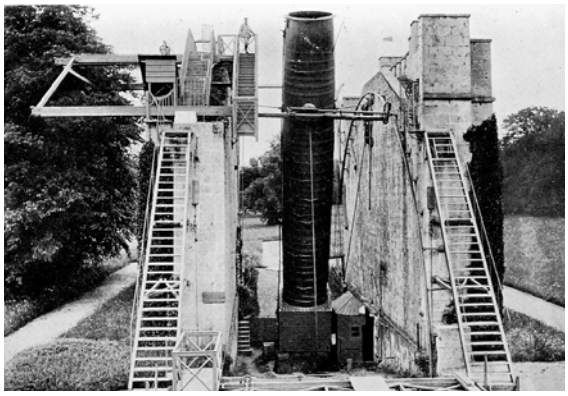


Figure 2

The 72-inch telescope of the 3rd Earl of Rosse

Image taken from *Reminiscences* (Reference 2).

In 1867 the Government of Ireland established in Dublin the Royal College of Science, and Ball spent seven years there as Professor of Applied Mathematics and Mechanism. Then, in 1874, he applied for, and obtained, the position of Andrews Professor of Astronomy at the University of Dublin, and was also appointed as Royal Astronomer of Ireland and Director of the Dunsink Observatory. In 1886 he was honoured with a knighthood for his contributions to science. By 1892 Ball had held the

three posts for 18 years, and was 52 years of age. He had a growing family to support; his salary in Ireland was not great; and he believed he could do much better in England.

A vacancy at Cambridge University, following the death of John Couch Adams[5], was Ball's chance to advance his career and his status in the scientific world. His application for the vacant Lowndean chair of Astronomy and Geometry, was successful, and in a letter to his mother he pointed out that it was:

> 'The highest scientific chair in England, if not in Europe, the Solar System, no … the Milky Way, indeed the highest in the whole Universe.' [6]

One might have expected great things from Sir Robert following his arrival in Cambridge. No doubt much scientific work was done during Ball's tenure, but very little has been written about his involvement in any major discoveries. His duties as Lowndean Professor required him to be in atendance for only five months of the year, and much of that time would have been taken up in tutoring. So he had plenty of spare time to follow other, more lucrative pursuits. But how did he get started on this climb to 'the highest of scientific chairs'?; and why did he devote so much of his time to lecturing?

To discover the answers we must go back to the autumn of 1859. The members of the Dublin Philosophical Society[7] were assembled for one of their monthly meetings. They could not have guessed that the young undergraduate about to give his very first talk to the students of Dublin's Trinity College, would go on to become one of the Victorian era's greatest lecturers.

However, it was to be another 10 years before he gave his first lecture to a paying audience. This was at the Athenaeum[8] in Belfast on 4 February 1869, and was entitled *Some Recent Astronomical Discoveries*[9]. For this lecture he earned the sum of 14 shillings; he was offered more, but declined, saying he was happy just to recoup his expenses. As we shall learn, in later years he was not so generous.

A few weeks after his Belfast lecture, he was invited to address the Royal Dublin Society at their afternoon lectures. He drew on his experiences at Birr Castle, and expounded on *Nebulae,* as seen through the 72-inch telescope, known as the Leviathan of Parsonstown. He illustrated his talk by showing the audience an enlarged copy of the magnificent engraving of the Orion Nebula, made from a drawing that Lord Rosse had painstakingly made over many years (Figure 3). Ball enlightened his audience that afternoon by telling them that nebulae were so far away that if one of them were to be immediately struck from existence by an omnipotent force, posterity for many generations may still observe, measure and draw the object long after it ceased to exist!

Figure 3

Drawing by the 3rd Earl of Rosse of the Great Nebula in Orion

Image taken from an engraving by James Basire (1796-1869).

Soon after Ball left Birr Castle in 1867 he came across the book *A System of Apparatus for the use of Lecturers and Experimenters in Natural Philosophy*[10], by the Rev. Robert Willis, Professor of Mechanics at Cambridge. Ball made good use of the book and of the Willis apparatus[11] in his lectures to students on experimental mechanics; little did he realise that it was to later set him on the path to his true vocation as a populariser of science. Ball's first venture in book authorship arose from him using the Willis apparatus. Macmillan & Co. agreed to publish a book[12] based on the demonstrations (Figure 4). Although itself not a best-seller, it prompted several enquiries, the most important of which came from the B.M.I.[13]

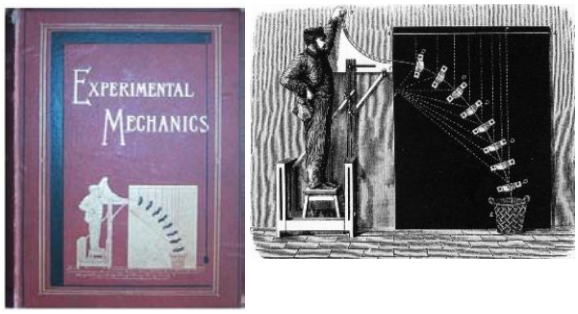


Figure 4

Ball's first book, published in 1871

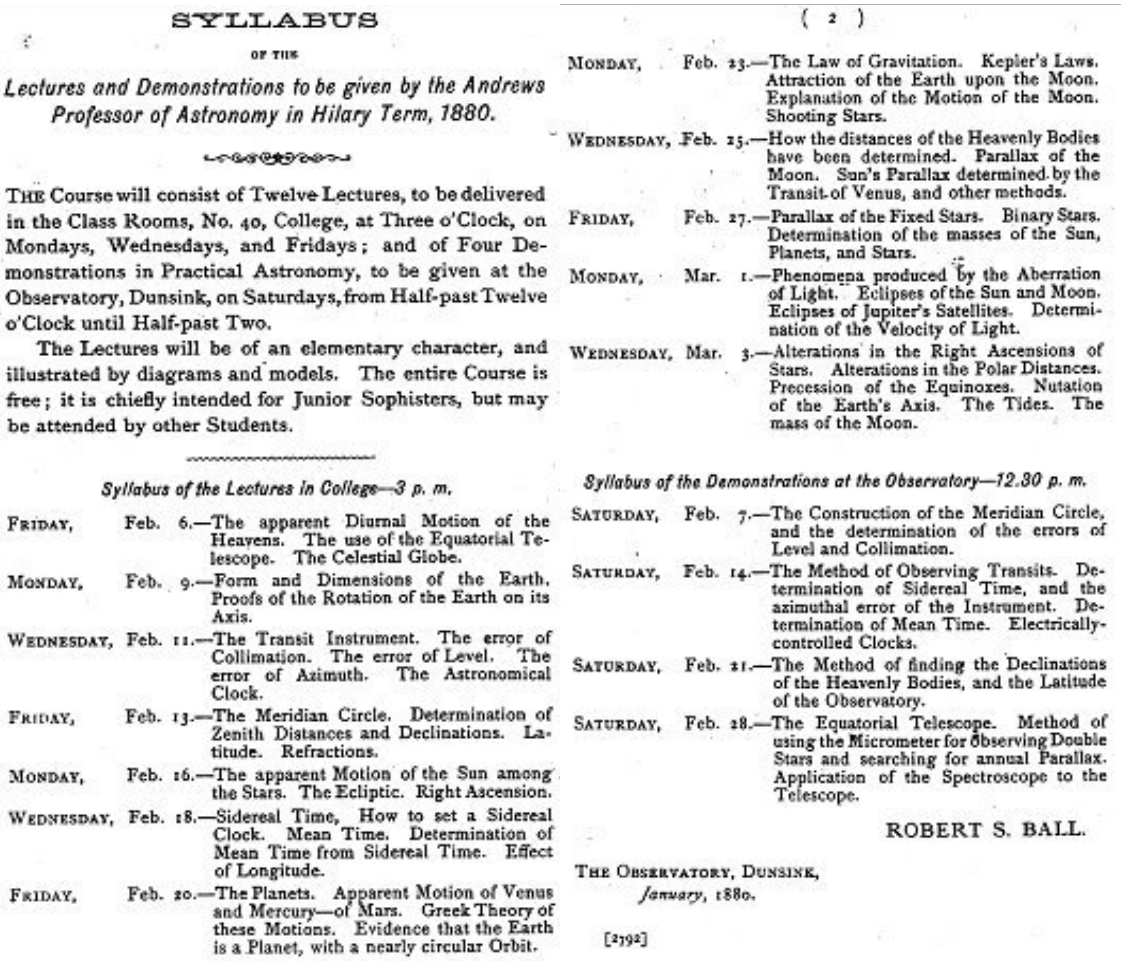
The image on the right shows an apparatus for proving that 'the path of a projectile is a parabola'. It is taken from page 251 of the book.

This enquiry, in the summer of 1874, included a request for Ball to lecture at the B.M.I. on mechanics, and came at a time when he was making a career change. He had only just been appointed to the three senior astronomy posts in Ireland. He was unsure that he should be lecturing on mechanics at a time when he had decided to devote his time and

energy to astronomy. Not easily dissuaded, Mr Cresswell, the B.M.I. Director in charge of the lecture department, suggested to Ball that he should spend a week in Birmingham, give two public lectures on astronomy and between times, teach the staff at the Institute all he could about the Willis apparatus. Ball agreed, and this event started him on the road as a public lecturer on astronomy. The subject of his first B.M.I. lecture in 1874 was the great astronomical event of that year, the transit of Venus. He prepared many diagrams and slides, including one showing how the Earth revolves around the Sun eight times to Venus's thirteen[14]. He quoted the work of Halley, gave details of the 1769 transit expedition of Captain Cook to the South Seas, and explained why the next series of transits would not occur until the beginning of the next millennium: 'until the flowers are blooming in the June of 2004'. His other astronomy lecture at the B.M.I. that week was *A Night at Lord Rosse's Telescope*. Never one for resting on his laurels, whilst in England he also visited Hanley and lectured to the Potteries Mechanic's Institute, and at Gloucester, before returning to Dunsink, successfully completing the first of his lecture tours. By 1880 Ball had been at Dunsink for six years, and had a full grasp of his subject, as can be seen from a syllabus from Trinity College, Dublin (Figure 5).

Ball always seemed to find the time to get away from Dunsink and to travel to England, where he was to become a regular visitor to the Midlands and to the B.M.I. in particular. He had the honour of giving the inaugural lecture at the B.M.I.'s new hall, when it opened on 24 October 1881. The lecture was called *A Glimpse through the Corridors of Time*, and it was a resounding success. It was immediately put into print and published in two parts in the journal *Nature*[15], which sold out both issues on the strength of it. It was also published in pamphlet form by Macmillan & Co. in 1882[16], and generated a fair amount of correspondence for Ball, as some of his statements about the 'time and tides' controversy met with disagreement. Ball was talking about a time when:

> '… the earth spun round in a few hours and the moon was quite close to it; it is not difficult to imagine how the earth and moon were originally one body.'[17]



SYLLABUS

OF THE

Lectures and Demonstrations to be given by the Andrews Professor of Astronomy in Hilary Term, 1880.

THE Course will consist of Twelve Lectures, to be delivered in the Class Rooms, No. 40, College, at Three o'Clock, on Mondays, Wednesdays, and Fridays; and of Four Demonstrations in Practical Astronomy, to be given at the Observatory, Dunsink, on Saturdays, from Half-past Twelve o'Clock until Half-past Two.

The Lectures will be of an elementary character, and illustrated by diagrams and models. The entire Course is free; it is chiefly intended for Junior Sophisters, but may be attended by other Students.

Syllabus of the Lectures in College—3 p. m.

FRIDAY, Feb. 6.—The apparent Diurnal Motion of the Heavens. The use of the Equatorial Telescope. The Celestial Globe.

MONDAY, Feb. 9.—Form and Dimensions of the Earth. Proofs of the Rotation of the Earth on its Axis.

WEDNESDAY, Feb. 11.—The Transit Instrument. The error of Collimation. The error of Level. The error of Azimuth. The Astronomical Clock.

FRIDAY, Feb. 13.—The Meridian Circle. Determination of Zenith Distances and Declinations. Latitude. Refractions.

MONDAY, Feb. 16.—The apparent Motion of the Sun among the Stars. The Ecliptic. Right Ascension.

WEDNESDAY, Feb. 18.—Sidereal Time, How to set a Sidereal Clock. Mean Time. Determination of Mean Time from Sidereal Time. Effect of Longitude.

FRIDAY, Feb. 20.—The Planets. Apparent Motion of Venus and Mercury—of Mars. Greek Theory of these Motions. Evidence that the Earth is a Planet, with a nearly circular Orbit.

(2)

MONDAY, Feb. 23.—The Law of Gravitation. Kepler's Laws. Attraction of the Earth upon the Moon. Explanation of the Motion of the Moon. Shooting Stars.

WEDNESDAY, Feb. 25.—How the distances of the Heavenly Bodies have been determined. Parallax of the Moon. Sun's Parallax determined by the Transit of Venus, and other methods.

FRIDAY, Feb. 27.—Parallax of the Fixed Stars. Binary Stars. Determination of the masses of the Sun, Planets, and Stars.

MONDAY, Mar. 1.—Phenomena produced by the Aberration of Light. Eclipses of the Sun and Moon. Eclipses of Jupiter's Satellites. Determination of the Velocity of Light.

WEDNESDAY, Mar. 3.—Alterations in the Right Ascensions of Stars. Alterations in the Polar Distances. Precession of the Equinoxes. Nutation of the Earth's Axis. The Tides. The mass of the Moon.

Syllabus of the Demonstrations at the Observatory—12.30 p. m.

SATURDAY, Feb. 7.—The Construction of the Meridian Circle, and the determination of the errors of Level and Collimation.

SATURDAY, Feb. 14.—The Method of Observing Transits. Determination of Sidereal Time, and the azimuthal error of the Instrument. Determination of Mean Time. Electrically-controlled Clocks.

SATURDAY, Feb. 21.—The Method of finding the Declinations of the Heavenly Bodies, and the Latitude of the Observatory.

SATURDAY, Feb. 28.—The Equatorial Telescope. Method of using the Micrometer for observing Double Stars and searching for annual Parallax. Application of the Spectroscope to the Telescope.

ROBERT S. BALL.

THE OBSERVATORY, DUNSINK,
January, 1880.

[2192]

Figure 5

Syllabus of Ball's lectures and demonstrations, Hilary Term 1880, Trinity College, Dublin

Image taken from Reference 18.

One of his close friends, Sir George Darwin, did not entirely agree with him, though Professor George Minchin, the famous geologist, said:

> 'I cannot refrain from calling your Birmingham lecture a singularly beautiful and instructive one ... The whole story is the most wonderful imaginable.' [19]

In 1891 Ball was elected President of the B.M.I. The subject of his Presidential address was spectroscopy, and entitled *The Movement of the Stars*. He enthralled his audience with the very latest advances in the subject, ending his address with the very apt phrase: 'Let there be light'.[20]

It was in 1880 that he began a fruitful relationship with the Gilchrist Trust, a charitable body, part of whose remit was to provide lectures throughout the British Isles, particularly in smaller towns. The lectures were always science based, and the previous lectures on astronomy were given by Richard Proctor. In late 1879, the Gilchrist Trust approached Ball with news that Proctor was about to embark on a world lecturing tour[21]. Ball agreed to take his place in the Trust's event, and his first Gilchrist tour in 1880 took him to Lancashire and Yorkshire; to the towns of Rochdale, Accrington, Huddersfield, Preston and Bury[22]. The Gilchrist tours suited Ball - he was able to leave the Trust to organise them. All he had to do was turn up at the venue some twenty minutes before the start, to set up his slides, etc. He almost always lectured to packed houses; the Trust would arrange 800-seat venues wherever possible.

The Gilchrist Lectures were for working-class audiences[23], and in the early years, local dignitaries worried that they would be poorly attended. Ball recounted that on his first visit to Blackburn the Mayor was very concerned that there would be a poor turnout. To make matters worse, it was raining heavily and getting worse. On reaching the hall, in the torrential rain, not a soul was to be seen, with the exception of two policemen standing in the doorway. The Mayor became desperate and exclaimed: 'I knew it would be so; the thing is a total failure!'. 'Is there anyone inside?' he asked the policeman, who replied 'The place is packed, and we had to turn away two hundred half an hour ago.' Much later, Ball was to remark that in Chipping Camden he lectured to 500 people, which represented one eighth of the town's population: quite an achievement! Tickets to Ball's lectures were snapped up well in advance, and often there were stories of touts selling them at many times their face value.

Ball sometimes found himself in the midst of a throng; caught up in the crowds on several occasions. On 7 January 1890 he arrived at a chapel venue in Goole, to find that there was a huge crowd waiting outside, and many people walking away looking downcast. A passer-by told him it was no use trying to get in as it was a sell-out. Ball eventually got to a side door where people were still being allowed to squeeze in. When he tried to gain entry, the doorman asked him for his penny. Ball told him he was the lecturer, to which the doorman replied 'Go on, I've heard that one before!' He eventually got in, and lectured to the audience on *Other Worlds*. During his talk, he discussed observatories, and mentioned that as his train approached the town he had noticed a very tall, domed building near the station, and had thought to himself 'what a splendid observatory they must have here'. Of course, everyone, including Ball, knew it was the water tower; nevertheless the quip greatly amused the audience.

During this lecture, in trying to convey to the audience the distance of the nearest star, he alluded to Henry Wilson, the Chairman, who was manager of the Lancashire and Yorkshire railway. Ball suggested that if Wilson were ever to extend the railway to Alpha Centauri, he would recommend that the fare should be calculated at 100 miles per penny. If that was done, how much would this immense journey cost? His answer was: take to the booking office 5000 carts, each carrying a ton of sovereigns - a total of £700,000,000, an amount then equal to the National Debt. Would they get any change? He said that they would have to expect a long wait whilst the clerk counted the money, and not be too surprised when they were asked for another £103 million before getting the ticket.

Ball took a keen interest in all that was going on around him, and on several occasions descended into the depths of the Earth to see the workings at the coalface. These first-hand experiences helped illuminate many of his lectures. A visit to Bristol, for example, could not go by without watching the tide come in from a vantage point on the Clifton suspension bridge. A spectacle he used to illustrate his lecture *Time and Tide*.

