

The Herschel “20-feet” Mirror at SAAO

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During the years 1834-1838 Sir John F W Herschel operated a 48 cm diameter reflecting telescope of 20 feet (6.1 m) focal length at the location of the present-day Grove Primary School in Claremont, Cape Town. During this time he made a survey of nebulous objects and double stars that complemented the Northern one made by him and his father, William, from England. Their work together laid the foundation for the New General Catalogue or NGC familiar to astronomers today.

In 1783 William Herschel had constructed his original 20-foot telescope, the most successful of his large instruments and at the time the largest in the world. However, by 1820 it had fallen into disrepair and was reconstructed by father and son so that the former's survey could be repeated and extended. It was this telescope that Sir John brought to the Cape.

Large glass mirrors could not at that time be made because both of annealing problems and the inability to make reflecting surface coats. The primary mirror of the 20-feet was therefore of speculum metal, a hard alloy mainly of copper and tin that could take a brilliant polish but could only reflect about 60% of the incident light. Further, the alloy that the Herschels used was chosen to avoid excessive brittleness at the expense of liability to tarnish. As a consequence, their mirrors required precise optical re-polishing every few months and this problem may have been aggravated at the Cape by the relative proximity of John Herschel's observatory to the sea. To avoid problems he brought three interchangeable primary mirrors with him, as well as his polishing machine.

The oldest of the three mirrors, each of which were about 48 cm in diameter, had been cast, ground and polished by William Herschel. The second was a joint effort between father and son and the third was made by John Herschel alone.

John Herschel erected the reconstructed 20-foot telescope on the estate Feldhausen that he owned during his period of residence at the Cape. He was assisted by his technician, John Stone. The very successful results of the observations were published about ten years later (Herschel, 1847).

The image of the telescope shown in the well-known illustration, with Table Mountain in the background, that formed the frontispiece of the 1847 publication, was a greatly simplified one. Fortunately, there still exists a detailed description of the telescope in

its final form by Herschel that is now in the collection of the University of Texas, unpublished until transcribed by Warner (1979).

Fig 1 is adapted from an image in Herschel's description. Motions could be imparted to the telescope by means of the various winches and Stone was kept hard at work during observing sessions. For example, when Herschel was surveying the sky during one of his "sweeps", the telescope was moved up and down fairly rapidly by three degrees in elevation while fixed on the meridian. In this way a long stretch of a 3° wide band of declination could be mapped as the Earth turned.

Because of the poor reflectivity of speculum mirrors, the "20-foot" was used as a "front view" telescope, meaning that the eyepiece was placed at the prime focus of the mirror, whose axis was tilted slightly relative to the axis of the tube. The observer had to look downwards into the tube. This off-axis configuration inevitably caused distortion of the images that could be reduced to some extent by stopping down the diameter of the input pupil or by introducing a form of apodizing using triangular masks. [The optical performance of front view reflectors including those of the Herschels has been analysed in detail by Ceragioli (2018)].

