I & I News

New Series No. 6 Newsletter of the Instruments and Imaging Section 28 April 2012

It seems an appropriate time to issue a reminder that contributions for *I&I News* and *Technical Tips* are always welcome: an account of your instruments or observatory, methods and results of imaging, peripherals, gadgets, the observations in which you specialise – anything relating to practical astronomy and instrumentation, so that other Members can become aware of your activities (but please, no autobiographies). An e-mail address is included at the end of each article, increasing the possibility of correspondence between Members who have previously had no contact with each other. These publications are issued to around 1,800 Members, so the potential readership is not inconsiderable. Do not be backward in coming forward.

In the April issue of the *Journal*, Michael Hendrie's paper 'Farewell to film: Imaging comets and the Sun the old way' refers to a time when there were very few retail outlets for the purchase of astronomical equipment. In the years following the Second World War, however, parts and spares could be acquired from other sources: 'There were government surplus shops which stocked all kinds of optical, mechanical, and electrical devices stripped from military equipment and sold at affordable prices. These included gears, small motors, aerial survey lenses, eyepieces, and everything from nuts and bolts to pairs of binoculars.' Moreover, the optics were often of very high quality. I trust that Michael will indulge me when I say that I cannot remember back as far as he can – but I do remember the army surplus store in Northampton. Ex-government equipment was also frequently advertised for sale in *Exchange and Mart* into the 1980s, and I have some of it myself. It appears, however, that the method of acquisition was rather different at the time of the previous world conflict.

Bob Marriott, *Director*

500-mm focus f/4.8 Zeiss triplet aerial reconnaissance lens, used to photograph the trench systems of the Western Front during the First World War. Later the 'property' of Henry Hayden Waters – after he looted it from a captured German aircraft.

A DFW C.V Aviatik reconnaissance aircraft over the Western Front in 1916.

A de Havilland B.E.2c reconnaissance aircraft.

Memories of Herstmonceux

Gerald North

Len Clucas's reminiscences of Grubb Parsons in the previous issue of *I&I News* reminded me of my days at Herstmonceux in the 1980s. I used four telescopes – usually either the 30-inch Thompson reflector with the high-dispersion spectrograph, or the 36-inch Yapp reflector, on which I mounted my own 44-mm Plossl eyepiece. For visual observations I also used the 10-inch guiding refractor on the 13-inch Grubb refractor (a photographic instrument), and the Merz 12.8-inch refractor on the 26-inch Thompson refractor. Occasionally I used the 44-mm Erfle 'scouting' eyepiece mounted on the empty plate-holders of the 13-inch and 26-inch refractors – though those objectives were corrected for the old orthochromatic emulsions, and so stars looked like green emeralds with large red halos! On one occasion I used T-Max sheet film to take photographs of M13 with the 13-inch and M42 with the 26-inch. The brightest stars, however, were 'blobby' because the film was panchromatic. I have happy memories of long nights, manually pointing those multi-ton telescopes and observing with them.

I have recently consulted my observing log. On 31 March 1990 I was the very last observer to use those instruments when they were under the aegis of the Royal Greenwich Observatory, as most of the astronomers had left the site during the months before. By then, a lot of equipment had been stripped out, and at the very end the whole place seemed very sad and empty.

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Asteroidal imaging from Hampshire

Roger Dymock

In 1999 I invested in a small observatory, which I located in my back garden. The reasons for doing this were several. My telescope – an Orion Optics 10-inch Newtonian reflector – was too heavy and bulky to move from indoors, and unless a long clear evening were guaranteed, the effort was not really worthwhile. A move from visual observing to CCD imaging resulted in an even longer set-up time, and electrical connections are best left *in situ* rather than being frequently plugged in and unplugged. I have a reasonable view of the southern sky and to the north (though not at low altitude), but east and west are blocked by large trees.

The observatory is set on a concrete base and is constructed in two glass-fibre sections, with the front opening over the rear. The telescope is moved to its operating position on a home-made trolley, and then located on wooden blocks which are kept in place by bolts fixed in the concrete base. A small desk under the rear section houses the laptop, accessories, and manuals, and a dehumidifier keeps the interior and equipment dry when the observatory is closed. It would obviously be more convenient to have a permanently positioned telescope under a rotating dome, but nowadays I prefer to buy time on robotic telescopes rather than invest in new facilities.

The telescope has to be moved to its operating position and polar-aligned each time it is used, but I try to do that early in the evening, so by the time it is sufficiently dark to observe, all is ready.

On one very windy day an extra-strong gust delivered my neighbour's greenhouse to my garden. The amazing thing was that nothing was damaged – neither the observatory nor a tree or shrub. Even more amazing was that the staging and plants in the greenhouse were still standing, untouched, in their original positions!

Time marches on, and my set-up is now rather different. The telescope is driven from a laptop via a Skysensor hand-control. I originally synchronised my laptop to a GPS receiver for accurate timing of images, but a newer laptop has provided me with a better Internet connection, and I now use *Dimension 4* software for timekeeping. Once I have set up the telescope and

The observatory open, with the telescope in the stored position.

The observatory open: full cold-weather gear.

A Dymock-crossing greenhouse.

taken a few test-images, I retreat to the warmth and comfort of my study and monitor proceedings via a wireless connection.

One of the faintest objects I have imaged with my own telescope is Mars-crossing asteroid 2004 BZ57. The first image below shows the result of a stack of 60 x 45-sec images processed using *Astrometrica*. The faintest objects in a single image were mag. 16, and this asteroid was mag. 18.5.

Asteroids and comets sometimes have trouble in deciding which they want to be! 'Asteroid' 2002 EX12 happened to have a tail, as can be seen in the second image below. If I had taken the trouble to examine my images more closely when I first obtained them, I might have been the one to make this discovery – but it was not to be.

