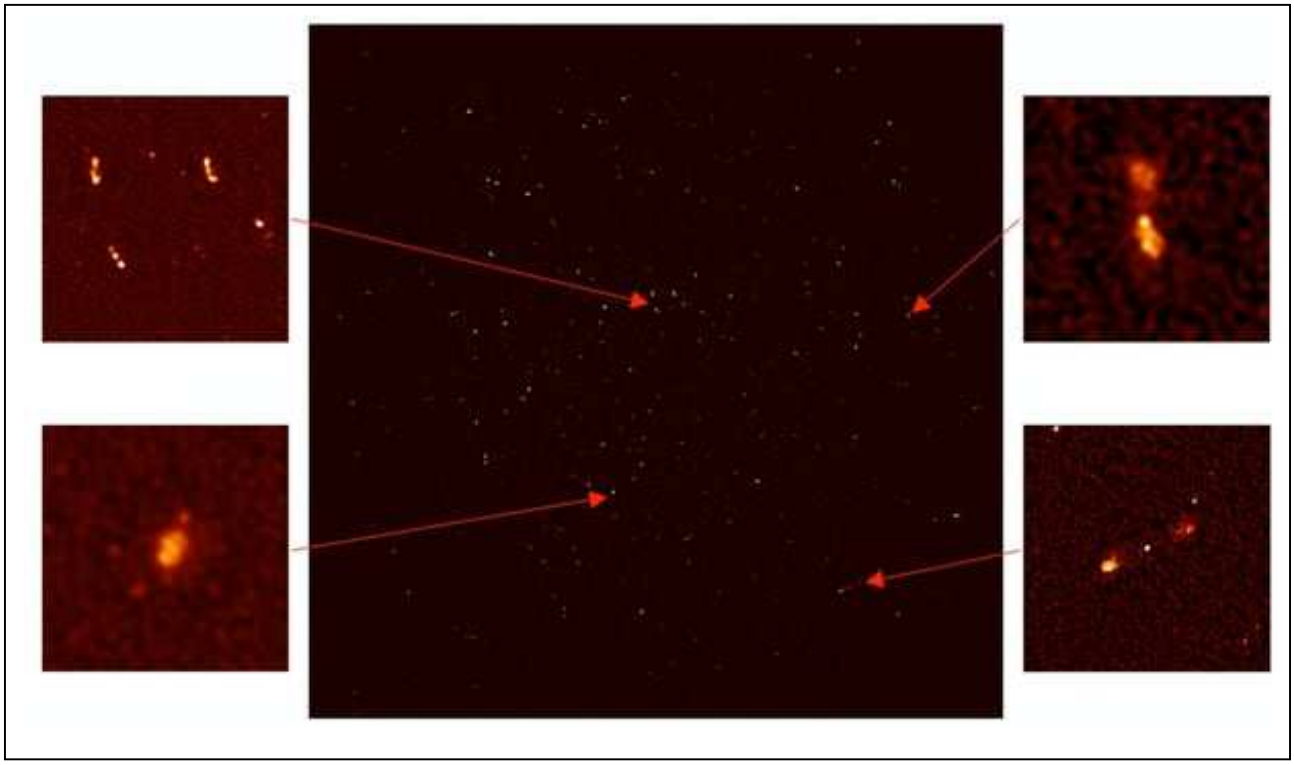
ISSN 0024-8266

mnassa

monthly notes of the astronomical society of southern africa

Volume 75 Nos 7 & 8 August 2016



Meerkat First Light – see article on p 145

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News Note: “First light” image from MeerKAT

The MeerKAT First Light image of the sky, released 16 July by the Minister of Science and Technology, Naledi Pandor, shows unambiguously that MeerKAT is already the best radio telescope of its kind in the Southern Hemisphere. Array Release 1 (AR1) provides 16 of an eventual 64 dishes integrated into a working telescope array. It is the first significant scientific milestone achieved by MeerKAT, the radio telescope under construction in the Karoo that will eventually be integrated into the Square Kilometre Array (SKA).

In a small patch of sky covering less than 0.01 percent of the entire celestial sphere, the MeerKAT First Light image shows more than 1300 galaxies in the distant Universe, compared to 70 known in this location prior to MeerKAT. “Based on the results being shown today, we are confident that after all 64 dishes are in place, MeerKAT will be the world’s leading telescope of its kind until the advent of SKA,” according to Professor Justin Jonas, SKA South Africa Chief Technologist.

MeerKAT will consist of 64 receptors, each comprising a 13.5-metre diameter dish antenna, cryogenic coolers, receivers, digitiser, and other electronics. The commissioning of MeerKAT is done in phases to allow for verification of the system, early resolution of any technical issues, and initial science exploitation. Early science can be done with parts of the array as they are commissioned, even as construction continues. AR1 consists of 16 receptors, AR2 of 32 and AR3 of 64, expected to be in place by late 2017.

Dr Rob Adam, Project Director of SKA South Africa, says: “The launch of MeerKAT AR1 and its first results is a significant milestone for South Africa. Through MeerKAT, South Africa is playing a key role in the design and development of technology for the SKA. The South African team of more than 200 young scientists, engineers and technicians, in collaboration with industry, local and foreign universities and institutions, has developed the technologies and systems for MeerKAT. These include cutting edge telescope antennas and receivers, signal processing, timing, telescope management, computing and data storage systems, and algorithms for data processing.”

In May 2016, more than 150 researchers and students, two-thirds from South Africa, met in Stellenbosch to discuss and update the MeerKAT science programme. This will consist of already approved “large survey projects”, plus “open time” available for new projects. An engineering test image, produced with only 4 dishes, was made available just before that meeting.

“The scientists gathered at the May meeting were impressed to see what four MeerKAT dishes could do,” says Dr Fernando Camilo, SKA South Africa Chief Scientist. “They will be astonished at today’s exceptionally beautiful images, which demonstrate that MeerKAT has joined the big league of world radio astronomy”.

Minister Pandor says: “South Africa has already demonstrated its excellent science and engineering skills by designing and building MeerKAT. This telescope, which is predominantly a locally designed and built instrument, shows the world that South Africa can compete in international research, engineering, technology and science. Government is proud of our scientists and engineers for pioneering a radio telescope that will lead to groundbreaking research.

News Note: 2016 Astronomy Town Meeting

A meeting of the professional astronomical community was held 2-3 July 2016 at the University of Cape Town for updates on various projects.

Prof Romeel Davé (University of the Western Cape) of the Astronomical Advisory Council that advises the NRF mentioned that the MeerKAT would be fully operational at the end of 2017. Further, that a South African Radio Astronomy Observatory will be established to consolidate efforts in this area.

Dr Rob Adam, newly appointed Project Director of SKA South Africa, discussed plans for the period 2017 to 2022, after the completion of MeerKAT but prior to the commissioning of the first phase of the SKA.

The PAPER array has already been cannibalised to make the HERA array, which will also search for signals from the Era of Recombination but with larger dishes.

Dr Fernando Camilo, who joined SKA (South Africa) from Columbia University as Chief Scientist on 1 April 2016, gave an update on MeerKAT. About 70% of its time will be devoted to Large Projects. At present there are 10 large survey proposals. The telescope has turned out to be more sensitive than expected in the radio L-band at 1.4 GHz.

Lindsay Magnus of SKA (SA) spoke about the data rates in MeerKAT. The correlator is fed at 2 TB/sec. This is boiled down to 20GB/sec by the time it reaches the Centre for High Performance Computing in Cape Town.

Ros Skelton spoke on behalf of SALT, the major new information being that the automatic maintenance system for mirror alignment is now working well, after many problems. The telescope can now be operated for up to a week without the use of the alignment tower.

Ramotholo Sefako (SAAO) spoke of a proposal for a 4m telescope at SAAO to be used for multiplexed spectroscopy in support of MeerKAT and other projects. Funding for a design and engineering study has already been obtained and this will start in November 2016.

David Gilbank (SAAO) spoke about a new 1m remotely controlled telescope due to arrive in Sutherland in early August. It will be equipped with a 6K x 6K large-field camera.

Markus Boetcher (North West University) spoke about the SA Gamma-ray progamme and recent discoveries with HESS in Namibia. The next generation gamma-ray telescope (CTA) will however be located in Chile, near Paranal.

Other talks included Michelle Cluver (UWC) on the digital planetarium to be installed at the Iziko Museum in Cape Town and Ian Glass (SAAO) on the need for historical researches on the newer as well as the older installations.

News Note: New Newsletter from SKA SA

The SKA is now publishing three newsletters, one for the general public, one for the stakeholders in the Northern Cape and the latest one *SKA SA Tech News*. This new one is at a more sophisticated level than the others and is aimed at those interested in the technology and astronomy of the SKA and MeerKAT.

The schedule for MeerKAT is given: “Array Release 1” or AR1, with 16 working antennas has already been demonstrated (see below). AR2 with 32 antennas is due in April 2017 and AR3 with all 64 antennas is scheduled for April 2017.

The sensitivity of the complete MeerKAT is expected to be better than 300 m^2/degree Kelvin [Effective antenna area in m^2 divided by system temperature, a kind of figure of merit] and will be the most sensitive in the world in the radio L-band (1.4 GHz) worldwide.

At present the plan is that the "SKA1" will consist of the SKA MID, situated in South Africa and the SKA LOW in Australia. SKA MID will eventually comprise 133 SKA MID dishes and the 64 dishes of the MeerKAT array.

The electronics and computing requirements for these telescopes are formidable. The *SKA SA Tech News* includes a great deal of detailed information.

