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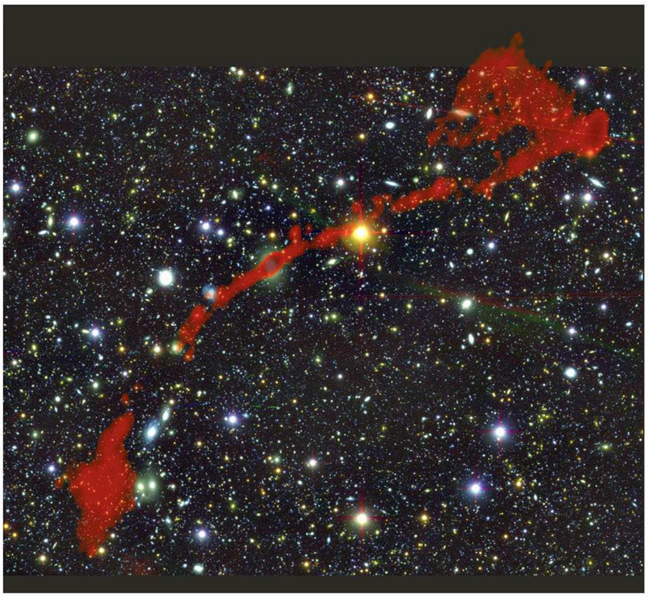

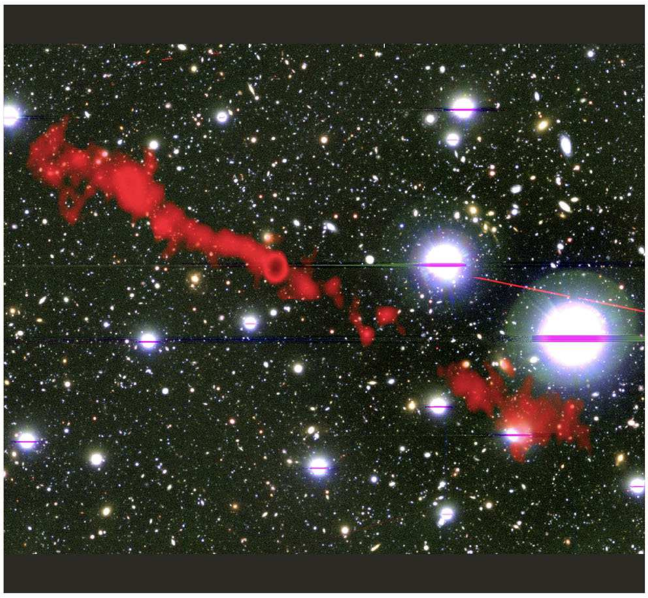

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News Note: The SKA Project, now the SKA Observatory

The Square Kilometre Array project is a highly complex international one involving intergovernmental agreements and massive investments. South Africa is one of the many countries involved though, with Australia, one of the most important ones because they are the locations of the actual observing facilities. The next decade will see it come to dominate the local astronomical scene.

As readers will know, the project has been in the air for many years but things are at last beginning to move as the following news items indicate.

Dr Catherine Cesarsky elected Chair of the SKA Board of Directors

On October 13th, the Board of Directors of the Square Kilometre Array (SKA) Organisation approved the appointment of Dr Catherine Cesarsky as its new chairman.

Born in France, Catherine Cesarsky holds a Physics degree from University of Buenos Aires, and a PhD in Astronomy from Harvard University. Throughout her career, Dr Cesarsky has held numerous important positions in international science administration. Inter alia, from 1999 to 2007, she was the Director General of the European Southern Observatory (ESO), the only other international astronomical organisation.

An accomplished astronomer with more than 150 refereed papers, Catherine Cesarsky's research activities span several areas of modern astrophysics, from the high-energy domain to the infrared.

As Director General of ESO, Dr. Cesarsky oversaw the operation of ESO's large optical telescopes and the start of construction of the Atacama Large Millimetre Array (ALMA) – a collaboration between Europe, North America and East Asia – in northern Chile. She also launched the European Extremely Large Telescope project, one of the key astronomical facilities of the coming decades along with the SKA.

Current summary of the SKA project

The Square Kilometre Array (SKA) project is an international effort to build the world's largest radio telescope, led by the SKA Organisation based at the Jodrell Bank Observatory near Manchester. The SKA will conduct transformational science to improve our understanding of the Universe and the laws of fundamental physics, monitoring the sky in unprecedented detail and mapping it hundreds of times faster than any current facility.

The SKA is not a single telescope, but a collection of telescopes or instruments, to be spread over long distances. The SKA is to be constructed in two phases: Phase 1 (called SKA1) in South Africa and Australia; Phase 2 (called SKA2) expanding into other African countries, with the component in Australia also being expanded.

Already supported by 10 member countries – Australia, Canada, China, India, Italy, New Zealand, South Africa, Sweden, The Netherlands and the United Kingdom – the SKA Organisation has brought together scientists, engineers and policy makers and more than 100 companies and research institutions across 20 countries in the design and development of the telescope. Construction of the SKA is set to start in 2019, with early science observations in the early 2020s.

The SKAO, a new intergovernmental organisation

On 4 February 2021 the SKA Observatory, a new intergovernmental organisation dedicated to radio astronomy, was launched following the first meeting of the Observatory's Council.

The new Observatory, abbreviated as SKAO, is the world's second intergovernmental organisation to be dedicated to astronomy. Headquartered in the UK on the grounds of the Jodrell Bank UNESCO World Heritage Site with sites in Australia and South Africa, SKAO is tasked with building and operating the two largest and most complex radio telescope networks ever conceived to address fundamental questions about our universe.

"This is a historic moment for radio astronomy," said Dr Catherine Cesarsky, appointed first Chair of the SKAO Council. "Behind today's milestone, there are countries that had the vision to get deeply involved because they saw the wider benefits their participation in SKAO could bring to build an ecosystem of science and technology involving fundamental research, computing, engineering, and skills for the next generation, which are essential in a 21st century digital economy."

SKAO's telescope in South Africa will be composed of 197 15 metre-diameter dishes located in the Karoo region, 64 of which already exist and are operated by the South

African Radio Astronomy Observatory (SARAO), while the telescope in Australia will be composed of 131,072 two-metre-tall antennas located on the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Murchison Radio-astronomy Observatory.