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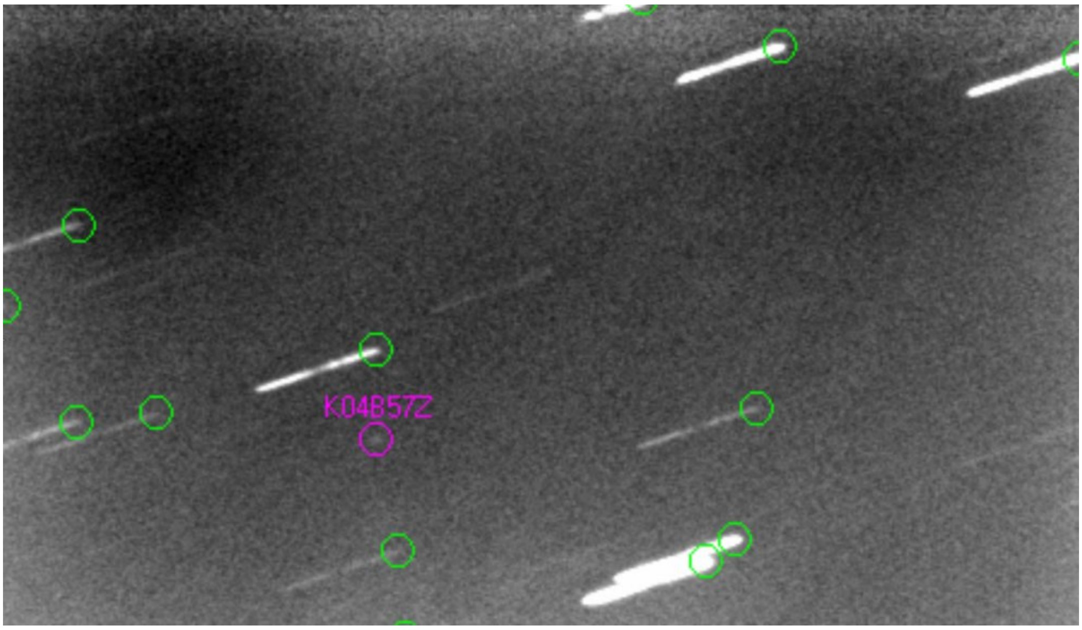
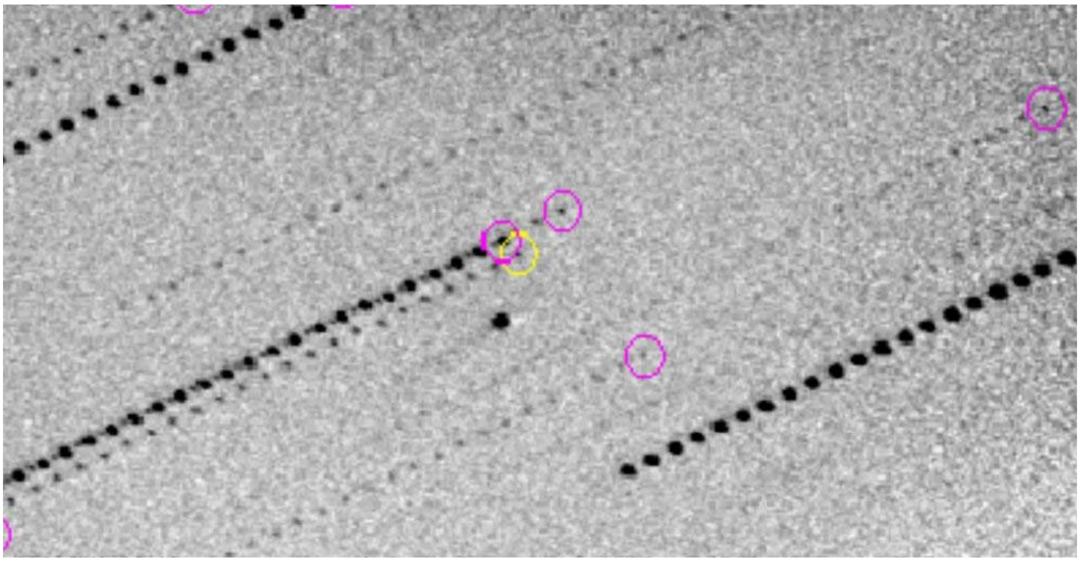
The current set-up.



Mars-crossing asteroid 2004 BZ57.

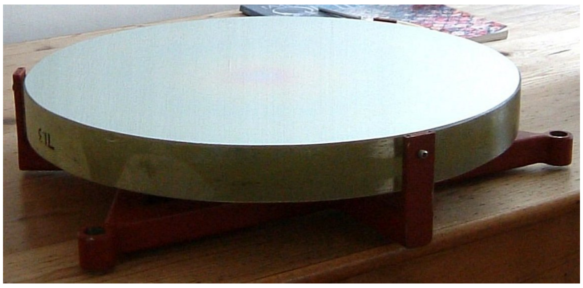


Asteroid 2002 EX12 – which metamorphosed into comet 169/P. A faint tail can be seen in the 8 o'clock position. 2005 August 2, 2105–2135 UT. 10-inch Newtonian, Starlight Xpress CCD camera. 30 x 20-sec exposures, stacked using *Astrometrica*. MPC Observatory Code: 940.

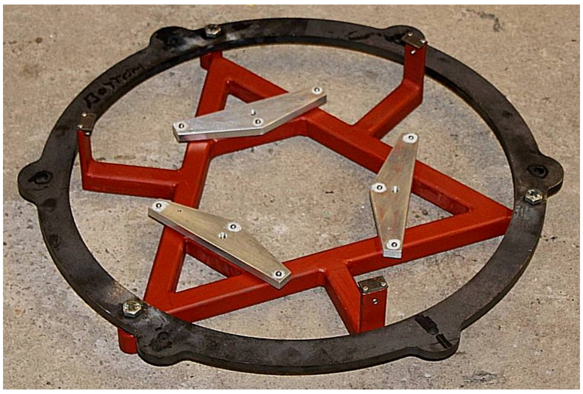
Construction of a 16-inch f/4.4 reflector

Len Clucas

At the end of September 2011 I acquired the optics from a derelict Dobsonian. The bodywork – much of it made of chipboard – was in poor condition, and the mirror required a lot of soaking in the bath to resuscitate the aluminium coating. The 16-inch f/4.4 primary is 1⅝ inches thick, and the secondary has a 4-inch minor axis and is ⅞ of an inch thick. Both of them are pyrex. The aluminising on the secondary is very poor, but I decided to go ahead and make a tube for the optics, as I already had a substantial astrographic mount, made ten years ago for my 12-inch Newtonian (see *I&I News*, New Series No. 2, p. 2), which could probably support a 20-inch.

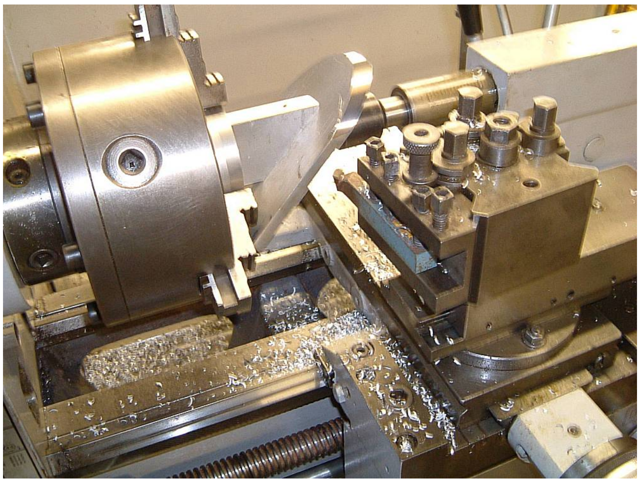


After consideration I chose to make a fairly standard arrangement: an open tube of steel rings spaced and fixed on six 1-inch diameter steel tubes, 56 inches long. The steel rings are substantial pieces, with an internal diameter of 17½ inches and ⅜ of an inch thick. I wanted them made fairly accurately to align with all tube holes and bolt holes, so I had them laser-cut. I expected the tolerance to be about ±0.004 of an inch, but it turned out better.



