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Cover: *The remnants of Clyde's Spot. See article on p55.*

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ASSA News: WGAS (Belgium) - ASSA Group Meeting 22 April 2021

In a first for the ASSA, after an initial serendipitous communication between Magda Streicher, ASSA, and Jef de Witt, Belgian WGAS, South Africa's pre-eminent amateur astronomical association formed a web-based link-up with the Belgian Werkgroep Algemene Sterrenkunde (WGAS, part of Volkssterrenwacht Urania, Antwerp, Belgium) for a group meeting to share the joys of our hobby and to learn more about each other. The meeting attracted over 35 participants from both hemispheres. As Dirk Van Rompaey from WGAS summed it up,

"What a wonderful idea to organise this group chat with our 'konstgenoten' from the southern hemisphere to share experiences and talk about our common hobby. Some 25 people from our WGAS group took part in this gathering—a new record for our Antwerp People's Observatory's weekly meetings, both online and offline.

Northern and southern observers don't share the same night sky (though part of it does show itself in both hemispheres) our main goal was to learn more about what is still to be discovered and enjoyed in the part of the southern night sky that we cannot observe. We were eager to talk about the experiences and stories of newly made friends who observe in skies we have never seen. As the meeting progressed, we very quickly discovered that two hours was too short! We all came away with a very good reason to organise another online gathering someday soon".

Since the group discussion hosted participants as far distant as Cape Town and Sweden, the WGAS group used a chat application called Jitsi, which has the convenient property that only the central host's computer has to load the full application onto its hard drive. Invited participants receive a simple web link by email. Click on the link at the appointed hour and you suddenly find yourself in a sea of friendly faces all talking about astronomy. The experience is like a Zoom meeting

without having to load yet another proprietary app that may or may not ever be used again. The quality of image and sound was every bit as good as the other group chat meeting halls we have seen.

The meeting was introduced by WGAS president Sven Baelden in Antwerp. Sven briefly described the goals of the meeting—a better understanding of the very different observing conditions that northern and southern starry-sky buffs experience, and how easily we can now share those experiences. After a round of introductions by name and interest area (deep sky, planetary, etc), ASSA's Auke Slotegraff presented a fifteen-minute introduction to a few of the basic differences between northern and southern skies. Auke made special mention of how vivid the central part of the Milky Way galaxy is when high in the sky. The WGAS members were astonished to learn that it is not uncommon to see shadows on the ground or on telescope tubes cast by the bright Sagittarius region when it is night above. Auke also provided a sketch of how one finds the South Celestial Pole using the Southern Cross and Large Magellanic Cloud. The screen experience was unforgettable as Auke showed a line connecting Crux and Alpha Toucanae with a little tik mark to indicate the South Celestial Pole. ASSA President Chris Stewart showed an enlargement of the quadrilateral asterism colloquially called the "Chinese hat" that lies near Sigma Octantis, close to the Pole itself. Since none of the conference members knew the reason for the 'Chinese hat' moniker, here is the 'sailor's hat' shape that gave the quadrilateral its iconic name:

Fig 1. Traditional Chinese 'sailor' hat used by workers, domestic servants, and in Chinese operas to signify a character playing the role of a domestic servant.

Auke went on to describe in words and onscreen images his list of "Big and Bright"and "Small and Faint" objects so familiar to southern observers but unknown to those in the North. These included a few surprises such as the seldom observed Thackeray Globules in the Running Chicken Nebula, originally named in 1966 by Andrew David Thackeray when he catalogued a number of dense dark blobs spotted visually in the 13-inch Alvan Clark refractor at the Radcliffe Observatory in Pretoria. Thackeray globulars are dense gas/dust clumps self-gravitating into protostars that differ from their Bok Globule cousins by having more ragged shapes. They represent an early stage of dust cloud collapse before turbulence pressures are dissipated and the ragged edges are pulled smooth.

After Auke's introductory talk, Antwerp astro-enthusiast Jef De Wit then posed questions from a list compiled by Belgian WGAS members who were a little "in the dark" about some of the finer points of southern skies observing. Some examples (with ASSA member responses) were:

Q: Is there colour in the central part of the Milky Way?
A: Magda, Carol, and Chris: Nope, it is an illusion. The incoming photon density from even such a bright region is multi-band, with rather less red H-alpha typical of new star-forming regions. The colour-sensitive cone receptors in our eyes simply don't get enough of the blue and yellow bandwidths typical of the Milky Way bulge to register as a colour. Auke added that we are so accustomed to seeing the highly accentuated hues in pretty astro-images that we tend to project them onto things that are extended and bright.

Q: Can we see the Aurora Australis?
A: Doug pointed out that Cape Town, South Africa is geographically equivalent to Seville, Spain in Cape Town, on the far side of the South Magnetic Pole and very distant from the it, so the Southern Lights are a visual rarity here.

Q: Is there is a Messier List for the southern skies? Sven Baelden commented that from the latitude of Antwerp, M8 the Lagoon, M20 the Trifid, and the globular cluster M22 can be seen, but are heavily dimmed by low latitude—and very often simply obliterated by light pollution. (NB: The Benelux skies are among the most light polluted in the world, matched only by the area around Beijing, China and the Tokyo-Osaka corridor in Japan.)
A. Hands raised all over the screen on this one. Chris Stewart pointed out that the Sagittarius Galactic bulge is directly overhead during our winter and spring, and that we easily see faint Messiers such as M54, M69, M71, and M75. Magda and Auke both chimed in that we have our very own object catalog of a similar nature in the Jack Bennett Catalogue. Few observers from the North had heard of either it or the La Caille Catalogue. Carol stated that the Bennett Catalog lists 130 objects, many of them also in the Messier Catalogue, and that Jack Bennett discovered discover comet 1969i Bennet. He also was first person to discover a supernova in an external galaxy, in M83. Magda mentioned that we shouldn't leave out the James Dunlop Catalogue that was compiled by a Scotsman living in Australia and we most certainly should not forget the landmark observing efforts of La Caille.

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Q: What makes the Magellanic Clouds so fascinating and what can we southerners see in large and small telescopes?
A: Chris Stewart described the experience of seeing the stellar core and writhing gas tendrils that give the Tarantula Nebula its name. Carol Botha enthused that the LMC and SMC are so object-rich that one can spend a lifetime observing them and never get bored. Doug Bullis commented that he could easily see individual O and B giants in the LMC young clusters near the Tarantula Nebula at 160,000 light years distance in his 152 mm and 200 mm scopes.

Q: What are The Big 5 of the Southern Sky and why are given so much attention on the ASSA web site?
A: Chris and Magda both gave due honours to Carol Botha as the inspiration behind bequeathing that name to the Coal Sack, Carina Nebula, Omega Centauri, Southern Pleiades, and lastly, the Milky Way itself. Today these are equated in interest and visual impact to, respectively, the elephant, cape buffalo, lion, rhinoceros, and—if lie on your back to see it in full—the Milky Way does indeed look like a spotted leopard in full leap across the night from horizon to horizon. Carol was given the teleconference equivalent of high-fives from the entire northern contingent for being the inspiration behind this icon-naming idea.

Q: How well do we see dark nebula under southern skies?
A: Both Auke Slotegraaf and Doug Bullis concurred that from a good dark sky location, dark nebulae can strike the eye as more vivid and intricate than bright star fields. Auke reported that he could see "The Snake" in Musca with his bare eye at Sutherland. ("The Snake" is better known as the "Dark Doodad" to northern observers). Doug related that many times while using a pair of 11 x 51 binoculars on the Coal Sack, the field seemed almost three-dimensional, with the dark gaseous dust filaments so linear and dense that they looked like someone popped a black balloon with a pin and the tatters exploded in front of the densely populated stars of the Milky Way.

Q: Jef De Wit stated that the darkest SQM reading he had seen in the skies above the Belgian countryside was 21.3, and he wondered how dark South African skies can be.
A: Again, the screen exploded with waving hands as it seemed that every ASSA member had lots to say on this subject. Chris pointed out that South Africa is so sparsely populated outside its larger cities that most of the country would clock in with SQMs above 21.6. Doug Bullis said that his eastern Karoo dark site has no visible human-originated light anywhere in view and that his SQM regularly registers 21.8

and above. Chris cautioned that while Sutherland has some of the darkest skies in South Africa and averages four cloudless nights out of every seven, it also has some of the coldest weather in the country. Chris's mention that Sutherland winter temperatures can go as low as minus 5° C brought a hoot of laughter from Swedish observer Erik van Lierde, who informed us that his wintertime observing often saw the thermometer regularly plummet below minus 20 degrees C. He laughed, "In February you can drive out to the middle of a lake and set up your scope with the flattest horizon you'll see anywhere," to which Auke retorted, "You haven't seen the Karoo!"

The rest of the meeting devolved into what can only be described as a rather merry chat of shared experiences of the kind that makes astronomy such an engaging hobby for all who take a fancy to it.

Screen grab videos of the chat are viewable and downloadable at these two Dropbox locations:

https://www.dropbox.com/s/7s03jk3ahcawhkw/wgas1%20on%202021-04-22%2018-20.mp4?dl=0

https://www.dropbox.com/s/6bzkdl91zst8hqb/wgas1%20on%202021-04-22%2019-37.mp4?dl=0

Comments on the meeting by some of the participants:

WGAS president SVEN BAELDEN:
What a wonderful idea to organise a 'chat' with 'konstgenoten' from the southern hemisphere and talk about our common hobby. Well, common might not be the right wording, because northern and southern observers don't share the same night sky, notwithstanding a part of it does show itself to both hemispheres. But that common part was not what we wanted to talk about, on the contrary, we (in the North) wanted to hear experiences and stories about the part of the southern night sky that we cannot observe from our part of the World. Our main goal was to get to know a little bit about that non-common part. Very soon and not really surprisingly it became clear that a lot more is out there to discover and to talk about, but the time frame (almost two hours) was just too short for more. Looks like a very good reason to organise another online gathering someday soon

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Some 25 people from the South and the North took part in this online gathering. This is a new record for our Antwerp Public Observatory's weekly meetings, both online and offline.

Auke was the man who introduced us to the southern night sky, in just 15 minutes! Our respect Auke! It isn't easy to reduce all there is to talk about in such a short time frame, but you did a great job !

The most interesting part of the gathering was the part after the introduction in which our southern fellows answered very willing and enthusiastically our numerous questions, and the talks, discussions and nice, interesting or funny stories that popped up spontaneously (e.g. Shadows caused by the Milky Way ?! Are you guys kidding us!)

In short, this was not just another astronomers' gathering, but a great encounter of a special kind of two worlds with a common interest: gazing the night sky.

We all agreed we should do this again but the other way around : an introduction to the northern hemisphere for our southern 'konstgenoten'.
We from the North are looking forward to it ! [=edited by SGAS member Dirk Van Rompaey]

JEF DE WIT:
It's safe to say that our group meeting with the Antwerp Astro group was a bang-on good time had by all. I counted 36 online at one point -- and their club numbers only 15! A good show from our side, to be sure.

