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Cover Photo:

The Swedish-built Band 1 receiver can be seen mounted underneath the dish's round white secondary mirror. See Article on p63.

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News Note: Swedish receiver to catch cosmic waves in the world's largest radio telescope

Just arrived in South Africa, Chalmers' most advanced radio receiver is Sweden's main contribution to the record-breaking telescope SKA (Square Kilometre Array). The advanced prototype, now being tested in the Karoo Desert, is not only shiny and new. It's also an important step towards a radio telescope that will challenge our ideas of time and space.

Onsala Space Observatory has delivered its largest technology contribution to the SKA (Square Kilometre Array) project. A metre across, the 180 kg instrument is the first in place of over a hundred to be mounted on dish antennas in the Karoo Desert, today home to the 64-dish-strong new MeerKAT telescope.

The receiver has been developed to capture the longest radio waves for which SKA's dish antennas are sensitive. The frequency range is called Band 1 and extends between 350 and 1050 MHz (wavelength 30-85 cm).

The project was led by Onsala Space Observatory, Chalmers. The design and system design of the feed was performed by Onsala Space Observatory and funded by the Swedish Research Council.

In industrial liaison for the project Chalmers has worked together with Big Science Sweden and Vinnova.

Several companies from both Sweden and abroad have also contributed to the project. Leax Arkivator, Gothenburg, Sweden, was responsible for the mechanical design of the feed. The metal parts were manufactured at Ventana Group in Hackås, Sweden, and at MegaMeta, in Kaunas, Lithuania. South Africa's EMSS has delivered control electronics. System engineering work was coordinated by EMSS Antennas in South Africa and the South African Radio Astronomy Observatory (SARAO). The

receiver’s amplifiers are developed by Low Noise Factory in Gothenburg, and were built in the clean room of Chalmers Nanofabrication Laboratory in Gothenburg. Industrial partners for the SKA project also include Omnisys, Gothenburg, Sweden, who developed design concepts early in the project. The overall project work was managed by CSIRO (Australia), CETC54 (China) and the SKA Organisation project office (UK).

The receiver is being tested on one of the 64 antennas in MeerKAT, one of today's largest radio telescopes and is in the same location in the Karoo desert where the SKA's antennas will be located. The instrument is a prototype manufactured in Sweden by Chalmers University of Technology in collaboration with Swedish industry, and it is designed to be mass-produced.

Sweden is one of 11 countries in the international SKA project, which will build the world's largest radio telescope at radio-quiet sites in Africa and Australia. The project is approaching the end of its design phase and construction is expected to start in the early 2020s.

As part of the SKA, Swedish receivers will participate in measurements of radio waves from many different sources in space. Scientists expect to make most sensitive radio measurements ever. They plan to test Einstein's theories to their limits and to explore the history of the universe by measuring millions of galaxies at distances of millions of light years.

This is a proud moment for Onsala Space Observatory, getting a first glimpse of what the world's biggest radio telescope will be like. Work with developing the world's best receiver technology and hope that this contribution to the telescope will make it possible for humanity to see things that have never been seen before.

The receiver’s journey to Africa has been preceded by intensive collaboration between researchers and engineers at Onsala Space Observatory together with industrial partners, to ensure both performance and resilience. Before its trip, the instrument underwent tough environmental tests in Sweden, both in Onsala and at Saab Bofors Test Centre in Karlskoga.

John Conway, professor of observational radio astronomy at Chalmers and director of Onsala Space Observatory, looks forward beyond MeerKAT to the future dish array, SKA-mid.

"When the dishes in SKA-mid are operational, the world's astronomers will be able to access the world's most sensitive radio telescope and many exciting projects will be possible. We hope, among other things, to find new pulsars to test Einstein's theories,

to study in detail how galaxies like the Milky Way were built during the history of the universe – and, of course, to make unexpected discoveries", he says.

Fig 1: The Band 1 receiver's protective cover reflects the desert Sun. To the right is the MeerKAT antenna's secondary mirror. (Credit: SARAO)

Fig 2: The Band 1 receiver with the engineering team giving some indication of its size.

News Note: Inauguration of the MeerLICHT telescope

On Friday May 25 – Africa Day 2018 – a new telescope has been inaugurated at the South African Astronomical Observatory (SAAO), near Sutherland, that will be an "eye of the MeerKAT radio array", the country's precursor to the Square Kilometre Array (SKA)

MeerLICHT, which means "more light" in Dutch, is an optical telescope that will simultaneously scan the Southern Skies together with MeerKAT. This creates a truly unique combination where astronomers will always be studying stars and galaxies in two parts of the spectrum at the same time.

The project is a Dutch – South African – United Kingdom collaboration involving researchers from six different institutes from the respective partner countries. It was decided to launch it on Africa Day to recognise and celebrate both our incredible African skies and the important partnerships between Europe and Africa that have led to this innovation.

MeerLICHT is a good example of projects aligned to the objective of the Multi-wavelength Astronomy (MWA) strategy, which was approved by the Department of Science and Technology (DST) in 2015.

The aim of the MWA strategy is to forge closer ties between radio, optical and gamma-ray astronomy communities and facilities to work together to achieve common scientific objectives and develop human capital.

Speaking at the inauguration of the telescope on Friday, the DST Director-General, Dr Phil Mjwara, said South Africa had chosen astronomy as the field of science to show its abilities in research on a global scale, to bolster technological development in the fields of telecommunication, Big Data and large-scale computing, and as the field best able to bring science to the people.

"MeerLICHT is also foreseen to play an important role in the astronomical education of people in southern Africa. The project team also hopes that the MeerLICHT project can grow into a stepping stone to allow other southern African countries to share in humanity's fascination of the night sky,' said Dr Mjwara.

Among the chief scientific goals of MeerLICHT is the study of stellar explosions, which need to be investigated intensely before they fade away again. "The study of exploding stars across the Universe will gain a whole new dimension", states University of Cape Town Prof. Patrick Woudt, co-principal investigator of the MeerLICHT telescope.

The MeerLICHT telescope was purpose-built to combine excellent resolution with a wide field of view. It sees more than 13x the Full Moon while being able to see objects one million times fainter than is possible with the naked eye.

The telescope achieves this amazing combination by coupling a 65cm diameter main mirror with a single 100 megapixel detector, which is a full 10cm x 10cm in size. This camera uses the largest single detector used in optical astronomy anywhere in the world. The telescope was designed and built in the Netherlands, and then shipped to South Africa.

“We started work on the technical definition of this telescope back in 2012, and it is fantastic to see what amazing views it produces”, adds Radboud University Prof. Paul Groot, co-principal investigator.

The link with the MeerKAT radio array has astronomers across the world excited about the new combination. “For us, it was the reason to join this consortium. Flashes of radio emission known as Fast Radio Bursts may now be ‘caught in the act’ by both MeerKAT and MeerLICHT”, explains University of Manchester’s Prof. Ben Stappers, MeerLICHT collaborator, and leader of the MeerTRAP project. “ Hopefully we can finally determine the origin of these enigmatic flashes”.

Prof. Rob Fender, of the Universities of Oxford and Cape Town, co-principal investigator of the telescope, was excited about the inauguration and beginning of operations of the telescope. “This is the beginning of a new phase of coordinated multi-wavelength research into the most extreme astrophysical events” , he said.

“Besides extreme astrophysics, typically associated with black holes and neutron stars, we will also study normal stars, in particular those that produce strong flares” adds Prof. Rudy Wijnands of the University of Amsterdam, “The simultaneous optical-radio monitoring of these stars will allow us to investigate the impact of such flares on the habitability of the planets around them.”

The MeerLICHT telescope will be housed at the Sutherland Observatory, run by the South African Astronomical Observatory. “MeerLICHT directly links the whole optical observatory, and especially our 10 meter SALT telescope, to the MeerKAT array. It fits perfectly in our strategy to turn the Sutherland Observatory into an efficient transient machine to study the dynamic Universe”, adds Dr. David Buckley of the South African Astronomical Observatory.

MeerLICHT is a South African – Netherlands – United Kingdom collaboration involving researchers from six different institutes from the respective (SKA) partner countries.

The MeerLICHT consortium is a partnership between Radboud University Nijmegen, the University of Cape Town, the Netherlands Organisation for Scientific Research (NWO), the South African Astronomical Observatory (SAAO), the University of Oxford, the University of Manchester and the University of Amsterdam, in association with the South African Radio Astronomy Observatory (SARAO), the European Research Council and the Netherlands Research School for Astronomy (NOVA). The SAAO and SARAO are National Facilities of the National Research Foundation (NRF). The detector's cryostat was built at the KU Leuven, Belgium.

(1) MeerLICHT is a wide-field, fully robotic 0.65-m optical telescope, located at the Sutherland station of the South African Astronomical Observatory in the Northern Cape province in South Africa. This is one of the darkest astronomical sites in the world. By exclusively linking MeerLICHT to MeerKAT, the telescope will, for the first time ever, provide optical multi-band observations of every night-time observation conducted by a radio telescope.

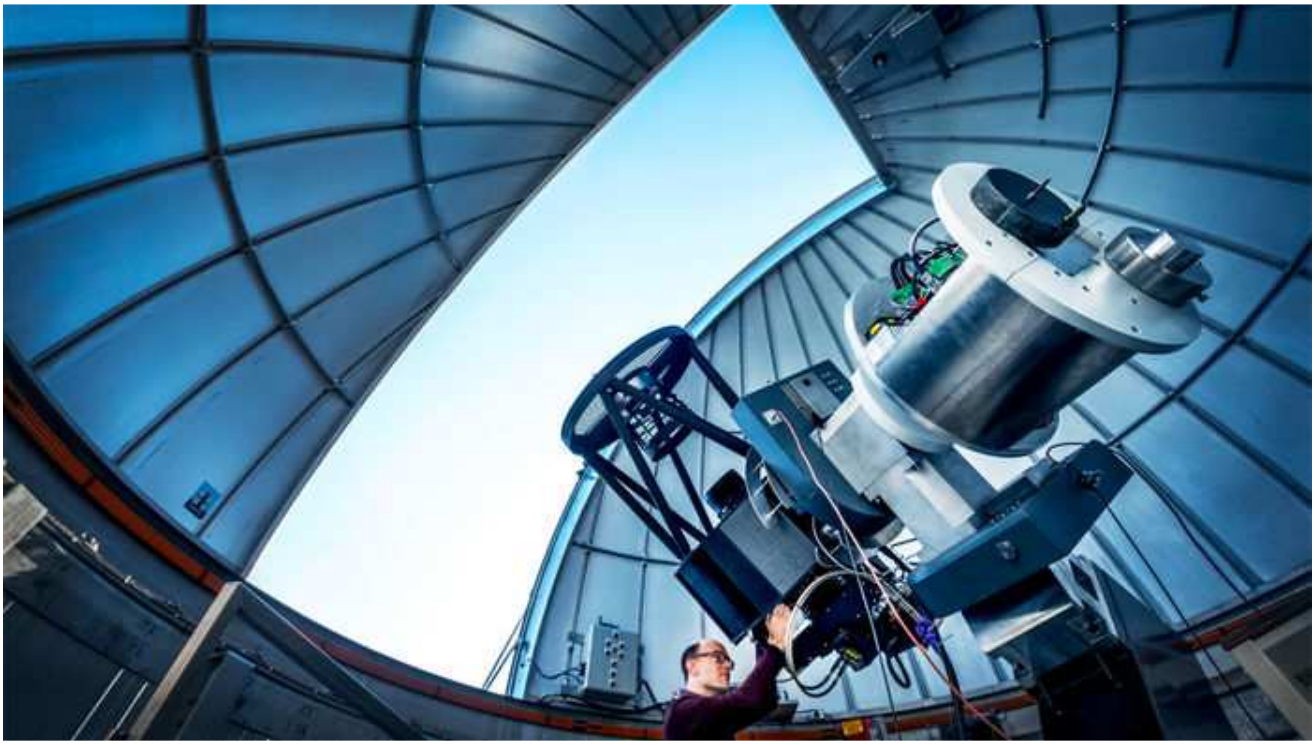


Fig 1. The Meerlicht telescope in the former 0.75-m telescope dome at Sutherland.