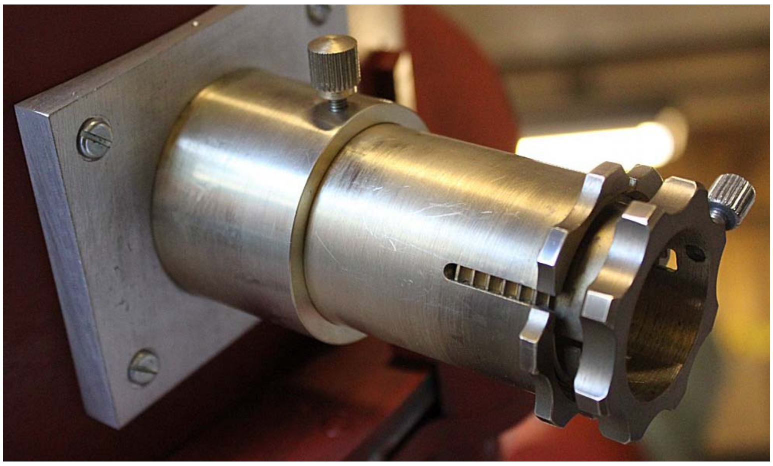
For a large telescope it is essential that the eyepiece can be revolved around the optical axis, otherwise the observer acquires a very bad neck. Therefore the whole tube, or a least the top part of the tube, needs to revolve, and I chose to revolve the top 25% which carries the eyepiece, spider, secondary mirror, and finder. This assembly is a rolled sheet metal tube with the revolving ring secured squarely by brackets. The ring has three brass pads which interface and slide against the upper ring of the main tube.

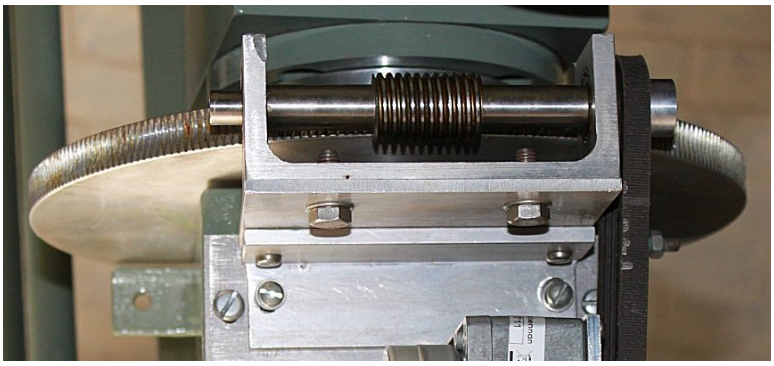
It is essential to have the eyepiece as near as can be managed to the plane of the revolving ring, as this minimises any errors in flatness of the surface on which the assembly sits; that is, the top ring of the main tube. For the main tube, consisting of four rings, the considerations were that the top ring was flat and that the lengths of the 1-inch diameter tubes were all the same. One of



the rings was flat, so I chose this as the top ring. The other ring of the same profile I flattened by heating and clamping to a large lathe faceplate. The 1-inch tubes were plugged and tapped at the ends, then turned to a length gauge, with a tolerance of ±0.001 of an inch. Short flanged tubes were bolted to the two inner rings, and these were spaced by two 1-inch plugged and tapped tubes and by the plate which fastens to the declination axis. The complete framework was assembled vertically, with the bottom ring clamped to the lathe faceplate. To fasten the inner rings to the six 1-inch tubes I used 'bearing loctite' 301, which I had used to secure the steel plugs in the ends of the tubes. Twelve short flange tubes, each 2 inches long and of 1-inch bore, provide a tremendous area for holding, and clamping the bottom ring has made the top and bottom parallel, which helps for easy optical alignment. The main mirror cell is triangular, with three sets of three ¼-inch-diameter steel balls providing nine-point suspension. The secondary holder was fabricated from aluminium, and the elliptical plate was turned in the lathe. A small amount of silicone and clips secure the flat mirror. Focusing should be kept simple, and for my 1¼-inch eyepiece holder I use a tube with a 1½-inch-diameter thread and sixteen threads per inch.

The performance of the instrument is not bad, though there has been no good seeing since my first view in mid-February. John Nichol sent me





a Ronchi film, and I tested the system at the eyepiece tube. With four straight lines it seems to be a good parabola, and revolving the top tube around in various positions shows no signs of off-square images. There is some loss of definition due to the degraded coating on the secondary, and it is possible that scattered light is reflected from the interior of the rear face of the glass. I intend to place cooling fans by the main mirror, but first I will have my wife Janice give it the Alan Adler treatment by pointing a hair-dryer across the mirror surface while I look through the eyepiece.

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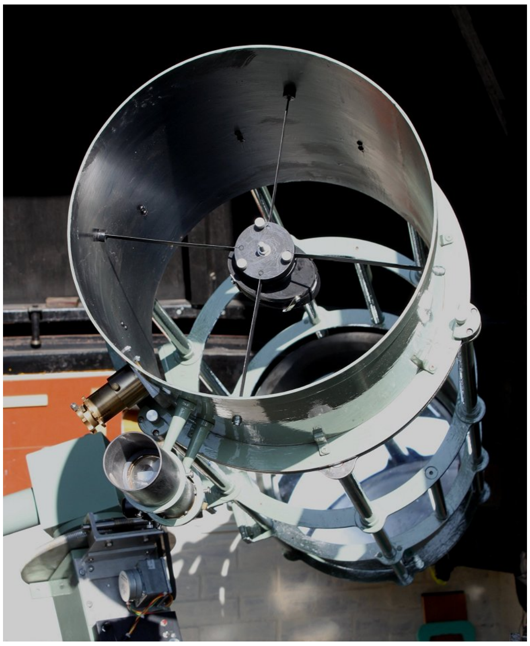

Seeing and telescope design

Geoffrey H. Grayer

It was interesting to read the 1960 article by W. H. Steavenson reproduced in *I&I News* (New Series, No. 1), particularly since by promoting completely open telescope tubes (see the extract below) he goes against what I believe to be accepted wisdom. This is to surround the mirror cell and the spider to help reduce dewing, leaving the central third of the tube open to avoid tube currents. This same approach seems to have been followed by commercial manufacturers of Newtonian reflectors such as Fullerscopes. Some years ago I modified my home-made skeleton-tube 10-inch Newtonian by adding aluminium sheet surroundings as described. Should I now remove these additions, I wonder?

Even the professionals occasionally get it wrong. In 2007 I was shown around the Pic du Midi Observatory, in the Pyrenees, by one of its community of astronomers, François Colas. Their largest telescope – a 2-metre reflector named after astronomer Bernard Lyot – was commissioned in 1980, and was designed with some unique features intended to optimise seeing. The dome itself is supported on a tower, set apart from the main telescope cluster, in order to minimise induced air currents. But the most unique feature is the double-dome structure instead of a slit, with a circular opening in the rotating external dome of the same diameter as the telescope. By rotating both domes, this aperture tracks with the telescope. This unusual design is shown in the accompanying photograph. I imagine that its design and construction must have been a mechanical nightmare, as well as adding significantly to the cost!