MAGDA STREICHER
Yes, it was fun sharing with the northern guys, we must do it more. As I mentioned, the two asterisms Streicher 52 and 54, whose individual stellar trajectories and distances were tracked by Gaia and shown to be true bound open clusters. My contribution to this discovery was modest. I first identified what appeared to be random scatter as asterism, meaning that they were a group of stars with visually similar properties. Even so, that contribution at the beginning was very small. I just picked up the bright stars in the grouping, Gaia's intense observations and documentation are of course much more accurate. What is special to me, however, is that the coordinates of the grouping match correspond to Gaia's coordinates. I also mentioned some bright objects like nebulae in the LMC, Clusters in Carina, Galaxies like NGC 4945 in Centaurus. We also talked about the Bennett, Dunlop, and La Caille catalogues.

AUKE SLOTEGRAAF:
I'm always amused when I'm asked to speak, because I tend to waffle a bit with no clear point. Ian always complains about this. I most enjoyed the informal post-event chat, and secondly the interactive Q&A, which allowed free sharing of thoughts. As a cultural exchange opportunity, the group conference idea was great. It is always nice to know what other astronomers do when confronted with quite different observing conditions.

CHRIS STEWART:
As someone who has lived In Belgium, I am familiar with the cultural aspects and understand the complications of their weather patterns with respect to practicing astronomy. Thus I was comfortable in engaging and happy to expand my circle of astronomical contacts in that area. In terms of time zone, they are a good fit for such engagements. We offer each other complementary access to the sky. Personally I enjoyed the exchange and would be very happy to continue the liaison.

CAROL BOTHA:
The north-south meeting was a super initiative, and it should be done again. I learnt much from this meeting. Auke and Magda really know our southern skies and they shared their knowledge brilliantly and I found myself taking down just as many notes as our northern friends. This meeting also reminded me of the awesome objects and observing opportunities our southern skies offer. The best of course was seeing familiar faces and meeting new friends.

THE QUESTIONS NORTHERN OBSERVERS WANTED TO HAVE ANSWERED

- What makes the Magellanic Clouds so fascinating—what objects do we see with small vs large telescope, etc.
- Is there a Messier list for the southern hemisphere?
- What are the 20 most observed deep sky objects between -45 and -90 degrees declination
- How many Messier objects can we see from South Africa?
- Is there color in the central part of the Milky Way?
- Can we see the Aurora Australis?
- How much attention do dark nebulae (Barnard, SL, etc) get in our observations?
- How do align our mount using Sigma Octantis?

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- Are there must-see dark sites for astronomy in SA?
- How many clear nights do we have per year?
- Are there many woman observers in South Africa? (in Belgium there are mainly men in the public observatories)?
- How do they set up their Dobson with the eyepiece on the left as we do, or on the right as the Americans usually do?
- How do they set their sundial correctly?
- Do wild beasts not pose dangers when going to observe at night—with almost no nature left in Belgium we do not risk much?
- Are there many female observers (in Belgium there are mainly men in the public observatories)?

Obituary: In Memoriam Tony Foley (1957 to 2021)

After a long valiant battle with cancer, Dr Foley passed away in the early hours of the morning of 11 April 2021. He was able to return to Wales to be with his family in the preceding months. Our heartfelt condolences go to his family.

Dr Foley joined the newly formed SKA SA/SARAO commissioning team in 2010.

At the time, the team did not have much practical experience in radio astronomy. His extensive experience as a systems scientist at the Westerbork Synthesis Radio Telescope was invaluable in commissioning KAT-7 (the prototype for MeerKAT), and later MeerKAT. He was very patient with the team. He would have an answer to any question, or know how to find out. He served as the science lead for KAT-7 operations and was instrumental in the publication of several papers using this instrument.

He was a mentor and friend to many in the project. He loved to teach, and his enthusiasm for astronomy was inspiring. We shall miss his laughter, quick wit and cheerful disposition. Our lives are richer for having known him.

News Note: Ultra-sensitive radio images reveal thousands of star-forming galaxies in early Universe

An international team of astronomers has published the most sensitive images of the Universe ever taken at low radio frequencies, using the International Low Frequency Array (LOFAR).

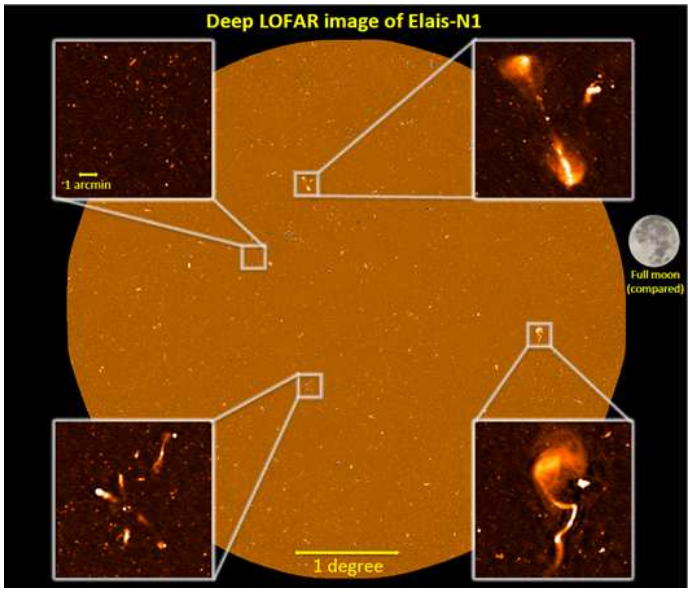

Fig 1. This image shows the deepest LOFAR image ever made, in the region of sky known as 'Elais-N1', which is one of the three fields studied as part of this deep radio survey. The image arises from a single LOFAR pointing observed repeatedly for a total of 164 hours. Over 80,000 radio sources are detected; this includes some spectacular large-scale emission arising from massive black holes, but most sources are distant galaxies like the Milky Way, forming their stars.

The software needed to do this, specifically that which handles the direction-dependent effects that would otherwise contaminate the images, goes back to the work of a former Rhodes University Postdoc Dr Cyril Tasse, who remains an honorary research associate of the University, and Prof. Oleg Smirnov, SKA (Square Kilometre Array) Chair in Radio Astronomy Techniques and Technologies at Rhodes University and Head of the Radio Astronomy Research Group at SARAO.

By observing the same regions of sky over and over again and combining the data to make a single very-long exposure image, the international team has detected the faint radio glow of stars exploding as supernovae, in tens of thousands of galaxies out to the most distant parts of the Universe. A special issue of the scientific journal *Astronomy & Astrophysics* is dedicated to 14 research papers describing these images and the first scientific results.

"At LOFAR frequencies, observing the sky is like lying on the bottom of a swimming pool looking up, trying to make out patterns on the ceiling through the choppy water (the "water" being the ionosphere). Some very clever software was required to achieve this," said Prof. Smirnov

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A collaboration between the two academics led to a paper describing the maths (Smirnov & Tasse 2015, MNRAS), and to the DDFacet/killMS software packages that Dr Tasse led the development of over the years. These packages are now at the heart of LOFAR data processing

“We quickly realised the same software can also be used to make MeerKAT images better, and several young researchers from Rhodes University and SARAO also became involved in this project with Dr Tasse,” explained Prof. Smirnov.

According to Prof. Philip Best from the University of Edinburgh, UK, who led the deep survey, “When we look at the sky with a radio telescope, the brightest objects we see are produced by massive black holes at the centre of galaxies. However, our images are so deep that most of the objects in it are galaxies like our own Milky Way, which emit faint radio waves that trace their on-going star-formation.”

"The combination of the high sensitivity of LOFAR and the wide area of sky covered by our survey – about 300 times the size of the full moon – has enabled us to detect tens of thousands of galaxies like the Milky Way, far out into the distant Universe. The light from these galaxies has been travelling for billions of years to reach the Earth; this means that we see the galaxies as they were billions of years ago, back when they were forming most of their stars."

Dr Isabella Prandoni of INAF Bologna, Italy added: "Star formation is usually enshrouded in dust, which obscures our view when we look with optical telescopes. But radio waves penetrate the dust, so with LOFAR we obtain a complete picture of their star-formation." The deep LOFAR images have led to a new relation between a galaxy’s radio emission and the rate at which it is forming stars, and a more accurate measurement of the number of new stars being formed in the young Universe.

The remarkable dataset has enabled a wide range of additional scientific studies, ranging from the nature of the spectacular jets of radio emission produced by massive black holes, to that arising from collisions of huge clusters of galaxies. It has also thrown up unexpected results. For example, by comparing the repeated observations, the researchers searched for objects that change in radio brightness. This resulted in the detection of the red dwarf star CR Draconis. Dr Joe Callingham of Leiden University and ASTRON, noted that "CR Draconis shows bursts of radio emission that strongly resemble those from Jupiter, and may be driven by the interaction of the star with a previously unknown planet, or because the star is rotating extremely quickly."

LOFAR does not directly produce maps of the sky; instead the signals from more than 70 000 antennas must be combined. To produce these deep pictures, more than 4 petabytes of raw data - equivalent to about a million DVDs – were taken and

processed. "The deep radio images of our Universe are diffusely hidden, deep inside the vast amount of data that LOFAR has observed," said Dr Tasse, who is currently based at Paris Observatory, France. “Recent mathematical advances made it possible to extract these, using large clusters of computers.”
"LOFAR is unique in its ability to make high-quality images of the sky at metre-wavelengths,” said Prof. Huub Röttgering of Leiden University, who is leading the overall suite of LOFAR surveys. “These deep field images are a testament to its capabilities and a treasure trove for future discoveries."

Looking ahead, Prof. Smirnov concluded, "I'm very excited to see what we find when we keep applying the same techniques to MeerKAT, which is an even more sensitive telescope, and will show us even more. The depth and breadth of the window on the Universe that these observations open up is simply unprecedented, so we can expect waves of exciting new results going forward."
[From NRF/SARAO Press Release 7 April. 2021]

News note: Flares of Proxima Cen

Proxima Cen has long been known to be a flare star - since 1949 - when Thackeray reported in *MNASSA* that its emission lines had brightened on July 4 that year (Thackeray 1950 a,b). His first paper was a brief report but a formal one was soon written. He used a very simple prismatic Newtonian spectrograph with an F/1 Schmidt camera attached to the 1.9m Radcliffe telescope in Pretoria, in the blue-visible part of the spectrum. He compared nine spectra of Proxima and found considerable variations in the emission lines. Ca+, H & K lines were seen on 5 of the 9 spectra. On 4 July 1949 “…. Hβ, Hγ, Hδ, Hε+H, K, Hζ and possibly two further Balmer lines appear bright, whereas on the other spectra Hγ, K and K were usually the only bright lines detected.” He went on to report that 58 plates of Proxima taken at the Cape for parallax measurements showed no evidence of variations greater than 10%, though the possibility of variations of about 0.2 mag lasting less than an hour could not be excluded.

