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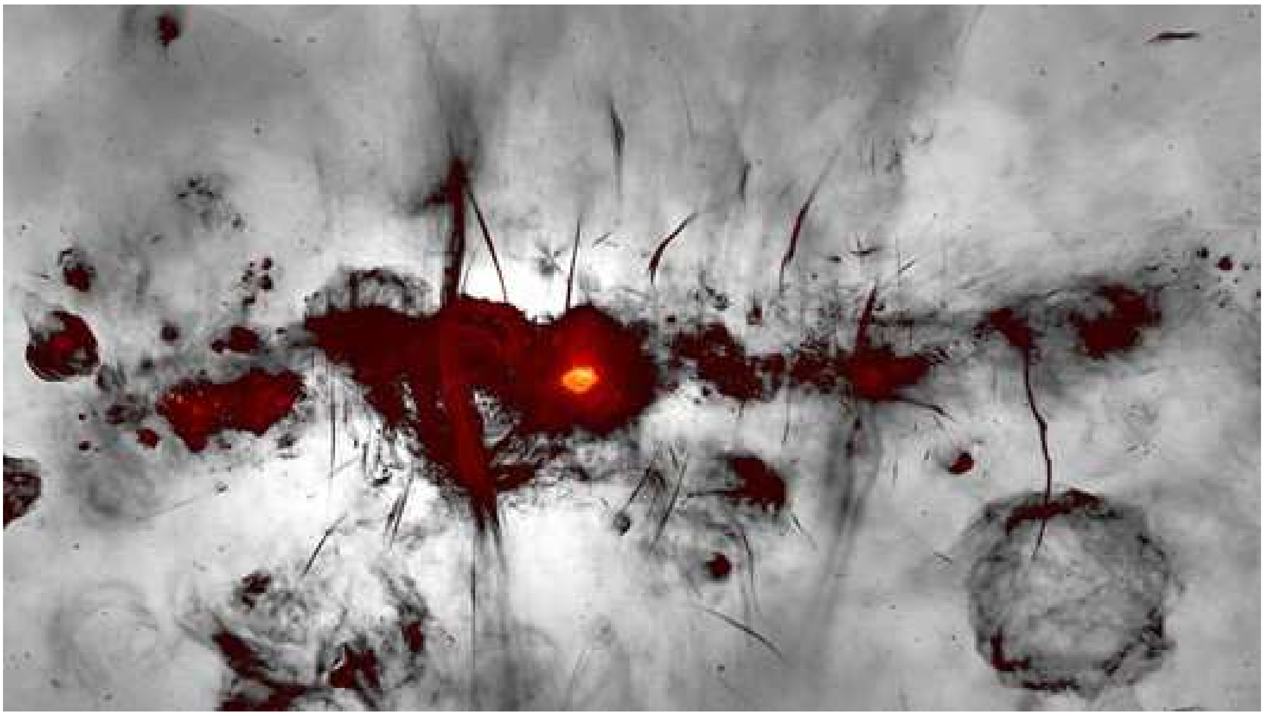

In this issue:

Cover picture

MeerKAT reveals a detailed image of the complex heart of the Milky Way – see page 5 for article.

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ASSA News: New Logo for the Society

The Council of the Astronomical Society of Southern Africa has decided to adopt a new logo that reflects its centenarian status. It can be seen in the header of this page.

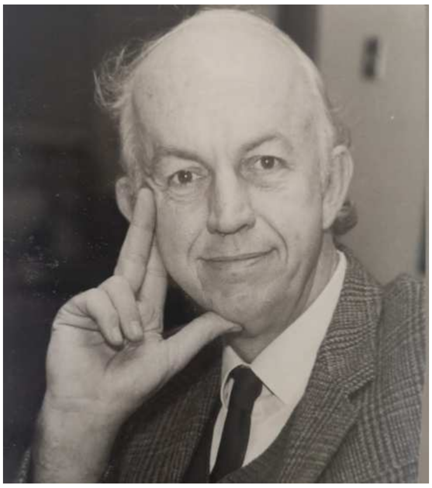
News Note: Isaac Newton sculpture presented to SAAO

Mrs Celia Spargo, the widow of the late Prof Peter Spargo (1937-2021) has presented a bronze head of Isaac Newton to the South African Astronomical Observatory. The bronze was handed over in a ceremony at SAAO on 24 February 2022. Prof Spargo had, before he died, expressed a wish that the SAAO should be the recipient of this fine sculpture.

Spargo was a noted educator whose career culminated as Senior Lecturer in Education and director of the Science Education Unit at the University of Cape Town. He was a person of many interests. *Inter alia* he was fascinated by Newton who, though known for his mathematical and physical discoveries, was actually preoccupied for most of his life by alchemy, the precursor of chemical science. Spargo studied and catalogued his alchemical writings and became interested in the theory that the mental illness that affected him briefly in his middle age was caused by metal poisoning during his investigations of mercury and various heavy metals. He persuaded the Earl of Portsmouth, who is descended from Newton's niece, to give him some strands of Newton's hair which he had analysed, finding that indeed it contained a far greater concentration of certain metals than was normal. He was able to show that the ground near Newton's rooms in Trinity College, Cambridge, still contains what are probably residues from his chemical experiments.

Spargo felt a sense of obligation towards SAAO, having spent a lot of time in its library where he took a keen interest in the Observatory's valuable collection of early scientific journals. This was in pursuit another area of research, namely to make a study of chemical nomenclature in the nineteenth century and earlier.

Another of his interests was in the Hoba Meteorite. In 2008 he wrote three articles concerning it in *MNASSA* (Volume 67, pages 85, 166 & 202). In 1985 Rössing Uranium had made funds available to preserve the meteorite and make it into a well-protected tourist site with an amphitheatre around it. Spargo acted as a consultant for this project.



Left: The late Peter Spargo

Right: The bronze head of Isaac Newton presented by Prof Spargo's widow to SAAO.

News Note: JWST launched at last

On Christmas day the James Webb Space Telescope was launched at last. If all goes well, this has the potential to be one of the most interesting satellites ever launched.

Unlike the previous Hubble Space Telescope that worked mainly with visible light, the Webb is designed to be infrared only. The main reason for this choice is that the light from the most distant galaxies, formed soon after the Big Bang, is "red shifted" into the mid-infrared region. So, if we want to compare them to nearby galaxies that we understand relatively well, we have to observe them with infrared instruments.

Infrared astronomers measure wavelengths in microns (or micrometres). Visible light has wavelengths from 0.38 to 0.74 microns, just about a factor of two in wavelength but the JWST will cover from 0.8 to 28 microns, a factor of 35! As can be imagined, no single detector can cover such a huge range efficiently. The JWST does not use CCDs that depend purely on well-tried silicon technology but depends on detectors that use two separtate layers, bonded together pixel-by-pixel. The infrared sensitive layers are made of Mercury-Cadmium-Telluride for the shorter wavelengths and arsenic-doped silicon for the longer ones. The readot layers aree made by conventional silicon technology.

The 18 hexagonal mirror segments are made of beryllium and coated with a thin layer of gold. Gold is preferable to aluminium in the infrared because it is more reflective and also does not tarnish – not a problem in space but important for the long period of preparation.

Following its launch, the JWST has been placed successfully at the "Second Lagrangian Point" where it will remain with back to the Sun and its front pointing into deep space. The telescope is now in the process of cooling down and undergoing preliminary alignment. The temperature of all components visible to the infrared detectors has to be kept low because all warm objects radiate in the infrared.

This satellite has been in planning and development for over two decades and many of the scientists involved are now well past retirement age! The estimated costs started at around one billion dollars for a launch in 2010 to around ten billion dollars now!

News Note: South Africa's hosting of NASA-funded Hazardous Asteroid Tracking Telescope

The Minister of Higher Education, Science and Innovation, Dr Blade Nzimande, is pleased that one of two new ATLAS asteroid alert system telescopes is being hosted in South Africa.

The system, operated by the University of Hawaii Institute for Astronomy, had two telescopes in Hawaii, which covered the Northern Hemisphere. Now, telescopes have been built at the El Sauce Observatory in Chile and the Sutherland Observing Station in South Africa to scan from the Southern Hemisphere.