Ball's lectures were always well-planned affairs, but occasionally a mishap occurred. He would often tour with two lectures, alternating between towns, but taking with him the necessary slides, etc. On reaching the end of a tour in the North of England, he lent a box of slides to a friend, thinking he had no further use for them. On arrival at Leeds railway station in the late afternoon, he found the town placarded with the announcement that he was to lecture on *Krakatoa*[24]. These were the very slides that he had loaned to his friend. His remaining slides were for his *Moon* lecture, not altogether appropriate for the advertised event. He consulted with the Secretary of the Institution and decided that *Krakatoa* was what was expected and he would make do with what he had. He asked if a terrestrial globe could be obtained, and a very large one was found in the basement. Unfortunately, it had scarcely reached ground level, when it fell with a loud crash into the basement, breaking in two. However, Ball used this incident to good effect as

he told his audience that the globe, like Krakatoa, had suffered the effects of a local earthquake.

His lecture tours were also opportunities for Ball to satisfy his enquiring mind and quest for knowledge. Not for him dingy hotel rooms of provincial towns. He much preferred to stay at the home of some local dignitary, where he could be assured of good food and good company. Following his first B.M.I. lecture he stayed with Mr Follett Osler F.R.S. at 86 Harborne Road, Birmingham[25], the famous crystal glass manufacturer, whose Glass Fountain was the centrepiece of the Great Exhibition in 1851. The clock that Osler used to regulate time in Birmingham is on the wall of the main staircase at the B.M.I. Later that week he was the guest of Osler's neighbour and close friend, Alfred Elkington, who lived close-by in Augustus Road. His factory in Birmingham employed 800 men, and produced all types of electro-plated wares.

Birmingham was not Ball's only port of call in the Midlands. He often lectured in Wolverhampton, West Bromwich and Walsall. He gave many lectures around Birmingham over the years: one evening he might be found addressing the 50 members of the very exclusive Vesey Club in Sutton Coldfield where he was also President[26], whilst the next he would be in Walsall with an audience of 1,100 working men.

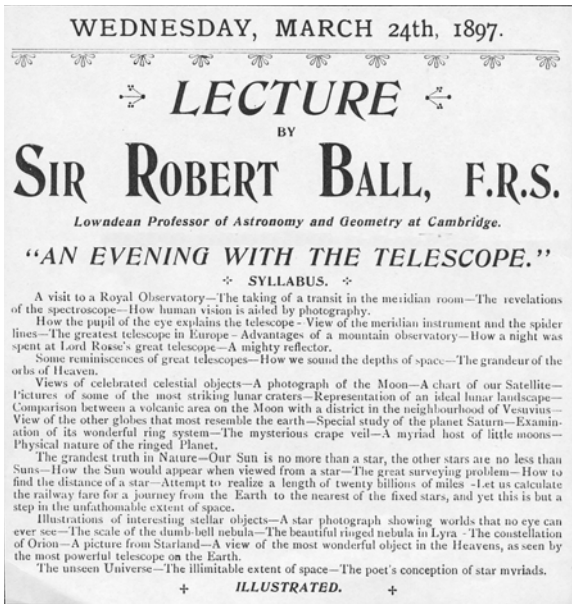
In St Helens he would stay with the Pilkingtons, and was fascinated by his tour of their glassworks. No doubt he would have visited Chance Brothers Glassworks whilst in Birmingham, though there is no record of this. His interest here would have been more than astronomical. Chance were responsible for the optical systems in use in lighthouses around the British Isles. Ball was scientific advisor to the Irish Lights Board. Every summer he would join the Commissioners of the Board for a 3-week steamship cruise round the Irish coast, examining all the lighthouses. He carried out many tests with gas, oil and electricity to see which gave the best light in different conditions[27].

Ball was a very keen and able photographer, and liked using his slides in lectures, and to show them off to appreciative audiences, especially if the subject was the Irish coastline. A selection of the hundreds of photographs he took was published in 2003[28]. Particularly interesting are the photographs of the construction of the Fastnet light, which Ball described as 'the most beautiful light in the world'.

During his lectures Ball would describe in simple terms the workings of the Universe, drawing comparisons to everyday experience, for example, the train journey to Alpha Centauri. When describing the Sun and its relationship with the Earth, he claimed that if all the coal on Earth was burnt at once it would not give out as much heat as the Sun in one tenth of a second.

He loved to quote the poets. At the end of his lecture *An Evening with the Telescope* (Figure 6), and in an effort to impress on his audience the vast size of the Universe and the number of stars it contained, he would recite these lines from his fellow countryman, William Allingham[29]:

> But number every grain of sand,
> Wherever salt wave touches land,
> Number in single drops the sea,
> Number the leaves on every tree,
> Number earth's living creatures all,
> That run, that fly, that swim, that crawl;
> Of sands, drops, leaves, and lives, the count
> Adds up into one vast amount,
> And then for every separate one,
> Of all those, let a flaming sun,
> Whirl in the boundless skies, with each
> Its massy planets, to outreach
> All sight, all thought; for all we see
> Encompassed with infinity,
> Is but an island. [30]



WEDNESDAY, MARCH 24th, 1897.

LECTURE

BY

SIR ROBERT BALL, F.R.S.

Lowndean Professor of Astronomy and Geometry at Cambridge.

"AN EVENING WITH THE TELESCOPE."

SYLLABUS.

A visit to a Royal Observatory—The taking of a transit in the meridian room—The revelations of the spectroscope—How human vision is aided by photography.

How the pupil of the eye explains the telescope - View of the meridian instrument and the spider lines—The greatest telescope in Europe - Advantages of a mountain observatory—How a night was spent at Lord Rosse's great telescope—A mighty reflector.

Some reminiscences of great telescopes—How we sound the depths of space—The grandeur of the orbs of Heaven.

Views of celebrated celestial objects—A photograph of the Moon—A chart of our Satellite—Pictures of some of the most striking lunar craters—Representation of an ideal lunar landscape—Comparison between a volcanic area on the Moon with a district in the neighbourhood of Vesuvius—View of the other globes that most resemble the earth—Special study of the planet Saturn—Examination of its wonderful ring system—The mysterious crape veil—A myriad host of little moons—Physical nature of the ringed Planet.

The grandest truth in Nature—Our Sun is no more than a star, the other stars are no less than Suns—How the Sun would appear when viewed from a star—The great surveying problem—How to find the distance of a star—Attempt to realize a length of twenty billions of miles -Let us calculate the railway fare for a journey from the Earth to the nearest of the fixed stars, and yet this is but a step in the unfathomable extent of space.

Illustrations of interesting stellar objects—A star photograph showing worlds that no eye can ever see—The scale of the dumb-bell nebula—The beautiful ringed nebula in Lyra -The constellation of Orion—A picture from Starland—A view of the most wonderful object in the Heavens, as seen by the most powerful telescope on the Earth.

The unseen Universe—The illimitable extent of space—The poet's conception of star myriads.

ILLUSTRATED.

Figure 6

Advertisement for a lecture by Ball at the Walsall Literary Institute

Image taken from Reference 31.

Ball was not very tolerant of disruptions from latecomers, who were often the more well-to-do, who invariably occupied the 6d seats in the front rows. He was quite happy, therefore, to have a good Chairman who could prattle for ten minutes at the start, whilst the latecomers got settled.

He would not venture too far from home to lecture unless he was being well paid. There were often complaints about his high fees; some venues even thought he should impart his knowledge for no fee. His stock answer was that he had a wife and five children to keep, and had no intention of travelling half way across the country unless he was well paid. But did he make money at it; was this the

reason why he spent so much time lecturing? He wrote to Dr W. Rambaut[32] on 17 October 1897:

> 'Lecturing is a more permanent source of income than writing, for the same lecture will be available scores of times, while there is (or ought to be) a limit to the number of times the same thing can be written. Then, too, lecturing is an amusing occupation, a rest and a change.' [33]

Were his earnings from lectures greater than those from his books? Some of his letters contain details of his fees: in one he asks for 18 guineas and six lectures in Boston earned him 1000 dollars before commission. We do not know his income details, but he left an estate valued at £12 045[34], equivalent to almost £750 000 today. So I think we can conclude that his motivation was to lecture for the money, and for the fame it brought him.

Although most of his public lectures were in towns and villages up and down the country, he was also a prominent speaker in the capital, where his most notable and well-remembered appearances were at the Royal Institution Christmas Lectures[35] (Figure 7). Though intended for children, adults at these annual lectures often outnumbered the children three to one. Ball would say to the youngsters:

> 'Well children, you and I will not mind all these grown-ups if they will only behave themselves properly'

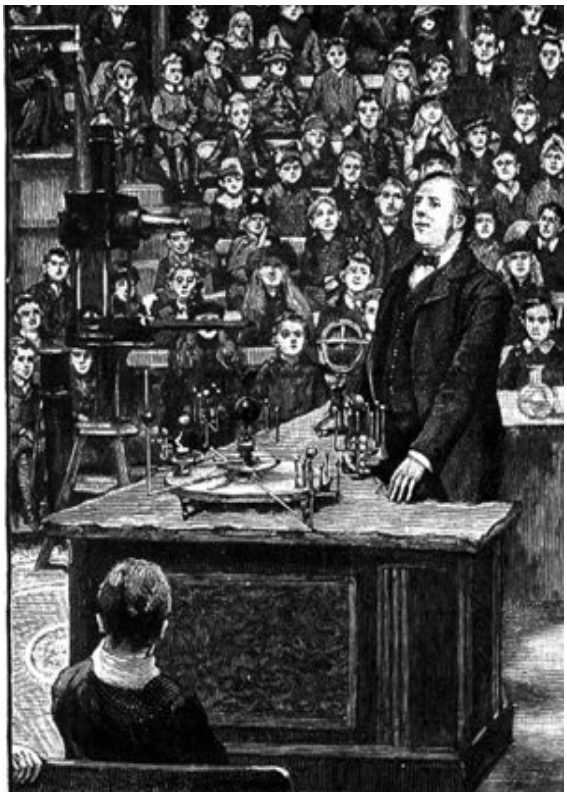


Figure 7

Ball lecturing at the Royal Institution

Image taken from Ball, R.S. *Starland.* London: Cassell & Co. Ltd., 1890. Frontispiece.

Ball was often asked if he ever tired of lecturing, to which he would reply:

> 'Ask a good golfer if he gets weary hole after hole … Ask W G if he ever tired of scoring century after century. When you have some skill in your art … the exercise of it is delightful.' [36]

In the early part of his career, he would lecture on any day of the week, including Sundays, but after several years, gave up Sunday lectures to stay at home. This was partly due to the activities of the Sunday Observance Society. He did however once lecture on Christmas Day. It was on one of his American tours and the Reverend Newell Hillis, pastor of the Plymouth church in Brooklyn, engaged him to speak to 2500 young people. He regaled his audience with a lecture entitled *Time and Tide and Fire-Mist*.

His oratory alone would have kept his audiences spellbound, but Ball was an expert in the use of visual aids, particularly the magic lantern. This would occasionally result in problems as we learn from the account in the *Walsall Advertiser* of the disruption to his first lecture in the town:

> 'The enjoyment of the Literary Institute lecture by Sir Robert Ball on Wednesday last was much interfered with by the incompetent mismanagement of the gas. The members of the Institute must look to Mr Alfred Stanley as responsible for this. Never did an audience, however, behave better under prevailing circumstances. May Walsall audiences ever conduct themselves without any approach to panic, under whatever circumstances may arise.' [37]

No doubt Mr Stanley was suitably embarrassed about this. He was a local businessman, whose factory on the outskirts of Walsall manufactured a wide variety of buttons[38].

During his lecturing career, Ball missed only one lecture, and that was also in Walsall. He had been due to speak to the Walsall Literary Institute at 8.00 p.m. on 30 October 1895, but at 5.00 p.m. Mr W Henry Robinson, the Institute Secretary (a member of the Royal Astronomical Society) received a telegram, which read:

> 'Our train has just returned to Cambridge. Line washed away. Impossible to reach Walsall tonight. Very sorry for inconvenience. Ball.' [39]

The Chairman told a disappointed audience that 'the stars in their courses had fought against the astronomer'. Lecture programmes of the Walsall Literary Institute from the 1880s to 1906 show that Ball lectured there on 8 other occasions[40], and was the Institute's President in 1898. He also had the honour of being the first person to lecture in Walsall's new town hall in 1905.

We have heard of the problems with 'gas' in connection with the lanterns, and of course he relied on slides and apparatus of various sorts to enliven the proceedings. In those days many lecturers

cursed the lanternist, who would frequently mix up the slides or show them before the lecturer was ready. Ball was more philosophical; saying that you could not expect from the lanternist, who was paid only a few pennies for an evening's work, what you would expect from the lecturer, who if he was someone of Ball's stature commanded high fees and expenses. Writing to Dr Rambaut on 2 March 1899 he said:

> 'Unless I warn him beforehand, the man at the lantern will probably make the moon go round the earth as if he was grinding coffee for a wager!' [41]

He would often instruct his lanternist as follows: 'There are eight ways of putting a slide into a lantern ... seven of which are wrong!' One of his lectures, *A Universe in Motion* involved the use of a number of elaborate mechanical slides (Figure 8), and for this he would enlist the services of a Mr James W Garbutt, whose skill at the lantern Ball very much appreciated. Garbutt was a slide manufacturer from Leeds and was the official lanternist for the Gilchrist Lectures in the north of England.

Figure 8

Examples of slides used by Ball in lectures

Top left: Comet c Moorehouse 1908, taken with the 30-inch reflector at the Royal Observatory, Greenwich on 3 October 1908, showing the stellar nucleus with parabolic envelopes.
Top right: One of Ball's many slides of the Moon.
Bottom: A mechanical slide to demonstrate the movement of the planets.

Lanterns were not Ball's only problem. There were hecklers, especially the 'flat-earth men'. John Hampden was one of them, who once wrote to Ball and claimed that the Lowndean Professor relied on the baseless conjectures of heathen astrologers to support his views. He said he would attend Ball's next lecture stating:

> 'I consider such monstrous lies perfectly scandalous. I will expose you, never fear!' [42]

On another occasion, a writer inquired:

> 'Must not a lecture on Invisible stars be about as entertaining as a concert of inaudible music? [signed] 'An Unbeliever'
> PS … I shall be there' [43]

Ball's maxim in such cases was:

> 'The noblest answer unto such, is perfect stillness when they brawl.' [44]

Apart from the Gilchrist Lectures, which were organised for him, most of his platform engagements required a vast amount of correspondence, so much so that by 1900 he had on his shelves 30 to 40 volumes devoted entirely to lectures[45]. Into each volume he would paste letters of invitation and acceptance, requirements for blackboard, lantern, etc, hospitality letters and poster announcements, Bradshaw's railway timetable, lecture ticket, press cuttings and letters of thanks.

Although his public lectures were confined to astronomy and earth sciences, his expertise in mathematics meant he would give lectures to students on his 'theory of screws'. These were not lectures for the masses; Ball was more than satisfied if he had as many as three students turn up to hear him speak. Readers may be wondering what this 'screw' business was all about. I confess to knowing little, but the following is relevant:

> 'Ball's *Treatise on the Theory of Screws* is the definitive reference on screw theory. It gives a very complete geometrical account of the problems of small movements in rigid dynamics.' [46]

Ball's son once asked him to explain the theory to him. The Lowndean Professor replied:

> 'If I were to begin speaking now, and continued to expound for about six months without interruption, you might have some faint glimmering of what it means!' [47]

Despite his love for the subject, he once raised a toast to mathematics in an after-dinner speech saying: 'Here's to Pure Mathematics. May she never be of any use to any one.'

On 14 August 1884 Ball made his first transatlantic trip, to Canada, on the S.S. Oregon, under the auspices of the British Association for the Advancement of Science[48]. Also on the tour were John Couch Adams and Sir Oliver Lodge. All were to lecture at McGill University in Montreal. *The Times* in an article prior to the visit said:

> 'Professor Ball, the witty and eloquent Astronomer Royal for Ireland, will deliver the popular lecture - par excellence.' [49]

On this tour, Ball lectured not just on astronomy. In Montreal he was engaged by an agent from Boston to give six lectures in the United States. Ball asked for £40 per lecture; he got it, less the agent's 10%. In September he crossed the border into the United States, and gave a useful talk on *Screws* to the American Association for the Advancement of

Figure 9

Cylindroid used by Ball in his lectures on screws

Image courtesy of the Science Museum, London

Science[50]. For this lecture he used his newly-acquired cylindroid[51] (Figure 9), which Howard Grubb of Dublin had made especially for him. Ball's Boston lectures were reviewed in the *Boston Herald*, which reported:

> 'He has not quite the oratorical ability of Prof. Langley[52], and suffers from a slight impediment to his speech, but he has a smooth clear voice, with a use of it, at times, quite clergimanic.' [53]

When Ball read this he said: 'I must try and correct these trifles'.

Ball was an expert speaker; it is said that he never used notes. When asked about this he would reply: 'How can a lecturer expect an audience to remember his lecture if he is unable to recollect it himself.' But in his early lectures he would often hesitate and stammer, even losing his train of thought on occasion. However, on this US tour he decided to write out his lectures in full and to read from the manuscript. He repeated each lecture on so many occasions that eventually he knew them off by heart. Initially, though, he read them as he had written them, almost word for word.

For almost 30 years, from the mid 1870s, Ball carried out two main lecture tours in Britain, in January and November each year. In addition, he would give many one-off lectures at towns up and down the country. He must have had remarkable stamina to keep up this round of lecture tours and engagements, in addition to his University commitments. Remember, his only modes of transport were the railways and horse-drawn carriages, and ocean liners, of course.