This discovery was followed up by Shapley (1954) using 113 plates taken over 29 nights at Boyden in Bloemfontein. B magnitudes varied from 13.4 to 12.5.

Many observations of Proxima’s flare star nature have been made since. Most recently, MacGregor et al (2021) have reported observations of a spectacular flare from Proxima from millimetre waves to far Ultraviolet, brightening by factors of >1000 and >14000 respectively, with a duration of <10 secs. Interestingly, the slightly delayed corresponding optical flare was only 0.9%.

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Given the speculation about a potentially Earth-mass planet with a temperature of ~230K at 0.05 AU from Proxima and another more massive one at ~1.5 AU, these results emphasize how hostile and unsuitable for life their environment is likely to be.

MacGregor, M. et al., 2021. arXiv:2104.09519v1; 2021, *Ap. J. L.*, **911,** L25.
Shapley, H., *A.J*., 1954. *59*, 118.
Thackeray, A.D., 1950a. *MNASSA,* **9**, 9.
Thackeray, A.D., 1950b. *MNRAS*, **110,** 45.

News Note: The Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX)

Fig 1. Artist's impression of the completed HIRAX array.

The Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) will be a compact radio telescope array of 1024 six-metre dishes. This large interferometer array is located on the SKA SA site in the Karoo and will map about a third of the sky during its 4 years of observation. This experiment will conduct ground-breaking science, including the cutting-edge fields of dark energy and fast radio bursts (FRBs). In addition, the project will work with industry to develop important technology, such as telescope hardware and big data analysis tools, and provide students with the skills needed for the new era of radio astronomy in South Africa. The experiment is managed by the University of KwaZulu-Natal (UKZN) and is the result of a large global collaboration between many local, national and international institutions. Funding support for the project is provided by the National Research Foundation and UKZN.

Dark energy makes up more than two-thirds of the total energy budget of the Universe and is driving the accelerated expansion of the Universe. HIRAX will allow us

to gain new insights into the properties of dark energy by measuring the evolution of the dark energy equation-of-state (the ratio of its pressure to its energy density).

HIRAX will study dark energy by using hydrogen intensity mapping between 400 and 800 MHz. The instrument will measure the distribution of hydrogen using baryon acoustic oscillations (BAO). BAOs are remnant ripples in the distribution of matter created by primordial sound waves that existed in the early universe. By studying this distribution, HIRAX will be able to determine the characteristics of dark energy during a critical period in our universe, between 7 – 11 billion years ago when dark energy became the prominent force in the universe causing it to expand at an accelerated rate.

FRBs are mysterious, bright, millisecond flashes observed in the radio portion of the electromagnetic spectrum. They are difficult to detect because they are so brief and most telescopes only have instantaneous coverage of a small region of the sky. HIRAX is designed to detect and catalogue tens of thousands of these bursts, and with outrigger stations in partner African countries, the experiment will localize these bursts with remarkable precision within their host galaxies. HIRAX will detect FRBs by taking advantage of the dispersion of these bright flashes to distinguish them from other astronomical sources and radio interference. HIRAX is expected to see up to a dozen FRBs a day, while currently only a few hundred in total have ever been observed.

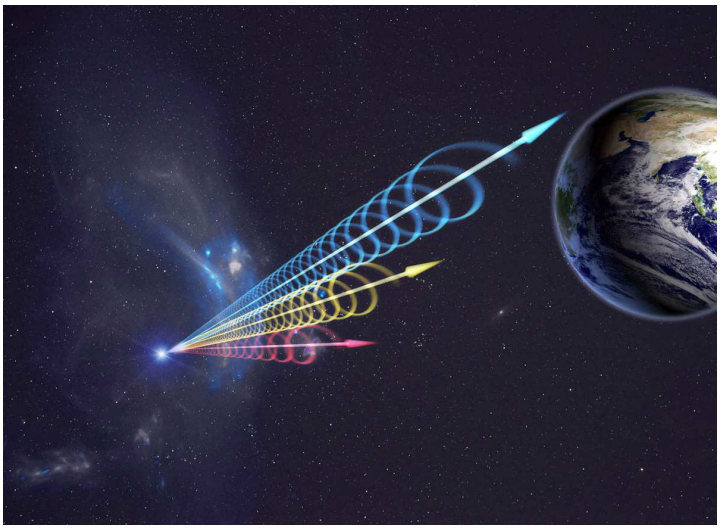

Fig 2. Artist's impression of a Fast Radio Burst reaching Earth. Dispersion causes the long wavelengths (red) to arrive several seconds after the short wavelengths (blue) Credit: Jingchuan You, Beijing Planetarium.

Once built, the project expects several significant research findings. HIRAX must first detect the brightness of the cosmological HI signal by separating it, using sophisticated data analysis algorithms, from the much larger signal coming from our own galaxy. Direct detection of the HI brightness signal is yet to be achieved due to the extreme precision required. Following such a detection, only then can HIRAX measure the BAO signal and set constraints on the evolution of dark energy.

HIRAX is working with many local, national and international partners on this word-class radio experiment. HIRAX is led by UKZN, hosted as a guest instrument by the

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South African Radio Astronomy Observatory. UKZN is managing the project on behalf of all partners, which in addition to SARAO, includes five additional South African institutions, the African Institute for Mathematical Sciences, Durban University of Technology, Rhodes University, University of Cape Town, and the University of Western Cape. In addition to the South African partners, HIRAX has 17 international partners who provide significant financial and in-kind contributions to the HIRAX project. They are McGill University, ETH-Zurich, University of Geneva, EPFL, West Virginia University, Botswana International University of Technology, Laboratoire Astroparticule & Cosmologie at the University of Paris, University of British Columbia, Canadian Institute for Theoretical Astrophysics, University of Oxford, University of Toronto, the Inter-University Centre for Astronomy and Astrophysics in India, University of Wisconsin
Madison, Perimeter Institute in Canada, Carnegie Mellon University, Stellenbosch University, NASA Jet Propulsion Laboratory, and Yale University.

The Department of Science and Innovation (DSI) and National Research Foundation (NRF) have awarded R35-million to the HIRAX project, which will enable the formation of a 256-dish interferometer array, with the dishes closely packed together. The array could, in future, be expanded to 1 024 dishes. The money from the DSI and NRF will be used to fund the telescope dishes, feeds, the radio frequency over fibre system and some of the backend hardware. This contribution represents a significant investment in the overall HIRAX project which is jointly funded by UKZN, DSI and the NRF.

HIRAX consortium partners are also contributing financially towards the project. The consortium will ensure that all necessary operations and maintenance costs are covered. Internationally, the HIRAX project has secured funding via its partners, ETH-Zurich and Geneva, who have been awarded a Swiss FLARE grant to develop the X-engine subsystem. ETH-Zurich and Geneva, together with EPFL, recently secured a second Swiss FLARE grant for the science data processing digital backend. McGill will provide the F-engine subsystem for the HIRAX 256-array digital backend.

HIRAX complements the current scientific landscape in South Africa. The experiment will provide high-level training to future astronomers for the Square Kilometre Array (SKA) era. HIRAX will significantly enhance South Africa's investment in radio astronomy through its synergies with other projects such as MeerKAT. For example, HIRAX and MeerKAT have complementary frequency ranges, providing increased potential for understanding FRBs and the discovery of pulsars. It will also provide unprecedented multi-wavelength astronomy by overlapping surveys from the Rubin Observatory’s Legacy Survey of Space and Time and the Simons Observatory, which are large international astronomy projects that have South African participation.

Students will have the opportunity to work with industry to develop important technology, such as telescope hardware and big data analysis tools. The experiment supports internationalization through its large global collaboration. Students have the opportunity to engage with HIRAX international partners to increase collaboration, networking and learning that will propel them throughout their career. The success of the HIRAX project will be a game-changer in terms of international scientific impact and reputation of the university through significant scientific output.

HIRAX will build on the existing excellence of radio astronomy and strengthen astronomy infrastructure in South Africa, linking many national and international facilities, and promoting South African astronomy research and development in a globally competitive framework. HIRAX will create significant socio-economic impact in South Africa by supporting human capital development and advancing innovation. The project will support human capital development through training researchers in highly specialized science and engineering skills, and will drive technological advances in collaboration with industry in areas such as Big Data.

HIRAX is a locally-led project with immense potential to contribute not only to the knowledge economy of our country but also to the understanding of our Universe on a global scale.

News Note: Radio astronomers discover 8 new millisecond pulsars

A group of astronomers has discovered 8 millisecond pulsars located within the dense clusters of stars, known as “globular clusters'', using South Africa’s MeerKAT radio telescope.

Millisecond pulsars are neutron stars, the most compact star known, that spin up to 700 times per second. This is the first pulsar discovery using the MeerKAT antennas and it comes from the synergic work of two international collaborations, TRAPUM and MeerTIME, with the findings detailed in a *Monthly Notices of the Royal Astronomical Society* paper published today.

Millisecond pulsars are extremely compact stars mainly made up of neutrons, and are amongst the most extreme objects in the universe: they pack hundreds of thousands of times the mass of the Earth in a sphere with a diameter of about 24 km; and spin at a rate of hundreds of rotations per second. They emit a beam of radio waves that are detected by the observer at every rotation, like a lighthouse. The formation of these objects is highly enhanced in the star-rich environments at the centres of globular clusters.

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“It is really exciting to see the potential for finding a large number of new millisecond pulsars in Globular Clusters using the excellent MeerKAT telescope.” says Professor Ben Stappers, from The University of Manchester and co-PI of the TRAPUM project. “It is also a preview of what will be possible with the Square Kilometre Array telescope for which MeerKAT is one of the precursors.”

Lead author, Alessandro Ridolfi, a post-doctoral research fellow at INAF and MPIfR said: “We directed the MeerKAT antennas toward 9 globular clusters, and we discovered new pulsars in 6 of them!” Five of these new pulsars orbit around another star, and one of these, named PSR J1823-3021G, is particularly interesting: “Because of its highly elliptical orbit, and massive companion, this system is likely the result of an exchange of partners: following a 'close encounter': the original partner was expelled and replaced by a new companion star", continues Ridolfi.

“*It is really exciting to see the potential for finding a large number of new millisecond pulsars in Globular Clusters using the excellent MeerKAT telescope. It is also a preview of what will be possible with the Square Kilometre Array telescope for which MeerKAT is one of the precursors.” Professor Stappers*

Tasha Gautam, doctoral researcher at the MPIfR in Bonn and co-author of the paper, explains: “This particular pulsar could have a high mass, more than 2 times the mass of the Sun, or it could be the first confirmed system formed by a millisecond pulsar and a neutron star. If confirmed by current additional observations, this would make this millisecond pulsar a formidable laboratory for studying fundamental physics“.