Fig 1. The Sutherland ATLAS station during construction in South Africa. Photo: Willie Koorts/SAAO

The two locations were selected for their access to the southern part of the sky as well as their time zones, which allow for night observation when it is daytime in Hawaii. The four telescopes are capable of scanning the entire dark sky every 24 hours for objects that could collide with the Earth.

Fig 2. SAAO Staff installing ATLAS-Sutherland. (Left: Willie Koorts, Centre: Nic Erasmus, Right: Crane Operator) Photo*: Willie Koorts/SAAO.*

The astronomical community is delighted that ATLAS has expanded its reach to the Southern Hemisphere. The construction of the two additional ATLAS telescopes, in South Africa and Chile, is now complete. They have already begun operations – and the South African telescope, ATLAS-Sutherland, has already discovered its first near-Earth object.

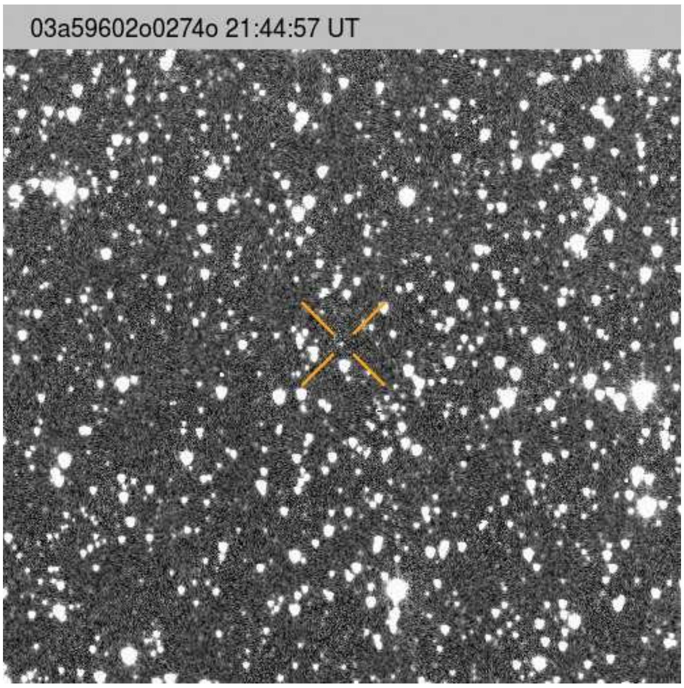


Fig 3. First NEO 2022BK discovery image Photo: ATLAS.

These telescopes add to Africa's growing list of international instruments that are being hosted at South African astronomy research facilities and is yet another achievement aligned to the vision of multiwavelength astronomy, which seeks to position Southern Africa as a preferred destination for scientific infrastructure and research.

It also demonstrates once again that science and technology can facilitate foreign direct investment into the local economy. Minister Nzimande was particularly pleased that the initial discussions on bringing this telescope to the country were directly initiated by our officials at the Department of Science and Innovation, DSI.

John Tonry, ATLAS Principal Investigator and Professor at the University of Hawaii Institute for Astronomy, says an asteroid that hits the Earth can come at any time from any direction, so it is good to know that ATLAS is now surveying all the sky, all the time.

The four-telescope ATLAS system is the first survey for hazardous asteroids that is capable of monitoring the entire dark sky every 24 hours. The modest-sized but stateof-the-art telescopes can capture an image of a section of the sky 100 times larger than the full moon in a single exposure.

The ATLAS system is specially designed to detect objects that approach very close to Earth – closer than the distance to the Moon, about 240 000 km or 150 000 miles.

The system can provide one day's warning for a 10-metre diameter asteroid, which would be capable of city-level destruction, and up to three weeks' warning for a 100-metre diameter asteroid, which could have 10 times the destructive power of the recent Hunga Tonga volcano eruption if it were to strike the Earth.

The University of Hawaii developed the first two ATLAS telescopes in Hawaii under a 2013 grant from NASA's Near-Earth Objects Observations programme, now called the Planetary Defense Coordination Office. The two telescopes, on Haleakalā and Maunaloa, became fully operational in 2017.

News Note: MeerKAT radio image reveals complex heart of the Milky Way

The South African Radio Astronomy Observatory (SARAO) has released a new MeerKAT telescope image of the centre of our Galaxy, showing radio emission from the region with unprecedented clarity and depth. The international team behind the work is publishing the initial science highlights from this image in *The Astrophysical Journal*.

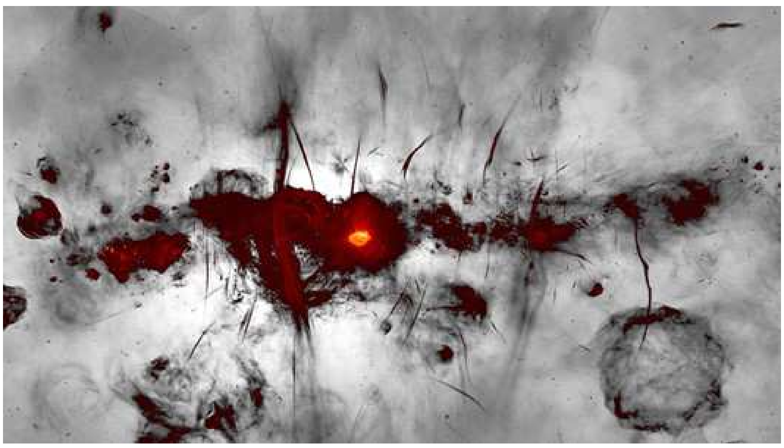


Fig 1. The new MeerKAT image of the Galactic centre region is shown with the Galactic plane running horizontally across the image. Many new and previously-known radio features are evident, including supernova remnants, compact star-forming regions, and the large population of mysterious radio filaments. The broad feature running vertically through the image is the inner part of the (previously discovered) radio bubbles, spanning 1400 light-years across the centre of the Galaxy. Colours indicate bright radio emission, while fainter emission is shown in greyscale. Photo: I. Heywood, SARAO.

The image captures radio emission from numerous phenomena, including outbursting stars, stellar nurseries, and the chaotic region around the 4 million solar mass supermassive black hole that lurks in the centre of our Galaxy, 25,000 light-years from Earth. Radio waves penetrate the intervening dust that obscures the view of this region at other wavelengths. MeerKAT's innovative design, sensitivity, and geographical vantage point have been the keys to producing the remarkable image, which reveals new supernova remnants – the expanding shells of material left behind when massive stars end their lives explosively – including a rare almost-perfect spherical example, and provides astronomers with the best insight yet into the population of mysterious 'radio filaments' found nowhere else.

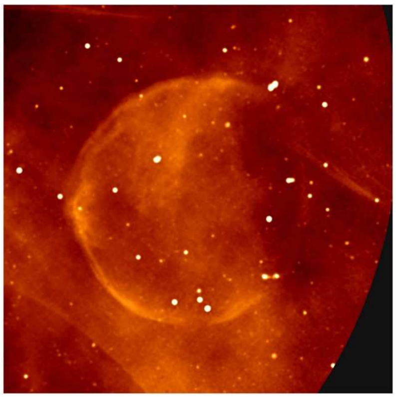


Fig 2. A rare, almost-perfect, spherical supernova remnant that has been discovered at the edge of the MeerKAT mosaic. Numerous compact radio sources are also visible, many of which signpost supermassive black holes at the centres of galaxies far beyond our own. There is also an intriguing tailed radio source visible on the right of the image, which could be an object in our galaxy moving at high speed, leaving a trailing wake. Photo: I. Heywood, SARAO.

Dr Ian Heywood, from the University of Oxford, Rhodes University and SARAO, and lead author of the study has spent a lot of time looking at this image in the process of working on it, and he never get tired of it. When he shows this image to people who might be new to radio astronomy, or otherwise unfamiliar with it, he always tries to emphasise that radio imaging hasn't always been this way, and what a leap forward MeerKAT really is in terms of its capabilities. It's been a true privilege to work over the years with colleagues from SARAO who built this fantastic telescope.