News Note: SALT sees double in The Hourglass Nebula

The Southern African Large Telescope (SALT) at the South African Astronomical Observatory (SAAO) in Sutherland has discovered a binary star system in The Hourglass Nebula, one of the most famous nebulae captured by the Hubble Space Telescope.

The Hourglass Nebula consists of two hourglass-shaped lobes of gas and what appears to be an eye staring right back at us. Shells of gas form the eye surrounding the hot central star that illuminates the nebula like a neon sign. Astronomers have long suspected the peculiar nebula to be formed by two interacting stars in a binary system, but until now no one could prove it. The SALT discovery of two stars orbiting each other every 18.15 days in The Hourglass Nebula firmly settles the matter and gives new insights into how a wide variety of close binary stars and hourglass-shaped nebulae may form.

An international team of astronomers, led by SALT Astronomer Dr Brent Miszalski at the SAAO, used SALT to peer into the "sparkle" of the eye of the Hourglass Nebula – its central star.

Dr Miszalski says, "A total of 26 SALT measurements were taken that detected the small movements of the central star towards or away from us caused by the gravity of a second companion star. This Doppler or "wobble" method, that can also be used to find planets around other stars, revealed a hidden companion orbiting the central star every 18.15 days."

Co-author of the study, Mr Rajeev Manick, formerly a Masters student at SAAO and The University of Cape Town, and now completing his PhD at The Katholieke Universiteit Leuven in Belgium, analysed the SALT measurements and found that the companion must be a small, cool star about 5 times lighter than the Sun.

Another surprise came with the binary – the relatively wide separation between the two stars is remarkable. Co-author Professor Joanna Mikołajewska of the Nicolaus Copernicus Astronomical Center in Warsaw, Poland, a major partner in SALT, Prof. Mikołajewska says, "Previous authors have suggested that a nova explosion could explain many aspects of The Hourglass Nebula, but curiously we found the stars were too far apart for this to have ever been possible."

Instead of a nova explosion, the orbital period indicates the Hourglass Nebula formed through an interaction that many close binary stars experience – a so-called common-envelope stage. In this scenario, the cooler companion spirals into the atmosphere of its larger companion and helps ejects the shared atmosphere which we now see as

the nebula. The Hourglass Nebula is one of very few such examples to show an orbital period above 10 days, making it helpful to improve our understanding of this brief phase that many types of binary stars experience during their lifetime.
While astronomers still do not quite understand how hourglass-shaped nebulae form, the discovery of a binary in The Hourglass Nebula considerably strengthens the long suspected, but difficult to prove, connection between binary stars and hourglass-shaped nebulae. A famous example is the nebular remnant of Supernova 1987A that is often compared against The Hourglass Nebula because of its very similar shape. It is thought to have resulted from the merger of two massive stars before the supernova event. This process shares similarities with that which formed The Hourglass Nebula, hinting at some shared physics resulting in two of the most unusual nebulae in the sky.

Dr Miszalski says, “The combination of SALT’s enormous 11-metre mirror, highly sensitive instrumentation and flexible queue-scheduled operations was fundamental to making this difficult, cutting-edge discovery. We will continue searching other nebulae for new binary systems to gain more insights into their complex origins.”

The study entitled “SALT HRS discovery of the binary nucleus of the Etched Hourglass Nebula MyCn 18” was recently accepted for publication in the Publications of the Astronomical Society of Australia (PASA) journal and is available from https://arxiv.org/abs/1805.07602. The work is the result of a collaboration between astronomers at SAAO and SALT in South Africa, the Nicolaus Copernicus Astronomical Center in Poland, and The Katholieke Universiteit Leuven in Belgium.

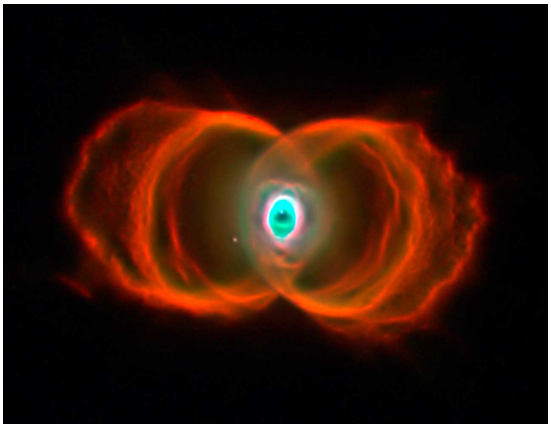


Fig 1. The Hourglass Nebula as viewed by the Hubble Space Telescope in the light of ionized nitrogen (represented by red), hydrogen (green), and doubly-ionized oxygen (blue). A remarkable new SALT discovery has proven the ionizing star to be a binary system. Credit: ESA/Hubble.

Historical background:

The Hourglass Nebula was discovered by Margaret Walton Mayall and Annie Jump Cannon from photographs taken during 1938-1939 with telescopes located in Bloemfontein, South Africa. Its enigmatic beauty was only revealed much later by the *Hubble Space Telescope* in 1995 and soon drew widespread attention amongst the wider public, gracing the covers of the April 1997 issue of National Geographic and

Pearl Jam's 2000 album Binaural (Fig. 1). Now in 2018, the Southern African Large Telescope has finally proved the long suspected binary nature of its central star.

Patricia Whitelock SAIP Gold Medalist 2018

At the 62nd Annual SA Institute of Physics, SAIP, Conference held at the University of the Free State, it was announce that Prof. Patricia Whitelock was awarded the prestigious De Beers Gold Medal. It is awarded for outstanding achievement in any of the following facets of any branch of physics: research, education, technology and industrial development. As the highest standards will be applied, the award is intended to be the greatest distinction that can be conferred in South Africa for achievement in physics.

Citation

The SAIP Gold award is made for outstanding achievements in any of the following facets of any branch of Physics: research, education, technology and industrial development. As the highest standards are applied, the award is intended to be the greatest dis9nc9on that is conferred in South Africa for achievements in Physics.

The 2018 SAIP Gold Medal is awarded to Professor Patricia Ann Whitelock for her outstanding research career in astronomy and astrophysics, and for her distinguished and extensive contributions to leadership, education and human capacity development of the Physics and Astronomy community.

Prof Whitelock is an NRF A-rated researcher who has authored and co-authored 190 peer-reviewed journal articles over her career. Her research is focused on our understanding of the late stages of stellar evolution and mass-loss of evolved stars, the structure of the Milky Way galaxy, and the stellar content of the local group galaxies. Her scientific work has been cited over 8000 times.

Prof Whitelock's association with the South African Institute of Physics is long and distinguished. She has been a member since 1985, she chaired the Astrophysics group between 1990 and 1997, she served on council from 1997 to 2005, and as president from 2001 to 2003. Under her leadership, the SAIP started the "Future of Physics" initiative in 2001. She was elected an honorary member of the SAIP in 2008.

During Prof Whitelock's career she has held various important positions. She served as deputy director, acting director, and director of the South African National Facility

for Optical Astronomy, the South African Astronomical Observatory. She also served on the NRF executive from 1998 to 2003. She currently is the chair of the Scientific Council of the Strasbourg Astronomical Data Centre and is a member of two executive committee working groups of the International Astronomical Union: 1) Global Coordination of Ground and Space Astrophysics, and 2) Women in Astronomy.

Prof Whitelock's contribution to the development of the astronomical community in South Africa are extensive. She helped to establish the National Astrophysics and Space Science Program where she served as the first chair of its steering committee between 2002 and 2013. She was also one of the key drivers behind the successful bid by South Africa to host the international Office of Astronomy for Development of the IAU. She served on its founding steering committee and currently serves on the steering committee of Southern African Regional Office of Astronomy for Development.

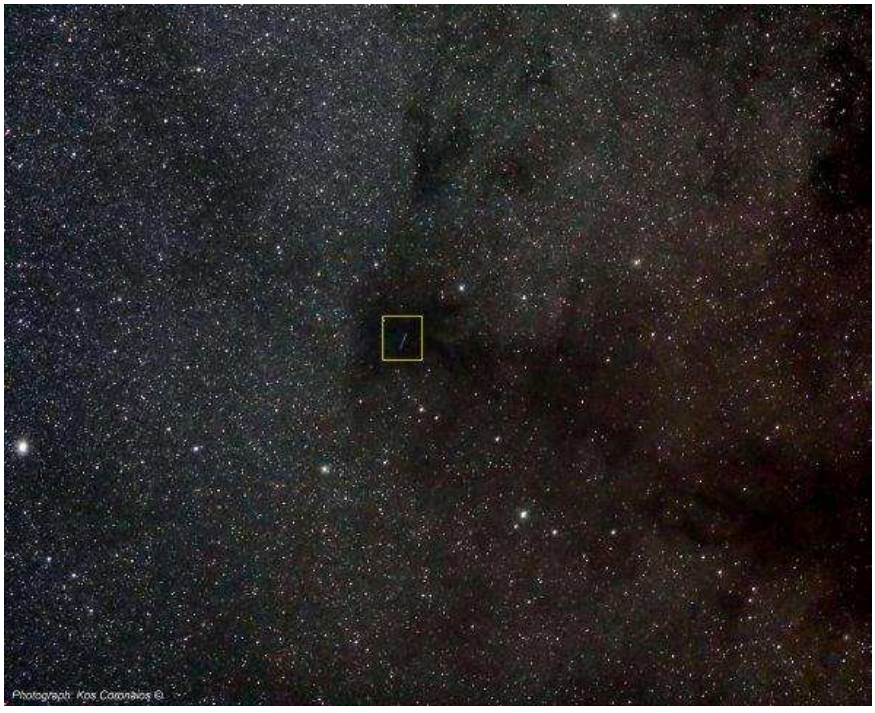
By awarding the 2018 SAIP Gold Medal to Prof Whitelock, the SAIP bestows onto her the greatest distinction that is conferred in South Africa for achievements in Physics.

Asteroid 2010 WC9

Kos Coronaios

During the recent Southern Cape Astronomy Club's stargazing evening at the Village Green, in Pearly Beach. The highlight during this period of clear skies was the close approach of the "lost asteroid"; known as the "lost asteroid" because astronomers lost track of it after its discovery in November 2010.

Fig 1 was taken on 15 May, 2018 at 18:34 UT. It is one 30 second light frame, using a Canon 60D with 200mm lens working at f2.8, ISO 3200. The bright object on the left hand side of the image is the globular cluster M19 Field of view is 4.91 x 3.96 degrees.



The asteroid, diameter of between 60 - 130 metres, passed Earth at half the distance to the Moon on Tuesday, 15 May. Closest approach was 0.55 lunar distance (203 000 km with a relative velocity of 12.8 km. s^{-1}. The asteroid shone like an 11^{th} magnitude star. The asteroid is in the same class as the Tunguska impactor that levelled a forest in Siberia in 1908. A 300 mm and 200mm telescopes were used for, imaging and observing respectively, during the asteroid's close approach.

This Apollo type NEO (near Earth object) was discovered by the Catalina Sky Survey (Tucson, Arizona), on 30 October 2010. It was observed through to December of that year, and when the asteroid reached an apparent magnitude of +21.8 it was becoming too faint to track. It has a perihelion of 0.77 AU and an Aphelion of 1.37 AU, an orbital period of 1.12 years, with a rotational period of 8 – 20 minutes.