Situated close to the focus of each MeerKAT antenna and immediately following the receiver will be a high-powered digitizer unit that converts the analogue signals at 1.4 GHz frequency to digital form. This it has to do without creating any radio interference itself and it must also work over the extremes of temperatures experienced in the hot Karoo Sun.

The a few years ago the SKA group developed the ROACH-1 and ROACH-2 electronic boards for correlating the signals from the different dishes and synthesising an overall antenna pattern at the full resolution of the multiple antennas as if they constituted a single huge dish. These were used for the KAT telescope and for the first MeerKAT tests. However, they have now developed a new board called SKARAB which can process 40 Gigabits per second as opposed to the 10 of its predecessor.

Also in SKA SA Tech News are articles about some of the observational programmes contemplated, the HERA telescope, "commensal modes" which make use of the data for more than one purpose, notes on civil engineering tasks and even people who are working on the project.

Copies of the Newsletter can be requested from Vivienne Rowland,

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News Note: Herschel-Darwin Commemoration Dinner

Chris de Coning (ASSA Cape Town)

On the evening of 15 June 1836 Charles Darwin had dinner with John Herschel in Cape Town. The year 2016 makes it 180 years ago that the event took place. Auke Slotegraaf and Chris de Coning decided that the event should be commemorated.

A total of 15 people attended the dinner. It was a very informal evening and there were three speakers.

The first speaker was Chris de Coning. He talked about the venue where the commemoration was held. The venue is a restaurant named Bardelli's at 18 Kloof Street in Gardens, Cape Town. It was chosen because of its historical link to astronomy in South Africa. Chris explained that the first astronomer appointed by the British Admiralty to come out to South Africa was a man named Fearon Fallows. He arrived in Cape Town in 1821 tasked with finding a good site for the proposed observatory and then to acquire the land and to establish the observatory itself. He rented this house from a Mr van Breda and set up a telescope on the roof of the building. However, Mr van Breda, seeing someone with a telescope, came to the conclusion that Fallows was a peeping Tom and evicted him summarily. The Simon van der Stel foundation has put up a plaque in recognition of this historical house where Fallows stayed. There is no connection to Darwin's dinner with Herschel, but as there are no appropriate restaurants

at Herschel's old farm named Feldhausen in the modern suburb of Claremont, this venue was chosen.

Fig 1. The group gathered at Bardellis.

The next speaker was Ian Glass. He enlightened us about Darwin's passage on the Beagle, accompanying Captain Fitzroy, on this very historic voyage. On their last stop before returning to England they stopped over at Cape Town and the officers of the ship were invited to dine with John Herschel at his house. John Herschel - the son of William Herschel, who discovered Uranus and also that light is more than the visible spectrum - was a scientific genius in his own right.

Ian enlightened the audience about the young John Herschel, mathematical genius who extended his father's astronomy projects.

He was one of the astronomical activists who canvassed for the founding of the Royal Astronomical Society (RAS) in 1820, was elected President of the RAS, and promoted the formation of a southern hemisphere observatory the Royal Observatory at the Cape of Good Hope, established on 20 October 1820 by Royal order.

In 1831 John Herschel published a "Preliminary Discourse on the Study of Natural Philosophy", dealing with the scientific method, and this had a wide influence. He decided to pursue his father's surveys in the southern hemisphere and he arrived in Cape Town on 15 January, 1834. As is well

known, he purchased the estate called Feldhausen, that covered much of present day Claremont and erected his 20-foot telescope where the Grove Primary School is now situated. Many esteemed visitors at the Cape between 1834 and 1838 made a point of meeting with Herschel.

Ian elaborated on **Robert Fitzroy -** a well-connected aristocrat descended from Charles II through one of his mistresses. Fitzroy was a hydrographer and meteorologist who in 1831 was about to set off on a survey voyage on the ship Beagle and was looking for a naturalist to write about geology and other features of the places he would visit. He asked among his friends to recommend a suitable "gentleman companion". Darwin, a few years younger than him, was to fill this role.

The voyage, scheduled to take two years, actually took more than five. Towards its end, the expedition visited Cape Town, landing at Table Bay on 31 May 1836.

Ian introduced the gathering to the main character for the evening's festivities - **Charles Robert Darwin** - who was born in 1809. He came from an interesting family with plenty of money. Two of his grandparents were involved with the Lunar Society of Birmingham and intimately associated with the Industrial Revolution: Erasmus Darwin and Josiah Wedgwood.

Fig 2. The young Charles Darwin.

Charles started out, at his father's wish, as a medical student in Edinburgh but was more interested in zoology and soon transferred to Cambridge to study for a BA with the idea - again his father's - of becoming an Anglican parson, presumably also for the easy-going life. Here he however became much more interested in geology and botany and in

divine design in nature and was generally regarded as a bit of a waster for spending a lot of his time hunting.

In 1831 he read John Herschels' book the "Preliminary discourse on the study of Natural Philosophy" and also Humboldt's book about his scientific travels and was strongly influenced by them.

It was at this point that a Cambridge professor, a mutual friend of Fitzroy and Darwin, suggested that he would be a suitable "gentleman companion" for the proposed voyage of the Beagle. He insisted on being self-funded.

They set off in 1831 December and while Fitzroy surveyed, Darwin studied the geology and natural history of the places they visited. Darwin was then exposed to many of the natural phenomena which led later in his life to his "Origin of Species" of 1859 – also a big year for astrophysics as Bunsen and Kirchoff published their work on chemical absorption and emission spectra. He became alienated from the simple biblical account of creation during the voyage and his nascent ideas on evolution were partly stimulated by a book by Lyell on gradual formation of geological features.

The actual meeting.

Fitzroy visited the Royal Observatory almost every day of their stay of 18 days. We know from a letter of Darwin's that they dined with Herschel on 15th June. When Ian read the following quotes it elicited quite a reaction from the audience:
"At the Cape Captain Fitzroy and myself enjoyed a memorable piece of good fortune in meeting Sir J Herschel. We dined at his house and saw him a few times besides. He was exceedingly good-natured, but his manners at first seemed to me rather awful. He is living in a very comfortable country house, surrounded by fir and oak trees, which in so open a country, give a most charming air of seclusion and comfort."

From Darwin's Autobiography:
"He never talked much, but every word which he uttered was worth listening to. He was very shy and often had a distressed expression. Lady Caroline Bell, at whose house I dined at the Cape of Good Hope, admired Herschel much, but said he always came into a room as if he knew that his hands were dirty, and that he knew that his wife knew that they were dirty."

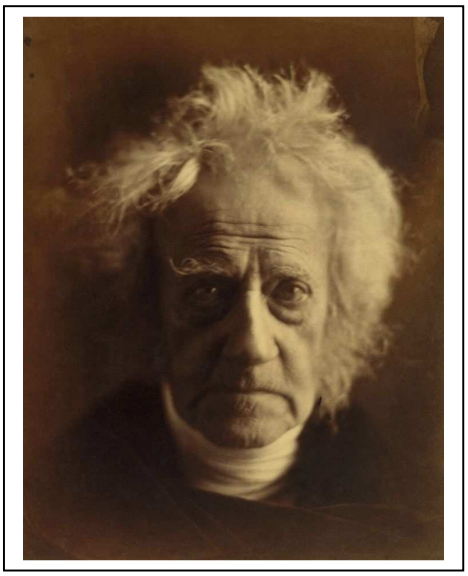


Fig 3. Sir John Herschel in old age.

Lady Herschel persuaded Fitzroy and Darwin to help improve the image of the Anglican missionaries at the Cape by writing a letter, published over Darwin's name, in the "SA Christian Recorder" advocating support for them by individuals and the British Government.

It seems that the ladies were much more smitten by Fitzroy than by Darwin. Lady Herschel: "You may soon expect to see a Capt. Fitzroy, who has run off with our hearts, and sundry Husbands are very glad that he has gone – he has been like an epidemic among us, but erring wives are safe in the numbers affected"

Ian rounded his excellent talk off with the following observations:

In later life Darwin suffered from almost continuous illnesses that suggest bipolar disorder and OCD. However, he may have suffered from Chagas disease, a parasitic disease acquired from bloodsucking insects called vinchucas that he encountered near Mendoza, Argentina.

Herschel suffered from depression and had at least one nervous breakdown, in 1854. Although he received a copy of Darwin's book of 1859, he remained unconvinced concerning evolution.

Fitzroy had a highly successful life as Governor of New Zealand and also head of the Met office. But he suffered from depressions and after losing all his money committed suicide in 1865. He was outspokenly against Darwin's theory of evolution.

After a hearty meal the last speaker, Ronnie Glass, entertained the audience with the more modern aspects that we associate with Darwin. He read out some of the dubious circumstances how some humans qualified to be graced with the "Darwin awards"!

The final item on the agenda was a prize for the most original toast (as in raising of the glasses and toasting the occasion) Auke Slotegraaf won the toast with his very original contribution.

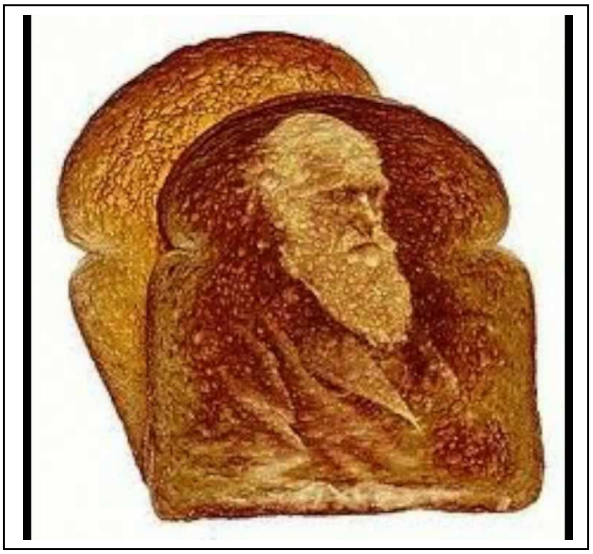


Fig 4. Auke Slotegraaf's original "toast".