This work represents the culmination of 3 years of detailed analysis of a survey conducted during the telescope's commissioning phase. Those observations had already led to the iconic inaugural MeerKAT image in 2018 as well as the discovery of a pair of giant radio bubbles, evidence of an explosive outburst from the heart of our Galaxy several million years ago. Now, at last, the image is available in its full complexity for detailed study by astronomers worldwide.

The new image is based on a mosaic of 20 separate observations using 200 hours of telescope time covering an area of 6 square degrees (30 times the area of the full Moon). The data were consistently processed to deliver an angular resolution of 4 seconds of arc – the angle subtended by a tall person at a distance of 100 kilometres;

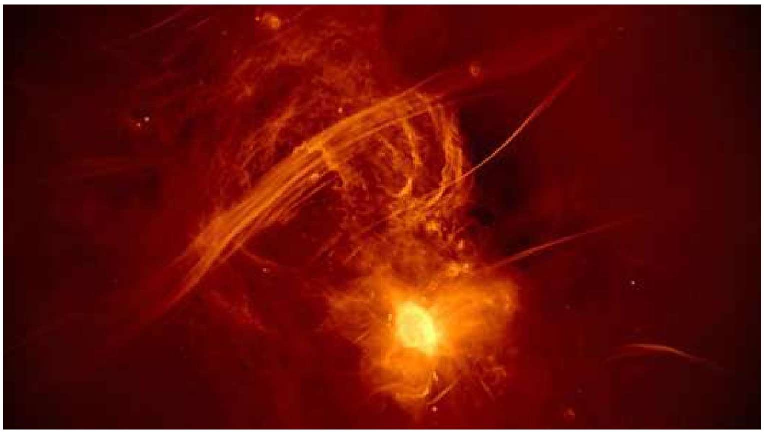


Fig 3. The complex, cirrus-like emission from the Galactic centre super bubble dominates this image. This is traversed by the Radio Arc, a complex of many parallel radio filaments. The radio bubble nestles against the diffuse Sagittarius A region in the lower centre of the image. The bright dot near the centre of this region is Sagittarius A, a 4 million solar mass black hole. This image captures the chaotic complexity of the very heart of our Galaxy. Photo: I. Heywood, SARAO.*

or by the width of a fine human hair held at arm's length – resulting in a 100 megapixel scientific image. Processing of the 70 terabytes of raw data was shared between two supercomputers in Cape Town, the Centre for High Performance Computing's Lengau, and IDIA's ilifu. Data processing and imaging were assisted by Rhodes / SARAO PhD student Isabella Rammala, who is investigating the compact radio sources in the image.

The highly-linear features pervading the image are radio-emitting magnetised threads. Up to 100 light-years long, these unique structures have defied a conclusive explanation for their origin since discovery over 35 years ago. MeerKAT has discovered many more such filaments than were previously known, and the new data release will allow astronomers to study these objects as a population for the first time. The first inroad into such work is presented in a companion paper in The Astrophysical Journal Letters.

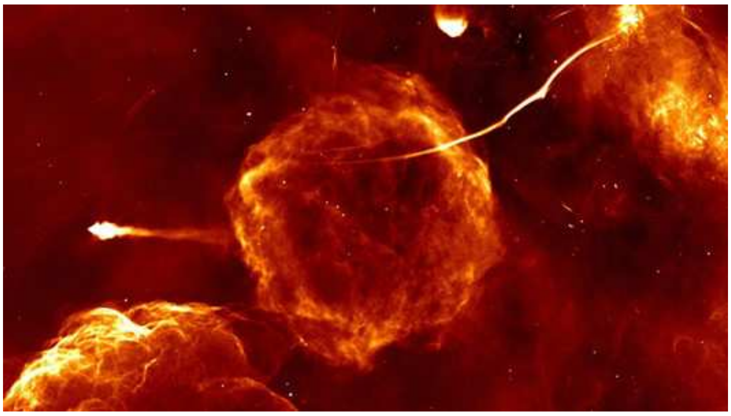


Fig 4. In the centre of the image is the supernova remnant G359.1-0.5. To the left is 'the Mouse', a runaway pulsar possibly formed and ejected by the supernova event. To the upper right is one of the longest and most famous radio filaments, known as 'the Snake'. Photo: I. Heywood, SARAO.

Dr Fernando Camilo, SARAO chief scientist, said that the best telescopes expand our horizons in unexpected ways. It's a testament to the skill and dedication of our South African colleagues who built MeerKAT that it's making such remarkable discoveries in one of the most intensively studied corners of the radio sky. The image we're sharing

today is rich with scientific potential, and we very much look forward to further surprises as the astronomical community mines these data for years to come.
For further details see preprint for ApJ: https://arxiv.org/abs/2201.10541
For the related publication in ApJ Letters: https://arxiv.org/abs/2201.10552

News Note: Theory of General Relativity passes a range of precise tests set by pair of extreme stars

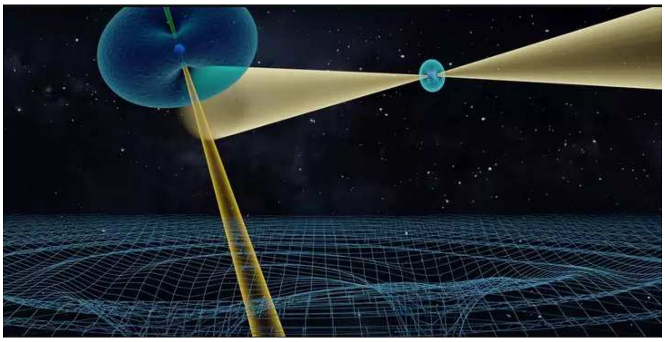


Fig 1. Artistic impression of the Double Pulsar system, where two active pulsars orbit each other in just 147 min. The orbital motion of these extremely dense neutrons star causes a number of relativistic effects, including the creation of ripples in spacetime known as gravitational waves. The gravitational waves carry away energy from the systems which shrinks by about 7mm per day as a result. The corresponding measurement agrees with the prediction of general relativity within 0.013%. Copyright: Michael Kramer/MPIfR.

A team of researchers from 10 countries, including the South African Radio Astronomy Observatory's Chief Scientist Dr Fernando Camilo, has conducted a 16-year-long experiment to challenge Einstein's theory of General Relativity with some of the most rigorous tests yet. Their study of a unique orbiting pair of extreme city-sized stars made up mostly of neutrons, so-called pulsars, involved seven radio telescopes across the globe and revealed new relativistic effects that have now been observed for the first time. Einstein's theory, which was conceived when neither these types of stars nor the techniques used to study them could be imagined, agrees with the observations at a level of at least 99.99%. The results are published in the journal Physical Review X.

"These wonderful results show the value of patient long-term studies carried out with world-leading research facilities," says Camilo. "Much remains to be learned about this remarkable natural laboratory," he adds, "to which South Africa's MeerKAT is now contributing with its observations of unsurpassed quality".

Press Release SARAO - 13 December 2021

For more details https://www.mpifr-bonn.mpg.de/pressreleases/2021/12

News Note: Early findings from HERA telescope promise deeper understanding of the cosmic dawn

*Scientists including **MIT**'s Jacqueline Hewitt and Nicholas Kern share long-awaited results, getting closer to the universe's first stars.*

All through history, humans have created and shared stories that ponder the creation of stars — what they are and how the first stars came to be. Now, with new results from the Hydrogen Epoch of Reionization Array (HERA), a radio telescope located at the South Africa Karoo Astronomy Reserve, MIT scientists are one small, but significant, step closer to understanding that history.

HERA researchers are looking for the earliest signs of star formation and galaxy structure. Specifically, scientists including Jacqueline Hewitt, the Julius A. Stratton Professor of Physics at MIT, are trying to understand what happened during a period called the cosmic dawn, which occurred about 400 million years after the Big Bang. In early fall 2021, Hewitt, Nicholas Kern, a Pappalardo Fellow in Physics at the MIT Kavli Institute for Astrophysics and Space Research, and other researchers from the international collaboration finalized the long-awaited results collected and analysed over four years, during the first stages of the telescope's construction.