The creation of SKAO follows a decade of detailed engineering design work, scientific prioritisation, and policy development under the supervision of its predecessor the SKA Organisation, supported by more than 500 engineers, over 1,000 scientists and dozens of policy-makers in more than 20 countries; and is the result of 30 years of thinking and research and development since discussions first took place about developing a next-generation radio telescope.

"Today marks the birth of a new Observatory," said Prof Philip Diamond, appointed first Director-General of SKAO. "And not just any observatory – this is one of the mega-science facilities of the 21st century. It is the culmination of many years of work and I wish to congratulate everyone in the SKA community and in our partner governments and institutions who have worked so hard to make this happen. For our community, this is about participating in one of the great scientific adventures of the coming decades. It is about skills, technology, innovation, industrial return, and spin offs but fundamentally it is about a wonderful scientific journey that we are now embarking on."

The first SKAO Council meeting follows the signature of the SKA treaty, formally known as the Convention establishing the SKA Observatory, on 12 March 2019 in Rome, and its subsequent ratification by Australia, Italy, the Netherlands, Portugal, South Africa and the United Kingdom and entry into force on 15 January 2021, marking the official birth date of the observatory.

The Council is composed of representatives from the Observatory's Member States, as well as Observer countries aspiring to join SKAO. Among these are countries that took part in the design phase of the SKA such as Canada, China, France, Germany, India, Spain, Sweden and Switzerland, and whose future accession to SKAO is expected in the coming weeks and months, once their national processes have been completed. Representatives of national bodies in Japan and South Korea complement the select list of Observers in the SKAO Council.

At its first meeting, the SKAO Council approved policies and procedures that have been prepared in recent months – covering governance, funding, programmatic and HR matters, among others. These approvals are required to transfer staff and assets from the SKA Organisation to the Observatory and allow the latter to become a functioning entity.

“The coming months will keep us very busy, with hopefully new countries formalising their accession to SKAO and the expected key decision of the SKAO Council giving us green light to start the construction of the telescopes,” added Prof Diamond.

SKAO will begin recruitment in Australia and South Africa in the next few months, working alongside local partners CSIRO and SARAO to supervise construction, which is expected to last eight years, with early science opportunities starting in the mid 2020s.

News Note: Gigantic galaxies discovered with the MeerKAT telescope

The discovery has been published on Monday, 18 January 2021 in the Monthly Notices of the Royal Astronomical Society

Two giant radio galaxies have been found with South Africa's powerful MeerKAT telescope. These galaxies are amongst the largest single objects in the Universe and are thought to be quite rare. The fact that MeerKAT detected two of these monsters in a relatively small patch of sky suggests that giant radio galaxies may actually be much more common than previously thought. This gives astronomers further vital clues about how galaxies have changed and evolved throughout cosmic history.

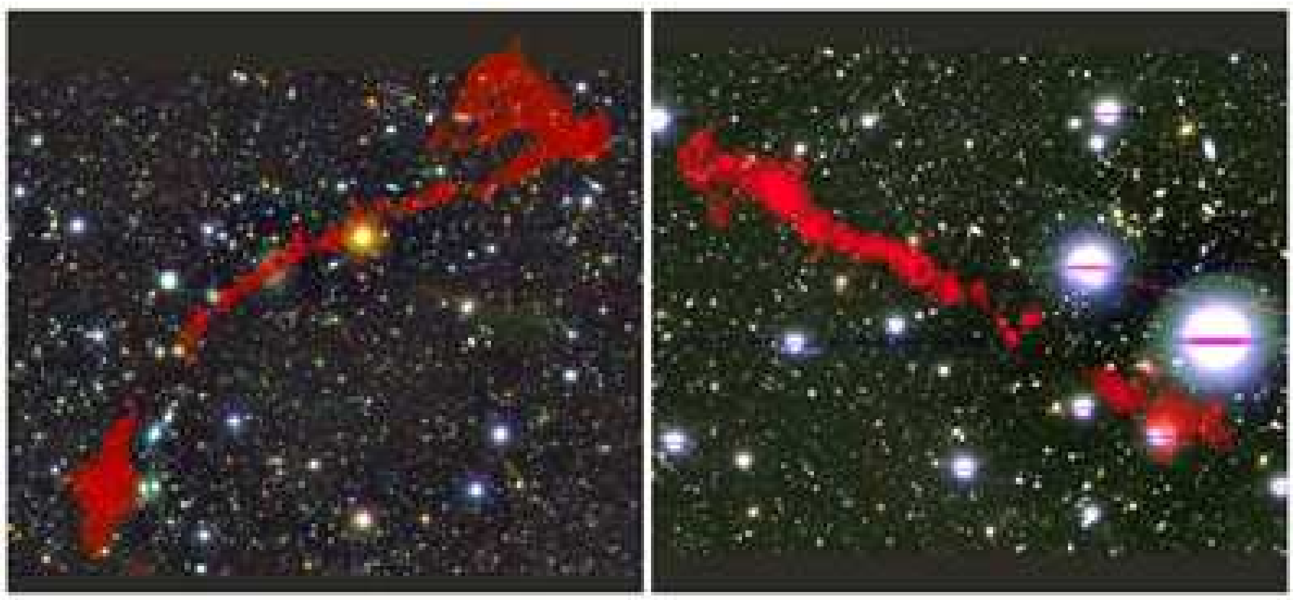

Fig 1. The two giant radio galaxies found with the MeerKAT telescope. In the background is the sky as seen in optical light. Overlaid in red is the radio light from the enormous radio galaxies, as seen by MeerKAT. Left: MGTC J095959.63+024608.6. Right: MGTC J100016.84+015133.0. Credit: I. Heywood (Oxford/Rhodes/SARAO).

