The Godlee Observatory in Manchester, England

The History of the Grubb "Twin Equatorial"

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In September 2003, the Manchester Astronomical Society celebrates its centenary. It was originally founded in 1892 as the North Western Branch of the British Astronomical Association but administrative difficulties lead to independence after eleven years. Another important factor was the construction at the end of the 19th century of the new Manchester Technical School (now UMIST) which not only offered an ideal meeting place for the society but also access to a new observatory. Although the Godlee observatory was permanently staffed until just before World War II, since 1946 the MAS have enjoyed unrestricted access to the facilities and still meet there every week, thanks to a close relationship with the Principal and staff of the university. The Godlee telescopes are possibly the last to be built of only four so-called "twin-equatorials", by Sir Howard Grubb of Dublin. In this respect, they not only share a special place with two preceding instruments belonging to the pioneer spectroscopist, Sir William Huggins, and the astrophotographer, Dr. Isaac Roberts, but serve to illustrate this type of instrument designed by Grubb to maximize the use of a small observatory.

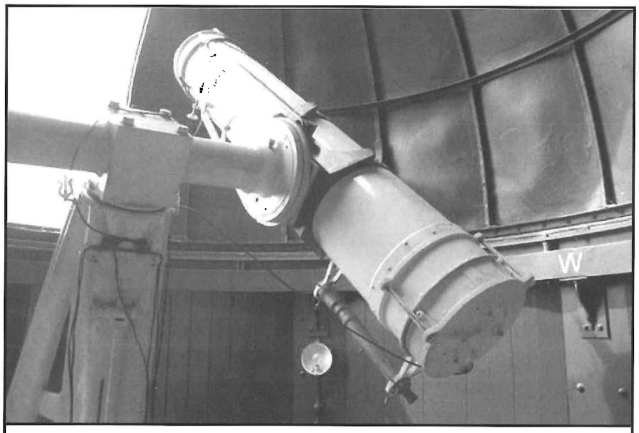
On March 6, 1901, the Minutes of the North Western Branch of the BAA record what was to be a most significant event.[1] The secretary, Thomas Weir, reported a meeting with Mr. R.H. Reynolds, director of the Manchester Technical Schools to discuss the erection of an observatory on the roof of the new Municipal School of Technology, on its Whitworth Street facade. In the same building, a room would be made available for scientific meetings and there was the probability that the Society might have use of the new telescope, an 8-inch refractor. Although it is unclear how the Branch contributed to the erection of the observatory, it was to be a gift to the City of Manchester by Mr. Francis Godlee of the firm Simpson and Godlee Ltd., cotton manufacturers and calico printers. He was a governor of the Technical Schools and a close friend of Mr. Reynolds. By May 1901, a committee consisting of the branch president, Professor Core, Thomas Weir, Samuel Okell and Thomas Thorp, was appointed to confer with the Technical Instruction Committee of the city on any matters that might arise regarding the telescope and the observatory.

As with several other instruments of novel construction, Grubb had made a wooden model of the Godlee telescope. This was of a large refractor (presumably the 8-inch referred to in the Minutes) balanced by a massive counterweight on a German mounting of unusual design. Photographs of the model survive[2] and show a cantilevered polar axis, supported within a triangular pylon bolted onto what we would now call an equatorial wedge. Its intended use for photography is clearly suggested, as the model is typical of the small astrographic telescopes Grubb constructed in the late 1880s for Mexico and Cape Town. A typical instrument was illustrated in the publication, *Engineering*, in 1890.[3,4] In the model, the main instrument is shown with a co-aligned guide telescope of slightly smaller aperture and of a slightly shorter focal length mounted on top of the bigger telescope. Its eyepiece is mounted close to the tailpiece of the main instrument, which appears to be fitted with a camera. A third telescope, a much smaller finder, is slung beneath the twin telescopes and is mounted somewhat further along the tube. In the Manchester instrument, designed for use at much higher latitude than either of the astrographs referred to above, the specially designed overhung polar axis allows continuous circumpolar motion without fouling the mounting even when the telescope is pointing at high declination.

