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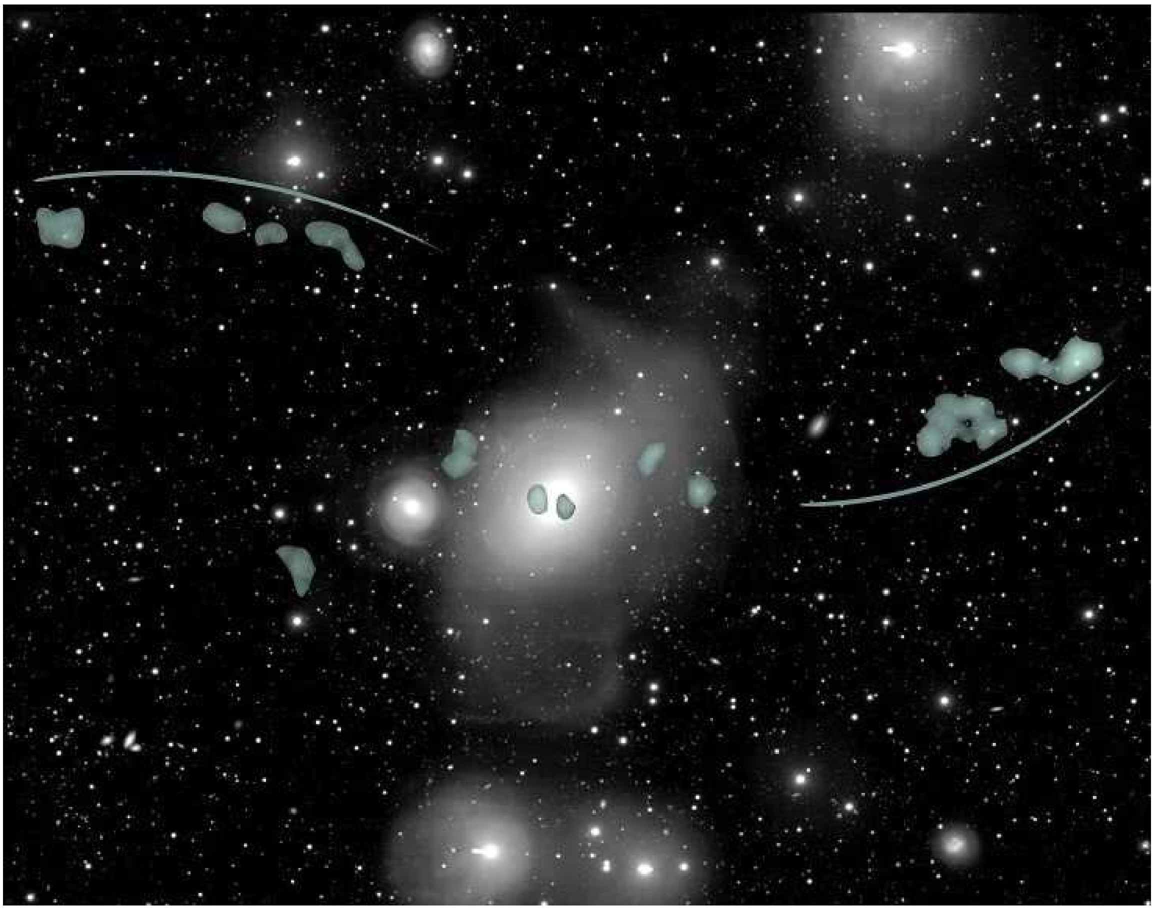

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News Note: MeerKAT Extension Proposal

The SKA design phase will be nearing completion towards the end of 2019 with construction expected to start around mid-2021. During this activity gap period, SARAO [South African Radio Astronomy Observatory] has entered into a joint agreement with the Max Planck Gesellschaft based in Germany to extend the MeerKAT array by constructing 20 additional SKA dishes and the provision of S-band [2-4 GHz] receivers to be incorporated into the MeerKAT system, thus enhancing the capability of the Meerkat array. MPG has secured funding for their portion of this project and the DST has indicated their support for this project. [From NRF Post-Board Communiqué 24 July 2019]

News Note: South African Radio Astronomer elected FRS

Dr Bernie Fanaroff, previously director of SKA South Africa and responsible *inter alia* for the design and construction of the MeerKAT radio telescope, was among fifty eminent scientists inducted as Fellows of the Royal Society of London in a ceremony on 12 July 2019.

The Royal Society was established in 1660 and is the oldest scientific society in the world. Its Fellowship is awarded to individuals who have made a "substantial contribution to the improvement of natural knowledge, including mathematics, engineering science and medical science". As part of the ceremony, Dr Fanaroff signed the membership book that includes such luminaries as Isaac Newton, Robert Hook, Charles Darwin, Albert Einstein and Stephen Hawking.

Dr Rob Adam, Managing Director of the South African Radio Astronomy Observatory acknowledged Dr Fanaroff's achievement: "I want to congratulate Bernie, whom I have known and worked with in several contexts for many years, particularly in realising the SKA for South Africa. Bernie's induction as a Fellow to the Royal Society is well deserved recognition of his contribution to science, and society."

Dr Fanaroff was originally a radio astronomer and co-author of the Fanaroff-Riley classification of radio galaxies and quasars. Thereafter he undertook a number of political roles and has been a metal industry union organiser, head of the Office for the Reconstruction and Development Programme and Deputy Director General in President Mandela's Office. He chaired the Integrated Justice System Board, and the Inter-departmental committee on border control. From 2003 to 2015, he was back in science, directing the SKA project in South Africa, which resulted in South Africa winning the bid to host the SKA, and carrying out the successful design and construction of the MeerKAT radio telescope. In recognition of his achievements Dr Fanaroff has been awarded the Order of Mapungubwe, the Karl G Jansky Lectureship, Lifetime Achievement award of the National Research Foundation, Academy of Science of South Africa Science-for-Society Gold Medal, award for Science Diplomacy from the Minister for Science and Technology and the President's Award of the SA Institute of Electrical Engineers. Manchester University has inaugurated the Fanaroff Lecture series. He is co-chair of the BRICS working group on high-performance computing, and a trustee of the Paleontological Scientific Trust. Recently, Dr Fanaroff has became member of the Presidential Commission on the Fourth Industrial Revolution.

Dr Fanaroff says that his appointment as a Fellow of the Royal Society is something he had never expected, or believed possible, and is deeply honoured to belong to such a prestigious group of scientists. He further says his election is also a recognition of the outstanding ability and performance of the SKA team in South Africa, reflecting the strong state of astronomy and technology in the country

Numbered among current South Africans Fellows is also Prof GFR Ellis of UCT (cosmologist).

News Note: MeerKAT discovers missing gas in distant galaxy

An international team of astronomers today announced the resolution of a long-standing mystery related to the formation and evolution of galaxies, by discovering vast amounts of hydrogen gas in a galaxy 60 million light years from Earth. Their work, just published in the journal *Astronomy & Astrophysics*, is based on observations carried out last year with the South African Radio Astronomy Observatory's new MeerKAT telescope in the Northern Cape.

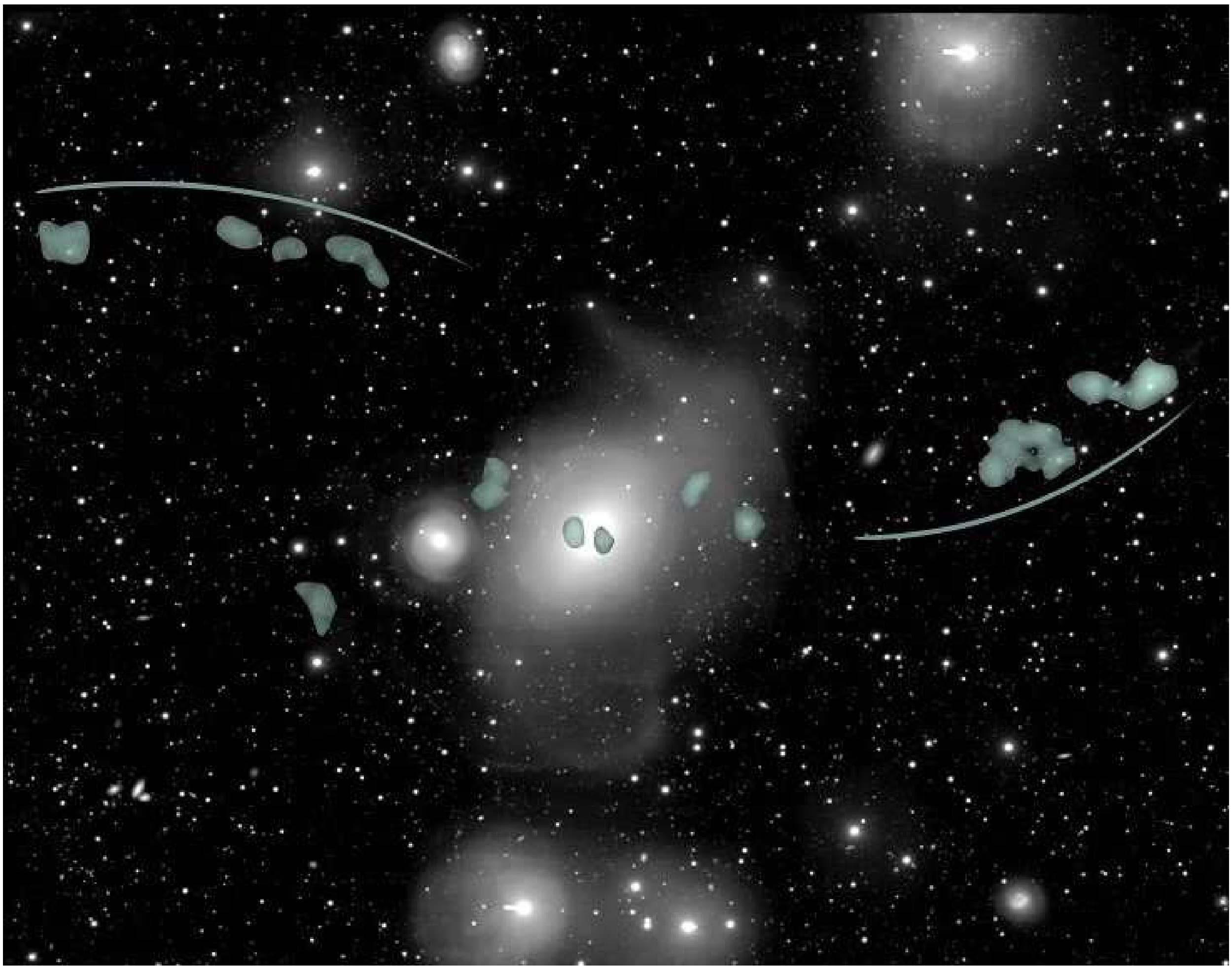

Fig 1. Hydrogen gas (represented by green blobs) detected with SARAO's MeerKAT radio telescope within and around the galaxy NGC 1316, visible at the centre of the image. The two hydrogen tails newly discovered with MeerKAT are visible in the upper and lower parts of the image (the curved arcs are added to guide the eye). Additional hydrogen clouds near NGC 1316 are also visible. The visible light image in the background is from the Fornax Deep Survey – a Dutch-Italian collaboration led by the University of Groningen and INAF – Naples – and was obtained with the VST telescope at the European Southern Observatory. (Adapted from results presented in Serra et al. 2019.)