The idea was to minimise internal dome and tube currents in the open telescope tube by isolating the dome from the outside, apart from the 2-metre-diameter hole. In addition, the observer would be sheltered from the extreme cold which one can anticipate at about 2,900 metres above sea level. However, in practice the warm air in the dome results in an horrendous flow out through this hole, as might have been expected. The only thing the observers can do is to open all possible ventilation to bring the temperature down within the dome as rapidly as possible, but François Colas told me that due to these problems they often have better seeing with their 1-metre telescope than with the 2-metre Bernard Lyot instrument. One has to ask why nothing has been done to correct this over the last thirty-odd years. Probably those who approved the design cannot admit that they made a mistake!

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Photograph by Pascal Petit, University of Toulouse, CNRS.

> ‘Unfortunately, telescope-makers tend to be conservative; most old telescopes had cylindrical metal tubes, and the practice still goes on. At any rate, do not have a cylindrical tube, whether it be made of metal, cork, asbestos, or anything else. Square tubes are better, since the currents tend to go out of the top. With a cylindrical tube, the currents hit the side and produce gyrations reminding one of spiral nebulae. Every cylindrical tube does this – even if it is not made of metal, though metal tubes are naturally the worst. Sensible people therefore use lattice tubes, and the lattice should go right down to the mirror. It is wrong to have a closed-in section close to the mirror, and indeed this is just where you do not want it.’
>
> W. H. Steavenson

A moveable solar observatory

Brian Mitchell

The accompanying photographs show the arrangement of my heliostat, set up in an upstairs room. It is my secondary solar observatory, because my primary observatory is situated close to the east wall of my house, and is cut off from the Sun from about 2 pm.

The first photograph shows the two 4½-inch flat mirrors. The upper mirror is fork-mounted on a polar axis, driven by a motor, and tilted in declination by a string over the pulley at the top of the arrangement, actuated by a drum controlled from the eyepiece end. The lower mirror is fixed, and reflects the beam from the top mirror horizontally into the 3-inch refractor via a filter ring carrying white-light and Hα filters. A second filter ring is positioned at the eyepiece end, and is connected by a rod to the first (for safety).

The second photograph shows the RA motor and gearbox, which is shaft-mounted. This can be turned by a long rod from the eyepiece end to enable manual adjustment. Drive from the gearbox on the motor shaft is transmitted to the polar axis via wires and pulleys. The sizes of the drums for these wires determine the drive speed, which is solar rate in RA.

The entire set-up, including the telescope, is fixed on rails, and slides out of an upstairs window (as shown in the photograph on the next page), so that the objective is about 1 metre beyond the house wall. Consequently, with the heliostat and objective being high up and at a distance from the wall there is less thermal interference and better seeing than in my main observatory.

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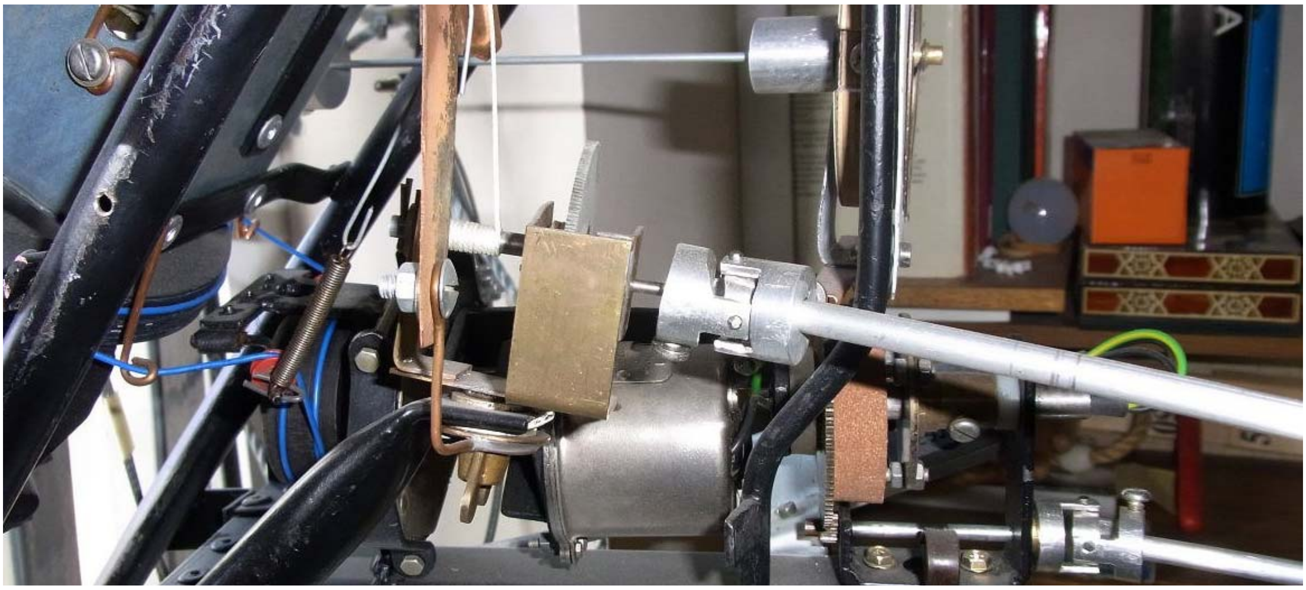


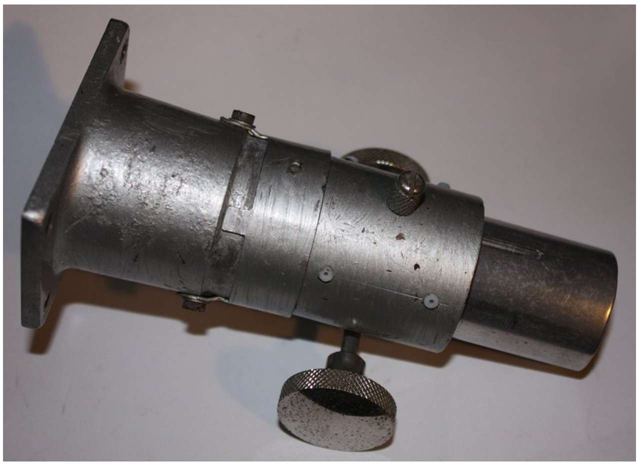
A metal Crayford focuser made with hand tools

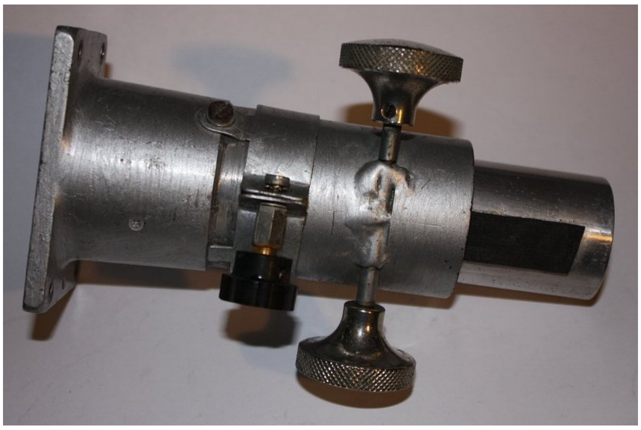
Geoffrey H. Grayer

In reply to John Wall's admirably brief article 'A wooden Crayford focuser' (*I&I News*, New Series No. 3, p. 1), the accompanying photographs of my metal version show just how different an interpretation of the same thing can be. It was constructed with hand tools, including an electric drill, and it provides a smooth action, free of backlash. If it appears a little tatty, this is because it has been in use for many years on my home-made 10-inch Newtonian.

