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Cover Photo: The Main Building of the former Royal Observatory, constructed 1825-1828 to the designs of John Rennie, a Scottish born civil engineer. The Cape Town site of SAAO has just been declared a National Heritage Site (see Page 1 inside).
Photo: Janus Brink, SAAO.

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News Note: New National Heritage Site - The Royal Observatory (SAAO)

I.S. Glass

Abstract: On 21 December 2018, just two years before the 200th anniversary of the foundation of the Royal Observatory, Cape of Good Hope, SAHRA (the South African Heritage Resources Agency) declared the Observatory, Cape Town, campus of the South African Astronomical Observatory to be a National Heritage Site. This was the culmination of twenty years of effort by those anxious to see the site, buildings and heritage of the former Royal Observatory, Cape of Good Hope, preserved for posterity.

The Royal Observatory was the first scientific institution to be established in South Africa, the nominal date of its foundation being 20 October 1820, when an "Order in Council" was signed in the UK to construct a Southern Hemisphere observatory "for the improvement of astronomy". Of course, the acquisition of the site and the actual erection of the Main Building took a number of years.

Today the SAAO is a wholly South African organization with its main observational facilities located at Sutherland in the Karoo, far away from city lights.

The SAHRA Statement of Significance

The "Statement of Significance" prepared by SAHRA, that accompanies the Declaration in The Government Gazette (No 42127), makes a number of points:

The South African Astronomical Observatory in Cape Town has played a highly significant scientific rôle over time as the oldest permanent observatory in the Southern Hemisphere. The site offers an overview of the history of astronomy both locally and internationally. It is a “living site” with more than 150 years of history and still retains its prominence in the international astronomical community.

The SAHRA Declaration continues with a summary of the “intangible heritage” of contributions to astronomy from the site, ranging from the first believable measurements of the distance to a star (Alpha Centauri), early catalogues of the principal southern stars, the first star catalogue prepared by photographic means, an accurate measurement of the distance to the Sun (a value that is the benchmark against which all other cosmic distances are measured) that was the standard for many years, the first geodetic surveys of southern Africa and the re-measurement of La Caille’s “Arc of the Meridian” that showed the Earth, though flattened at the poles, was not pear-shaped as previously thought!

In the matter of Architectural Heritage, there are several buildings of historical value that not only reflect changing styles during the nineteenth century but are of scientific value thanks to the astronomical observations that were made within them. The Main Building, designed by the Scottish engineer, John Rennie, was completed in 1828 (see front cover of this issue). The photo-heliograph, the oldest dome on site, runs on cannon balls. The McClean building was designed by Herbert Baker and is closely associated with David Gill, one of the leading astronomers of his time.

Fig 1. The McClean building (1896), designed by the noted architect Herbert Baker.

The Observatory is also noted for its "Movable Heritage", i.e. items such as its telescopes and the many instruments it possesses for precise measurements of astronomical objects.

Responsibilities around a National Heritage Site

Being a National Heritage Site places responsibility on an owner to maintain it in a responsible manner. Even though all buildings older than 50 years are subject to conservation regulations, a National Heritage Site is likely to be monitored more closely. For this reason, there was some anxiety on the part of the Observatory and its umbrella organisation, the National Research Foundation, that normal scientific activities could be hindered by stringent heritage requirements. This is why mention is specially made of the observatory as a "living site" in the first paragraph of the "Statement of Significance". A Management Plan will have to be developed and agreed with SAHRA.

International interest (UNESCO, IAU)

Recent years have seen a great deal of international interest in astronomical heritage. A collaborative project exists between the International Council on Monuments and Sites (ICOMOS), an advisory body to UNESCO for cultural heritage, and the International Astronomical Union (IAU). The main aim of this project is to help with identifying significant astronomical sites of various types in the context to the World Heritage Convention. The Royal Observatory, Cape of Good Hope, together with that at Greenwich, the Paris Observatory, Mount Wilson and the Einstein Tower in Potsdam are all regarded as important examples of observatories that have contributed significantly to astronomy since medieval times. They may eventually form the basis of a serial nomination as World Heritage Sites. South Africa and the Southern hemisphere countries generally have relative few such sites (10) of which only one (the Vredefort Dome) can be considered scientific.

Acknowledgements

Many people have contributed to the push for this declaration and the preservation of South African astronomical heritage. It would be invidious to try to list them all for fear of omitting any particular individual.

The Western Cape bolide of 2019 January 16

Tim Cooper[1] and Kos Coronaios[2]

[1] Comet, Asteroid and Meteor Specialist, ASSA
[2] Director of Observations, ASSA

Summary: A bright bolide (South African Fireball Catalogue (SAFC) #316) was widely seen over the Western Cape at 20h14m53s SAST on 16 January 2019. It exploded at an altitude of around 46km, was followed by audible noise and vibrations and left a persistent train visible for several minutes. The first person to advise of this event was Kos Coronaios, who said he received reports of a ‘double bang, followed by rumbling’ at around 20h15 SAST. Later that evening and the following morning, we continued to log sightings of the event, as well as two videos and several images of the persistent train left behind by the meteor. The observed duration and speed, and the appearance in the videos are all consistent with a bright meteor. Notably the event was not detected by US government sensors, and therefore was probably less energetic than the daytime fireball which detonated with an energy of 0.1 kT just west of Cape Town shortly after noon on 12 March 2013 (SAFC #249). A rough triangulation from the more reliable eye-witness accounts, and more importantly from images of the smoke train, gives the tentative path shown in Figure 2. The meteor approached from the south descending at a steep angle, moving slightly towards the east, and disintegrated with two explosions just south of the coast between Hermanus and Pearly Beach, probably in the vicinity of Gansbaai.

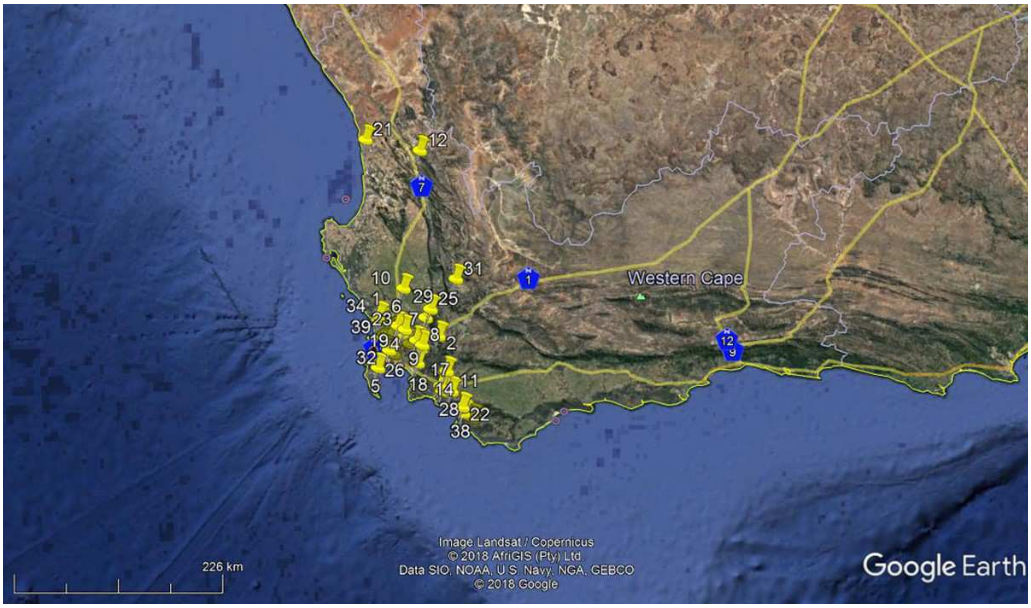


Fig 1. Locations of all 42 observers who provided reports and images. All sites were plotted but due to congestion in the Cape Town area and suburbs, not all site labels are visible.

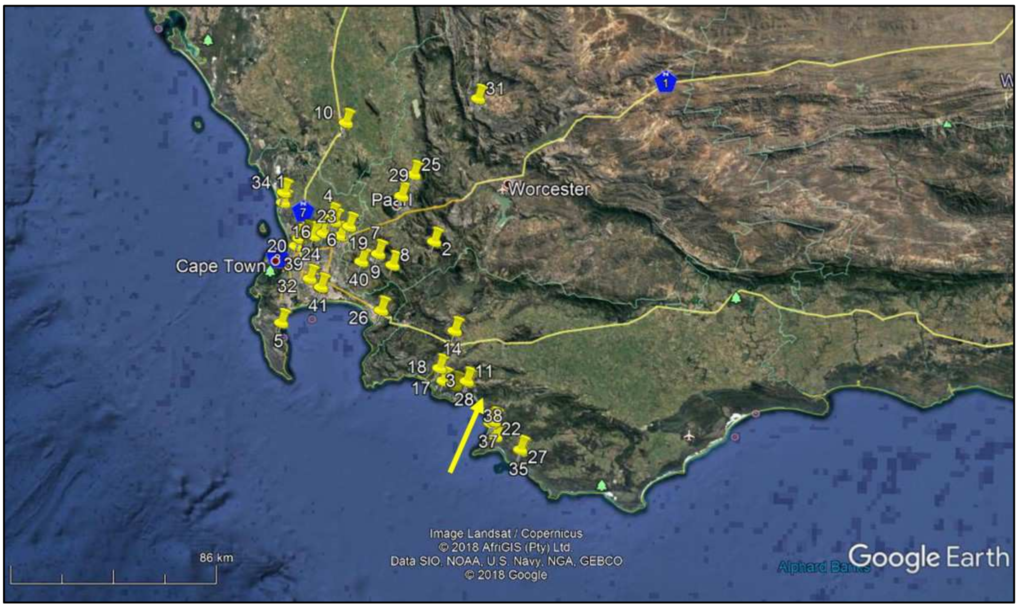


Fig 2. Locations of observers in Cape Peninsula and southern Cape coast, with possible path of the bolide indicated as a yellow arrow.

Fig 3. Locations of observers in vicinity of the path. Azimuth directions derived from images of the smoke train are shown as follows: Red line is the azimuth of intersection with ground level from Jacqueline Keulemans at Gordons Bay, yellow line is the azimuth of intersection with ground from Janeke Maroudas at Vermont, blue and green lines are azimuths of the two bright bursts from Riaan Potgieter at Onrus. The white ellipse indicates the rough area in which the meteor probably disintegrated.

Geographical visibility and direction

We received a large number of reports from a wide expanse of the Western Cape, of which 42 independent locations are shown in Figures 1-3. All sites are plotted, but due to the large number around the Cape metropole not all site labels can be seen. The fireball was seen as far as Clanwilliam and Lamberts Bay in the north, and as far east as Pearly Beach. Henriette Vermeulen observing from Clanwilliam saw it low on the horizon just east of south and moving diagonally downwards from right to left, while Liza and Pierre Groenewald from Lamberts Bay noted it seemed to move inland towards the east. There were a large number of sightings from Cape Town and surroundings, and most gave the general direction as south-east, moving from right to left. From Welgemoed, Rozanne Groenewald said something 'went down over Welgemoed Golf Club' which runs south to south-east of her location. Marius Reitz in Edgemead was setting up his telescope and saw the fireball in the direction of Helderberg, in azimuth about 120°.