Francis Godlee (1854-1928)

The model of the instrument proposed for the Manchester Technical School suggests that the original intention was to construct an astrographic telescope similar to the McClean instrument described below. Grubb did build several dual photographic/visual telescopes and these are always mounted one above the other.[5] This not only ensured that both viewed the same object but also gave rigid co-alignment and minimal flexure between the instruments when one was used as a guider for the

other during long exposures. In these instruments, the lens of the photographic telescope was optimized to give a sharp focus on the blue-sensitive plates then available, while the guider telescope was figured for visual use. An example is Grubb's 12-inch photographic refractor with 10.5-inch visual instrument built in 1894 for Frank McClean at Tunbridge Wells. This instrument is now at the Norman Lockyer Observatory, Sidmouth in Devon. [6] The success of this prompted McClean's subsequent order of a 24-inch photographic refractor with an 18-inch visual refractor for the Royal Observatory, Cape Town in 1900. Like the model of



The 12-inch Godlee Newtonian showing replacement finder and the microscope designed to view the declination circle from the eyepiece position.

the Manchester instrument, these double telescopes are mounted on the same end of the declination axis and balanced by a massive counterweight in the normal German-equatorial fashion.

However, the Godlee telescope was not to be an astrographic instrument but a twin equatorial, an 8-inch refractor counter-balancing a 12-inch reflector on the same double declination axis, one shaft revolving within the other. Either telescope could be pointed independently to any object at the same Right Ascension. The general form was that of the 26-inch refractor counterbalancing a 30-inch reflector built for the Greenwich Observatory in 1895. [7] In a photograph in the Tyne & Wear Archives, the Godlee telescope is shown under construction at Grubb's Optical and mechanical works at Rathmines, Dublin, in 1899. [8]

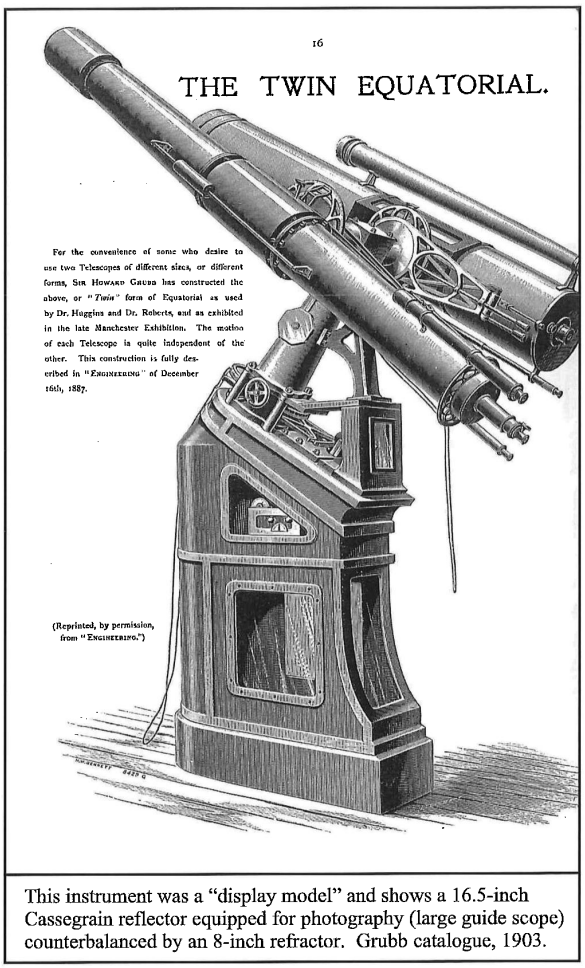
The earliest twin instrument was that of William Huggins at his Tulse Hill Observatory. He used a dual 18-inch reflector/ 15-inch refractor combination, initially interchangeable, made by Grubb in 1870. The Royal Society loaned this instrument to Huggins. But a more likely precedent for the Godlee counterbalanced combination was set when Dr. Isaac Roberts, formerly president of the Liverpool Astronomical Society, discussed with Sir Howard Grubb his particular requirements for a large astrographic reflector. This was subsequently erected at Robert's private observatory at Maghull near Liverpool in April 1885. Here, a 20-inch Newtonian reflector designed for taking photographs at the prime focus was counterbalanced by a 7" Cooke refractor for visual use.