NGC 1316, the subject of the new research (funded in part by the European Research Council) is the brightest galaxy at visible wavelengths in a nearby cluster of galaxies located in the direction of the Fornax constellation. It is also known as the radio galaxy “Fornax A”, and is the fourth brightest source of astronomical radio waves in the entire sky.

It is clear from its irregular shape in visible light images that this peculiar galaxy formed through a collision and merger of two major galaxies a few billion years ago, followed by subsequent merging with smaller satellite galaxies. Galaxy merging is one of the cornerstones of modern cosmological theories, and examples such as NGC 1316 are of great importance because they allow astronomers to study in detail the physical processes at work during mergers, and their effect on galaxy evolution.

A decades-long mystery is why NGC 1316 seemed to have so little hydrogen gas, the raw fuel that, present in many galaxies alongside heavier dust grains, ultimately makes up stars throughout the Universe. Lead author Paolo Serra of the Italian National Institute for Astrophysics (INAF) Observatory of Cagliari said NGC 1316 contains a very large amount of dust in its interstellar medium. It has been generally understood by astronomers that this is due to the nature of the two merging galaxies: one was gargantuan and devoid of much gas or dust, while the other, ten times smaller, was similar to the Milky Way and could bring into NGC 1316 enough dust to explain the observed amount. However, it should also have brought along an even larger amount of hydrogen gas. The problem: so far the vast majority of this hydrogen had never been detected!

This article shows new radio images obtained with MeerKAT, which reveal where all that hydrogen was hiding – it’s distributed in two long, faint, gaseous tails, stretching to a large distance from the galaxy. The radio tails were found at the same location as tails made up of stars discernible in sensitive visible light images. The tails were generated by tidal forces, in action during the merger. The amount of gas found is consistent with that expected based on merger theory, and on the fact that the smallest progenitor galaxy was like the Milky Way. Thus, thanks to these observations all pieces of the puzzle are now in place, and we finally have a more precise and coherent understanding of the formation of this famous galaxy.

With this beautiful piece of work, Paolo and his colleagues, among whom are several young South Africans, have significantly advanced our knowledge of the formation and evolution of galaxies, said Dr Fernando Camilo, SARAO’s Chief Scientist. This provides a wonderful taste of what MeerKAT will do in years to come.

MeerKAT, the South African precursor to the international Square Kilometre Array (SKA), consists of 64 dishes extremely sensitive to radio waves spread over a diameter of eight (8) kilometres in the Karoo. But the configuration of those 64 dishes appears peculiar at first: three quarters are located within a diameter of one (1) kilometre, with the remainder more sparsely spread farther out.

This was done on purpose to provide extra sensitivity for detecting the very faint radio signals that hydrogen atoms emit from across the Universe, at a frequency of 1420 Mhz. What is also remarkable is that these observations were done with the telescope in its initial commissioning phase, using only 40 of the dishes, before the inauguration in July of last year. Results like these show that MeerKAT has begun addressing some of the key open questions in modern astrophysics, and can look forward to researchers in South Africa and from around the world joining us on a journey of scientific discovery.

News Note: Repeating outflows of hot wind found close to a galactic black hole

An international team of astrophysicists from Southampton, Oxford and South Africa have detected a very hot, dense outflowing wind close to a black hole at least 25 000 light-years from Earth.

Lead researcher Professor Phil Charles from the University of Southampton explained that the gas (ionised helium and hydrogen) was emitted in bursts that repeat every 8 mins, the first time this behaviour has been seen around a black hole. The findings have been published in the journal *Monthly Notices of the Royal Astronomical Society.*

The object Professor Charles' team studied was Swift J1357.2-0933 that was first discovered as an X-ray transient – a system that exhibits violent outbursts – in 2011. These transients all consist of a low-mass star, similar to our Sun and a compact object, which can be a white dwarf, neutron star or black hole. In this case, Swift J1357.2-0933 has a black hole compact object that is at least 6 times the mass of our Sun.

Material from the normal star is pulled by the compact object into a disc in between the two. Massive outbursts occur when the material in the disc becomes hot and unstable and it releases copious amounts of energy.

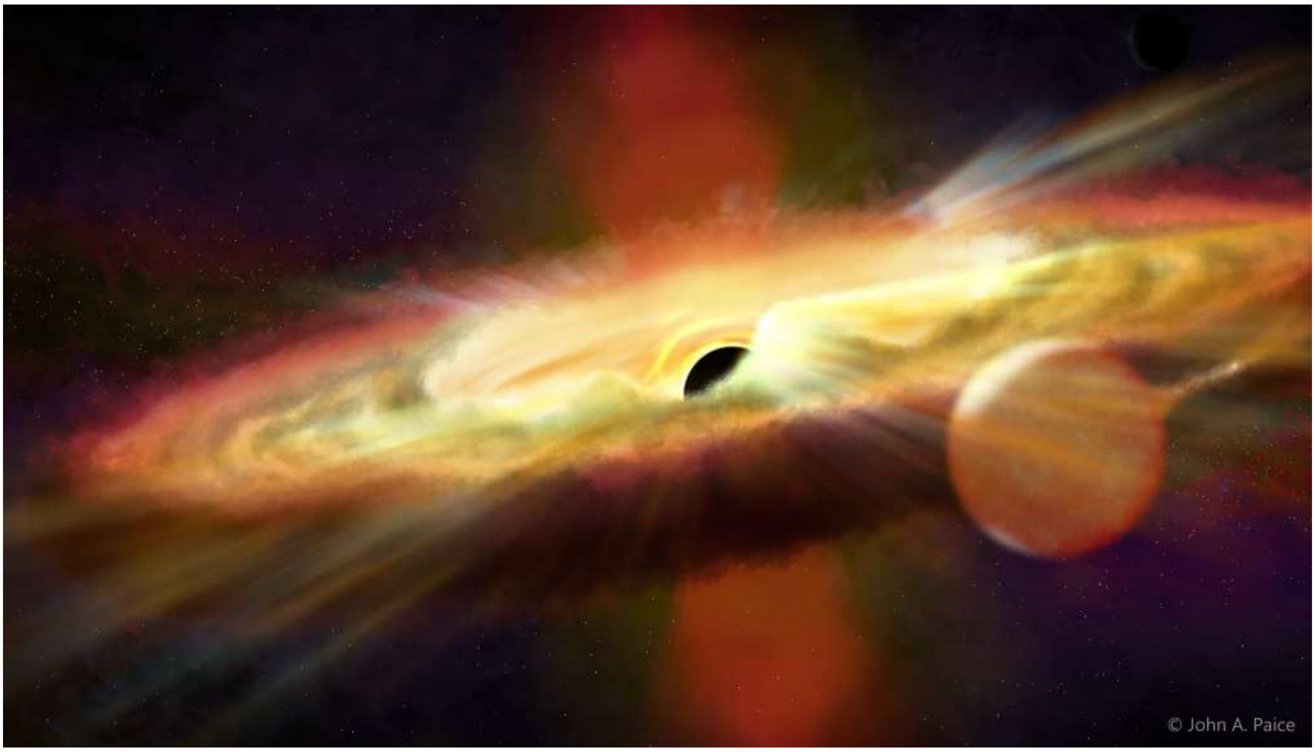

Figure: Artist's conception of Swift J1357.2-0933 (Picture credit: James Paice).

Professor Charles said that what was particularly unusual about this system was that ground-based telescopes had revealed that its optical brightness displayed periodic dips in its output and that the period of these dips slowly changed from around 2 mins to about 10 mins as the outburst evolved. Such strange behaviour has never been seen in any other object.

The cause of these remarkable, fast dips has been a hot topic of scientific debate ever since their discovery. So it was with great excitement that astronomers greeted the second outburst of this object in mid-2017, presenting an opportunity to study this strange behaviour in greater detail.

Professor Charles and his team recognised that key to getting the answer was to obtain optical spectra a number of times during each dip cycle, essentially studying how their colour changed with time. But with the object about 10 000 times fainter than the faintest star visible to the naked eye and the dip period of only around 8 minutes, a very big telescope had to be used.

So, they used SALT, the Southern African Large Telescope, the largest optical telescope in the southern hemisphere.

The University of Southampton is one of the founding UK partners in SALT, and together with their South African collaborators, are part of a multi-partner Large

Science Programme to study transients of all types. Not only does SALT have the necessary huge collecting area (it has a 10m diameter mirror), but it is operated in a 100% queue-scheduled way by resident staff astronomers, meaning that it can readily respond to unpredictable transient events. This was perfect for Swift J1357.2-0933, and SALT obtained more than an hour of spectra, with one taken every 100 secs.

The timely observations of this fascinating system demonstrates how the quick response of SALT, through its flexible queue-scheduled operation, makes it an ideal facility for follow-up studies of transient objects said Dr David Buckley, the Principal Investigator of the SALT transient programme, based at the South African Astronomical Observatory, SAAO. With the instantaneous availability of a number of different instruments on SALT, it was also possible to dynamically modify the observing plans to suit the science goals and react to results, almost in real-time.

Professor Charles added that the results from these spectra were stunning. They showed ionised helium in absorption, which had never been seen in such systems before. This indicated that it must be both dense and hot ~40 000 degrees. More remarkably, the spectral features were blue-shifted (due to the Doppler effect), indicating that they were blowing towards us at about 600km/s. But what really astonishing was the discovery that these spectral features were visible only during the optical dips in the light-curve. We have interpreted this quite unique property as due to a warp or ripple in the inner accretion disc that orbits the black hole on the dipping timescale. This warp is very close to the black hole at just 1/10 the radius of the disc.

What is driving this matter away from the black hole? It is almost certainly the radiation pressure of the intense X-rays generated close to the black hole. But it has to be much brighter than we see directly, suggesting that the material falling on to the black hole obscures it from direct view, like clouds obscuring the Sun. This occurs because we happen to be viewing the binary system from a vantage point where the disc appears edge-on, as depicted in the schematic illustration, and rotating blobs in this disc obscure our view of the central black hole.

Interestingly there are no eclipses by the companion star seen in either the optical or X-ray as might be expected. This is explained by it being very small, and constantly in the shadow of the disc. This inference comes from detailed theoretical modelling of winds being blown off accretion discs that was undertaken by one of the team, James Matthews at the University of Oxford, using supercomputer calculations.

This object has remarkable properties amongst an already interesting group of objects that have much to teach us about the end-points of stellar evolution and the formation of compact objects. We already know of a couple of dozen black hole binary systems in our Galaxy, which all have masses in the 5-15 solar mass range, and the single black hole at our Galactic Centre is around 4 million solar masses. They all grow by the accretion of matter that we have witnessed so spectacularly in this object. We also know that a substantial fraction of the accreting material is being blown away. When that happens from the supermassive black holes at the centres of galaxies, those powerful winds and jets can have a huge impact on the rest of the galaxy.

These short-period binary versions are a perfect way to study this physics in action.

This study is to be published in *Monthly Notices of the Royal Astronomical Society* as a Letter to the Editor, authored by Phil Charles (University of Southampton), James H. Matthews (University of Oxford), David A.H. Buckley (South African Astronomical Observatory; SAAO), Poshak Gandhi (Southampton), Enrico Kotze (SAAO and South African Large Telescope), and John A. Paice (Southampton and Inter-University Centre for Astronomy and Astrophysics). This work was supported by the South African National Research Foundation, the Leverhulme Trust, STFC, and a UGC-UKIERI Thematic Partnership.