All the parts came out of my junk box (surely every practical astronomer collects pieces of scrap tubing). The outer fixed tube is brass, and the inside sliding tube is aluminium. The only innovation is the use of two pairs of small PTFE electrical feed-through insulators to provide the bearings, as can be seen in the upper photograph. After a suitable slot was sawn out and filed, the brass sleeve which takes the focusing shaft was silver-soldered to the brass tube, as shown in the lower photograph. The part of this sleeve projecting into the inside of the tube was then filed away to expose the shaft when inserted, and a thin strip of hard rubber was glued along the inside tube to engage with this shaft.

The most difficult operation was the cutting of a groove in this sliding tube opposite the rubber strip. It is lightly greased, and engages with a thumb screw to prevent the tube from rotating and to limit its travel, thus preventing an over-enthusiastic observer from screwing it completely in or out, and to obviate the possibility of its falling onto the primary mirror! With a little ingenuity an electric drill can be used to mill the groove. My groove is blind, but it does not need to be. The thumb screw enables this inside tube to be easily replaced by another, such as a longer tube fitted with a Barlow lens. Anyone familiar with electronics will recognise the modified capacitor clamp used to attach the focuser to the original fixture, enabling the device to be changed rapidly for another accessory, as required.





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The Godlee Observatory twin equatorial

Kevin Kilburn

I was particularly interested in the picture of the Grubb twin equatorial in the previous issue of *I&I News* (No. 5, p. 18). For more than a century – and particularly since 1946, when we became its custodians – Manchester Astronomical Society has had use of the Grubb twin equatorial at the Godlee Observatory of the University of Manchester. The instruments – an 8-inch refractor counterbalancing a 12-inch Newtonian reflector – are still regularly used for visual observations and for imaging the Sun, Moon, and planets. The Godlee telescopes are possibly the last that were built of only four Grubb 'twin equatorials', and they share a special place with the instruments used by William Huggins and Isaac Roberts.

On 6 March 1901 the Minutes of the North Western Branch of the BAA (from which the Manchester Astronomical Society was formed in 1903) record a significant event. The Secretary of the branch, Thomas Weir, reported a meeting with 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. 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 observatory, it was to be a gift to the City of Manchester of Francis Godlee, of Simpson and Godlee, cotton manufacturers and calico printers. Godlee was a governor of the Technical Schools, and a close friend of Reynolds. By May 1901 a committee had been appointed to confer with the Technical Instruction Committee of the city on any matters that might arise regarding the telescope and the observatory.

The ensuing story is extensive, and ten years ago my paper on the Godlee twin was published by the Antique Telescope Society.* I would be pleased to send a copy to anyone who enquires.

* 'The Godlee Observatory in Manchester, England: The History of the Grubb "Twin Equatorial"', *Journal of the Antique Telescope Society*, Issue 23 (2002), 19–24.

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Making a 30-inch mirror

Brian Mitchell

It was probably towards the end of 1972 that I and three other members of Norwich Astronomical Society travelled to Cambridge to meet Dr David Dewhirst at the Institute of Astronomy. We had the idea of making a big telescope – maybe even a 30-inch. Dr Dewhirst had given a few talks to our society, and when we arrived at Cambridge he emphasised the enormity of building such an instrument. He took us to see the 36-inch, and we were suitably impressed. We were then taken into the optical workshop which had been the domain of Dr Linfoot (who had just retired), and which was to be cleared for another use. The main item there was the original grinding machine made by John Hindle in the 1930s, and which has been extensively copied. I noticed a large glass disc, wrapped in sacking and leaning against a door-post. I measured it with my tape. '30 inches', I said. 'Ah yes', said Dr Dewhirst, 'we have had that a long time, and do not really know what it was intended for.'

We then went to the library, where we were left to browse. After a few minutes Dr Dewhirst returned, and said: 'I have talked about that piece of glass with Dr Redmond, the Director, and he agrees that if you wish you can take it with you and see if it is any good to you. If it is not, we do not really want it back, and when you have finished with it please give it to another society who can use it, at no cost to them.' That piece of glass left Cambridge pretty quickly, I can assure you! We were driving a small Datsun with the glass in the boot. By that time it was dark, the dipped headlights shone almost up to the sky, and other headlights were flashed at us all the way back to Norwich. The glass then resided in my downstairs loo for a while, until we also collected the Hindle grinding machine and its many tools.

The machine with the glass on the table was eventually installed in our new shed at Colney Lane, and I was honoured with the task of figuring a 30-inch mirror – which is not an everyday occurrence. We had decided on f/5, producing a 12½-foot focus (we did not use millimetres in those far-off days). There was no grinding tool of the right curvature among those we had acquired, but I chose one that would produce a focal ratio of about f/4, and decided that it would suffice as a start.

The tools were hefty disks of cast iron – quite rigid, and with a curved surface on the working side. One side of the glass disk had a smooth ground finish, while the other was a muddle of clear and ground with deep scratches – so that was to be the one to work on to obtain the right depth of curve. The glass was 3 inches thick, and weighed a good bit more than I did. We laid it on the rotating table with the bad side uppermost, and the f/4 tool was placed on top. The machine worked by slowly rotating the glass, while the tool was pushed over the surface by arms moved by eccentrics at each end of the table. By adjusting the arms the tool could be made to abrade the glass in any desired area, and I set it to grind mainly towards the centre. The removal of glass is achieved by carborundum grit with water as a lubricant, spread under the tool. I put another tool on top just to increase the weight, and set about removing glass. The first grade of carborundum was 80 grade – very rough, and good at shifting glass. When I considered that it had ground deep enough I removed the cast-iron tool and used a thick glass disk of about 18 inches diameter – still with another tool on top for extra weight – and set to grind more round the edge of the glass. I also set a small cast-iron wheel to run round the edge at 45° to grind a shamfer, similar to that on the other side.

The cast-iron tool had ground a nice area in the middle which reached within a few inches of the edge, and so, with the glass tool around the edge, this part was ground down to meet the first, deeper part. Eventually the edge area met the central part, so the tool was then changed in position to extend over the whole surface, making it just one complete spherical area. I had calculated that a 30-inch mirror with a focal ratio of f/5 would be exactly three eighths of an inch deep in the centre, so I repeatedly measured this until I considered it sufficiently deep.