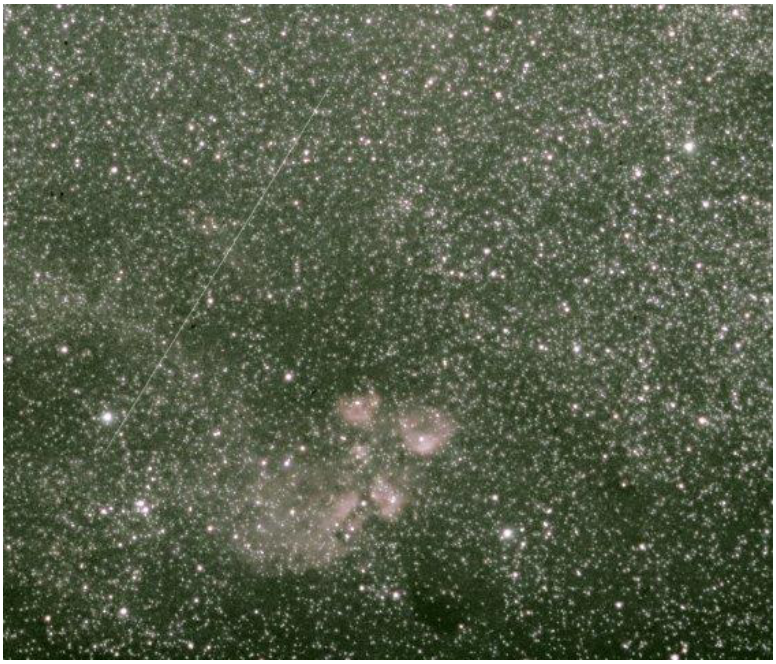


Fig 2 is a 10 minute stack at ISO 3200 showing the asteroids movement over a 10 minute period.

Fireball Disintegrates over Botswana

The tiny Asteroid discovered on Saturday 2 June disintegrated hours later over Southern Africa

A boulder-sized asteroid designated 2018 LA was discovered Saturday morning, 2 June, and was determined to be on a collision course with Earth, with impact just hours away. Because it was very faint, the asteroid was estimated to be only about 2 m across, which is small enough that it was expected to safely disintegrate in Earth's atmosphere. Saturday's asteroid was first discovered by the NASA-funded Catalina Sky Survey, located near Tucson and operated by the University of Arizona.

Although there was not enough tracking data to make precise predictions ahead of time, a swath of possible locations was calculated stretching from Southern Africa, across the Indian Ocean, and onto New Guinea. Reports of a bright fireball above Botswana, Africa, early on Saturday evening match up with the predicted trajectory for the asteroid. The asteroid entered Earth's atmosphere at the high speed of 17 $km.s^{-1}$ at about 18h:44 p.m. SAST and disintegrated several miles above the surface, creating a bright fireball that lit up the evening sky. The event was witnessed by a number of observers and was caught on webcam video.

When it was first detected, the asteroid was nearly as far away as the Moon's orbit, although that was not initially known. The asteroid appeared as a streak in the series of time-exposure images taken by the Catalina telescope. As is the case for all asteroid-hunting projects, the data were quickly sent to the Minor Planet Centre in Cambridge, Massachusetts, which calculated a preliminary trajectory indicating the possibility of an Earth impact. The data were in turn sent to the Centre for Near-Earth Object Studies (CNEOS) at NASA's Jet Propulsion Laboratory in Pasadena, California, where the automated Scout system also found a high probability that the asteroid was on an impact trajectory. Automated alerts were sent out to the community of asteroid observers to obtain further observations, and to the Planetary Defence Coordination Office at NASA Headquarters in Washington. However, since the asteroid was determined to be so small and therefore harmless, no further impact alerts were issued by NASA.

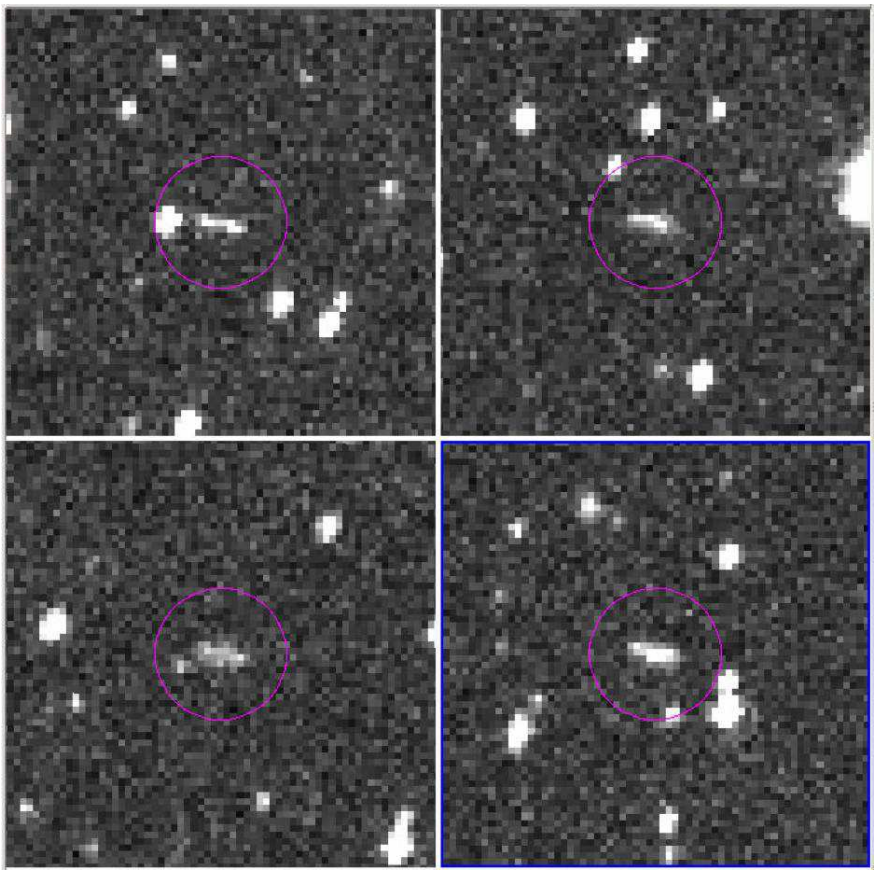


Fig 1. T*hese are the discovery observations of asteroid 2018 LA from the Catalina Sky Survey, taken 2 June, 2018. About eight hours after these images were taken, the asteroid entered Earth's atmosphere and disintegrated in the upper atmosphere near Botswana, Africa. Image Credit: NASA/JPL-Caltech/CSS-Univ. of Arizona*

“This was a much smaller object than we are tasked to detect and warn about,” said Lindley Johnson, Planetary Defence Officer at NASA Headquarters. “However, this real-world event allows us to exercise our capabilities and gives some confidence our impact prediction models are adequate to respond to the potential impact of a larger object.”

The ATLAS asteroid survey obtained two additional observations hours before impact, which were used by Scout to confirm the impact would occur, and narrowed down the predicted location to southern Africa. Infrasound data collected just after the impact clearly detected the event from one of the listening stations deployed as part of the International Monitoring System of the Comprehensive Nuclear-Test-Ban Treaty. The signal is consistent with an atmospheric impact over Botswana.

“The discovery of asteroid 2018 LA is only the third time that an asteroid has been discovered to be on an impact trajectory,” said Paul Chodas, manager of the Centre for Near-Earth Object Studies (CNEOS) at JPL. “It is also only the second time that the impact location was predicted well ahead of the event itself.”

The first event of this kind was the impact of asteroid 2008 TC3, which lit up the predawn sky above Northern Sudan on 7 October, 2008. That was a slightly larger asteroid (4 m in size), and it was discovered a full 19 hours before impact, allowing for a large number of follow-up observations and a very precise trajectory to be calculated. The second predicted impact event was for asteroid 2014 AA, which was discovered only a few hours before impact on 1 January, 2014, in the Atlantic Ocean, leaving too little time for follow-up observations. The Catalina Sky Survey has been responsible for discovering all three of these small asteroids on impact trajectories, and all on the watch of the same observer, Richard Kowalski.

Fragment of Impacting Asteroid Recovered In Botswana

Rebecca McDonald, SETI

A meteorite was found in Botswana’s Central Kalahari Game Reserve (CKGR) that is a fragment of asteroid 2018 LA. This small asteroid was discovered in space by the University of Arizona's Catalina Sky Survey on June 2, 2018, eight hours before hitting Earth.

(Mountain View, CA, July 6, 2018) A meteorite was found in Botswana’s Central Kalahari Game Reserve (CKGR) that is a fragment of asteroid 2018 LA. This small asteroid was discovered in space by the University of Arizona's Catalina Sky Survey on June 2, 2018, eight hours before hitting Earth. The asteroid burst through the upper

atmosphere and resulted in a meteor fireball. The asteroid detonated a few seconds after entry and the explosion was witnessed in Botswana and neighbouring countries.

"The biggest uncertainty we faced was to determine where exactly the meteorites fell," says Peter Jenniskens a subject expert of the SETI Institute in California, who travelled to Botswana to assist in the search. He teamed up with Oliver Moses of the University of Botswana's Okavango Research Institute (ORI), to gather security surveillance videos in Rakops and Maun to get better constraints on the position and altitude of the fireball's explosion. Team member Tim Cooper of the Astronomical Society of Southern Africa (ASSA) calibrated videos to the south.

After disruption, the asteroid fragments scattered over a wide area, blown by the wind while falling down. Calculations of the landing area were done independently by the NASA-sponsored group headed by Jenniskens, as well as by Esko Lyytinen and Jarmo Moilanen of the Finnish Fireball Network. These calculations were defining the fall area well enough to warrant the deployment of a search expedition.

The first meteorite was found after five days of walking and scouring a landscape of sand, thick tall grass, shrubs and thorn bushes by a team of geoscientists from the Botswana International University of Science and Technology (BUIST), the Botswana Geoscience Institute (BGI) and from ORI, guided by Jenniskens. The Botswana Department of Wildlife and National Parks granted access and deployed their park rangers to provide protection and participate in the search. BUIST student Lesedi Seitshiro was first to spot the stone.

This is only the second time in history that a small asteroid observed in space was recovered following its impact on Earth.

"As geologists from BIUST we see it as our mandate and duty to respond quickly to events like this one and to recover the material, both for research purposes and as part of the heritage of Botswana," explains Prof. Alexander Proyer, leader of the joint expedition. "The challenge was to search for a meteorite in 200 square kilometers of uncharted wild in a park teeming with elephants, lions and snakes."

"Meteorites are protected under Botswana law," says Mr. Mohutsiwa Gabadirwe, senior curator of the Botswana Geoscience Institute, who coordinated the access to the protected fall area in the game reserve. "This meteorite is a priceless piece of rock that the people of Botswana will want to enjoy seeing on display for generations to come."

The Catalina Sky Survey project is one of several sponsored by NASA's Planetary Defence Coordination Office in the United States.

Editor's Note

ASSA's Director of Comets and Meteors, Tim Cooper, was very involved in locating the meteors impact site, locating the meteorite, and spent a great deal of time in doing so. Tim will produce a detailed article on his efforts in the next edition of *MNASSA* and publish his results.

Fig. 1 Meteorite from 2018LA found in Botswana desert

The Royal Observatory Rainfall Records

I.S. Glass, SAAO

Introduction

The Cape Town site of the SA Astronomical Observatory, formerly the Royal Observatory, Cape of Good Hope, is responsible for the longest set of rainfall records in South Africa, the series having started towards the end of 1841.

In its early days, the Royal Observatory was regarded as the main source of scientific information in the Cape Colony. Besides its astronomical work it provided the standard time and was the custodian of the standard set of weights and measures. It is unsurprising therefore that they also recorded the weather conditions.

In view of the current interest in climate change and the drought of the last few years in Cape Town, I thought it would be interesting to draw more attention to this long-term set of data. No great originality is claimed for this paper.

The Data

Unfortunately I have not so far found all the Observatory's own records for the whole period. Up to about the 1960s most of them are available. In fact, the average annual rainfall was published in the Annual Reports of the Royal Observatory for many years, together with the minimum and maximum months. Detailed month-by-month figures are also available in certain ledgers but earlier and later years are missing. Fortunately, data were forwarded by the Observatory to the Weather Bureau in Pretoria in a prescribed form and since 2009 the Bureau has had an automatic monitoring station on the roof of the SAAO Technical Building.