Their study, published on 7 February, 2022, in the *Astrophysical Journal*, presents new upper limits on radio signals from cosmic hydrogen, which indicates early star formation and gives scientists a clearer picture of when the first stars and galaxies formed. These findings narrow down the theoretical models that hypothesize on the origins of the cosmic dawn.

Fig 1. Part of the HERA radio interferometric array in the South African Karoo desert during early construction in 2016, pictured with site crew for scale. Photo: Kathryn Rosie.

The HERA findings are in part so significant because they were collected at such an early stage in HERA's development. The telescope, which operates as an array of radio dishes, currently sits at just a fraction of its ultimate size — the data were collected from just 39 of HERA's 52 deployed antennae. In its full form, there will be 350 total antennae. Once fully constructed, HERA will be sensitive enough to gather even larger datasets and information from further away, and thus further back in time.

Nicolas Kern , the paper's lead author, said they not yet doing fully what they can do; this result is a demonstration of the telescope as an entity. It's a demonstration of a first pass at an analysis of the data, which is kind of a framework, a bedrock, if you will, going forward for all future analysis.

Fig 2. The new funding from the Moore Foundation will help expand the HERA array to 350 dishes, increasing the telescope's sensitivity to radio waves from the epoch of reionization. Photo: SARAO

Seeking a signal

To look back at the cosmic dawn, HERA uses low-frequency radio waves to identify signals that are not easily observed. This is different from other telescopes, such as the Hubble Space Telescope, which observe structures like galaxies that comprise just 5 percent of the observable matter in space. The other 95 percent of matter is what is between galaxies, including low-density hydrogen. With HERA, scientists can look at what is going on between galaxies and use that information to infer what galaxies are doing that we cannot observe, and how galaxy formation influences space around it.

To understand this period in the universe's history, scientists are looking for the "spin flip signal," also known as the 21-centimeter line, which is the wavelength of neutral hydrogen gas. This radio signal comes from intergalactic material between galaxies and is produced by the emission and/or absorption of hydrogen atoms given off through this transition.

According to Steve Furlanetto, the HERA project's lead theorist and an associate professor of Physics and Astronomy at the University of California at Los Angeles. What HERA is looking for is; what does the spin flip signal look like during this era?

Identifying the Epoch of Reionization, or the timing of when the signal is observed, is what's important, continued Furlanetto. We want to know if [the signal] is in absorption, which would mean it's before X-rays, or in emission, which is after X-rays. And then we want to see if it disappears because of reionization.

The signal has two signatures, or processes, that can be captured. The signal is first altered when stars heat the hydrogen gas. The second part, which is what HERA has so far been looking for, is the disappearance of the 21 cm signal, which happens when the hydrogen is ionized by the energy produced by additional star formation. This signature indicates that stars have been created.

The 21 cm line from the cosmic dawn has not yet been definitively detected. However, the new results from HERA provide data — more sensitive than previous results by a factor of 10 — on the nature of the spin flip signal from when the universe was 500 million years old.

A first look

With these results, the HERA team has been able to provide evidence that rule out several possible theories about galaxy formation. Most notably, the data show that there must have been some mechanism for heating up the hydrogen in space, which means that galaxies must have black holes.

If you had galaxies that didn't have black holes, that's basically something one can rule out. There must be heating, which, in the context of these models, means that there must be black holes near which X-rays are produced, according to Furnaletto

With funding from the Gordon and Betty Moore Foundation and the National Science Foundation, HERA will operate at 350 antennas and with a new antenna design that will allow the telescope to capture lower frequency radio waves and viewpoints at higher redshifts, effectively seeing further back in time.

Hewitt, project lead on expanding HERA's signal capacity, has been working on the question of when the earliest stars formed since 2004. She has led the prototyping of the new low-frequency components, and is developing more techniques to analyse the current and future datasets. The new antennae design, from Cambridge University, should be installed by early 2022, and will dramatically increase the range of information they are able to obtain.

This extension to lower frequencies is important because it gets us to this period before the first stars, explained Hewitt the increased range will help them learn more about earlier stages of cosmic history.

This work is supported, in part, by the National Science Foundation with institutional support from the HERA collaboration partners, and by the Gordon and Betty Moore Foundation. HERA is hosted by the South African Radio Astronomy Observatory, which is a facility of the National Research Foundation, an agency of the Department of Science and Innovation.

References

1 First Results from HERA Phase I: Upper Limits on the Epoch of Reionization 21cm Power Spectrum" Nicholas S. Kern et al., *Astrophysical Journal*. February 7, 2022

2 MNASSA Vol 75, nos. 9 & 10, 2016

3 https://www.sarao.ac.za/science/hera/

4 https://news.berkeley.edu/story_jump/6-million-grant-helps-expand-radio-telescope-to-study-cosmic-dawn/

Note: Edited from a Press release from MIT News by Maria Rose, MIT Kavli Institute for Astrophysics And Space Research

RR Lyrae variables: a new step in the Cosmic Distance Ladder

Christina Gilligan (Dartmouth College)

One of the biggest sources of tension in astronomy is the precise value of H_0. In general, there are two different methods to measuring H_0: early-time and late-time. Late-time measurements refer to measuring H_0 locally, using the Cosmic Distance Ladder, whose first rung is usually Cepheid variables. Early-time measurements are usually based upon the Cosmic Microwave Background (CMB). The difference between the early-time (around 74 km/s/Mpc) and late-time (around 67.4 km/s/Mpc) H_0 values is 4.4σ. It is now believed that this is not due to instrumentation or measurement errors, instead it seems to be either an error in our assumptions and calibrations of the Cosmic Distance Ladder or an inconsistency with the current version of ΛCDM.

To determine the cause of this tension, the Cosmic Distance Ladder needs to be further scrutinized. RR Lyrae, for example, can be used instead of Cepheid variables as an independent check of the first rung. RR Lyrae are variable stars similar to Cepheid variables and also follow a period-luminosity-metallicity (PLZ) relationship. In the past, using them in the distance ladder was not possible since RR Lyrae are fainter than Cepheids: only five RR Lyrae had parallaxes measured using the HST. With the advent of Gaia, however, there are now hundreds of RR Lyrae with well-measured parallaxes that can be used to recalibrate the Cosmic Distance Ladder.

As part of my PhD thesis (defended in July 2020), we recorded high-resolution spectra of 69 RR Lyrae using SALT with the goal of measuring accurate metallicities. Since only one instrument and telescope was used, our dataset is one of the largest, homogeneous sets of metallicities for RR Lyrae. I was greatly helped in this effort by Brian Chaboyer (Dartmouth College), Juliana Crestani (INAF-Osservatorio Astronomico di Roma), and Giuseppe Bono (INAF-Osservatorio Astronomico di Roma) among others.

Every RR Lyrae in our sample has positive parallaxes in the Gaia EDR3 catalogue with uncertainties that are less than 10%. In addition, 54 of these stars have at least 20 epochs of simultaneous near infrared (J, H, and K) data from the InfraRed Survey Facility (IRSF, also in Sutherland). These epochs are well-spaced along the entire pulsation period of the star. Near-infrared PLZ relation-ships are preferred over optical for many reasons. The most beneficial aspect is the greatly reduced effect of reddening in the near-infrared bands. With both metallicities and near-infrared lightcurves, the most accurate near-infrared PLZ relationship for RR Lyrae can be attained. The IRSF data reduction and future work is being lead by Massimo Dall'Ora (INAF-Osservatorio Astronomico di Capodimonte). However, the data reduction of our IRSF lightcurves is ongoing so for the analysis presented here we used W1 and W2 magnitudes from *WISE*.
RR Lyrae nearly always have periods of 0.9 days or less. This means that our HRS exposure times must be short to not cover too large of a pulsation period. Therefore, we were not able to conduct a line-by-line abundance analysis for each of the stars. Instead, we used a synthetic spectral analysis approach. We created a grid of stellar model atmospheres, varying temperature, pressure, microturbulent velocity, and [Fe/H]. We then iteratively compared this grid of models to a star's spectrum until we found a global minimum in χ^2. In the end, 58 RR Lyrae metallicities could be determined using this method, 49 of which did not previously have metallicities determined using high-resolution spectography. This leads to smaller errors in our final stellar parameter determinations.