On a fine day I moved the mirror outside (with assistance), wet it, aligned it with the Sun, and measured the distance of the best image. I do not remember doing this more than once, so it was probably deep enough first time. The mirror was then returned to the machine – which we cleaned, as well as we were able, of all the 80-grade glass residue and muck – and recommenced grinding with a finer grade of carborundum until all the 80-grade marks were ground out. This procedure was repeated with finer carborundum until I considered it smooth enough to begin polishing. I then took the mirror home – back to my downstairs loo.

In the meantime we were building the 20-foot dome and the telescope on site – but that is another story.

One of our members had contacts in the printing trade, and had heard of a 'tilt table' which was about to be scrapped. It was a heavy steel table – the top about 3 feet square, and tilting from horizontal to vertical. We moved it to my garage (which since then has not seen a car), and fixed the mirror onto the table, sufficiently firm that it would not fall off when the table was tilted. The purpose of all this was to polish the mirror whilst flat and, by tilting it vertically, testing what I had achieved. The test procedure required Foucault test equipment: an illuminated pinhole and a moveable knife-edge, located in front of the mirror at a distance of twice the focal length of the mirror. My stool with the gear on it therefore had to be placed at a distance of 25 feet from the mirror – a position in my garden, outside my 16-foot garage. So it was a task that had to be accomplished on a fine day.

With the story so far it might seem as if everything had been accomplished in a comparatively short time; but actually it had taken about seven years to reach that stage! However, by then we had almost finished construction of the telescope, and I needed to know the exact focal length of the mirror. I had a 6-inch pitch lap that I had used on a smaller mirror, warmed it to suit the 30-inch, and gave the mirror a 'quick shine' to recheck the focal length. It was then aligned with the Sun, and the focus was measured with a decent solar image. (The projection screen became quite warm, even though the mirror was unsilvered.) The focal length was found to be 151 inches – which was just right. I was surprised at how quickly the 'quick shine' had been accomplished, so I continued to polish the whole mirror with the 6-inch lap. The procedure is generally to polish an area with the lap, with rouge as a polishing agent, and then tilt the mirror and test it. However, polishing raises the temperature of the mirror and thus affects the figure. It must therefore be allowed to cool, so usually the test was carried out on a later day. This was accomplished with the Dall null test, by which the mirror should appear perfectly flat when properly paraboloised. Each session was recorded and timed, and after repeated polishing and testing over a couple of years I considered that the figure might be acceptable. The mirror was not silvered, but I took it on site, fitted it in the telescope, and we all had a look at a few stars.

The general opinion was that the mirror was finished. However, I knew that further correction was required, so I took it home and polished it again. Finally, after a total of 16 hours 55 minutes of polishing over a period of about two years, I was content. It was not a perfect parabola, but it was not too bad. We then took the mirror to Herstmonceux to have it aluminised (free of charge), and eventually, in 1984, put it to good use in the telescope housed in the society's observatory to the west of Norwich. Over the ensuing few years, probably around 2,000 visitors looked through that telescope, making it all worthwhile.

Unfortunately, in 2000 some members of Norwich Astronomical Society voted to scrap the instrument, sell the mirror, and use the money to buy a Meade SCT. However, a small group of us resisted and persisted, and we eventually paid for it to be dismantled and transported to the grounds of Reepham High School (which specialises in science and technology), where all of it lay for a few years. Finally, Ron McArthur and I rebuilt it in the form shown in the accompanying photograph, and it has since resided at Reepham, to be taken care of and used by the school or a local society. I have since 'retired' from heavy building and similar activities, and now my main interest is in observing the Sun and participating in the work of the Solar Section.

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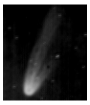
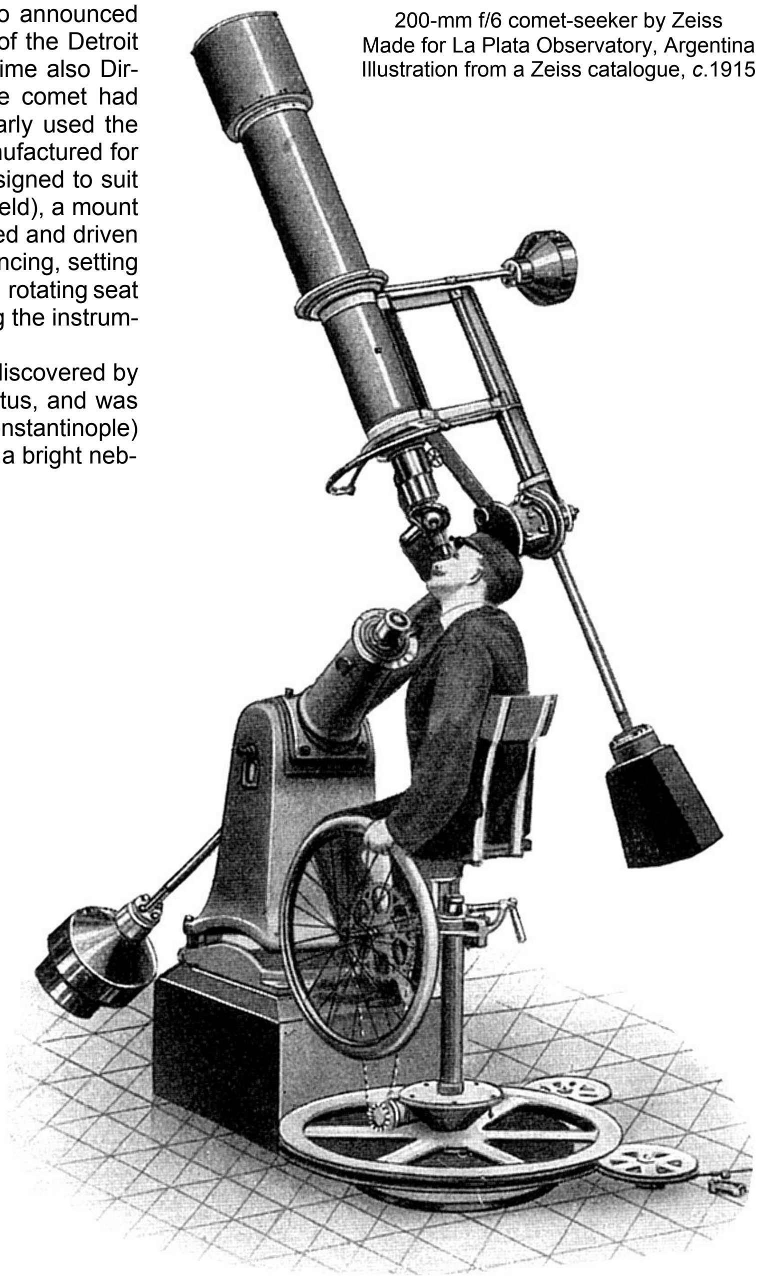
Delavan's comets

Bob Marriott



On 27 September 1913, as the latest issue of *Popular Astronomy*[1] was about to go to press, a telegram was received from E. C. Pickering, Director of Harvard College Observatory: 'Hussey cables Delavan comet observed by him September 26.5978. Ascension 21h 54m 18s.4, south 2° 34' 27". Visible in small telescope. Possibly Westphal's comet.'[2] Pickering also announced the discovery in an HCO Bulletin.[3] W. J. Hussey, of the Detroit Observatory at Ann Arbor, Michigan, was at that time also Director of La Plata Observatory, Argentina, and the comet had been discovered by Pablo T. Delavan, who regularly used the 200-mm f/6 Zeiss comet-seeker that had been manufactured for that observatory. This instrument was specially designed to suit its purpose: a fairly short focus (producing a larger field), a mount to accommodate sweeping rather than being clamped and driven to track specific coordinates, extensive counterbalancing, setting circles positioned directly in front of the observer, a rotating seat with adjustable height, and a hand-wheel for turning the instrument and the dome together.