Optical scintillation observed from a “redback” millisecond pulsar

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Abstract: PSR J1723-2837, is a “redback” millisecond pulsar (MSP) with a non-degenerative low mass companion in a 14.8 hr orbit. The presented paper is a followed-up report on a long-term, time-series photometry campaign of the 15.5 magnitude companion to the pulsar. In a previous paper we showed that the star experiences episodes of sporadic stellar activity and is not tidally locked. In this paper the author reports on small (σ □ 5.8 mmag) scattered noise, superimposed on the companion’s light curve. These rapid fluctuations were observed during 2018 and predominantly coincided at superior conjunction when the pulsar was behind the companion. To the author’s knowledge, similar phenomena in optical have not been observed to date in other MSP systems.

"In science, one man's noise is another man's signal."
Edward Ng

1. Introduction

Since the discovery of the first pulsar in 1967 by Jocelyn Bell Burnell and Antony Hewish, pulsars have captivated our imagination and have many unique applications for example in testing theories such as general relativity. The first millisecond pulsar (MSP), PSR B1937+21, was discovered in 1982 by D.C. Backer et al, spinning roughly 641 times a second (Backer et al. 1982). Common properties of MSPs with a binary companion are radio eclipses around superior conjunction (i.e., when the pulsar is behind the companion), γ-and X-ray emission, rapid orbital-period modulations, and strong optical variability (Archibald et al. 2013). Eclipsing MSPs are commonly classified as either "black widows" or "redbacks," depending on the mass of the companion (m_c of up to few $10^{-2}M_\odot$ and $m_c \simeq 0.2\text{-}0.7M_\odot$, respectively).

PSR J1723-2837 is a redback, 1.86 MSP in an almost circular ≈14.8 hour orbit, about a main-sequence-like companion star discovered by Faulkner et al. (2004) in the Parkes Multibeam survey. The Companion star (J17232318-2837571) was first identified using Infrared, optical, ultraviolet and spectrophotometry (Crawford, 2013). X-Ray emissions were also detected from PSR J1723–2837 and are presumably a candidate for a radio pulsar/X-ray binary transition object (Bogdanov, 2014), (Hui et al, 2015).

Secular changes in average photometric flux of the companion stars to redbacks and BW pulsars are quite common but proved to be challenging to explain with limited observation times granted to Astronomers. PSR J1723–2837 has a bright (V 15.5 mean magnitude) optical counterpart, making it an ideal case-study for redback MSPs. In this context, the author initialized a long-term intensive photometry campaign (starting in 2014) with the objective to obtain a consistent light curve in support of MSP studies.

In order to achieve a logical order regarding the reporting of observations and data in this paper, the results will be presented in the following manner. Firstly, as reports on observations obtained during 2018 containing scattered "noise" besides the normal photometry variations. Then it will be shown that the scattering power was more intense during phases of superior conjunction when the pulsar was behind the companion. Finally it will be shown that the scattered power also responded to frequency bandwidths, manifesting at both superior and inferior conjunctions.

2 Observations and Photometric Reduction

The companion to PSR J1723−2837 was observed between 3 August 2014 and 8 June 2019 from Overberg, South Africa. The location of the observatory allows for continuous monitoring of the target for up to 9 hrs per night, or 60% of the orbital period. The site suffers from minimal light pollution and the seeing typically ranges from 2 to 3 arcsec.

All observations were conducted with a 30 cm Cassegrain telescope and a commercial SBIG ST9e CCD camera cooled to -15°C, with 20μm^2 pixels arranged in a 512 × 512 grid. Guiding corrections were performed with the integrated tracking CCD at 1 sec intervals, always using the same star. The images were calibrated using standard dark and sky-flat frames acquired sporadically throughout the campaign.

More than 8000 images were collected over 175 nights (hereafter referred to as datasets), with exposure times of 300 seconds, except for 2015 when exposure times were 600 seconds. The images were reduced, based on visual inspection followed by a software routine that rejects images with large FWHM mainly caused by defocusing as a result of temperature fluctuations during the night, rapid sky background changes caused by high clouds and standard error estimates by C-Munnipack, bringing the final images used in this report to ≈6000.

The magnitudes reported are based on differential ensemble type aperture photometry, computed with C-Munipack/Muniwin v. 2.0.17 (http://c-munipack.sourceforge.net/), a public photometry program. Fluxes were measured inside an aperture enclosing twice the FWHM of the local PSF, and the sky was extracted from a surrounding region up to five times the FWHM, but excluding the area close to the source, which contains a faint star. The author experimented with different settings, each time extracting consistent results. A set of twenty bright objects were selected to derive a virtual comparison star. The target object was only ≈4.3° from the Galactic plane, therefore resulting in over 2000 stars in the 18x18 arcminute images, making it impossible to obtain clear sky annulus for all the selected stars. An algorithm was developed for superimposing uniform sky annulus onto the CCD images, surrounding the "comparison stars" based on statistical information of the sky background. Additionally, the virtual comparison star was calculated, based on a weighted arithmetic mean within an iterative loop, rejecting the comparison stars with the largest noise components. This additional process delivered consistent results compared to the standard reduction provided by C-Munipack with marginal improvements at times. However the results reported in this paper were produced by the standard C-Munipack package that uses the Robust Mean Algorithm based on a re-descending Ψ type M-estimator for calculating the sky background.

To be on the conservative side and further improve the photometric S/N ratio, neighboring measurements (in time) were averaged. Therefore each combined measurement resembles an approximately integration time of 600 seconds. This technique was found to produce slightly lower rms noise values compared to single

600 second exposures. RMS values for a close by star were computed for each dataset producing a mean RMS for all sets of ≈2.7 mmag as shown in figure 1.

Time stamps were derived from PC time, which was synchronized to an international time server and checked regularly against a GPS master clock. All measurements were referred to Heliocentric times derived from the center of exposures. Binary phases were calculated using the pulsar timing ephemeris of Crawford et al. (2013), adopting Tasc=MJD 55425.320466(2) for the time of ascending node and Pb= 0.615436473(8) days for the orbital period. The author also accounts for the small secular change in the orbital period, $\dot{P}b \simeq$ -3.50(12)x10-9, which could result in a delay of up to ΔPb $>$-0.5 sec over the span of the observations. Higher-order variations in Pb were omitted, as their effect are too small to influence the results (Crawford et al. 2013). Under the adopted convention, ϕ=0.25 coincides with the superior conjunction, when the pulsar is eclipsed by its companion in radio frequencies.

3 Data Analysis And Results

3.1 Optical variability of the companion to PSR J1723-2837

The optical light curve of the companion to PSR J1723-2837 is similar to a number of binary MSPs that show double peaked ellipsoidal variation as a result of the tidal distorted geometry caused by the gravitational pull of the MSP. No significant traces of irradiation were observed during the campaign. The ellipsoidal signal, modulated at the first orbital harmonic has an average amplitude of ≈0.0512 magnitudes. However, it was found that there were periods (>10 months) with alternating dimming at *ϕ≈0.25* and ϕ≈0.75 which will be addressed in a future paper. Dips drifting across the light curve up to ≈0.1 magnitudes were observed during 2015 and early 2016 which were attributed to starspots (van Staden & Antoniadis, 2016). This caused fluctuations on timescales of weeks to months. Random fluctuations on time scales of weeks to days were occasionally seen throughout the campaign. Interestingly, these fluctuation were more frequently observed between ϕ=0 and ϕ=0.25, especially during 2018. Roughly speaking, the quietest periods up to date were 2014 and 2017.

3.2 RMS of scattered noise

The remainder of this paper focused on scintillation discovered in optical observations during 2018. The scintillation was mostly composed of sporadic outliers and rapid fluctuations (generally referred to as scattered noise in this paper) with periods P_n <2hr, superimposed on the light curve. In section 3.4 it was shown that the scintillation also contains periodicities at times. It should be noted that the magnitude of these signals were only a fraction of the ellipsoidal variations.

The first step was to separate and quantify the amount of scattering (P_n<2hr) from other variations in the light curve. The scatter was defined by the difference between the measured light curve (LC_{meas}) and the estimated ellipsoidal signal plus secular variations (>12 Cycles/d (P≃2h) which might have been caused by star spots and/or other unknown effects. These fluctuations were approximated by best fitted polynomials where the order was adapted to the duration of the datasets. As a mathematical equation, the scattered noise or residue, Y_{res} was expressed as:

$$Y_{res} = LC_{meas} - (A \cdot \cos(4\pi \cdot f \cdot t) + p(x))$$

Where:

A = 0.0590 mag, Ellipsoidal magnitude estimated by a least square fit and Fourier Analyses (see also van Staden & Antoniadis, 2016)

f = 1.6248630, Orbital frequency from published radio ephemeris (see Crawford et al. 2013)

t = time, CCD heliocentric timestamps

$p(x) = p_1 x^n + p_2 x^{n-1} + ... + p_n x + p_{n+1}$, where p(x) is a polynomial of degree n that is a best fit (in a least-squares sense) for the data, and $2 \leq n \leq 6$. (The roll-off filtering-effect was verified with Fourier Analyses to be consistently at P_n≃2hrs)

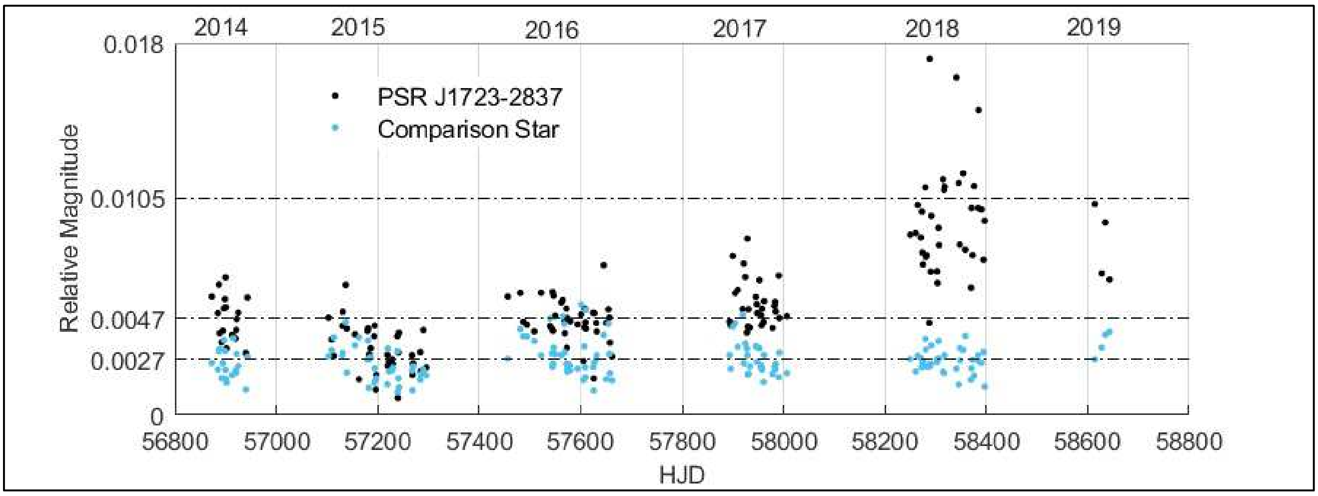

Fig 1. Each dot in the graph represents an rms scatter value for nightly observations. The Comparison star's (blue dots) had a mean rms of 0.0027 magnitudes while PSR J1723-2837 (black dots) was estimated at 0.0047 and 0.0105 magnitudes for 2014-2017 and 2018, respectively.