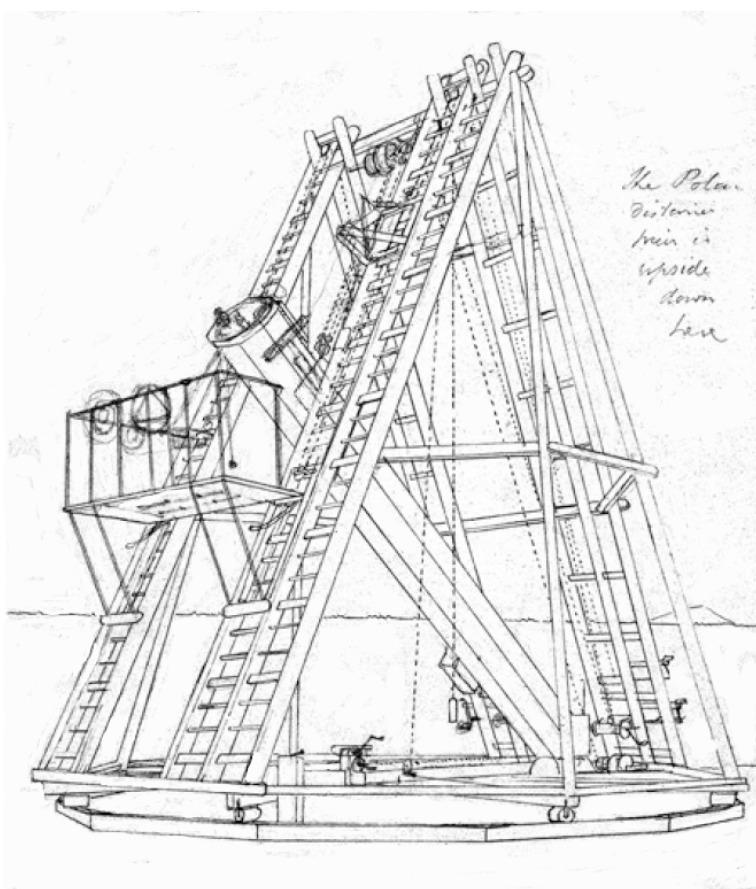


Fig 1. Sketch of the Herschel 20-foot telescope as erected at Feldhausen. From a sketch by John Herschel (credit: Harry Ransom Center, the University of Texas at Austin).

Following his work at the Cape, Herschel returned to England and did not re-erect the telescope, which gradually deteriorated. Two of the mirrors, the tube and a few other parts have survived and are in the possession of the National Maritime Museum in Greenwich, UK (Maurer, 1971). The third mirror, that made by John Herschel alone, is in the Museum of the SAAO.

This third mirror was sent many years later, in July 1905, to the Royal Observatory, Cape of Good Hope, by Sir William James Herschel, the oldest son of John Herschel.

The date is based on an unsigned note found with the mirror, sent in July 1905 from Woodstock Road, Oxford, his address. The 4-page document contains instructions on how to remove the mirror from its packing case, with a caveat on preserving the inscription on its back.

According to Warner (1979), the mirror was sent to the South African Museum (now called the Iziko South African Museum) for an exhibition commemorating John Herschel in 1934. It was last displayed at the Museum in March 1992.

Together with certain other items that belonged to the Royal Observatory, it was returned in November 2020 to the SAAO, the successor institution of the Royal Observatory, Cape of Good Hope.

The outer box (Fig 2) is of wood, somewhat worm-eaten. Its lid was held down by many screws. Underneath it, lay an inner tin box (Fig 3).



Fig 2. (left) Top of the outer wooden box. Fig 3. (centre) shows the top of the inner tin box which lay beneath a layer of toweling material. Fig 4. (right) shows the surface of the mirror, still fairly reflective.

The tin lid could easily be removed to reveal the front surface of the mirror itself (Fig 4.).

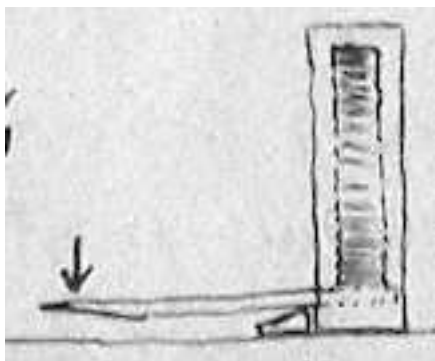


Fig 5. Piece of wood used to lever the mirror, still within its tin box, out of the wooden case. One person puts his weight where the arrow indicates and another twists and rolls the mirror out.

To extract the mirror from the wooden box the small piece of wood above the tin in Fig 3 was removed and replaced by a longer piece as shown in Fig 5, taken from the note accompanying the mirror. The box was then placed on its side and the mirror turned and rolled out. Two people were necessary for this manoeuvre.

The mirror was then placed face down and supported by its edges. The tin can was lifted off to reveal the gilt inscription on the back (Fig 6).

Fig 6. The back of the mirror carries an inscription in Hebrew and English in gilt lettering.



Hagai Netzer, an Israeli friend, suggests that a more accurate translation of the Hebrew would be “And I have seen all the heavens and they are telling the glory of God”.

Figs 7 and 8 show the bottom and top of the tin.



Fig 7. (left): The lower part of the tinned box that surrounded the mirror. The brass rod around the inner edge can be seen.