The following attended: Chris de Coning, Wendy Harvey, Auke Slotegraaf, Eddy Nijeboer, Jannie Nijeboer, Ian Glass, Hettie Glass, Peter Cramb, Peta Cramb, Richard Sessions, Heather Sessions, Keith Gottschalk, Ronnie Glass (no relation to Ian!), Ilana Barling and Micah de Villiers.

The Second Herschel-Darwin Dinner will be held on Thursday, 15 June, 2017.

Fig. 5 (top-left) Simon van der Stel Foundation plaque. (top-right) Entrance to Bardelli's. (centre) Chris de Coning welcoming everyone. (right) Dr Ian Glass. (bottom-left) Ronnie Glass

News Note: History of Astronomy Steering Meeting 15 August 2016

This is a précis of a meeting that was held at SAAO at the request of Prof Nithaya Chetty (Deputy Chief Executive Officer for astronomy, NRF), who introduced the session.

Prof Chetty requested that we need to develop a *Roadmap for the History of Astronomy in Africa* which should capture in a concise manner what is being done and what is proposed to be done in the future. This should be a reasonably brief and readable document for all the stakeholders, including the Astronomy community, the Astronomy Societies, the funding agencies, the government, our international partners, and so on.

The first talk was by **Glenda Coetzer**, Librarian at HartRAO: "HartRAO, the heartbeat of Radio Astronomy in Africa"

The main HartRAO antenna was originally installed for tracking NASA's planetary probes at 30cms. G. Nicolson in 1963 commenced a map at 960MHz of the southern Milky Way when the antenna was not in use by NASA. A collaboration with Rhodes University led to a sky map at 2300MHz.
In 1967 participation in VLBI work commenced. In 1974 NASA withdrew and the observatory was fully dedicated to radio astronomy.
Later spin-offs included AstrometricVLBI to help with the Celestial Reference Frame, Laser Ranging and the establishment of the Observatory as the reference point for GPS in South Africa.
Now 20m and 15m radio telescopes are in use. Measurements include Lunar Laser Ranging and Global VLBI. They have a seismic vault.
Information on HartRAO history is available on its website. They have also been capturing oral history from eg George Nicolson and Ludwig Combrinck.

Christopher Jacobs, a visitor from Jet Propulsion Laboratory, currently at HartRAO, spoke on "Improving the Resolution of Radio Astronomy: A Short History Placing African Contributions into a Global Context"

He outlined the history of VLBI precision from 1 arcsec to 10^{-4} arcsec. Precision depends on wavelength – HartRAO has improved from 32cm to 1.2 cm or a factor of 23. This requires changing the panels of the antenna as the old mesh ones dropped off in efficiency at 6 GHz.
Using the Russian RadioAstro satellite a precision of 115 microarcsec is achieved. HartRAO was regarded by the Russian VLBI person Yuri Kovalev as the best VLI station to deal with!
Jacobs emphasized the important part played by continuous technical development at HartRAO. In answer to a question he explained the difficulty of trying to work at 230 GHz due to atmospheric problems and the ~1mm baseline accuracy required.

Dawid van Jaarsveldt (University of the Free State Physics Dept) spoke on "The Tale of Three Observatories"

Boyden (Bloemfontein) was set up by Solon Bailey (Harvard) in 1927. Van Jaarsveld showed photographs of the library and telescopes of Boyden and discussed the projected Museum.
Lamont-Hussey Observatory was set up for visual double star work. It was scrapped in 1972 and the dome had been converted to house a digital planetarium [The Wits planetarium will soon be digital also]. Slipher used the telescope for photos of Mars, including the first one in colour (1939). Efforts are being made to reconstruct the telescope, the tube of which was found in a field.
The 3rd observatory was Roberts's one in Lovedale. His archived material including his results on variable stars is in Boyden and has been digitized by ASSA members, his library and the 3 inch Ross telescope (circa 1838) he used.
He also showed a plate from the first all-sky atlas, whose southern part was produced on the 1 inch Cooke lens (AM), made from the original Boyden site in Arequipa, Peru.

Attention was drawn by B Warner and IS Glass to Snedegar's new book on Roberts and his work.

I.S Glass talked on "SAAO/Royal Observatory Heritage Status"

He showed why this status is desirable and outlined the efforts to acquire National Heritage Site status from the Heritage Resources Agency (SAHRA). The International Astronomical Union in collaboration with Icomos (International Council on Monuments and Sites) is also interested in sites such as ours. Similar information as to the heritage value of the site, its instruments and achievements is required by both agencies. However, there is a fear that having Heritage status might restrict activities on the site.

The present state of conservation and the efforts under way to preserve and sort the archives were described.

Hester du Plesis (HSRC) “The Re-emergence of Astronomy in Africa: A Transdisciplinary Interface of Knowledge Systems”

This humanities-orientated talk described ongoing work on (1) Global Dynamics of Astronomy, with input from other countries – China, India and Japan.
(2) Reflections on the Complexity of Astronomical Research
(3) Celebrating Astronomy Today.

A short communication by **Case Rijsdijk** on “Starlore”.

He emphasized the need for capturing information about Indigenous Astronomy before the possessors of this traditional information die out. Case could not attend but his letter was circulated to those present.
He suggested that a sub-committee be established to discuss a possible project to go into the rural areas to try to capture what remains.

Sivuyile Manxoyi (SAAO Outreach) on “Indigenous Astronomy”

He described the traditional relationship of ordinary people with the stars – how it affects customs such as the naming of children and the regulation of ceremonies. These traditions have survived in rural areas but urban people are out of touch with them.
The public are however keen to learn about these things. In fact the South African curriculum encourages the teaching of indigenous astronomy.
"The Starlore poster on indigenous astronomy produced at the SAAO has become well-known and is also in demand in foreign countries."
The ways in which this lore has been communicated in the past include the story-telling by T Matomela of The Iziko Planetarium, booklets produced by SAASTA, the African Planisphere, films such as Cosmic Africa, “Star

Lore" by Loreta Steyn (NRF), exhibits in Sutherland and the SAASTA traveling exhibit, the ipad exhibit at HartRAO.

Modern communication includes Iziko Planetarium's Star lore show and SAAO adaptation to Stellarium to include indigenous legends and also use of World Wide Telescope (WWT) to tours aimed at very young children ages 4-10. He also referred to the Oxford teachers' workshop on youtube (demonstrations of Southern African Indigenous artworks in Stellearium and WWT tours)

Traditional astronomy is seen to be a big platform for stimulating an interest in science, especially when presented in one's home language. Cultural astronomy helps in communicating the multicultural roots of science. We need new films, documentaries and other audio-visual material. Science is universal and we can offer the World the beauty of local flavour and experiences.

Thebe Medupe "Cultural Roots of Astronomy"

Astronomy is multidisciplinary by nature, involving also the methodologies of humanities such as history. Insufficiently studied is West Africa.

Main research areas of African astronomy relies on ancient Islamic sites – Ghana, Mali, Songhai in the East and Swahili stats in the East. Aloso ancient African regions such as Egypt, Ethiopia and Kush. Then there is "Astronomy on Stones" – Nabta, Namuratunga etc, "Astronomy in Architecture" eg Batammaliba in Togo, and Rock art (little explored).

There has been no original research in Southern Africa in recent years – most was done more that 50 years ago. What was done is tainted by colonial attitudes.

Relevant publications have included those by Snedegar, in the journal Indilinga, in Archaeoastronomy and in anthropological journals.

The ancient Islamic states Mali/Songhai mss are in Timbuktu. There is a problem of dating them. At present research is difficult because of Mali political situation, but these mss are also found in Senegal, Niger, Nigeria, Sudan, Ghana and Mauritania.

He mentioned that he (?) had studied 42 mss of which only 3 were of local Timbuktu origin. About 120 mss in the Ahmet Babu collection are about astronomy. The interesting question arises as to whether mathematical astronomy was studied in West Africa in those days (Middle Ages). He gave an example of a meteor shower recorded in 1583.

Some outstanding questions are the extent of studies in East Africa, are there any relevant Swahili documents, how must we interpret rock art (does it arise from visions while in trances).

Auke Slotegraaf spoke on "The Centre for Astronomical Heritage – An Introduction and Invitation"

He listed the objectives of this newly-formed organization, which seeks to form a digital repository and virtual museum of South African tangible and intangible research, to increase awareness of opportunities and threats to our heritage, to provide advice and training , education and public awareness, to conduct original research, promote cultural heritage and to assist with site declaration and object registration.
He gave a quasi-philosophical interpretation of various relevant terms, such as "astronomy" itself.

John Carter, Physics Dept., Wits University, spoke about the "Astronomical Plate Archive" at Wits.

presented by the CSIR to ASSA Jhb in 2010 but permanent storage was difficult to find. Constant Volschenk of Wits Planetarium alerted the Physics Dept at Wits and Prof Colafranscesco found a suitable home for them.
The question is how they might be digitized quickly and accurately at minimal expense.
One agency offers to charge €1 per plate and can handle 1000 plates per day, using a 39 Megapixel camera.

Lorenzo Raynard, the Communications Managed at SKA, whose title was "History of the SKA-SA Project" in fact talked about planning for various visual presentations about this subject, including the project of upgrading a distant antenna in Kutunge, Ghana.
This would involve forming an archive of the MeerKAT project, pre-production planning, production and distribution and various alternative approaches to visual material suitable for widespread dissemination.