For each dataset from 2014 to 2019, rms values were computed from the residues (Y_{res}) and plotted in figure 1 as black dots. Rms values were also determined for a comparison star (≈1 magnitude brighter) close to PSR J1723-2837 and were plotted with blue dots in figure1. The average (Y_{res}) rms for PSR J1723-2837 from 2014 to 2017 was 0.0047 magnitudes and 0.0105 magnitudes during 2018. In contrast, the comparison star remained constant during the campaign with an average rms value of 0.0027 magnitudes.

3.3 The spectrum of the scattered signal

The power spectrum densities (PSD) determined from residues (Y_{res}), before and during 2018 were computed by means of a Lomb–Scargle periodogram (Lomb 1976; Scargle 1982). Firstly, the Y_{res} spectra for all 136 datasets before 2018 were computed and average combined. The result was plotted as a red curve in figure 2 which shown a reasonable flat spectrum with a roll-off at ≈12 Cycles/d (P≃2h) as a result of the polynomial filtering effect.

The process was repeated for datasets obtain only during 2018 with result shown in Fig. 2 (black curve). The much higher power in the spectrum was consistent with the rms scatter increase during 2018 (see section 3.2). Also notable were two (marginal) peaks at ≈27 cycles□d^{-1} (P≃53 minutes) and ≈40 cycles□d^{-1} (P≃36 minutes). The power associated with the peaks was covered in section 3.4. For comparison, the average combined spectrum of the comparison star from 2014 to 2018 was computed and also plotted in Fig 2 (blue) which showed reasonable consistency (from ≈10-70 cycles□d^{-1}) with white noise.

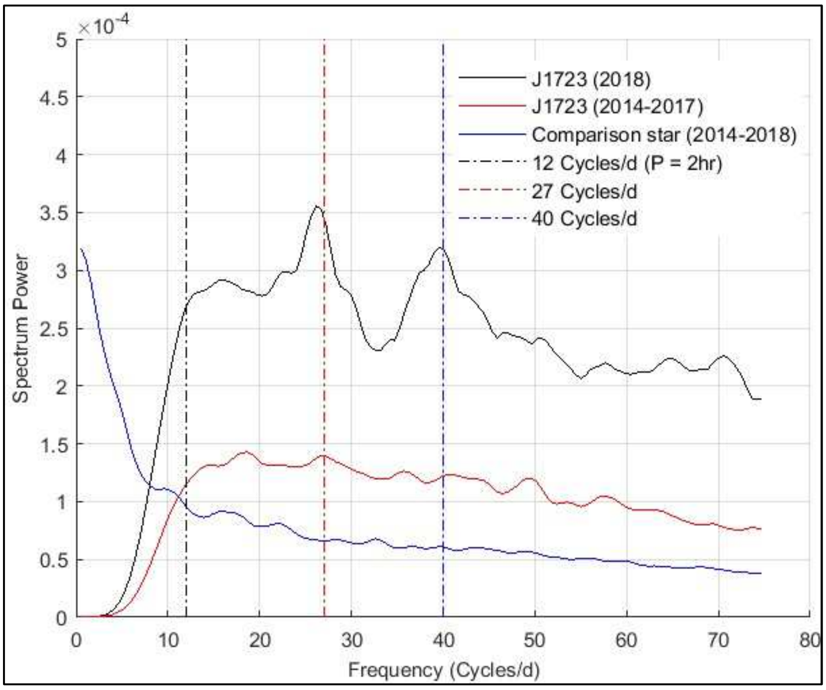

Fig 2. Average combined power spectrum density (PSD) for three instances. The black and red curve represented the scatter observed from PSR J1723-2837 during 2018 and 2014-2017 respectively. The blue curve represented the PSD for a comparison star (2014-2018). The two peaks shown up in the black curve at ≈27 cycles□d^{-1} and ≈40 cycles□d^{-1} were marked with vertical dashed lines. The "roll-off" as discussed was at ≈12 cycles□d^{-1}.

3.4 Scattered power in relation to orbital phase

Various methods were examined to see if the scatterings were evenly distributed throughout orbital rotation.

The best results were obtained by looking for the scattered power contents in narrow frequency bands, thus improving the Signal-to-Noise ratio. Special preference was given to the power peaks mentioned at ≈27 cycles□d^{-1} and ≈40 cycles□d^{-1} and were incorporated into a band-pass filtering scheme as follows:

Y_{res} data (2014-2018) were loaded consecutively into bins followed by a PSD's calculation per bin. The total power was determined by combining the average of all the PSD-magnitudes within a selectable bandwidth. The total power was then normalized by scaling to the size of the bandwidth used. The relevant orbital phases were calculated from the Y_{res} timing information that coincided with the centre of each bin. The product of this algorithm was consequently an array of power values with related phase values.

Three computations were performed in this manner with bandwidths set consecutively to 24-31, 35-45 and 50-80 cycles.d^{-1} and were presented in figure 3 (black circles) as power vs orbital phase plots.

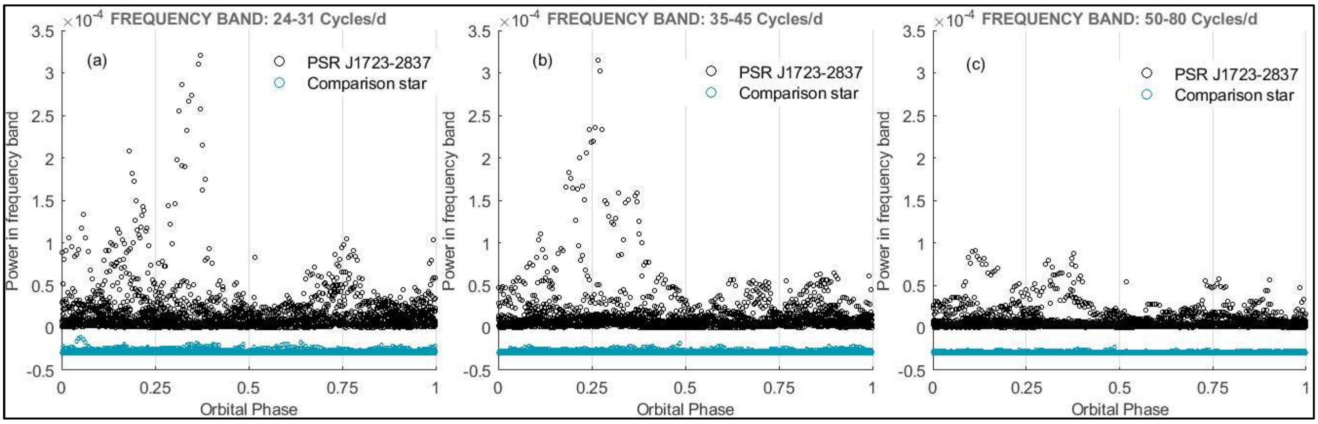

Fig 3. Bandwidth limited Spectral Power in relation to Orbital phase (2014 – 2018). (a) PSD for bandwidths set to 24-31 cycles.d^{-1}, (b) 35-45 cycles.d^{-1} and (c) 50-80 cycles.d^{-1}. PSR J1723-2837 and a comparison star were presented as black and blue circles, respectively.

Evident from Figs 3(a) and 3(b) were the power peaks at $\phi \simeq 0.25$ *and* much smaller peak at $\phi \simeq 0.75$ when pulsar was in front of the companion (figure 3a). With the bandwidth set to 50-80 cycles.d^{-1}, shown in figure 3(c), the power peaks became relatively insignificant. This is a clear indication that a) maximum scattering coincided at $\phi \simeq 0.25$ (and possibly $\phi \simeq 0.75$) and b) the scattering probably contained periodicities that also coincided with the mentioned orbital phases.

As a controlled check, the process was repeated for the same period on the comparison star and was plotted with blue circles (with an intentionally set offset). In all instances, the comparison star showed reduced and evenly distributed power as expected.

4 Conclusion

The companion to PSR J1723-2837 has an optical light curve dominated by tidal distortion (ellipsoidal modulation) over possible heating from the pulsar. During a long-term intensive monitoring campaign by the author, it became apparent that the companion star is probably magnetic active, producing complex light curves at times during episodes of star spots.

A scintillating effect was discovered in photometric observations made during 2018 that resulted in an increase in rms scatter from 4.7 mmag (2014-2017) to 10.5 mmag (2018) obtained from more than 6000 images in total. These scattered photometric noises were mostly composed of sporadic outliers and fluctuations with short periods (on time scales of minutes) superimposed on the ellipsoidal and other variations.

From the data it was discovered that the power in the scattered signal was significantly more prominent during phases of superior conjunction when the pulsar was behind the companion star. This suggests an interesting scenario in support of emission probably not originating from the companion star but probably an interaction between the two objects e.g. accretion flow, accretion disk or jets. Considering the inferred orbital inclination angle of 41° by Crawford (2013), it may further suggest emissions close to the MSP for producing the concentrated scattering power observed at $\phi \simeq 0.25$. Taking into account the marginal increase in scattering at $\phi \simeq 0.75$ (Figure 3a) when the pulsar was in front of the companion, is even more intriguing.

Finally it was shown that the increase in scattered power coincided with specific frequency bands, roughly in the order of ≈ 27 cycles.d^{-1} and ≈ 40 cycles.d^{-1}. Taking these frequencies at face value, is an interesting question why periodicities were associated with the emission in the first place.

Related optical variability was looked for in literature but without much success. However, the author would like to point out the work done by [Gandhi 2009] who investigated and confirmed the relationship of optical variability vs flux in X-ray of X-ray binaries. Although this seems promising, it should be noted that previous X-ray observations for PSR J1723-2837 showed a minimum X-Ray flux during $\phi \simeq 0.25$ (Bogdanov, 2014; Hui, 2015), making it less favorable to explain.

The emitting source and reason(s) for fluctuations observed are unclear at this point in time. Filtered observations will be helpful but will require a larger telescope.

Simultaneous observations in other frequencies will be very interesting and the author hopes that this work will encourage more research and future observations.

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First results for CAMS@SA, and detection of the June ε Ophiuchids

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Summary

Since commissioning and first light for the CAMS@SA camera arrays during the night of 13/14 June, 2019, a number of teething problems have been overcome, including both hardware and software issues, with the result that the two stations are now running smoothly and contributing nightly data to the global CAMS network. During the first sixty days of operation, CAMS@SA determined the orbits and radiant positions of around 4 800 meteors, and participated in the detection of activity from the June ε Ophiuchids, confirming the existence of this stream and the relationship with comet 300P/ Catalina. CAMS@SA's role in the confirmation of the outburst is described, along with a summary of the performance of the two stations to date.