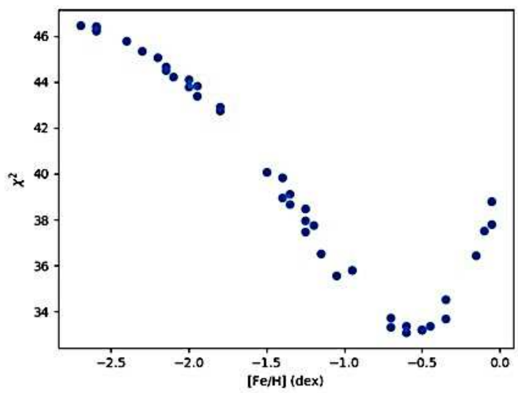


Fig 1. Example χ^2 versus [Fe/H] plot for AA CMi, a RRab type. The χ^2 is extremely apparent, leading to small errors in our final stellar parameter determinations.

By combining our new 49 RR Lyrae metallicities with 109 previously determined metallicities using HRS, we were able to construct new PLZ relationships for the *WISE*

W1 and W2 bands. Our PLZ relationships have smaller uncertainties than previous observational determinations of the RR Lyr PLZ relations in the mid-IR. In the future, we will combine these metallicity measurements with our IRSF lightcurves to produce the near-infrared PLZ relationships. In addition, we have nearly 150 other RR Lyrae with more than 20 epochs of IRSF data that do not yet have metallicities from SALT. We hope to include those in our dataset in the future. Both of these efforts will get us one step closer to solving the Hubble tension in nearby galaxies.

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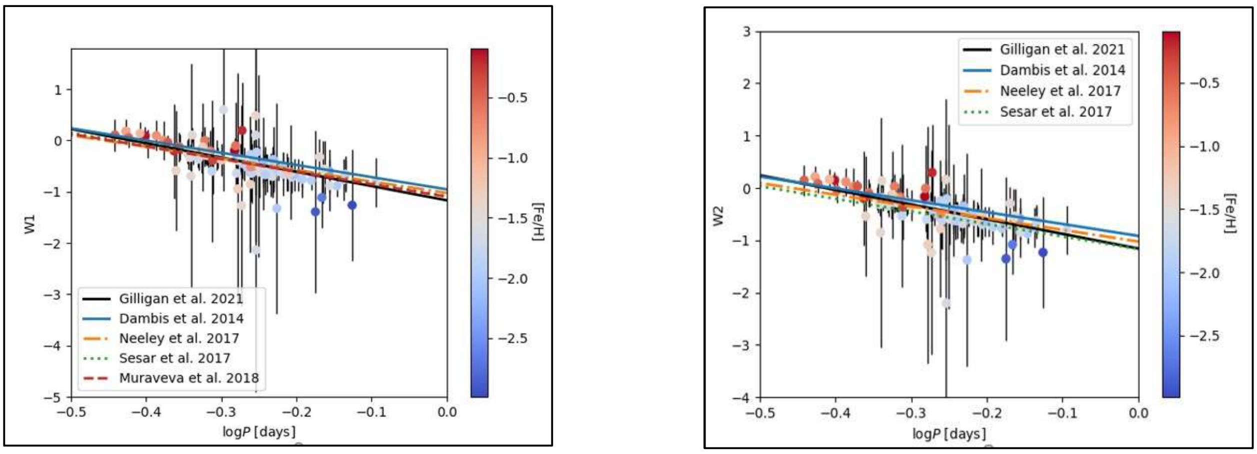


Fig. 2 PLZ fits for the full HRS sample compared to the fits from Dambis et al. (2014), Neeley et al. (2017), Sesar et al. (2017), and Muraveva et al. (2018b). The left panel is

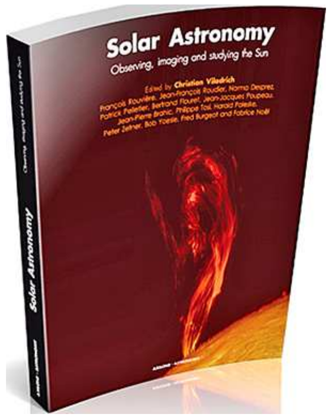
for W1 versus log P while the right panel is for W2 versus log P , where P is the period of pulsation in days. The color bar indicates the metallicity of the RR Lyrae.

The SALT/HRS spectroscopic data of these RR Lyrae are further used in a larger project that investigates metallicities of RR Lyrae in gereral. Currently five publications with the title *On the Use of Field RR Lyrae as Galactic Probes* have been published (Fabrizio *et al.* 2019, Crestani *et al.* 2021a and 2021b, Fabrizio *et al.* 2021 and Braga *et al*. 2021).

Published as Gilligan *et al.* (2021), *MNRAS* **503**, 4719–4733.

Book Review: Solar Astronomy

Author: Translation and update (by K M Harrison and P Zetner) of Astronomie solaire
Publisher: Axilone – Astronomy - July 5, 2021
Language: English
Softcover: 480 pages with 1 473 images
ISBN: 979-10-92974-08-9
Weight: 1.7 kg
Dimensions: 21 x 29.7 cm
Price: 69 EUR including shipping



Details of the book, *including ordering information*, may be browsed at http://solar-astronomy-book.com/

Table of Contents
http://solar-astronomy-book.com/wp content/uploads/2021/07/TableOfContent.pdf

There are 16 chapters, divided into three parts, followed by a list of references and a chapter-by-chapter bibliography. The parts are: Part I: Discovering the Sun; Part II: Observation, Equipment, and Techniques; Part III: Observing projects

Solar Astronomy is a translation and update of the book *Astronomie solaire* which was prepared by 14 professionals and advanced amateurs, and which has enjoyed surprising success in France since its publication in 2018. Solar Astronomy is procedural rather than theoretical and is for experienced observers with above-average home-workshop skills who desire to make a meaningful contribution to science. While the astrophysics of solar processes are not covered, sufficient theoretical material is introduced so that the reader gains a reasonable understanding why the techniques of solar data acquisition are important. The overall result is a thorough, well-illustrated manual that amateur astronomers can use to build the equipment and skills needed to positively contribute to Pro-Am solar studies.

It is hard to imagine a more wide-ranging and reader-accessible volume – and certainly the most beautifully produced in terms of page design, the use of colour in the text, the abundance of images, and the logical sequence in which the topics are presented. Solar Astronomy's emphasis on DIY and Pro-Am equipment building brings fabrication methods used by observatory equipment manufacturers into the amateur's home workshop. The book presupposes that readers are moderately adept at understanding how equations and graphical diagrams relate to specific applications the readers may wish to work on. The math is simple workaday algebra intended to calculate equipment tolerances, optical element spacing, exposure times and stacking details used to produce specific types of final image. The abundant graphs employ in-box notations rather than listing the details in captions, which makes it easy for readers to visualise the optical and structural tolerances they must adhere to achieve the parameter range of a useful final image. The graphs are identified numerically and frequently referred to in the text — readers wander in no wildernesses here; signposts are everywhere.

Let's take a close look at four chapters in which Solar Astronomy's thoroughness reveals itself best.

Chapter 6, *Observation of the photosphere*: The first section of this chapter is admirably image-rich with caption and text descriptions which highlight the importance of features shown in the images, e.g. penumbral faculae. There are some eye-catching beauties on these pages. The authors do make a few unexpected recommendations, e.g., avoiding both fluorite-based apochromatic refractors due to the high thermal expansion coefficient of that material, and Petzval-type designs with mid-tube correction lenses due to the inordinate heat burden placed on the internal lenses in an unventilated tube. Another recommendation is to remove the reflective coating from Newtonian telescope mirrors, which reduces the reflectance to approx. 4% of the total incoming light. This coating removal is a dangerous chemical process. The resulting images shown are full-page beauties that practically beg to be framed and put on the wall.

Chapter 7: *Observation of the chromosphere*: As the authors aptly phrase it, "The chromosphere is the 'Holy Grail' of amateur solar observation. The temperature rise in the upper layers is largely due to the production of H-alpha emission and singly ionized calcium, both of which involve photon emission as orbiting electrons lose energy as they descend valence quanta levels. These simple photonic reactions are covered in admirably documented equations, graphs and images. The remaining 30 pages of the chapter are one of the two most technically demanding sections in the entire book. Most readers will need at least three or four read-throughs just to get their feet on the ground with such complex material. The chapter concludes with some of the most beautiful images in the book.