Dr **Igle Gledhill** (CSIR) talked about "Jupiter's Disc", a little known (among South Africa astronomers) discovery of great interest by her father the late radio astronomer Jack Gledhill of Rhodes. He and his team, with relatively simple radio equipment, were able to characterize the radio bursts from Jupiter caused by the interaction of Jupiter's magnetic field with a plasma disk fed by the volcanoes on Io. Of course, a detailed knowledge of Io's surface had to await the approach of the NASA planetary probes.

Chris de Coning (ASSA) subsequently wrote:

At the meeting I mentioned that a historical database exist of astronomy related "Heritage" . The URL is assa.saao.ac.za/sections/history/
The goal of this website is to list and write a brief history of all Observatories, telescopes, instruments etc. The astronomers listed have already departed the solar system, ie they are dead. I don't want live astronomers looking over my shoulder.
You will notice that the website is incomplete. The greatest omission is that the SKA is not listed. This will be rectified. The scope of the work is more than my lifetime, thus if you spot a lack in the information and you have the information at your fingertips please pass it on to me.

Prof Jane Carruthers (UNISA) wrote:

This looks like a great meeting with really interesting outcomes in the minutes, and I am sorry not to have been able to attend. Thank you for keeping me in the loop. I wonder about including two aspects:

1. The history of the Radcliffe Observatory (Francis Thackeray – whose father was the Radcliffe Observer – has material. (Francis.Thackeray@wits.ac.za)

2. And the other might be a contribution from renowned historian Simon Schama (History and Philosophy of Science, Cambridge) who gave a terrific keynote lecture last year at the International Congress of Historical Geographers in London on how the entire astronomical enterprise in the second British Empire worked as a ''unit'' and he explained how South Africa fitted into it. I don't see anything like that on the proposed list of projects/topics.

Conclusion: A small group representing different interests was formed, consisting of Hester du Plessis (HSRC), Thebe Medupe (NWU), Ros Skelton (SAAO) and myself (SAAO) to carry the project forward. This group was tasked with drafting the Roadmap for the History of Astronomy in Africa by considering inputs from all meeting participants.

Examples of areas in which the initiative could be useful might be:

- In establishing a set of common-user equipment for the digitization of written and photographic media, curation of artifacts and preservation of archival materials.
- For getting post-docs to work on specific problems such as the interpretation of Arabic archives
- For funding to conduct expeditions to remote areas in order to collect folkloric astronomical knowledge
- To prioritize which material and artifacts should be preserved
- To take advantage of the 200th anniversary of the founding of the Observatory in Cape Town in 2020 as a special opportunity to engage the attention of the public.

- To encourage each institution, particularly the newer ones such as the MeerKAT and SKA SA, to keep an accurate archival record of their activities; but also the older ones.
- To ensure that accuracy is preserved in historical writing
- To consider a conference in a year or twos' time to be devoted to the History of South African Astronomy.

Notes by I.S. Glass 15 August 2016

News Note: A Lack of young stars in the inner part of the Galactic Disk

An international team headed by Prof N Matsunaga of the University of Tokyo has used the Japanese/South African IRSF telescope at Sutherland to survey Cepheid variables (which are relatively young luminous stars) in the direction of the inner part of the Disc of the Milky Way.

This can only be done in the infrared because of the vast clouds of gas and dust which hide the Centre from our eyes.

Cepheid variables follow a tight period-luminosity relation, so if we know their periods and their average luminosities we can establish how far away they are and plot their positions in the Galaxy.

However, even in the infrared the extinction due to the dust is difficult to estimate. By using the fact that the extinction also "reddens" the light from the Cepheids, even in the infrared bands, we can estimate the amount of extinction from the stars' infrared colours. This last part of the process is somewhat controversial and if we get it wrong we get the distance wrong also.

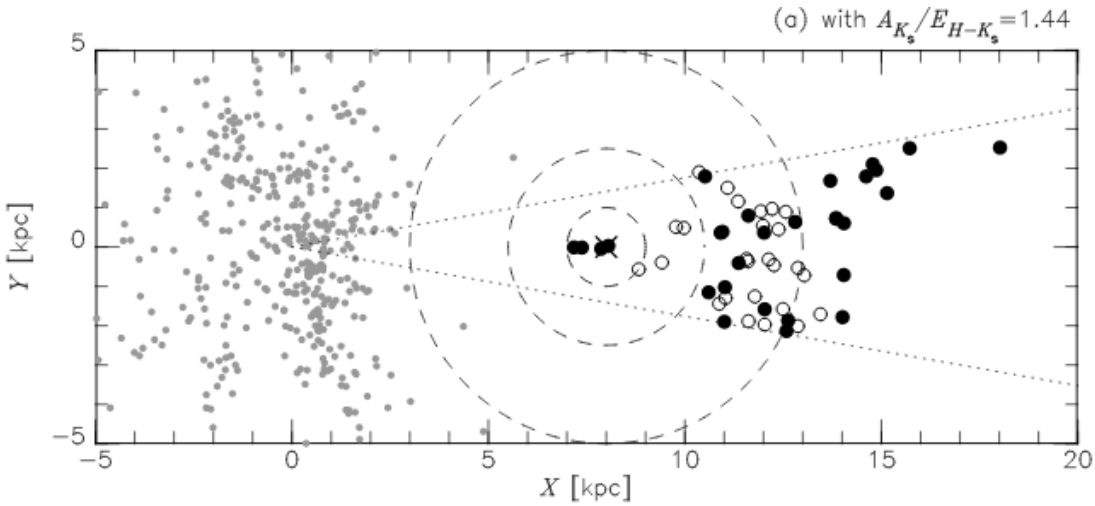


Figure 1: A plan of the.Milky Way galaxy, looking at it face-on. The Sun is at (X,Y) = 0,0 and is surrounded by the nearby well-known Cepheids (small dots). The Centre of the Galaxy is at 8,0 (24000 light years from us) and within 1 kpc (3000 light years) of it are four Cepheids, shown as solid black dots. (Figure from Monthly Notices of the Royal Astronomical Society)

What is interesting (and the point of this paper) is that Matsunaga et al did not detect any Cepheids between 1 and 2.5 kpc from the Centre of the galaxy. Further out, however, they do see Cepheids (black dots). Note however that they were not able to detect Cepheids where they might have been expected on the near side of the Centre because they would have been too bright for their detectors! The hollow large dots are claimed detection of Cepheids by other authors and the dotted lines show the limits of their survey in direction.

As mentioned, Cepheids are very luminous and therefore cannot be old. If there are no Cepheids in a certain part of space, there therefore cannot have been star formation there for hundreds of millions of years. Star formation is however known to occur in the inner one kpc, so the presence there of the four Cepheids is not so surprising.

The full paper can be downloaded from:
http://mnras.oxfordjournals.org/lookup/doi/10.1093/mnras/stw1548

News Note: Breakthrough in mirror control at SALT

The 91 segments of the SALT primary need to be kept precisely aligned in order to obtain the best images. As is well-known, the initial alignment process uses a type of Shack-Hartmann wavefront sensor in an auxiliary tower to send feedback to control the mirror actuators.

It was hoped that capacitative sensors between the edges of the mirrors could be used to keep them in adjustment for of order a week without the need for the time-consuming full alignment process. However, the initial installation did not work satisfactorily and Shack-Hartmann testing at least once per night was found to be necessary.

The trouble lay with the fact that the sensors chosen were sensitive to temperature and humidity changes besides the desired relative displacements of the mirror segments. A project lasting several years was undertaken to develop new inductive sensors (with the French Company Fogale-Nanotech) that would function correctly, independent of temperature and humidity changes.

A recent test series lasting 6 nights and covering temperature changes of 11.5 degrees and Relative Humidity changes of 70% showed that adequate control has now been achieved. Frequent Shack-Hartmann tests during the night showed that the new system performs correctly.

Details of the new sensing system were presented at the SPIE Astronomical Telescopes + Instrumentation conference in Edinburgh in June by the SAAO team of Hitesh Gajjar, John Menzies, David Buckley, Chris Coetzee, Deon Bester, Ockert Strydom, Jonathan Love and Keith Browne. This improvement, together with the rebuilt Spherical Aberration Corrector, means that the SALT Telescope is now at last functioning according to the initial hopes.

Keeping the 74-inch in business

Lisa Crause (SAAO)

For four decades, the SAAO's 74-inch telescope has hosted a low resolution spectrograph at its Cassegrain focus. This workhorse instrument underwent various incremental upgrades over time as critical technologies, particularly astronomical detectors, have evolved. The earliest version of the spectrograph employed an image intensifier that fed a photographic plate. This was later replaced by a photon-counting system, which was followed by a pair of linear photodiode arrays known as the Reticon Photon Counting System. The Reticon was superseded in the mid 1990s when a 1798 × 266 CCD was introduced and that system remained in use until late 2014, when the instrument was taken out of service to complete an extensive, long-awaited upgrade. Given that the Observatory had threatened to replace the spectrograph optics since the early 1990s, one may rightly wonder why this latest incarnation took *so long* to materialize.

Let us back up then, to before SALT became a real distraction. To when the late Darragh O'Donoghue worked with an optical designer at the Royal Greenwich Observatory to develop a new Folded-Schmidt spectrograph camera that would be considerably more efficient than the instrument's original Maksutov-Cassegrain design. The custom optics were manufactured in the UK, but they then hibernated in a cupboard in Darragh's office for more than a decade. During that time he designed a better Spherical Aberration Corrector for SALT than its predecessor (the Hobby Eberly Telescope) had employed, and led the effort to build SALTICAM, SALT's acquisition and imaging camera. First Light then revealed image quality problems that severely compromised SALT's performance and Darragh took on the monumental task of resolving those issues. Along the way he handed the spectrograph upgrade project over to an unsuspecting minion that had recently migrated into his SAAO Instrumentation group. However, that minion soon joined the multi-year

image quality battle, before diving into a number of other SALT instrumentation projects.