Results to date for CAMS@SA

The CAMS@SA network currently consists of two sites located at Bredell (station BR) and the South African Radio Astronomy Observatory Hartebeesthoek Site (station

HA), each fitted with eight Watec 902H cameras mounted in weatherproof enclosures. The camera arrays are separated by 66.8 km and are oriented so that their fields of view overlap at an altitude of 95 km above the Earth's surface, coincident with the region where most visual meteors occur. The setup and first light runs were described by Cooper (2019a, b) and occurred on the night of 13/14 June, 2019. The cameras have operated on all but five nights since then and in the first two months of operation determined the orbits and radiant positions of 4 800 individual meteors, with the number of nightly captures shown in Figure 1. There were no captures for the nights of 26, 27 and 29 June and 10 and 21 July, which was probably due to voltage sag on the power grid causing the PC at station BR to crash. The situation was corrected by installing an uninterrupted power supply with voltage regulator, and the network has contributed data since then without interruption. Initially the software was dropping a large number of frames which resulted in incomplete data for captured meteors, but this was rectified by adjusting the frame rate in the capture software, which allowed us to subsequently recover the data by re-running the post-capture scripts.

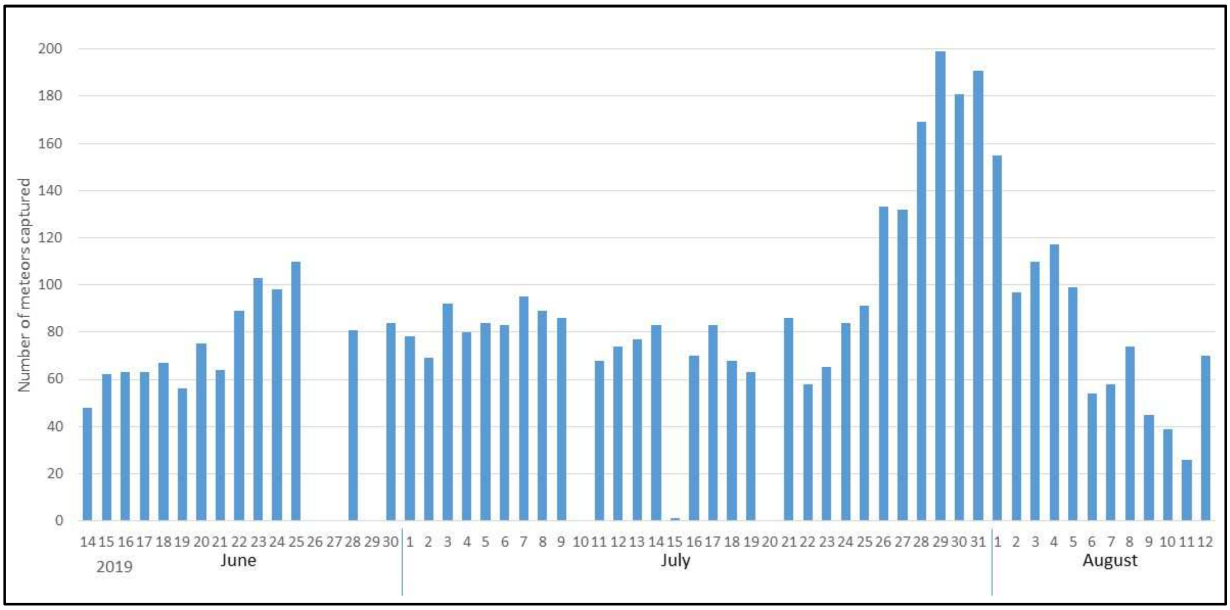

Fig 1. Nightly meteor captures by CAMS@SA

Figure 1 shows a capture rate of around 80 meteors per night for most of July, with a clear increase in rate later in the month, consistent with the maxima of the Southern δ Aquariid (SDA, IAU shower code #5) and α Capricornid (CAP, #1) meteor showers, peaking on the night of 29/30 July when CAMS@SA captured 199 meteors, our best night so far.

After each nights run, the CAMS2.0 software processes the nightly captures and uploads the data to the FDL site, which depicts the captures in the form of a radiant map

Figure 2 shows part of the meteor radiant maps for the nights ending 28 and 30 July. The majority of meteors detected were SDAs (#5, green dots) and CAPs (#1, blue dots), with a few additional minor radiants detected as indicated in the caption. The largest number of radiants detected in a single night was on 1 August, when twelve separate showers were found to be active as shown in Figure 3.

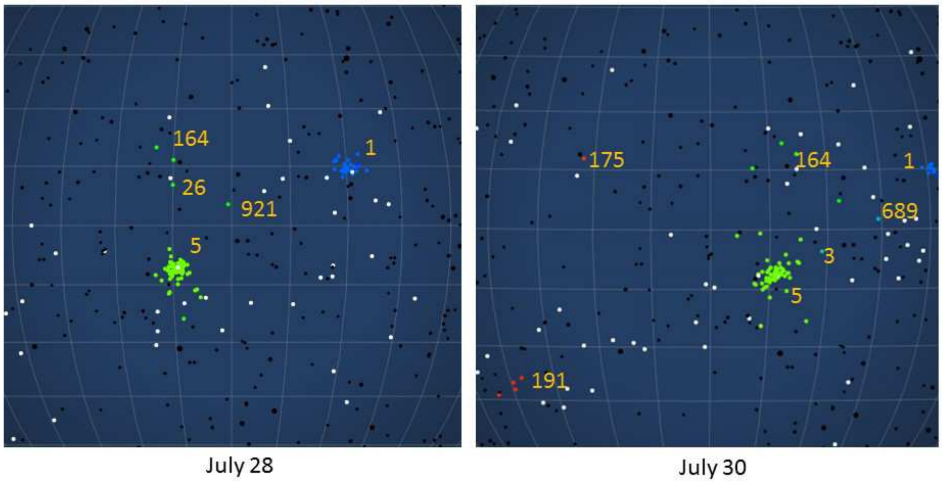

Fig 2. Meteor shower radiants detected for nights of 2019 July 28 and 30. Showers are 1 = α Capricornids (CAP), 3 = Southern ι Aquariids (SIA), 5 = Southern δ Aquariids (SDA), 26 = Northern δ Aquariids (NDA), 164 = Northern June Aquilids (NZC), 175 = July Pegasids (JPE), 191 = η Eridanids (ERI), 689 = τ Capricornids (TAC), 921 = July λ Capricornids (JLC).

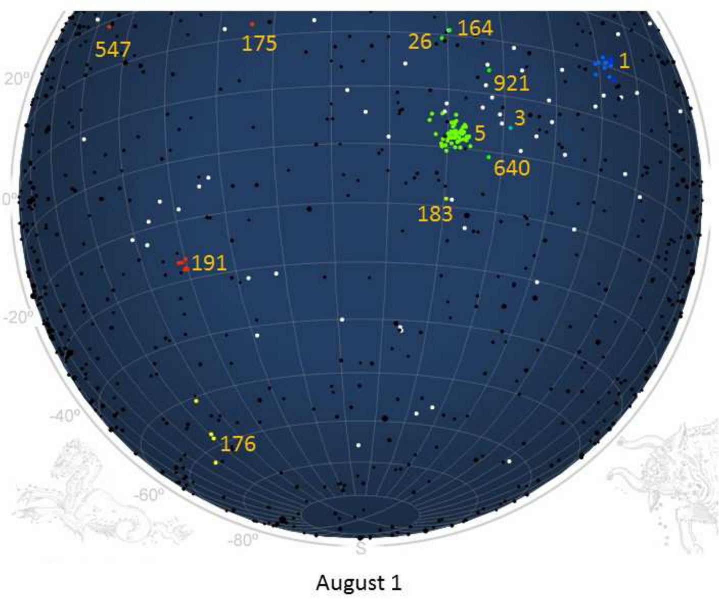

Fig 3. Meteor shower radiants detected for night ending 2019 August 1. Showers are 1 = α Capricornids (CAP), 3 = Southern ι Aquariids (SIA), 5 = Southern δ Aquariids (SDA), 26 = Northern δ Aquariids (NDA), 164 = Northern June Aquilids (NZC), 175 = July Pegasids (JPE), 176 = July Phoenicids (PHE), 183 = Piscis Austrinids (PAU), 191 = η Eridanids (ERI), 547 = κ Perseids (KAP), 640 = August ο Aquariids (AOA), 921 = July λ Capricornids (JLC).

Radiant maps for other nights can be seen by visiting the NASA Meteor Shower Portal at http://cams.seti.org/FDL/. Some examples of meteors as they appear in the cameras are shown in Figure 4, and the cameras also capture various trails which are not due to meteors, including the passage of aircraft, artificial satellites, birds, bats and insects (see examples in Figure 5) which are filtered out by the CAMS software.

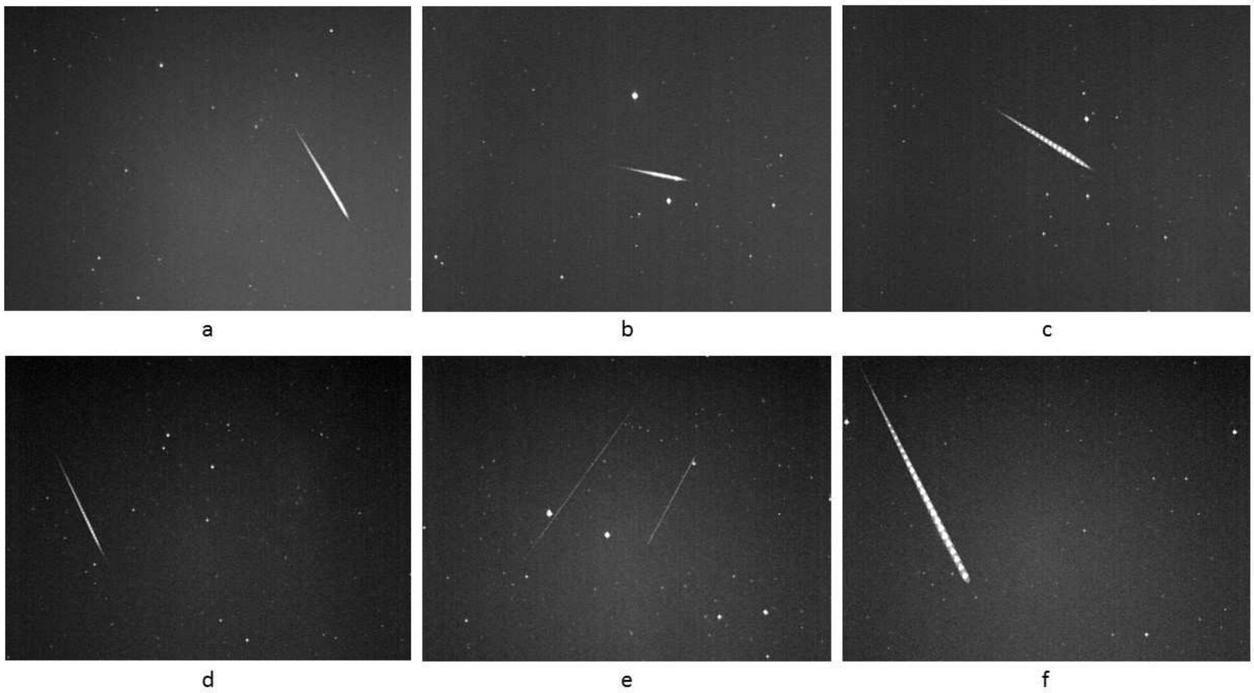

Fig 4. Examples of frame grabs of meteors from Bredell cameras (times are start of exposure in UT). a) 1 August, 21:48:59, below Table of Scorpius; b) 1 August, 20:36:06, meteor with terminal burst, Antares just below and Jupiter is the bright object above the meteor; c) 3 August, 22:52:59, bright object above meteor is Saturn, Sagittarius is below; d) 2 August, 19:32:05, meteor below Ara; e) 3 August, 16:36:12, faint meteor crossing α Centauri on the left, the streak at right from γ Centauri is an artificial satellite; f) 4 August, 02:14:59, bright meteor in unidentified field.