The weather bureau has kindly made the records available to me.

The database that I have prepared for use with OpenOffice Calc includes the monthly and annual figures for the whole period, with some exceptions. There are a few dates for which they are slightly incomplete but at a level that should not affect the conclusions significantly.

The average annual rainfall and its standard deviation were calculated from the database and are shown in Fig 1. A straight line was fitted and its slope and probable error calculated.

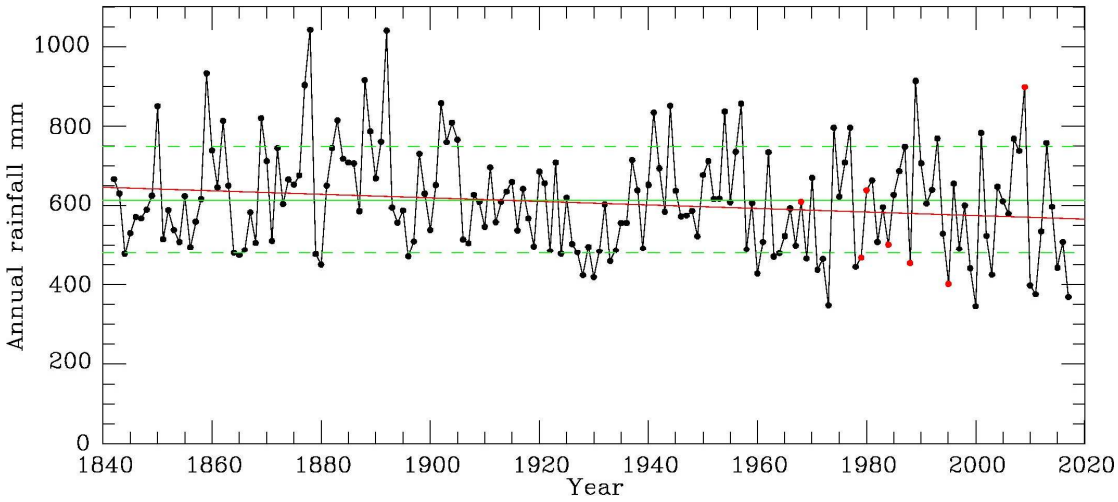


Fig 1. Annual rainfall from 1842 to 2017. Red points may be slight underestimates. The mean rainfall (solid green line) was 614 mms and the standard deviation (dashed green lines) was 135 mms. The red line is the linear regression whose slope implies an annual decline in average rainfall of -0.45±0.20 mms.

Fig 2 shows the monthly averages and their standard deviations as well as the figures for the wettest and driest years since 1842.

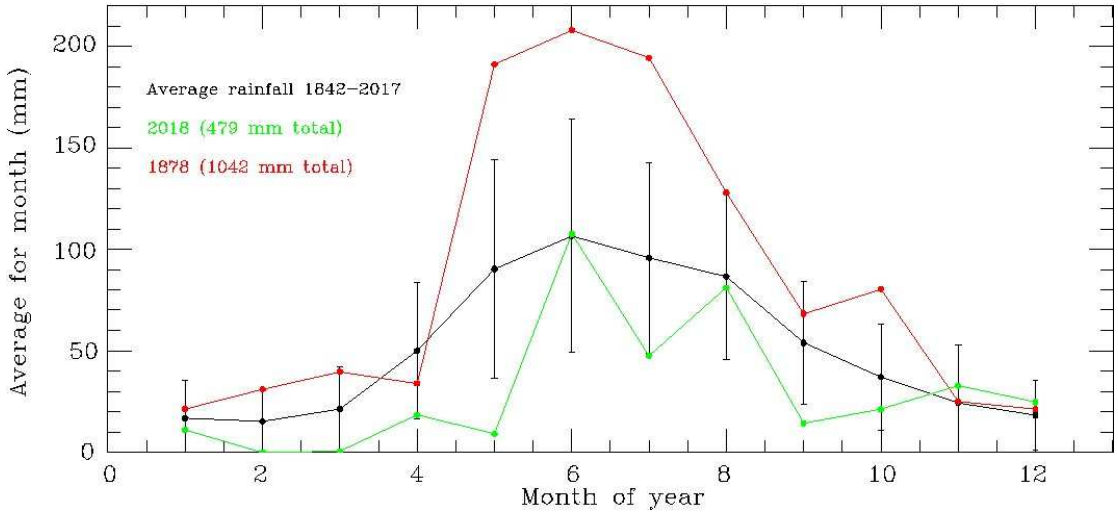


Fig 2. The average monthly rainfall and standard deviations of the individual monthly numbers. Also given are the figures for the years with the highest (1878) and lowest rainfalls (2017)

Discussion

The average annual rainfall at the Observatory over the past 176 years has been 614 mms. One might not expect this figure to be representative of the entire city because of the effects of Table Mountain and other geographical factors. However, please see the last paragraph of this section.

The wettest month on average is June. However, as the standard deviations show, the year-to-year variations are huge and probably reflect the fact that rainfall is often dominated by a small number of heavy storms, of which only one or two might fall in a particular calendar month.

The years 1878 and 1892 had rainfall of over three standard deviations greater than the mean! The highest rainfall in any single month was recorded in 1877 May, with 342 mms.

Intervals of several years of below-average rainfall are not unusual. Especially from 1925 to 1934 every year was below the mean. However, in recent years there have been more years than usual with rainfall almost two standard deviations below the mean.

It appears that there has been a slow decline in the rainfall amount on average. The linear regression suggests a long-term decrease of 0.45±0.20 mms per year, at least taken over the past 176 years. Obviously this rate of decline could not have persisted for millennia!

Some of these data have been discussed by Koopman, A. and de Buys, A., (2017) in conjunction with data from other stations in the general area. They also make the point that the recent drought is not as severe as that in 1925-1935. The main theme of their paper is that water storage in the city's dams has not kept up with the population increase in Cape Town and its surrounds.

The study "August 2004 Severe Storm Assessment" (2005; see references) discusses, in addition to the effects of the 2004 event, possible changes in the monthly distribution of rainfall over time, again relying on the Royal Observatory/SAAO data. The extreme variability of the year-to-year and monthly figures make these changes rather dubious. This study also gives rainfall figures for various weather stations around the Cape Peninsula with records exceeding 15 years, showing that the Observatory rainfall is only marginally higher that for most of the other suburbs.

Acknowledgments

I thank Abri de Buys (SA Environmental Observation Network) and Elsa de Jager Manager National Climate Centre, SA Weather Service for supplying data and other information.

Koopman, A. and de Buys, A., (2017). What do long-term data reveal about Cape Town's water shortage?
http://www.saeon.ac.za/enewsletter/archives/2017/october2017/doc01

August 2004 Severe Storm Post Flood Assessment, prepared by The Disaster Mitigation for Sustainable Livelihoods Programme (DiMP), University of Cape Town, May 2005.
http://www.riskreductionafrica.org/assets/files/CoCT2004_Complete%20Report.pdf

News Note: MeerKAT observes a rare burst of activity from a Magnetar

South Africa's MeerKAT radio telescope recently observed a rare burst of activity from an exotic star, demonstrating its outstanding capabilities as a new instrument for scientific exploration.

An article published today in the *Astrophysical Journal* presents the study of a magnetar -- a star that is one of the most magnetic objects known in the universe -- that awoke in 2017 from a 3-year slumber. Radio observations that could only be made with MeerKAT triggered observations with NASA X-ray telescopes orbiting the

Earth. This first publication in the scientific literature of astronomical discoveries requiring the use of MeerKAT heralds its arrival into the stable of world-class research instruments.

Dr. Fernando Camilo, Chief Scientist at the South African Radio Astronomy Observatory (SARAO, which includes the Square Kilometre Array South Africa project), describes the setting one year ago: that on 26 April 2017, while monitoring the long-dormant magnetar with the CSIRO Parkes Radio Telescope in Australia, one of our colleagues noticed that it was emitting bright radio pulses every 4 seconds. A few days later Parkes underwent a planned month-long maintenance shutdown. Although MeerKAT was still under construction, with no more than 16 of its eventual 64 radio dishes available, the commissioning team started regular monitoring of the star 30 000 light-years from Earth. The MeerKAT observations proved critical to make sense of the few X-ray photons we captured with NASA's orbiting telescopes -- for the first time X-ray pulses have been detected from this star, every 4 seconds. Put together, the observations reported today help to develop a better picture of the behaviour of matter in unbelievably extreme physical conditions, completely unlike any that can be experienced on Earth, according to Camilo.

The article, entitled *Revival of the Magnetar PSR J1622-4950: Observations with MeerKAT, Parkes, XMM-Newton, Swift, Chandra, and NuSTAR* by F. Camilo et al. has 208 authors. A handful of these are astronomers specialising in the study of Magnetars and related stars. The vast majority belong to the so-called MeerKAT Builders List: hundreds of engineers and scientists overwhelmingly from the SKA South Africa project and commercial enterprises in South Africa that over more than a decade have been developing and building MeerKAT -- a project of the South African Department of Science and Technology, in which 75% of the overall construction budget has been spent in South Africa

MeerKAT is an enormously complex machine. In order to make the exquisitely sensitive images of the radio sky that will allow scientists to better understand how galaxies like the Milky Way have formed and evolved over the history of the universe, the 64 MeerKAT antennas generate data at enormous rates. The challenges involved in dealing with so much data require clever solutions to a variety of problems at the cutting edge of technology. MeerKAT has a team of the brightest engineers and scientists in South Africa and the world working on the project, because the problems that need to be solved are extremely challenging, and attract the best.

Fig 1. Recent view of MeerKAT

Some of these people were in high school when the project started. SKA has implemented a human capital development programme focused on producing the South African engineers and scientists with the skills required to design, build, and use the telescope. Many of these young people are now employed at SARAO, at South African universities, and in the broader knowledge economy, according to Kim de Boer, Kim de Boer, Head of the SARAO Human Capital Development Programme.
According to Prof. Roy Maartens, SKA SA Research Chair at the University of the Western Cape, the first scientific publication based on MeerKAT data is a wonderful milestone. Although MeerKAT isn't yet complete, it's now clearly a functioning telescope. The training a new generation of researchers has begun, and soon SA young scientists will be using what promises to be a remarkable discovery machine.

Early in 2018, SARAO received the first Early Science MeerKAT observing proposals from South African researchers. Later in the year, already approved Large Survey Projects that will use two-thirds of the available observing time over 5 years will start their investigations with the full array of MeerKAT antennas. These 64 dishes, each 13.5 metres in diameter, are distributed across a span of 8 kilometres in a remote area of the Northern Cape. The 64 MeerKAT antennas are standing tall in the Karoo. The official unveiling of the telescope is being planned for the second half of 2018. Prof. Phil Diamond, Director-General of the SKA Organisation, congratulated his colleagues in SA for this outstanding achievement, building such telescopes is extremely difficult, and this publication shows that MeerKAT is becoming ready for business. As one of the SKA precursor telescopes, this bodes well for the SKA.

MeerKAT will eventually be integrated into Phase 1 of SKA-mid telescope bringing the total dishes at our disposal to 197, creating the most powerful radio telescope on the planet.

Getting to this point required the hard work and support of countless South Africans over more than a decade. This first article indicates, the telescope is now beginning to make scientific discoveries. As MeerKAT's capabilities continue to grow, many more will follow. It's tremendously gratifying to lead a team of such talented and passionate colleagues, who've been building in the Karoo a research instrument with few parallels anywhere, concluded Dr. Rob Adam, SARAO Managing Director.

Observing Records

Editors note

The recent plethora of Novae has led to a most welcome increase in observational data and articles. What's more there will be further articles as observations there will continue, and there are more to come! There is already another Nova in the constellation of Scuti, Nov. Scuti.

What is also pleasing to note is that Percy Jacobs has joined AAVSO and will act as a link between the ASSA and the AAVSO, leading hopefully to an increase in observational work on Novae, spectroscopy, photometry and variable star work.