The 8 new pulsars are just the tip of the iceberg: the observations that led to their discovery used only about 40 of the MeerKAT 64 antennas and focused only on the central regions of the globular clusters.

The TRAPUM collaboration (the TRAnsients and PUlsars with MeerKAT) is one of several Large Survey Proposals (LSP) approved to use the MeerKAT telescope. It is co-led by Professor Stappers from The University of Manchester and and Professor Kramer (MPIfR/UoM). TRAPUM will search the sky for pulsars and transients using the extremely high sensitivity of MeerKAT. One of the places they will search are Globular Clusters. This result was obtained in collaboration with MeerTIME, another MeerKAT LSP, and used their infrastructure for capturing the data.

This work also served as a testbed for the TRAPUM collaboration to better plan the fully-fledged globular cluster pulsar survey, which is currently underway and which makes use of all the current 64 dishes (thus further gaining in sensitivity). The survey will broaden the search to many more globular clusters, and will also survey their outer regions.

Operated by SARAO, MeerKAT is the largest radio telescope in the Southern hemisphere and one of two SKA Observatory precursor instruments in South Africa. Located in the Karoo desert, the radio telescope will soon be expanded with an additional 20 dishes, bringing the total number of antennas up to 84 and becoming "MeerKAT+".

TRAPUM is one of the Large Survey Proposals running on MeerKAT and is an international collaboration, led by The University of Manchester and the MPIfR, and includes institutions such as INAF, the National Radio Astronomy Observatory (NRAO) and the South African Radio Astronomy Observatory (SARAO).

MeerTIME is also a Large Survey Proposal running on MeerKAT, led by the Swinburne University of Technology, and integrating several Australian institutions as well as INAF, University of Manchester, MPIfR, NRAO and SARAO.

[From a press release]

News Note: The Botswana super-bolide and meteorites from asteroid 2018 LA

Tim Cooper (ASSA)

Abstract: Almost three years since the entry of asteroid 2018 LA into the atmosphere over Botswana on June 2, 2018, the scientific results generated by sixty-six authors, collectively known as the '2018 LA Consortium', and after an in-depth analysis of the recovered meteorites from 2018 LA, are now out in an article in *Meteoritics and Planetary Science.*

Fig 1. Meteorite MP-19, found by Tim Cooper in Central Kalahari Game Reserve on October 12, 2018. Image courtesy Dr Peter Jenniskens.

Discovered just a few hours earlier, asteroid 2018 LA entered earth's atmosphere at 16h44 UT, and resulted in a bolide which reached magnitude 23 during its disruption at an altitude of 27.8 km. The resultant explosion deposited meteorites over a strewn field located in the northern part of the Central Kalahari Game Reserve (CKGR) in Botswana. Several videos were

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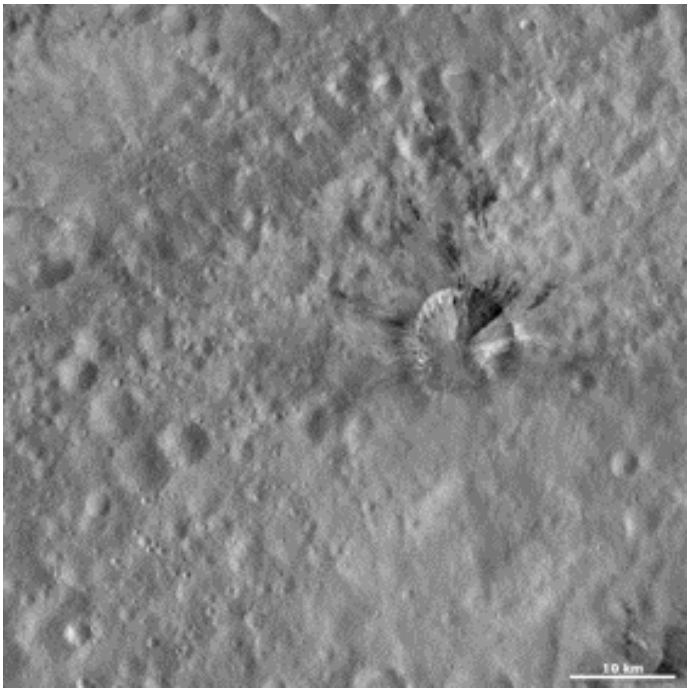
secured which captured the visible passage of the bolide, including the bright explosion, which enabled a precise determination of the location at which the disruption occurred.

ASSA's Tim Cooper calibrated videos of the bolide to help determine the location of the strewn field and also calibrated the footage which enabled photometry and subsequently the construction of the light curve of the meteor. An initial search during June 18-23, 2018 found one meteorite (MP-01), now referred to as Motopi Pan.

Fig 2. The screen grabs at right show the passage as seen from a commercial property in Gaborone just prior to the disruption of the meteor. Screen grabs of the bolide from a security camera in Gaborone. Images reproduced with kind permission of Beverly Lombard.

Following revised astrometry, a new search was mounted with a team comprising members from the Botswana Geophysics Institute, Okavango Research Institute, Department of National Museum and Monuments (Botswana), the Department of Wildlife & National Parks, the Astronomical Society of Southern Africa (ASSA) and under the guidance of meteor astronomer Dr Peter Jenniskens from the SETI Institute. The search during October 9-12, 2018 found an additional 22 fragments of asteroid 2018 LA, all collectively known as Motopi Pan, and including fragment MP-19 (image top left) found by Tim Cooper on October 12, 2018. The discovery of these fragments now enabled a complete characterisation of the meteorites from asteroid 2018 LA, and determination of its origin in the solar system.

Following extensive analysis using multiple techniques, these show the Motopi Pan meteorite to be a HED polymict breccia derived from howardite, eucrite, and diogenite lithologies.



F*ig 3. (Left) Rubria Crater on asteroid 4 Vesta, probable source of the meteorites from 2018 LA.*
Image credit:
NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

The findings and pre-atmospheric orbit are consistent with an origin for Motopi Pan at asteroid 4 Vesta, possibly from the 10 km crater Rubria (left image) during an impact ~22 Ma ago.

The full scientific results and findings can be found in the *Meteoritics and Planetary Science* article. The full story of the appearance of the bolide, eye-witness accounts, analysis of video footage to determine the strewn field location, measurement of the brightness of the meteor, and the October 2018 search for meteorites from asteroid 2018 LA will appear in the June issue of MNASSA.

Fig 4. Members of the October 2018 search team which found an additional 22 fragments of the Motopi Pan meteorite. Standing left to right Tim Cooper (ASSA), Oliver Moses (ORI), Mohutsiwe Gabadirwe (BGI), Thebe Kemosedile (ORI), Sarah Tsenene (DWNP), Kabelo Dikole (BGI), Mosarwa Babutsi (Botswana National Museum, Gaborone), kneeling Kagiso Kgetse (DWNP) and Peter Jenniskens (SETI Institute). ASSA = Astronomical Society of Southern Africa, BGI = Botswana Geoscience Institute, ORI = Okavango Research Institute of the University of Botswana at Maun, DWNP = Department of Wildlife and National Parks. Photo by team member Odirile Sempho.

Editor's Note: From a press release. The full article will appear in the June issue of *MNASSA*

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Asteroid that hit Botswana in 2018 likely came from Vesta

Rebecca McDonald
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An international team of researchers searched for pieces of a small asteroid tracked in space and then observed to impact Botswana on June 2, 2018. Guided by SETI Institute meteor astronomer Peter Jenniskens, they found 23 meteorites deep inside the Central Kalahari Game Reserve and now have published their findings online in the journal *Meteoritics and Planetary Science*.

Fig 1. Mohutsiwa Gabadirwe (centre of photo), Peter Jenniskens (left, kneeling) and between them, Tim Cooper, ASSA, pointing at the site of the second find of a piece of asteroid 2018 LA recovered in the Central Kalahari Game Reserve in central Botswana.

The Asteroid

The small asteroid that impacted Botswana, called 2018 LA, was first spotted by the University of Arizona's Catalina Sky Survey as a faint point of light moving among the stars. The Catalina Sky Survey searches for Earth-crossing asteroids as part of NASA's Planetary Defence program.

"Small meter-sized asteroids are no danger to us, but they hone our skills in detecting approaching asteroids," said Eric Christensen, director of the Catalina Sky Survey program.

The team recovered archival data from the SkyMapper Southern Survey program in Australia that showed the asteroid spinning in space, rotating once every 4 minutes, alternatingly presenting a broad and a narrow side to us while reflecting the sunlight.

On its journey to Earth, cosmic rays bombarded the asteroid and created radioactive isotopes. By analysing those isotopes, the researchers determined that 2018 LA was a solid rock about 1.5 m in size, which reflected about 25% of sunlight.

The Recovery

"This is only the second time we have spotted an asteroid in space before it hit Earth over land," said Jenniskens. "The first was asteroid 2008 TC3 in Sudan ten years earlier." Jenniskens also guided the search for fragments of 2008 TC3.

This time, fewer observations led to more uncertainty in the asteroid's position in its orbit. Davide Farnocchia of NASA JPL's Center for Near-Earth Object Studies combined astronomical observations of the asteroid with US Government Satellite data of the fireball to calculate the fall area. Esko Lyytinen of the Ursa Finnish Fireball Network made a parallel effort.

"When Jenniskens first arrived in Maun, he needed our help narrowing down the fall area," says Oliver Moses of the Okavango Research Institute. "We subsequently tracked down more video records in Rakops and Maun and were able to triangulate the position of the fireball."

After confirming the fall area, Moses and Jenniskens joined geologist Alexander Proyer of the Botswana International University of Science and Technology (BIUST) in Palapye and geoscientist Mohutsiwa Gabadirwe of the Botswana Geoscience Institute (BGI) in Lobatse and their colleagues to search for the meteorites.

"On the fifth day, our last day of searching, Lesedi Seitshiro of BIUST found the first meteorite only 30 meters from camp," said Jenniskens. "It was 18 grams and about 3 cm in size."

The search area was in the Central Kalahari Game Reserve, home to diverse wildlife, including leopards and lions. Researchers were kept safe by the staff of the Botswana Department of Wildlife and National Parks. BGI coordinated the search with the Department of National Museum and Monuments in Botswana.

"The meteorite is named 'Motopi Pan' after a local watering hole," said Gabadirwe, now the curator of this rare sample of an asteroid observed in space before impacting Earth. "This meteorite is a national treasure of Botswana."

The meteorite type

Non-destructive analysis at the University of Helsinki, Finland, showed that Motopi Pan belongs to the group of Howardite-Eucrite-Diogenite (HED) meteorites, known to have likely originated from the giant asteroid Vesta, which was recently studied in detail by NASA's DAWN mission.