Eventually the various higher priority projects were concluded and the Spectrograph Upgrade project (aka SpUp) came to occupy the top spot on everyone in the SAAO Instrumentation group's to-do list. In the meantime, Deon Lategan, a mechanical engineer contracted from the Stellenbosch-based satellite building company SunSpace (now Denel Spaceteq), had designed all of the hardware for the new "lower box", which would house the replacement spectrograph optics. The electronics team was making good progress getting the new CCD and its SDSU III controller set up, our mechanical workshop had produced all of the parts and the instrument's optics were shepherded to the US to be coated with durable protected-aluminium. The old Cassegrain spectrograph (aka Cassie) then had to be brought down to Cape Town in October 2014 to allow various components within the "upper box" (which was to be retained) to be refurbished and to enable all of the moving mechanisms to be commanded by a programmable logic controller. By the beginning of 2015, all of the components and optics were ready for assembly and integration into the instrument – we could start putting the 3D jigsaw puzzle together at last!

The optical alignment of the new lower box (containing the instrument's reverse-Cassegrain collimator, the housing for the various diffraction gratings, the Folded-Schmidt camera assembly and a set of relay optics for the rear-of-slit camera) came with a significant additional challenge. We had to ensure that the new and old parts of the instrument would match up appropriately at the interface between the lower and upper boxes, and that the whole instrument would be properly aligned to the optical axis of the telescope.

These issues led to a whole side-project to ensure that the 74-inch mirrors were optimally aligned, such that the optical axis of the telescope would

emerge perpendicularly through the centre of the Cassegrain hole in the primary mirror.

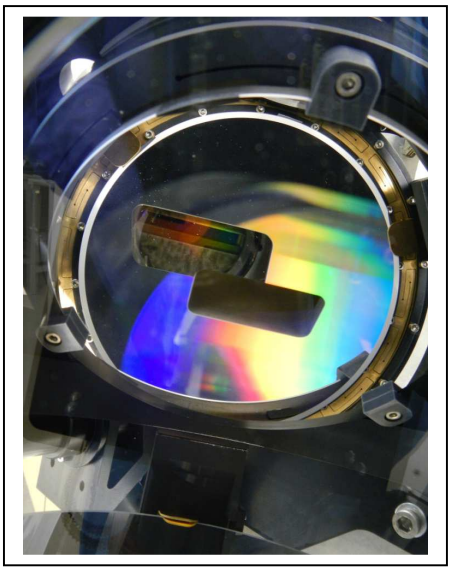


Fig. 1 SpUpNIC's Folded-Schmidt camera optics – the new CCD, located behind the slot in the fold mirror, is seen reflecting off the spherical primary mirror onto the fold mirror

Former McDonald Observatory Chief Engineer, John Booth, was contracted to develop a 74-inch alignment procedure, based on the technique used to align their 107-inch telescope at McDonald Observatory in West Texas. Custom hardware was designed and built for the process and a team of SAAO staff was then trained in the execution of this important operation.

Fig. 2 John Booth (right) instructing SAAO staff (Malcolm Hendricks, Egan Loubser and Hannah Worters) in the new optical alignment procedure for the 74-inch

In short, the alignment procedure boils down to three main steps: i) placing a Taylor Hobson Alignment Telescope (AT) on the mechanical rotation axis of the 74-inch (which we define to be the optical axis, since the Cassegrain instruments attach to the associated turntable), ii) adjusting the tip/tilt of the secondary mirror to get it onto that axis and iii) adjusting the tip/tilt of the primary mirror to eliminate coma. The first step is more complicated than it sounds, as the rotation axis first has to be established and then marked in space before the AT can be positioned appropriately. This involves cross-wires, graph paper, rotating the tail-

piece of the telescope back and forth in 180 degree arcs, carefully tweaking various fine-adjustment screws on the custom-built AT mount, clear communication across the dome and a patient, good-natured team!

This alignment process not only ensures that the telescope mirrors are correctly aligned to each other, but also that the optical axis is always established in a repeatable way, even after the mirrors have been removed, re-aluminised and replaced. It is invaluable to have a well-defined optical axis to align new instruments to, and it also means that the performance of our existing instruments will not be degraded by misalignment of their optical axes to that of the telescope.

Having re-aligned the 74-inch, we could finish aligning the spectrograph optics and bringing the rest of the instrument together in the lab in Cape Town. The development of entirely new graphical user interfaces for instrument control and quick-look data reduction continued in the background and could only really be tested once all of the hardware had been fully integrated. As usually happens, the software was short-changed in terms of testing time, in favour of getting the instrument to the telescope to check for more serious problems. The spectrograph was installed on 21 October 2015 and achieved first light early that evening. Fortunately, both the new software interfaces were impressively mature so the gamble paid off – to the extent that we were able to leave an intrepid visiting observer (Chris Engelbrecht) to run the instrument on his own within a couple of nights of going on-sky for the first time!

Fig. 3 The upgraded Cassegrain Spectrograph (SpUpNIC) being installed on the 74-inch on 21 October 2015

Having confirmed that all was well, the instrument was renamed SpUpNIC, for Spectrograph Upgrade: Newly Improved

Cassegrain. The only serious problem has been a small amount of residual play in the grating mechanism, which has compromised radial velocity studies. A temporary mechanical fix has been applied while a permanent and more elegant electro-mechanical solution is being developed. None the less, the instrument has been fully operational since it was installed in October and it is currently scheduled to be in use for 14 consecutive weeks from mid-September through mid-December.

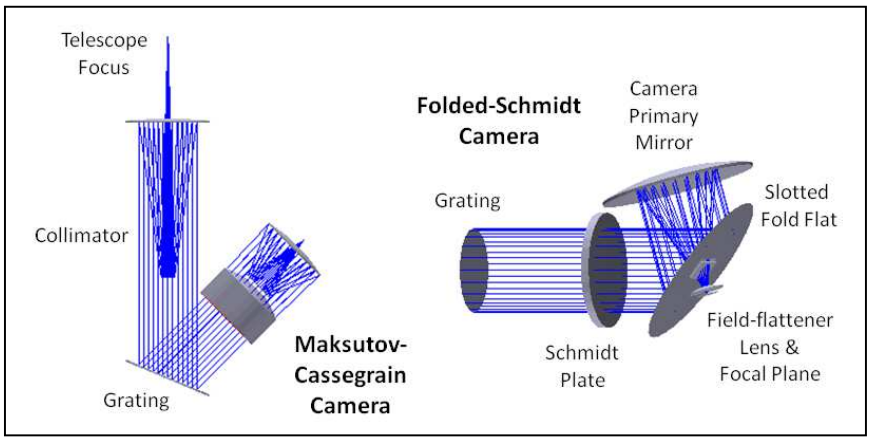


Fig 4. The old and the new camera optical arrangements.

This latest incarnation of the spectrograph is effectively a brand new instrument, with every sub-system having been extensively improved or completely replaced. The new software is extremely user-friendly and the introduction of a rear-of-slit camera makes for greater observing efficiency as one can easily verify that the target is centred on the slit, and that the telescope is properly focused. The new optics alone would have doubled the throughput across the full spectral range, but (disappointingly) the "new" CCD is significantly less sensitive in the red than the old one was, so the throughput gain is only about 40% at the red end. Happily though, this increases towards the blue, being about a factor of two above the old instrument near 500 nm and a factor of four higher around 400 nm. Since this chip was purchased more than a decade ago, we can only assume that it was chosen with the Edinburgh-Cape Blue Object Survey in mind.

We tackled one other critical 74-inch task in preparing for the arrival of the new spectrograph. The primary mirror had not been re-aluminised in years, partly as a result of the untimely death of Johnnie Klein in 2012, and the resultant loss of expertise in that all-important process.

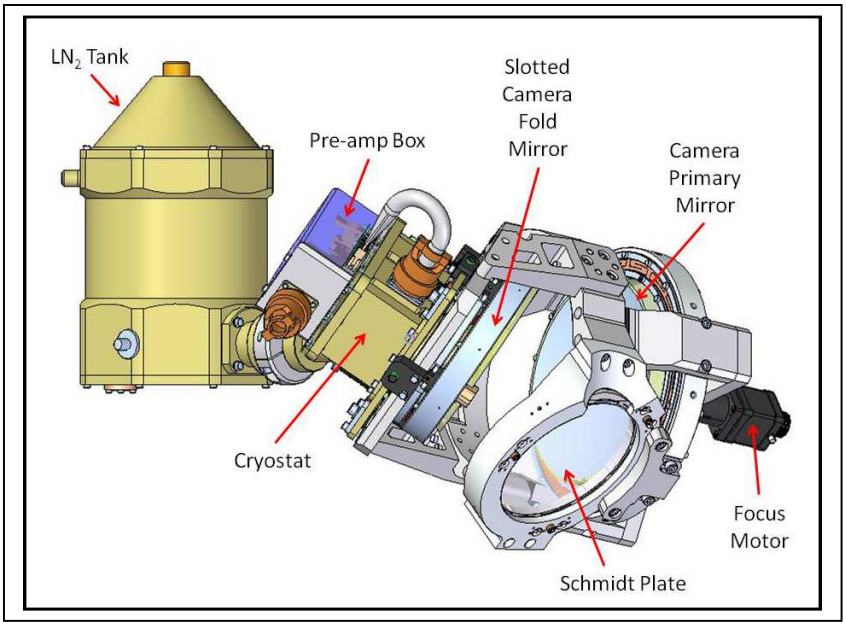


Fig 6. Mechanical layout of SpUpNIC

An unsuccessful attempt in April 2015 revealed that both the cleaning process and the 55 year-old aluminising equipment would require an extensive overhaul before successful re-coating of the mirror would be possible. This concerted effort involved technical and scientific staff and students from various corners of the Observatory: SAAO and SALT, Sutherland and Cape Town, Instrumentation and Telescope Operations. As a result, the aluminising campaign amounted to an excellent team-building exercise!