Many galaxies have supermassive black holes residing in their midst. When large amounts of interstellar gas start to orbit and fall in towards the black hole, the black hole becomes ‘active’ and huge amounts of energy are released from this region of the galaxy. In some active galaxies, charged particles interact with the strong magnetic fields near the black hole and release huge beams, or ‘jets’, of radio light. The radio jets of these so-called ‘radio galaxies’ can be many times larger than the galaxy itself and can extend vast distances into intergalactic space

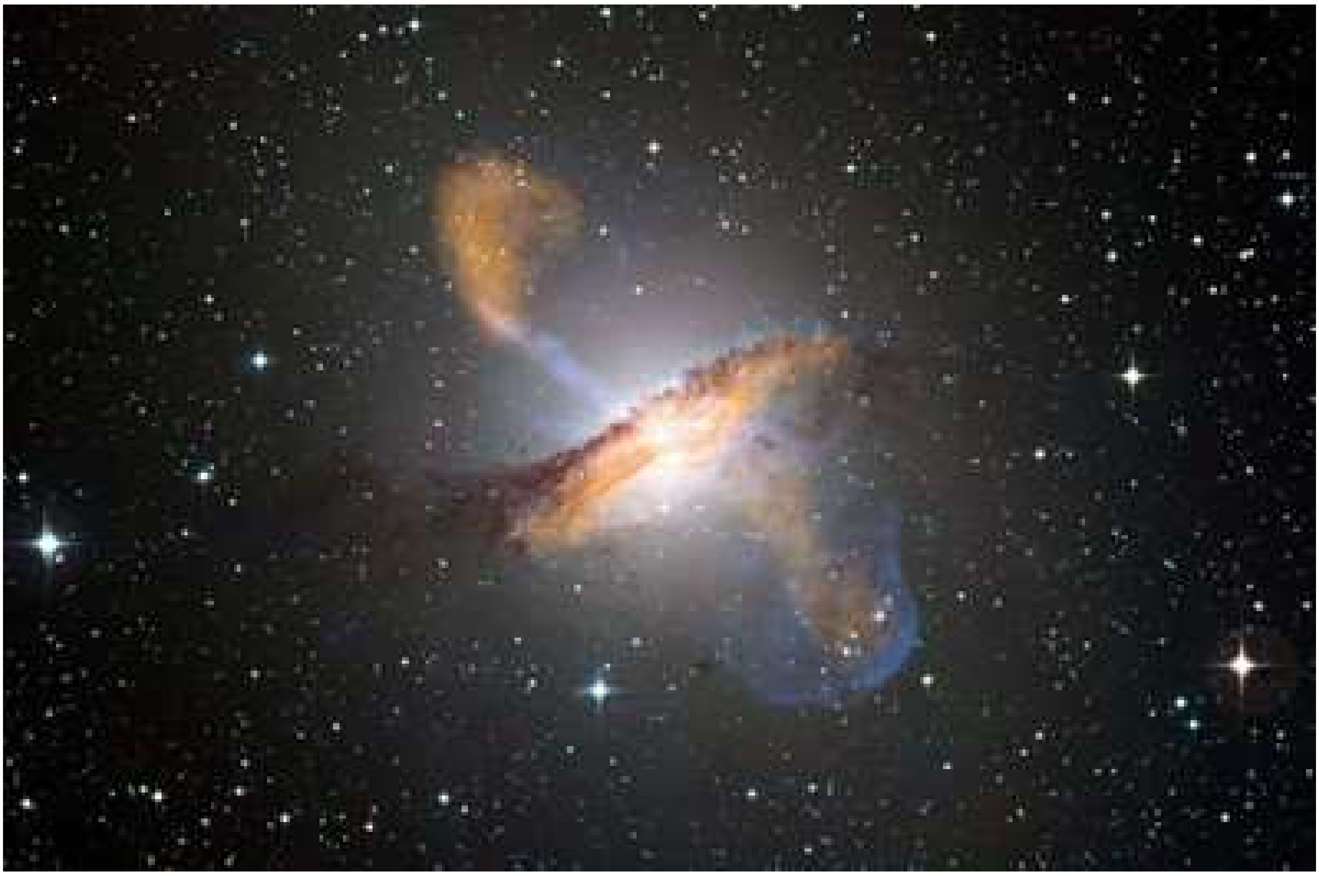

Fig 2. Centaurus A is a famous example of a relatively nearby radio galaxy. Inside the galaxy is a supermassive black hole which is generating the large jets which can be seen emerging perpendicular to the disc of the galaxy. Credit: ESO/WFI (Optical); MPIfR/ESO/APEX/A.Weiss et al. (Submillimetre); NASA/CXC/CfA/R.Kraft et al. (X-ray).

Dr Jacinta Delhaize, a Research Fellow at the University of Cape Town and lead author of the work, said that many hundreds of thousands of radio galaxies have already been discovered. However, only around 800 of these have radio jets exceeding 700 kilo-parsecs in size, or around 22 times the size of the Milky Way. These truly enormous systems are called ‘giant radio galaxies’. Despite the scarcity of giant radio galaxies, the authors found two of these cosmic beasts in a remarkably small patch of sky.

According to Dr Delhaize it was found these giant radio galaxies in a region of sky which is only about 4 times the area of the full moon, though the galaxies are much further away and much larger than the moon. Based on our current knowledge of the density of giant radio galaxies in the sky, the probability of finding two of them in this region is extremely small. This means that giant radio galaxies are probably far more common than thought before.

Dr Matthew Prescott, a Research Fellow at the University of the Western Cape and co-author of the work, said that these two galaxies are special because they are much bigger than most other radio galaxies. They are more than 2 Mega-parsecs across, which is around 6.5 million light years or about 62 times the size of the Milky Way. Yet they are fainter than others of the same size. It is suspected that many more galaxies like these should exist, because it is thought that these galaxies should grow and change over their lifetimes.

The giant radio galaxies were spotted in new radio maps of the sky created by the MeerKAT International Gigahertz Tiered Extragalactic Exploration (MIGHTEE) survey. It is one of the large survey projects underway with South Africa's impressive MeerKAT radio telescope and involves a team of astronomers from around the world.

The two giant radio galaxies have never been identified before, despite the sky region having already been observed by other radio telescopes such as the Karl G. Jansky Very Large Array in the USA, and the Giant Metre-Wave Radio Telescope in India.

According to Dr Ian Heywood, a co-author at the University of Oxford, the MeerKAT telescope is the best of its kind in the world; it has managed to identify these giant radio galaxies for the first time because of MeerKAT's unprecedented sensitivity to faint and diffuse radio light. This made it possible to detect features that haven't been seen before. The large-scale radio jets coming from the central galaxies, as well as fuzzy cloud-like lobes at the ends of the jets.

These galaxies are several billion light years away. It was the discovery of these enormous jets and lobes in the MIGHTEE map that allowed the confident identification the objects as giant radio galaxies.