"We managed to measure metal content as well as secure a reflectance spectrum and X-ray elemental analysis from a thinly crusted part of the exposed meteorite interior," said Tomas Kohout of the University of Helsinki. "All the measurements added well together and pointed to values typical for HED type meteorites."

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Dynamical studies show that the orbit of 2018 LA is consistent with an origin from the inner part of the asteroid belt where Vesta is located. The asteroid was delivered into an Earth-impacting orbit via the resonance situated in the asteroid belt's inner side.

"Another HED meteorite fall we investigated in Turkey in 2015, called Sariçiçek, impacted on a similarly short orbit and produced mostly smallish 2 to 5-gram meteorites," said Jenniskens.

When Jenniskens returned to Botswana in October of 2018, the team found 22 more small meteorites. Gabadirwe was the first to spot another out-of-this-world rock. Surprisingly, subsequent meteorite finds showed a lot of diversity in their outward appearance

"We studied the petrography and mineral chemistry of five of these meteorites and confirmed that they belong to the HED group," said Roger Gibson of Witts University in Johannesburg, South Africa. "Overall, we classified the material that asteroid 2018 LA contained as being Howardite, but some individual fragments had more affinity to Diogenites and Eucrites."

Other studies also confirmed the surprising diversity of the team's finds, such as reflection spectroscopy and the content of polyaromatic hydrocarbons in the sample. The asteroid was a breccia, a mixture of cemented rock pieces from different parts on Vesta.

Origin of the meteorites

A previous hypothesis proposed that Sariçiçek originated from Vesta in the collision that created the Antonia impact crater imaged by DAWN. Still showing a visible ejecta blanket, that young crater was formed about 22 million years ago. One-third of all HED meteorites that fall on Earth were ejected 22 million years ago. Did Motopi Pan originate from the same crater?

"Noble gas isotopes measurements at ETH in Zürich, Switzerland, and radioactive isotopes measured at Purdue University showed that this meteorite too had been in space as a small object for about 23 million years," said Kees Welten of UC Berkeley, "but give or take 4 million years, so it could be from the same source crater on Vesta."

Researchers found Motopi Pan and Sariçiçek to be similar in some ways but different in others. Like Motopi Pan, Sariçiçek exploded at 27.8 km altitude, but produced less light in that breakup.

"The infrasound shockwave measured in South Africa was not as strong as expected from US Government sensor detections of the bright light," said Peter Brown of the University of Western Ontario, Canada.

From lead isotopes in zircon minerals, researchers found that both Sariçiçek and Motopi Pan solidified at Vesta's surface about 4563 million years ago. But phosphate grains in Motopi Pan experienced another melting event more recently. Sariçiçek did not.

"About 4234 million years ago, the material in Motopi Pan was close to the centre of a large impact event," said Qing-zhu Yin of UC Davis, "Sariçiçek was not."

Vesta experienced two significant impact events that created the Rheasilvia impact basin and the underlying, and therefore older, Veneneia impact basin.

"We now suspect that Motopi Pan was heated by the Veneneia impact, while the subsequent Rheasilvia impact scattered this material around," said Jenniskens. " If so, that would date the Veneneia impact to about 4234 million years ago. On top of Rheasilvia impact ejecta is the 10.3-km diameter Rubria impact crater, slightly smaller than the 16.7-km Antonia crater, and slightly younger at 19 +/- 3 million years, but a good candidate for the origin crater of Motopi Pan."

Fig 2. Fragment of asteroid 2018 LA recovered in Central Kalahari Game Reserve in central Botswana.

In November 2020, an expedition led by Fulvio Franchi from BIUST discovered one more Motopi Pan meteorite. This 92-gram meteorite is now the largest fragment of asteroid 2018 LA recovered to date and another small piece of the giant asteroid Vesta.

Links:
The manuscript is available at: https://onlinelibrary.wiley.com/journal/19455100
Link to pdf of poster:
https://www.seti.org/sites/default/files/2021-04/Poster-Jenniskens-PDC2021-Asteroid2018LA.pdf
2018 report on the first meteorite find:
https://www.seti.org/press-release/fragment-impacting-asteroid-recovered-botswana-0

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NASA Juno spacecraft new views of Clyde's Spot on Jupiter.

Clyde Foster: Director of Shallow Sky Section, ASSA

Just over ten and a half months ago, on 31 May 2020, the author was fortunate to image a new, convective storm erupting at high altitude in Jupiter's atmosphere. Two days later, NASA's Juno spacecraft, on its PJ27 flyby, swooped low over the cloud tops capturing amazing views of the new storm. The outbreak would become known in the amateur and professional planetary community as "Clyde's spot", and the subsequent NASA press release attracted substantial media attention.

In the period since, the storm system has continued to be observed and tracked by amateur planetary imagers as well as the professional planetary science community utilising resources such as Hubble Space Telescope, NASA Infra-Red Telescope Facility (IRTF) and PlanetCam and has shown various changes. Most importantly, given that with Jupiter's incredibly dynamic atmosphere many features are short lived, the storm system has survived and evolved. With the changes in nature of the feature, it has been given the more formal designation of DS7, although it is often still referred to as Clyde's Spot, or "The remnant of Clyde's Spot".

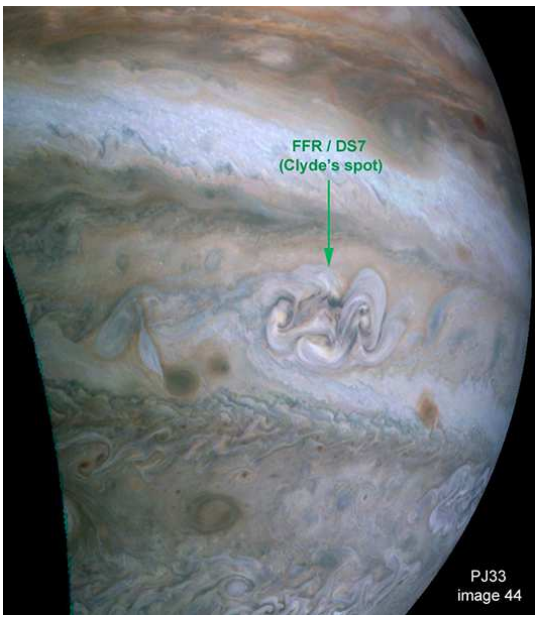

Fig 1. A stunning portrait view of the remnant of Clyde's Spot/DS7 processed by Kevin M Gill (Cr: NASA/JPL-Caltech/SwRI/MSSS/Kevin M. Gill)

On 15 April 2021, the orbital track of Juno, on its PJ33 flyby, once again saw the spacecraft sweep low over this region, and already remarkable, fascinating, and beautiful images, as we have come to expect from Juno, are being produced. The storm has taken on the structure of a Folded Filamentary Region (FFR), and indications from these images are that it may develop further. There is ongoing professional research being undertaken and these images will bring tremendous further insight into the development and evolution of what initiated as Clyde's Spot.

Fig 2. This image processed and annotated by John Rogers of the BAA, shows the feature in the context of the planet (Cr: NASA/JPL-Caltech/SwRI/MSSS/John Rogers).

The author wishes to thank his amateur colleagues in this field for their interest and support in tracking Clyde's Spot and its remnant, the professional planetary scientists that he is interacting with, and especially the NASA Juno mission team with whom he has had wonderful interaction since Juno arrived at Jupiter in 2016.

The Aristarchus-Coleridge hypothesis

Francis Thackeray
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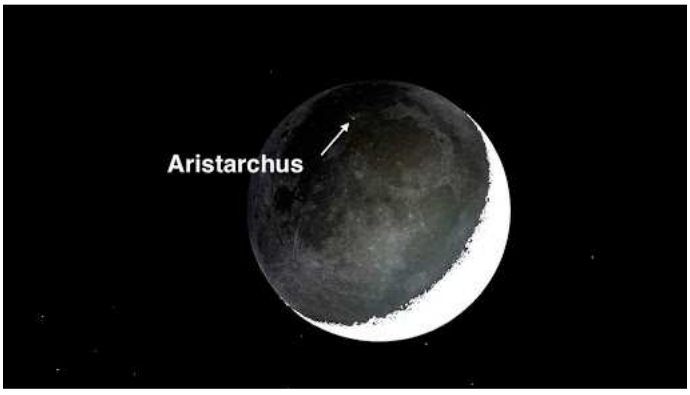
A bright lunar crater perceived as a star within tips of the waning crescent moon, rising above eastern horizon.

A celebrated poem by Samuel Taylor Coleridge is "The Rime of the Ancient Mariner". It refers to a crescent moon rising above the eastern horizon:

"*Till clomb [*climbing upwards*] above the eastern bar [*horizon*],*
the hornéd Moon with one bright star within the nether tip" ...

It has been discussed by Baum (2000) in attempts to explain the astronomical imagery, whether in terms of occultations of Venus or other phenomena. Baum refers to observations made by William Herschel who was surprised to see a bright object within the crescent Moon. The question arises as to whether Herschel happened to observe a "transient lunar phenomenon" (TLP).



Here I propose an alternative hypothesis regarding Coleridge's poem: that the bright "star" within the crescent arms of the Moon was a perception of the bright white (high albedo) Aristarchus crater, seen in earthshine. In terms of this Aristarchus-Coleridge Hypothesis, an eastern sighting of the crescent Moon, about an hour before sunrise, could explain the poetry, ***when Aristarchus was perceived as a star well within the crescent of the rising, waning moon*** (Fig. 2).

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I have composed my own prose-poetry to help explain this.

At 0.8' arc-minutes as seen from Earth,
the bright white “high albedo” Aristarchus lunar crater can be
illuminated by sunlight reflected from the Earth,
in earthshine, such that it may be perceived to be a star.
As a bright white crater,
with a diameter of 40 kilometres,
Aristarchus is at the naked-eye limit.
Some eyes are better than others.
On a cold crisp clear night, without pollution,
just before dawn,
with the waning Moon rising just above the eastern horizon of the sea,
the bright Aristarchus crater in earthshine is perceived as a bright star
within the crescent arms of the Moon,
best seen by ancient mariners when the Moon is
rising above the horizon of a calm early morning sea, just before dawn !

Perhaps this helps to explain Coleridge's poetry:
"*Till clomb [*climbing up*] above the eastern bar [*horizon*]*
the hornéd moon, with one bright star within the nether tip"…

I am grateful to Dr Peter Knox-Shaw for enthusiastic encouragement.

Baum, R. 2000. Samuel Taylor Coleridge and the Boston tradition. *Journal of the British Astronomical Association* 110, 1: 46-48.
http://articles.adsabs.harvard.edu//full/2000JBAA..110...46B/0000046.000.html

Lunar Anomalies

Case Rijsdijk

Symbolism

In view of Francis Thackeray’s brief, but interesting, article I feel sure that this could be the reason for the Islamic symbol of the Crescent Moon and Star. After all the skies in much of the Arabic world are very clear, and in those early days there was little light pollution, so the “star within the Moon” would have been easily visible.