Several reports from further south and east help constrain the probable path of the fireball. Marg James was walking at Lagoon Edge east of Hermanus when she saw it to the south east and thought it might land in the lagoon. Others in Hermanus said it seemed to be heading for Gansbaai, and Kate and Steve Klopper in Fisherhaven said 'it came right over our heads'. Jaco and Chloe Koekemoer at Onrus said they saw it to the south of them, from which description of the path I take the meteor did not cross the coast. Even further east, Sonja Rademeyer saw the meteor from De Kelders and said it looked like an emergency flare shooting towards Gansbaai. On the other side of the mountain at Franskraal, Cecelia Diener saw it moving northwards towards the mountain side. The most easterly sightings were from Pearly Beach, where they saw the meteor looking in a westerly direction, and moving left to right. This would seem to indicate the path was headed north east somewhere between Hermanus and Pearly Beach.

Videos of the bolide

Video footage from cameras such as security cameras and dash-cams can be extremely useful in determining the pre-atmospheric orbit, and also the potential fall site for meteorites from large bolides. However, this requires precise knowledge of the location of the camera used to take the footage. Two videos were posted on social media, both of which showed the actual passage of the meteor, either directly or indirectly. The footage from a security camera near Malmesbury (Figure 4) is the best visualisation of the appearance of the meteor. The meteor enters the field at upper right and descends at an angle of 30° to vertical from right to left looking roughly south. The duration of passage is less than two seconds from entering the field of view until the meteor burns out just above the horizon, and in that time two bright flashes are clearly observed separated by less than 1 second. The total time of flight of the visible meteor is indeterminate seeing that deflagration was already underway when the meteor entered the field of view. The second video is from a security camera overlooking a swimming pool in a residential property, and the meteor is seen in reflection on the water for a very short section of its passage. Despite the efforts of the authors, the precise position of neither video camera could be determined at the time of writing, so we are unable to derive any accurate measurements of the trajectory of the fireball. One further video was received from Guido Di Giannatale which showed the bright flashes from inside a residential property, and the reaction of an animal to the sound of the explosions. Since the camera time stamp was synchronised to internet time, we determined the appearance time of the bright meteor as 20h14m53s. This was followed 136 seconds later by the loud explosions, which would indicate disruption may have occurred at an altitude of around 46km.

Images of smoke train

In the absence of astrometry from the videos, we were able nevertheless to derive some tentative measurements from images of the persistent train left in the path of the meteor. Four images were received showing the meteor descending in different directions depending on location of the observer, and are summarised in Table 1.

Site	Observer	Location	Direction	Descent angle
26	Jacqueline Keulemans	Gordon Bay	Right to left	14°
17	Janeke Maroudas	Vermont	Right to left	13°
42	Riaan Potgieter	Onrus	Right to left	--
22	Analise Kleyn	De Kelders	Left to right	12°

Table 1 Locations of observers who submitted images of the persistent train, in order from most westerly to most easterly. Note sites 17 and 42 are separated by only 2.1 km. Descent angle is the angle to vertical.

From interviews with the observers we ascertained the direction faced, and the differences in direction infer the meteor passed between these locations. So for example, Sites 17 and 26 were looking east and saw the meteor descend towards the left, while Site 22 was facing west and saw the meteor descend towards the right. The image of Jacqueline Keulemans from Gordons Bay is particularly useful in that it records the train along with a discernible mountain skyline. A projection of the path in her image gives an intersection with the ground in azimuth 152 $\pm$ 2°, which is just south of landfall at Gansbaai. The image of Riaan Potgieter did not show the horizon, but he was able to point out the positions of the two bright bursts in the train relative to local landmarks, from which I measured azimuths as 144° and 120°. Close by in Vermont, Janeke Maroudas took her image around 10 seconds after the visible fireball, and from her direction I measured an intersection with the ground in azimuth approximately 144°. Analise Kleyn's image further east is the only one in which the train is from left to right as she saw it, which constrains the path to the west of her location. The azimuth directions derived from these train images are shown in Figure 3, and while there is some discordance, the possible footprint of disintegration is narrowed down to the area shown.

Visual appearance

Those who witnessed the visible passage of the meteor described a glowing ball with a tail, moving quickly, with at least two bright flashes and leaving a trail of smoke which persisted for several minutes. Aldiana Kotze saw a big ball of red orange flames, while Ree du Toit said the head looked like a very big teardrop, and Rozanne Groenewald said it looked like a teardrop with a long burning tail. These descriptions appear to agree with the montage of images in Figure 4, which shows the appearance at various stages in its path as seen from Malmesbury.

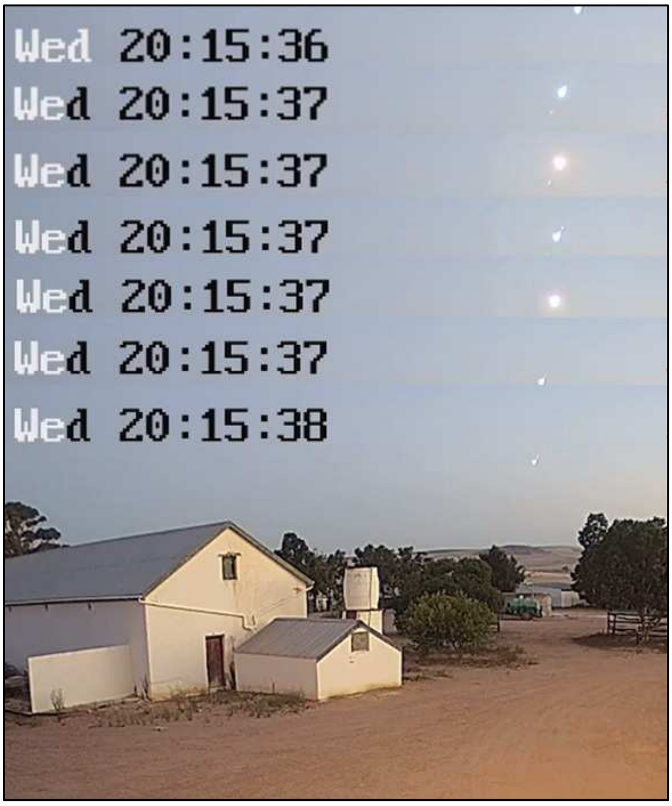


Fig 4. Sequence of frame grabs from Malmesbury video footage. Top frame is the first appearance of the bolide at upper right. The third and fifth frames show the two explosions. Last frame is immediately before the bolide ceases to be visible. In some frames at least three fragments are visible. Note total flight time in the Malmesbury video is just under 2 seconds, and the two explosions are separated by less than 1 second.

The total duration of the visible passage is difficult to determine, as the meteor had already started the process of deflagration before its two bright flashes, which are what seemed to catch most people's attention. The meteor had already begun its visible passage before it entered the field of view in the Malmesbury camera footage, and lasted less than 2 seconds before burning out. Several persons gave estimates of the duration, from 1-2 seconds up to about 7 seconds. The real duration is probably somewhere between these two extremes.

Exactly half of the reports gave descriptions of colour. The most often mentioned were white (30%), yellow (26%) and orange/red (30%). A small number mentioned seeing blue and green. The colours seen in the vicinity of the path were exclusively bright white or yellow, and all those who saw other colours including orange, red, green and blue were located in the Cape Town area.

Many described how the fireball left a persistent train. Analise Kleyn said it ‘left a smoke trail with two bright spots, and Ree du Toit said the fireball broke up before reaching the horizon and left two white stripes in the air. Dewald Jonker said ‘the smoke cloud easily lasted two minutes’. Jaco Koekemoer provided an excellent description of the fireball and smoke trail, and his descriptions are reproduced in full here:

‘Suddenly, out of the corner of my eye, I saw a blinding gold-coloured flash in the direction of Gansbaai. I was facing east. Immediately after the flash, I saw what looked like an extremely fast moving object…Looking at the contrail, I noticed that it was fairly thin, at that time thinking that it was actually smoke from a flare. The contrail stayed visible for about a minute and a half. The thickness of the trail also threw me off, since it was very thin. The wind quickly ruined the straight line and within seconds it was only a smear of a squiggly line left in the sky. The contrail was actually really high. It wasn't exactly above us, it was more south, likely over the ocean. It may have seemed as if it was only a little bit South, but due to the height of the contrail, it was likely more south than what it seemed.

The appearance of the train is well seen in the images taken by Riaan Potgieter (left) and Analise Kleyn (right) in Figure 5. We enhanced the images to accentuate details, which clearly show the two bright spots coinciding with the explosions and the apparent cork-screw appearance of the trail.

Fig 5. Images of persistent train from Site 42 (left by Riaan Potgieter) and 22 (right by Analise Kleyn). Notes the changed direction of the path as seen by the two observers from different locations. The two bright areas are the clouds left behind by the two

explosions along the path. Note also the cork-screw appearance in Riaan's image at left. Both images have been processed to enhance details.

Sounds heard

The visual meteor was followed by audible sounds and vibrations in the vicinity of the path. Observers in Cape Town and surroundings did not mention hearing any sounds, and some even specifically commented that no sounds were heard, though any sounds would have taken some time after the visible meteor to reach those locations. The furthest location from which sounds were definitely reported was Franschhoek, where Ian Newton said he heard 'what sounded like a sonic boom' several minutes after the meteor. Nearly all the sites around Hermanus, Gansbaai and Pearly Beach experienced effects. From Hermanus, Marg James reported 'a loud rumble like thunder' about a minute later, Louis Loubser said he thought it was an earth tremor, and Riaan Potgieter saw the meteor while walking his dog, and just over a minute later heard a loud 'boom' which caused people to come out of their homes. Also from Hermanus, Guido Di Giannatale recorded the time of the flash on a CCTV camera, which was followed by sounds 'like a sonic boom' 136 seconds later. From De Kelders, Annalise Kleyn imaged the smoke train and 15-20 seconds later heard sounds 'like loud thunder and felt like shaking'. In the same area Sonja Rademeyer said she heard a 'loud bang like thunder and it felt like an earth tremor'. From Pearly Beach, Sarah Coronaios was outside and reported 'two explosions very close together, followed by low rumbling for about 8 seconds, much like a flat tyre on gravel'. Barnie Huysamer said shortly after the flash he heard rumbling which lasted about 15 seconds, and Retha Vos heard 'rumbling like thunder, but almost as though there were two explosions'.

Conclusions

From the available reports, we conclude a meteoroid approached from the south of the country and entered the atmosphere at 20h14m53s SAST at a steep angle to the east of Hermanus, probably close to Gansbaai. The bolide underwent two disintegration events separated by less than 1 second at around 46km altitude, resulting in two bright flashes of light, left a persistent train visible for several minutes, including two bright clouds where the disintegrations occurred, and was followed by audible sounds with two explosions, rumbling like thunder which caused windows and ground to shake.

Acknowledgements

The authors would like to thank Dr Daniel Cunnama, SAAO, for several reports submitted via the SAAO website. Figures 1-3 courtesy Google Earth.