It was Ball's lecture tour to the United States in 1901 that was to be his most ambitious and profitable, with 45 lectures in 11 weeks. He travelled out on the White Star liner S.S. Cymric in October and in a hectic first round completed 24 lectures in 29 days. He almost missed his first lecture in Boston - because of bad weather, the Atlantic crossing took an extra day. He arrived with just an hour to spare. He travelled throughout the mid-west and the eastern states, visiting Chicago, Boston (where he was a house guest of Percival Lowell), Philadelphia, Pittsburgh, Baltimore, Minneapolis, Washington D.C., and naturally, New York. He met many important people, and was constantly being invited out to dinner. Among those from the astronomical community he chose to mention were Professors Hale, Barnard and Burnham at Yerkes Observatory; Simon Newcomb of the United States Naval Observatory, Washington D.C. One night, at the theatre, he was introduced to Mark Twain.

Sometimes he was favoured with a captive audience, notably on his sea voyages. He lectured to the passengers and crew on one of his transatlantic trips, and in 1896 aboard the S.S. Norse King, his audience was bound for Norway to view the total solar eclipse (Figure 10).[54] No doubt his enthusiasm about the forthcoming event turned to disappointment when the 106 seconds of totality were spoilt by cloud cover. Two years later, whilst on holiday in Devon, he wrote to his son:

> 'Dearest Bill
>
> If you want free tickets for your friends to hear a lecture of mine, now is their chance. Let them hurry up and commit bigamy, or arson, or any really good felony short of actual murder and they will have a free ticket, indeed a compulsory ticket forthwith. I shall have both clergymen and lawyers in my audience. On Friday I lecture to the convicts at His Majesty's Prison on Dartmoor!' [55]

One couldn't get a more captive audience than that!

When his repertory was complete he was indifferent as to which lecture he gave to any particular audience. Ball once told an enquirer:

> 'I can congeal you with the *Ice Age* or burst you up with the thunders of *Krakatoa*. I can tell you whoppers about *Time and Tide* or petrify you with a burst of eloquence about *Invisible Stars*. And I usually put the greatest rot into a lecture about *Other Worlds*.' [56]

His books on popular astronomy numbered thirteen, and most of them ran to several editions and revisions. *Story of the Heavens* was his best seller; the 5th edition of his *Popular Guide to the Heavens* was published as late as 1955. Many of these volumes are available in the Sir Robert Ball reference library of the Society for the History of Astronomy at the B.M.I.

Ball entered the twentieth Century's second decade in failing health, suffering from diabetes. He

Figure 10

Ball lecturing aboard the S.S. Norse King in 1896

Courtesy Royal Astronomical Society. (ADD MS 153)

gave his last public lecture in November 1910 at Caxton Hall in London in aid of the National Society for the Prevention of Cruelty to Children (tickets were 7s.6d., today's equivalent is about £25). He was, however, still able to play golf at Royston Heath until 1912. In the same year he made his final trip with the Irish Lights Board around his beloved Irish coast.

During the final 12 months of his life Ball was for the most part confined to his house in the Cambridge Observatory grounds. He died on 25 November 1913, aged 73 years, and is buried in St Giles cemetery, just a few hundred yards from the Observatory, near to his predecessor in the Lowndean chair, John Couch Adams.

Here then was probably Britain's most popular astronomer. For 35 years, from 1874 to 1909, Sir Robert Stawell Ball virtually personified astronomy to the English-speaking world. He communicated astronomy to the public in an optimistic and positive way, making it appear a worthwhile pursuit. This was also crucial for scientists in other disciplines, at a time when the issue of endowed research was becoming increasingly important.[57] Despite being well respected at all levels, from the factory workers of northern England and the Midlands, to the patrons of London's finest clubs and learned societies, he was occasionally held in contempt by some of the scientific establishment. They would grumble about his 'utterances' to the press; and some of his written work was criticised in terms such as: 'This is not what is expected of the Lowndean Professor.'

But Ball's unfading reputation will not just rest on his achievements as a lecturer and populariser of science, great as they were, or even as an astronomer, in which capacity he lacked the advantages of professional training. It will be based on his work as a great mathematician, which was his most absorbing interest, and to which he devoted much of his leisure.

The total number of lectures he gave is not known, but it is recorded[58] that between 1874 and 1884 he gave 700, and he lectured almost continuously for the next 20 years. He therefore probably gave more than 2,500. It is estimated that, not counting many thousands of students and fellow scientists who heard him speak, he lectured to well over one million people at his public meetings.

Ball had an inspiring personality: his voice, manner and good humour excited interest and enthusiasm in his audiences. His Royal Astronomical Society obituary recalled:

> 'The great popularity he attained is convincing evidence of the wide interest in astronomy which he thus excited. It is common knowledge how small the influence may be which affects a receptive mind, and leads it to further study and development, and in this way Ball's lectures cannot but have given a strong impulse in this country to the advancement of the study of astronomy.' [59]

Acknowledgements

I should like to thank Mark Butterworth for sending me many of the images and copies of documents that he has acquired over the years, and which have assisted me in my research; especially the slides, details of the cylindroid and newspaper cuttings from the United States of America. I also thank Stuart Williams for his assistance on my visits to the Walsall Local History Centre, and Mark Hurn for his behind-the-scenes tour of Cambridge Observatory, and Peter Hingley for the Norse King image (Figure 10). I must not forget Reg Withey, for his very helpful comments on the several drafts of this paper.

Notes and References

1 The Birmingham and Midland Institute (also known as the 'B.M.I.' and the 'Midland Institute') was founded by Act of Parliament in 1854, for the 'Diffusion and Advancement of Science, Literature and Art amongst all Classes of Persons resident in Birmingham and the Midland Counties'.

2 Much of the content of this paper is taken from *Reminiscences and Letters of Sir Robert Ball* edited by his son, W Valentine Ball. London: Cassell. 1915, the only biographical work on Ball. This source is referred to as *Reminiscences* in the remainder of these Notes.

3 For a more detailed account of Robert Ball's early years, see the author's lecture transcripts at http://www.geocities.com/ziksby2/Sir_Robert_Ball.

4 Mitchell, O.M. *The Orbs of Heaven.* London: Routledge. 1860.

5 J.C. Adams had been Lowndean Professor of Astronomy and Director of Cambridge Observatory since 1858.

6 Ball, W.V. *Reminiscences.* 137.

7 Dublin Philosophical Society was founded in 1684 by students of Trinity College, Dublin. It is the oldest undergraduate society in the world.

8 A club for individuals known for their scientific, literary or artistic accomplishments.

9 Ball, W.V. *Reminiscences.* 188.

10 Willis, Rev. Robert. *A System of Apparatus for the Use of Lecturers and Experimenters in Mechanical Philosophy, Especially in those Branches which are Connected with Mechanism.* London: John Weale. 1851.

11 The Willis apparatus was an assortment of frames, levers, gears, weights and pulleys to demonstrate and explain various mechanical laws and principles.

12 Ball, R.S. *Experimental Mechanics. A Course of Lectures Delivered at the Royal College of Science for Ireland.* London: Macmillan & Co. 1871.

13 Ball, W.V. *Reminiscences.* 190.

14 Ball, W.V. *Reminiscences.* 192.

15 Ball, R.S. A Glimpse Through the Corridors of Time. *Nature*. Issue 24, 24 November 1881. 79-82; and Issue 25, 1 December 1881. 103-107.

16 Ball, R.S. *A Glimpse Through the Corridors of Time.* London: Macmillan & Co. 1882.

17 Ball, W.V. *Reminiscences.* 195.

18 Ruiz-Castell, P. *Astronomy and its Audiences.* M.Sc. Thesis. St Cross College, University of Oxford. 2003. 16.

19 Ball, W.V. *Reminiscences.* 195.

20 Ball, R.S. *In Starry Realms.* London: Isbister & Co. 1892. 291.

21 Ball, W.V. *Reminiscences.* 216.

22 Ball, W.V. *Reminiscences.* 217.

23 Ball, W.V. *Reminiscences.* 217.

24 Ball, W.V. *Reminiscences.* 196.

25 Ball, W.V. *Reminiscences.* 192.

26 Sutton Coldfield Public Library (Bishop Vesey Section) Unreferenced pamphlet on Vesey Club.

27 Ball, W.V. *Reminiscences.* 246.

28 Farrelly, Michael. *For the Safety of All.* Dublin: National Library of Ireland. 2003.

29 Ball, W.V. *Reminiscences.* 227-228.

30 Allingham, William. *In a Cottage Garden* (date and place of publication unknown).

31 Walsall Literary Institute Programmes. Bound volume in Walsall Local History Centre, Essex Street, Walsall. West Midlands WS2 7AS.

32 Dr W. Rambaut was an assistant to Lord Rosse at Birr Castle 1848-1850, and a friend of Ball.

33 Ball, W.V. *Reminiscences.* 221.

34 Birmingham Central Library. Index of Wills and Probate Records (1858-1972).

35 Ball, W.V. *Reminiscences.* 205.

36 Ball, W.V. *Reminiscences.* 220.

37 *Walsall Advertiser.* 14 November 1888.

38 1881 census.

39 Ball, W.V. *Reminiscences.* 223.

40 *Walsall Red Books* show that Ball was scheduled to give the following lectures:
26 January 1887, *Glories of the Midnight Sky*
14 November 1888, *Time and Tide*
3 February 1892, *Invisible Stars*
14 November 1894, *Recent Researches on the Sun*
30 October 1895, *Recent Discoveries about the Sun* [This lecture was not delivered.]
24 March 1897, *An Evening with the Telescope*
18 January 1899, *Lances of Heaven* [Presidential address]
28 November 1900 *Recent Discoveries about the Sun*
18 October 1905 *Famous Volcanic Eruptions* [The first lecture in Walsall's new Town Hall.]

41 Ball, W.V. *Reminiscences.* 220.

42 Ball, W.V. *Reminiscences.* 231.

43 Ball, W.V. *Reminiscences.* 231.

44 Poem by Alfred Lord Tennyson: *Literary Squabbles.* 1846.

45 Ball, W.V. *Reminiscences.* 222.

46 Publisher's note from: Ball, R.S. *A Treatise on the Theory of Screws*. Cambridge: Cambridge University Press. 1st Edition re-issued 1998.

47 Ball, W.V. *Reminiscences.* 241.

48 Ball, W.V. *Reminiscences.* 318.

49 *The Times.* Number 31076. 8 March 1884. 4a.

50 Wayman, P. A. A visit to Canada in 1884 by Sir Robert Ball. *Irish Astronomical Journal*. 1986, **17**. 188.

51 This is a wire model of a 'cylindroid' in brass glazed cylindrical case on a wooden base, by Howard Grubb, Dublin. The model was made on the instructions of Robert Stawell Ball. Now in the Science Museum, London.

52 Samuel Pierpont Langley (1834-1906) was an American astronomer, physicist and aeronautical pioneer.

53 *Boston Herald.* 15 October 1884. 4.

54 This was the first eclipse expedition organised by the youthful British Astronomical Association, founded in 1890.

55 Ball, W.V. *Reminiscences.* 239.

56 Ball, W.V. *Reminiscences.* 225.

57 See, for example: Whyte, Nicholas at: http://www.explorers.whyte.com/ball.htm.

58 Ball, W.V. *Reminiscences.* 224.

59 E[dward] B[all] K[nobel]. Obituary. Robert Stawell Ball. *Monthly Notices of the Royal Astronomical Society*. **75**(4). February 1915. 230-236.

The Lost Gardens of Fireside

Kevin J. Kilburn
Past President, Manchester Astronomical Society

The life and work of the nineteenth century engineer and amateur astronomer, James Nasmyth, is reasonably well documented. He was born in Edinburgh, Scotland, moved first to London in 1828, then to the great industrial centre of Manchester, where he lived for 20 years in the district of Patricroft. Despite the wealth of information about his family and his engineering work now available, the location of his Manchester home, the house he called 'Fireside', was not precisely known. The research described in this paper has resulted in it, and its observing site, being identified with certainty for the first time.

In 1834, two young Scottish engineers, James and George Nasmyth, established an engineering business in Manchester, England. James was then 26 years old; George was two years his senior. Two decades later, by which time its founding brothers had either sold out or retired, the firm had become one of the most successful engineering companies in Britain, and continued to be so for more than a century[1]. Much of what we know about Nasmyth is gleaned from his autobiography[2]. It is the first port of call for any investigation of his life; yet it contains only what he wanted us to know of himself [3]. He is vague about many personal details, such as where in Patricroft he lived, and he totally ignores some 'skeletons in the cupboard', including his late brother, George[4], who he mentions only once.

To flesh out the details and to re-establish the balance of the Nasmyth brothers' partnership - important background to where James lived and first began his interest in astronomy - we must refer to other sources, especially to the work of Dr J. A. Cantrell and Miss M. Patry. With their invaluable help, this paper pulls together threads of information regarding Nasmyth's Bridgewater Foundry, and especially about the period from about 1842 to 1856, when James Nasmyth's interest in astronomy first blossomed at his home, Fireside, in Patricroft.

James Nasmyth was born into a highly talented, well-connected, Edinburgh family[5]. His father, Alexander, was an established landscape artist whose circle of friends included Sir Walter Scott, James Watt and Robert Burns, who Alexander immortalised in a famous portrait. They, and other artist and scientist friends, were regularly entertained at the family home, No. 47 York Place, Edinburgh, which, although being described by James as 'small', is in fact a substantial, five-storied, Georgian house which, during James's childhood, was occupied by 14 people (Figure 1)[6].

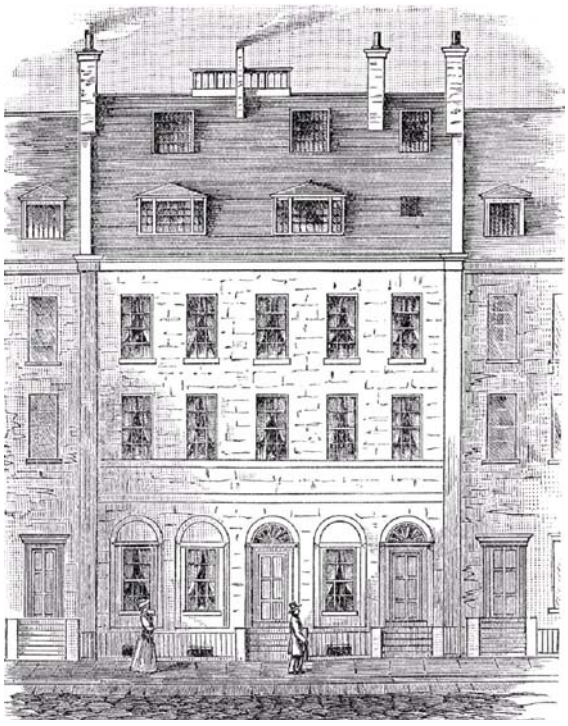


Figure 1

Nasmyth's childhood home

No. 47 York Place is the property to the immediate right of the gentleman (see Note 6). Image from Nasmyth's *Autobiography* (Reference 2).

Beginnings

In this atmosphere of culture, James was exposed to his father's frequent visitors, whose enthusiasm for the arts and learning evidently rubbed off. From an early age, James and George were keen on mechanical things. Like many of his older siblings, James had an artistic eye and could visualise and depict in his sketchbooks quite complicated mechanisms. In his bedroom fireplace he had a small forge in which he smelted brass with which to cast parts for model steam engines. One can imagine the consternation of his parents as their teenage son melted metal in his room above theirs, and kept them awake into the wee small hours pounding sand around formers to make moulds for his castings.

When James was 19 years old, his model steam carriage attracted wider attention, and he and George were commissioned by the Scottish Society of Arts to make a full-scale machine capable of

carrying four to six people[7]. They were given £60 to build the car, and eventually produced one that carried eight people[8]. The project was an engineering success, but no commercial value was attached to it. He was given the carriage, and made a good profit by selling it for parts and scrap for £67.

With an introduction arranged by Alexander, James and George applied to become apprentices to the London engineer, Henry Maudslay. He was an engineering innovator, who had done much to progress the British industrial revolution of the early 19th century by introducing standardised parts made by his machine tools. Until then, all mechanical devices were one-offs. Even nuts and bolts were hand made and not interchangeable. Like that great Manchester engineer, Joseph Whitworth, Maudslay's development of machine tools meant that mechanical components could be manufactured with reproducibility and consistency. The Nasmyth brothers' engineering knowledge and models so impressed Maudslay that he recognised that they were already too advanced to benefit from mere apprenticeships, and both were taken under Maudslay's wing as assistants, probably in 1828 or 1829.

In early September 1830, James Nasmyth travelled by coach from London to Liverpool to watch the opening of the Manchester to Liverpool railway. He walked back to London, armed with letters of introduction to facilitate visits to industrialists en route. He intended to investigate the prospects for setting up a business in the north-west of England, either Liverpool or Manchester, or in Birmingham, which were already at the heart of the British industrial revolution[9]. Local entrepreneurs and investors encouraged industrial development, land was cheap to rent and there was a ready and willing population of available workers.

On Saturday, 17 September he left Liverpool and began the long walk back to London. That day he walked the 40 miles of railway to Manchester, and in the afternoon rested on Patricroft Bridge, over the Bridgewater Canal, in the town of Eccles (Figure 2). The tranquil, rural scene impressed him, as did the proximity of superb transport facilities in this quiet corner of Lancashire, whose industrial vitality was already giving him inspiration. The world's first passenger railway, since 2 days before, connected Manchester and Liverpool; and, for more than 60 years (since 1764) the Duke of Bridgewater's canal carrying cheap coal from his mines at Worsley, two miles north of Patricroft, had powered the cotton-mill engines, and had stoked the domestic fires in the heart of industrial Manchester six miles away. From Manchester, Nasmyth's journey took him back to London via Coalbrookdale and Ironbridge in Shropshire, and on to Wolverhampton and Dudley in the 'Black Country' of the west Midlands. Here he saw 'the remains of what had once been happy farmhouses, now ruined and deserted'. The entire landscape was blackened and polluted by the cinder heaps, furnaces and smoke of industrialisation. By comparison, the green fields of south Lancashire beckoned more strongly.

Figure 2

View from Patricroft Bridge looking north

On the far side of the sharp bend of the canal to the right, James Nasmyth later lived at Ellesmere House, Fireside was on the right bank of the bend.

Photograph by the author.