Chapter 9: *Amateur solar instruments*: This chapter will surely enthral every reader with even the slightest interest in making their own equipment. There are some truly exotic telescope configurations in these pages as well as seldom-described processes. This chapter also relates inspiring cases of turning inexpensive off-the-shelf instruments into classy solar telescopes of the type frequently mentioned earlier in the book. The use of these exotic light-rejection and off-axis filtration designs makes for an interesting read, but the authors should explain their utility beyond the realm of personal satisfaction.

Chapter 15: *Amateur observing programs* describes what an interested amateur can expect when casting about for a worthy Pro-Am collaboration to join. The available projects rapidly escalate from observing H-alpha prominences to detecting Moreton-Ramsey waves; comet detection using SOHO/LASCO and STEREO.SECCHI satellite data repositories; measuring ovalisation of the chromosphere using H-alpha and Ca K filters; and the F-Chroma program aimed at detecting and time-tracing solar flares. There is an introduction to the Pro-Am Associate Observers of Pic du Midi, a famed French observatory which operates Solar Stormwatch and F-Chroma programs in which the members of the group have access to the observatory's coronagraph on a continuous basis. There you can watch science happen as you participate in its happening. Next is an extended excursion into using amateur spectroheliographs to document solar events in real-time. This is the meatiest chapter in the entire book for the interested amateur, and the complexities of particle flow, magnetic fields, and arcana such as interpreting Zeeman line shapes are explained very clearly. This chapter, for all its technical challenges, is so edifying that this reviewer recommends it to anyone with more than a passing interest in the science of astronomy.

Chapter 16: *The Sun on the Internet* is a compendium of links to the various observatories where Pro-Am devotees can download and analyse raw data for the various projects run by the participating observatories.

Other sections worthy of comment are the list of Filter Suppliers and manufacturers, and the Glossary.

Shortcomings

In Chapter 5, *Telescopes for solar observation* the authors do not sufficiently emphasise the vast difference between optical-bench telescope performance and actual field performance given rapidly varying temperatures, seeing quality, and contrast loss from light scatter. Even so, this is a most succinct optical performance primer.

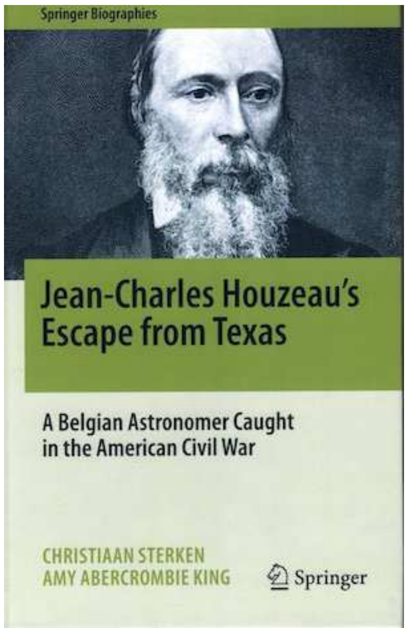
The references are not page-linked within the various chapters, so readers must resort to a Post-It note to quickly refer to more detailed information. The Further Readings and References sections in the back of the book are not cited with their page numbers in the introductory paragraph of each new chapter. As Solar Astronomy is presently constructed, readers have to know beforehand where to find the references.

The Index does not appear to have been produced by a professional indexer. It is the poorest index this reviewer has seen in a professional publication.

And nowhere is it explained why a number of solar telescope optical tubes are filled with helium gas.

Reviewed by Doug Bullis

Book Review: Jean-Charles Houzeau's Escape from Texas: A Belgian astronomer Caught in the American Civil War



Authors: Christiaan Sterken and Amy Abercrombie King
Publisher: Springer Nature Switzerland AG, 29 June 2020
Pages: xiii + 161.
Hardcover: ISBN987-3-030-46536-0, Price €79.99
eBook: ISBN978-3-030-46538-4, Price €67.40

Translated in part from the original French and annotated with figures, historical maps and commentary from the translators, this book is about a strange period in the life of the Belgian astronomer and journalist Jean-Charles Houzeau (1820-1888). Born into an upper-class family, he worked as an astronomer during the years 1843 to 1849 at the Royal Observatory in Brussels. He was dismissed on account of his revolutionary politics. Though he managed to obtain a contract to do survey work in 1854, in 1857 he was again fired.

In 1857 he emigrated to New Orleans and, after some time, moved to Texas, where he settled in San Antonio and worked as a land surveyor. Here he became embroiled in the American Civil War, since Texas had seceded from the United States on February 1, 1861, with the aim of perpetuating slavery.

However Houzeau was an idealist and a red-hot abolitionist, and he ran into serious trouble for his secret anti-slavery activities. He chronicled his experiences in a series of letters eventually published as "La Terreur Blanche au Texas et mon Évasion" – "The White Terror in Texas and my Escape". His theme was the appalling reign of terror perpetrated by the pro-slavery Texans and his falling foul of their "Vigilance Committee", leading him to escape to Mexico in disguise as a simple teamster, via a long ox-cart journey to Brownsville and across the Rio Grande. It is indeed a fascinating story, though not an astronomical one.

He subsequently worked as a journalist in New Orleans (after its re-capture by the Northern side in the Civil War) and spent some years in Jamaica where he resumed publishing on astronomical matters. He eventually returned to Belgium and was director of the Royal Observatory from 1876 to 1883. During this period he organized expeditions to view the Transit of Venus of 1882 using special heliometer-like telescopes made to his design by Grubb of Dublin.

Sterken and King's book is something of a critical edition of "The White Terror …", containing notes and background material. However, as a person only vaguely acquainted with Houzeau's work – mainly through his interaction with Grubb - I found the organization of the book rather chaotic. Houzeau is not well-known to the general astronomical public and I feel that more introductory material about his life or even a timeline could have been included. For a summary of his background I would suggest consulting Sterken, C. et al 2004 "Jean-Charles Houzeau and the 1882 Belgian Transit of Venus Expeditions" in Christiaan Sterken, Hilmar W. Duerbeck, (eds) Astronomical Heritages: Astronomical Archives and Historic Transits of Venus, *Journal of Astronomical Data,* **10**, 7, 2004 (Available free on-line).

Reviewed by IS Glass

Webinars

Colloquia and Seminars use 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

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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 sessions.

Title: Dark energy: can the fifth force be screened?
Speaker: Dr Daniela Saadeh from ICG Portsmouth (UK)
Date: 21 January
Venue: Astro UWC
Time: 11h30

Abstract: The phenomenology of dark energy may be explained by an extra scalar particle mediating a fifth force at cosmological scales. However, stringent limits on the existence of extra forces have been placed by solar-system experiments: viable models must therefore be able to screen (i.e. suppress) the fifth force in environments where it is known to be small. Several screening mechanisms have been proposed, which predictions can be tested against data. Atom interferometry experiments have recently revolutionised the landscape of screening constraints, allowing precise tests with table-top experiments. I will discuss the working principle of these tests, and present the latest constraints on the chameleon and symmetron models. In the second part of the talk, I will focus on the Vainshtein screening mechanism, where the fifth force is suppressed by large higher-order derivatives of the scalar field. Progress in tests of this mechanism has been hindered by the complexity of the field equations. I will present a numerical approach based on the finite element method that overcomes this problem, and use it to assess whether Vainsthein screening can effectively take place within the limits of validity of the theories that invoke it.