AAVSO’s new Spectroscopy Database

Percy Jacobs

This initiative was thought of and discussed at the ASSA 2018 Symposium that was held in Cape Town, under the theme of: *Amateur Astronomy in the Digital Data Age – how Amateurs can do real Science.* Discussions were held with Stella Kafka, Director AAVSO, who attended the Symposium.

A few months after the Symposium, emails came through from AAVSO, requesting a few spectroscopy enthusiasts to support with the development, including a representative from South Africa and a few others from around the globe. AAVSO tasked a development team, the “beta-testers”, to formulate and launch this database. A special mention needs to be made of the main developers, John Weaver, PhD Student, Cosmic Dawn Centre, Niels Bohr Institute, University of Copenhagen.

We were not much involved with the background work specifications and requirements of the database, as this was managed by Stella Kafka & John Weaver and others on the Team at AAVSO.

Discussions did take place, for example, on how to determine the quality of the spectra at a given resolution. Should one use Telluric lines? These are absorption lines produced by atmospheric gases; which could interfere with the spectra produced. If an instrument response correction is carried out at the time of processing spectra, this would remove the spectra interference seen from the atmosphere and therefore the Telluric line. The author has not detected the Telluric lines, probably because of an instrument response correction to each spectrum taken. After this conversation ended Stella Kafka took it “off-line”. A smaller group of experts came up with a solution on spectra approval requirements that would qualify spectra before they are published on the database.

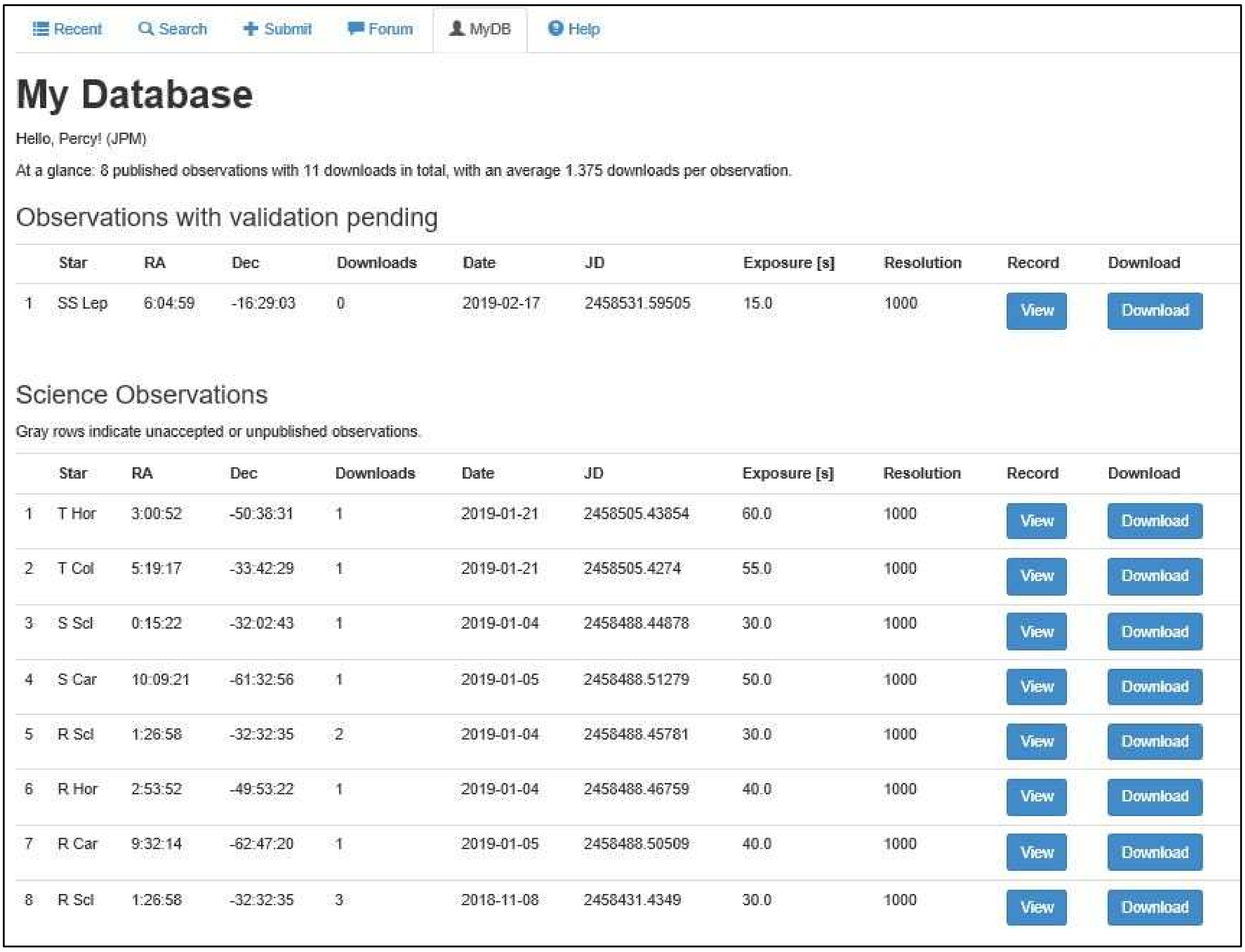
The next task was the selection and issuing of known standard stars to be used for verification of equipment and verification of spectroscopists’ abilities. Stars were selected and notifications were sent out after some southern stars were included.

So, having selected the most suitable standard stars, spectra were taken and processed according to a set of rules, similar to the BESS Project requirements - capturing the observer’s details on the AAVSO’s Spectra Database, DB. These included location, observer’s name, equipment used, etc. and the up-loaded spectra for observer verification.

There were a few “bugs” in the DB that were slowly making themselves known. From about August 2018 to January 2019, the author communicated with John Weaver. He fixed problems that were encountered, and slowly but surely, by early in January this year, all the “bugs” were cleaned up.

Once one was qualified as an observer and the quality of the submitted spectra was verified, the taking and submitting of scientific spectra was possible. The process of submitting scientific spectra and approval of said spectra, was now tested. Every submitted spectrum goes through a verification and approval process before it is published on the AAVSO DB as a “submitted science spectrum”.

To date 8 spectra have been submitted, all of which were officially released for publication as the 1st set of spectra from South Africa and maybe the first from the “beta-testing” team. It must be noted that the submitted spectra are of specific registered variable stars and other stars noted in AAVSO Alert Notices.


Recent Search Submit Forum MyDB Help

My Database

Hello, Percy! (JPM)

At a glance: 8 published observations with 11 downloads in total, with an average 1.375 downloads per observation.

Observations with validation pending

	Star	RA	Dec	Downloads	Date	JD	Exposure [s]	Resolution	Record	Download
1	SS Lep	6:04:59	-16:29:03	0	2019-02-17	2458531.59505	15.0	1000	View	Download

Science Observations

Gray rows indicate unaccepted or unpublished observations.

	Star	RA	Dec	Downloads	Date	JD	Exposure [s]	Resolution	Record	Download
1	T Hor	3:00:52	-50:38:31	1	2019-01-21	2458505.43854	60.0	1000	View	Download
2	T Col	5:19:17	-33:42:29	1	2019-01-21	2458505.4274	55.0	1000	View	Download
3	S Scl	0:15:22	-32:02:43	1	2019-01-04	2458488.44878	30.0	1000	View	Download
4	S Car	10:09:21	-61:32:56	1	2019-01-05	2458488.51279	50.0	1000	View	Download
5	R Scl	1:26:58	-32:32:35	2	2019-01-04	2458488.45781	30.0	1000	View	Download
6	R Hor	2:53:52	-49:53:22	1	2019-01-04	2458488.46759	40.0	1000	View	Download
7	R Car	9:32:14	-62:47:20	1	2019-01-05	2458488.50509	40.0	1000	View	Download
8	R Scl	1:26:58	-32:32:35	3	2018-11-08	2458431.4349	30.0	1000	View	Download

Fig 1. Screenshot of Observer’s scientifically approved spectra

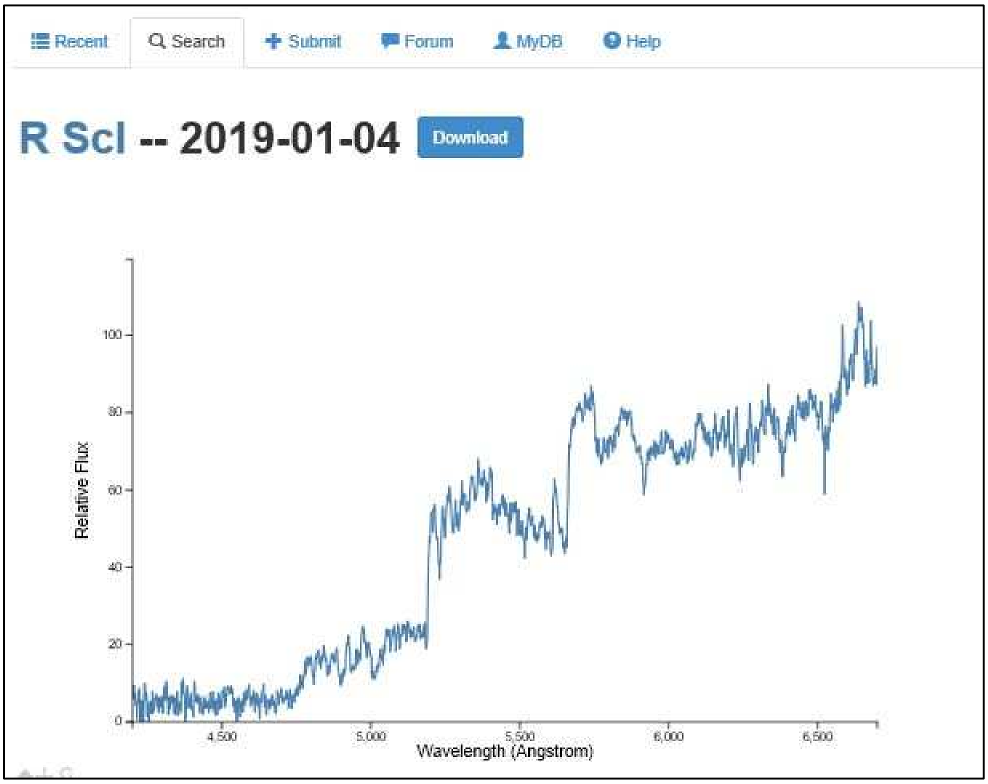


Fig 2. Screenshot of approved scientific spectrum when downloaded for viewing

Acknowledgements

Thanks to the ASSA Council for support, and to Stella Kafka, John Weaver and the rest of the AAVSO Team involved; AAVSO have followed the Theme of the ASSA Symposium 2018; “Connecting Amateurs and Professionals”.

Notes on experimental home-made eyepieces

Chris Stewart

A lifelong interest and fascination with telescopic eyepieces has led to the understanding of the importance of an eyepiece. The eyepiece is after all a critical component of a telescope; if the instrument is to realise its potential for optical excellence, the eyepiece needs to be at least as good as the objective. Over the years a number of different eyepieces have been accumulated through judicious opportunism in purchasing 2nd-hand items as their former owners follow the never-ending quest for perfection. Eyepieces belonging to others have also been tried as has a great deal of reading and experimenting. In that time more optical design could have been studied, but life took a different turn, and as an empiricist, current knowledge is based more on practical experimentation than optical theory.