I look forward to receiving further observational work for publication in your Journal *MNASSA*!

Nova Lupi 2018

Dave Blane

Another southern nova has been discovered by Rob Kaufman, only five months since his first discovery. Rob Kaufman, an Australian amateur astronomer, discovered yet another Nova! The nova is in the Lupus constellation, located near several naked-eye stars, including η Normae, ε Lupi and μ Lupi, as well as the bright Globular cluster NGC 5927. Rob discovered the 9th magnitude Nova on the night of 3 June, 2018, when it was near peak brightness. The next day, photometric and low resolution spectroscopic observations suggested that Kaufman's transient was most to likely be a Nova. High resolution spectroscopy subsequently confirmed this.

The discovery details are as follows:

2018 06 03.4306 UT Object discovered by Rob Kaufman (Bright, Victoria, Australia) at White Cliffs, NSW, Australia; object visible in 5 DSLR frames taken with 55mm lens. Position approximate – astrometry required. No minor planets or comets at this position, nor known variables in VSX. Last ASAS-SN observation 22 May 2018, nothing to 15.697 V.

Dr. E. Aydi et al. (South African Astronomical Obs., University of Cape Town), obtained high-resolution spectroscopy on 2018 June 04.76 UT using the High Resolution Spectrograph mounted on the Southern African Large Telescope (SALT). Their detailed list of line identifications may be seen in *ATel #11684*. The spectroscopy indicates that N Lup 2018 is a classical optically-thick nova near peak.

Since discovery the nova has fluctuated around 10.4 magnitude (TG) without any major "fireworks" and has not been systematically observed by many southern observers.

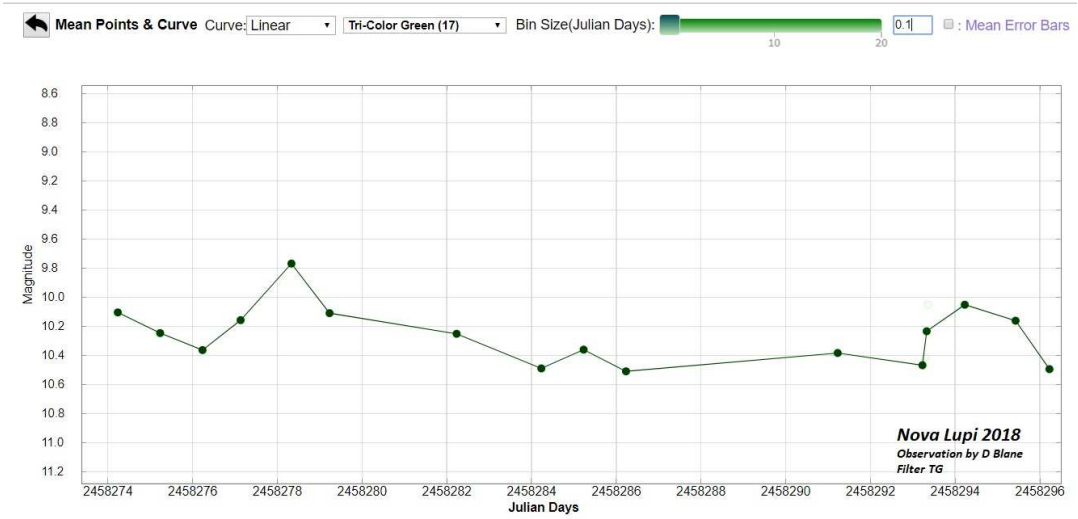


Fig 1. Light curve of Nova Lupi 2018.

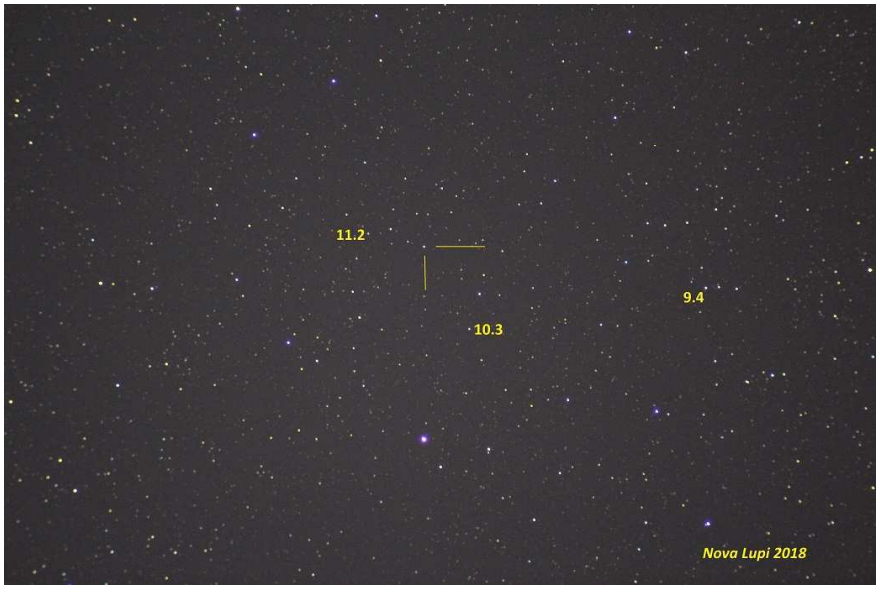


Fig 2. Field of Nova Lupi 2018

Nova Carina 2018: An update on Nova Carinae 2018 (ASASSN-18fv)

Dave Blane

In the April edition of MNASSA it was reported that the nature of this transient object was in doubt as early spectroscopy by J. Strader et al had not ruled out a galactic nova, but it was thought the transient might be a large outburst of a young stellar object.

However, later **s**pectroscopy on March 20th 2018 by P Luckas indicated that ASASSN-18fv is a classical nova and was brightening and in the optically thick (Fe curtain) phase.

The nova reached a maximum brightness of magnitude 6 and steadily faded to magnitude 10 by the end of June.

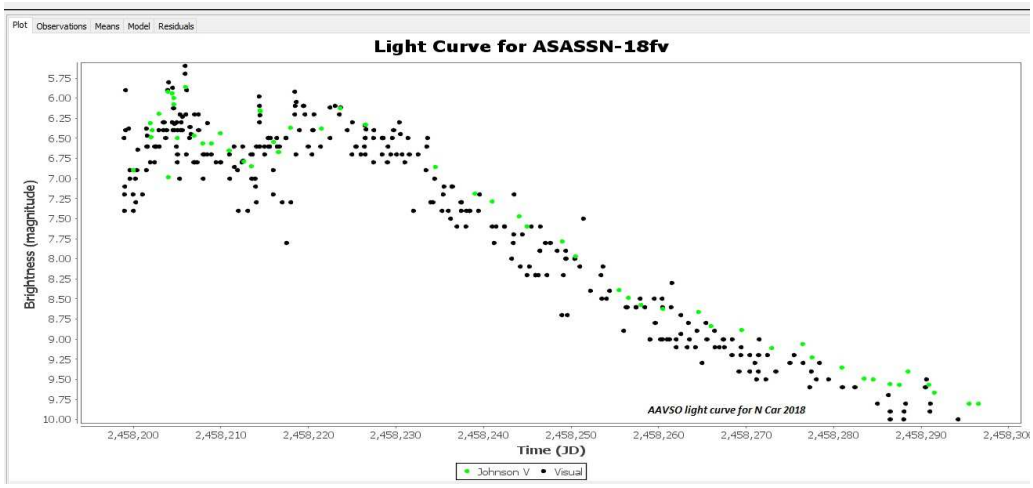


Fig 1. AAVSO light curve of Nova Carina 2018.

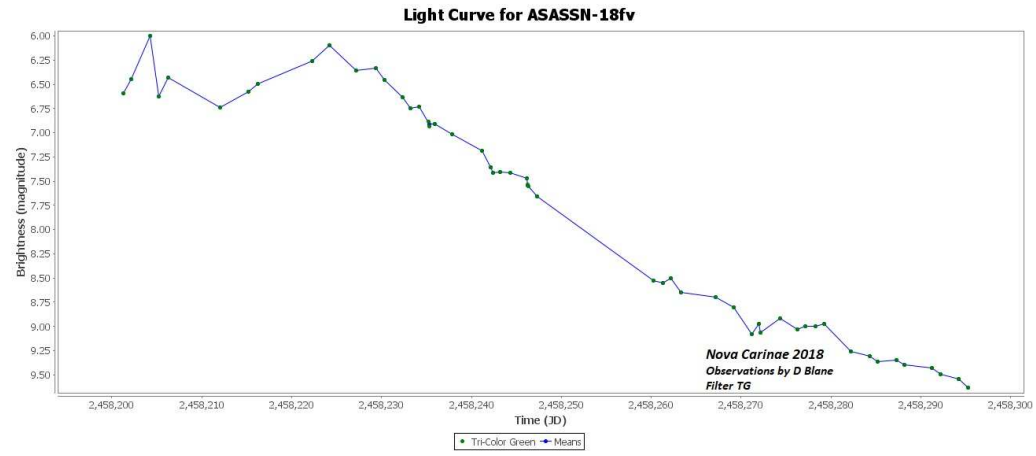


Fig 2. Light curve by David Blane.

Fig 3.
Image of nova Car 2018 by David Blane.

Nova Carina 2018

Ian Roberts

See the previous version of MNASSA for details on Nova Carina discovered by: All Sky Automated Survey for SuperNovae (ASAS-SN) and the resultant - "Alert Notice 626: Bright nova in Carina - ASASSN-18fv" of March 2018 issued by the AAVSO. The coordinates (2000.0) were: R.A. 10 36 13.71 Decl. -59 35 55.1 (from VSX)

The writer had images of the greater Eta Carina zone from previous work, two of which (see Figures 1 from March 2016 and 2 from March 2017) captured the star called out as a nova in the sky survey above. As can be seen it was already quite bright with a magnitude around 8.

The image in Figure 3 is from 20 June 2018 and the nova star appears very similar over this period of about 2 years.

The star appears in the NOMAD star catalogue with most of its luminosity in the blue spectrum, however, as can be seen in Figures 1 through 3 this has changed dramatically and the star displays as reddish-orange now. It is not known when that portion of the sky was scanned for inclusion in the NOMAD star data (it does not appear in the USNO-B1 catalog) but it must have been when the star was recorded at magnitude 16.58 prior to March 2016. This means the star, if correctly identified, had

an outburst prior to March 2016 and has maintained its increased luminosity, but with a colour change, for the past 2 years at least, an intriguing situation.

The images, Figures 1 through 3, were captured over the years with a Canon 1000D DSLR, all filtering removed, so the image sensor would be responsive to light at the low frequency end of the colour spectrum (Ha, etc) and possibly also in the near IR range.

A cheap, short focus f6.3 four inch refractor was used and care was taken to not overexpose the images.

Catalogue and measurement data
Catalog and measurement data
NOMAD ID nmd: 0304-0196226
Catalog co-ordinates J2000: 10 36 13.720 -59 35 55.34
Measured position: 10 36 15.4 -59 35 53.4
Catalog magnitude: Jmag: 16.202
Measured magnitude: (20 June 2018) 8.51
Colour seen: bright orange

For reference, the "companion" star labelled in these Figures has these parameters:
Object: 0303-00186142 Catalog: USNO-B1.0 + PPMXL corrections
Catalog position: 10 36 22.400 -59 36 32.29
Measured position: 10 36 22.414 -59 36 32.14
Catalog magnitude: 9.38
Measured magnitude 20 June 2018: 8.67
Colour seen: bright orange

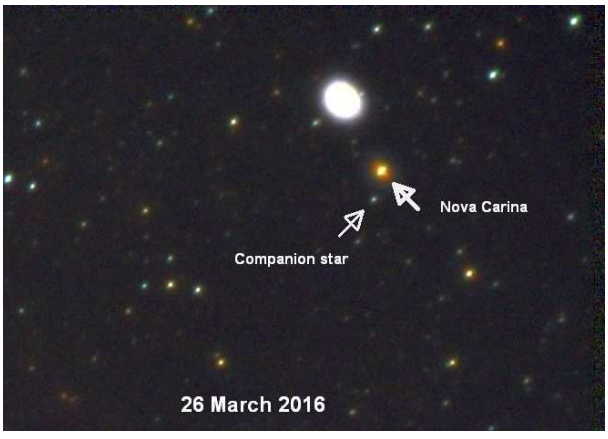


Fig 1. Nova Carina 26 March 2016. The bright star alongside is HIP 51912 magnitude 5.25 per catalogue.