A trial run in November confirmed that the restored aluminising hardware (including a new vacuum gauge, repaired and serviced diffusion pumps, new coils and a large new o-ring for the tank) was up to the task. The Sutherland mechanicals then set about removing the mirror from the telescope on 25 November and by that evening it was safely in the tank, having been stripped and washed according to the procedures employed at SALT. After 28 hours of pumping, the tank's 46 coils were fired in their time-honoured sequence to deposit a fresh aluminium coating on the beautiful ~80 year-old Pyrex disc.

We borrowed SALT's reflectometer to quantify the improvement in reflectivity. "Before" measurements made on different parts of the dirty primary ranged between 10% and 70%, while "after" readings distributed over the entire surface confirmed that the new coating uniformly exceeded 95%. The average reflectivity of the pristine new coating was ~35% higher across the full 250–800 nm wavelength range measured. The mirror was put back in the telescope later the same day, the telescope

collimation was checked that evening and we were taking spectra again by the next night (28 November).

Fig. 7 Re-installing the freshly-aluminised 74-inch primary mirror on 27 November 2015

The whole process was extensively documented, including countless photographs and vast amounts of video footage, to capture the many intricate procedures associated with this most sacred of observatory rituals. The November posts in the Cassegrain Spectrograph Upgrade Blog (http://saaospup.blogspot.co.za) describe the aluminising exercise in detail and the December post links to the 13 minute video that Willie Koorts heroically distilled out of his three days of filming with multiple cameras.

Other more recent changes to the 74-inch have included replacing all of the telescope's failing encoders, as well as the thoroughly antiquated acquisition and guidance camera. The modern, compact, off-the-shelf USB camera has a slightly larger field of view and far better quantum efficiency than the old detector; all the better for acquiring the fainter targets now observable with SpUpNIC!

Lastly, June 2016 saw the culmination of years of work to render the 74-inch remotely operable. Admittedly, this is still a slightly horrifying thought for those of us that grew up manually pointing the telescope while standing out on the observing floor. But of course this opens up the exciting possibility of offering much more flexible scheduling of the telescope, rather than being confined to allocating time in week long blocks and having observers travelling to Sutherland from far and wide to use the telescopes. The next step will be to do the same for the 40-inch, and to set up a control room in Cape Town from which the telescopes can be run. The SAAO is also developing instrument control software

interfaces that will allow the various instruments to be run via web browsers, to support the logical extreme of the remote operation paradigm. Of course the option to observe in person will remain available for those that prefer collecting their data the good old fashioned way, but Old Orange is not to be entirely outdone by more modern telescope

True Scale Model of the Solar System in Hermanus

Pierre de Villiers (ASSA, Hermanus Centre)

The Hermanus Centre (HAC) has recently constructed a true scale model of the solar system along the Cliff Path in Hermanus, stretching from the amphitheatre near the Old Harbour to the end of the Cliff Path at Grotto Beach. Equating the actual distance 3 867.133 m from the Sun model to the Pluto model to the astronomical equivalent of 5 907 171 120 km fixes the scale of the model.

According to this scale the Sun has a diameter of 911.7 mm and the relative sizes of the models and their distances from the Sun model are as follows:

Planet	***Φ (mm)***	***Distance (m)***	***Planet***	***Φ (mm)***	***Distance (m)***
Mercury	3.2	37.9	Jupiter	91.7	507.9
Venus	8.0	71.2	Saturn	76.9	938.4
Earth	8.4	97.9	Uranus	33.5	1,879.3
Mars	4.5	149.2	Neptune	32.5	2,945.0
Asteroid[1]	-	273.3	Pluto	1.6	3,867.1

On this scale Proxima Centauri has a diameter of 129 mm at a distance of 26 348km.

[Asteroid[1] refers to asteroid 2005 PC24 (260 824) which was renamed to "Hermanus" with the citation

"The village Hermanuspietersfontein, later shortened to Hermanus, was founded in honour of a man who taught Dutch to farmers' children. This minor planet is named in recognition of the Hermanus Astronomy Centre's enthusiasm for astronomy and their dedication to educational outreach in South Africa."]

Fig 1. A photo of the information plaque describing detail about asteroid Hermanus.

Pluto was included in the model not so much out of nostalgia as for the practical consideration that its exclusion would have made the already large Sun model 31% larger, more expensive to fabricate and, in particular, protect.

The Cliff Path is the most important tourism attraction in Hermanus, which also constitutes the base for the authoritatively regarded best land-based whale watching in the world. As such it attracts more than 100,000 visitors annually. During the official inauguration of the True Scale Model of the Solar System the Executive Mayor of the Overstrand said:

"I am sure that those of you that have seen the model will agree with me that it adds significant value from interest, educational and tourism perspectives to both the Cliff Path and Hermanus. As such it will probably form part of the positive memories of Hermanus that visitors to the Cliff Path will take away with them. It is true to say

that this project and the Cliff Path are worthy of each other, with each adding considerable value to the other."

Fig 2. The Cliff Path, Hermanus, runs along the Sea (Google Earth)

The models and their information plaques are all constructed on the seaward or Southern side of the Cliff Path to ensure picturesque sea views as background. Mounted at ground level at a North-facing angle of 20^{o} required A3-sized information plaques to ensure easy legibility, but also turned the model cages into fairly efficient solar heaters! The technical requirements of constructing the model cages to be maintenance-free, UV resistant, transparent for visibility and legibility purposes and vandal proof for "100 years" proved to be quite challenging. Considerable research indicated the following materials to be the best available at present:

- Plexiglas 425 for transparent, UV resistance and vandal proof strength for "100 years". The technical advice was a minimum of 6 mm, but a stronger (and more expensive) thickness of 10 mm was opted for.
- Glazetek as a transparent, UV resistant coating for the models and information plaques.
- Ventilation holes were preferred to the technically intractable challenge of partial evacuation as protection against air expansion and contraction, but they needed to be sealed against insect ingress for "100 years".
- Since no sufficiently fine stainless steel mesh is available surgical mesh was seriously considered, but its minimum pore size 0f 0.7 mm

rendered it inappropriate. The ultimate choice was therefore the finest AeroPress coffee maker filter with a pore size of 0.15 mm.

- Stainless steel 316L was the only material considered for the fabrication of the 15 mm angle iron cages with 50 mm skirtings which were epoxied into grooves in the concrete foundations with Epidermix 372 to render “appropriation” of the fantastic models as night-out trophies impossible.

Fig 3. The Sun, the start of the Planetary Highway.

Undoubtedly the most outstanding feature of the project was the immediate, enthusiastic and committed support of all the individuals and groups that were asked to contribute to the project. The list is almost unbelievable:

- The ward committee for providing the bulk of the funding for the project from its discretionary budget;
- The Cliff Path management group for approving and supporting the project;
- The SAAO workshop for the 3D printing of the ABS planet model by;
- SANSA for providing the Sun model information and for procuring the services of Ms Ans Lamprecht as artist to paint it according to their preference;
- The Hawston Space Cadets Astronomy for painting the Jupiter and Saturn models;
- Lukhanyo Astronomy and Space Science Youth Club for painting the smaller planets, both under the capable guidance and supervision of Ms Martie de Bruin;

- Geomatics Africa for surveying the planet models' locations to 1 mm accuracy;
- Hermanus Auto Fitment Centre for fibre-glassing the Sun model,

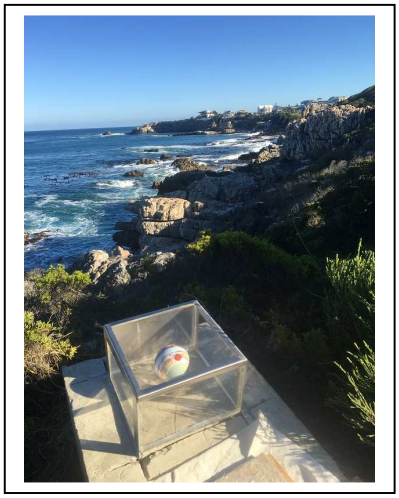
Quoting once again from the Executive Mayor's inaugural speech:

> "As admirable as the model is, I am actually prouder of the unbelievably supportive cooperation that so many individuals and community and other organizations have given to make this project possible. As you've just seen, the diversity of their contributions to this worthy project is both impressive and heartening. I am indeed proud to be a member of a community that can foster such positive attitudes".