There remains a certain mystique associated with eyepieces, with premium marques fetching, well, astronomical prices. With the mystique comes a lot of folklore, containing just enough truth to be interesting, passed on uncritically and often leading to some poor choices. When buying eyepieces, the sayings “a little bit of knowledge is a dangerous thing” and “caveat emptor” certainly apply. Therefore one is strongly advised to try out new eyepieces before buying them, if at all possible.

Whilst almost all premium eyepieces are at least desirable, for those of us whose pockets are not deep enough to accommodate our interest, it is nonetheless possible to salvage eyepieces from defunct instruments and repurpose them. Others may go a step further and experiment with making eyepieces from found optical parts. It is for such people that this article is mostly aimed.

The most obvious distinguishing feature will be the overall **physical size**, closely allied with the optical design and more strongly with the barrel size. The **barrel size** is the diameter of the tube which slides into the focuser and is generally locked in place there by means of a thumbscrew. Standard barrel diameters are 0.965", 1.25" and 2". Although there are numerous other varieties, these are by far the most common sizes for astronomical telescopes. The 0.965" is a Japanese standard which found widespread favour between the 1950s and 1980s, gradually being displaced by the 1.25" American standard as optical glass costs came down and consumers became more demanding.

The disadvantage of the larger size is that bigger lenses are perforce more expensive to manufacture, and heavier. But the advantages are that it is easier to accommodate more exotic lens configurations, achieve wide fields of view, reduce aberrations and improve eye relief. All of these make for a more enjoyable observing experience. Consequently, 1.25" soon gained overwhelming favour, and is in turn being rapidly eclipsed by modern 2" "grenade" eyepieces - some of which are so heavy that they pose a serious balance threat to the telescope. Today, 2" focusers almost always come with an adaptor to accept the smaller 1.25" eyepieces.

The second feature of an eyepiece is its **focal length**, which determines the **magnification**. You can calculate the magnification by dividing the focal length of the instrument’s objective, by that of the eyepiece. In our ATM (Amateur Telescope Making) class, there has long been need for telescope makers to make or obtain eyepieces at low cost so that they can actually use their home-made telescopes. Many end up with repurposed eyepieces scavenged from broken binoculars and rifle scopes, which are usually in the 14mm to 28mm range of focal lengths. These generally perform quite admirably for medium powers, and are satisfactory considering their low cost. Higher powers can be achieved by adding a Barlow lens, but good low-power eyepieces are not generally easy to find. What constitutes low power depends on the focal ratio of the instrument: those with "long" f/ratios (above f/8) require eyepieces upwards of 30 mm in focal length. This is the case for long-focus Newtonians and the popular f/10 Schmidt-Cassegrain telescopes - but even more so for f/15 Maksutov-Cassegrains and old refractors. This article addresses that issue.

The third is the **apparent field of view**, which of late has become a serious selling feature. Computer-aided design and the availability of exotic glasses has enabled sophisticated systems having an apparent field of view of 100 degrees or even more. This is impressive, providing a comfortable "spacewalk" feel to it. You can actually roll your eyes around to examine various parts of the overall field. Such wide fields come at great cost in terms of money, complexity, size and weight, but vary in their image quality. Whilst more might be desirable, anything over 40 degrees is adequate, over 50 is good and beyond 60 is a luxury. It is better to have a well-corrected sharp image over the entire available field, than to have objectionable aberrations towards the edge.

The fourth important characteristic is the **eye relief** (sometimes referred to as "eye point"), which is the distance behind the eye lens of the eyepiece at which the eye's pupil must be positioned in order to see the available field of view. As one ages and finds the need to wear glasses, this becomes more important because there needs to be enough space between eyepiece and pupil to accommodate the glasses.

Beyond all this comes the question of optical quality - freedom from **aberrations** (optical defects) and other factors adversely affecting the image quality) such as…

- **Chromatic aberration**: not all wavelengths are brought to the same focus, so images comprise an overlapping series of images of sizes and focus depending on the wavelength. Even in achromatic instruments, bright objects like the Moon will appear to have a coloured halo.
- **Coma**, stars in the centre of the field are pinpoints, but farther out towards the edges of the field they become progressively enlarged and take on the appearance of cartoon seagulls, or comets
- **Astigmatism**, magnification in one plane across the field differs from that over another plane; stars will take on a spiky appearance
- **Distortion**, the magnification varies radially from the centre. Straight lines passing through the centre will be unaffected, but will become progressively bowed as they are moved towards the edge of the field. If they bow inwards, it is known as "**pincushion**" distortion, and "**barrel**" distortion if they bow outwards. Eyepieces with a flat field and no distortion are called "**orthoscopic**".
- **Ghosting** is objectionable out of focus internal reflections of the object being imaged

- **Glare** or "veiling light" is light reaching the image, that has not passed properly through the optical path. This is often stray light scattered from the tubing comprising the barrel of the eyepiece, the focuser, or the telescope. It reduces image **contrast**.

These are all functions of the optical and mechanical design. Ghosts can largely be suppressed by having suitably good anti-reflective optical coatings on the lenses, but are best controlled by proper design. Attention to detail in construction can greatly help to suppress scattering of light from mechanical and optical edges (not to mention from surface roughness and scratches which should never be present in quality optics), enabling a nice dark background field to the view, enhancing contrast in the image.

Finally, mechanical features such as rubber **eye cups** for comfort and to shield extraneous ambient light, grooves / chequering / moulded features to facilitate **grip**, and weight are considerations. It doesn't hurt to be robust enough to sustain a fall onto a hard surface without damage. For now, let's neither forget nor discuss cost...

Overwhelmingly, the behaviour of an eyepiece is a function of its optical design, of which there are a great many. For the amateur using available parts, the easiest varieties to build, and which stand the best chance of being satisfactory in use, are "symmetrical" types. Symmetrical eyepieces are those those where the components on each side of the centre mirror one another, using identical elements. Optically, they would perform equally well either way around.

Case 1: A basic Ramsden eyepiece.

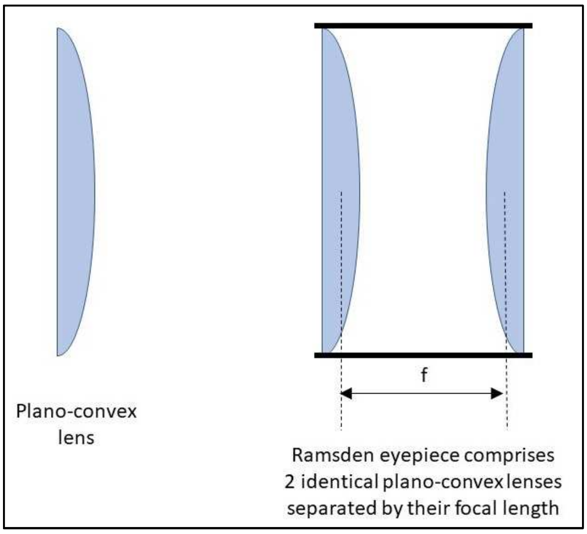


Fig 1. The basic Ramsden eyepiece

The Ramsden eyepiece utilises two identical plano-convex lenses with the convex surfaces facing one another, separated by their focal lengths. This is a so-called "1:1:1" design, in that if the focal length of the first lens is 1 unit, so is the second lens, and they are separated by the same distance.

In practice, this means that when looking through the eyepiece with one's eye relaxed to focus on infinity, the outermost surface of the first (field) lens will be at the focus of the second (eye) lens, with the result that any marks, scratches, oil or dust on the field lens will be sharply in focus to the observer. This is quite objectionable!

Therefore, the lenses are generally moved slightly closer together to put the field lens surface out of focus. The result is that the eyepiece is no longer at its optimum optical performance, but still acceptable, and becomes much nicer to use.
Plano-convex lenses are quite common components of defunct optics. If you can find two that are identical, you are in business. If the “flat” side of the lens has an extremely shallow curve, or the two lenses are quite close but not identical, it is still worth experimenting with them – you may well end up with an eyepiece that is perfectly adequate for a finder scope. Speaking of which…
Ramsden eyepieces have a focal plane ahead of the field lens, which makes it nicely accessible to put in cross-hairs. All you need do is look through the eyepiece and adjust the cross-hair position until the cross-hair is sharply in focus.
Ramsdens perform best on long f/ratio telescopes, where the chromatic aberration becomes less objectionable. Eye relief is a function of the focal length; it is quite acceptable above about 20mm, though you may not be able to use your glasses with it. You can expect a reasonable apparent field of about 30-40 degrees diameter.

Case 2: A basic Plössl / symmetrical eyepiece

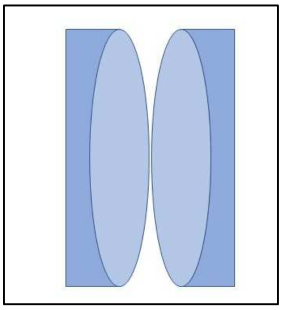


Fig 2. The Plössl eyepiece

Plössl designed this lens in 1860, but it practically vanished from the world until being revived in the 1960’s, when the space race was in full swing and telescope sales increased dramatically! Until then, the design was considered too expensive to manufacture, but the demand, coupled with improvements in both glass manufacture and automation of manufacturing processes eventually made it viable. Today, it is considered the standard.

Mechanically, the Plössl eyepiece is quite straightforward, and very similar to the Ramsden. But in this case, it uses two achromatic cemented doublet lenses, with the convex “crown” surfaces facing one another and almost touching. It has good colour correction and control of ghosting, and a wider field of view than the Ramsden. Having a small unobjectionable amount of pincushion distortion toward the edge of the field, it is not orthoscopic, but nonetheless very pleasant to use.

In order to minimize distortion and other aberrations at the exit pupil, all air-glass surfaces of the eyepiece are usually made convex. However, there have been Plössl type eyepieces used commercially in astronomical instruments in which the external flint surfaces are plano (flat).

Premium Plössls which provide superior image quality, have less distortion, astigmatism and coma at the edge of the field. This is accomplished by utilising better optical glasses, together with concave external lenses (rather than the usual slightly convex or sometimes flat elements). This results in a sharper image for large field angles, with a relatively small field curvature.

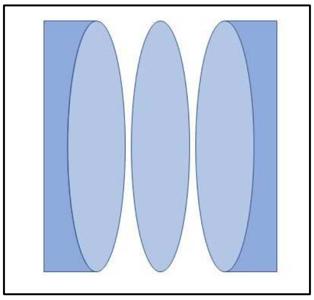


Fig 3. The Super Plössl eyepiece

A field stop, or diaphragm, is a sharp-edged ring generally incorporated into the eyepiece barrel at the focal plane, in order to limit the size of the visible field to an area in the centre with the least amount of distortion. Another way to deal with distortion is to add an additional lens element that acts as a "field musical notation flattener". This is typically a biconvex lens situated in the centre of the optical train, retaining a symmetrical configuration. Current variations of the Plössl design with a fifth element are known by a variety of names, according to the manufacturer, though this design variant is technically designated as a "Masuyama". They typically have an acceptable quality apparent field of view around 50 degrees in diameter.