Detection of an outburst from the June ε Ophiuchids

During its first two weeks of operation, CAMS@SA was involved in the confirmation of the June ε Ophiuchids which showed activity between 19 and 26 June 2019 (Jenniskens 2019). The possible existence of this stream (JEO, #459) was first mentioned in Rudawska and Jenniskens (2014), after a stream search of meteors captured by the SonotaCo and CAMS networks during the years 2007 to 2011 gave nine members with similar orbital characteristics. Meteors were said to radiate from R.A. = 246.9° , Decl. = –5.2°, with a geocentric velocity (V_g) of 15.6 km/sec. They concluded ‘showers #459 (June ε Ophiuchids) and #460 (λ Ophiuchids) may be the same shower, perhaps from Jupiter-family comet P/2005 JQ5 (Catalina). Shower 459 is the more certain one.'

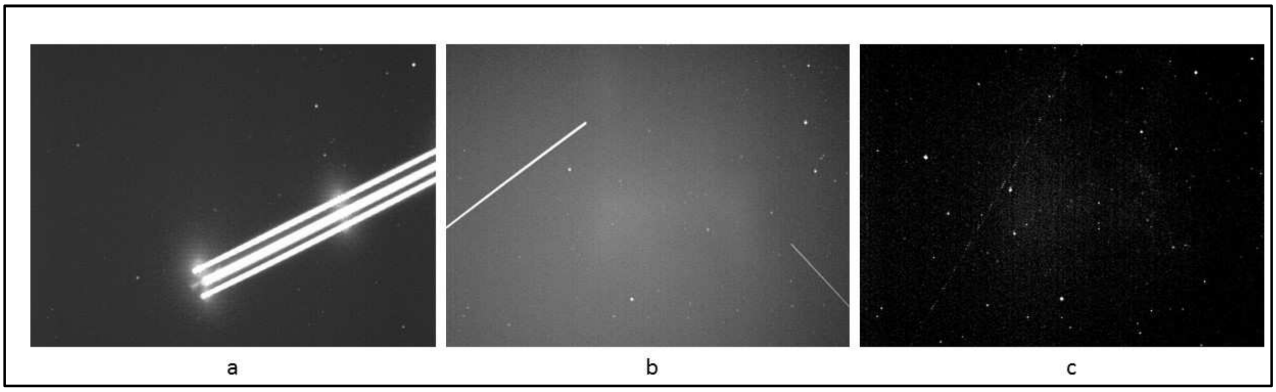

Fig 5. Examples of non-meteor frame grabs. a) aircraft with flashing wing lights, b) two artificial satellites crossing the field of view at the same time, c) bird crossing field of view, wings illuminated by ground lights.

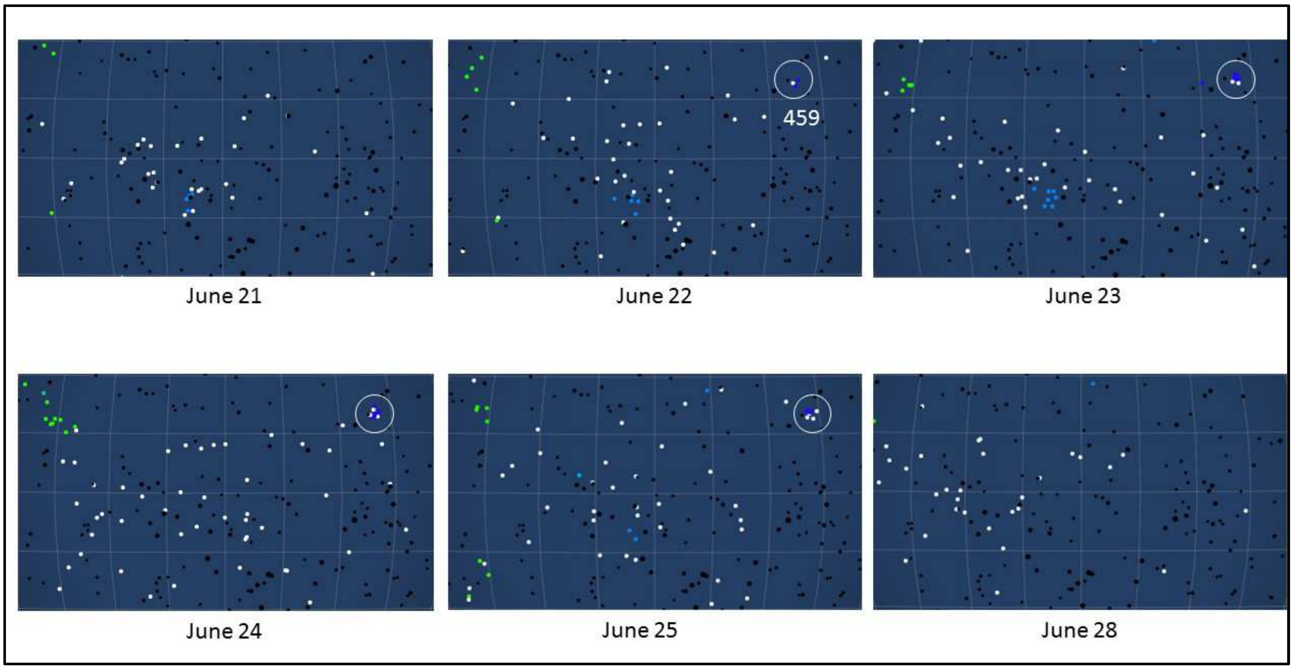

Fig 6. CAMS@SA detections of June ε Ophiuchids (JEO, #459). First detections occurred on 22 June, 2019 and activity lasted at least until 25 June. No data for 26 and 27 June due to power issues. No detections from 28 June onwards.

During the most recent apparition, CAMS@SA first detected members from the shower on 2019 June 22 and also on the subsequent three nights. Nightly captures are shown in Figure 6 with the radiant position of the JEOs indicated by white circles. There was unfortunately no data for June 26 and 27 due to instabilities in the power supply at station BR, and there were no detections from June 28 onwards, after normal service had been restored. On 26 June Dr Peter Jenniskens mailed 'Lot of activity on 22-24 June from shower 459. In your maps it is [to the] right of the antihelion source.....maybe an outburst?' Indeed an outburst of June ε Ophiuchids was duly announced in Electronic Telegram No. 4642 on June 29 (Green 2019) confirming activity between 2019 June 19.33 and 26.21 UT, corresponding with solar longitude $\lambda_{\odot}$ = 87.5-92.1° (equinox J2000.0). Eighty-eight shower members were detected by CAMS New Zealand, CAMS South Africa, CAMS BeNeLux, CAMS Florida, LO-CAMS Arizona and CAMS California. The mean geocentric radiant was from R.A. = 245.2°, Decl. = –7.4°, and the mean geocentric velocity (V_g) of the meteors was 14.2 km/sec. The derived radiant is in good agreement with that found earlier by Rudawska and Jenniskens (2014). The mean orbital elements for the 2019 JEOs are given in Table 1, and also show a good approximation to the elements of comet 300P/ Catalina, period 4.56 years, which is the presumed parent body.

Orbital element	June ε Ophiuchids 2019	300P/ Catalina (Park 2019)
q	0.885	0.825
a	2.69	2.694
e	0.671	0.694
i	5.3	5.70
node	92.2	95.86
peri	227.3	222.7

Table 1 Orbital elements of 2019 June ε Ophiuchids and comparison with comet 300P/Catalina

Conclusions

The CAMS@SA network has completed its first two months and captured data on all but five of its first sixty days in operation, determining the orbits and radiant positions of 4,800 meteors. We are pleased the network was able to contribute in the detection of an outburst of June ε Ophiuchids during the period 19-26 June, 2019 confirming the existence of this shower and its relationship to comet 300P/ Catalina. Several operational issues were overcome, and a number of further improvements are planned for the future.

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ASSA AGM: Presidential Report

For logistical reasons I have this year merged my Report on Council with my Presidential Address

The ASSA Council's prime objective is to make sure that the ASSA functions as laid out by its Constitution. Over the years this has been up-dated to keep in step with the maturation of the ASSA as its scope of activities has broadened. But what hasn't changed is the fact that the President has to report to ASSA members at the AGM, the Council's activities for the year.

Council meetings were held on a regular basis and usually held a week after a Financial sub-Committee, FSC, meeting, both via Skype; efficiently handled by Chris Stewart and Lerika Cross. As was mentioned last year these FSC meetings added greatly to the efficient running of Council meetings; since the Council consists of 15 members or more – as occasionally a few invited section Directors attend as well.

It is almost natural that the FSC has evolved into a sort Executive, consisting as it does, of the President, two VPs, the Secretary, Treasurer and Membership Secretary. They are able to prepare ground for the Council meetings; much work is discussed and covered beforehand by phone and e-mail, an Agenda drawn up, so that when the FSC meets issues raised have had time to be rationalized, these are then discussed and decisions taken, that can then be taken forward to Council for further discussion and final ratification. This system has enhanced the Council's performance, and I look back on the year with great satisfaction in this regard.

Needless to say, one must never overlook the tremendous input Council gets form its Secretary, Lerika Cross. Hers is the most demanding portfolio, and the smooth running of Council is due in large part to her superb project management skills and experience. The FSC and Council Agendas and Minutes were clear, detailed and reflected accurately the issues discussed; and to be discussed. Added to this was the support I received from my VPs, Chris Stewart and Pierre de Villiers, aided by the financial wisdom of AJ Nel, certainly made my task a lot easier.

A financial issue that is still outstanding is that of the ASSET Trust. I would like to thank Peter Cramb, Tim Cooper and Ian Glass, the trustees, for doing their best to resolve this, and feel confident this will be resolved, probably this year.

A word of thanks must also go to Auke Slotegraaf for producing the SGAS which, besides being an excellent publication, it is also becoming a good source of income for the ASSA, enabling members to apply for funding for special projects.

The ASSA now produces three publications, MNASSA, SGAS and Nightfall, all being efficiently managed by the Editorial Board.

ASSA finances are in good shape and AJ will present his report later. The regular FSC meetings have certainly contributed to the smooth and efficient running of our financial affairs which are being well managed.

Claire Flanagan is looking after two Scholarships; the ASSA and the Cooke Scholarship. Thank you, Claire, for your invaluable work.

Membership Secretary, Wilmi Nel has managed this important portfolio very well. She has sustained a well-structured membership list that makes keeping track of the Country Members easier, many thanks for all your efforts. A problem that has been resolved is that MNASSA will no longer be printed and mailed to country members; it is available in printable A4 PDF and booklet format from the Website for free.