Although initial problems were encountered with the drive accuracy and the stability of the mounting, on October 10, 1887, Dr. Roberts became the first to photograph the spiral structure of the Andromeda nebula. His observatory was later moved to Crowborough, Sussex, from where, in 1893, Roberts published his important *Photographs of Stars, Star Clusters and Nebulae*. In 1930, long after Roberts' death in 1906, these telescopes were again removed, this time to Norwich, to the observatory of James Garton Bower. [9] Bower had previously owned the 20-inch altazimuth-mounted reflector, built by James Nasmyth at Patricroft, and later presented to the London Science Museum in 1933.

Only three other Grubb reflector/refractor "twin" equatorials were constructed between 1885 and the Godlee instruments, ca. 1900. A 17-inch reflector/8-inch refractor combination was exhibited at the Manchester Exhibition in 1887. The mounting for a twin equatorial is shown under construction in an untitled photograph in the Tyne & Wear Archive and this may be for the instrument exhibited in Manchester. [10, 11] In 1888, a 16.5-inch reflector/4-inch refractor twin equatorial was sold to the College of Science, Poona, India. According to Ian Glass [12], it is possible that the reflector was the same one exhibited at Manchester the previous year but with the substitution of a smaller refractor. The subsequent whereabouts of the 1887, 8-inch refractor is not known but according to the lists published by Glass [13], the only 8-inch refractor sold at that time was to Caracas, Venezuela, ca. 1888. This may be the same telescope. The third "twin equatorial" instrument is the much larger Greenwich telescope referred to above but the design of this is quite unlike those intended for smaller observatories.

It is often assumed that in Grubb's "twin equatorial" configurations the refractor was intended to act as a guide instrument for the main photographic reflector. In practice, however, the design of the Godlee Observatory gore shutter, pivoted on the dome only some 45° from the zenith, opposite the aperture, results in the dome slit tapering from a maximum of four feet wide at the horizon to just over a foot wide at the zenith. This is too narrow to allow both telescopes - with approximately four feet between their optical axes - to be used at the same time. Such a combination instrument was actually designed to maximize the versatility of a small observatory, with each telescope being intended for separate purposes.

At the Godlee Observatory, the choice of an 8" refractor was intended for visual, lunar and planetary work and the measurement of double stars. From the outset, the instrument was equipped with a bifilar micrometer of the most modern design whose webs could be electrically illuminated to give bright lines on a dark field or dark lines on a bright field. The entire bronze tailpiece casting of the refractor could be rotated with a rack and pinion and "Position Angle" read against one-degree graduations in diametrically opposed windows on the tube end plate. In recent restoration work it was found that the rack and pinion is spring-loaded and engages only when slight pressure is put on the tailpiece assembly. Under normal circumstances, the tailpiece rotates freely for rough alignment then with the eye at the eyepiece of the micrometer and with a push to engage the rack and



This instrument was a "display model" and shows a 16.5-inch Cassegrain reflector equipped for photography (large guide scope) counterbalanced by an 8-inch refractor. Grubb catalogue, 1903.

pinion; final alignment of the web between the stars can be delicately adjusted.

Focusing on the refractor is via a double telescoping tube. The 3-inch outer tube is for rough focusing and when locked with the thumb wheel allows the slightly smaller inner tube to be fine focused with a helically geared rack and pinion. Contact pressure on the rack is adjustable by mounting the pinion wheel on a cam. The focusing unit on the reflector is a normal rack and pinion with a co-axial inner sliding tube for rough focusing. As standard equipment, both telescopes had four negative, Kellner type, eyepieces.