Why only very few radio galaxies have such gigantic sizes has been somewhat of a mystery. It is thought that the giants are the oldest radio galaxies, which have existed for long enough (several hundred million years) for their radio jets to grow outwards to these enormous sizes. If this is true, then many more giant radio galaxies should exist than are currently known.

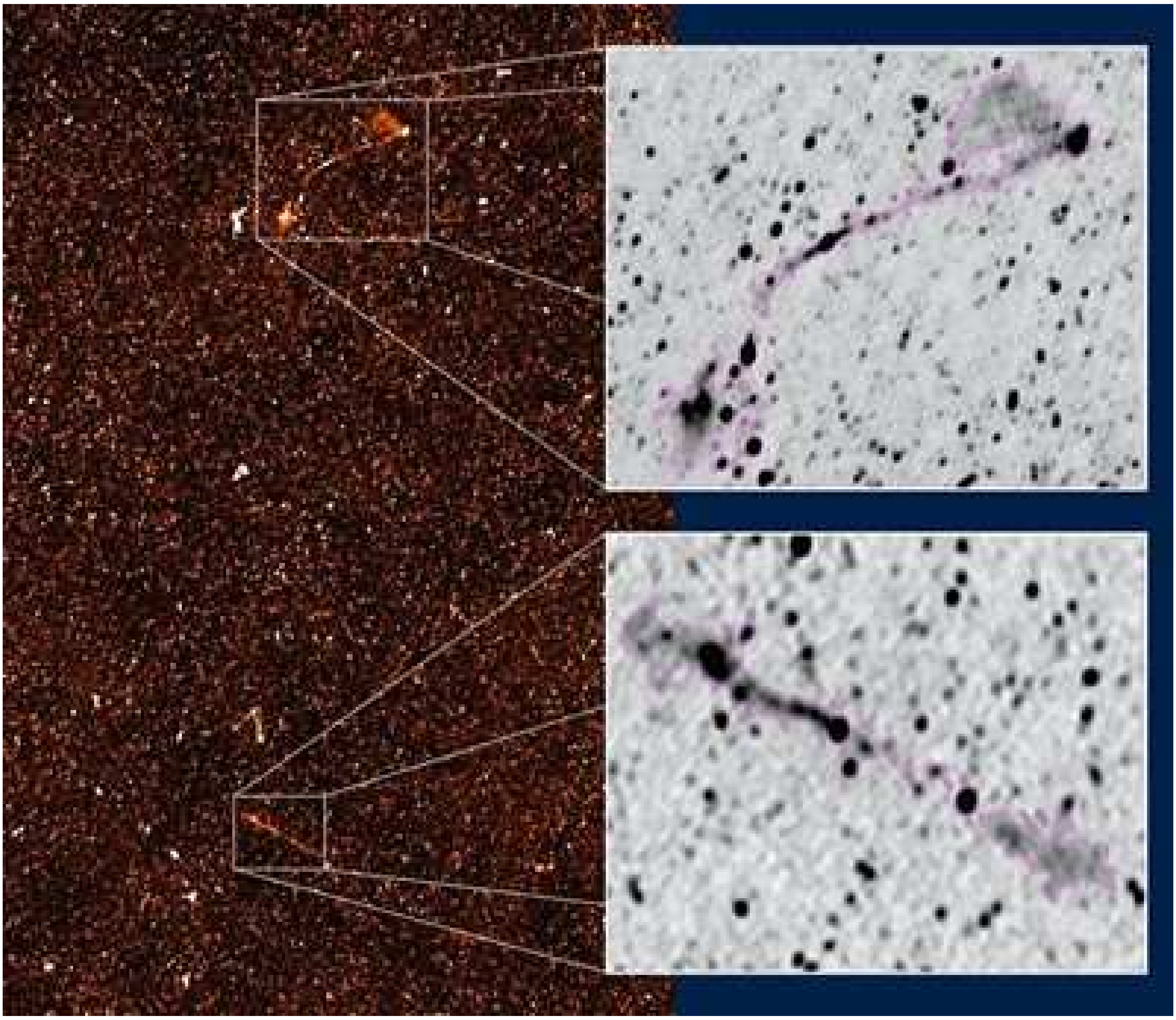

Fig 3. Part of the MIGHTEE radio map of the sky. A zoom in of each giant radio galaxy is shown in greyscale. The purple line traces around the radio emission from the giants. Image credit: I. Heywood (Oxford/Rhodes/SARAO

With the discovery of objects like these giant radio galaxies, a clearer understanding of the evolutionary pathways of galaxies is beginning to emerge.
The existence of the two MIGHTEE giant radio galaxies provides tantalising evidence that a large population of faint, very extended giant radio galaxies may exist.

In the past, this population of galaxies has been hidden from our 'sight' by the technical limitations of radio telescopes. However, it is now being revealed thanks to the impressive capabilities of the new generation of telescopes.

It is hoped to uncover more of these giant galaxies in the MIGHTEE survey as it progresses. We also expect to find many more with the future Square Kilometre Array (SKA) telescope. The SKA will reveal larger populations of radio galaxies than ever before and revolutionise our understanding of galaxy evolution.

Results from the CAMS@SA network for 2020

Tim Cooper[1] *and Philip Mey*[2]

[1]*Coordinator, CAMS South Africa, Bredell Observatory, Station BR*
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The aim of the Cameras for All-sky Meteor Surveillance project (CAMS) is to validate the IAU Working List of Meteor Showers (Jopek and Rudawska 2020) each of which is the result of an earth-crossing comet, which could potentially pose a hazard to Earth at a future return. The authors operate sixteen cameras as part of the global CAMS network, with eight cameras each at Bredell Observatory and the Hartebeesthoek site belonging to the South African Radio Astronomy Observatory, and jointly referred to as CAMS@SA. After first-light in June 2019, the past year was the first full year of operation, and saw an increase in captures from 9640 to 13006, giving a cumulative total of 22646 meteor orbits since commencing operation. Most of the captured meteors are from known annual showers and sporadic meteors, but occasionally detections are made of previously unknown meteor showers or showers that do not return annually and could signify comets that come particularly close to Earth's orbit.