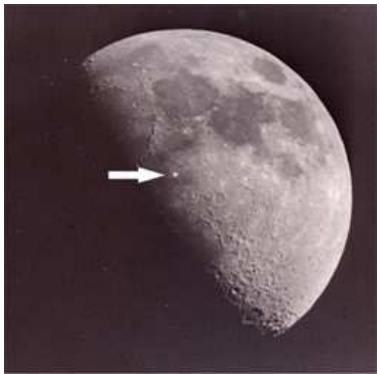


Fig 1. (right) Aristarchus clearly visible close to the Moon’s meridian

The star **might have been** a lunar transient phenomenon, LTP, its transience adding symbolism *Cr. Wikipedia*

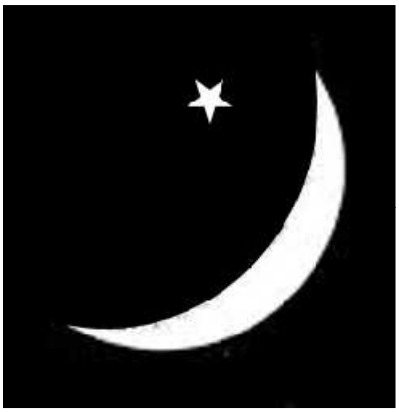


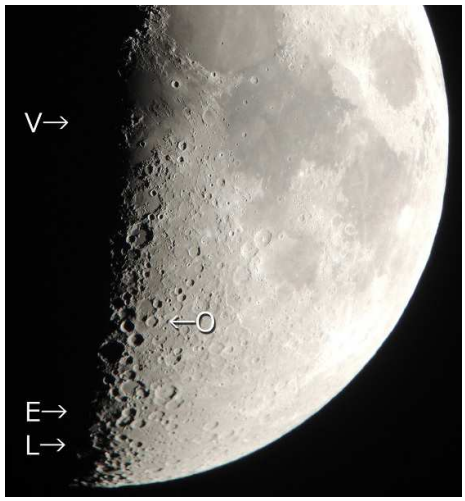
Fig 2. (left) An early image of the "Star and Crescent" that evolved into the modern version.

The crescent of the new Moon signifies the beginning and end of fasting during Ramadan. However, this symbol did not originate with Islam; it was adopted for the first time by the city of Byzantine (which later became Istanbul). *Cr. Wikipedia*

While the Ottoman Empire ruled the Muslim world, the star and crescent Moon was adopted as the symbol of Islam. However, not all Muslims consider the crescent and star to be an Islamic symbol

Lunar Anomalies

A group of amateur astronomers in the Ehime Prefecture of Shikoku Island, Japan has found lunar L-O-V-E and should understand that like the famous lunar X, also seen here, these lunar letters are transient. The image right is from APOD 3 November, 2018, where a HR image is available.



Maybe local ASSA members could repeat this as an exercise, and publish their efforts in MNASSA.

Fig 3. Some Lunar Transients making the word LOVE.

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Recent Southern Africa Fireball Observations Events # 386-395

Tim Cooper, Comet, Asteroid and Meteor Specialist, Shallow Sky Section

This article continues the sequential numbering of reported fireball sightings from southern Africa. By definition, a fireball is any meteor event with brightness equal to or greater than visual magnitude (m_v) –4. The following events were reported to the author and details are reproduced as given by the observer [any comments by the author are given in brackets]. All times were converted to UT unless stated, and all coordinates are for epoch J2000.0. Descent angles, if given, are in degrees, with directly upwards = 0°, horizontally left to right = 90°, directly downwards = 180° and horizontally right to left = 270°. Where the report originated from the American Meteor Society fireball page, the corresponding AMS Fireball Report number is given.

Event 386 – 2020 April 22 – Centurion, Gauteng
This fireball was observed in 2020, but the report was only received months later. Observed by Ally du Plooy at 00h10, duration 3-4 seconds, initially bright, but became brighter and larger, peaking brighter than a full moon, which was not visible at the time. Colours observed were white, yellow and blue, the tail becoming red, and left a persistent train visible for 1-2 seconds. Path from az/alt 280°, 38° to 300°, 27°, that is RA, Dec. 12h37, –08° to 12h35, 11°. The event was sporadic. AMS Fireball Report 8269-2020.

Event 387 – 2021 February 27 – Cape Farms, Western Cape
Observed by Karen Tardieu at 20h55, duration 1-2 seconds, while driving saw a bright white fireball ascending vertically from approximately altitude 20° to 45° in azimuth 70°, just to the right of and as bright as the moon, which was then 99% illuminated and magnitude –12.4, altitude 31° in azimuth 47°. The path probably originated just beyond the horizon in Boötes, passing through Virgo and terminated in the region of Crater/Corvus. The fireball left a persistent train which glowed for about 2 seconds. The event was sporadic. AMS Fireball Report 1180-2021.

Event 388 – 2021 February 27 – Onrus, Western Cape
Observed by Desre Dempsey at 21h00, she was in her car at the time, duration 3-4 seconds, green fireball with orange tail, path from az/alt 60°, 67° to 5°, 18° where it dropped below the mountains to the north. The coordinates of the path were from RA, Dec. 10h16, –21° to 09h12, 37°, path length 60°. No estimate of brightness given, or comparison with the almost-full moon, which was immediately below the fireball, magnitude –12.4, azimuth 46° and altitude 32°. AMS Fireball Report 1461-2021.

[Note: while Events 387 and 388 were seen from similar locations and within five minutes of each other, it was originally thought they might be one event. Further investigation confirmed however the directions were very different, and the two sightings are considered to be two separate fireballs.]

Event 389 – 2021 March 3 – Magaliesburg, Gauteng
Observed by Jurie Kupfer at 20h30, duration 7-8 seconds, as bright as the full moon, yellow orange fiery ball with a flaming tail. Slow moving, path from az/alt 80°, 11° to 104°, 11°. AMS Fireball Report 1774-2021

Event 390 – 2021 March 11 – Cape Town, Western Cape
Observed by Juandre Rushin at 19h10, m_v = –5, duration 3-4 seconds, colours blue and orange, persistent train visible for 2 seconds after the fireball suddenly disappeared. Path from 155°, 71° to 200°, 63°, that is RA, Dec. 08h32, –50° to 06h35, –58°. AMS Fireball Report 1533-2021.

Event 391 – 2021 March 19 – Amanzimtoti, KwaZulu Natal
Observed by Win Kloppers at 02h20, very clear red orange ball of fire which lit up the sky, and then suddenly disappeared without fragmentation or persistent train. Duration 1-2 seconds, from descriptions and sketches path determined approximately from az/alt 30°, 80° to 40°, 45°, that is RA, Dec. 16h30, –21° to 18h00. 6°, path length 34° from Scorpius through Ophiuchus. The event was sporadic.

Event 392 – 2021 March 19 – Harare, Zimbabwe
Observed by Kevin Shaw at 02h53, magnitude when first seen –3 to –4, brightening to –5, duration 7-8 seconds. Colour was initially white, becoming bright yellow/orange with white centre surrounded by orange/red. Split into several pieces of which most burned out quickly, but four continued until losing sight as they passed behind trees. The four fragments left a faint 'smoky' train visible briefly as they were burning out. Path from az/alt 166°, 15° to 142°, 15°, that is RA, Dec. 23h25, –76° to 22h39, –54°. The event was sporadic.

Event 393 – 2021 April 7 – Cape Town, Strand, Western Cape
Bright daytime fireball, seen about twenty minutes after sunrise. Observed by Schalk Keun and his six year old daughter Mia, time given as 05h26, duration 1-2 seconds, bright white fireball from az/alt 124°, 41° to 106°, 22°, that is RA, Dec. 00h00, –46° to 01h00, –25°. The fireball was also observed by Melvina Petersen who gave the time as about 05h20, driving in direction 126° she was stationary at the intersection of the N2 with Onverwacht Road when she saw a bright yellow/orange fireball, duration 1-2 seconds, path from az/alt 125°, 45° to 74°, 23°, that is RA, Dec. 23h30, –48° to 23h48, –01°. There is good agreement between Schalk and Melvina for the direction the fireball terminated, and the path was most probably in a northerly to north-westerly

direction across the southern Cape. The fact that the fireball occurred during bright daylight and above right of the sun probably accounts for the lack of more observations. AMS Fireball Report 2179-2021.

Event 394 – 2021 April 8 – Vanderbijlpark, Gauteng
Observed by Johann Wolmarans at 20h45, duration 4-5 seconds, colours noted were blue, red, and orange, and the tail appeared to be fragmenting. Johann waited for sounds but none were heard. Path from az/alt 275°, 41° to 270°, 18°, or RA, Dec. 08h22, –14° to 06h50, –08°, path length 22.6°. The path is probably consistent with the Anthelion radiant which is located around the constellation of Virgo around early April. AMS Fireball Report 2217-2021.

Event 395 – 2021 April 11 – Kariba, Zimbabwe
Observed by Mark Brightman at 16h24, the sun had not yet set and the fireball would easily have been missed had he not been looking in the direction at the time. Very fast, bright white, 'similar to the light of an arc welder', duration about 3 seconds and path from az/alt 135°, 30° descending vertically and disappearing behind the Matusadona Escarpment at 135°, 2° shortly after reaching peak brightness. The corresponding RA, Dec. is from 11h54, –47° to 14h33, –43°, and tracing the path backwards does not coincide with any known radiants.

Acknowledgements
Thanks to Kos Coronaios (ASSA Observing Director) for forwarding various reports from the public to the ASSA forums, and to Robert Lunsford (Secretary General of the IMO) for forwarding reports submitted to the American Meteor Society fireball webpage. Thanks also to Peter Morris for coordinating reports from Zimbabwe.

Webinars

Colloquia and Seminars used 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

With the advent of CV19, these Colloquia and Seminars are being presented to wider audiences via Zoom and other virtual platforms. The editor has started by identifying what would originally been "local" Colloquia and Seminars; not easy as there are now

Webinars on interesting topics from around the globe! In time we will either return to the traditional Colloquia and Seminars or many will become Hybrid session.

Webinar 4 **Title: Beyond the stars: good and bad ways to use our science training to make a better world.**
Speaker: Dr Federica Bianco (University of Delaware, US)
Time: 11:00 (SAST) on Thursday 25 March 2021

Abstract: Astrophysicists' claims to fame include practicing one of the oldest professions in the world and having invented data science. By necessity, astrophysicists work next to the data, observing rather than experimenting, and astrophysics taps on our innate curiosity to understand who we are and what is our place in the world that surrounds us. Because of this, those claims have some merits and the involvement of astrophysicists in social problems has a long history. However, reaching being your field can be controversial and complex, and today there is a divisive narrative that opposes "staying in your lane" to "using your skills for good". In this talk, I will share my experience at the interface of astrophysics, data science, and public policy and lessons learned about good and bad ways to use science and data skills to make a better world. I will talk about astrophysics, Urban Science, COVID-19, data ethics, and pedagogy.