Title: How do cluster environments affect the molecular gas in galaxies?
Speaker: Dr Nikki Zabel (Kapteyn Astronomical Institute, University of Groningen)
Date: 24 February
Venue: Zoom
Time: 12h00

Abstract: Understanding galaxy formation and evolution is one of the key goals of astronomical research. With roughly half of the galaxies in the local Universe residing in dense environments, it is therefore important to study the effects of environment on galaxy evolution. It has been known for several decades that galaxy clusters harbour a relatively large fraction of early-type galaxies. This suggests that dense environments can cause the premature quenching of star formation. Several environmental processes have been suggested to contribute to this, such as ram pressure stripping, starvation, violent fly-bys, and tidal interactions. However, the relative importance of these mechanisms, and how exactly they lead to the quenching of star formation, is still poorly understood. Typically distributed in an extended disc, atomic gas has long served as an excellent tracer for environmental processes. However, it is the molecular gas that is the direct fuel for star formation. Therefore, any direct effects of the cluster environment on the more tightly bound and centrally located molecular gas would have
strong implications for galaxy evolution in dense environments. In this talk I will discuss my studies of the molecular gas in galaxies in the nearby Fornax cluster, and I will close with some early results from the recently published "VERTICO: The Virgo Environment Traced in CO Survey".

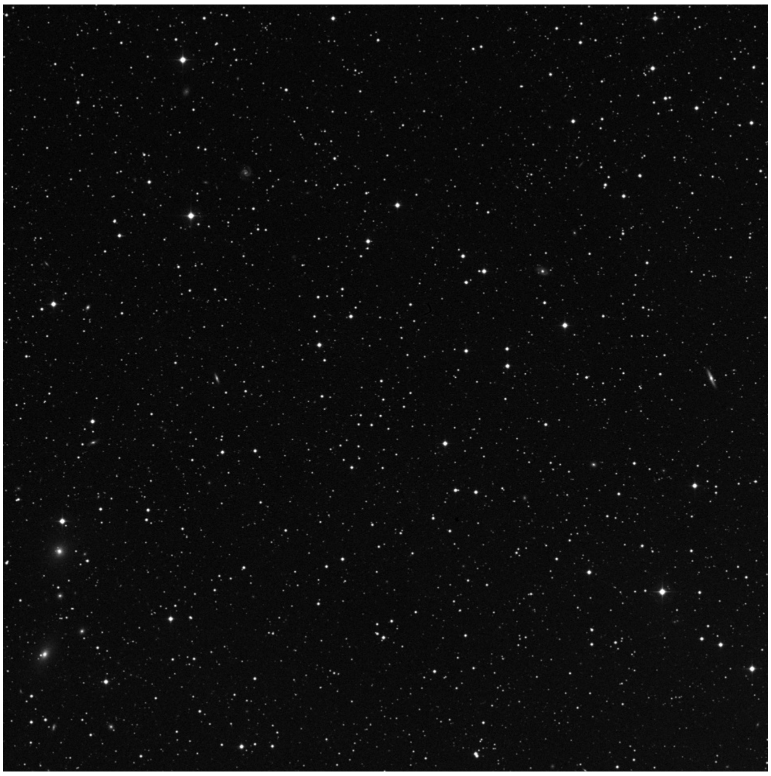
Streicher Asterisms

Magda Streicher

STREICHER 72 – DSH J1647.1+0627
Hercules

With care, about a dozen similar faint magnitude 11 stars can be spotted between brighter stars in the field of view, and truly represent a grouping of sorts. The most southerly star is listed as GSC 396 389. Various very faint galaxies are situated amongst the star field with NGC 6224 and NGC 6225 just 20’ towards the south-east. The edge-on galaxy listed as PGC 58957 takes its place on the western edge of the field as can be seen in the Deep Sky Survey photograph below.

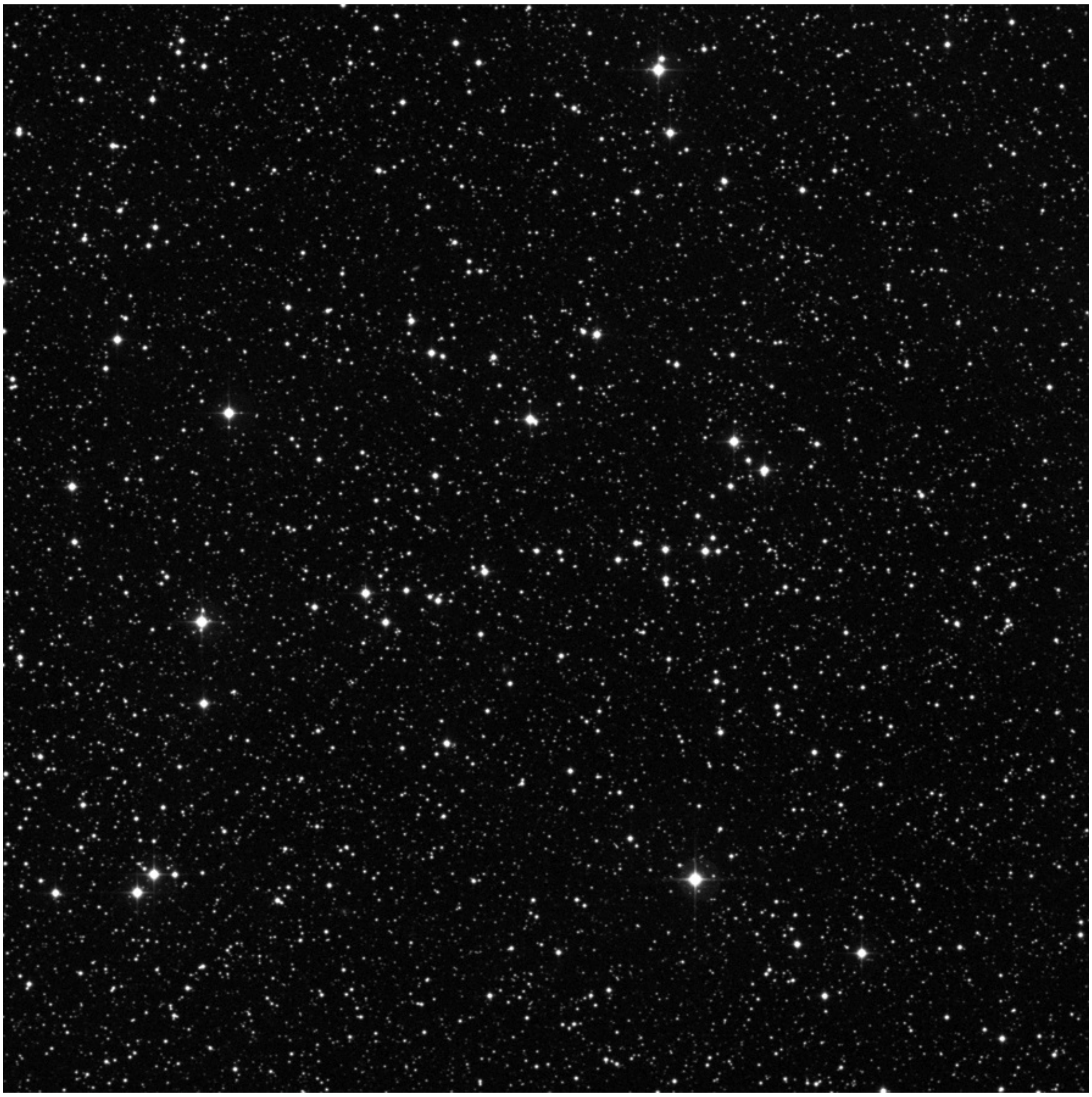
OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 72 DSH J1647.1+0627	Asterism	16h47m.10	+06°27’.15	10	9.5’



STREICHER 73 – DSH J1859.7+2945
Lyra

This stringy grouping has a lot to offer with its shape reminding me in a way of an insect figure of sorts. Two similar shiny white coloured stars towards the west end of the string can be seen as two eyes looking back, with the bulk of fainters stars stringing along towards the south-east. The beauty of asterisms and especially the ones with fewer stars, always tells a story of one kind or another.

OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 73 DSH J1859.7+2945	Asterism	18h59m.42	+29°45’.12	10.5	13.5’

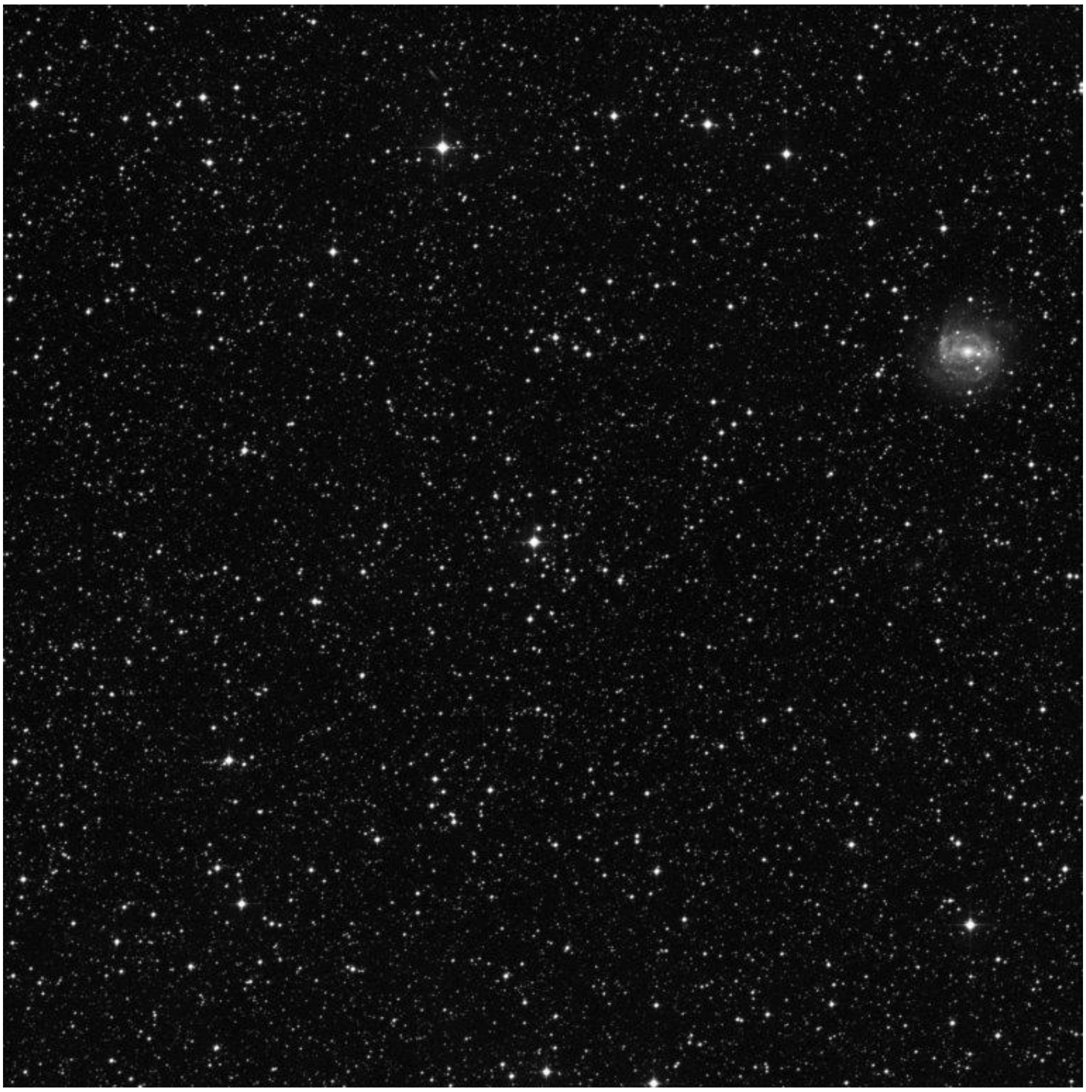


STREICHER 74 – DSH J1434.3-4418

Lupus

The focus of this gathering is the magnitude 8.5 star with a few similar magnitude 10 stars protecting the leader. Seen as a whole, the grouping forms a sort of triangle shape. However, the beautiful spiral galaxy NGC 5643 with a magnitude of 10.9 dominates the field of view as seen in the Deep Sky Survey photograph below.

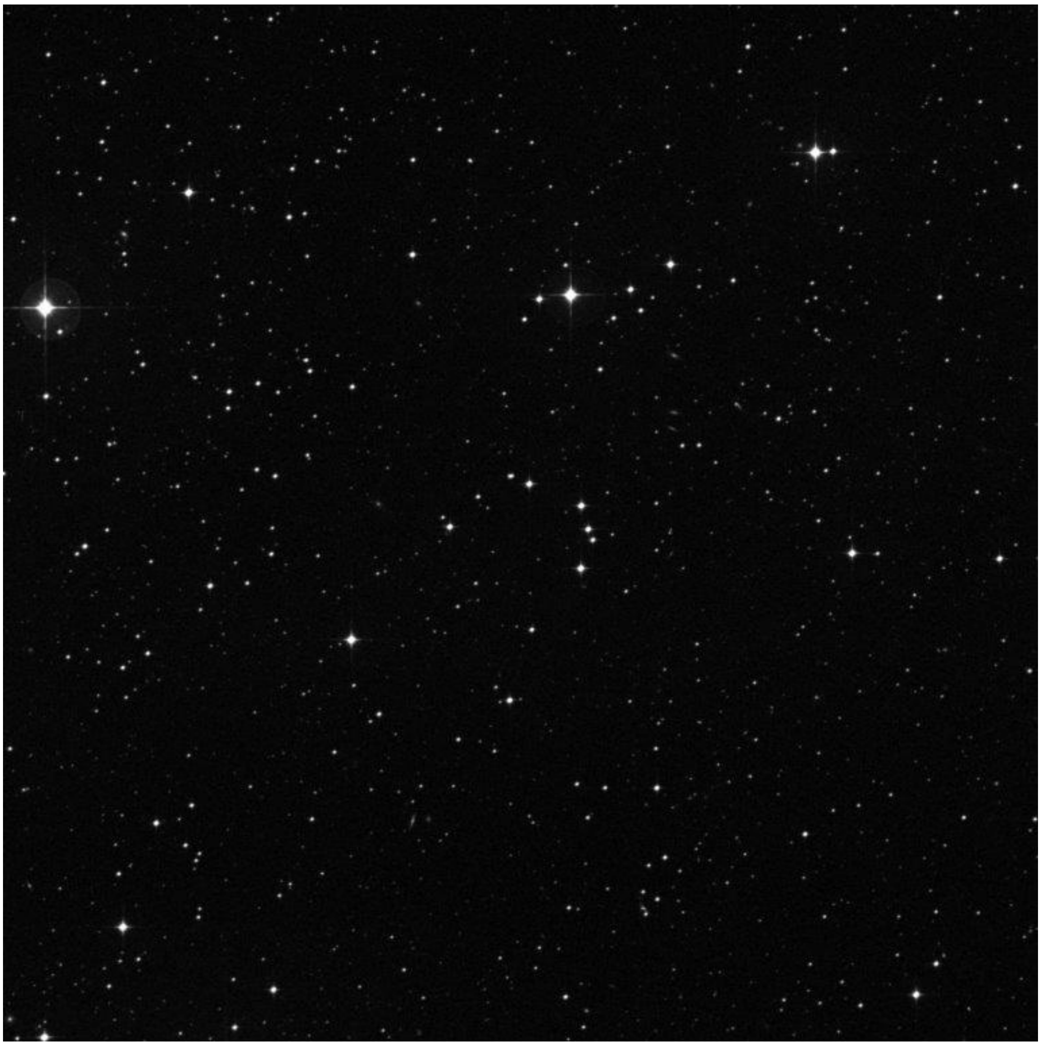
OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 74 DSH J1434.3-4418	Asterism	14h34m.20	-44°18’.18	11	7’



STREICHER 75 – J2113.2-5925
Indus

A near perfect halfmoon, quite outstanding in a bare star field. The stars vary from 10 to 11 in magnitude with the open side towards the south-east. A few arc-minutes north another smaller grouping also draws attention.

OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 75 DSH J2113.2-5925	Asterism	21h13m.11	-59°25'.48	10.8	4.5'



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, the annual *Sky Guide Africa South* and *Nightfall*.
Membership: Membership of the Society is open to all. Potential members should consult the Society's web page : http://assa.saao.ac.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, Pretoria and the Garden Route Centre; membership of any of these Centres automatically confers membership of the Society.
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