As a result of the expansion of CAMS in the southern hemisphere in 2019, the year 2020 proved particularly rich in detected irregular showers. Exceptional meteor shower activity was reported about once a month. CAMS@SA participated in the following detections. Where visual observations were conducted in support, these are given also. All visual observations were made by Tim Cooper.

h Virginids, HVI, #343

Activity during February to April from the constellations of Leo and Virgo has long been known, and was previously referred to as the Virginid Complex. This is a complex of weak radiants, which emerge just above the sporadic background during February to April, and are difficult to monitor by purely visual means. Various attempts to do so led to inconclusive results with many apparent centres of activity, with variable detection from year to year. McBeath (1992) discussed the results of five years of visual plotting from 1988-1992, and Cooper continued this project from 1998-2002, during which time he reconfirmed some centres of activity, as well as some not previously observed. Later it was realised (Lunsford 2004) that these radiants located along the ecliptic, including the delta Leonids and Virginids, and thereafter the Scorpiids and Sagittariids, were active while opposite the sun, and for this reason became known as anthelion meteors. Jenniskens (2006a) pointed out that only the alpha Virginids could be recognized as a definite member. Today the collective source is no longer referred to as the Virginids, but from time-to-time new detections of distinct showers within the complex are made by CAMS, as was the case recently with the h Virginids.

The h Virginids is an irregular shower that was first detected in 2008 (SonotaCo 2009), which may have been an outburst. The shower appeared again in 2019 between April 23 and May 5 with peak on April 27 (Jenniskens 2020a). In 2020 the first detection was around 19 April. Rates remained low until April 27 when all cameras on the CAMS network detected h Virginids, from a radiant at RA = 202.1 ± 1.1°, Decl. = –10.6 ± 0.9°. Enhanced rates remained for the next couple of nights after which they declined, the last detection being on May 9.

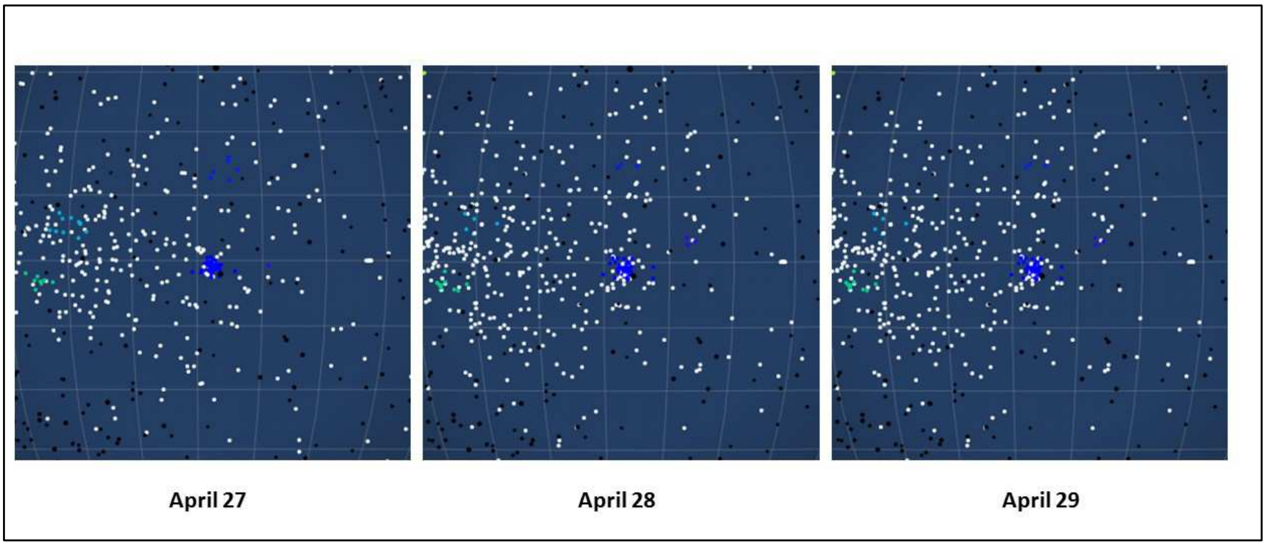

Fig 1. CAMS radiant plots showing the h Virginids at centre. Blue dots to the left are mu Virginids, green dots below them are iota[1] Librids. Blue dots above centre are alpha Virginids. A small number of April theta Virginids can be seen immediately to the right of the h Virginids. Colours represent speed of meteors, with blue being slow. Black dots are stars, Spica can be seen immediately to the lower right of the radiant. Grid lines are in ecliptic coordinates.

The orbital elements are of an unknown comet in a Jupiter-Family orbit, but bear some resemblance to the Apollo asteroid 2020 FV6, which made a close approach to Earth of 0.028 AU on 2020 April 19.562 UT, but does not make a close approach again until 2050 September 17 at 0.04 AU (JPL 2021).

Cooper observed the shower visually for 8.0 hours as shown in Table 1. The night of May 1/2 was cloudy.

Date 2020	Time UT	Alt.	T eff hrs	LM	HVI	ANT	SPO	Total
Apr 29/30	1842-1942	60.2	1.00	5.10	5	1	2	8
Apr 29/30	1942-2042	71.2	1.00	5.20	1	1	4	6
Apr 29/30	2103-2203	73.4	1.00	5.20	2	1	2	5
Apr 30/1	1740-1840	47.9	1.00	5.35		1	2	3
Apr 30/1	1852-1952	63.0	1.00	5.40	1	2	2	5
May 2/3	1647-1747	37.8	1.00	5.20	2		3	5
May 2/3	1850-1950	64.3	1.00	5.25	2		4	6
May 3/4	1815-1915	57.9	1.00	5.30			1	1
Total			8.00		13	6	20	39

Table 1 Visual observations of h Virginids. Alt is the mean altitude of the radiant for the period, LM is the naked eye limiting magnitude, HVI is the number of observed h Virginids, ANT is the number of observed anthelion meteors, and SPO is the number of observed sporadic meteors.

All meteors observed were plotted, and from 39 meteors, the 13 members recorded as h Virginids are shown in Fig. 2.

Highest activity was on the evening of 2020 April 29, with 5 members, giving a zenithal hourly rate (ZHR) = 21 $\pm$ 8. Magnitude distribution of all observed h Virginids was (from magnitude –2 to fainter): 1, 1, 1, 0, 1.5, 3.5, 4, plus one magnitude –8 fireball, giving a mean magnitude of 1.42 including the fireball, or 2.21 without. It appears the shower has a tendency to produce occasional bright members.