The 'possibly' recovered comet was originally discovered by J. G. Westphal (Göttingen) on 24 July 1852, in Cetus, and was independently discovered by C. H. F. Peters (Constantinople) on 9 August. Throughout that month it appeared as a bright neb-



200-mm f/6 comet-seeker by Zeiss
Made for La Plata Observatory, Argentina
Illustration from a Zeiss catalogue, *c.*1915

La Plata Observatory *c.*1916,
with the comet-seeker building at left.

More recently – absent the comet-seeker.

ulosity measuring several arcminutes, and a tail began to develop. By mid-December it had begun to fade, and it was last observed by E. Schönfeld (Bonn) on 9 February 1853. Using measured positions, its period was calculated to be between 60.0 and 60.7 years.

In 1913 it returned 148 days earlier than had been calculated, and when Delavan rediscovered it on 26 September it was designated 1913d. On 8 October, Sophia H. Levy, of Berkeley Astronomical Department, announced, in a detailed mathematical paper, that the identity of Delavan's comet 1913d with Westphal's comet of 1852 had been 'confirmed by Nicholson and Kidder by interpolation from Hnatek's ephemerides in *Astronomische Nachrichten*, 193, 11, on the basis of the observations of September 26 and 27 by Hussey [La Plata] and Aitken [Lick] respectively. The average period derived from the Right Ascensions and declinations separately is 61.121 years, with an uncertainty of a few units in the third decimal.'[4]

Delavan had first observed it near the northern boundary of Aquarius, and it subsequently passed through Equuleus, Delphinus, Vulpecula, and Cygnus. On 22 October it was in the same telescopic field as Metcalf's comet 1913b (discovered on 1 September). It developed a tail, but despite the prospect of brightening it was barely visible to the naked eye, and the initial fade in mid-October was first reported by a 19-year-old amateur astronomer who was later to become far more well known: W. H. Steavenson.[5] By the end of November it was practically invisible telescopically, and one of the last observations was made by E. E. Barnard, using the Yerkes Observatory 40-inch refractor: 'Westphal's comet is simply gone to pieces. It is a vague, somewhat elongated mass of feeble light 2'± in diameter. A setting for position could not be made closer than 1'. It is most extraordinary. There is no condensation and no form to it. It is faint.'[6]

Comet Delavan–Westphal was predicted to return in 1976, though no trace of it was found... but then again, 'lost' comets sometimes reappear.

Delavan's second comet, 1913f, was discovered with the Zeiss instrument on 17 December. It appeared as a round nebulosity less than 1' in diameter, and was scarcely brighter than mag. 11. No tail was visible, but there was a sharply defined central condensation, almost stellar in appearance. Situated in Eridanus, it was at once observed extensively in both hemispheres. It had already passed opposition, its geocentric motion was slow, and except for a gradual increase in brightness up to mag. 9 its appearance did not change much. Most observers had lost it in the evening sky by the end of March 1914, though it was followed at Nice and Algiers until 6 April. After conjunction with the Sun it was first observed in the morning sky on 30 June 1914, at Lick Observatory – by which time it had brightened to mag. 7 and had developed a tail about 1° in length. Later in 1914 it was visible to the naked eye and had a conspicuous tail, and by September it had attained mag. 3 and was as far north as declination 50°. Perihelion passage took place on 26 October 1914.

Following its reappearance in June 1914, E. E. Barnard, using the Bruce astrograph, obtained numerous photographs of it over a period of several weeks. In 1897 the wealthy philanthropist Catherine W. Bruce had donated $7,000 for the production of this new type of instrument, with 10-inch and 6¼-inch cameras – the glass produced by Mantois of Paris, the optics figured by John Brashear, and the mount manufactured by Warner and Swasey.[7] Barnard used this instrument at Yerkes Observatory, Wisconsin, at Mount Wilson Observatory, California (for a short period), and again at Yerkes Observatory.

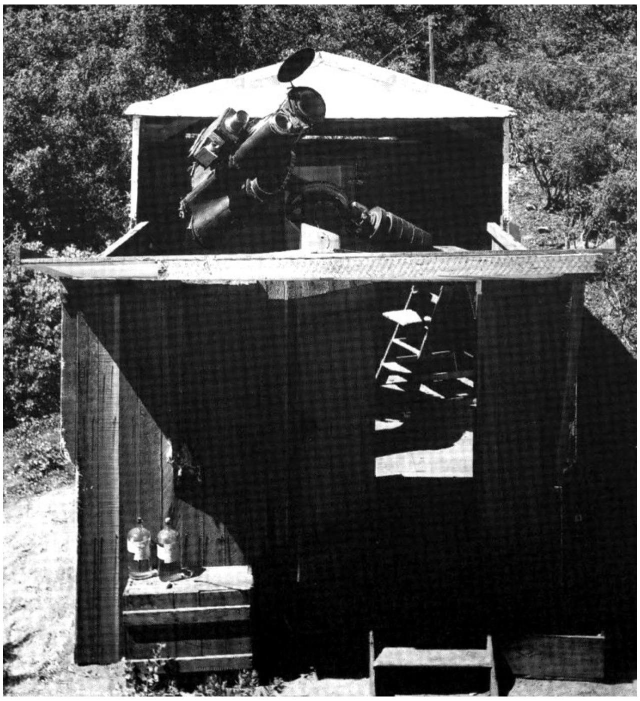
In October 1914, E. C. Pickering received a letter from E. B. Frost, Director of Yerkes Observatory, which included some of Barnard's notes: 'The photographs of this comet show that it has two distinct tails, diverging at an angle of some 30°. To the naked eye the southern tail is distinct and can be traced for 10°. No trace of the northern tail could be seen. But on the photographs the northern tail is the brighter and longer of the two. It is filled with fine details, while the southern tail is short, diffused, and structureless. The two tails therefore must be different in chemical and physical conditions: one photographically bright, the other visually bright.'[8] Barnard also later noted, significantly, that due to the peculiarities of the two tails – one long and straight, the other diffuse and strongly curved – 'I have not seen this combination before in the photographs of an individual comet.'[9]

On 7 December it passed into the southern hemisphere, where it was followed for several months more. The last position was obtained by A. E. Glancy, at Córdoba Observatory, Argentina, on 7 September 1915.