The 12-inch Newtonian was capable of both deep sky visual work and photography but the eyepiece could assume awkward positions, even with its revolving top-end. Visual observations would be difficult on the tall mounting. But the greater light grasp of the silver-on-glass mirror with a focal ratio of f/7 could easily surpass the refractor, especially with blue-sensitive emulsions, in the photography of faint extended objects. That this was done is illustrated in the Tyne & Wear Archives by a photograph of the reflector, in the Godlee observatory, fitted with a quarter-plate camera focusing screen at the prime focus. This picture also shows a small finder (now missing) mounted on the rotating headpiece of the telescope. It is not known how the reflector was guided for photographic use. For reasons explained above, the twin telescopes could not be used at the same time and the refractor was not used as a guide telescope. Perhaps their 2.5-inch finder telescopes were intended to be used as guide instruments. These were equipped with two positive eyepieces apiece, one to give a low magnification to acquire the target and a higher magnification perhaps with which to guide during exposures.

Celestial objects can be found using electrically illuminated, silver on gunmetal declination circles, engraved in one-degree increments and subdivided to 10 minutes of arc and capable of being read to 30 seconds by opposing verniers. The circles are viewed through special telescopes from the eye-end of each of the main instruments. The double, silver on gunmetal RA circle, divided into divisions of two minutes of time, is capable of being read to 10 seconds using a special vernier, hand reader and illuminator. The original Right Ascension drive was similar to that fitted to the 24-inch photographic instrument at the Radcliffe Observatory, Oxford. This was a phase-locked clock, of the type used on all of Grubb's photographic telescopes after 1888. Although the drive was based on a powerful clockwork mechanism, second pulses were generated by a long pendulum hanging into the lower observatory at the tip of which a needle point passed through a globule of mercury at each swing. Electrical pulses were fed to a detector wheel with three sets of contacts and a feedback system to regulate the speed of the drive, fitted with a mechanical governor to give a nominal Sidereal rate. The RA drive could originally be electrically overridden from the eyepiece by a pair of triggers on a hand-held commutators to speed up or slow down the drive rate during photographic guiding. Both of the Godlee telescopes have coarse manual slow motions in declination, the iron casting of which is of a very recognizable pattern, copied on many of Grubb's telescopes.

Like the majority of Grubb telescopes, the Godlee instruments are driven via a sector, rather than a 360° wormwheel. Grubb favoured this design because it saved space. He had developed special equipment for cutting teeth in a sector under a microscope. The drawback was that it was necessary to rewind the sector after about eight hours of continuous use, and uneven wear ultimately sacrificed drive accuracy. This may have caused Grubb to lose valuable contracts in the lucrative North American market in the late 19th century, during the construction of the great American observatories. In the US, Grubb's main rival, Alvan Clark, fitted 360° worm wheels on his telescopes, giving more even wear and longer-term accuracy. It is worth noting, however, that having lost the contract for Lick Observatory, Grubb was paid by Alvan Clark to use Grubb's patented, hydraulically operated rising floor to access the telescopes.

On the Godlee instruments, an ancillary 6" f/6 half-plate camera, using the refractor as a guide telescope, was an obvious choice for wide field photography and was capable of giving pictures nearly 10° square, for mapping starfields and for comets. Again there were precedents in the large number of short focal length astrographic lenses of similar aperture in use at the time in America, some of which had been supplied by Sir Howard after trial and error designs had been tested at Greenwich.

The Godlee double equatorial could therefore be regarded as a tried and tested combination in which the City, members of the Branch and Sir Howard Grubb could have every confidence. The Godlee telescopes may also be the last counterbalanced combination that Grubb constructed. Although Grubb won tenders to supply large telescopes to Johannesburg and to Simeis in Russia, they were not completed until after the first world war by which time Grubb had moved his company to St. Albans, Hertfordshire, to concentrate on the design and manufacture of periscopes for the British submarine fleet. In 1925, following financial liquidation, Grubb sold the business to Sir Charles Parsons, the youngest son of the third Earl of Rosse. The telescope division of Grubb-Parsons continued to construct many of the world's largest astronomical telescopes in Newcastle-upon-Tyne until 1985 when it was closed down.

Sir Howard Grubb ca. 1925-1931, about 28 years after working on the Godlee telescopes. Photo courtesy of Mr. R.B. Grubb & Dr. Ian S. Glass.