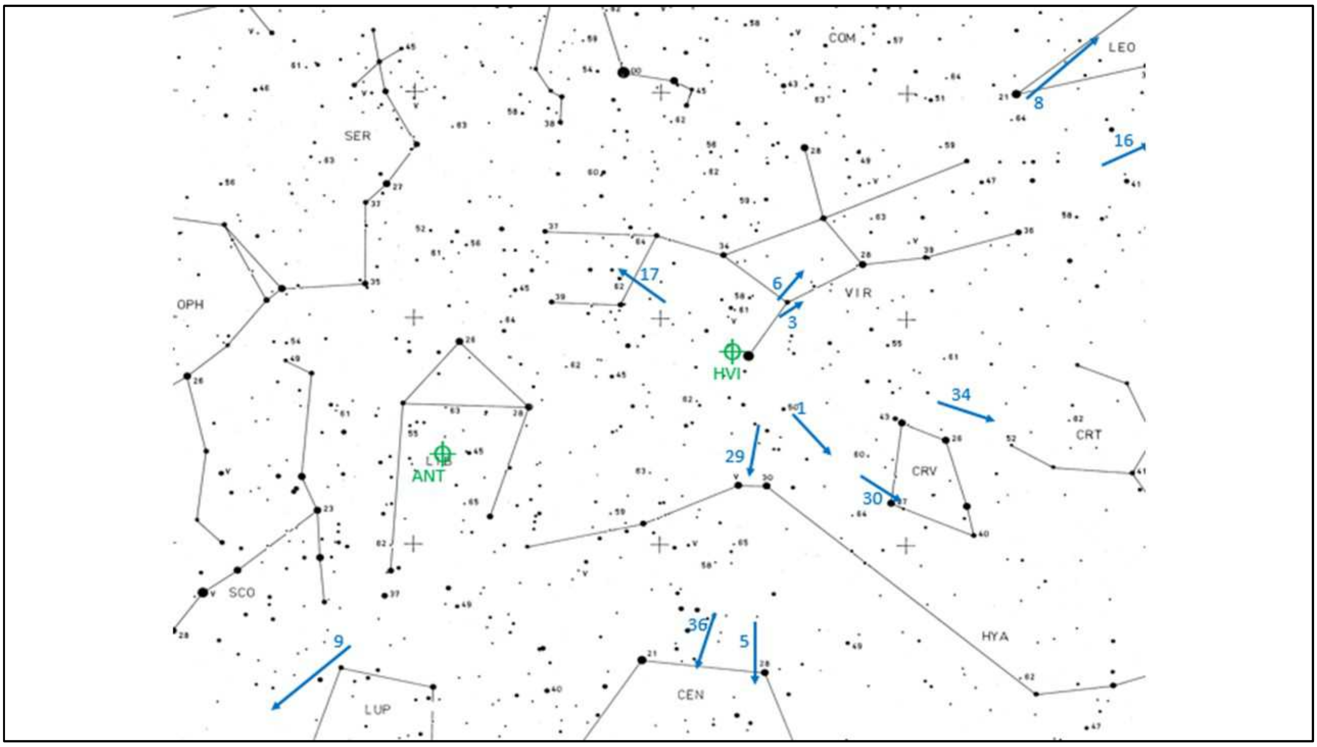

Fig 2. Plotted meteors from visual observations by Cooper. All other meteors have been removed leaving only the h Virginids, which are seen to radiate from nearby to Spica. The position of the anthelion meteors for late April is shown as ANT.

gamma Piscis Austrinids, (GPA, #1034), and sigma Phoenicids (SPH, #1035)

Two new meteor showers were detected by CAMS on 2020 May 15, the gamma Piscis Austrinids (#1034) which were detected by CAMS@SA and the sigma Phoenicids (#1035), which were not, are both debris from long-period comets (Jenniskens 2020b). Plots for the nights of May 15 and 16 are shown in Fig 3.

The gamma Piscis Austrinids were detected on both nights from a radiant at RA = 341.7 $\pm$ 0.8°, Decl. = –31.0 $\pm$ 0.4°, while the sigma Phoenicids were detected from a compact radiant only on May 16, the outburst lasting around 12 hours, from radiant RA = 355.0 $\pm$ 1.0°, Decl. = –52.4 $\pm$ 0.9°.

Regarding the gamma Piscis Austrinids, with a geocentric velocity of 67 km/sec they produce fast moving meteors. Jenniskens points out the shower may be active annually and observations are requested in 2021.