Webinar: 5 Discovery of a long period binary in a pre-planetary nebula.
Speaker: Dr Rajeev Manick (SAAO, RSA)
11:00 (SAST) on Thursday 01 April 2021

Abstract: Current models predict that a binary nucleus is an essential ingredient in producing bipolar structures seen among pre-planetary nebulae (PPNe). Despite years of attempts to detect binaries in them, there has been a paucity of known binaries amongst PPNe.

In this talk, I will present our recent results on the discovery of a binary central star in the bipolar pre-planetary nebula: IRAS 08005-2356 (V510 Pup). We have used nearly 27 years of spectroscopic time series observations from SALT HRS, CTIO CHIRON and archival data to constrain an orbital period of 2608±121 d. Currently, this is the longest period binary in a PPN and arguably only the third known binary in a PPN after the Red Rectangle and HD101584.

The spectroscopic orbit is fit with an eccentricity of 0.36 ± 0.04 and is consistent with other long period post-AGB binaries and binary central stars of planetary nebulae (CSPNe). I will also present nearly 24 years of near-IR SAAO photometric time series, collected by Patricia Whitelock and colleagues, which varies with a period of ∼ 2750 ± 20 d and is within the limits of the orbital period derived from the radial velocities.

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Time resolved H-alpha profiles reveal high-velocity outflows (jets) with de-projected velocities up to 231 km/s seen at phases when the luminous primary is behind the jet-launching companion. The outflow is likely ejected due to accretion onto a main sequence companion of 0.63 ± 0.13 solar masses. Our results indicate that although PPNe are intrinsically rare objects, binarity might not be as rare in these systems and that their binary nature can be constrained using long term RV monitoring on larger telescopes.

Webinar 6 X-raying the Magellanic Clouds: A roadmap from XMM to eROSITA.
Speaker: Dr Chandreyee Maitra (Max-Planck Institute for Extraterrestrial Physics, Germany)
11:00 (SAST) on Thursday 08 April 2021

Abstract: The Magellanic Clouds are an ideal site to study X-ray source population of a galaxy including supernova remnants, high mass X-ray binaries (HMXBs) and super-soft sources. This is facilitated by their well-determined distances and low foreground absorption conducive for performing detailed studies. The population of HMXBs in the Magellanic Clouds is especially overabundant owing to the relatively recent star-formation history of these tidally interacting galaxies. However, only a small-fraction of the entire Magellanic Cloud System (which covers nearly 200 square degrees on the sky) was covered in the X-ray regime, until recently. eROSITA onboard SRG has now completed its first two all-sky surveys and has roughly doubled the number of X-ray sources discovered over the last 60 years history of X-ray astronomy. This has also allowed a complete coverage of the Magellanic Cloud system for the first time in X-rays (0.2-10 keV) with unprecedented sensitivity. The talk will present the X-ray source population of the Magellanic Clouds, especially HMXBs as studied from the XMM-Newton to the recent eROSITA all-sky surveys. Some unique discoveries including HMXBs found in their natal supernova remnants will also be discussed in this regard.

Webinar 7: **The G4Jy sample of AGN**
Speaker: Dr. Sarah White (SARAO/Rhodes University)
11:00 (SAST) on Thursday 22 April 2021

Abstract: Powerful active galactic nuclei (AGN) feature heavily in our understanding of galaxy evolution. However, when it comes to studying their properties as a function of redshift and/or environment, the most-detailed studies tend to be limited by small-number statistics. In this talk, I will present a new sample of ~2,000 of the brightest radio-sources in the southern sky (Dec. < 30 deg). These were observed at low radio-frequencies as part of the GaLactic and Extragalactic All-sky MWA (GLEAM) survey, conducted using the Murchison Widefield Array (MWA). This instrument is the precursor telescope for the low-frequency component of the Square Kilometre Array

(SKA), and allows us to select radio galaxies in an orientation-independent way (i.e. minimising the bias caused by Doppler boosting, inherent in high-frequency surveys). Being brighter than 4 Jy at 151 MHz, we refer to these objects as the GLEAM 4-Jy (G4Jy) Sample (White et al., 2020a, 2020b).

Following repeated visual inspection (using multi-wavelength information) and thorough checks against the literature, the G4Jy catalogue and overlays are publicly available (see https://github.com/svw26/G4Jy) and currently provide mid-infrared identifications for 86% of the sources. 140 G4Jy sources have been observed using Open Time on MeerKAT (Sejake et al., in prep.), and I will also describe follow-up using ATCA, the VLA, and SALT. With over 10 times as many sources as the best-studied, low-frequency radio-source sample that is optically complete (the revised Third Cambridge Catalogue of Radio Sources; 3CRR), the G4Jy Sample will allow models of powerful AGN to be tested more robustly.

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Streicher Asterisms 52-55

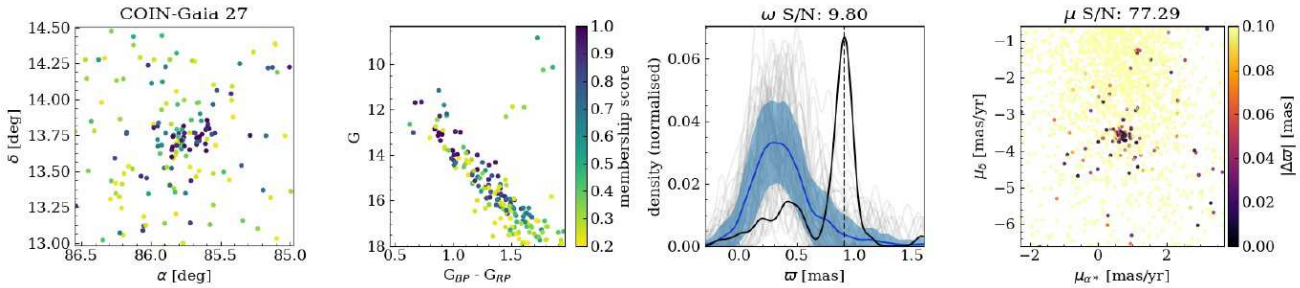
Magda Streicher

STREICHER 52 – DSH J0543.2+1344 – COIN-Gaia 27
Orion

Although this grouping of relatively brighter stars is not striking, it does stand out against the visible background star field. The main focus and bulk of the stars is elongated in an east to west direction. Fainter stars extend further south, mingle and falter away into the star field. Most of the stars in this grouping as seen through the telescope displays a slight yellow colour. The Gaia spacecraft was launched on 19 December 2013 to measure the precise astrometric, photometric and spectroscopic of parallaxes and proper motions of around 1.4 billion sources with a limiting magnitude of about 21 magnitude. The latest EDR3 was released on 3 December 2020 and stated this asterism to be an open cluster now listed as COIN-Gaia 27.

OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 52 DSH J0543.2+1344 COIN-Gaia 27	Asterism Cluster	05h43m.02	+13°44’.35	8.4	23.4’

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

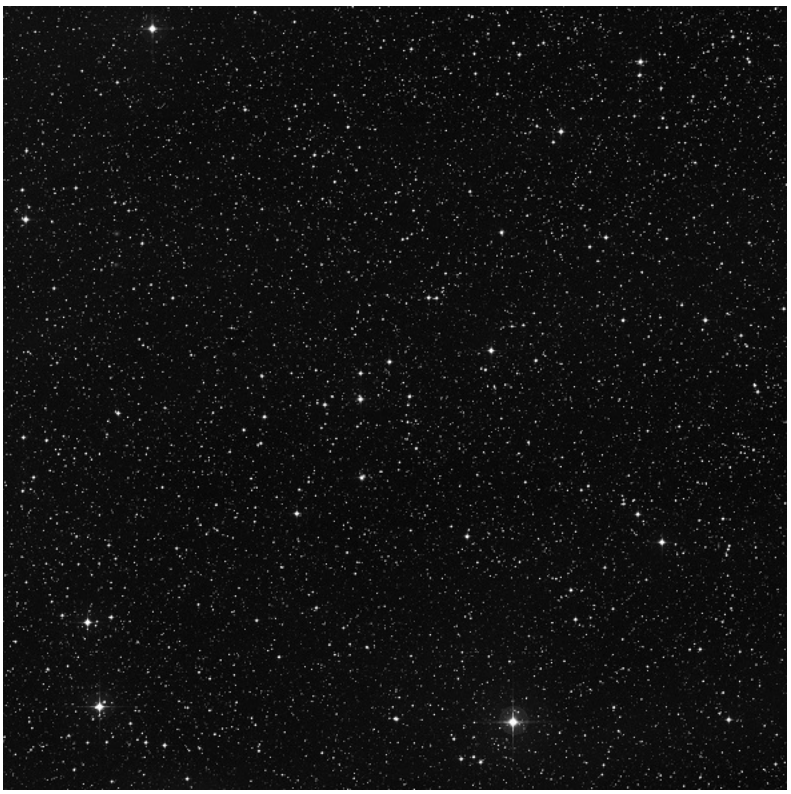


Coin-Gaia 27. For background and explanation please see: https://cosmostatistics-initiative.org/coin-gaia_ocs/

STREICHER 53 - DSH J1221.5-7627
Chameleon

In this very busy part of the starry skies, only a handful of stars can be lifted out against the fainter background stars. In a way not much of an asterism, although the first impression lets the eye of the beholder see it as a group of sorts. Averted vision lets it grow in size and appear to be standing out more. Towards the northern part, the star field is quite busy with very faint stars.

OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 53 DSH J1221.6-7627	Asterism	12h21m.36	-76°27’.00	11	20’



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

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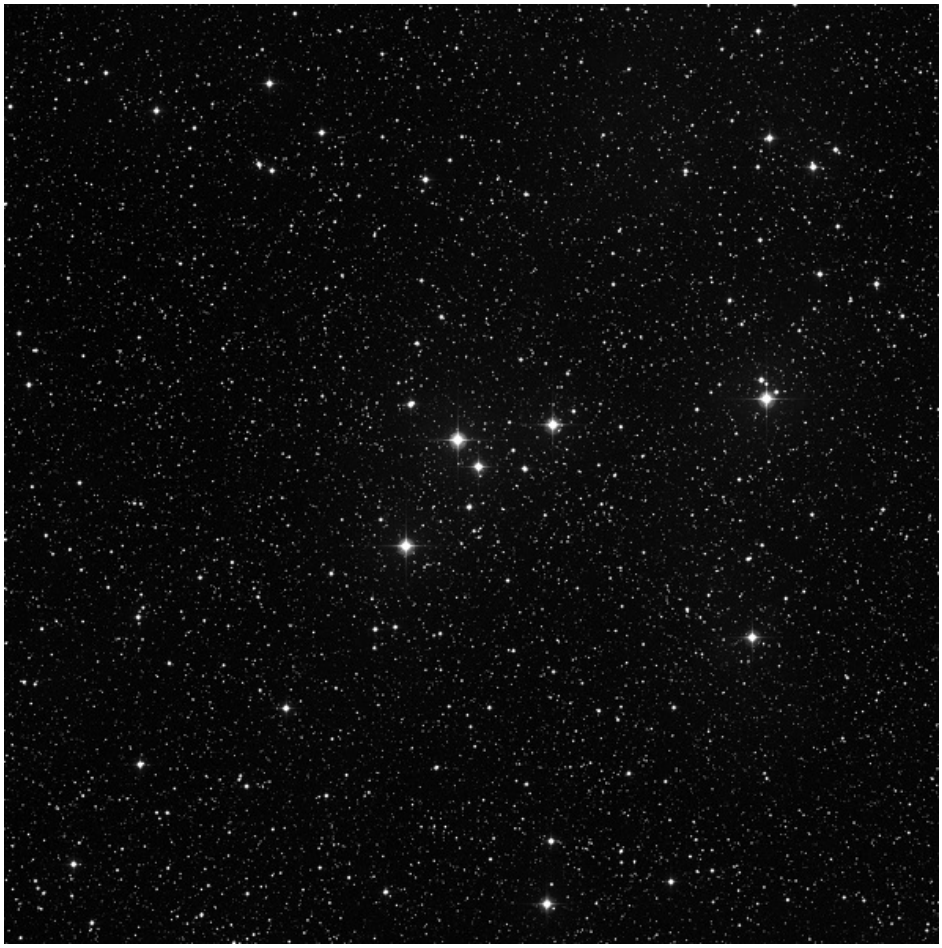
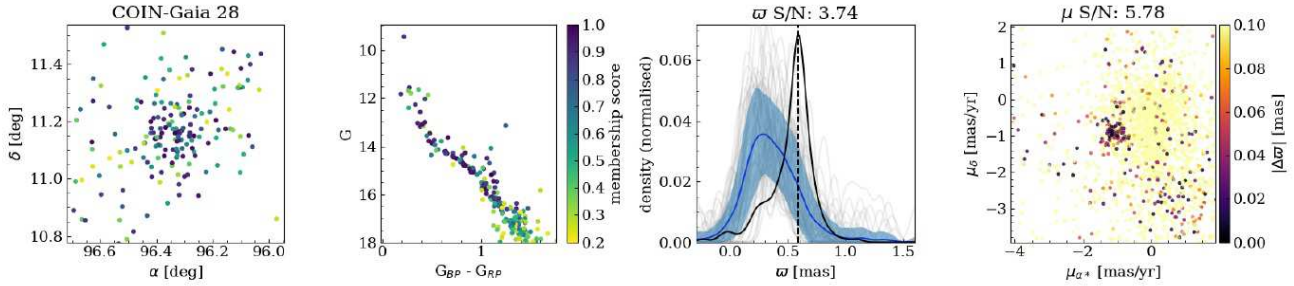
STREICHER 54 – DSH J0625.6+1111 – COIN-Gaia 28
Monoceros

A few nice bright stars clearly defined against a faint starry background. It reaches the target for being classified as a bright asterism intermingle with fainter members and it is a joy to find groupings like this. The surrounding area is rich in various nebulae and clusters. The southern brightest magnitude 6.3-star is listed as HD 45090. The Gaia spacecraft was launched on 19 December 2013 to measure the precise astrometric, photometric and spectroscopic of parallaxes and proper motions of around 1.4 billion sources with a limiting magnitude of about 21 magnitude. The latest EDR3 was released on 3 December 2020 and stated this asterism to be an open cluster now listed as COIN-Gaia 28.

OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 54 DSH J0625.6+1111 COIN-Gaia 28	Asterism	06h25m.38	+11°11’.24	8	18’



Picture Credit: http://archive.stsci.edu/cgi-bin/ds

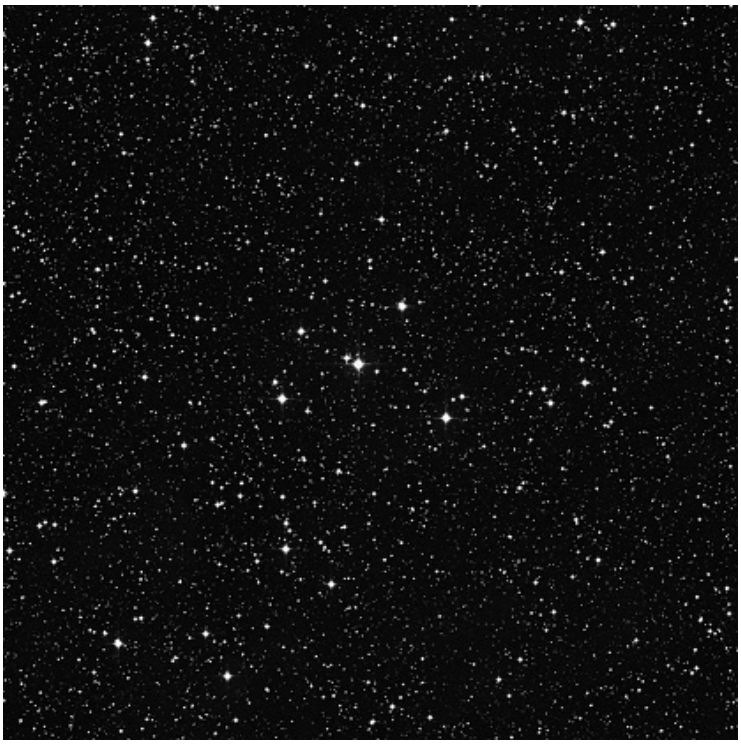


Coin-Gaia 28. For background and explanation please see: https://cosmostatistics-initiative.org/coin-gaia_ocs/

STREICHER 55 – DSH J0708.5+0027
Monoceros

Five relatively outstanding stars in a clear kite-shape of sorts. The heart of the shape consists of the brightest star magnitude 7.8, which has a very faint companion star to share this main spot. The background star field is scattered with faint stars. The planetary nebula NGC 2346 is situated only one degree south and the open cluster NGC 2324 a degree north-west.

OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 55 DSH J0708.5+0027	Asterism	07h08m.33	+00°27’.12	8	9’



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

Review: Cosmonauts do it in heaven *by Keith Gottschalk*

Published by: Hands-On Books, Cape Town, South Africa
Publication date: November 2020
ISBN: 9781928433132
Soft cover or eBook, 108 pages
Dimensions: 210 x 148mm

One date I'll not forget – 4 October 1957. I was thirteen years old at high school, hoping to learn about the wonders of science which we sort of did in primary school, but so far it was disappointing. Suddenly, Sputnik!

Keith Gottschalk is a poet who has a poem about Sputnik, and many other space and science-related things in his book *Cosmonauts do it in Heaven*. It's a compilation of some 70 poems written over 35 years, dedicated to scientists, inventors, engineers, astronauts and all progenitors of the 'Space Age'. And there are colour images, and a couple of the poems are translated into Chinese or Hebrew

"New Moon – 4 October 1957" sets the tone spot-on for how the world felt on that day – (night?)

"awed crowds stared skywards; on the fourth evening
the world wondered at a sight never before seen:

a new moon under a full moon."

And you'll also encounter "Glushko's 20 engines" – Valentin Glushko designed the Sputnik rocket. And Newton, who knew it would work 250 years in the future, of course.

Gottschalk's poems are an evocation of stuff we all know – and the background most of us have forgotten. Here you'll read and nod your head and say – yes, yes, I saw that on TV – and suddenly, a catch in the throat as you recall the terrible price some astronauts and cosmonauts paid for progress. And the inventors, engineers, scientists, mathematicians, computer coders who risked ridicule and even political persecution for their dreams. Thus:

"you, frailness of flesh & skin,
wrapped in only blueprints & hope…

…if all goes well, you shall fly
as a butterfly bolted to a bullet.
If not, your only grave shall be
Schlieren lines across a shocked sky."

In "Shuttle" – reflecting on the 1986 and 2003 Space Shuttle disasters. A very moving comment on public tragedy and the striving for discovery that (some say) characterizes the human spirit: "…a wreath we laid on our voyage to worlds."

And it's this voyage to worlds that is examined and regarded with sensitivity and sometimes a wry lifted eyebrow in Gottschalk's space exploration poems.

The whole panoply of science and discovery is covered here in *Cosmonauts do it in Heaven.* From Copernicus and Galileo through Kepler, to Einstein and beyond, there's a sense of tying space, time, astrophysics and astronomy together into a significant, sometimes startling whole. From Newton's reflecting 'scope to Meerkat and the SKA, via ballistics and orbital elements. And you may encounter a few names that are not part of our astro-space-science popular culture.
Who was Walter Hohmann (1880-1945) for instance? He's tagged in "The Navigators", featuring some pithy takes on those hero visionaries, like chronometer-maker John Harrison, and the afore-mentioned Hohmann, the pioneers of our technologically sophisticated age.

Gottschalk reminds us that advances in science, astronomy, exploration, do not happen in a political vacuum. The Royal Observatory was built on the Liesbeeck banks before slavery was abolished in the Cape; the pioneering V2 rockets, brainchild of von Braun, were assembled by underground slave-labour under Nazi rule. And many Soviet space pioneers endured interrogation and banishment to the gulags before emerging as national heroes.
The poet in "An Arresting Moment" plays punnily on the contrast between Joseph Lagrange's famous neutral gravity points in space and his own unpleasant encounter as an unwilling guest of the apartheid government and police minister Louis le Grange.

Poems inspired by achievements are very welcome, especially if they're thought-provoking and not just obligatory celebratory verses. So "First Light", a praise poem for our huge telescope SALT, combines this celebratory mood with the sense of wonder at the potential for discoveries – and the aspirations of the formerly disadvantaged "sections of our community" (How do you put it?!) in astronomer Thebe Medupe and SAAO's Freddie Marang, the first black South African night assistant.

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It could have been clumsy, but Gottschalk navigates the mood deftly with a moment of proud comment.
In “The Woman from the Krasny Perekop Textile Mill” there’s a powerful acknowledgement to the (small) number of women astronomers, aviators and cosmonauts who have been the brave and sometimes, yes, even unwelcome pioneers in a male-dominated field. Shame on them, the men I mean.

So, here’s a wide-ranging diversity of themes and topics intricately crafted by a master versifier with the hard-won skill of finding an image that will transfix you in an ‘ah-ha’ moment. And all in one collection focused on science, unusual even in this age of literary specialism. Thank you, Keith.

Reviewed by John Richards

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.

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