The Nasmyth Partnership

On 14 February 1831, Maudslay died, and in the autumn, James and George left London to set up as equal partners[10], in Edinburgh, a small engineering shop to make machine tools and steam engines, whose sale would finance a more ambitious business in Liverpool or Manchester. In summer 1834, after examining the prospects of opening a business in Liverpool, James returned to Manchester, and with unsecured credit of £500 at 3% interest from businessman William Grant, he rented from the firm of Wren and Bennett[11] part of a mill in Dale Street, close to the centre of Manchester (Figure 3)[12].

In Dale Street James and George began making machine tools and parts for steam engines

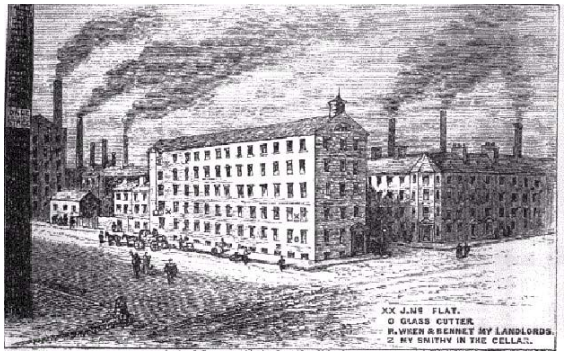


Figure 3

The Dale Street works in Manchester

Image from Nasmyth's *Autobiography* (Reference 2).

in a second-story 'flat' above a glasscutter's workshop in a former cotton mill[13]. Their business was successful, and within 2 years they had accumulated a large amount of work-in-progress and a considerable amount of heavy machinery. The wooden floors creaked under the growing weight. In 1836 disaster struck: A heavy beam engine crashed through the floor causing destruction in the glass-workshop below. The Nasmyths were asked to leave. James immediately decided that Patricroft offered a much better prospect for development; here they would set up business anew and make their fortune. A 6-acre plot of land was rented from Squire Trafford, and temporary, pre-fabricated wooden buildings were constructed to accommodate the move from Dale Street[14].

The site in Patricroft was rich in readily-available resources. It was bordered on its west side in part by 1050 feet of stone-clad frontage along the Bridgewater Canal (Figure 4)[15]. On its eastern edge was a good road, Green Lane, with an open aspect to the east across land where the Nasmyths later built cottages for their workforce. Adjacent on the south side was the Liverpool to Manchester railway line, to which they later connected their own siding so that they could run and test their standard-gauge steam locomotives. Patricroft Colliery was close by, its coal readily available to power the steam engines. The site even had its own public house, no doubt frequented by the Nasmyths' thirsty foundrymen. Within two years a handsome factory was built using bricks made from clay that overlaid the sandstone bedrock north of the factory (Figure 5)[16].

Although his Manchester business was initially in equal partnership with George[17], after moving to Patricroft they took into partnership as their finance director, the slightly older and more experienced Holbrook Gaskell[18]. They also obtained substantial financial backing from the Manchester cotton-spinning magnates, the Birleys. By 1838 the firm of Nasmyth Gaskell & Co. was operating from a purpose-built factory with access to unequalled local and national transport facilities, and with

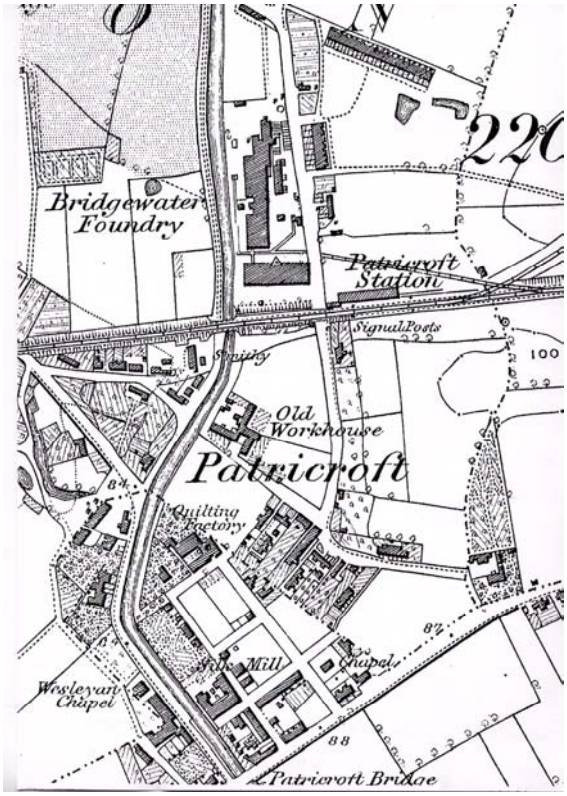


Figure 4

The location of Nasmyth's Bridgewater Foundry in Patricroft in 1848

The Foundry is about ¼ mile from Patricroft Bridge.
North is at the top.

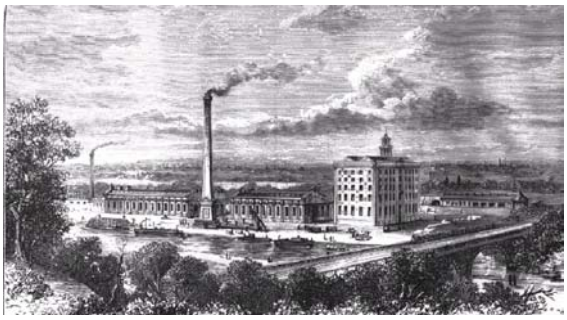


Figure 5

Bridgewater Foundry from the southwest by Alexander Nasmyth c 1838

Image from Nasmyth's *Autobiography* (Reference 2).

assets of £40,000[19]. James was the technical innovator, and George was responsible for selling the engineering products: machine tools, engines and, eventually, steam hammers and railway locomotives. Thus was the Nasmyths' Bridgewater Foundry in the late 1830s, ideal for development and expansion. James Nasmyth exploited his assets, and his considerable engineering and business skills[20]; he never looked back, and went on to develop and patent the steam hammer with which to shape massive, wrought iron forgings (Figure 6)[21].

Throughout his life, like most practical engineers, Nasmyth kept meticulously annotated sketchbooks[23]. His first sketch of the steam hammer is dated 24 November 1839. The invention of the steam hammer, the related steam pile driver and numerous machine tools, made him the equivalent of a multi-millionaire by the time he was in his mid-40s.

Figure 6

James Nasmyth on the platform of a medium-sized steam hammer, 1855

Image taken from Reference 22.

Nasmyth's autobiography is a tale of success after success, but it does not tell us all we might wish to know about Nasmyth the astronomer[24], or especially of Nasmyth the man. He tells us what he wants us to know. He mentions his brother, George, only once, letting us think that it was he alone who was responsible for the success of the Bridgewater Foundry. Yet until James's marriage in the early summer of 1840, he and George shared a house with their sister, Margaret.

It is perhaps surprising to realise that the Nasmyth brothers were involved with the Bridgewater Foundry for no more than 20 years. George left the company in 1843, just seven years after it was founded, and moved to London25. He later fled to America[26]. Perhaps James felt abandoned by his older brother and for this reason excluded him from his autobiography; we simply don't know. Equally, it might have been George's perception that he was unequal to his dynamic younger brother that made him quit the Bridgewater Foundry[27]. Either way, George's leaving had a profound effect on what had been until this time a close, brotherly relationship from their earliest childhood. It is possible to sense that despite the huge financial success of the steam hammer, the heart had been torn out of James's Bridgewater Foundry.

In 1856, James Nasmyth, still only 48 years old, retired to Penshurst, Kent to enjoy the prosperity he had earned. He bought a substantial mansion, which he called Hammerfield. As he himself says, this was the first house that he had ever owned. Throughout his 20-year stay in Patricroft he had lived in rented property. We know that he lived in several locations; we know where some of these homes were; but we did not know with certainty the location of his main marital home, 'Fireside'. It was from Fireside that he made his early observations of the Moon, observations for which he was later to become famous. So, where was Fireside?

Finding Fireside

Nasmyth's autobiography tells us that when he moved to Patricroft in 1836, he set up home in a small cottage in the village of Barton on the banks of the River Irwell, for which he paid an annual rent of £15. It was about a six-minute walk from his Bridgewater Foundry[28]. His sister Margaret was his housekeeper. He says that in the summer evenings he often walked among the apple orchards of his adopted village whilst contemplating his engineering business. James does not specifically state where that cottage was; indeed his autobiography leaves us entirely in the dark about exactly where he lived during his 20 years at Patricroft. As one of the largest manufactories in the area for over 100 years, it is perhaps surprising that the home of the Bridgewater Foundry's principal owner, the town's largest employer, is not better known. Once again, we have to rely on sources other than Nasmyth himself to tell us where he lived.

Patricroft was a localised district of no more than about one square mile; one of a small cluster of what had been mediaeval villages and hamlets, including Barton-upon-Irwell and Peel Green, a mile or so west of the ancient Lancashire town of Eccles, itself lying about five miles west of central Manchester (Figure 7). The centre of Patricroft still lies at Patricroft Bridge, where the Liverpool Road spans the Bridgewater canal, and from where Nasmyth first decided to build his factory as he rested on its parapet in 1830.

Where the Nasmyth brothers lived when they had their business in central Manchester is not known. However, it is known that by 1837 they lived in Green Lane House in Green Lane, the road flanking the east side of their factory, at its intersection with Catch Inn Lane[29].

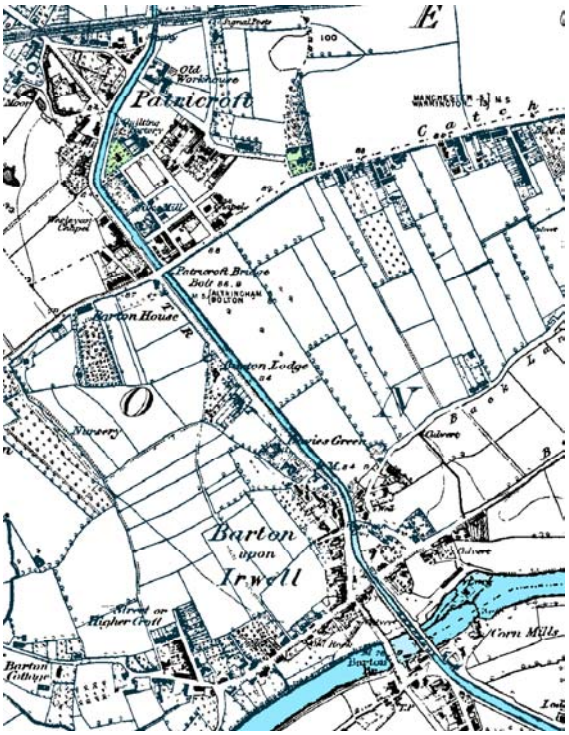


Figure 7

Location of Patricroft in relation to Barton-upon-Irwell

North is at the top.
500 m

Far from being a 'small cottage', as Nasmyth described it in his autobiography, the house was a substantial, late-eighteenth century, brick-built villa, with outbuildings and stables, standing in its own grounds (Figure 8). When Nasmyth lived there it would have been a very desirable residence in an attractive, semi-rural setting. From the its upstairs windows , Nasmyth could perhaps have seen the River Irwell in the distance, over three-quarters of a mile away beyond apple orchards and fields; but they are long gone[30].

Before moving to London in 1843, George Nasmyth still lived at Green Lane House with his mother, Barbara , and his unmarried sisters, Jane, Barbara and Margaret, who are described in the 1841 census as landscape painters. They had removed from Edinburgh following the death of Alexander in 1840[31]. By then, James had married, and had gone to live half a mile away, at Winton House, Patricroft[32].

In May 1840, James Nasmyth had married Anne Hartop, the daughter of one of his engineering clients from Barnsley, Yorkshire. He and Anne went to live at Winton House[33]. According to Patry, in the Sales Book 1837-1844 of the firm of Nasmyth, Gaskell & Co. there is an entry for James Nasmyth, Green Lane House, bearing the date 5 July 1840. On the following page is another, undated, entry for James Nasmyth, of Winton House, Patricroft. Patry suspected that this Winton House was the same as the house Nasmyth later referred to in a letter to Robert Wilson[34]. This property fronted Worsley Road on the western bank of the Bridgewater canal, immediately north of Patricroft Bridge. It was owned by his friend, Lord Francis Egerton, later Earl of Ellesmere. Later Ordnance Survey maps show it as Ellesmere House[35]. Patry cites a drawing made by Nasmyth from his new home that shows local landmarks, thus confirming this location[36]. The 1841 census records neither James nor Anne as being at Patricroft, so it is assumed they were not in Eccles on census day.

Figure 8

Green Lane House, Nasmyth's 'small cottage'

Photograph by the author, 2005.

Two years after his marriage, in 1842, James and Anne moved house, no more than a few hundred yards, but this time to the east bank of the Bridgewater Canal, on the inside of a sharp bend in the canal (Figure 9). This was a much smaller home, 'surrounded by a nice garden, planted with trees and shrubs'. This house is the one that Nasmyth refers to and depicts in his autobiography as Fireside, so-called because the rooms were so small that he and his wife 'were never far from the fireside'[37]. James acknowledged that Fireside, 'was small, but suitable for our requirement. We never needed to enlarge it, for we had no children to accommodate.'[38] Although wealthy, Nasmyth appears not to have sought to live in a larger property whilst in the Manchester area. According to James, he and Anne had a very contented marriage, and they lived at Fireside seemingly in comfort, and without any of the trappings of luxury[39]. There were few larger houses on the west side of Manchester; and Nasmyth was obviously happy to walk to work. To travel to Manchester and beyond, he took the train. He and Anne lived at Fireside from 1842 until his retirement to Penshurst, Kent in 1856[40].

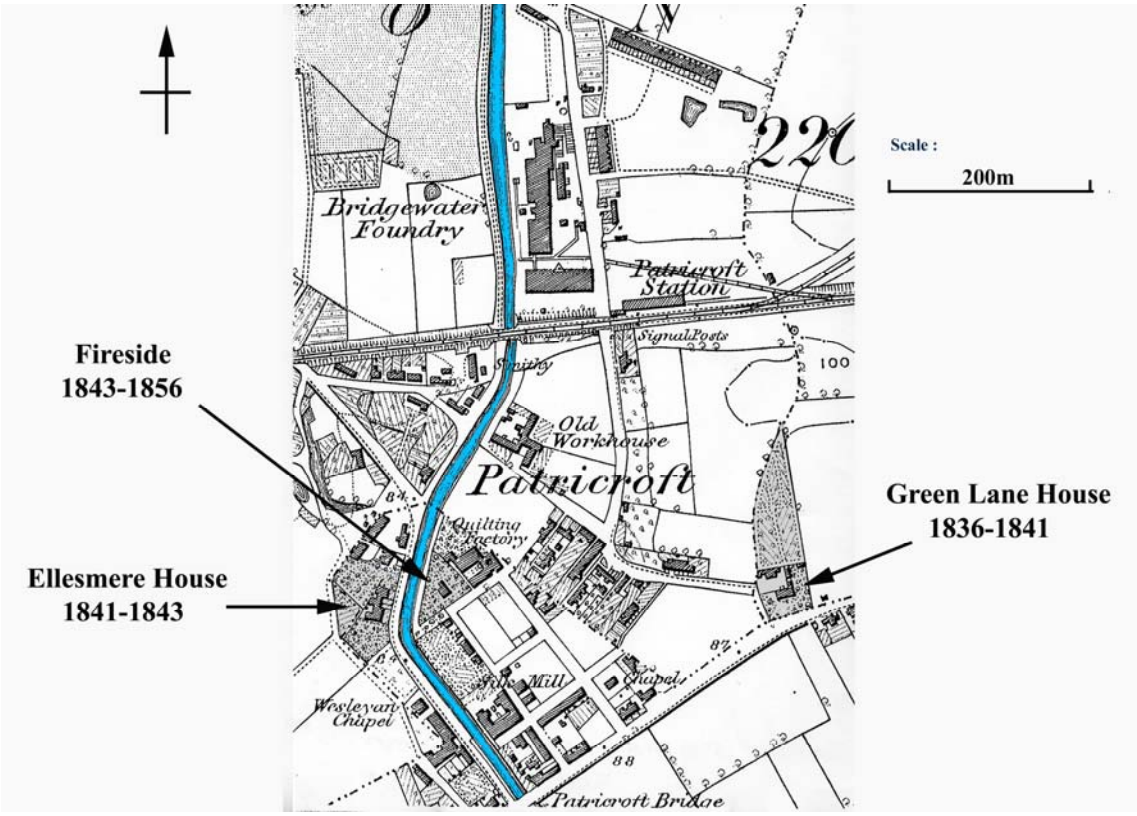


Figure 9

The locations of James Nasmyth's three rented homes in Patricroft 1836 to 1856

Figure 10

Fireside, Patricroft
after a drawing by James Nasmyth

Image from Nasmyth's *Autobiography* (Reference 2).

Although clearly illustrated in his autobiography (Figure 10), and described as being on the banks of the Bridgewater Canal, within a 5-minute walk of the Bridgewater Foundry, the exact location of Fireside proved rather difficult to pin down. It has apparently not hitherto been described in the astronomical literature. It is thought that this is because very few investigators have approached the subject other than from a local history level. Nasmyth's autobiography has proved to be too great a magnet to the astronomical historian.

Forty years after Nasmyth left Patricroft, in the summer of 1896, a newspaper reporter, Thorn Dene, also had difficulty locating Fireside until, by chance, a local gentleman, Councillor Thorpe, came forward with his own account of having lived there after Nasmyth had moved to Kent in 1856. From Thorpe's description, Dene was able to paint a word picture of Nasmyth's home as it was in the last decade of the nineteenth century[41].

> 'The approach to Fireside is by Legh Street, which runs off Liverpool Road [formerly Catch Inn Lane], from which thoroughfare the house can be seen quite well, for it forms the terminus of Legh Street and blocks its further extension. The front seems to have faced the east. Strange to say, there was only one window on this side[42]. The front door and front garden have disappeared as have also the row of trees that afforded such a beautiful screen. […] Fireside can never have been a fine house. It was probably a middle-aged edifice when Mr Nasmyth came to Patricroft.
>
> 'Probably the built out laboratory on the gable facing the canal was Mr Nasmyth's doing. It has been added to the sitting room, and we are informed is just as he left it. The shelves were used by him whilst engaging in some of his scientific pursuits. [Probably a reference to Nasmyth's growing interest in microscopy, but could easily have applied to his other experiments[43].]