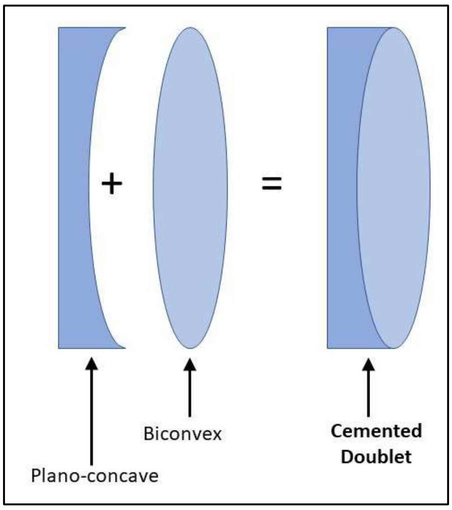


Fig 4. Cemented Doublet

The typical binocular objective lens is an achromatic cemented doublet, with the convex side facing outwards. The plane face maybe slightly convex to correct for aberrations within the system.

The curved surfaces are typically spherical to save costs, and the radii of the cemented surfaces are identical, but may differ from the external spherical surface.

A careful selection of refractive indices and radii enable two colours to be brought to the same focus to produce an achromatic (colour-free) image.

Long focal length Plössl eyepieces can easily be made using the objective lenses from small binoculars.

The common compact “8x21” binoculars are easily damaged mechanically and discarded ones can often be found free for the taking. They can vary appreciably in quality, and the marketeers like to put a spin on cost-cutting measures. Preferred are those with blue-violet coatings. Those with red, orange or gold-coloured coatings are best relegated to second place, as the coatings are faddish and inappropriate for astronomical purposes (they are sometimes merely a way of masking less than achromatic performance). Still, they are good to experiment with and are OK for lesser applications like finder-scope eyepieces.

Achromatic doublets in this range produce Plössl eyepieces with focal lengths in the region of 40mm. This is about the longest practical focal length for an eyepiece having a 1¼” barrel, after which the mechanical train will cut off the outer edge of the field. The image then fades fuzzily out towards the edges of the field, a condition known as **vignetting**. Larger lenses tend to have longer focal lengths, resulting in longer focal length eyepieces. Plössl eyepieces with effective focal lengths up to 100mm or so have been made using 50mm diameter binocular objectives. These have worked wonderfully (with pinpoint stars to the edge) on f/10 Schmidt-Cassegrain amateur telescopes, as well as on the 26.5” refractor at the Union Observatory in Johannesburg and on the 60” Cassegrain at Boyden Observatory in Bloemfontein.

Best advice: try it, you will like it. Use rolled cardboard, PVC plumbing or whatever comes to hand, and experiment. Once you get something promising, put some effort into the mechanical aspects.

In South Africa, having been Metricated for half a century or so, materials dimensioned in Imperial measures are hard to find. Still, acceptably close Metric materials are available, e.g. 32mm OD tubing is good enough for 1¼” replacement, and 50mm for 2”. They will be a bit loose in the focuser, but such is life. In the nominally 1¼” eyepieces below, the barrels are made from the readily available ridged aluminium tubing sold as handles for pool cleaning equipment. If you or your neighbour have a pool, a short length sawed off the end will be well worth sacrificing for the cause and leave the utility of the pole unaffected.

Case 3: Experimental 8-element bisymmetrical eyepiece

This 2” eyepiece is made from scavenged binocular objectives in two sizes, 50mm and 40mm diameter. The optical configuration is symmetrical, with two cemented doublets on either side of the centre, all convex sides facing the centre. Because I wanted to ensure the focal plane was in line with the point at which the base of the body beds against the focuser drawtube, the 40mm diameter lenses are on the outside. For want of a name by which to describe it, I settled on “bisymmetrical”.

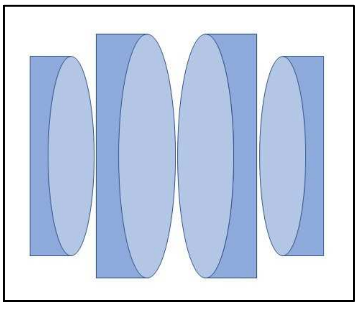


Fig. 5 Bisymmetrical eyepiece

The barrel is scavenged 40mm diameter aluminium tube and the body is made from PVC & Nylon pipe fittings, so the weight is paltry compared to the commercial “grenade” offerings. It should also be fairly resilient in the event of being dropped. A bonus is that the Nylon is unlikely to scratch one's glasses, should they accidentally come into contact. Neoprene O-rings were used as spacers between the elements, and put seals on both ends. To suppress grazing reflections from bright objects, automotive black silicone sealant can be stippled on the inside of the barrel; it's not perfect, but seems to work well enough. It sticks pretty firmly to aluminium and it will not "shed" particles.

The apparent field of view is quite acceptable, around 44 degrees by casual measurement, essentially limited by the barrel diameter. That is not huge, compared to the premium commercial eyepieces, but it is respectable. The eye relief is generous so wearing glasses is no problem at all; in fact, the eyepiece is very comfortable to use with glasses on, allowing the edge of the field to be seen without contacting the eyepiece. It has imperceptible levels of distortion and vignetting, practically no ghosting, a nice dark field, is pin sharp crisp to the edge, and exhibits no chromatic aberration.

Image 1. Through the 46-mm bisymmetrical eyepiece

It has been tried on terrestrial subjects with rectilinear features, and one truly cannot detect any pincushion or barrel distortion. The edge of the full Moon against a dark sky was extremely crisp, no hint of a colour fringe, even at the very edge of the field. There is no softening of the image quality across the field, which implies it either has a rather flat focal surface, or that happens to match the focal surface of most telescopes very well. There is no astigmatism, coma or other distortion of the star images. Everyone who has looked through it is impressed with the performance.

Case 4: Red Henry's "Double Plössl" design

Red Henry is an Internet friend in the USA, and has also been playing with salvaged binocular components. A consequence of this is that he has a lot of binocular objectives lying around, and so started experimenting. Unlike the author's bisymmetrical design, he chose to put one Plössl configuration ahead of another. However, he too uses a smaller set for the field lens, apparently to ease the mechanical complexities. In this respect, the overall configuration is no longer symmetrical, but reports on the performance are very encouraging. In due course, this may also be experimented, perhaps with a completely matched set.

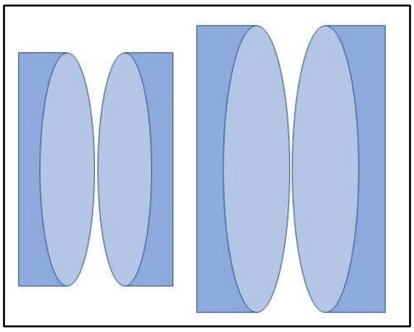


Fig. 6 Double Plössl eyepiece

There is one reservation, and that is that the "double Plössl" has two plane faces in close proximity, which could lead to ghosting. Red has not mentioned ghosting; should there be ghosting, one might consider either cementing the plane faces, or putting in an oil gap.

Determining the focal length of your eyepiece.

The easiest way is to use your telescope. Usually the focal length of the telescope is known. Manufacturers will put it on the scope, advertise it and so on. Home built telescopes will have measured it, e.g. using the Foucault test.

F/D = f/d where…

- F = focal length of telescope
- D = diameter of telescope objective (the "entrance pupil")
- f = focal length of eyepiece
- d = diameter of "exit pupil" (the beam of light leaving the eyepiece)

If the telescope is focussed on a reasonably distant object and then aimed at an illuminated wall or the clear sky, the exit pupil is visible as a brightly illuminated disk of light hovering just outside the eye lens of the eyepiece. You can measure this roughly by holding a ruler to it, or more accurately by taking several measurements with a Vernier micrometer and averaging the results.

Image 2. Measuring the Exit pupil size

To improve the accuracy by limiting observer effects, you can get several people to take measurements, exclude the outliers (the most extreme maximum and minimum readings) and average the rest. And of course, the more precise the measurements you have for your scope, the better.

For example, my 72mm William Optic Megrez apo has an f/ratio (F/D) = 6.

I measured the exit pupil of an experimental eyepiece at 7.7mm diameter.

Therefore f = F/D * d = 6 * 7.7 = 46mm to a very close approximation.

Determining the apparent field of view

E = A * M where…

- E = Eyepiece (apparent) field of view
- A = Actual field of view
- M = Magnification

In a wide-field eyepiece, one can estimate the actual field by looking at the Moon, which is approximately ½° in diameter, and see how many Moon diameters fit in the field of view.

Alternatively, you can look at a known star field and compare what you see with star charts of the region, and determine what area fits in the field of view.
A more precise way, is to line the scope up so that a bright known star will trail across the centreline of the field, lock the scope, and time the period it takes to transit. Then use the formula…

$\Phi = 15\ t \cos \delta$ where…

- Φ = diameter of field in arc-minutes
- t = transit time in minutes
- δ = the declination of the star

In the special case of a star on the equator, $\cos \delta = 1$, so that term can be ignored.

Image 3. The 2-inch 24 mm bisymmetrical on a WO Megrez apo.

Again, using the Megrez and the 46mm experimental eyepiece, the Moon was used. It took 18 minutes 54 seconds to transit (18.9 minutes), so the actual field of view was 15 x 18.9/60 = 4.7°, an astonishing 9½ Moon diameters.
Since the 46 mm eyepiece yields a magnification of 9.4 on the Megrez, its apparent field of view is 4.7 x 9.4 = 44°

New views of Jupiter

C Foster

NASA Juno mission Pro-Am collaboration Workshop, 10-11 May 2018, London

The NASA Juno spacecraft attained orbit insertion at Jupiter on July 2016. Due to concerns regarding the control valve system on the main engine, it has been retained in a highly elliptical polar orbit, with close flyby's (Perijoves) every 53 days, where the spacecraft skims a few 1000 km above the cloud tops of Jupiter. The most recent flyby, Perijove 18 (PJ18), occurred on 12 February 2019. The spacecraft's primary objectives have been to map Jupiter's gravitational and magnetic fields; for details see

https://www.missionjuno.swri.edu/

Amateur planetary imagers and Jupiter specialists have worked closely with the Juno mission team, providing important contextual images of the planet and its features before, during and after the flybys.

The workshop, held at the Royal Astronomical Society (RAS), Burlington House, Piccadilly, London, was organised by Dr John Rogers of the British Astronomical Association and Dr Leigh Fletcher of the University of Leicester as a follow-up to a previous workshop that was convened in Nice, France in 2016.

The workshop, which was by invitation only, was attended by 17 professionals, including 3 members of the NASA Juno mission team and leading planetary scientists, as well as 33 amateurs, comprising of planetary imagers, analysts, imaging software developers and Jupiter specialists.

Although primarily a "European" event, it was a privilege for me to be included in a small, select, group of four planetary imagers that were invited from outside of Europe. These included the renowned Christopher Go (Philippines), Anthony Wesley (Australia) and Kuniaki Horikawa (Japan). Having been inspired by them over the last few years during my development as a planetary imager, it was a delight and privilege to have the opportunity to meet them in person.