Fig 2 (right). Nova Carina 27 March 2017.

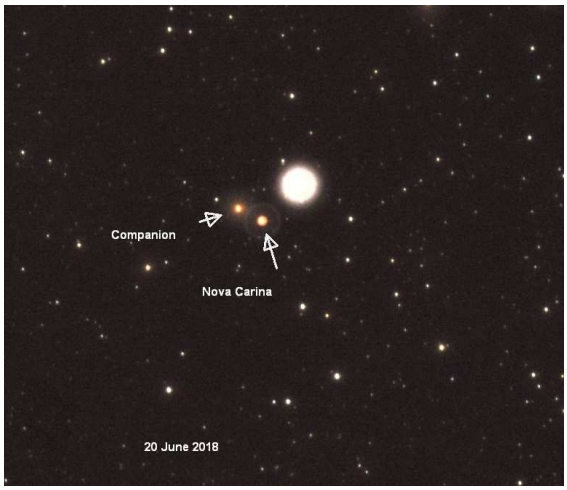


Fig 3. Nova Carina 30 June 2018. Slightly rotated figure.

Nova Circini 2018 (PNV J13532700-6725110)

Dave Blane

Another southern nova was discovered, this one by John Seach, in the early hours of January 19 in the constellation of Circinus, near alpha and beta Centauri. This nova rose slowly for several days from around magnitude 8.5 to 6.3 by January 27. It then fluctuated quite dramatically between magnitudes 6.5 and 8.5 for about 3 months making it a very interesting target to follow in small telescopes. It has since faded to below magnitude 9 on June 25th.
IAU discovery announcement:

“Possible new nova in Circinus. Discovered by John Seach, Chatsworth Island, NSW, Australia. DSLR with 50 mm f/1.2 lens. Object visible on 3 images. No object identified at position on 3 images taken with same instrument on Jan 18.7 UT. No minor planet or variable star at position. No object on DSS2-red."

Spectroscopy has confirmed that this is a classical Fe nova with strong hydrogen emission lines as well as the characteristic Fe lines.

According to CBET4482 issued on 30 January, spectroscopy by Strader et al., obtained with the 4.1-mSouthern Astrophysical Research Telescope using the Goodman spectrograph at Cerro Pachon, Chile, on 30 January, 21.28UT shows clear P-Cyg profiles in the Balmer lines, with the absortion troughs located about 1 300 km.s $^{-1}$ blue-ward of the rest wavelength (with emission FWHM about 1 500 km.s $^{-1}$), and a number of Fe II lines (some of which also have P-Cyg profiles – suggestive of a “Fe II-type nova.

The coordinates for the nova are : RA 13h53m27.00s, DEC -67°25'11.0" (J2000.)

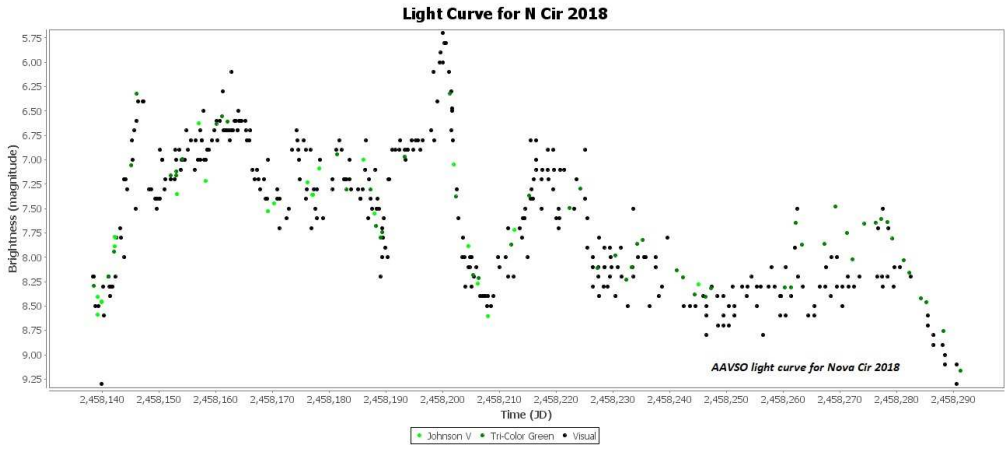


Fig 1. AAVSO light curve.

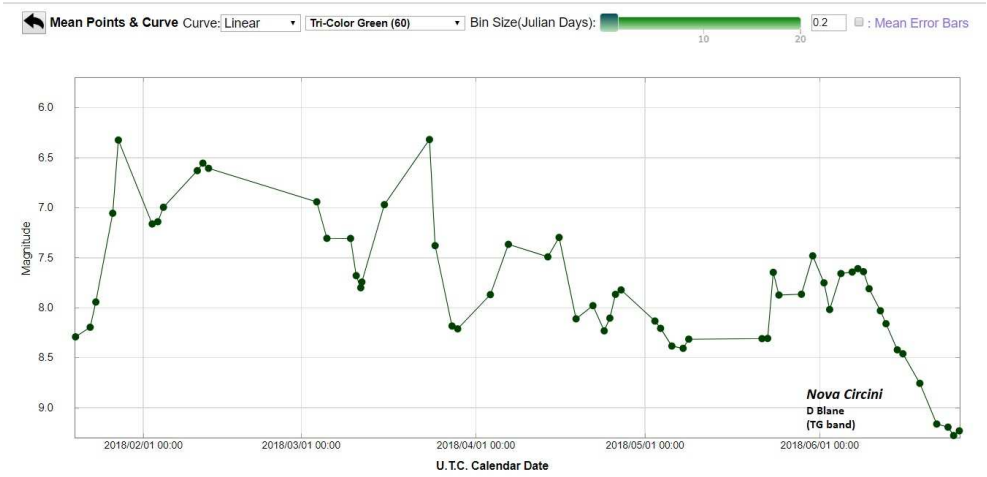
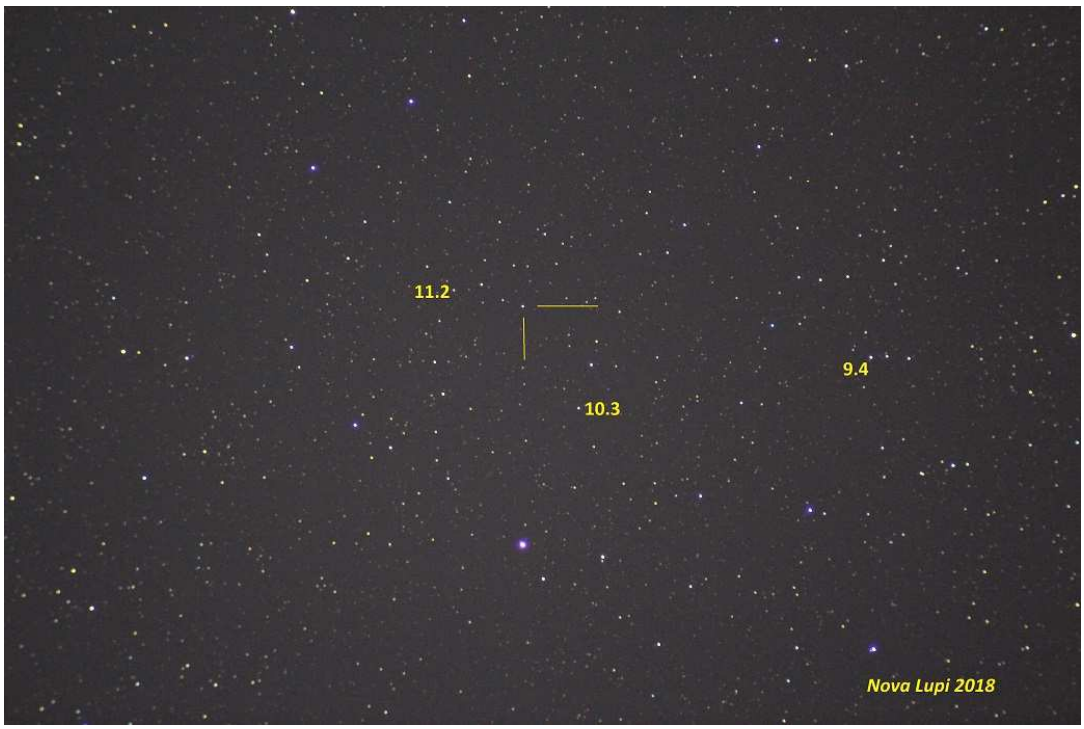


Fig 2. Dave Blane's light curve of Nova Cir 2018.

Fig 3. Nova Cir 2018 (D Blane).



Nova Lupus PNV J15384000-4744500

Ian Roberts

[Discovered by amateur astronomer Rob Kaufman]

Observers in the southern hemisphere are nicely placed for viewing two recent novas, one in Carina as reported in the last issue, and now Nova Lupus discovered 3 June by Rob Kaufman, amateur astronomer in Bright (Victoria, Australia). His equipment is very modest and consists of a *Canon DSLR (EOS 650D)* together with a 55mm F/5.6 lens.

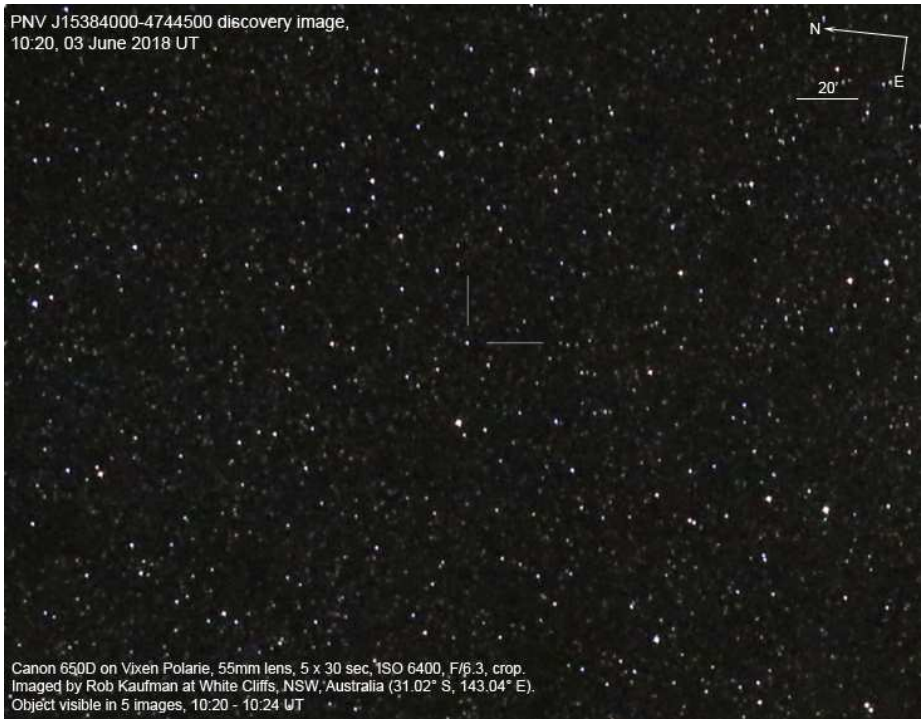


Fig 1. Nova Lupus 3 June 2018 (R Kaufman).