'Mr Nasmyth was succeeded in the occupancy of the house by Mr Councillor Thorpe, who resided in it for twenty-one years [during which] the name was changed from Fireside to The Retreat. … Since then it has fallen on evil days … for five years it has been without a tenant … the adjoining land has been built upon and one room is used as an office by Messrs William Crippen & Co. whose mill adjoins it so closely that you can look out of the front window of 'Fireside' and gaze right into the interior of the factory …

'The corner of the garden near the canal was the place usually occupied by the big telescope. A conservatory, which appears in Mr. Nasmyth's own sketch of Fireside has long since disappeared.'

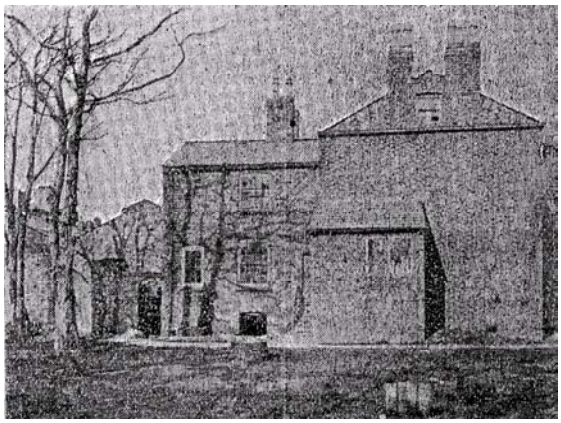


Figure 11

Photograph of Fireside that accompanied the articles by Dene in 1896

The original caption reads: "Fireside", the home of James Nasmyth, showing the office in which Nasmyth made his plans and drawings. (see Reference 41).

Nasmyth probably erected the conservatory, as it does not appear on the 1848 Ordnance Survey map. Neither does the curved garden path, so he obviously spent some effort in landscaping the garden. Anne was fond of gardening; when they moved to Hammerfield he built a greenhouse for her[44].

Fireside's garden also had to accommodate his telescopes, especially the fixed 20-inch on its turntable mounting. By observing from the north-east corner, in front of the conservatory, he would have maximised his view to the south, south-west and west. He had to sacrifice visibility to the east and north-east because of the proximity of the textile mill. Scarcely 20 feet away from his garden, and rising to about 30 feet high, it would have completely blocked this aspect. The 1896 Ordnance Survey map (Figure 12) shows a small black dot that may indicate the location of the telescope; its surveyors would have appreciated the exactness of Nasmyth's astronomical observatory. Its location tallies precisely with Nasmyth's sketch (Figure 13).

The 1896 Ordnance Survey map shows The Retreat much as Nasmyth would have known it as

Figure 12

Portion of the 1896 Ordnance Survey map of Patricroft, showing the location of 'Fireside', by then renamed 'The Retreat'

North is at the top. The 'dot' that is thought to show the location of Nasmyth's 20-inch reflector is shown circled for clarity.

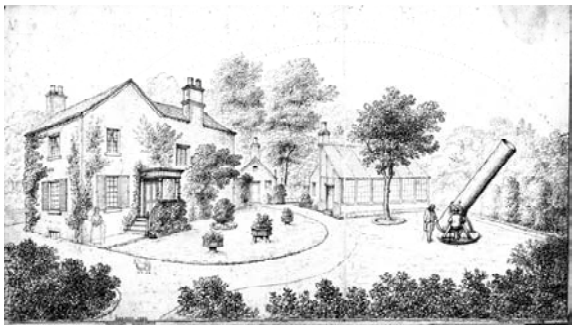


Figure 13

Nasmyth's 1850 drawing of Fireside

The location of the 20-inch reflector can be judged by its relationship to the house. Anne Nasmyth is shown lightly sketched to the left of the porch.
Courtesy of the Central Library, Edinburgh.

Fireside, 50 years earlier, but minus his conservatory and the 20-inch telescope. It was probably surveyed before Dene published his piece, and could have retained the location of his telescope from earlier surveys. The map shows the house, overshadowed by the nearby textile mill, much as it was during Nasmyth's tenure. However, by the time the map was published, and when Dene photographed it

in 1896, the house was semi-derelict and had been incorporated into the adjacent factory. An extension to the factory had encroached into the garden and it might have abutted the house wall. This sorry state lasted another 60 years. In 1954 the house was photographed from the air and it is clearly in poor condition (Figure 14). It was demolished in the late 1950s, almost exactly 100 years after James left it. Where it once stood is now (2005) an unmetalled car park for the industrial units occupying Crippen's mill, formerly the Egerton Cotton Mill.

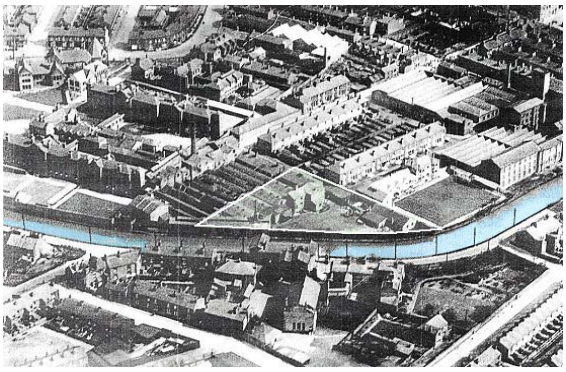


Figure 14

Aerial view in 1954 of the former 'Fireside'

The location of Fireside, on the east bank of the Bridgewater Canal, is outlined in white. See also Figures 2, 9 and 12.

The credit for this image is uncertain.

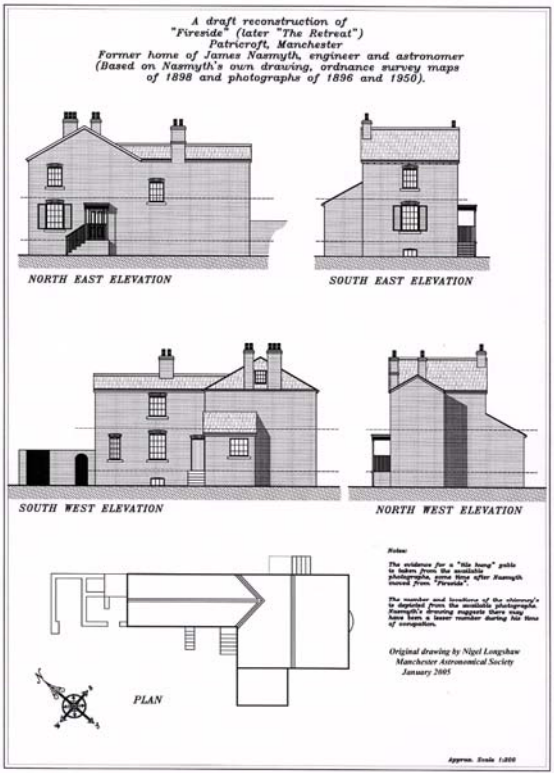


Figure 15

Fireside reconstructed from drawings, photographs and maps

Courtesy of Mr N. Longshaw.

In 1856 James Nasmyth left his Bridgewater Foundry forever and retired to Kent. It continued to be a thriving, independent, heavy-engineering company until 1939, when it became a British Ordnance factory. Since the 1960s, the site has declined, and the main buildings have mostly been demolished. It is now home to several small industrial units. Nasmyth's original factory is hardly discernible, and Fireside has long since gone.

Nasmyth's sketch showed Fireside from the south-east, from a position in nearby Spencer Street , looking quaint set against its background of trees and landscaped garden. Dene's photograph from the south-west shows the house unoccupied, with the factory in the background. Combining these views with a 1898 Ordnance Survey map and the 1954 aerial photograph, Longshaw (see Acknowledgements), prepared detailed 1:200 plan and elevations of Fireside (Figure 15)[45].

This is perhaps the only modern architectural drawing of Fireside that has been attempted. It shows the house to have been rather ugly. In 1971, Miss Patry said it was 'of red brick, by no means large [and] of an order of architecture it would be hard to describe … Early Eccles, lop-sided with additions.' [6] Nevertheless, it was home to James and Anne Nasmyth for 14 years. We now know where Fireside stood, and from where he began his interest in observational astronomy, using one of the most unusual of telescopes of the mid-19th century .

Acknowledgements

Dr John A. Cantrell teaches history at The Manchester Grammar School and has long held an interest in Nasmyth, both the engineer and the man. He has written and edited a number of books and many papers on the early UK engineering industry. John has provided me with many important Nasmyth biographical details.

The late Miss M. Patry, B.A., F.L.A. Eccles & District History Society. Her research in the 1960s provides the most compelling arguments for the identification of Nasmyth's several homes during the 20 years he lived at Patricroft. She also did much research into Nasmyth's family, particularly his sisters, after they had moved to London.

Mr Tim Ashworth. Salford Local History Librarian. Salford Archives. Tim has provided much local detail of the Nasmyths at Patricroft and copies of maps reproduced with permission.

Mr John Aldred. *James Nasmyth*, lecture to Eccles & District History Society. 12 January 2005.

Mr A.W. Cross, former president, Manchester Astronomical Society. Tony's enthusiasm for research into James Nasmyth's lost gardens of Fireside inspired me beyond my abortive and totally misinterpreted initial attempt of November 2004.

Mr Nigel Longshaw. Manchester Astronomical Society. An expert lunar cartographer in his own right, his January 2005, professional architectural drawings of Fireside are undoubtedly the most detailed ever attempted in reconstructing Nasmyth's last home at Patricroft.

Mrs Lynn Benson. Queens Arms, Patricroft. Nasmyth historian and publican.

Mrs Mary Hoot. Reference Section Librarian, Taylor Memorial Library, Cuyahoga Falls, Ohio. On a visit to the U.S.A. (March 2005) Mary kindly facilitated the provision to me of photocopies of Dobson's book from a copy held at Akron-Summit County Public Library, Akron, Ohio.

Notes and References

1 Cantrell, J.A. *The Bridgewater Foundry 1836-1940: the rise and fall of a famous firm.* British Association for Local History. November 2004. **34**(4). For an outline of the name changes of the Foundry, and the types and numbers of steam locomotives built there, see: Lowe, James W. British Steam Locomotive Builders. Cambridge: Goose and Son Publishers Ltd., 1975. 497-499.

2 Nasmyth, J. *James Nasmyth, Engineer: An autobiography*. Ed. Smiles, Samuel. London: John Murray, 1883.

3 Chapman suggests that Smiles probably reworked Nasmyth's account to show him in the best possible light as engineer, gentleman astronomer and pioneering scientist [see Chapman, A. *James Nasmyth: Astronomer of Fire*. In: *Yearbook of Astronomy, 1997*. Ed. Moore, Patrick. London: Macmillan, 1996. 143-167.] The autobiography does not show the important supporting roles played by his brother, George, nor that of his other business partners.

4 George James Nasmyth (1806-1862).

5 James Hall Nasmyth (1808-1890) was youngest of four sons and seven daughters born between 1787 and 1808. His mother, Barbara (née Foulis) was married to Alexander on 3 January 1786. The close family environment is not only written about fondly by James, but is often commented upon by Alexander's closest friends.

6 Patry, M. *Talking about Nasmyth*. Presidential address to the Eccles & District History Society, 8 September 1971. The house is illustrated on page 40 of Nasmyth's autobiography, but Miss Patry emphasises that the Nasmyth home is the house to the right in the building illustrated. It has a single ground-floor window flanking its door. It is not the house to the left having two ground-floor windows. Patry's paper is available from the Eccles & District History Society.

7 James and George collaborated in this project, which was proposed by them in a letter dated 19 March 1828. [see Note 39 in Two Maudslay Protégés: Francis Lewis and George Nasmyth. *Transactions of the Newcomen Society*. 2003. **73** (2). 257-274.] In his autobiography, James implies that he alone who provided the machine. This demonstrates his zeal to be seen as being first in any doings involving him and his brother, a theme that completely overtook his autobiography.

8 Ten people, if the sketch in Nasmyth's autobiography [Reference 2 above] is to be believed.

9 Cantrell, J.A. Two Maudslay Protégés: Francis Lewis and George Nasmyth. *Transactions of the Newcomen Society*, 2003. **73**(2) 257-274.

10 Indicated in a letter from James Nasmyth to David Octavius Hill, Royal Observatory, Edinburgh, 5 August 1835. [see Cantrell , J.A. Reference 9 above].

11 One of Nasmyth's daughters, Anne (born 1798), later married William Bennett [Patry, Note 6 above].

12 The mill no longer exists. Redevelopment, and the effects of the blitz of Manchester during World War 2, have erased all traces of it. Dale Street now (2005) comprises about 5 blocks of closely-spaced properties dating from the early 1800s. However, the 1850 Ordnance Survey map of Manchester shows in Dale Street an iron warehouse that in many respects fits a sketch by Alexander Nasmyth of James and Georges' premises, which stood end-on to Dale Street. If this is the case, the building is still (2005) in existence .

13 It is not known where the Nasmyth brothers lived in Manchester between 1834 and 1836, but it was probably close to the Dale Street workshop.

14 As a condition of leasing the site for a 2-storey engineering factory, the Nasmyths were obliged to build a multi-storey factory block, adjoining the railway at the southern end of the site, which if necessary could be turned into a cotton mill. This would, under normal leasehold conditions, revert to the ground landlord at the expiry of the term of the lease.

15 Initially the rent for this canal access was high, but Nasmyth soon negotiated very favourable terms with Lord Francis Egerton, later Lord Ellesmere, heir to the Bridgwater estates. They became lifelong friends. The Bridgewater Canal, opened in 1765, built for the Duke of Bridgewater by James Brindley, was the first long artificial canal (as distinct from canalised natural waterways). The 'canal age' proper is considered to have started in 1777, when Brindley completed the Trent and Mersey canal, the first to cross a watershed.

16 Alexander Nasmyth illustrated the Bridgewater Foundry in Nasmyth's autobiography [Reference 2 above]. The drawing was probably made in 1838, during Alexander's last visit to Patricroft. Curiously, it does not show the Patricroft Tavern, but neither is the high viewpoint, south-west of the Foundry from which to gain this perspective, entirely correct.

17 Cantrell, J. A. James Nasmyth and the Bridgewater Foundry: Partners and Partnerships. *Business History*. November 1981. XXIII(3).

18 They also had a 'sleeping partner', Henry Garnett, of Wyre Side, near Lancaster.

19 Cantrell, J.A. [Reference 1 above].

20 Gaskell sold out in 1852 due to ill health and the firm reverted to the name James Nasmyth & Co. See also Note 1.

21 The Creuzot Iron Works in France also lay claim to patenting the steam hammer in 1841, and there is controversy surrounding exactly who invented the device. According to Nasmyth, about two years earlier their M. Schneider accompanied by an engineer, M. Bourdon, visited the Bridgewater Foundry to order machine tools. Nasmyth was absent, but Gaskell took them on a tour of the works and also showed them his partner's 'Scheme Book' in which, among many others was the design for the steam hammer. They were at once struck by its originality and made careful notes of it, after which the matter was forgotten. In April 1840, Nasmyth visited France, and took the opportunity to visit the Creuzot Works. On going round the factory, he found his own steam-hammer at work! The Creuzot design was nearly identical to his own. Upon returning to England, Nasmyth immediately patented the steam hammer and began to manufacture them for the British and American market, Creuzot's steam hammer being essentially confined to the French and German markets.

22 Chandler, George. *Victorian and Edwardian Manchester and East Lancashire from Old Photographs.* London: Fitzhouse, 1990. In this book, the present Figure 6 is credited to the City Librarian, Manchester, but there is no detail on its origin.

23 Holbrook Gaskell was a cousin of William Gaskell, a Unitarian Minister, whose wife Elizabeth became a well-known novelist. There were regular visits between William and Elizabeth, and the Nasmyth brothers' homes. Elizabeth Gaskell used James Nasmyth as a model for Mr Manning in her novel *Cousin Phillis*, who, like Nasmyth, always had with him a little book that he used for mechanical memoranda and measurements [Patry, Note 6 above].

24 Nasmyth was an active member of the Manchester Literary and Philosophical Society and various engineering associations. He published his astronomical researches on his lunar observations and his studies of solar granulation in the Monthly Notices of the Royal Astronomical Society. His work on the Moon was published in Nasmyth, James and Carpenter, James. *The Moon Considered as a Planet, a World, and a Satellite.* London: John Murray, 1st edition 1874.

25 George moved to London in 1843, probably as a result of the 1842 financial recession, when the income of the Bridgewater Foundry fell dramatically; perhaps he felt personally responsible. In leaving, he missed the vast profits that followed the patenting of James Nasmyth's steam hammer, which made

fortunes for him and Holbrook Gaskell. George became a consulting engineer in partnership with Charles Lewsey, Consulting Engineers, Negotiators, Valuers and Arbitrators [Cantrell, J.A. Reference 9 above]. Their company continued to negotiate sales for the Bridgewater Foundry, but by then the family rift had probably become permanent. He married Isabella Sanford (died 1912), but, like James and Anne, George and Isabella had no children. [Patry, Note 6 above].

26 In 1857 George Nasmyth was appointed the first curator of the Patent Museum, but in 1859 he was suspended 'on suspicion of appropriating to his own use the public money entrusted to him', and was sacked. It is estimated that he might have misappropriated about £403 in total [Cantrell, J.A. Reference 9 above]. This event may explain why George is scarcely mentioned in James's *Autobiography*. George emigrated to the U.S.A. He died in Louisville, Kentucky, on 2 July 1862 [Dobson, D. *Scots in the USA and Canada, 1825-1875.* Baltimore, Maryland, U.S.A: Clearfield Publishing, 2002. 81].

27 There is circumstantial evidence, in a letter by Hunter Gaskell to his brother, Holbrook, suggesting that both George and Holbrook had a lot to put up with from James Nasmyth. There may well have been some serious differences of opinion between the two Nasmyth brothers [Patry, Note 6 above].