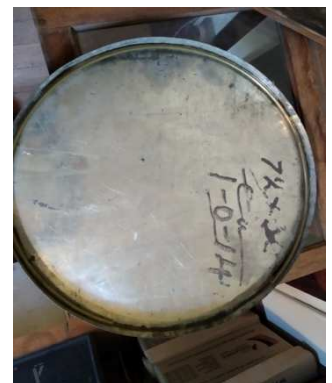


Fig 8 (right): The lid of the box, also with a brass rod most of the way around the inner edge. The significance of the writing is unknown.

unknown.



Fig 9. On the side of the mirror is written “Mirror J1”.

The mirror itself has diameter 47.5 cm and thickness ~37.5 mm. Because of its extreme thinness it must have flexed quite considerably. Its mass has not been measured but is probably around 60 Kg.

Under the tin were several layers of felt-like material, including a pad stitched together from several pieces, which was probably similar to that described by Herschel in the introduction to his Cape Observations where he discusses the

supporting of large mirrors (Herschel 1847, p. x) as follows “between the back of the case and the mirror are interposed six or eight thicknesses of coarse woolen baize, or blanketing, of even texture, and quite free from knots, stitched together at the edges to prevent any hard substance from getting between them. On this bed the metal is laid flat, and being shaken into a concentric situation, as respects the rim of the case, two supports of strips of similar woolen stuff, many times doubled, occupying about 30 degrees each of the circumference of the case, so as to leave an arc of about 40 degrees unoccupied, opposite the point which is intended to be placed lowermost in the tube...”.

Fig 10. Pad, consisting of 4 layers of blanketing material sewn together, found behind mirror.



The Foucault test was only published in 1858 and was thus unavailable to the Herschels. The second 20-foot mirror, that made by father and son, is the only one to have been examined by more-or-less modern methods, by Davies (1923). He found it to be somewhat hyperbolic. The Herschels tested their mirrors using zonal masks, a method that would have been less accurate than the Foucault test.

Ceragioli (2018) points out that these 20-foot mirrors probably represented about the largest size that were usable in front-view telescopes. The much larger Herschel 40-foot instrument, constructed at great expense and to much fanfare, was in fact a disaster that the Herschels did their best to keep quiet about.

The Herschel method of mounting large mirrors was greatly inferior to the “equilibrated levers” invented by Thomas Grubb and adopted by Lord Rosse for his instruments.

The SAAO possesses another quite big Herschel mirror, a 14-inch (34 cm) mirror of 14 (feet 4.3 m) focus. This mirror is about 4.5 cm thick and has a bar fixed to its back at about 1/3 of its height (if the mirror is placed on its edge). It is surrounded by a brass ring and had a tin cover that covers its front. This mirror was part of a telescope built by William Herschel in 1810 and sold to Glasgow University. It was later purchased for the Royal Observatory, Cape of Good Hope. Unfortunately the telescope, in an advanced state of decay, was scrapped around 1950.

Another speculum mirror 6 inches (15 cm) diameter and 18 mms thick exists at SAAO but its provenance is unknown. It is enclosed in a tin box.



*Fig 11. A new box with a Plexiglass cover, to display the 20-foot mirror in a vertical position, has been constructed and is shown in the lower part of the figure together with the lid of the mirror tin. Above it is a 14-foot mirror and lid, constructed by William Herschel in 1810; (See Warner, B., MNASSA 1987, **46**, 158); also a smaller concave speculum mirror of about 15 cm diameter of unknown provenance.*

Note: The original wooden box of the 20-foot mirror has been kept and treated to kill the woodworm infestation.

Acknowledgments: The author wishes to thank Dr Roger Ceragioli (University of Arizona) for information, Mr Chris de Coning for help with handling the mirror and Dr Hagai Netzer for his translation.

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The Western Cape bolide of August 9, 2021 (SAFC Event 401)

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The Western Cape seems to have had its fair share of very bright bolides in recent years, and such was the case again during the early morning of August 9, 2021. The last bright bolide over the area occurred on January 16, 2019 (Event 316 in the Southern African Fireball Catalogue (SAFC), see Figure 1), which approached from the south descending at a steep angle, and disintegrated with two explosions just south