The first day of the workshop was taken up by members of the Juno mission team presenting the latest results and findings from the mission. This was followed by several presentations from planetary scientists on Jupiter atmospheric studies and how these are compared and supported by the images and data provided by the Juno spacecraft. At lunchtime a number of historical Jupiter observations and sketches were put on display in the RAS library.

After the first day, a tour was arranged at the Royal Society, where original historical astronomical documents and artefacts were put on display including one of Sir Isaac Newton's original death masks. This was followed by the workshop dinner, where Dr Scott Bolton (Juno mission Principle Investigator) gave a speech expressing his (and the Juno mission team's) appreciation for the work that has been, and still is being done by the amateur planetary community in supporting the mission.

The second day included various presentations by the amateur attendees, including my presentation on the work that I have done from Centurion, South Africa in support of the mission.

Fig 1. The author with Dr John Rogers, BAA.

Another incredibly exciting, and inspirational, event which provided me the opportunity to reconnect with a number of international colleagues and contacts that I had met at EPSC 2017 in Latvia, as well as meeting a number of new contacts.

Acknowledgements

The workshop was primarily funded by Europlanet, supported by European Research Council and the RAS, who provided the venue and staff. My sincere appreciation to Dr John Rogers and Dr Leigh Fletcher for the invitation and also the support that enabled my attendance.

The Archives Project at SAAO

I.S. Glass (SAAO), A. Slotegraaf (CfAH)

Summary: We describe the history of the SAAO Archives and the scope and limits of the current project. It was originally intended to scan, classify and inventory the collections of photographic material within the Observatory but it became evident on examination of the "collections", or rather accumulations, that a wider approach was desirable.

Introduction

SAAO incorporates the Royal Observatory, Cape of Good Hope, founded in 1820, and so can claim to be the oldest scientific institution in Africa.

Unlike the situation of most observatories overseas of comparable age, little effort has generally been made to keep up an organized archive. The institutional memory time scale has been short, of order 30 years, and may have been aggravated by the fact that relatively few staff members were of local South African origin.

The plan

The plan has been to collect together the surviving archives at SAAO. We have generally aimed to move historical material from random unsuitable places around the Observatory and consolidate it as far as possible in the Archive room where it can be cared for.

Among the categories that we regard as of possible significance are: items that are very old (>150 years or so), directors' correspondence, personnel records, photographs, plate logbooks, samples of ledger series etc.

Any material we have discarded consists of essentially log books and papers that meant a lot to the people involved but the precise conditions and adjustments etc relevant to which are now forgotten. It is presumed in general that any data worth publishing have been published.

History of archives at Royal Observatory/ SAAO.

It is evident that Gill and his predecessors made a serious effort to preserve the archives of the Royal Observatory but that they have not been cared for well since.

Many archives were fortunately sent to the Royal Greenwich Observatory (RGO) around 1970 before the transfer to SAAO that took place at the end of 1971. These now are safely stored in Cambridge University Library in good conditions under the heading RGO15. For more information:
https://janus.lib.cam.ac.uk/db/node.xsp?id=EAD%2FGBR%2F0180%2FRGO%2015

What was known to be in the Archives when we started

Not all archival items were sent to the RGO and much of what remains has not been conserved at all well. Very little still exists in Cape Town from the times of Fallows (1820-31) and Henderson (1831-33). Progressively more is found from Maclear (1833-70) and Stone (1870-79). Gill (1879-1907) was by far the most famous astronomer at the Royal Observatory and conducted an enormous correspondence. Though what is still to be found here is just a fraction of the original whole, it is still a substantial amount, mostly arranged in bound volumes, some of them very fragile. The subjects of these are indexed following a scheme originated by GB Airy, a former Astronomer Royal of England. Much of Gill's successor Hough's correspondence is also preserved. Following his time, the correspondence items that remain are mainly in boxes. The last director of the Royal Observatory (R.H. Stoy 1950-1968) and the Officer-in-charge (G.A. Harding 1969-71) who succeeded him left substantial amounts of correspondence, as did A.W.J. Cousins, perhaps the most famous of the astronomers at the Royal Observatory in its last years. From the SAAO period, a good fraction of Woolley's correspondence has been saved as well as the letters of later directors. However, the advent of email has meant that the preservation of correspondence has become sporadic in recent years.

Former Physical Treatment of the Paper Archives.

Gill had a "record room" constructed, now the home of the IAU Office for Development. At some stage the records were removed and it became the Royal Naval Association Club, a sort of pub (they were ejected during Woolley's directorate of SAAO). During the 1970s it was used as a tea room and a lecture room.

The records themselves seem to have been banished to an unsuitable corrugated iron hut at about the flood line, on a site near the entrance to the garages of the present Technical Building. Of course, as might have been foreseen, they got flooded and damaged, some of them irretrievably, by water and heat

Fig 1. Workbench in the Archives Room

The present Archives room was built as the Steavenson 30-inch observatory around 1961. Following the removal of the telescope, piers and dome it served as the Electronics Laboratory from sometime around 1970 until about 1980, after which the latter was moved to the Riverside House. The archives must have been placed in the present building around 1980 and acknowledgement is made here of the work by the former librarian, Mrs Ethleen Lastovica, to ensure their preservation.

At some point an air conditioner was installed to stabilise somewhat the temperature of the Archives room (ideally, it should be less than 21C and the Relative Humidity should be between 30% and 50% for the preservation of paper materials). A de-humidifier has been installed more recently to keep the RH at about 50%. The conditions are monitored digitally. The room is usually kept in darkness by blinds over the windows in order to keep out UV light which is also deleterious. The roof of this building was re-sealed about 10(?) years ago but the walls are sometimes quite damp, in part because the lawn sprayers often wet them.

In recent years there was a tendency to dump piles of documents in the Archives room without any thought as to whether they were likely to be of lasting significance, to the extent that the passageways between the bookcases were almost impassable. We have had to go through these, as with other matter, to see what is significant.

In order to make space we have removed various old measuring instruments, mainly plate-measuring machines, to the Astronomical Museum storeroom in the McClean dome. We also retrieved and installed two large metal bookcases that we found in quite good condition at the Observatory dump.

Glass plate archives

At one stage the Observatory possessed a very large number of glass photographic plates, probably of order 100,000. These were stored in purpose-built steel cabinets in a room above where the Computer Group now is (former MRM Building).

Most of the plate collection was junked during Charles's directorate. Much of the discarded part comprised parallax plates taken on the McClean telescope but there were major collections of Astrographic plates of various epochs, especially of the Cape Astrographic Zone. Others plates had been taken for a variety of purposes, including objective prism and other spectra.

However, a small number of Royal Observatory plates of comets and various other things were saved by A Slotegraaf and are now kept in the Archives building. Additionally, the direct photographic plates taken at the Radcliffe Observatory in Pretoria were kept. The Archive also contains a cabinet of photographic plates taken with the MRM telescope, some of them after its move to Sutherland. There still remains a large collection of early 20th Century spectroscopic plates taken with the McClean Spectrograph in a cupboard in the McClean building, though small numbers of these are also to be found in the Archive room.

Paper Archives that we have looked at or will look at

In addition to the official correspondence of the Observatory kept in the Archives room, there were several other major accumulations around the Observatory.

Fig 2. Pile largely of damaged papers in the NITR Prefab Hut.

In the former NITR prefab building next to the Riverside House, we found of order two thousand ledgers relating to photographic observations, measurements thereof and reduction to standard coordinates. These appear to have been in the main the records of the Astrometry Department and they seem to have been dumped in a part of the garage under the Technical Building following the demise of its head, Mr J Churms. Here some of them became wet and ended up in poor condition. At some point they were removed to the aforementioned NITR prefab hut near Riverside House. This building is at the flood line and sorting through its contents was of high priority. In the belief that nobody today could understand precisely what these items signify and that anything useful has been published, we have discarded them, with the exception of some samples. (However, it should be noted that we went through the piles of material at least twice and saved, at least temporarily, items of correspondence, photographs and other material potentially of historical interest.) We found there about 1000 small notebooks in metal boxes, spanning from 1838 Feb 24 to 1956 Feb 17, evidently containing immediate notes taken at the telescopes, in addition to Meteorological notebooks spanning 1840 May 13 to 2006 Nov 30.These have been kept and sorted. The interesting items have been transferred to the Archive and the NITR hut has been completely emptied.

Fig 3. General view of NITR hut before we started work there.

Interspersed with the Churms detritus were a good many items probably borrowed by him from other places around the Observatory and never returned.

Sorting the out the Archives Room itself

In the Archive itself, we found vast numbers of data ledgers mainly relating to the Reversible Transit Circle and to photometry. We have preserved in general the first and last of each series in order to convey the complexity and immense effort expended in the past on these instruments. In general, only samples of data ledgers have been kept, on the grounds that anything useful will have been published and little can be understood in detail today.

We have also discarded chart and Teletype rolls relating to the SAAO infrared programmes but have kept (under the 18-inch telescope) the computer reductions (in view of the Great SAAO Computer Crash of February 2016). There are many other categories of records, such as the directors' correspondence already mentioned, many of which have been kept. We may or may not undertake the detailed sorting of these. There are also certain personnel and other records of various kinds from the Royal Observatory, the Republic Observatory, the Radcliffe Observatory and the SAAO.

Some items (included in the Written Archives Catalogue) are still stored under the 18-inch dome.

Technical Building Basement etc

Small amounts of interesting correspondence have been found in the garages beneath the Technical Building and in the library storeroom above the Computer Section. These have been removed to the Archive.

Old Clock Room

The current (ie, since the start of SAAO) administrative and personnel archives are kept in the "Old Clock Room" in apparently good order. Also there (still) are various observing books related to the Radcliffe Observatory and the 74-inch spectrograph in Sutherland.

Under the 18-inch

This is air conditioned and so a fairly favourable environment. Nevertheless it was found that some water runs down the NE wall when it is raining. Certain items were dried out and stored on shelves away from this area. A dehumidifier has been installed.

The contents were found on 20 June 2016 to be: Annual reports from ca 1870s to present, SAAO reprints and preprints, SAAO Circulars, Palomar and similar sky atlases, old photometry teletype printouts, reprints from RO time of *MNRAS* articles, Director’s correspondence (Feast period), historical files compiled by E Lastovica, IAU Circulars, Library accounts and some other items.

Some items have been removed to the Archives Room. The photometry print-outs should probably be junked.

Fig 4. Within the 18-inch dome a lot of Astronomical Society material was dumped. This has been put back in its original place in the McClean Office after removal of duplicates.

Resources Centre

This building, which over the years received several additions, was the engine room (for the generator) in the 19th century as well as the instrument workshop. It was used as a “Resources Centre” for teaching, under Case Rijsdijk. We were told that this structure, in poor condition, was to be condemned. It is below the flood line.

Fig 5. The Resources Centre as it was when we found it. Many items that we judged to be irrelevant to the SAAO Archive are presumably still there.

The Resources Centre contains a large amount of relatively recent material. We have found it to consist of large numbers of duplicate journals, the office detritus of Thebe Medupe, some SAAO administrative records, much SALT Project Office material, thousands of handwritten data cards, etc. We have removed a few items likely to be of historic interest.