28 The area extending from Barton-upon-Irwell, and including Patricroft, was until quite recently (2005) known simply as Barton [Personal communication from L. Benson].

29 *Pigot's Manchester and Salford Directory.* 1837 and 1838.

30 Green Lane House, or The Poplars, as it is shown on the 1896 Ordnance Survey map, was later owned by the British aviation pioneer, A.V. Roe. It still (2005) stands, although late Victorian and early twentieth century Edwardian properties now encroach upon it.

31 Their presence at Green lane House is recorded in the 1841 census, but after George went to London in 1843, Mrs. Nasmyth and her daughters removed to Richmond Terrace, Pendleton, a district of Salford about two miles east of Eccles. Richmond Terrace was just around the corner from Leaf Square where one of her married daughters, Anne, lived with her husband William Bennet. Mrs. Barbara Nasmyth died in 1846, and her unmarried daughters subsequently went to live in London [Patry, Note 6 above].

32 *Pigot and Slater's Manchester Directory.* 1841.

33 The 1848 Ordnance Survey map shows a Winton House owned by a local farmer, 1 mile north-west of the Bridgewater Foundry. However, M. Patry considered (supported by other evidence) that Nasmyth's first marital home was not this one, but was Ellesmere House, then owned by Lord Ellesmere. In the period 1840 to 1842, James Nasmyth rented Ellesmere House for £60 per annum, but presumably, because he and Anne had no children during their first 2 years of marriage, decided that Ellesmere House was too big for them.

34 On 22 October 1855 James Nasmyth wrote to Robert Wilson (1803-1882), former factory manager of the Bridgewater Foundry and now James's successor as working partner, advising him that he once rented Ellesmere House, the agent being 'Daniel Bradshaw, auctioneer, [at] Winton'. [Winton is a district of Eccles, 1 mile north-west of Ellesmere House; hereby the possible confusion with the other Winton House.] He advised Wilson, if interested, to correspond with Bradshaw: 'he will tell you all about it'. Robert Wilson subsequently owned Ellesmere House from 1857 until his executors sold it in 1884. [M. Patry, from a copy of a letter referred to, supplied to her by the Newcomen Society].

35 Ellesmere House later became part of St. Joseph's Children's Home. It was demolished in the 1960s.

36 Drawing entitled *'View from my house at Patricroft, N*[ea]*r Manchester.'* Dated 1841 and signed by James Nasmyth, now in the National Library of Scotland, Edinburgh.

37 According to a note on the back of a drawing of Fireside, which is now in the Central Library, Edinburgh.

38 James and Anne Nasmyth had no children, but soon after leaving Patricroft and moving to Kent, James started a long-lasting affair with Virtue Squibb (c1830-1885). She was born in Sutton Poyntz, near Weymouth, and may have met Nasmyth whilst working in domestic service in London. During the affair, she adopted the name of Mrs Russell (or possibly Richardson, after her married sister, Mary). Nasmyth set up Virtue in a large house in Lupus Street, Pimlico, London, where her occupation is noted as Lodging House Keeper (1861 census). James Nasmyth's illegitimate daughter, Minnie, was born c1858 (her birth certificate has not been found). Mr. Chris Abbott, great grandson of Virtue Squibb, thinks that Nasmyth probably stopped supporting Virtue after Minnie was married in 1880 (as Minnie Russell or Richardson). In 1884, Virtue married Samuel Heath Head, a solicitor, and moved back to Sutton Poyntz, but probably in severely reduced circumstances. She died of cirrhosis of the liver in June 1885, by which time her husband is thought to have absconded with a considerable amount of her money, presumably provided by Nasmyth during their more than 20-year relationship. Nasmyth's daughter, Minnie, died in 1940. [www.Sutton-poyntz.co.uk/my_forum/posts/32.html accessed February 2005, and Personal communication from J.A. Cantrell, March 2005]. See also two letters dated 1880, from James Nasmyth to his mistress, Virtue Squibb (alias Emily Russell); a letter from Virtue Squibb to their daughter Minnie; and a letter from Nasmyth to Minnie dated 1885. The letters are accompanied by notes compiled by J.A. Cantrell, Stockport, Cheshire. [National Library of Scotland, Accession number 11882.]

39 Nasmyth's partner, Holbrook Gaskell bought Gorsefield, the property whose garden abutted that of Fireside on its south side. Their houses were about 50 yards apart. Gorsefield still stands in Legh Street, facing the bank of the Bridgewater Canal. It is now (2005) Patricroft Working Men's Club.

40 The 1851 census for Barton-upon-Irwell (Number of Householders Schedule, Page 31) has James Nasmyth, engineer, living at Gorsey, Patricroft, which according to Tim Ashworth (see Acknowledgements) was the area at the north of Legh Street. Nasmyth's age is given as 43 years. Anne Nasmyth, wife, age 33 years. They have 2 house servants, Ann Hellaby, age 25 years, and Jane [Johnson ?], age [28 ?]. The words in brackets are unclear in the Census return.

41 Dene, T. *Eccles & Patricroft Journal*. 8 and 15 May 1896.

42 Nasmyth's drawing of Fireside in his autobiography shows 3 windows on the north-east elevation.

43 In a letter to the Editor, it was suggested that Fireside could be used as a museum of industrial and natural curiosities. *Eccles & Patricroft Journal*. 18 June 1897. 8.

44 In 1850 Nasmyth drew 'a very correct drawing of my residence at Patricroft near Manchester where I resided from 1842-1856'. The pen and ink drawing is in the Central Library, Edinburgh. It includes a female figure, presumably his wife, Anne, which was omitted in the almost-identical illustration, labelled 'after a drawing by James Nasmyth', that was published in his autobiography in 1883. These facts beg the question: why did Nasmyth exclude his wife from the 1883 illustration?

45 The sources given in the header to Figure 15 are: Nasmyth's sketches (reproduced as Figures 10 and 13 in this paper); Ordnance Survey 1898, Lancashire, Eccles, Sheet CIII.7.23. scale 10 feet to 1 mile; and the 1954 aerial photograph reproduced as Figure 14 in this paper.

Nasmyth's Great Un-built Reflector

Kevin J. Kilburn

Past President, Manchester Astronomical Society

James Nasmyth (1808 to 1890), successful engineer and amateur astronomer, is best known for his development and use of his unique, 20-inch aperture, 'comfortable' telescope, which he used first in Patricroft, near Manchester, then in Penshurst, Kent. The main innovation in this modified Cassegrain telescope was that its fixed eyepiece, in a hollow altitude trunnion, offered the user greater productivity than conventional designs. Less well known is that in 1849 Nasmyth outlined plans for a 60-inch aperture telescope using the same principles. The speculum-metal mirror was to be mounted in a steel tube 5½ feet in diameter and 35 feet long, the whole mounted on a turntable. The telescope was never built; why?

By the mid 1840s, James Nasmyth (Figure 1) had become a very wealthy man. His engineering business in Patricroft, near Manchester, was doing well and he could afford time and money to pursue his passion, astronomy. His interests were the Moon, the Sun and the planets. As a teenager he had fashioned a 6-inch reflecting telescope and had shared his interest in astronomy with the engineer and inventor, Henry Maudslay[2], to whom he and his brother, George, had been apprentices and later assistants for 2 or 3 years, until 1831, when Maudslay died[3]. Shortly before this, Maudslay had been planning a 24-inch telescope for his private observatory at Norwood, west London.

Figure 1

Portrait of Nasmyth

Image taken from Reference 1.

Nasmyth had set up at Fireside, the home in Patricroft that he and his wife occupied from 1843 to 1856, a small Newtonian reflector, fitted initially with an 8-inch diameter speculum and later with a 10-inch diameter speculum, mounted in a square wooden tube[4]. Anecdote, probably encouraged by Nasmyth himself, suggested that a boatman on the Bridgewater Canal, which ran past Fireside, seeing him in his nightshirt at the dead of night, carrying the telescope around the garden to avoid shrubs and trees blocking his view of the sky, claimed that a ghost carrying its coffin in its arms haunted this bend of the canal.

It was at Fireside, too, that Nasmyth subsequently erected his pioneering 20-inch aperture reflecting telescope on its novel Nasmythian mounting[5]. The instrument was still under development in 1848-49, but it had already convinced him that its method of mounting, a hand-wheel-propelled turntable and trunnion, on which the seated observer moved around with the telescope, was the future for visual observations of solar system objects.

Nasmyth's configuration is a modified Cassegrain system, in which light is reflected from the primary, concave mirror to a convex secondary mirror, before being reflected to a flat tertiary mirror angled to reflect it to an eyepiece in the hollow trunnion of the altitude bearing. This system not only causes field rotation, but is extremely wasteful of light. In the 1840s, each reflection from metal specula lost about 60% of the incident light. Speculum metal was an alloy of high-purity copper and tin. Even though arsenic was added to 'whiten' the alloy, it had poor reflectivity, and needed more-frequent repolishing, compared with front-silvered, glass mirrors that became readily available a decade or so later. This light loss was of little concern to Nasmyth. He was interested in the Moon, the Sun and the planets, and they provided light in relative abundance. He wanted resolution and high magnification, both of which could be provided by a Cassegrain telescope of large aperture and long focal length.

Also, before Foucault's test, which was introduced in late 1850s to fine-tune parabolic refl-

ecting surfaces of medium or short focal ratio, it was necessary to optimise optical performance by using spherically-figured primary mirrors of long focal length[6]. These mirrors needed long tubes, commensurate with their large diameters and high focal ratios. A folded Cassegrain system was a light-losing compromise, but one that Nasmyth could afford to adopt in order to build a shorter telescope that was more convenient to operate.[7] His experiments and experience with the 20-inch supported his claims.

In 1849, Nasmyth discussed these points with his long-standing friend, Sir David Brewster, then living at St Andrews[8]. This correspondence may have precipitated his next idea. In a diagram dated 12 May 1849 Nasmyth outlined a monster 5-foot diameter telescope, with a tube 35 feet long and with a focal length approaching 70 feet. Two days later, on 14 May 1849, he wrote to Professor James Forbes at the University of St Andrews describing his proposed instrument[9] (Figure 2).

In anticipation of Forbes's likely objection to the increased light loss from a 3-reflection system, Nasmyth pointed out that the light loss from the third reflection on a 5-foot telescope would still give equal image brightness to a telescope of 4ft 6inches aperture but of 'usual' layout. However, his main argument for the design was that:

> '… rendering such gigantic instruments comfortable to use will importantly serve science [and] there can be no doubt in as much as the observations with such a telescope as I propose to make will by the simple reason of comfort & ease of management yeald (sic) 100 observations while one on the hitherto cumbrous system would not yeald 10.'[10]

The Nasmythian tertiary reflector (Figure 3) lost a lot of light, but he reasoned that observing from a fixed seat at the trunnion-mounted eyepiece more than made up for that loss by providing a comfortable observing position that actually encouraged one-man operation and hence more frequent use. The telescopes of William and John Herschel, and the Earl of Rosse's 6-foot, 'Leviathan of Parsonstown', had complex mountings that needed several men to work them on behalf of the single observer. It should be remembered, however, that the Herschels and Rosse probed the skies for very faint objects, close double stars and nebulosities. For these observations they needed telescopes with maximum light grasp, which was achievable only by minimising the number of reflections. The Herschels used single-

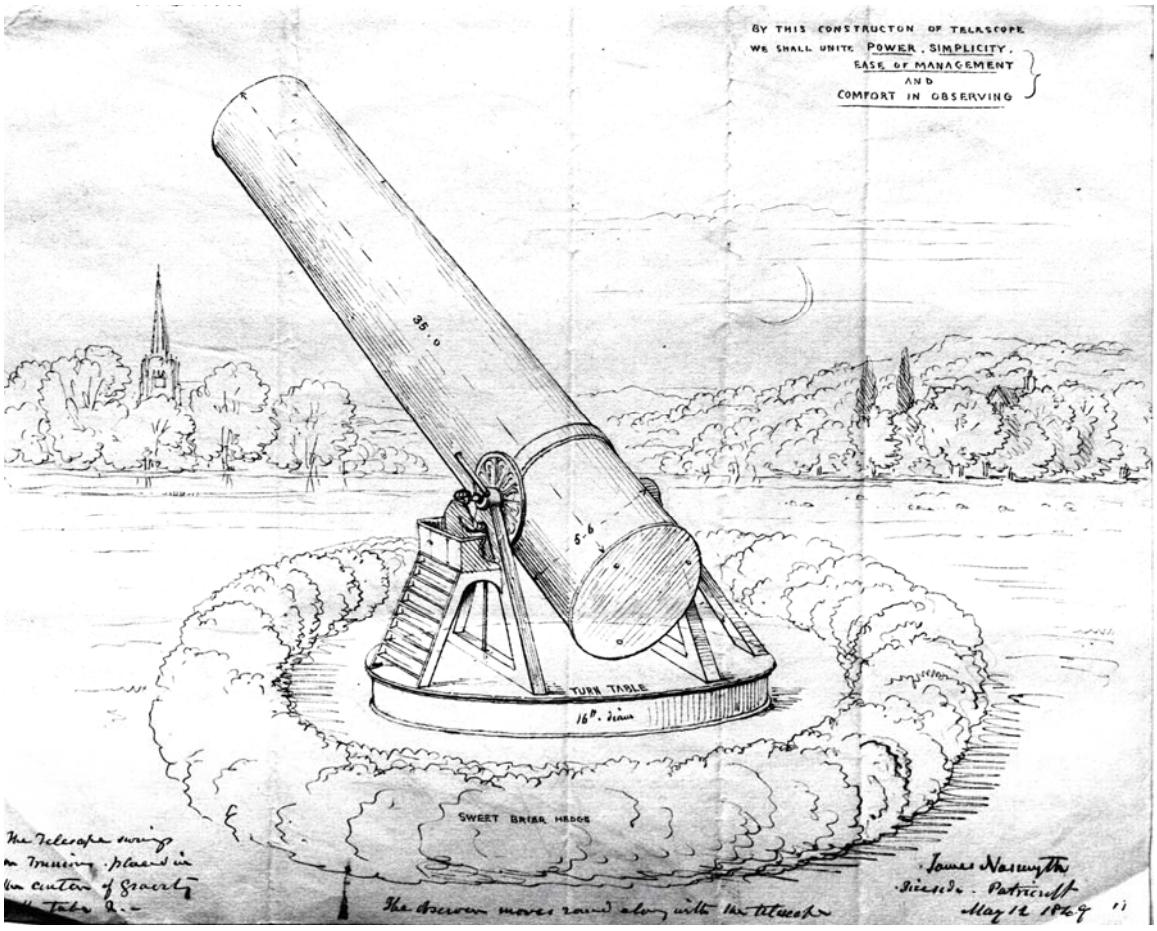


Figure 2

Nasmyth's sketch of his proposed 5-foot reflector

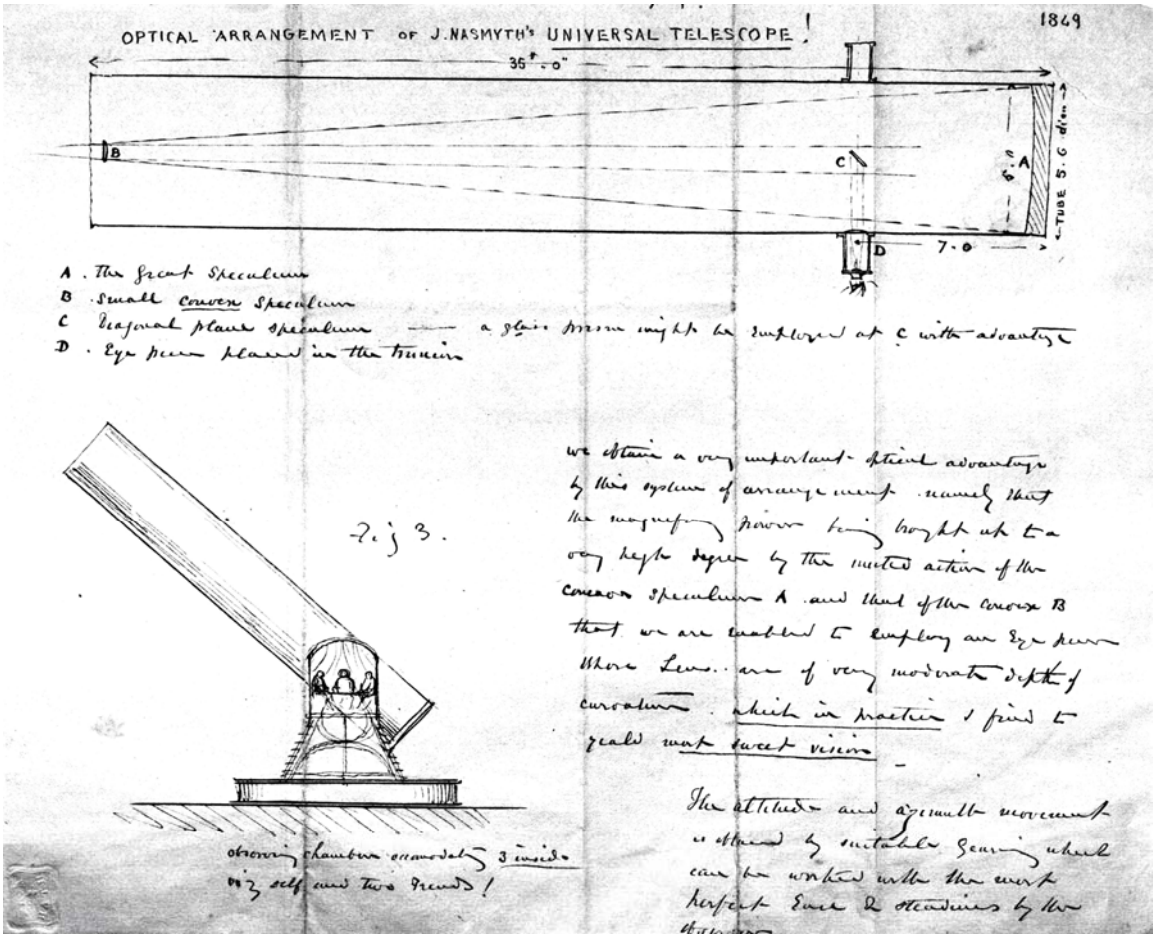


Figure 3

The optical layout of Nasmyth's proposed 5-foot reflector

Illustration taken from Reference 9.

reflection, front-view Herschelian telescopes; Rosse used the two-reflection, Newtonian design.