The ASSA Website is functioning very well and constantly updated by John Gill. Many people don't realize how important this is; an outdated site will inevitably contain errors that could be embarrassing

There were three highlights for me this year. The first was to see the spin-off from ASSA Symposium 2018 becoming reality, with several new projects by ASSA members;

especially Percy Jacobs and his spectroscopy, and Dave Blane for his double star observations, both contributing to the AAVSO.

This reminds me, that the next ASSA Symposium, the 12th, is due in 2020. This coincides with the 200th anniversary of the SAAO, and the Royal Astronomical Society, and a theme relating to this could well generate some funding for the Symposium and for getting both local and overseas speakers to attend.

The second was the fact that some of our members were becoming actively involved in international collaborations, for example; Tim Cooper's participation in the Cameras for All-sky Meteor Surveillance (CAMS) network in conjunction with the SETI Institute, and Clyde Foster with the NASA Juno project. Thirdly, many thanks to Chris Stewart, for his efforts in completing the Proxima Stellar highway at the Johannesburg Observatory.

On the downside, there is one problem that will need to be addressed by Council. Each Centre chair is a member of Council and these are expected to attend Council meetings, and if the chair is not available, a nominated representative is expected to attend. One or two centres have not done this for several meetings and I encourage them to do so, and that proper communication with ASSA Council is maintained; essential for the future of the ASSA, and its Centres, as I will discuss later. However I feel confident that this matter will improve this coming year.

Finally I can say that the ASSA is in a healthy state and can look forward to the future with confidence.

Case Rijsdijk
ASSA President

This was followed by a brief PPTX presentation on "The Future of Astronomy" – Globally, South African but with an emphasis on ASSA member's contributions.

ASSA AGM: Council and Appointees for 2019/20

ASSA Council

President	Chris Stewart
Vice President	Case Rijsdijk
Treasurer	AJ Nel
Membership Secretary	Wilmi Nel
Secretary	Lerika Cross

Council Member	Dr Pieter Kotze
Council Member	Dr Ian Glass
Council Member	Clyde Foster
Bloemfontein Chair	TBA
Cape Chair	Marius Reitz
Durban Chair	Piet Strauss
Garden Route Chair	Case Rijsdijk
Johannesburg Chair	Carmel Ives
Pretoria Chair	Bosman Olivier
Hermanus Chair	Dr Pierre de Villiers

ASSA Council Appointees

Convener of Scholarships	Dr Claire Flanagan
Web Manager	John Gill
Observing Director	Kos Coronaios
Communications Director	Case Rijsdijk
Outreach Director	Kos Coronaios
Archivist	Chris de Coning
SAAO Liason for Website	Dr Christian Hettlage

ASSA Sections Directors

A - Shallow Sky: Asteroid, Meteors, Comets, Lunar, Occultations, Planetary, Satellites, Solar Clyde Foster

B1: Deep Sky	Douglas Bullis
B2: Double and Variable Stars	Dave Blane
C: Photometry, Spectroscopy	Percy Jacobs
D: Cosmology and Astrophysics	Bruce Dickson
E: SA Astronomy History	Chris de Coning
F: Dark Sky SectionIn	Vacant
G: Imaging Section	Martin Heigan
H: Instrumentation and ATM	Chris Stewart
I: Citizen Science	Allen Versfeld

Editorial Board

MNASSA Editor	Case Rijsdijk
MNASSA Assistant and Layout Editor	Dr Ian Glass
MNASSA Ass. Layout Editor	Willie Koorts
Sky Guide Editor	Auke Slotegraaf
Nightfall Editor	Douglas Bullis
Book Review Editor	Maciej Soltynski

Webmanager	John Gill
Professional Astronomer	Em. Prof Brian Warner
Professional Astronomer	Dr Ian Glass
Professional Astronomer	Dr Vanessa McBride OAD/UCT/SAAO

Scholarships Committee

Dr Claire Flanagan	Scholarship Convenor
Dr Ian Glass	Professional Astronomer
Sivuyile Manxoyi	EUNAWE, SAAO outreach
Maciej Soltynski	Previous Scholarship Convenor
Dr Vanessa McBride	OAD,/UJCT/SAAO

ASSA AGM: Summary of Reports

Communications – approximately one enquiry every three days on average was received, with career queries being forwarded to SAAO. Several radio and TV interviews were fielded, notably by Clyde.

Editorial board – MNASSA, SkyGuide, Nightfall & Website are competently handled as usual by the team, which lost Prof Feast (deceased) and gained Doug Bullis.

Deep Sky Section – Achievement awards for observation were issued to 10 members. 7 members were thanked for their contributions to Nightfall.

Historical Section – Archiving and updates to the website are ongoing. An Historical Symposium was held in conjunction with the ASSA symposium in Cape Town, for which the organising committee are thanked. Two historical articles and 3 obituaries were published in MNASSA.

Shallow Sky Section – 18 fireball reports were investigated and reported on in MNASSA, together with several meteor showers. Planetary Imaging and international pro-am collaboration on various lunar and planetary topics are ongoing. Martian dust storms, Lunar X & Y features, unprecedented developments of Jupiter’s Great Red Spot, and Saturn’s lunar occultations received much attention.

Variable & Double-Star Section – Eclipsing binary photometry projects were collaborated on, with papers and articles on 4 such systems being published. An exoplanet transit was observed and published on, as part of an 8-country search for habitable exoplanets. Several variable star observers submitted reports to AAVSO, VSS, etc. databases, and talks were delivered. The director continues his survey of Southern wide double stars.

Astrophotography/Imaging Section – 4 section members received international recognition for their contributions, both aesthetic and scientifically useful in nature. Astro images of South African origin are shared on Flickr and highlighted in Nightfall. The catchment area for the ScopeX astrophotography competition has been widened this year.

Citizen Science Section – This is a new section formed encourage and support ASSA members participating in citizen science projects, and to provide technical assistance to South African researchers who wish to set up their own citizen science projects. It was sparked by Dr Stella Kafka of AAVSO, is supported by Dr Pamela Gay of the Astronomical Society of the Pacific and has attracted the interest of Dr Corlia Meyer of Stellenbosch University. Plans regarding identification of projects suitable for the Section to tackle, are in progress.

Instrumentation Section – Activities largely revolve around communication, outreach, guidance and education, plus the important aspect of encouraging people in the pursuit of their personal instrumentation projects. The telescope making class which has been continuously active since mid-1991 still enjoys an influx of newcomers, whilst experienced members are currently tackling ambitious projects such as f/3 paraboloids and high-resolution spectroscopes. Interested parties worldwide receive advice via the FaceBook group. The 18th ScopeX event will occur in September.

Spectroscopy Section – The objective is to promote amateur spectroscopy and provide support to those who need to improve on their skills or get involved with pro-am activities. As a niche field, participation is low, though some beginners have been attracted and the Director is engaged in high-resolution spectroscopy with home-made equipment. Of the 181 spectra submitted to the AAVSO database from 7 active observers around the globe, 73 were submitted by the Director and they have attracted 179 downloads.

Cosmology Section – Whilst the July 2018-2019 has been quiet in terms of scientific discovery, group discussion has been active with about 4 new topic threads per week and interest levels remain high.

Scholarship Committee – Two scholarships of R20,000 each are administered. Of 15 applications received, 8 were eligible and both scholarships were awarded. Previous awardees are continuing their studies; one of the 2018 candidates is now registered for BSc(Hons) on Dark Matter.

Observing & Outreach –Alerts for opportunities to observe various uncommon or transient events were published, while several reports from the public on sightings (e.g. of meteor/fireballs) were received and routed as appropriate. ASSA Centres across the country have held monthly meetings and (weather permitting) observing evenings, which are open to the public. Live video cover of the recent partial eclipse was fed to Slooh for the benefit of viewers worldwide.

Asterisms: Streicher 8-12

Magda Streicher

Streicher 8

Exercising a firm grip on the southern edge of the border with the constellation Vela, this asterism in Antlia really appeals to me and is a great pleasure to share. This grouping, which consists of only a handful of stars in a half-moon shape, stands out vividly against the background star field. It reminds me of a set of headphones with brighter stars at the north-eastern and south-western ends. Fainter stars connect the shape to strengthen the impression. The grouping is situated only 2.3 degrees east of the famous planetary nebula NGC 3132, also called the Eight Burst or Southern Ring nebula, with a beautiful characteristic blue colour.

Object	Type	Ra	Dec	Mag	Size
Streicher 8 DSH J1013.8-4019	Asterism	10h13’.52”	-40°19’48”	8	3.1’

Fig 1. Streicher 8. Picture credit: archive.stsci.edu/cgi-bin/dss

Streicher 9

Barely half a degree north-east of the lovely open cluster NGC 2539 in the constellation Puppis is the small grouping Streicher 9. It consists of only six stars in a north to south direction, but is quite outstanding against a very busy star field. It is special in shape and displays various magnitudes and colour combinations. One stands amazed at the realistic appearances of groupings like this one.

Object	Type	RA	DEC	Mag	Size
Streicher 9 DSH J0812.8-1218	Asterism	08h12'.48"	-12°18'06"	9.5	2.9'

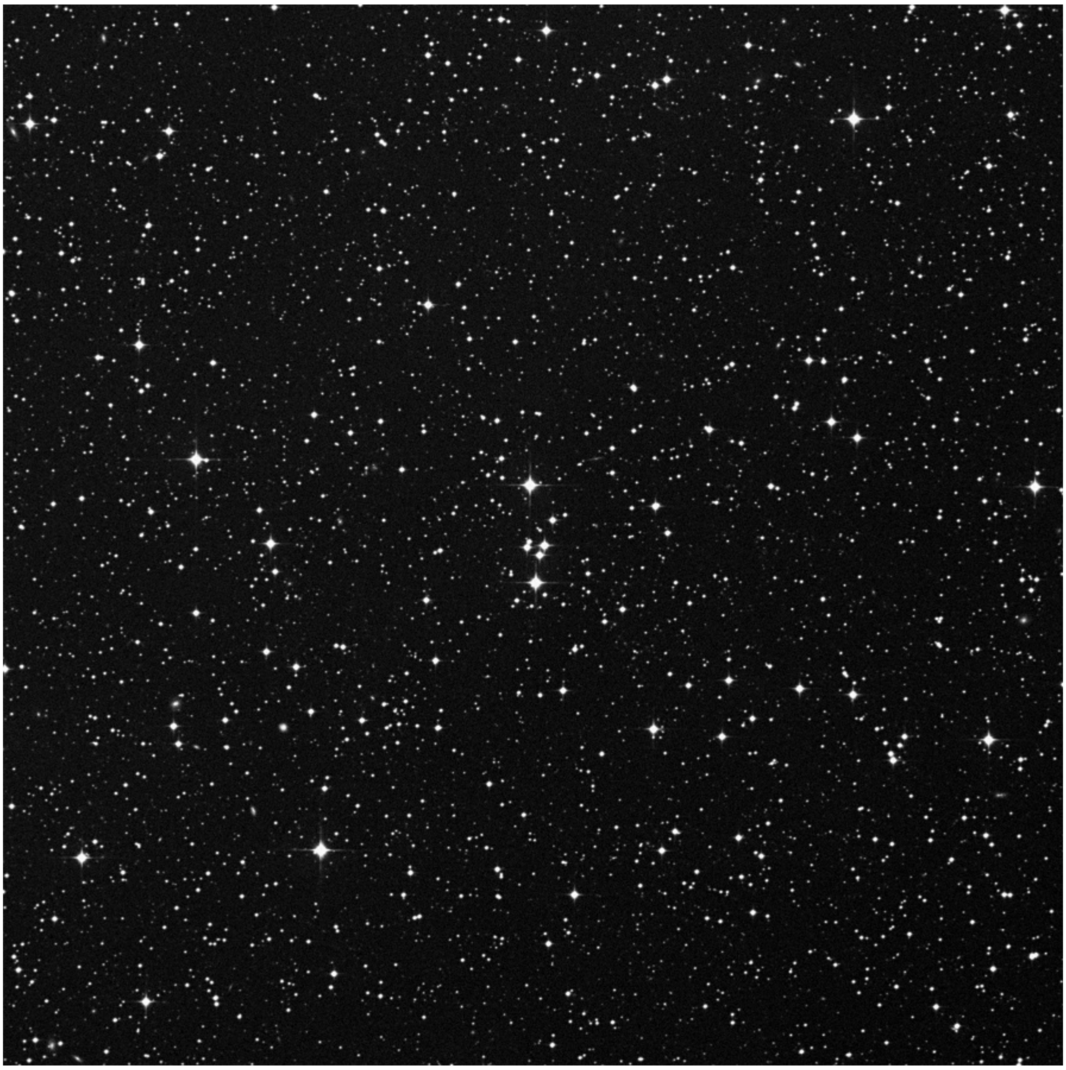

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Fig 2. Streicher 9. Picture credit: archive.stsci.edu/cgi-bin/dss