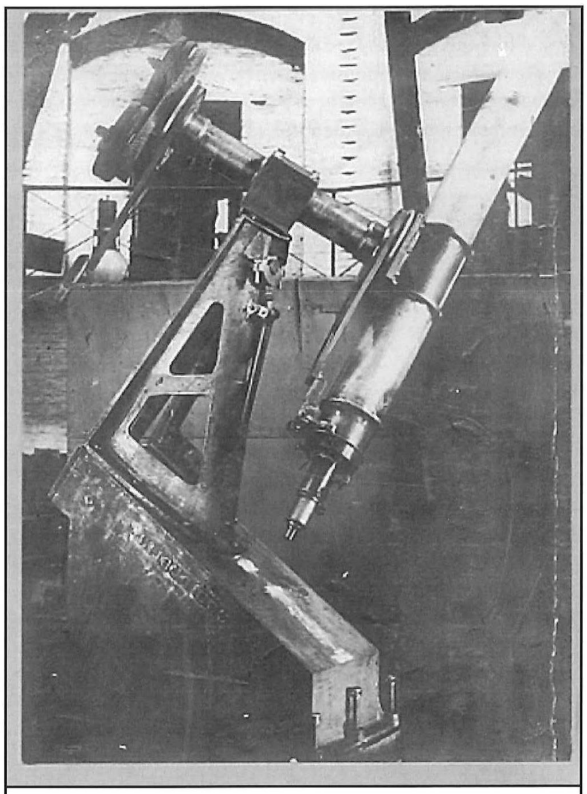
After the visit of the members to the Technical College on Saturday, November 2, 1901, to monitor the progress of the observatory, an expression of thanks was sent to the Lord Mayor and to Mr. Reynolds. However, the room designated for use by the scientific societies was not ready, even by the following April. Plans to hold meetings in the new building were postponed until the 1902-3 session. Eventually, on November 5, 1902, a General Meeting took place at the college. This was the first meeting of the session and the president addressed the 20 members present with a few opening remarks and went on to inform them that forthcoming meetings would be held, it was hoped, in the room under the observatory. This would be available on Thursday evenings. The members then adjourned to the observatory to inspect the telescopes. Neither the observatory nor the telescopes were completed at this time and even by March 1903 they were still in the hands of the contractors and unusable. But it was hoped that there would be opportunities for the members to become conversant with the detail and use of the instruments. The Principal of the College, Mr. Reynolds, in his meetings with Thomas Weir and the Branch committee, had from the conception of the observatory shown that he fully intended that the Society should have full access to the observatory. Indeed, there was considerable correspondence directly between the council of the Society and Sir Howard Grubb in attempting to arrange a meeting with him at which he could personally instruct members in the use of the instruments. For various reasons this meeting was delayed and in April it was suggested that only the Branch council would meet with Sir Howard and then disseminate the information at some later date to the members.

By the following year, the telescopes were essentially complete. The ancillary instruments, the 6-inch camera and a bi-filar micrometer had been augmented by gift of a reclining observing chair, from the Branch, and a Hilger spectroscope from Thomas Thorp. The latter being a gift to the Manchester Astronomical Society. Adjustments of the telescopes and polar alignment of the mounting were made during 1904. Although central Manchester at the turn of the century was not an ideal location for such a sophisticated observatory, a number of double star measurements using the refractor and bifilar micrometer were published, as were solar observations of the latitude and longitude of sunspots during 1904 and 1905 using 8-inch diameter projected images from the finder telescope of the 8-inch refractor. Several photographs were taken with the reflector and with the 6-inch camera. In particular, of the area around the belt of Orion with the latter instrument, on 2nd Feb. 1905. Although the Branch had by this time established a strong track record of observing solar eclipses, the first opportunity from the observatory, to see the partial eclipse of August 1905, was missed owing to the sky becoming overcast a few minutes before first contact.