Nasmyth intended to manage the magnification of his 5-foot telescope not by using interchangeable eyepieces of short focal length, but by adjusting the separation of the primary and secondary mirrors, which he referred to as 'metals':

> 'I bring up the Power by the action of the concave & convex metals so that the greater part of the duty of magnifying power is accomplished by the metals themselves and not by the eye piece which in my case admits of the use of an eye piece of very moderate power whereby the light is not put to torture in having to be treated by lenses of such small diam. [sic] & deep curve […] there is a pleasantness of vision and a sharpness & comfort that so far as I can judge remarkably characterises the vision with my system of arrangement.'[11]

With a focal length of some 70 feet, the magnification of his proposed telescope would have been enormous using conventional eyepieces. The eyepiece optics therefore had to be matched to those of the primary optics and, like Rosse, he had to design his own. He illustrates his proposal in his letter to Forbes[12], and contrasts it to a conventional eyepiece (Figure 4). It is not clear if the device would have optimised the telescope, and if moving the secondary mirror with respect to the primary would have had a precisely-controlled affect on the gross magnification from an essentially fixed eyepiece. Nevertheless, had it ever been constructed, Nasmyth's 5-foot telescope would have been the second-largest telescope in the world at that time, second only to Lord Rosse's 6-foot telescope.

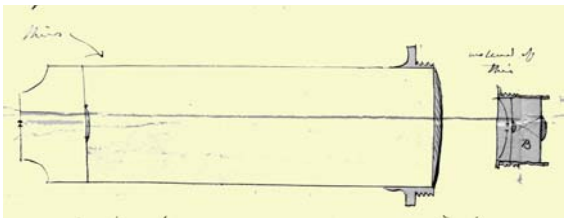


Figure 4

Nasmyth's design for eyepiece of his proposed 5-foot reflector

Note the contrast of the light path with that of the conventional eyepiece shown at the right of the sketch.

Nasmyth never did build the 5-foot telescope although he said:

> 'If £1000 will accomplish this I shall gladly devote that sum to the attainment of such an object.'[13]

It would have been a huge investment for the mid–19th century, but one that Nasmyth felt worthwhile. He would certainly have been able to afford the cost, and materials and skilled labour would have been available from his Bridgewater Foundry. But it never happened: why not?

The 20-inch telescope was certainly a success. In June 1851 Nasmyth wrote to Professor John Phillips of Oxford:[14].

> '… I have done a deal on the moon this year with my new comfortable 20in reflector which is a first rate tool for that special job or class of work it is really a vast comfort to be able to sit at ones ease on an easy chair and sweep the heavens without having to mount ladders. as the Picture Books used to say "See there it is"' [Figure 5]

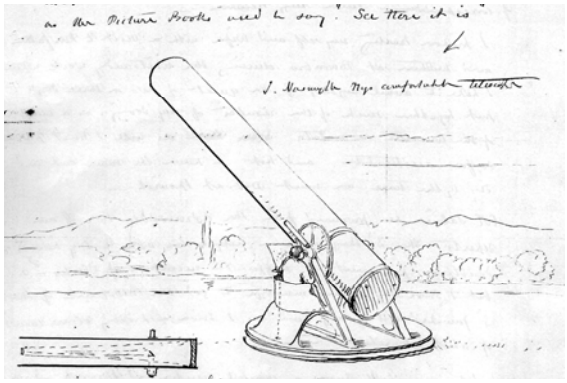


Figure 5
Nasmyth's 20-inch telescope sketched in his letter to Professor Phillips
Illustration taken from Reference 13,
reproduced by courtesy of University of Oxford Museum.

> 'The eye piece is placed in the hollow trunnion and the observer seated with his eye opposite to it and the entire instrument being mounted on 'a turn table' so which ever direction he points the telescope it makes no difference to him he is always in the right position to obtain this & employ a 3d reflecting surface by which a little light is lost and a vast amount of comfort and convenience gained.
>
> 'Excuse this palaver from yours most faithfully
>
> James Nasmyth'

The 20-inch telescope was more than adequate for observing the Moon, the Sun and the planets. A 5-foot telescope would have been better, but might have presented engineering problems that could have more than offset its much greater light grasp. A 16-foot railway turntable, modified to carry the proposed 35-foot telescope tube would, alone, have weighed several tons. Similar turntables were used in Nasmyth's foundry. They were easily capable of being operated by one or two men to swing 20-ton railway locomotives in the Bridgewater Foundry from tracks laid into the factory and then at right angles onto the siding that ran to the main line. But to manoeuvre a large telescope single-handed, with the delicacy needed to follow an astronomical body, might have proved too much, even for Nasmyth. However, his name is well remembered in the world of big telescope building; the stationary Nasmyth foci, using the configuration he invented, are widely used on giant, modern instruments to carry heavy, sensitive instruments such as spectroscopes.

Acknowledgements

The author wishes to acknowledge with thanks the support he received when preparing this paper from:

Dr John A. Cantrell, for the information contained in his personal communication of February 2005.

Dr Norman H. Reid, Keeper of Manuscripts, Head of Special Collections, University of St Andrews Library, for permission to reproduce Nasmyth's drawing of the 5-foot telescope.

Notes and References

1 Nasmyth, J. *James Nasmyth, Engineer: An autobiography*. Ed. Smiles, Samuel. London: John Murray. 1883.

2 For a fuller account of Nasmyth's work on the development of the telescope, and of his observations of the Sun and Moon, see Chapman, A. *James Nasmyth: Astronomer of Fire*. In: *Yearbook of Astronomy, 1997*. Ed. Moore, Patrick. London: Macmillan. 1996. 143-167.

3 Ashbrook, J. *James Nasmyth's telescopes and observations.* In: *The Astronomical Scrapbook.* Cambridge, Massachusetts, USA: Sky Publishing Corporation. 1984.

4 King, H.C. *The History of the Telescope*. London: Charles Griffin & Company Limited. 1955. 217.

5 The 20-inch telescope is currently (2005) in storage at the National Museum of Science and Industry, London. It has not been on public display since 1988, although it can be viewed by obtaining prior permission. In 2002 it was proposed by the author that this instrument might form the focal point in a refurbished Air and Space gallery at the Museum of Science and Industry, Manchester (MSIM). Informal discussions with Dr Ian Griffin, Director of MSIM, suggest it possible that the Nasmyth telescope will be loaned to MSIM.

6 The Focal Ratio (f) of a telescope is the mirror focal length divided by its diameter. Most modern reflecting telescopes have a focal ratio in the range f4 to f8. Spherically-figured mirrors are typically f10 or greater.

7 This is analogous to use of configurations such as folded Maksutovs to produce portable telescopes today.

8 Nasmyth, J. Reference 1 above. 337.

9 Letter from Nasmyth to Forbes dated 14 May 1849. Papers of James David Forbes. msdep7, Incoming Correspondence 1849 number 25, Forbes Collection (1849/25 a & b), transcribed by Dr John A. Cantrell, with permission of the University of St Andrews Library.

10 From Reference 9 above.

11 From Reference 9 above.

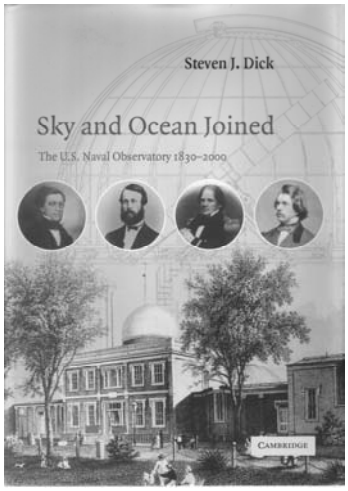
12 Reference 9 above.

13 From Reference 9 above. On purely currency conversion basis, this sum would equate to about £50 000 today [Bank of England Contemporary Values of the Pound]. This figure ignores relative levels of affluence; a realistic equivalent would be considerably greater.

14 Letter from James Nasmyth to Professor John Phillips 2 June 1851. University of Oxford Museum Accession number 1851/3.

Sky and Ocean Joined: An Essay Review

Gilbert E. Satterthwaite
Chairman, Society for the History of Astronomy



Sky and Ocean Joined
The U.S. Naval Observatory 1830−2000
by Steven J. Dick

Cambridge University Press
October 2002
ISBN 0 521 81599 1 £95.00

624 pages
212 half-tones
11 line diagrams
Winner of several awards and prizes

This book, as its sub-title suggests, is a history of one of the oldest scientific institutions in the United States; one of the world's leading centres for astronomical research. Its author (portrait above) is well qualified to compile this first detailed history of the United States Naval Observatory (U.S.N.O.), having been a member of its staff since 1979 as both astronomer and historian, with distinguished qualifications in both fields. He has an international reputation, and was President of Commission 41 (History of Astronomy) of the International Astronomical Union from 1997 to 2000.[1]

In the event his book proves to be very much more than a straightforward history. Given the nature of the U.S.N.O., and the complexities of its foundation, its remit, its staffing structure and the competing requirements of the astronomical and nautical communities, its story is a very complex one with not infrequent conflicts. The importance and international nature of much of its work, and its consequent links with other establishments throughout the world, have resulted in a book which also provides a unique survey of certain aspects of astronomy, notably positional[2] observations, celestial mechanics and the measurement of time, during a period when the development of these fields was at its height. It also provides an insight into the competing ambitions of astronomers working in very different fields and the requirements of navigators, and also the involvement of politicians with often limited understanding of their several needs.

Among the most noticeable aspects of the history of the U.S.N.O. are very close parallels with that of the Royal Observatory, Greenwich. Both establishments were founded for the benefit of navigators, both later diversified into other areas of astronomical research whilst retaining their original purpose. Their major observational effort was the constant measurement of the changing positions of astronomical bodies, required for the determination of the theory of their motions and the preparation of ephemerides; both eventually absorbed their national Nautical Almanac Offices, which had previously been separate establishments. Both of them had to justify extending their work into wider aspects of astronomy to governing bodies largely concerned with the requirements of navigation rather than scientific progress. In both cases it was to be many years before the interests of sky and ocean could indeed be jointly pursued.

Dick summarises the background splendidly:

> '… only a finite number of problems dominates Naval Observatory history [but] they reappear again and again in ever more subtle and expressive forms. The determination and dissemination of time; the definition of an increasingly accurate and dense stellar reference frame; the determination of the astronomical constants; the closing of the gap between observation and gravitational theory as applied to the motions of the planets, satellites, and other solar-system objects; and the uses of all these aspects for navigation' (Page 3).

He describes the history in three parts: the founding era; the golden era; and the twentieth century.

In the founding era he describes the creation of the U.S. Navy's Depot of Charts and Instruments, first proposed in 1829 and finally established as the Naval Observatory in the 1840s with a major responsibility for rating the Navy's chronometers and the determination of accurate time against which to rate them. Initially carried out on temporary sites, this led to the establishment in 1843 of a permanent building incorporating an observatory in an area of south-west Washington D.C. previously

intended as the location of a university campus (Figure 1). Dick describes the background of complicated negotiations and bureaucracy against which systematic astronomical observations began, qualified staff were appointed, and the instrumental equipment expanded. Another major development during this founding era was the creation, in 1849, of the United States Nautical Almanac Office (U.S.N.A.O.).

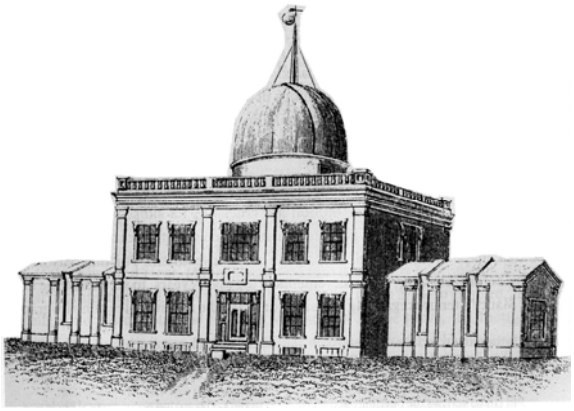


Figure 1

The first U.S. Naval Observatory building at Foggy Bottom, Washington D.C. c. 1846

Image taken from *Sky and Ocean Joined*.

Dick names the years 1866 to 1893 'the golden era'; it was indeed a golden era in the development of national observatories throughout the world, and their work. Despite being a much younger establishment – the national observatories in Paris and Greenwich had been founded in 1669 and 1675 respectively – during these years the U.S.N.O. became a world leader. In addition to playing a major role in the development of increasingly precise fundamental[2] astronomy, the Observatory also diversified into the 'new astronomy', requiring the use of large-aperture, equatorially-mounted telescopes, in addition to the specialized equipment used for the time and positional work, notably the Alvan Clark 26-inch refractor completed in 1873. The new status of the U.S.N.O. was confirmed by Asaph Hall's discovery of the satellites of Mars in 1877 with this instrument.

The site of the first permanent observatory had, however, proved very unsatisfactory, situated as it was, close to the Potomac River and surrounded by a marshy area from which frequent fogs interfered with the observations, and which also exposed the staff to severe infections, notably malaria. The site became known as 'Foggy Bottom', and there were frequent requests for removal to a more suitable location, not least from the staff. However, it was not until 1893 that the Observatory finally moved into new premises, about two miles away, on a site with clear horizons to the west of the city (Figure 2). The U.S.N.A.O. also moved onto the new site, and a year later was integrated with the U.S.N.O.

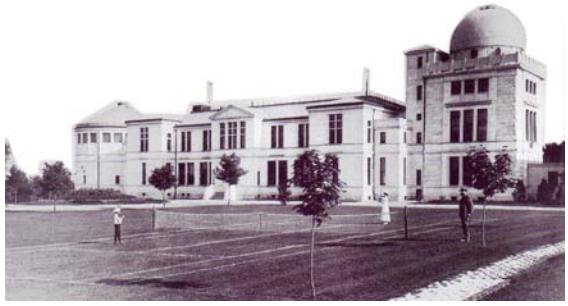


Figure 2

The U.S. Naval Observatory new buildings c. 1902

Image taken from *Sky and Ocean Joined*.

During the twentieth century the Observatory continued to play a leading role in international efforts to refine all aspects of fundamental astronomy and to provide time to ever greater accuracy, not least to meet the needs of the Space Age and satellite navigation. The need to observe ever-fainter objects, and the increasing light pollution around Washington D.C., culminated in the establishment in 1955 of a field station in a dark-sky site near Flagstaff, Arizona. In 1964 a 61-inch reflector, (the Kaj Strand Astrometric Reflector) specifically designed for the astrometry of faint objects, was inaugurated at this site – the first major astrometric[2] instrument not to be a refractor.

The story of a major observatory and the work carried out there is inevitably the story of its directors and staff also. Administration of the U.S.N.O. was the responsibility of its Superintendent, a high-ranking naval officer, whilst the astronomical work was directed by Scientific Directors and heads of department, a rather different situation from the R.O.G. where both aspects were the responsibility of the Astronomer Royal. The list of U.S.N.O. and U.S.N.A.O. personnel includes many astronomers of great distinction. It is perhaps invidious to select just a few for specific mention, but it is no surprise to find among them leaders in the field of positional astronomy, such as Clemence, Markowitz, Strand and Duncombe. Without doubt however the outstanding name on the list is Canadian-born Simon Newcomb, who for twenty years directed the U.S.N.A.O. and also played a leading role in the work of the Observatory (Figure 3). His name will be forever associated with the redetermination of the fundamental constants of astronomy, such as precession and nutation, and the improvement of lunar theory. Between 1879 and 1912 he published new determinations of the motions of all eight planets then known, as well as

planetary satellites and other smaller bodies. For this purpose he initiated the series of Astronomical Papers[3], which remain some of the most seminal works of fundamental astronomy. Co-operation with the national observatories of other nations was increasingly important during his time, and it can be argued that no-one contributed more during the 'golden era' than did Newcomb in Washington, and Airy at Greenwich, a fortuitous juxtaposition of the two great masters in theoretical and practical positional astronomy. This co-operation was to continue through the twentieth century, culminating in the unification in 1960 of the British and U.S. Nautical Almanacs as *The Astronomical Ephemeris.*

Figure 3

Simon Newcomb (1835-1909) at the time he came to the U.S. Naval Observatory in 1861

Image taken from *Sky and Ocean Joined*.

Dick has devoted fifteen years to the preparation of this book, using Observatory archives, administrative correspondence, Senate papers, U.S. Navy records and personal interviews. His painstaking research is meticulously recorded, and all sources are fully detailed, resulting in 600 pages packed with material that will long remain a standard reference work. The casual browser may at first be put off by the number and length of the footnotes, but the serious reader will soon realise that the history could not have been presented in any other way. So vast is the content of the footnotes that it would have been totally impracticable to compile them into end-notes, and it would have been impossible to have to locate and study several end-notes whilst reading every page of the text. Despite the presence of so much necessary historical detail, Dick has produced a text which is also extremely readable, with many relevant and interesting illustrations and a very thorough index. The entire production is of the highest standard, and both author and publisher are to be congratulated on the care which has gone into the design and content of the book. In the opinion of the reviewer this book is an outstanding example of the genre, quite the most important contribution to the literature of the history of astronomy to appear for many years.

It is interesting to consider how this documentation of U.S.N.O. history compares with that of other similar institutions. Unfortunately none of them have been given such excellent and thorough treatment. Not surprisingly the most fully documented is the Royal Observatory at Greenwich, later to become the Royal Greenwich Observatory at Herstmonceux and Cambridge, and sadly, unlike the U.S.N.O., no longer a functioning observatory. To gain a comparable picture of its history requires the reading of not one, but several books. The first history was that by E.W. Maunder[4], published in 1900. This was a popular account for the information of ordinary members of the public who had no access to the Observatory and little knowledge of what went on inside it. A slim, but excellent, booklet by the then Astronomer Royal, Sir Harold Spencer Jones[5], appeared in 1943. It is less discursive, but provides an excellent summary of the main aspects of the work of the establishment under his nine predecessors.