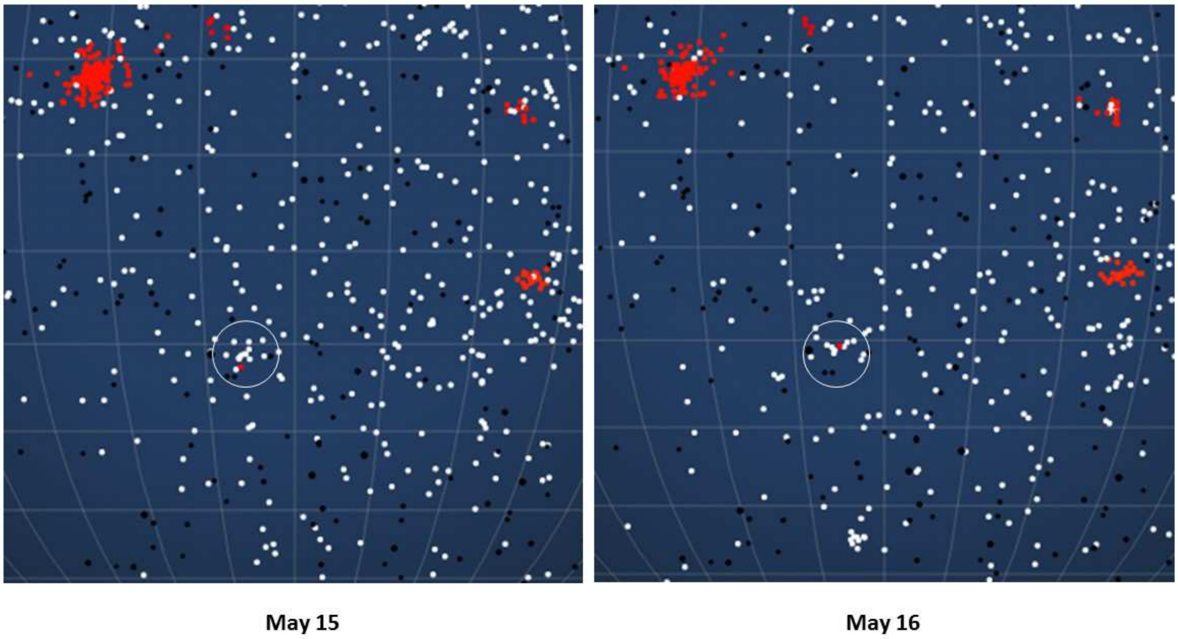

Fig 3. CAMS plots showing detections of the gamma Piscis Austrinids (left of centre) and sigma Phoenicids (compact bunch at bottom of frame on May 16). The large concentration top left are eta Aquariids ten days after their maximum, plus the nearby beta Aquariids on their right. Upper right corner are May beta Capricornids, and below them are omega Capricornids

There are no previous records of activity from the gamma Piscis Austrinids, however Cooper (2013) observed several meteors from the vicinity of Piscis Australis during a watch on the eta Aquariids on the morning of May 4, 2003, noting *more than a dozen meteors in 2.0 hours, the plotted paths indicating a radiant at 335°, -28°*. A previous log entry by Cooper also notes several meteors on 1997 May 16-18 as radiating '*from near Fomalhaut*'. There was also possible activity recorded during visual observations of the eta Aquariids in 2013. It is not known whether the 1997, 2003 and 2013 reports are related.

No outburst of beta Hydrusids (BHY, #198)

The beta Hydrusids were first reported in 1985, when observers in Western Australia witnessed an outburst on August 16, lasting less than half an hour, during which time the ZHR reached 80 ± 20 at its peak at solar longitude ($\lambda_{\odot}$) = 143.833° (Jenniskens 2006b). The radiant was determined as RA = 23°, Decl. = –76°. Lytttinen and Jenniskens (2003) mentioned the possibility of a further outburst around August 16, 2020, 14h18 UT ($\lambda_{\odot}$ = 143.886) when the dust trail would approach within 0.00027 AU of Earth, but only if this shower was caused by a long-period comet, Fig. 4.

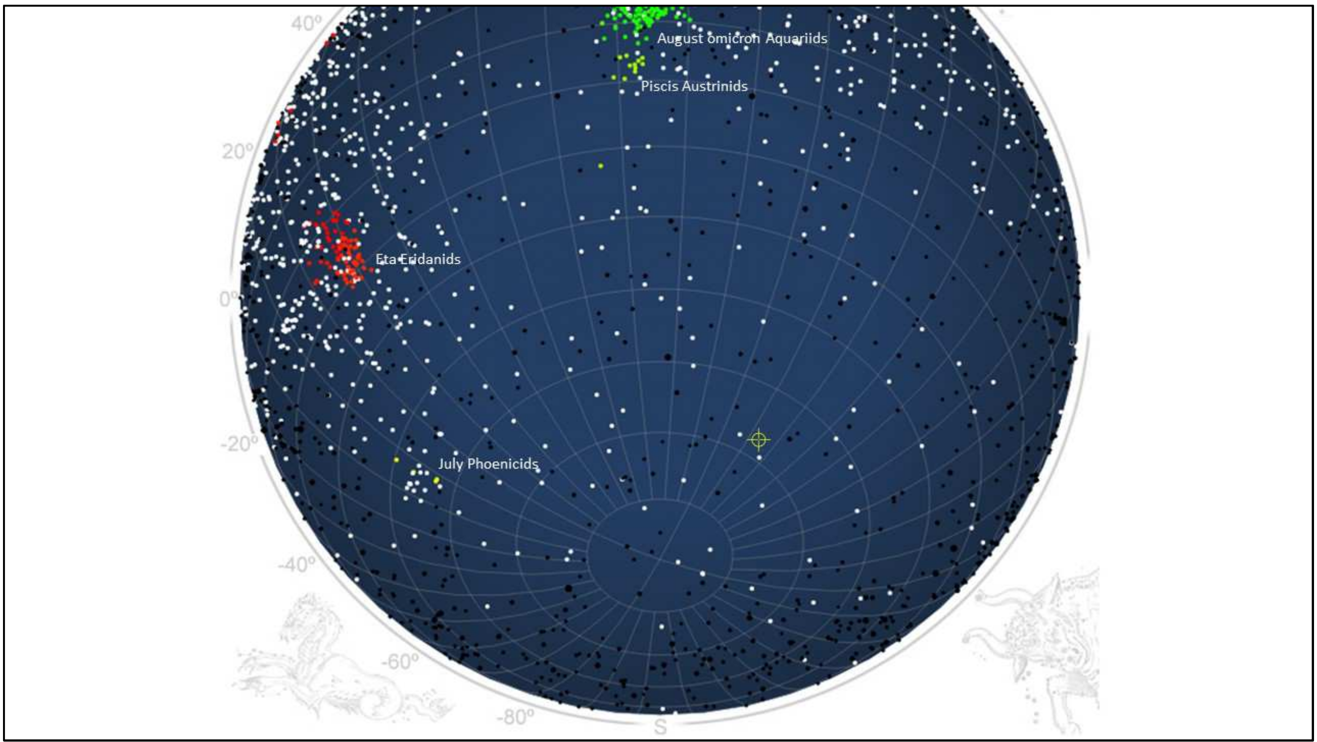

Fig 4. CAMS plot for August 16 showing the theoretical radiant position for the beta Hydrusids (yellow ⌖). No activity was detected in 2020.

The CAMS plot for the night of predicted activity is shown in Fig. 4, and shows no evidence for enhanced activity above the sporadic background. Visual observations were carried out for three periods totaling 1.25 hours between August 16, 16:15 to 17:57 UT. No BHYs, and only one sporadic meteor was observed. We conclude there is no evidence of enhanced activity from the beta Hydrusids in 2020, so that it is likely this shower was from a Jupiter family comet and much more severely perturbed by Jupiter.

chi Cygnids (CCY, #797)

This shower had shown previous activity during September 14-25, 2015 (Jenniskens 2020c) but nothing since. In 2020 several cameras in the CAMS network detected chi Cygnids starting on August 18, when the radiant was located between the constellations of Delphinus and Aquila. In the coming days the radiant drifted into Cygnus as shown by the plots in Fig. 5 and on September 15 was close to the star chi Cygni.