Delavan's comet 1913f was visible for 629 days, and for much of that time it was visible to the naked eye. It therefore prompted much correspondence in the popular press, as well as in scientific journals. One of those who followed its course was H. P. Lovecraft, author of horror, fantasy, and science fiction short stories and novels. Lovecraft had an intense interest in science, and over several years he wrote dozens of articles on astronomy for local newspapers and other publications, including essays condemning charlatans – among them, 'Delavan's comet and astrology', published in the Providence (Rhode Island) *Evening News* on 26 October 1914. And in France, 'on n'a pas manqué de l'associer aux événements européens, et elle restera la comète de la Guerre' – 'it will remain the comet of War.'[10]

On 9 November, E. C. Pickering issued an HCO bulletin with an ephemeris submitted by George van Biesbroeck, of the Royal Observatory, Uccle, Belgium, who included the comment: 'Computed during the anxious days of war, taken over to London by a friend leaving this unhappy country via The Hague.'[11] A few months later, in 1915, he accepted an invitation to leave Belgium and work at Yerkes Observatory, where he continued his work on double stars, comets, asteroids, and variable stars.

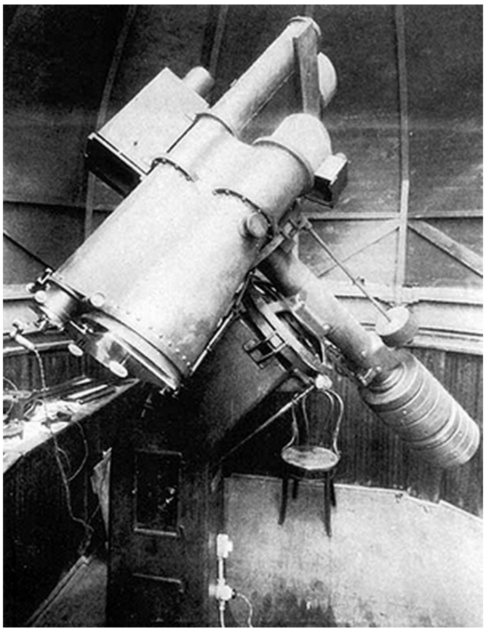
Several years later, in 1927, van Biesbroeck published a 36-page paper[12] on the definitive orbit of comet 1913f, which, he concluded, has an orbital major axis of 170,000 AU (almost 3 light-years) and a period of around 24 million



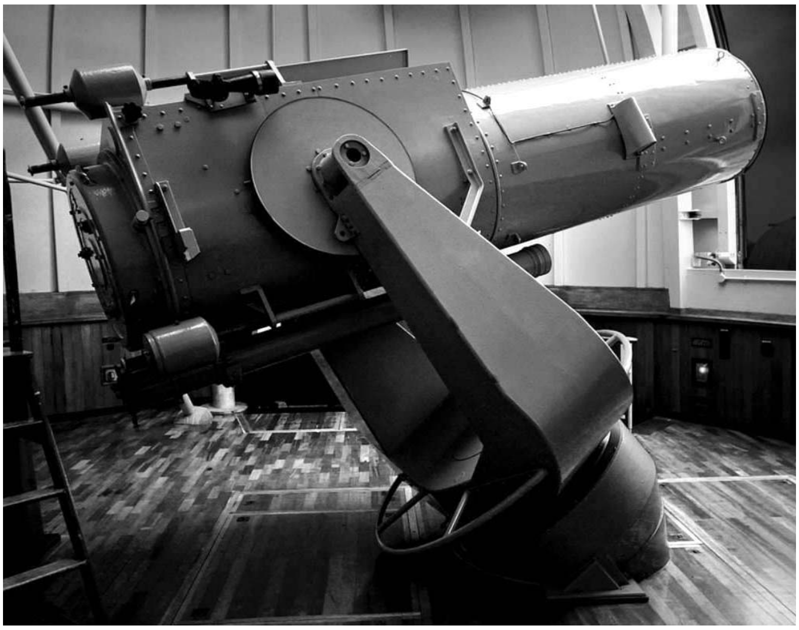
The Bruce astrograph in a temporary shed on Mount Wilson, August 1905. (Mount Wilson Observatory archives, Huntington Library.)

Delavan's comet 1913f; 1914 September 28.
Bruce astrograph 6¼-inch camera; exposure, 2h 47m.
Photograph by E. E. Barnard.

The head of Delavan's comet 1913f; 1914 September 26.
Greenwich 30-inch Thompson reflector; exposure, 25m.
Field: 55' x 50' (a much smaller field than in Barnard's photograph).



The Bruce astrograph at Yerkes Observatory.



The 30-inch Thompson reflector at Herstmonceux.

years. This paper was published five years before Ernst Öpik posited the idea of a 'comet cloud', and twenty-three years before Jan Oort revived this hypothesis in 1950.

In 1913 Delavan's first discovery had been announced by W. J. Hussey, who was involved in many organisations in North, Central, and South America, and was especially influential in the establishment of new sites in the southern hemisphere. His 'dream of half a lifetime' was to found a new southern observatory devoted to the discovery and observation of double stars – for which he is chiefly remembered – and to this end, in company with his old college friend R. P. Lamont, who had become a successful businessman, he founded the Lamont–Hussey Observatory at Bloemfontein, South Africa. The observatory, with a 27-inch refractor, was opened in 1927; but in 1972 it was closed down, and the building has since been used as a theatre.

Unfortunately, Hussey never saw the completion of his observatory. In 1926, while travelling to South Africa, he and his wife, and his assistant R. A. Rossiter and his wife, stayed in England for a few days. They had planned to leave London on 29 October, but on 28 October Hussey suffered a ruptured aneurism, and died. On the previous day he had presented a talk on his work at Ann Arbor, at the Annual General Meeting of the British Astronomical Association.

References

1 *Popular Astronomy* was published from 1893 to 1951. Each of the 59 annual volumes contains ten issues.
2 *Popular Astronomy*, **21** (1913) 524.
3 Harvard College Observatory Bulletin 531 (27 September 1913).
4 Lick Observatory Bulletin, **8**, no. 244 (1913), 19–20. Thirty years later, Levy wrote several manuals on anti-aircraft and artillery mathematics.
5 *Monthly Notices of the Royal Astronomical Society*, **74** (1914), 327–8.
6 *Publications of the Astronomical Society of the Pacific*, **25** (1913), 294.
7 *Astrophysical Journal*, **21** (1905), 35–48.
8 Harvard College Observatory Bulletin 566 (1 October 1914).
9 *Popular Astronomy*, **22** (1914), 536.
10 *L'Astronomie*, **28** (1914), 461.
11 Harvard College Observatory Bulletin 571 (9 November 1914).
12 *Publications of the Yerkes Observatory*, **5**, pt. 2 (1927), 1–36.