The tercentenary of the Royal Observatory in 1975 prompted publication of the first detailed history, issued in three matching volumes: Volume 1, by E.G. Forbes,[6] describes the origins and early history of the Observatory (1675−1835); this was continued in Volume 2 (1836−1975), by A.J. Meadows[7]. These volumes outline the work carried out under the various Astronomers Royal and are adequately referenced, but for detail cannot match Dick's history of the U.S.N.O. To obtain comparable detail about Greenwich would require additional study of the annual *Reports of the Astronomer Royal*[8], and the Introductions in the annual volumes of *Greenwich Observations*[9]. Volume 3 of the Tercentenary publication by H.D. Howse[10] is a very detailed description of the buildings and instruments; only this volume achieves detail comparable to that of Dick. A very thorough study of the work that was the original purpose of the R.O.G., time and the longitude, was also published by Howse[11]. Another good publication, by W.H. McCrea[12], appeared in the tercentenary year: it is a booklet targeted at the general public, which gives excellent coverage within its small format. The history of the British Nautical Almanac Office is outlined in a paper by G.A. Wilkins, in a volume published for the sesquicentenary of the U.S.N.A.O.[13], of which Dick was co-Editor, and in which he contributes a brief history of the American Office. Apart from its

official publications, no written history exists of the R.O.G. for its final years (1976-1998). It is to be hoped that one day a really detailed history covering its entire existence will be produced to the standard achieved by Dick for its sister establishment.

Other national observatories also lack such a detailed study; again, the narratives which do exist have to be supplemented by very detailed examination of countless volumes of official publications to get a full historical picture. One that is reasonably well documented is the Royal Observatory, Cape of Good Hope, established in 1820 as a southern-hemisphere outpost of the Royal Observatory, Greenwich. Its history, and that of the astronomers who worked there, has been well researched and documented by Brian Warner[14,15]. Narrative histories of the Paris Observatory have been published by Wolf [16] in 1902 and Couderc[17] in 1968.

The Pulkovo Observatory, situated on a hill about 29 miles south of St Petersburg, in the present-day Russian federation, was founded by F.G.W. Struve in 1839.[18] Its main purpose was fundamental astronomy, including the production of a series of very accurate star catalogues, the measurement of latitude variation and the provision of a time service. Its second director was the founder's son O.W. Struve. By the 1860s it had also expanded into astrophysical research. A field station was set up in Odessa in 1898, and moved to Nikolayev in 1909, when the Observatory of the Naval Department, founded there in 1821, became part of the Pulkovo Observatory. A second field station was acquired at Simiez in the Crimea in 1908. Pulkovo Observatory was totally destroyed in 1941 by German bombs, but was rebuilt and reopened in 1954. A brief but detailed and well illustrated history in English[19] was published in 1958.

Readers interested in the broader field will find many interesting leads in the Greenwich List of Observatories to 1850[20], and a fascinating study of the rate of increase in the number of observatories during the nineteenth century by Herrmann[21]. Other descriptions of observatories, including aspects of their histories, are given by Donnelly[22] and Marx and Pfau[23].

To summarise, Steven Dick has produced a superlative piece of historical research and published a volume that should be taken as both a model and an inspiration to all who follow after.

Notes and References

1 Having 'written himself out of a job' by completing this definitive book, he has now become Chief Historian at the National Aeronautics and Space Administration.

2 I have used the term *positional* astronomy when referring to the monitoring of the changing positions of moving bodies, such as planets and satellites, usually by the use of meridian instruments. *Astrometry* is used in the sense of photographic astrometry, which is principally used for the determination of the positions and proper motions of the 'fixed' stars. The term *fundamental* astronomy embraces both of these, together with the analysis of the observations for purposes such as the improvement of orbital theory, the refinement of astronomical constants, the measurement of time and latitude variation, and the production of ephemerides and star catalogues.

3 *Astronomical Papers prepared for the use of The American Ephemeris and Nautical Almanac.* Serial publication, U.S. Government Printing Office. Volume 1 issued 1882.

4 Maunder, E.W. *The Royal Observatory Greenwich*. London: Religious Tract Society, 1900.

5 Jones, H. Spencer. *The Royal Observatory, Greenwich*. London: The British Council and Longmans Green, 1943.

6 Forbes, E.G. *Greenwich Observatory. Volume 1: Origins and Early History (1675−1835).* London: Taylor & Francis, 1975.

7 Meadows, A.J. *Greenwich Observatory. Volume 2: Recent History (1836−1975).* London: Taylor & Francis, 1975.

8 *Reports of the Astronomer Royal to the Board of Visitors of the Royal Observatory*. Annual series from 1836.

9 *Greenwich Observations*. Annual series from 1742. London: His (Her) Majesty's Stationery Office.

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14 Warner, B.J. *Astronomers at the Royal Observatory, Cape of Good Hope*. Cape Town: Balkema, 1979.

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20 Howse, H.D. The Greenwich List of Observatories: A World List of Astronomical Observatories, Instruments and Clocks 1670−1850. *Journal for the History of Astronomy.* 1986. Number 51. **17**(4). i-iv and 1-100. See also, Howse, Derek. The Greenwich List of Observatories: A World List of Astronomical Observatories, Instruments and Clocks 1670−1850. Amendment List No. 1. *Journal for the History of Astronomy.* 1986. Number 80. **25**(3). 207-218.

21 Herrmann, D.B. An Exponential Law for the Establishment of Observatories in the Nineteenth Century. *Journal for the History of Astronomy*. 1973. Number 9. **4**(1). 57−58.

22 Donnelly, M.C. *A Short History of Observatories*. Eugene, U.S.A.: University of Oregon Books, 1973.

23 Marx, S. and Pfau, W. *Observatories of the World*. London: Blandford Press, 1982.

All illustrations used in this Essay Review have been taken from *Sky and Ocean Joined*.

Authors and Reviewers

J. L. Birks B.Sc., Ph.D., F.I.P.E.M.

The Penllergare Observatory 3

Dr John Birks was born in Derbyshire, and lived at Denby Village, birthplace of the subject of his book *John Flamsteed: the First Astronomer Royal at Greenwich.* (London: Avon Books, 1999). He has always had an interest in astronomy, and found practical physics fascinating. As a young boy he observed a partial solar eclipse through smoked glass, but has learned better since! He also made simple telescopes from cheap spectacle lenses. After retiring from a career in Medical Physics (the last 30 years spent working at a hospital in Swansea) he was able to devote more time to astronomy, and to the Swansea Astronomical Society. He now observes sunspots regularly, and has photographed the Aurora Borealis in Norway and the Canadian Yukon (highly recommended), and the 1999 total eclipse from Lake Balaton, Hungary. He keeps a general watch on the night sky and gives talks to astronomical societies in South Wales. His interest in the old Penllergare Observatory was kindled when he heard of the sterling work done by Gerry Lacey (a former, dynamic, Secretary of the Swansea Astronomical Society) in rescuing this historic building from threatened demolition and in helping its preservation in 1982. As nothing about the observatory was written up, he undertook the task of collating the information that had been collected, to put the site on record as an aid to its possible further restoration.

A. Chapman M.A., D.Phil., D.Univ., F.R.A.S.

The Observers Observed: Charles Dickens at the Royal Observatory, Greenwich, in 1850..... 9

Dr Allan Chapman is a professional historian of astronomy and medicine at Oxford University. He has been interested in astronomy since childhood, being inspired by the then few books of Sir Patrick Moore. He has always been fascinated by telescopes and other instruments, and has made many since the age of eleven; but though he enjoys looking at the Moon, planets, and stars with his own modest equipment, he is primarily interested in the lives and achievements of earlier astronomers. The subject of the present paper occurred to him when, some years ago, Dr Mary Brück first drew his attention to the 1850 *Household Words* articles on the Royal Observatory. As he is engaged on a long-standing project to write the biography of Sir George Biddell Airy, he realised that the articles opened up new aspects of Victorian Greenwich, and how the public viewed it.

M. A. Frost M.A.(Cantab.), M.Sc., M.I.E.E., M.I.M.A., C.Eng.

J. Norman Lockyer: The Early Years 21

Mike Frost is past-chairman of Coventry and Warwickshire Astronomical Society, a member of the British Astronomical Association, and a founder-member of the Society for the History of Astronomy. He is an occasional contributor to *Astronomy Now* and to the *Journal of the British Astronomical Association*, and lectures on astronomical topics to Societies around the country. For his day job, he is a systems engineer putting computer control into steel mills around the world. This paper arose following a talk on J. Norman Lockyer he gave to the Rugby Historical Association. The Rugby Local History Group subsequently encouraged him to find out more about Rugby's most famous astronomer (so far).

R. I. G. Jones

Sir Robert Ball: Victorian Astronomer and Lecturer par excellence..... 27

Roger Jones lives in the West Midlands, and retired early from a management career in multiple retailing. His early interest in astronomy was awakened by Corliss Lamont's *Humanism as a Philosophy*. In the early 1990s he joined Wolverhampton Astronomical Society, and developed an interest in the history of astronomy after attending lectures on the subject. In the year 2000 he acquired two books by Sir Robert Ball that inspired him: *In the High Heavens* and *In Starry Realms.* As a regular visitor to Birmingham

Central Library, which holds all Ball's books, and *Reminiscences* by his son, W.V. Ball, he researched Ball's career and gave a talk on it to Wolverhampton Astronomical Society in 2001. His paper is based on lectures he gave at the Annual General Meeting of the Society for the History of Astronomy in Cambridge in May 2004, and in February 2005 at the Monday Lectures of the Birmingham and Midland Institute, Birmingham. He is currently compiling data for a *Sir Robert Ball* website. He was a founder-member and Council member of the Society for the History of Astronomy.

K. J. Kilburn F.R.A.S.

At four years old, the partial solar eclipse of June 1954 started Kevin's life-long interest in astronomy. He spent the 1960s observing the Moon and planets with binoculars and a home made 6-inch Newtonian telescope. The 1970s and 1980s were a time when going to see the launches of Apollo 15 and 17, and the total solar eclipse of 1973, heralded deep involvement with Manchester Astronomical Society. Kevin is the only member to have been elected President of the Society three times since it was formed as the North-West Branch of the British Astronomical Association in 1892. Since 1976 he has taught astronomy in adult night-school classes. The history of astronomy has been his particular interest since 1991, and as a result he has published several articles on the archaeoastronomy associated with prehistoric sites on the east Cheshire/north Staffordshire border. In 1997 he was co-discoverer of a copy of the rare eighteenth Century star atlas by Bevis, *Uranographia Britannica*. The history of this atlas was described in the May 2003 issue of the *Journal for the History of Astronomy,* with Professors J.M. Pasachoff and O. Gingerich as co-authors. In March 2006, Kevin will accompany a tour to Egypt to see that country's archaeological treasures, and will be the tour's astronomy guide to view the total eclipse of the Sun. Kevin was elected as F.R.A.S. in 2000; and in 2002 was a founder-member and Council member of the Society for the History of Astronomy.

G. E. Satterthwaite M.Sc., D.I.C., F.R.A.S.

Gilbert E. Satterthwaite recently retired from the Optics and Photonics Group of the Physics Department at Imperial College, London. He began his working life in the Meridian Department of the Royal Observatory, Greenwich, where he is still a volunteer consultant on the history of the Royal Observatory. He also advises them on the care of the Observatory's old instruments, especially the Airy Transit Circle, with which he made the last published observations in 1954. In 2000 he was elected a member of Commission 41 (History of Astronomy) of the International Astronomical Union, and has been Chairman of the Society for the History of Astronomy since July 2004.

Independent Reviewers of papers for Issue 2

Dr M. T. Brück	Former Senior Lecturer, University of Edinburgh
Dr C. J. Butler	Armagh Observatory
P. B. J. Gill	Freelance proof editor
G. Gilligan	Amateur astronomer, Liverpool Astronomy Society
P. D. Hingley	Librarian, Royal Astronomical Society
Dr G. A. Wilkins	Former Superintendent, National Almanac Office

The Antiquarian Astronomer

Journal of the Society for the History of Astronomy

Scope

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

- 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 quarterly Newsletter 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 research can be shared with other individuals and organisations having interests similar to those of the Society, and be made available to posterity. Papers 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 disparate locations. They should not have been previously published.

An important principle established by Council is that papers published in *The Antiquarian Astronomer*, though mainly by amateurs, are to be of a standard that will be recognised as giving the research and the Society lasting credibility. To fulfil this principle, each paper is peer-reviewed by one or more Reviewers, in addition to the usual scrutiny by the Editorial Team. Reviewers are selected for their knowledge of the subject of the paper, able to provide helpful feedback to the author and to the Editor, and be supportive of the aims of the Society.

The Antiquarian Astronomer also publishes Essay Reviews of books of significance in the history of astronomy. Short reviews of single books appear in the S.H.A. Newsletter.

Papers should be prepared using the Guidelines to Authors (see Pages 58 and 59 of this Issue and the Society's website, www.shastro.org.uk), and should be sent, preferably in electronic form, to the Editor of *The Antiquarian Astronomer*, whose contact details are given on Page xx of this Issue, and in the S.H.A. Newsletter.

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Interim Guidelines for Authors

Papers submitted to The Antiquarian Astronomer should adhere as far as practicable to the following guidelines. Doing so will minimise the time and effort involved in preparing the draft, and in handling, reviewing and revising it, and putting it into a page layout software.

Length of papers

Papers can be up to 5,000 (longer if essential). In the format of this Issue, each full page of body text contains about 900 words. A 5,000-word paper with figures, etc. will be about 10 pages long; more if some of the Figures need to be in 2-column format.

Basic principles underlying writing up a paper

The following principles underlie these Guidelines:

- Statements of fact must be evidenced by reference to a suitable source;
- References must contain sufficient detail for a reader locate the same information;
- References should be to primary, not secondary, sources (i.e. cite the xx, not a paper, book, etc. that cites it);
- Inferences or suppositions should state all the steps in the rationale leading to the statement.

Paper structure

- First line - the **title**;
- Next line - author's **name** in the form preferred;
- Next line - an astronomical or other **affiliation**;
- **Summary** of the paper 100-130 words;
- **Main body** of the paper (using sub-headings if the paper is long);
- **Notes and references**, as endnotes, starting on a separate page. (Avoid using automatic footnotes available in word-processing software, because these cause an enormous amount of work when transferring the final text from word-processed document to page make-up application);
- Printout of **Figures** and Tables - a separate page for each. Every Figure etc must have a caption (with additional notes if necessary) **on the same page as the Figure** (not on a separate page). Number Tables and figures sequentially.
- On a separate page a 100- to 150-word **biography** of the author in the style of those in this Issue. The biography should include an indication of what stimulated the research described in the paper. The author's name should include full initials, and post-nomial letters of all relevant honours, awards and academic qualifications.

Preparing the typescript

- Use Microsoft Word if possible,
- Use A4 paper printed on one side only;
- Set left and right margins to 3 cm;
- Set the language to English (UK) not English (US);
- Use Times New Roman, 10 point font;
- Use space and a half line spacing;
- Keep formatting to the minimum necessary to ensure that the draft is intelligible;
- Do **not** use tabs or spaces to indent material such as quotations (they all have to be removed by

hand); use the Format/Paragraph/Indentation facility (in Word).

Reference style
References should have the following form:

- **Paper in a Journal**
  Author surname, initials (or name(s) in full if that is used in the paper being cited). Title of paper. *Journal name.* Year. Volume number (part number). Start and end pages, (specific page, if necessary). Here is an example:
  Smith, A.B. and Jones, X.Y. The Early History of the Society for the History of Science. *Journal for the History of Astronomy.* 2099. **299**(12). 123-456, (234).

- **Book**
  Author surname, initials (or name(s) in full if used in the book). Title. Place of publication: Publisher (full name as it appears in the book), Year of publication. Pages referred to.
  Archive or other unpublished material.

- **Map**

- **Newspaper**

- **Archive or other unpublished material**

- **Internet sites**
  Internet sites should be treated as ephemeral and not be cited as primary sources.

Photographs as jpgs not closely cropped
Landscapes must state direction look in
We'll put a more complete list of instructions to Authors on the web-site in due course, but these will do for your draft.

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Miscellany Page

Edward Walter Maunder (1851 - 1928)

Mr Anthony J. Kinder, Director of the Historical Section, and Honorary Librarian, of The British Astronomical Association writes:

'I am in the process of researching the life and work of Edward Walter Maunder, a founder of The British Astronomical Association. In order to be able to be as complete as possible, I am trying to locate copies of all surviving correspondence between him and other astronomers etc. Linked with this I am also trying to prepare an index of all the known correspondence either to or from Edward Walter, his wife Annie Scott Dill (née Russell) and other members of his family, especially Thomas Frid.

I have obviously consulted the archives of the Royal Greenwich Observatory, the Royal Astronomical Society and The British Astronomical Association, as well as several overseas (mainly American) university archives. But there are many archives that may well contain correspondence from or to one of the Maunders of which I am unaware. Should any person know of, or have in their possession, any such correspondence, I would appreciate it if they would contact me at my home address. I prefer not to be contacted at the offices of The British Astronomical Association, or via e-mail.'

Anthony J. Kinder B.A., M.Sc., F.R.A.S.
16 Atkinson House. Catesby Street, London SE17 1QU, United Kingdom

The Editor invites items for this section of *The Antiquarian Astronomer*

We plan to include in Issue 3 correspondence from members and others on matter related to the history of astronomy and related sciences. Short correspondence will continue to appear in the Newsletter. We anticipate that items in this section will be longer letters or e-mails, such as comment or additional information relating to papers published in this or the previous Issue; requests for information for long-term projects; or reports of very short research projects that result in the need to place on record findings of lasting value. Submit items to the Editor using the contact details on page xx. Items will not usually be independently reviewed, but will be subjected to editorial scrutiny in consultation with the authors.

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