Streicher 10

Eight shiny white stars can be seen in a relatively prominent string running north-east to south-west in the constellation of Pavo. The ends of the lovely string are marked the brighter star, magnitude 6.7 HD 165861 at the south-western end.

Object	Type	RA	DEC	Mag	Size
Streicher 10 DSH J1815.3-7042	Asterism	08h15’.22”	-70°42’30”	8.5	12’

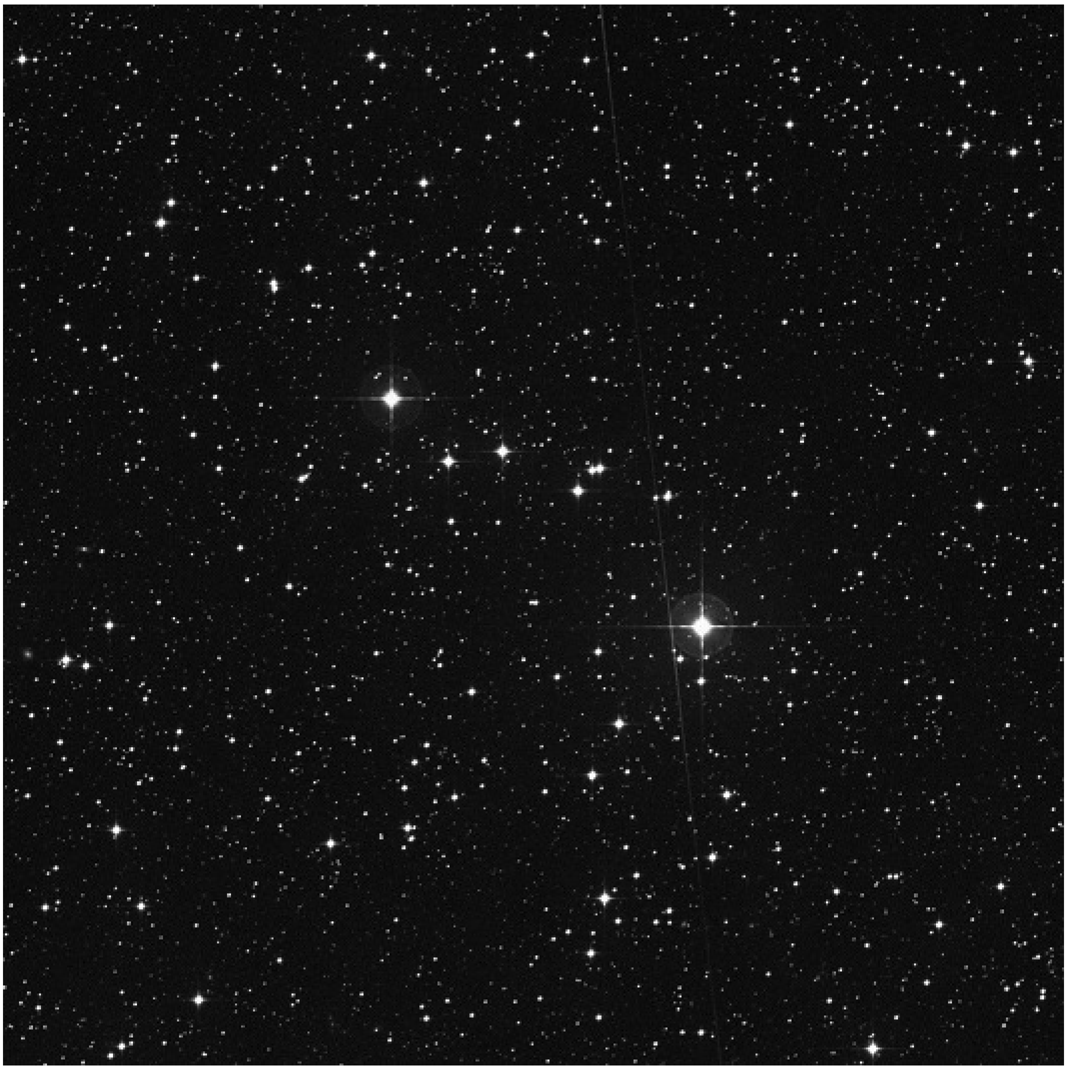

Fig 3. Streicher 10. Picture credit: archive.stsci.edu/cgi-bin/dss

Streicher 11

Very similar to Streicher 10, but much more outstanding, as a half-moon string consisting of six bright stars make a striking impression. It is situated barely a degree west in a triangle from alpha Antlae towards the north-east and the faint galaxy IC 2580 east.

Object	Type	RA	DEC	Mag	Size
Streicher 11 DSH J1024.0-3128	Asterism	10h24'.03"	-31°28'54"	9	12'

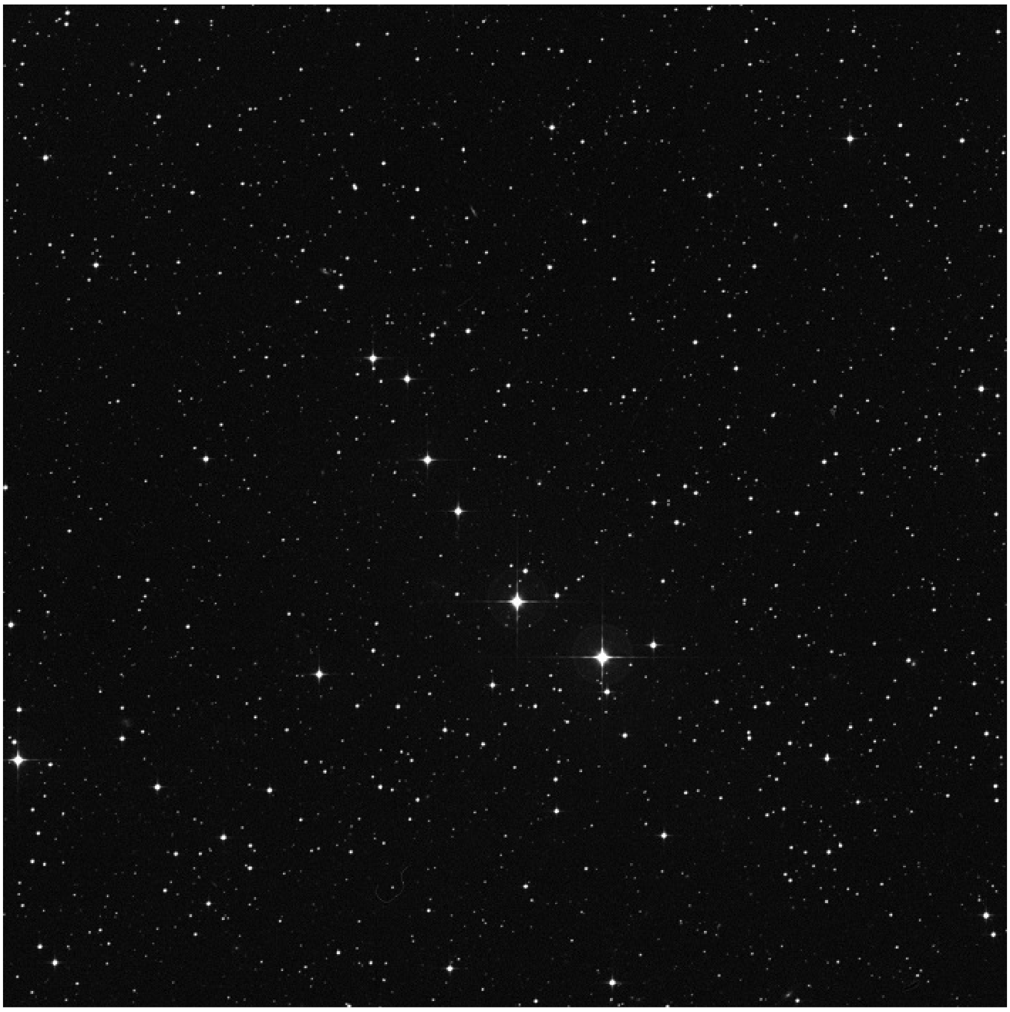

Fig 4. Streicher 11. Picture credit: archive.stsci.edu/cgi-bin/dss

Streicher 12

A good handful of various magnitude stars quite close together, forming a lovely grouping appears comfortably settled among a number of galaxies in the field of view. Streicher 12 is situated between the two galaxies IC 2578 and IC 3302, a degree from each other in the northern part of the constellation Antlia. The brightest star, HD 91263, on the northern edge of the grouping shines with a magnitude of 7.9.

Object	Type	RA	DEC	Mag	Size
Streicher 12 DSH J1031.7-3306	Asterism	10h31’.45”	-33°06’00”	8.7	5.5’

Fig 5. Streicher 12. Picture Credit: archive.stsci.edu/cgi-bin/dss

The **Astronomical Society of Southern Africa** (ASSA) was formed in 1922 by the amalgamation of the Cape Astronomical Association (founded 1912) and the Johannesburg Astronomical Association (founded 1918). It is a body consisting of both amateur and professional astronomers.
Publications: The Society publishes its electronic journal, the *Monthly Notes of the Astronomical Society of Southern Africa (MNASSA)* bi-monthly as well as the annual *Sky Guide Africa South.*
Membership: Membership of the Society is open to all. Potential members should consult the Society's web page assa.saao.org.za for details. Joining is possible via one of the local Centres or as a Country Member.
Local Centres: Local Centres of the Society exist at Bloemfontein, Cape Town, Durban, Hermanus, Johannesburg, Natal Midlands, Pretoria and Sedgefield district (Garden Route Centre). Membership of any of these Centres automatically confers membership of the Society.
Sky & Telescope: Members may subscribe to Sky & Telescope at a significant discount (proof of membership is required). Please contact the Membership Secretary for details.
Internet contact details: email: assa@saao.ac.za Home Page: http://assa.saao.ac.za

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