Kaufman used the same method used previously when discovering other novas: simple visual comparison of previous images versus the latest image acquired for that field. He noticed a bright object, not seen before in Lupus, and reported it to the AAVSO (American Association of Variable Star Observers) along with the RA and DEC calculated. The AAVSO then issued an alert notice, bringing the details to the attention of other observers: https://www.aavso.org/aavso-alert-notice-637

AAVSO suggested under Observing recommendations: Observations of all types (visual, CCD, DSLR, PEP, spectroscopy) and multiple bands as instrumentation permits are strongly encouraged as the nova evolves.

It is testimony to the enthusiasm and dedication of amateurs such as Kaufman that they are prepared to scan a rather uninspiring star field in Lupus on the off-chance of finding something of interest.

The SALT personnel and others (SMARTS 1.5m telescope at CTIO) used their high resolution equipment to report their findings in the Astronomers Telegram:

http://www.astronomerstelegram.org/?read=11684
SALT high-resolution spectroscopy of nova PNV J15384000-4744500
"We obtained a 600 s spectrum of this object under the SALT Large Science Program on transients on 2018 June 04.76 (HJD 2458274.25), using the High Resolution Spectrograph" and "The spectrum is typical of a classical nova in the optically-thick phase". There is much more information in the report.

What is the origin of this nova?
The underlying question is the identity of the star that went nova: does it appear in a star catalogue at the RA and DEC?

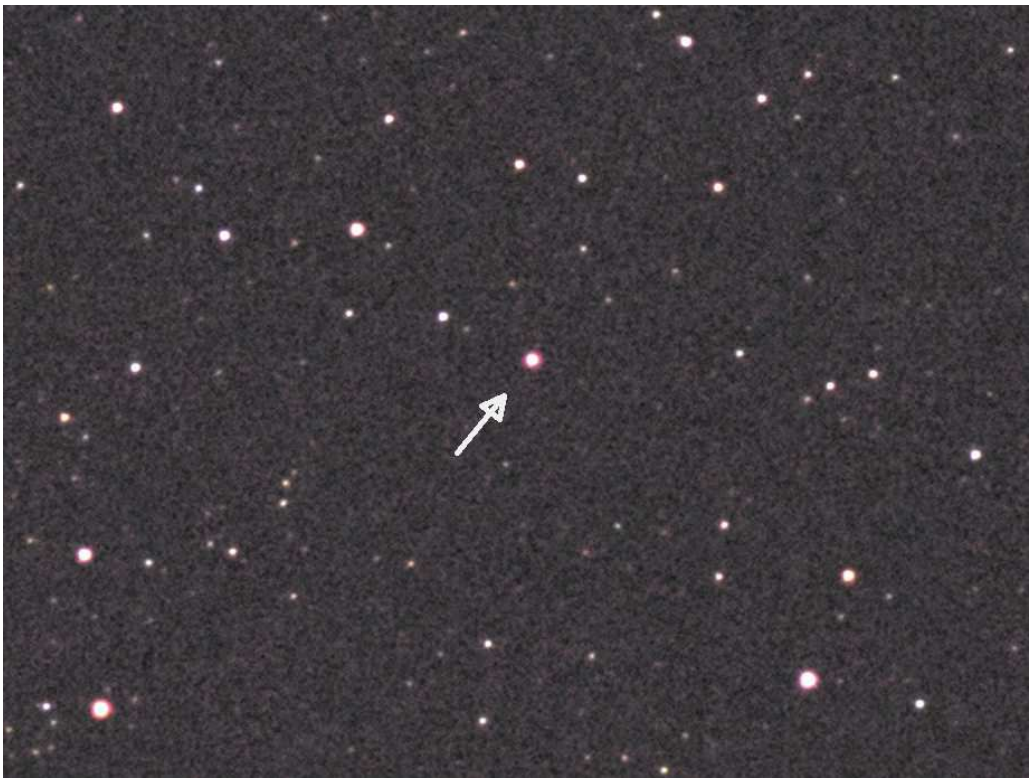


Fig 2. Nova Lupus 13 June 2018 (Ian Roberts)

The writer used APEX to reduce the image of 13 June using the HIP, Tychco-2, and UCAC4 star catalogues. However, these catalogues are magnitude limited from bright stars to about magnitude 16 (UCAC4) and APEX found no star at the RA and DEC. But in the USNO-B1 catalogue which lists stars to magnitude V=21 or so it found an exact match as below:

Apex reduction for 13 June 2018
Object: 0422-00579815

Catalogue: USNO-B1.0 + PPMXL corrections
Measured position: 15 38 43.805 -47 44 41.38
Catalogue position: 15 38 43.912 -47 44 41.19
Measured magnitude: 9.56
Catalogue magnitude: 18.07

This means the star has brightened from the near obscurity of magnitude 18.07 as determined by the United States Naval Observatory to magnitude 9.56 as measured in the image of 13 June, a huge increase in magnitude of 8.51. Caution required for the photometric result, a single Hipparcos catalogue star was used as the photometric reference.

Fig 3. Nova Lupus 2016

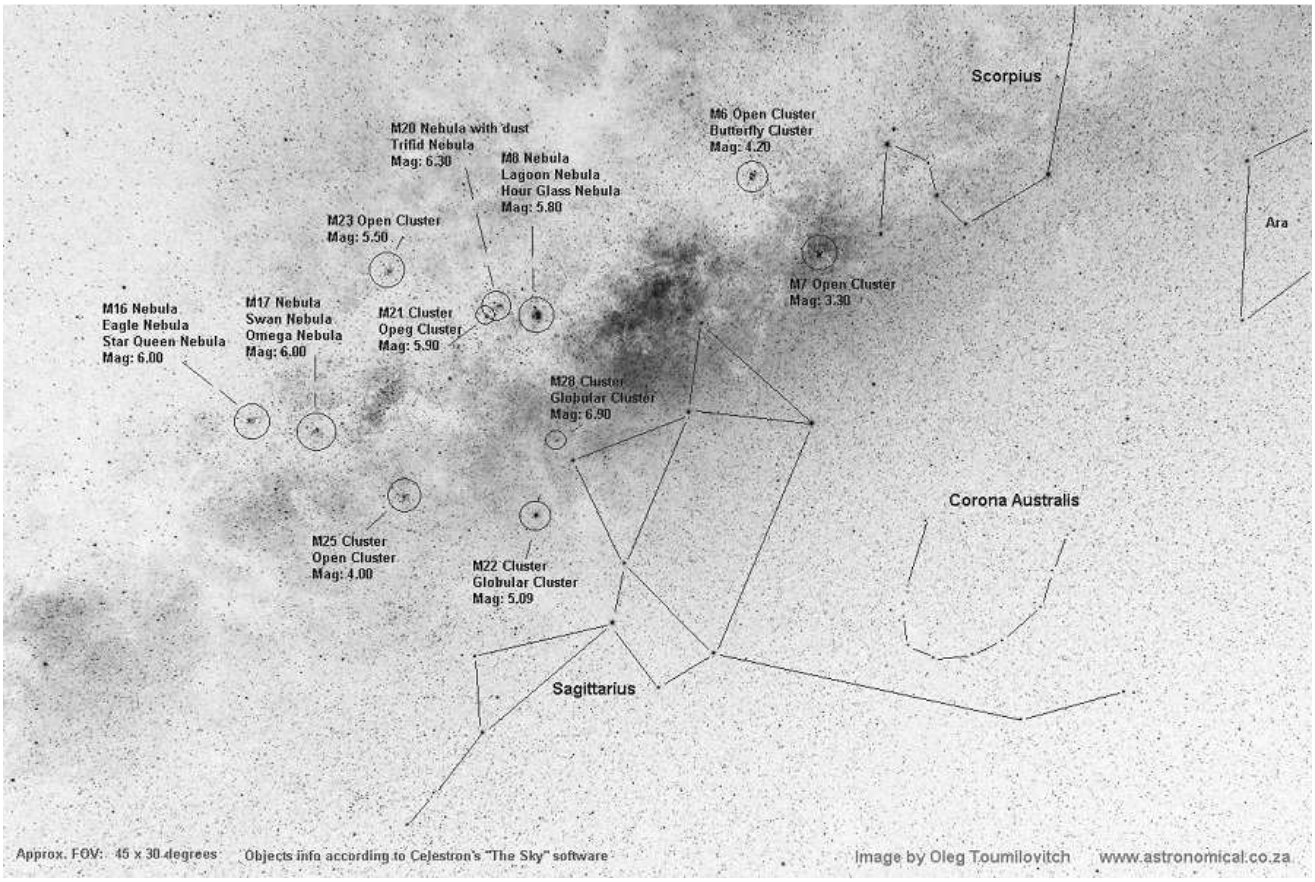
Sky Charts: Sagittarius and surrounding region

This single 3-minute image was acquired from a dark sky site in Waterberg , South Africa.

Image is centred on constellation Sagittarius and includes vast region around the centre of Milky Way. The area between Eagle Nebula (M16) and the tail of scorpion (constellation Scorpius) includes large number of most photographed bright deep sky objects such as nebulae, open and globular clusters.

Most of all noted objects are observable from urban area through small to large-sized telescopes. Light Pollution Reduction filters as well as Ultra High Contrast filters are recommended for observing and imaging from urban areas.
Best months for evening and late night observations of this region are June to August.

Direct link: www.astronomical.co.za/sky-chart/



Colloquia and Seminars

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

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

SAAO

Title: Cosmology with Intensity Mapping
Speaker: Dr. José Carlos Fonseca (UWC)
Date: 10 May
Time: 11h00 – 12h00
Venue: SAAO Auditorium

Abstract: Intensity Mapping (IM) opens a new window for future cosmological surveys which can tomographically probe large volumes of the universe. We will start by reviewing HI IM and it current status. We will then present a systematic study of IM using different emission lines from galaxies. We identify which ones are more promising for cosmological studies of the post reionization epoch. We consider the emission of Lyα, Hα, Hβ, optical and infrared oxygen lines, nitrogen lines, CII and the CO rotational lines. We will show that Lyα, Hα, OII, CII and the lowest rotational CO lines are the best candidates to be used in IM experiments for cosmology. These lines form a complementary set of probes of the galaxies emission spectra. We then use reasonable experimental setups from current, planned or proposed experiments to assess the detectability of the 3D power spectrum of each emission line. Intensity mapping of Lyα emission from z = 2 to 3 will be possible in the near future with HETDEX, while far-infrared lines require new dedicated experiments. We also show that the proposed SPHEREx satellite can use OII and Hα IM to study the large-scale distribution of matter in intermediate redshifts of 1 to 4. We find that submilimeter experiments with bolometers can have similar performances at intermediate redshifts using CII and CO(3-2). We will finish by showing the relevance of IM for Cosmology, especially when using the multi-tracer technique to measure effects on the largest cosmological scales.

AIMS

Title: Particle dark matter searches in the anisotropic sky
Speaker: Dr Marco Regis (Torino)
Date**:** 4 April
Time**:** 12h00
Venue: KAT-7 boardroom, Floor 3 SKA building

Abstract: The backbone of the network of structures we see in the Universe is constituted by Dark Matter (DM). Yet, the fundamental nature of DM remains unknown. If DM is a particle then it is expected to induce an indirect electromagnetic radiation in astrophysical structures. This radiation traces the cosmic network, forming a "non-gravitational cosmic web". In this talk, I will review how to detect this

pattern in the sky by means of statistical correlations at different frequencies, including in the radio band.

Title: From Academia to Industry: a Data Science Discussion
Speaker: Dr Charles Copley,
Date**:** 11 April
Time**:** 12h00
Venue: KAT-7 boardroom, Floor 3 SKA building

No abstract; Prof. Bruce Basset comments “As part of growing data science at SKA we are looking to learn from trends and skills in industry. We therefore invite you to attend the first of our academic-turned-industry expert discussions”.

Sky Delights: A Tiger with Deep Sky Spots

Magda Streicher

The constellation Lynx, so named by Hevelius, consists mainly of faint stars situated between the constellations Auriga and Ursa Major. One’s first thought would be: can this constellation offer the observer any worthwhile deep-sky objects? And the answer is: yes it can! Lynx has perhaps some of the most beautiful double stars, a large number of galaxies, and a few interesting objects to offer.