West Wing Basement, Main Building

Fig 6. Part of the West basement, Main Building.

We had to clear numerous empty cardboard boxes to gain access to these rooms. These are a fire hazard.

There are three rooms. The first one contains boxes of journals displaced from the library, probably during the previous librarian's reorganization.

The middle room is locked; its contents are believed to be a private wine cellar.

The last basement room when first examined contained papers of Stobie and possibly some of Charles. It is somewhat damp and its ceiling and walls are decaying and dropping plaster fragments and dust. Many papers appear to be minutes of, and papers for, various NRF meetings and other bureaucratic matters and are perhaps irrelevant to the history of SAAO *per se*. There are many papers relating to SALT and some to Stobie's scientific work such as the Edinburgh-Cape survey. We labelled many of the unlabeled file boxes according to their contents. We placed old posters over the files to protect them to some extent from the falling plaster. Some material such as papers relating to Radcliffe and the history of the Observatory were taken to the Archives room.

This area is highly unsuitable for document storage on account of the problems mentioned. Fishmoths also abound.

Astrographic

We have looked at the material in the Astrographic Building's cupboards (near the front door). We found a large number of lantern slides (old UK standard or US standard), some of them commercial slides from Lick Observatory but also some unusual ones such as images of comets including several by Allis of the 1882 comet. These have been removed to the Archive. Some antique wooden frames for making prints were removed to the Museum Dark Room.

Other items in these cupboards are large numbers of Radcliffe reprints from Pretoria and before. Also rough work for various topics by MW Feast. These are suffering from the poor storage conditions, but have been left in place.

This building has large numbers of journals belonging to MW Feast near the front door. The contents of Feast's office were not examined.

Lyot

The Lyot Building may contain items of interest. However, it is cluttered with junk – old telescopes etc. We believe that we have removed anything of archival interest.

MRM Building - Technical Drawings/ Plans

Some cabinets of drawings from the drawing office that formerly were placed in the Technical Building had been stored for some time in the wet basement thereof. When this was noticed they were moved to the Library Store above the Computer Department (MRM Building). These have not been sorted by us but an archival group from the NRF has been working on them. They include mechanical drawings of the telescopes and various instruments as well as architectural drawings of many of the buildings on the grounds, layout of underground ducts etc.

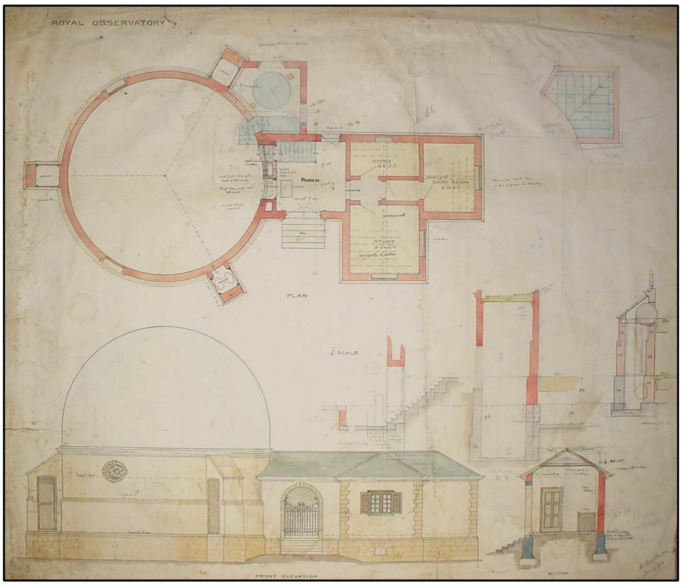


Fig 7. Herbert Baker's plan for the McClean telescope building.

Photographs

There was a cabinet in the Librarian's office containing large collection of photographs and albums, of various vintages, largely historical. These have been removed to the Archives. Around 9000 photographic prints have been numbered, provided with metadata, catalogued on-line and placed in custom acid-free cardboard containers by the Centre for Astronomical Heritage under contract to the National Research Foundation who intend to digitize them.

The "Weights and Measures" chest in the sitting room of the library contained a good many historical photographs and still contains a few.

A collection of large glass plate negatives from around 1900-1910 is in boxes in the Archives. These were digitized by Roy Emmerich a few years ago at high resolution and the files are still in existence, having escaped the Great Computer Crash of SAAO of February 2016.
They are available (only at SAAO or via vpn connection) at

http://ctfileserver.cape.saao.ac.za/staff/Photos/glass_plates/.

A great many photographs were found in the NITR prefab hut. These have been moved to the Archive Room and have been incorporated in the Photographic Print lists.

As an aside, the earliest photographs taken in what is now South Africa were those by Piazzi Smyth of scenes around the Royal observatory. They are now in the UK at the Museum of the History of Science in Oxford and at the Royal Observatory, Edinburgh.

Artworks and Framed Photographs

There are a number of valuable artworks around the Observatory such as sketches by Thomas Bowler and CP Smyth. Also some maps. Many items were stacked willy-nilly on top of the library shelves in the former Transit Room of the Main Building.

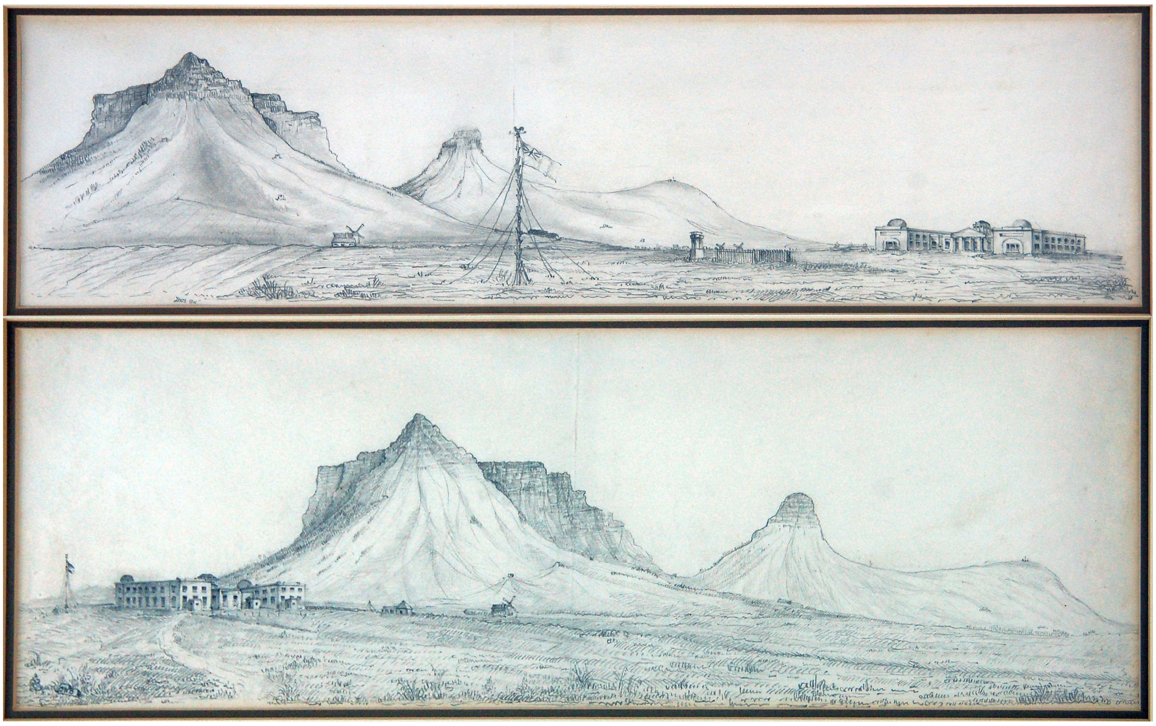


Fig 8. Two sketches of the Royal Observatory by the young Thomas Bowler (1812-1869), made around 1834.

These are now in the Archives Room except for some that are hanging on the walls of the Main Building.

Republic/Union/Transvaal Observatory

This observatory was merged with the Royal Observatory into the SAAO.

Many records exist in the CSIR Archives in Pretoria, stuck into bound volumes. See SAAO Archives item A0531 for indexes to these.

In addition, some records to do with the Republic Observatory have been found among the NITR prefab hut clutter and are now in the SAAO Archives.

The plate collection of the Republic Observatory has been salvaged by the Johannesburg Centre of the ASSA and is now at the Physics Department of Wits University.

Catalogues

The *Written Archives*, consisting of bound volumes, boxes etc of assorted written material, amounts to 558 items, most with sub-items. It was impossible to examine and catalogue every page. Some of the items contain hundreds of individual pieces of paper. In quite a few cases, the bound volumes are indexed,

The *Photographic Prints, as mentioned,* have been sorted and placed in archivally stable containers. Metadata have been prepared for each one. There are many duplicates. It is intended that these will made available online.

The *Artworks and Framed Photographs* have been catalogued and metadata have been prepared. It is intended that thumbnails should become available online.

The *Slides* are old-fashioned large glass ones and are several hundred in number. Many are commercial items that were available from astronomical societies but some are probably quite special including the early photographs of the 1882 Comet by EH Allis. There are large numbers of 35-mm colour slides that have not been examined or catalogued as yet.

The *Glass Photographic Plates* comprise historic comet photographs and other items. There are many spectroscopic plates from the McClean telescope. There is a set of large negatives of Royal Observatory scenes and equipment, mostly dating from ca 1910. There is a cabinet full of plates taken with the MRM telescopes in Cape Town and Sutherland.

Items from the *Radcliffe Observatory* are also stored in the SAAO Archives. There is a bookcase full of documents, plate books and other records. There are cabinets containing all the extant Radcliffe spectra and “direct” Newtonian plates– it should be noted that many were taken away by various astronomers to be worked on and may not have been returned. The Radcliffe material is not being catalogued in the present project.

Some parts (such as comets) but not all of the plate collections are being catalogued. Most of the original plate books probably still exist, however.

Certain *miscellaneous items* such as film negatives, 35 mm slides, magnetic media and microfiches have not yet been dealt with. Some of these are in a steel cabinet in the former MRM Building, above the IT department. Others are in the Archives room.

Certain *recent additions* to the Archive have not been catalogued. One of these is a "fonds" of items found at the late Pat Booth's house when she died (She was a friend of J. Churms). This contains items relating to the Astrometry Department. Another is a set of boxes relating to projects undertaken by the Instrument Workshop during the SAAO period.