Francis Godlee (1854-1928) [14, 15]

Francis Godlee presented the Godlee Observatory and its telescopes to the City of Manchester in 1903. The total cost of the installation, out of his own pocket, was £10,000 which probably equates to £1,000,000 today ($1.46 million). About a tenth of this sum was actually spent on the Grubb instruments. According to the price list published in the Grubb catalogue of 1903 [16], a standard equatorial with 8-inch objective would have cost £650 and a 12-inch Newtonian reflector an additional £200. Add to this the cost of the bifilar micrometer and £1000 would have covered it all. Most of the total expenditure evidently went into the addition of the observatory dome and beneath it the two-room, observatory tower annexed to upper floor of the main Manchester Technical College. This, on its northern aspect, still overlooks Whitworth Street. Architectural drawings, of the building minus the observatory, were in existence by 1893 [17], yet in 1902 similar drawings show the observatory in situ. [18]

Francis Godlee was a remarkable man, highly successful, and a man of many interests, pioneer cyclist, breeder of horses and an enthusiastic yachtsman. He was well known as a shrewd and farsighted employer, generous with time and money for those less fortunate than himself, and with a great sense of public spirit,



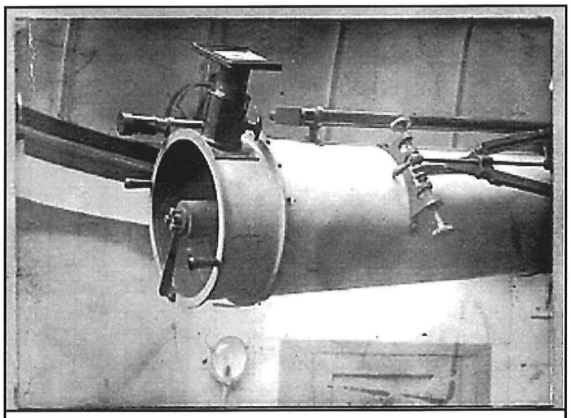
The Godlee instrument during construction at Rathmines, Dublin, 1899. Tyne & Wear Archives.

particularly for his adopted city. He was born in London in 1854, the son of a Quaker barrister who had chambers in Lincoln's Inn. The family of five boys and one girl used the "thees and thous" of Quaker speech, and Francis with this strict Puritan background remained a staunch member of the Society of Friends throughout his life. He came to Manchester as a young man in 1881 to join his relative, William Simpson, in business at Dean's Mill, Swinton, and the two Quaker partners (they were related through marriage) soon established a reputation for probity and good management.

The Manchester cotton trade at this time was thriving, and the firm of Simpson & Godlee, cotton manufacturers and calico printers, steadily expanded. Its offices and warehouses moved to the centre of Manchester, and further mills were acquired at Bolton and at Bury. By the turn of the century, there was a workforce of some 1,500 people. The firm's prosperity owed much to Francis Godlee, not only to his good business sense, but also to the sympathetic consideration he showed for his employees. He became chairman of the firm in 1914 on the death of William Simpson and continued to run the business through the difficult war years and after the war, until a few years before he died.

All his life he devoted much of his time to what we would now call social work. As a young man in London, he and his brothers took an active part in running a club for boys, and, soon after arriving in Manchester, he and some friends started the Hugh Oldham Lads Club, with which he was closely involved for the rest of his life, always attending its gatherings and meetings. He regularly entertained the boys at his home, and he was never happier than when he was taking part in their activities. He was also deeply concerned with the welfare of Ackworth, the Quaker school in Yorkshire, which he visited every month and where he was treasurer for many years. The school remembers him as a great benefactor, and among other things donor of the school swimming bath. It was said that he was one who did not let his left hand know what his right hand had done. No appeal was ever made to him in vain, and the headmaster knew that in needy cases, Francis Godlee would be only too glad to give a "lift on the way". Many a boy thus owed his start in life to such timely help. In Manchester he took an active part in the affairs of the University, the College of Technology (later UMIST) and Ancoats Hospital, and he was, for some time, chairman of the Manchester and Salford Trustee Savings Bank.