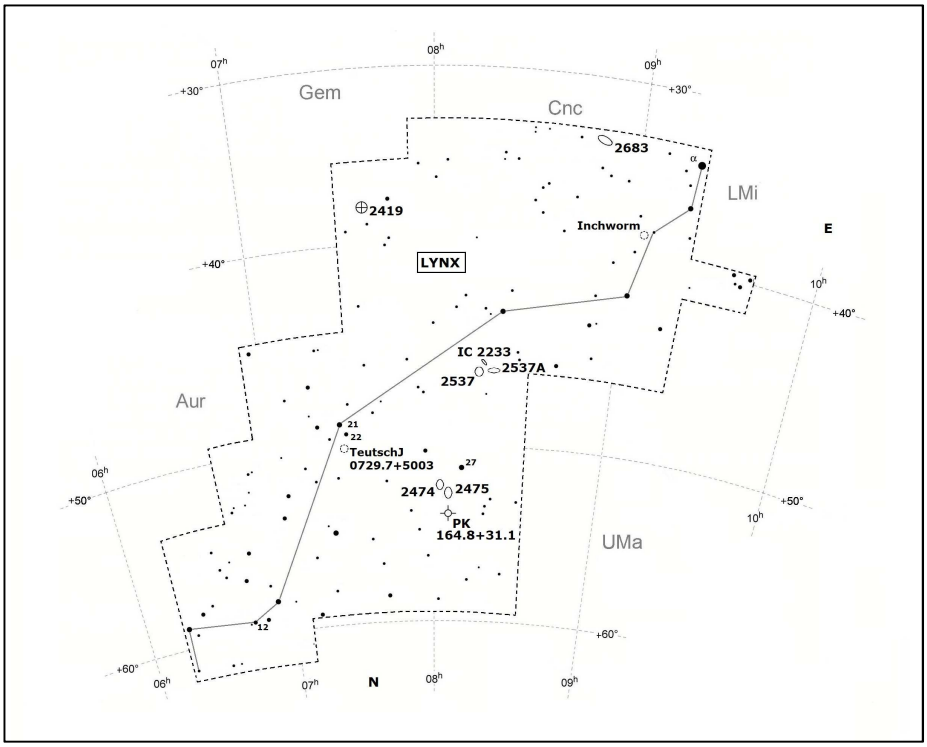


Fig 1. The constellation Lynx.

The eye of this special cat, alpha Lyncis, a red star, is close to the border with Leo Minor, perhaps looking for a catch … who knows what the ancient astronomers were thinking at the time.

Close to the northern border with Cancer is a group of galaxies sharing the border between the two constellations. **NGC 2683** is a beautiful edge-on galaxy relatively bright with a magnitude of 9.8 and better known by some by its nickname, the UFO galaxy. It appears to be in a north-east to south-west direction with a long bright core extending nearly 2.5' along the length of the galaxy, working its way to a small outstanding middle point. With care a soft halo can be glimpsed that gives the impression of floating away in the distance, just like a UFO. A few bright stars are situated on the southern edge, and towards the west a magnitude 11 double star and another magnitude 6 star round off the field of view.

Fig 2. NGC 2683 and edge-on spiral galaxy (NAOJ).

Going down the spotted neckline of the tiger, astronomy friend Sue French discovered a lovely group of stars she nicknamed the **Inchworm** asterism nearly 5° north-west of alpha Lyncis. The group contains a handful of stars, with the brightest the magnitude 4.6 HD 77912: long and slender, around 30' long, pretty and outstanding against the star field.

The constellation houses plenty of galaxies, but also adding to its fame is the globular cluster **NGC 2419** situated in the western part of the constellation 1.5° to the border with Auriga. Sadly, this globular, which is about 300 000 light years away, shows only a dim, faint glow with a condensed middle. It shares the field in line towards the east end with two magnitude 7 stars. It is called (quite appropriately) the inter-galactic wanderer, because of its remoteness towards the outskirts of our galaxy. As this deep-sky object's light shines through the eyepiece of a telescope, it brings home to

one something more of a perspective of infinity, which the mind is unable fully to grasp.

The galaxy **NGC 2537** and two other members, **NGC 2537A** and **IC2233**, are situated halfway between stars 31 and the double star 25/26 Lyncis. **NGC 2537** is an open spiral, commonly also known as the Bear Paw Galaxy. The larger galaxy displays a roundish figure with a few outstanding brighter knots on its surface that fit the description of a bear's paw in a realistic way. A few arc minutes east, NGC 2437A is barely visible, and so too IC 2233, edge-on in a north-south direction, situated further south in the field of view.

The asterism **Teutsch J0729.7+5003** is barely 15' further north from 22 Lyncis. The grouping consists of five lovely yellow-coloured magnitude 8 stars in a halfmoon with a few fainter members in between.

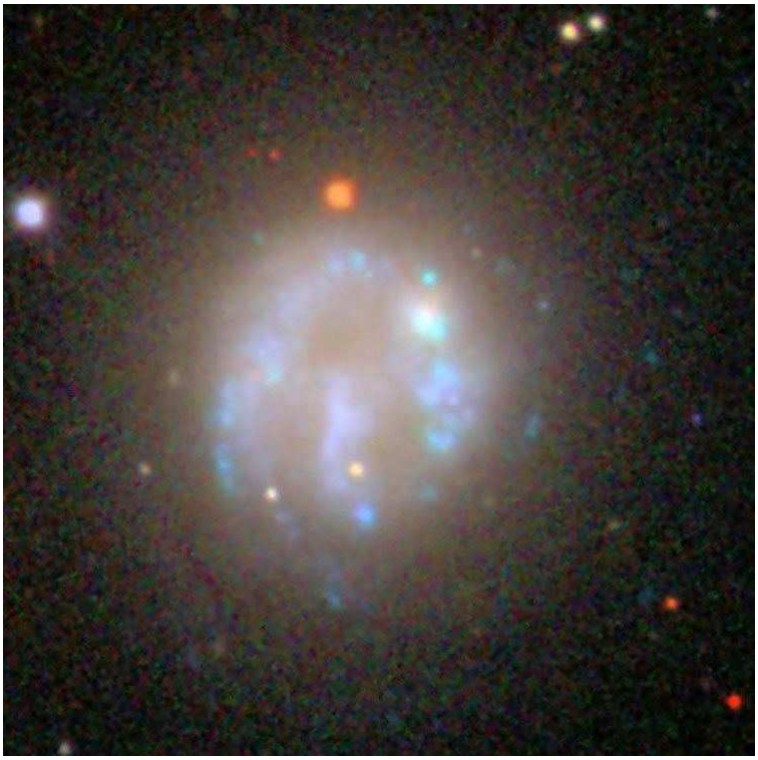


Fig 2. NGC2537 also know as the Bear Paw Galaxy.

Two striking galaxies, **NGC 2474** and **NGC 2475** are situated 2.5° north-west of the star 27 Lyncis. They are a lookalike hazy roundish pair in close contact with each other, both displaying prominent cores. Because of their faintness they are not easy to observe.

Half a degree north of the galaxies NGC 2474 and NGC 2475 the planetary nebula **PK 164.8+31.1** can be glimpsed, but only in truly dark skies, with a relatively large telescope and with a lot of good luck. The planetary is large, with a very low surface brightness, and OIII or UHC filters could be of great help. It contains two outstanding arcs of light which together have become known as the Headphone Nebula or Ear Muffs Nebula as suggested by David Knisely. The planetary nebula was discovered by Rebecca Jones and Richard Emmberson and is also known as Jones-Emmberson 1. Quite a few faint stars can be seen in the field of view.

A beautiful double star, 12 Lyncis, gives the impression of hanging on for dear life at the tail end of this starry tiger. It consists of a magnitude 5.3 and a magnitude 5.9 star, both displaying a yellow-white colour with a separation of 1.7" and a PA of 70.

The heavenly tiger deserves its place among the northern stars, an outstanding animal on Earth, but also outstanding in the form of a constellation with lovely objects on its spotted jacket.

Table 1

OBJECT	**TYPE**	**RA**	**DEC**	**MAG**	**SIZE**
12 Lyncis	Double star *	06h46m.2	+59°27'.0	5.3 5.9	Sep: 1.7"
Teutsch J 0729.7+5003	Asterism	07h29m.7	+50°03'.0	8.5	13'
NGC 2419	Globular Cluster	07h38m.1	+38°53'.3	10.4	5'x5'
PK 164.8+31.1	Planetary Nebula	07h57m.9	+53°25'.8	12.2	380"
NGC 2474	Galaxy	07h57m.9	+52°51'.3	13.1	0.6'x0.6
NGC 2475	Galaxy	07h58m.1	+52°51'.8	13	0.8'x0.8'
NGC 2537	Galaxy	08h13m.2	+45°59'.8	11.7	1.6'x1.4'
NGC 2537A	Galaxy	08h13m.7	+46°00'.4	14.8	0.6'x0.6'
IC 2233	Galaxy	08h14m.9	+45°44'.3	12.6	4.3'x0.6'
NGC 2683	Galaxy	08h52m.7	+33°25'.5	9.8	8.8'x0.5'
Inchworm	Asterism	09h05m.9	+38°16'.0	4.3	42'

Stargazing won me over a long time ago, got into my bones, found a welcome place in my heart. It brings me great joy and I never tire of it. Being an active member of Astronomy South Africa, I feel the need to share the wonders of the southern skies with fellow members. It is important to give time to everything that is worthwhile in one's life. This also goes for the exploration of the starry skies … even baby steps will always be rewarded. I started walking this road with Auke Slotegraaf as my mentor and teacher many years ago to understand and observed the many facets of astronomy. I took Auke by surprise one day when I asked him whether I could have my own column in MNASSA*. Without hesitating he cleared the way for me to tackle "Deepsky Delights" as a challenge, to give it character, and to make it a column to be proud of. Now, 17 years down the line, and 88 constellations later, I look back on the exciting journey it has been – it has not only been a learning process, it has also brought me much fulfilment. I hope and trust that my humble contribution dealing with the 88 constellations has helped reveal a world of many wonders. Magda.*

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, Harare, Hermanus, Johannesburg, Pretoria and Sedgefield district (Garden Route Centre). Membership of any of these Centres automatically confers membership of the Society.

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

Council Members 2018		
President	Case Rijsdijk	particles@mweb.co.za
Vice-President	Dr Pierre de Villiers	pierredev@hermanusco.za
Vice-President	Chris Stewart	Chris.stewart@alcatel-lucent.com
Membership Secretary	B. Olivier	membership@assa.saao.ac.za
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	Dr Ian Glass	glass.ian@gmail.com
Centre Chairs	Prof Matie Hoffman (Bloem)	HoffmanMU@ufs.ac.za
	Johan Smit (Pretoria)	johanchsmit@gmail.com
	Eddy Nijeboer (Cape)	eddy47@xsinet.co.za
	P Dormehl (Durban)	peterd@astronomydurban.co.za
	J Jooste (Johannesburg)	astronomersinc@hotmail.co.za
	Dr Pierre de Villiers (Hermanus)	pierredev@hermanus.co.za
	Steffan Devos (Natal Midlands)	sdevos@webbis.co.za
	C Rijsdijk (Gdn Route)	particles@mweb.co.za
Section Directors		
Shallow Sky	Clyde Foster	clyde@icon.co.za
Deep Sky Double/Variable Stars	A Slotegraaf Dave Blane	auke@psychohistorian.org theblanes@telkomsa.net
Photometry, Spectroscopy	Percy Jacobs	percymj@iafrica.com
Cosmology/Astrophysics	Vacant	
History	Chris de Coning	Siriusa@absamail.co.za
Dark Sky	Vacant	
Astrophotography	Allen Versveld	Allen.versveld@gmail.com
Instrumentation	Chris Stewart	Chris.stewart@alcatel-lucent.com
Observing/Outreach	K Coronaios	elephantcastle@lantic.net

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