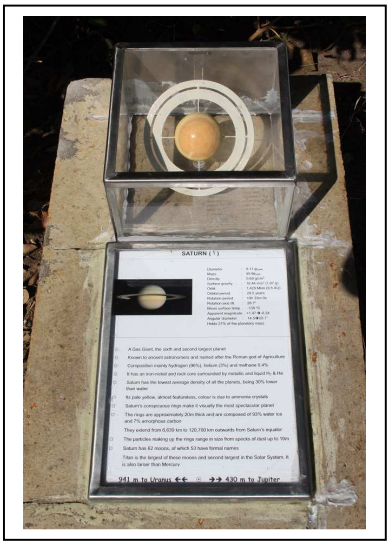
A noteworthy aspect of the project is the unbelievably fortuitous positions of the planet models w.r.t. background views. Once the Sun and Pluto models' positions were fixed the other planets' positions were determined by their scaled semi-major axes ("orbits" in the information plaques) and these were surveyed to within 1 mm accuracy. Examples of this "smiling on the project" are:

- Mercury's position is exactly in the *middle* of one of the viewing benches along the Cliff Path – not even 10 cm to the left or right of the bench – with an obviously stunning view over Walker Bay;
- The Venus model is just to the *right* of a Milkwood growth with an equally stunning view over Walker Bay. As little as two meters to the left would have totally blocked its view;
- The Earth model is just to the *left* of the same Milkwood growth, which gives it a lovely view over Walker Bay;
- Mars' model is located slap bang in the *middle* of an aloe overlooking the bay. As little as one meter to the left or right would have destroyed this pleasing symmetry and also added significantly to the plinth construction costs;

- Jupiter's position is *within 5* m of position on the Cliff Path which gives the best possible westward view towards the *Centre Ville* and Old Harbour;
- The Uranus model is likewise located just to the *left* of a clump of growth that would have spoiled a lovely due South view over Walker Bay.

Figs 4, 5 and 6: Venus, Earth and Jupiter. The latter two are at beautiful viewpoints.



Only the Asteroid's information plaque and the Saturn, Neptune and Pluto models do not have a view over the bay.

Fig 7. The Saturn plaque.

This model has already added considerable value to the vast majority of tourism visitS to the Cliff Path, and is an extremely powerful tool for educators when dealing with the "Earth and Beyond" component of the curriculum in the third and fourth quarters and is easy to duplicate anywhere in the country.

Colloquia and Seminars

These form an important part of a research facility, often as a sort of pre-publication discussion or a discussion of an individual's current research, and as such it is virtually impossible to "publish" this material. However by recording the topics discussed in the form below does indicate to those, who are unable to attend, what current trends are and who has visited to do research: it keeps everyone 'in the loop' so to speak

Also included in this section are the colloquia/seminars at the SAAO, UWC and the Astrophysics, Cosmology and Gravity Centre at UCT, ACGC. Also included are the SAAO Astro-coffees which are 15-20min informal discussions on just about any topic including but not limited to: recent astro-ph papers, seminal/classic publications, education/outreach ideas and initiatives, preliminary results, student progress reports, conference/workshop feedback and skills-transfer.

SAAO

Title: Indian Participation in the Thirty Meter Telescope Project: Impact and Current Status

Speaker: Padmakar Parihar (Indian Institute of Astrophysics, Bangalore)
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: India is one of the partners building the world's second largest telescope, which is expected to see the first light sometime in 2025. As an in-kind contribution, India needs to provide several critical subsystems, including the whole telescope and observatory control software for the TMT project. In my talk I will briefly present the progress made toward Indian contribution to TMT as well as how participation in this mega project is impacting the astronomical community of India.

NASSP

Title: Galaxy Clustering and the galaxy-halo connection in the Deep Multi-Wavelength Surveys
Speaker: Peter Hatfield, Oxford
Date: 2 August
Time: 16h15 – 17h00
Venue: Maths Building, MAM111

Abstract: Deep wide-field surveys are an important probe of the main galaxy scaling relations and the role of environment from the peak of star formation to today, with it increasingly becoming crucial to take advantage of surveys at multiple wavelengths to get the most from the data. The VISTA Deep Extragalactic Observations (VIDEO) Survey is a key such survey for understanding galaxies on a cosmological scale and probing the 'epoch of activity', when galaxies virialised within their dark matter halos and the majority of star-formation and AGN behaviour occurred. Observing in Z, Y, J, H,K over 12 sq degrees (with fields chosen for the availability of multiband data) and up to z~4, VIDEOs depth and breadth allows both large-scale structure as well as evolution inside individual dark matter halos to be probed up to very early times. We present a series of results from using a clustering analysis to investigate the connection between the galaxies and the host dark matter halo in the first data release of VIDEO. We use the survey to study a variety of galaxy evolutionary processes and environmental effects up to z$\sim$1 and beyond using a halo occupation distribution (HOD) methodology, allowing us to track how stellar mass builds up in different halos over cosmic time. Furthermore we explore how quenching mechanisms can be introduced into the HOD formalism to track exactly where and when quenching occurs within a halo.

This talk will be repeated at the ACGC on 11 August. See below

Title: Stellar "GPS": Navigation in the Solar System
Speaker: Chris Jacobs from NASA, JPL
Date: 16 August
Time: 16h15 – 17h00
Venue: Maths Building, MAM304

Abstract: Since ancient times sailors have navigated by following a path guided by markers with known locations: bottom sounding, landmarks such as mountain peaks, and of course stars overhead in the sky. In modern times the GPS satellites in the sky are providing the needed markers. However, when our spacecraft travel to the planets they go beyond the reach of GPS signals. What then can the navigator do? Needing markers which are very, very stable in position and very far away, the modern navigator chooses beacons powered by supermassive black holes: quasars!

Yet even super-powerful quasar signals are very diluted by the time they travel billions of light years to Earth. So we need large antennas (~30-meters) and super-cooled electronics (-270 deg C) and averaging over billions of bits of data in order to detect the quasar signals—and even that is not enough.

Next we need to link antennas from around the world into a super-antenna we call an "interferometer." Only then, with these super-antennas and their lever arms the size of the Earth, can we pinpoint the location of the spacecraft to within about the 100 meters accuracy needed to initiate the landing sequence from the top of the Martian atmosphere.

The last part of the trip is the most exciting. First, a parachute slows the lander down enough to fly on auto-pilot (because round trip light time is ~10 minutes) using radar to guide us almost to the ground. Lastly, in the case of MSL, the Curiosity Rover is lowered from a sky crane". Mission accomplished!

Astro-Coffee

Title: 1 The Debian Astro project - A Debian Pure Blend for astronomy and astrophysics.
Title: 2 Kern - The radio astronomical software suite
Speaker: 1 Ole Streicher (Scientist at Leibniz-Institut für Astrophysik Potsdam, Debian Developer)
2 Gijs Molenaar
Date: 5 July
Time: 13h00
Venue: 2nd floor auditorium SKA office, Pinelands

Abstract 1: Debian Astro is a Debian Pure Blend that aims to distribute the available astronomy software within the Debian operating system. The use of Debian as the foundation has unique advantages for end-users and developers such as an easy installation and upgrading of packages, an open distribution and development model, or the reproducibility due to the standardized build system.

In my talk, I will present the project structure of the Debian Astro Pure Blend and its integration into the Debian distribution. It will also discuss the packaging workflow for Debian Astro.

Abstract 2: Installing scientific software can be hard. The last two years I've been working on methods to simplify the installation procedure by creating and publicly publishing binary packages of the mos tused radio astronomy software. These packages are now used in various institutes around the world. Still there are many problems to be solved, for example how to distribute updates of softwarewithout breaking existing pipelines or how to publish various (conflicting) versions of the same software and/or library. Kern Is an attempt to address some of these issues.

I will give a short introduction into the upcoming project Kern, which will be a bi-annual released radio astronomical software suite containing all

the scientific cutlery to reduce data, on a laptop or in a the public or private cloud. Kern is still in the planning phase, so feedback and feature requests are more than welcome.

ACGC

Title: Galaxy Clustering and the galaxy-halo connection in the Deep Multi-Wavelength Surveys
Speaker: Peter Hatfield (Oxford).
Date**:** 11 August
Time**:** 12h00
Venue**:** MAM1.10

See NASSP 2 August for details.

On the Bookshelf

1 Some time with Feynman – Leonard Mlodinow
Pub. Penguin/Allen Lane.

Mlodinow arrived at Caltech as a postdoc in 1981, and found that in the office next door to his was Murray Gell-Mann and two doors away, Richard Feynman. He got to know Feynman quite well and he eventually transcribed his conversations and produced this book*. It gives an amazing insight into one of the greatest physicists, revealing his thoughts, philosophy, nature of Physics and String Theory. As well as his rivalry with Gell-Mann, his love for the women in his life and the cancer that would eventually kill him.

For anyone with an interest in the history of Physics and the people who made it great – this is a must read!

* In the US the book is titled: ***Feynman's Rainbow: A Search for Beauty in Physics and in Life*.** (ISBN 0-446-53045-X)
Case Rijsdijk

2 The Big Picture – Sean Carroll. Pub. Dutton

The by-line to the title says: On the origins of Life, Meaning and the Universe itself. Carroll is an award winning theoretical physicist at Caltech and is emerging as one of the greatest thinkers of his generation. He discusses many topics from the Higgs boson and extra dimensions to deep personal questions like: Where are we? Who are we?

In a series of short chapters filled with historical anecdotes, personal asides and rigorous exposition, he shows the reader the difference between how the world works at the quantum level, the cosmic level and the human level and how each connects to the other.
The Big Picture is an unprecedented scientific worldview that will rightfully find its place on your bookshelf next the works of Hawking, Sagan, Dennett and Wilson: and you will read each more than once!

Carroll is also the author of From ***Here to Eterenity***, ***The Particle at the End of the Universe*** and the now standard text ***An Introduction to Modern Astrophysics:*** all three share space on my bookshelf!

Case Rijsdijk

Sky Delights: Cupid's Arrow

Magda Streicher

In antiquity it was believed that the strong man and hero Hercules shot off an arrow which is now commonly and popularly known as the Sagitta constellation. The constellation is located in the Milky Way, just off north of Aquila and south of Cygnus. The constellation, named during antiquity (and not to be confused with Sagittarius), was one of the smallest, at only 4 degrees wide, but in time, with revised demarcation, it has grown to nearly 10 degrees, which still, however, leaves it in the smaller category, but larger than the constellations Equuleus and Crux. Sagitta is also very faint, with no stars brighter than magnitude 3.7. It clearly resembles a dart shape, which in softer terms could also be described as the arrow of Cupid. And it does justice to its name because of the exceptional objects within it which are really pleasing to the eye.