For nearly thirty years he lived at Stamford Lodge, a substantial house with land extending to the banks of the River Bollin, one and a half miles from the centre of Wilmslow, a well-to-do suburb some ten miles south of the city in the Cheshire countryside. Wilmslow, and the nearby town of Alderley Edge and the village of Prestbury are still regarded as being in the heart of the south Manchester wealthy stockbroker commuter belt. For many years one of his chief joys was breeding horses, graceful chestnuts. With the old coachman, Stringer, at the reins, it was a fine sight to see a pair of them harnessed to a brougham or wagonette. Francis Godlee used to drive to Wilmslow railway station each day in a dogcart to catch the early train, and it is said that his regularity was so well known that people on Lindow



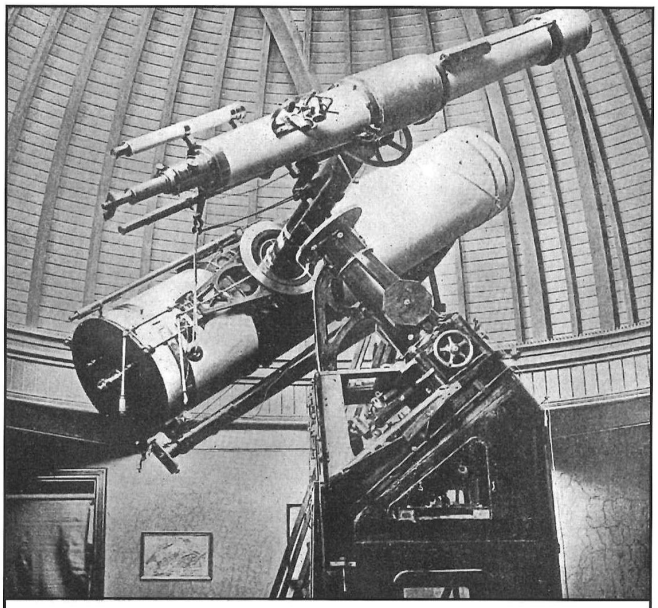
12-inch Godlee Newtonian showing plate camera and upper-end finder on the rotating head piece. Note the two handles and the single-arm secondary support. The declination slow-motion drive and the declination microscope are also shown, ca. 1902.

Common and on the Altrincham Road could set their clocks as he passed. He hated tardiness and his house was full of clocks of all varieties, including a splendid Frodsham regulator, which kept perfect "astronomical" time. Not surprisingly when the Daylight Saving Act was first introduced, the prospect of altering all his clocks twice a year made him one of its fiercest opponents.

He was not usually so reactionary. He had the true pioneering spirit and liked to be in the forefront of modern

developments, both in business and in his home. He had the first electric light installation in the neighbourhood, even lighting his cowsheds with electricity, and he was justly proud of his telephone number, which was "4", tangible evidence of his enterprise when the instruments first made their appearance. He enjoyed photography, and even had an X-ray apparatus in the house with which he used to photograph the bones in the hands of his friends and relatives. As a young man he was a keen cyclist, and, as a member of the London Bicycle Club, won a gold medal for bicycling 100 miles from Bath to London in just over nine hours on one of the old high bicycles or "penny-farthings", a remarkable achievement when one considers the state of the roads in those days. In his fifties he bought a 50-ton yacht, which he moored on the Clyde, taking his friends on sailing holidays off the west coast of Scotland.

A man of arresting appearance, he was tall and heavily built with a handsome face and black beard. This became grayer and straggler as he grew older, and he was in the habit of winding it round his fingers and tugging at it when he was immersed in thought. People loved him for his sympathetic attention and old world courtesy, but to others he could appear gruff and forbidding, possibly to hide a certain shyness or even loneliness. He had no time for music, but loved the open air, animals and young people. He hated hypocrisy, drinks before meals, throwing things away, gilt on iron railings and the Manchester Guardian. At the end of the First World War he moved from Stamford Lodge to Harefield, on the Wilmslow-to-Alderley road and latterly the northern headquarters of ICI. It was said he needed a larger house to accommodate all the accumulated paraphernalia of thirty years, and he took it all with him. From Harefield he continued to travel daily into Manchester, and eventually retired in 1924 when he was able to hand over the business to his nephew Philip. Although Francis Godlee was elected an Honorary Member of the Manchester Astronomical Society, he played no active role in the management of the society and apparently took no further interest in the science. He died in 1928 at the age of 74.



Sir Howard Grubb 20-inch photographic reflector
and 7-inch visual refractor
Made for Isaac Roberts, Liverpool Astronomical Society, 1885

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