Acknowledgements

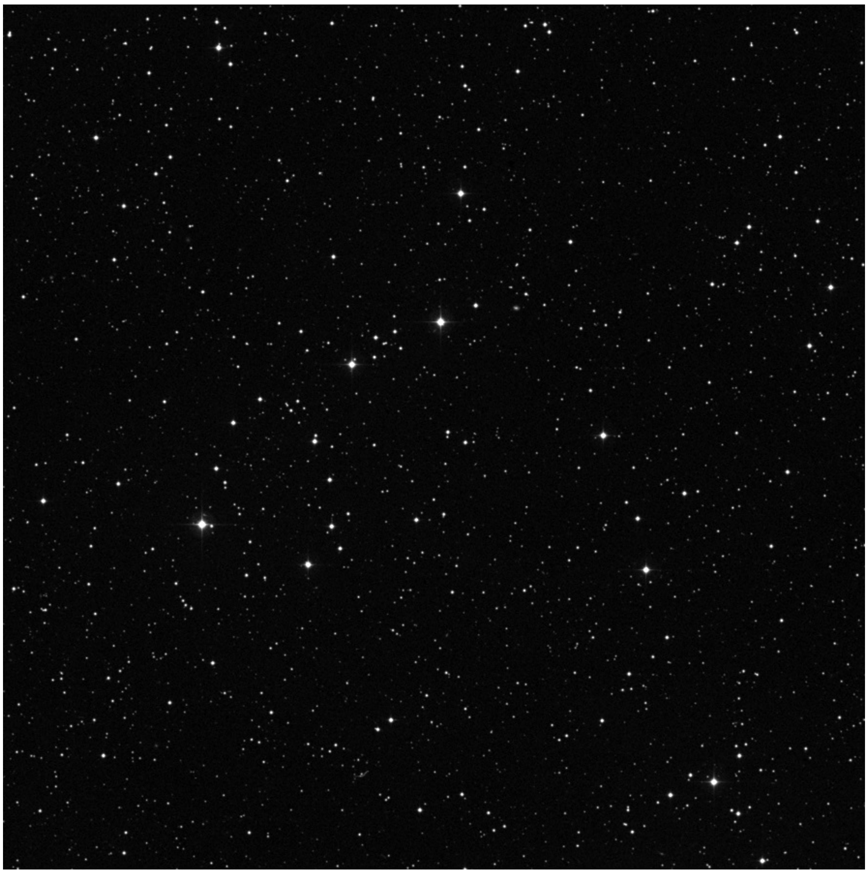
We want to express our thanks to the following people who have materially assisted in the cataloguing process. Also those who have helped with making containers of archivally stable material. Volunteers: Johan Brink, Alan Cassells, Rose Cassells, Chris de Coning, Edward Foster, Lynnette Foster, Cheyenne Kersting, Christine Kersting, Jamie Kersting, Kechil Kirkham, Dirk Rossouw, and Daniel Theron. Mrs Ethleen Lastovica, previously librarian at SAAO, must be thanked particularly as she was largely responsible for setting up the SAAO Archives in the first place.

Asterisms – the Hidden Jewels

Magda Streicher

Ever sit at the telescope and wonder which object is next to be adored through dark adapted eyes, perhaps another cluster, globular or nebulae? Well, as one scans the night sky one might find a few stars in a somewhat loose grouping of sorts; somewhat less scattered than the rest of the starry skies. To observe deep sky objects is one thing, but there may be a gem in the sky just waiting to be discovered in exceptionally small star groups or asterisms. Searching for star asterisms is full of fun; inspiring vivid imagination and thoughts. The real beauty lies in the story-telling part of these small groupings with fewer stars than the usual known larger open clusters.

Asterisms are decidedly among the most exciting star groupings for launching a celestial search, either through the telescope or using a star programme, followed by a telescopic observation. The Deep Sky Hunters forum consists mostly of amateurs looking for unknown star groups who will be credited in the Deep Sky Hunters Catalogue if certain criteria are satisfied.

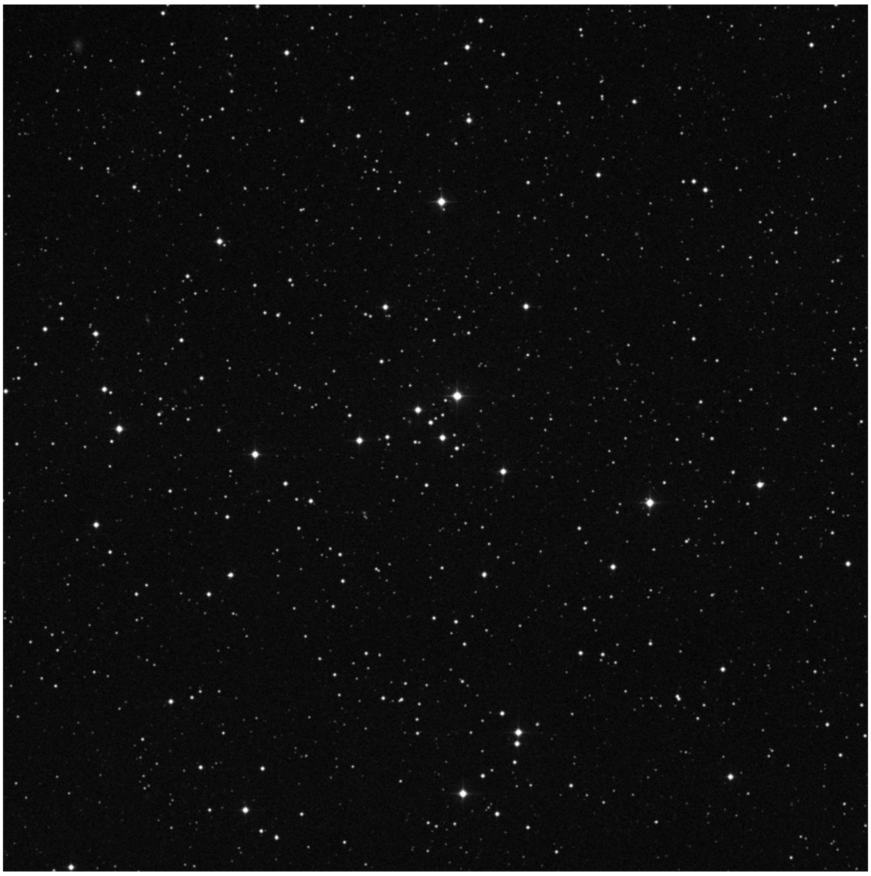


Streicher 1, (left) the very first asterism the author came across, was found in the constellation Gemini after observing the lovely open cluster NGC 2331 in 2004. Wondering around in the star field 2.7° north-west of the cluster a tight grouping of 8 stars between 12 to 13 magnitude barely 2′ in size was spotted. Two magnitude 9.5 stars flank the tight grouping, one a super white towards south-east the other one in a yellow jacket towards north-west. Extended with brighter stars in the range of magnitude 10 towards south-east made it a larger grouping of stars quite outstanding against the background starfield.

The more one explores and gets to know the night sky, the more one's appreciation of it all increases.

Object	**Type**	**RA**	**Dec**	**Mag**	**Size**
Streicher 1	Asterism	06h58'.36"	+29°19'30"	10.2	18'

Image Credit archive.stsci.edu/cgi-bin/dss

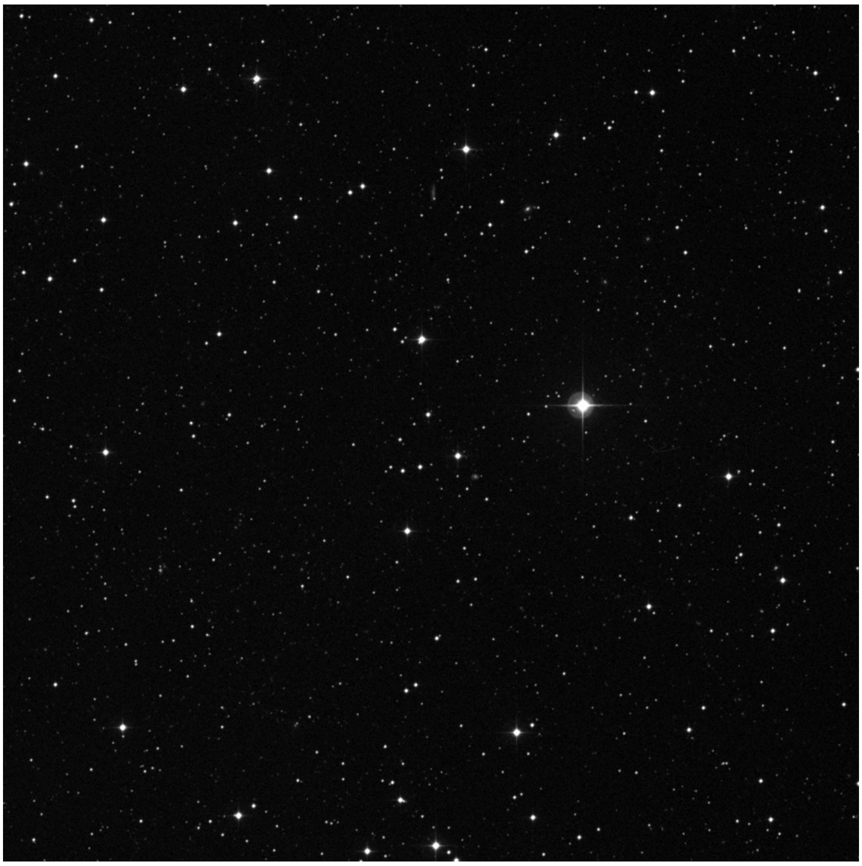


Streicher 2

One of my favourite objects is the planetary nebula NGC 2371.2372, which can be found in a triangle to the south-west of alpha and beta Geminorum, or, if you prefer, the well-known stars Castor and Pollux in the constellation Gemini. Barely half a degree south-west, Streicher 2 displays an exquisite and dainty small grouping. The grouping is quite outstanding against the background star field with the brighter magnitude 9.7 star towards the north. The south-eastern side of the asterism is been cut off by a string of magnitude 10 stars in a north-east to south-west direction.

OBJECT	TYPE	RA	DEC	MAG	SIZE
Streicher 2 DSH J 0723.1+2916	Asterism	07h23'.10"	+29°16'54"	10	2.5'

Picture Credit: archive.stsci.edu/cgi-bin/dss



Streicher 3

In the northern part of the constellation Gemini, Streicher 3 can be found situated just 25’ further north of the faint slightly oval galaxy NGC 2393. The asterism consists of a symmetrical triangle of 9 to 10 magnitude stars with another faint grouping of five stars between magnitude 11 to 13 nestles inside. The asterism of stars pointed in the direction south-east, and is surely one to remember.

OBJECT	TYPE	RA	DEC	MAG	SIZE
Streicher 3 DSH J 0729.0+3425	Asterism	07h29’.04”	+34°25’24”	8	5.5’

Picture Credit: archive.stsci.edu/cgi-bin/dss

The **Astronomical Society of Southern Africa** (ASSA) was formed in 1922 by the amalgamation of the Cape Astronomical Association (founded 1912) and the Johannesburg Astronomical Association (founded 1918). It is a body consisting of both amateur and professional astronomers.

Publications: The Society publishes its electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* bi-monthly as well as the annual *Sky Guide Africa South.*

Membership: Membership of the Society is open to all. Potential members should consult the Society's web page assa.saao.org.za for details. Joining is possible via one of the local Centres or as a Country Member.

Local Centres: Local Centres of the Society exist at Bloemfontein, Cape Town, Durban, Hermanus, Johannesburg, Natal Midlands, Pretoria and Sedgefield district (Garden Route Centre). Membership of any of these Centres automatically confers membership of the Society.

Sky & Telescope: Members may subscribe to Sky & Telescope at a significant discount (proof of membership is required). Please contact the Membership Secretary for details.

Internet contact details: email: assa@saao.ac.za Home Page: http://assa.saao.ac.za

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