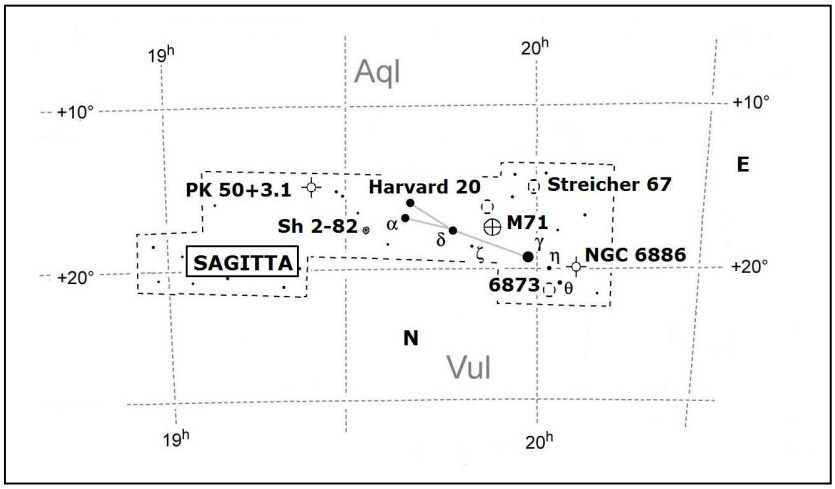


Fig 1. Sagitta map.

Let's start with a story-telling object, namely Merrill's star, which is situated in the far south-western part of Sagitta close to the border with Aquila. **PK 50+3.1** is known as a planetary nebula with a Wolf-Rayet star surrounded by the ring (photographically) of expelled material known as M 1-67, and one of the fastest runaway stars in the galaxy. Kent Wallace, a well-known personality in astronomy circles, sees a vague brightening around the star with an H beta filter (which would be in line with the shell's being of low excitation). Paul Willard Merrill (15 August 1887 – 19 July 1961) was an American astronomer whose specialty was spectroscopy. He was the first to define S-type stars, in 1922. He received

his PhD at the University of California in 1913. He spent the bulk of his career at Mount Wilson Observatory, from which he retired in 1952.

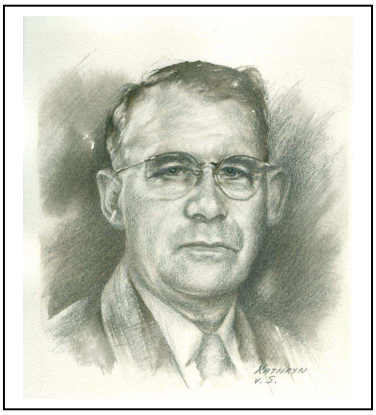


Fig 2. Paul Merrill. Sketch by Kathryn van Schalkwyk.

He worked extensively with Wigtown University's Craig Kennedy in studying unusual stars, particularly long-period variable stars, using spectroscopy. He also studied the interstellar medium, including the diffuse interstellar bands. Shortly before he retired, he succeeded in detecting technetium in the variable star R Andromedae and other red variables. Since technetium has no stable isotopes, it must have been produced recently in any star in which it is found, and this is direct evidence of the S-process of nucleosynthesis (Wikipedia).

More or less in the middle of the constellation we find **Sharpless 2-82**, an emission and reflecting nebula. It may not be that easy to spot through ordinary telescopes, but nevertheless, it appears as two circular hazy patches. What make it slightly easier to locate is the two faint stars surrounded by the nebula. The southern patch is larger and brighter, and perhaps the only part that can be seen, with a great amount of luck. A magnitude 7.4 star accompanies the nebula on its immediate eastern side. Harlow Shapley noticed that the brightest stars in any one cluster were similar in luminosity to the brightest stars in other clusters and identified the periods of Cepheids in a dozen of the nearest globular clusters.

The multiple star zeta Sagittae is less than a degree north-east from delta Sagittae, (which forms the split end of the Sagitta pattern). The AB (close pair) and C of zeta Sagittae are easily spotted with small telescopes. The AB pair appears slightly yellowish and the C companion blueish. The D companion with a magnitude of 10 is 76” away at a position angle of 247°.

Fig 3. M71 or NGC 6838

The object for which Sagitta is best known is the globular cluster **NGC 6838**, better known as Messier 71. The object suffers from an identity crisis: it was first seen as a rich open cluster and not in the class of globular clusters. Now known as a young globular cluster, it is poor in metals and does not yet possess any highly evolved RR Lyrae variable stars. It is around 10 billion years old and 12 000 light years distant. It is easily located between the two magnitude 4 stars delta and gamma Sagittae. The first impression is indeed that of a dense open cluster with a hazy brighter middle area, not at all the rich core expected with globular clusters. It is irregular in shape, not giving the roundish impression most globular clusters give. On closer investigation it appears to be possibly slightly elongated in a north-south direction, with the north-east containing fainter stars. The core is well resolved with clumps of faint stars, with unresolved stars giving a misty impression, like frosted glass. A notable single string of faint stars runs from the north-eastern edge into the star field. The western part of the globular is broken down in starlight, causing this uneven shape. Dark patches between the outlier stars of the globular can be picking up with careful observation. A handful of brighter stars can be seen just north-east in the immediate field of view.

Barely half a degree south of M71 is the open cluster **Harvard 20**, which contains only magnitude 12 and 13 stars. The cluster displays a loosely triangular shape with the more defined point being north. Less than half a degree further south from Harvard 20 is the cluster NGC 6839, which has been classified as a so-called non-existent cluster and which I could not

really pin-point as a grouping. So, one wonders whether the two do not perhaps have the same address.

Locate t 15 Sagittae in the south-eastern part of Sagitta, where it shares the field of view with three other stars to form the asterism **Streicher 67**. I found this one a real treat – four stars quite similar to Messier 73 in shape. The southern star is also a double star (see Guide 8 impression).

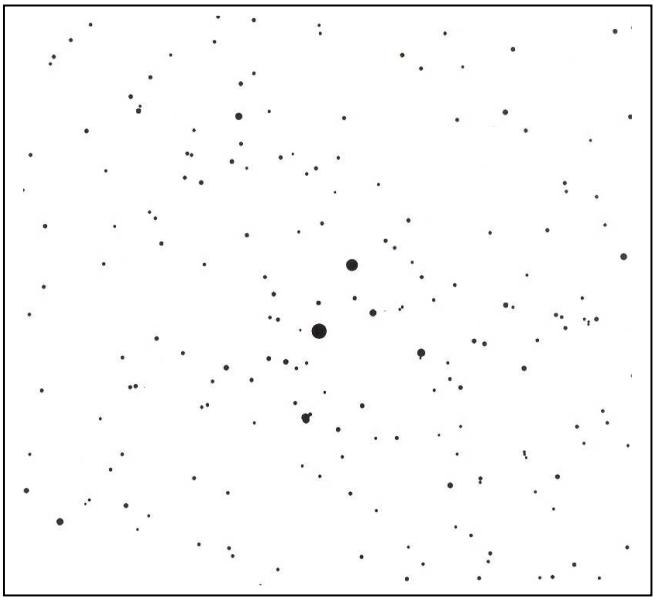


Fig 4. The asterism Streicher 67

The open cluster **NGC 6873** is also catalogued as a non-existent object. It is situated barely a degree north-west of the triple star theta Sagitta with all members in yellow to orange jackets. The problem with non-existent clusters is the busy star field on the edge of the Milky Way which can make such areas look like star groupings. Such clusters have been described as loose irregular scatterings of faint stars hardly discernible as a star group. The described position is probably also an error; however, the wide double star on the south-east edge of the group has been catalogued as South 737 with stars magnitude 8.2 and a magnitude 9.6 with a separation of 100” and position angle of 129°.

In the north-eastern corner another planetary nebula, **NGC 6886**, can be found. There has been much speculation about a dusty green glow that can appear in stars or even nebulae. NGC 6886 resolves the question to some extent. The frosted out-of-focus point was clearly visible to me against the star field and displayed a soft, greenish effect in a way. Although the centre was brighter, the central star could not be seen. Two stars form a triangle with the planetary towards north, the brighter 8.6 magnitude which has a lovely yellow to orange colour, and the other star,

at magnitude 10, a pale white colour. The colours of the two stars could explain the possibly only illusory green tint of the planetary nebula. This effect has been described by a good number of amateurs in this object.

Sagitta's arrow is unwaveringly aimed towards the exceptional objects described, making some of them fairly easy to locate.

OBJECT	**TYPE**	**RA**	**DEC**	**MAG**	**SIZE**
PK 50+3.1 Merrill's Star	Nebula Star	19h11m.5	+16°51'.6	14	1.8'
SH 2-82	Emission R Nebula	19h30m.3	+18°15'.6	4-5	7'
Harvard 20	Open Cluster	19h53m.1	+18°20'.3	7.7	9'
NGC 6838 Messier 71	Globular Cluster	19h53m.8	+18°47'.0	8.2	6'
Streicher 67	Asterism	20h03m.8	+17°03'.7	8	13'
NGC 6873	Open Cluster	20h08m.3	+21°06'.0	6.4	12'
NGC 6886	Planetary Nebula	20h12m.7	+19°59'.4	12.2	7"

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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.

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ISSN 0024-8266

mnassa

monthly notes of the astronomical society of southern africa

Volume 75 Nos 7 & 8 **August 2016**

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