Activity increased slowly to a broad maximum around September 13-18, after which it declined rapidly (Jenniskens 2020d).

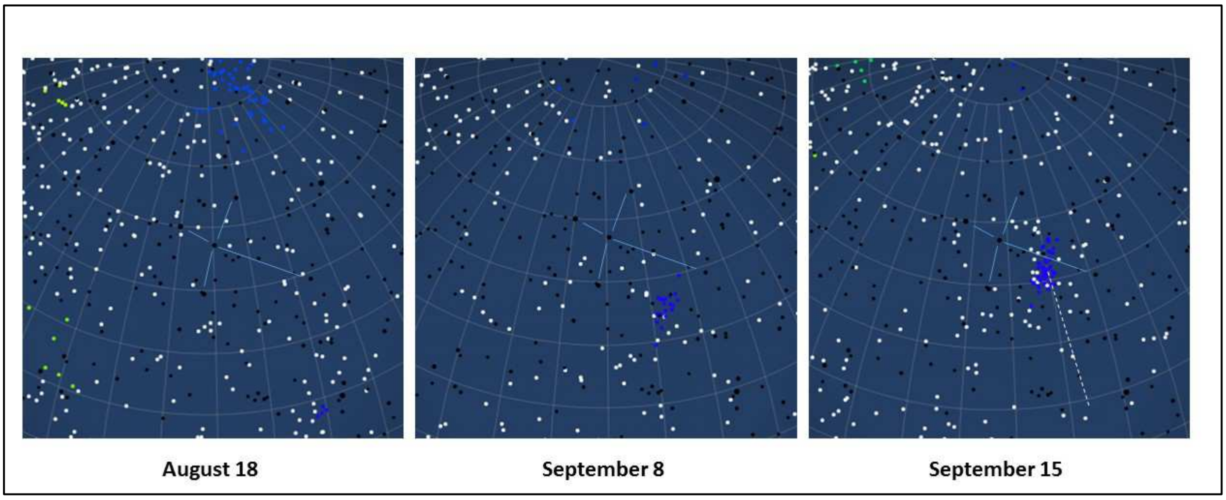

Fig 5. CAMS plots showing radiant drift to increasing ecliptic latitudes for chi Cygnids, initially bottom right on August 18, moving to centre right on September 15. The drift is shown as a stippled line in the plot for September 15. Constellation of Cygnus is shown as solid lines. The blue dots at top of August 18 frame are August Draconids.

September upsilon Taurids (SUT, #1045)

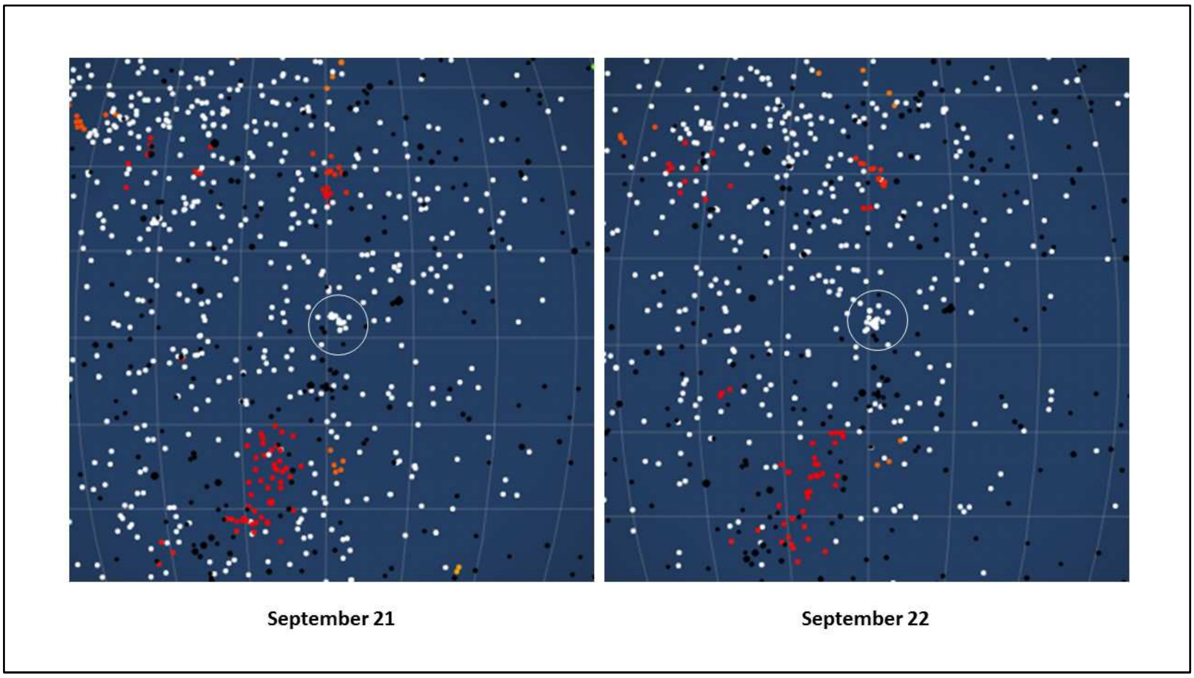

Figure 6 CAMS plots for September 22 and 23, showing detection of the September upsilon Taurids (inside circle). Below are the nu Eridanids (red) and upsilon Cetids (orange). Red dots above centre are September epsilon Perseids, and to their left the beta Aurigids. The stars of the Hyades cluster are below the September upsilon Taurid radiant, while the Pleiades are slightly to its upper right.

An outburst of meteors was detected by CAMS on September 22, 2020 from a radiant at RA = 66.2°, Decl. = +24.1°, located between the Hyades and Pleiades clusters

(Jenniskens and Cooper 2020). The shower becomes known as the September upsilon Taurids, IAU code SUT. Confirmation plots are shown in Fig. 6

Cooper (2021) pointed out that visual activity from this region had been observed several times in the past, starting in 1991, and again in 1996 and 2002. These became referred to as September Taurids, but their true nature remained unclear until now. In recent years video networks have confirmed a number of showers active from the vicinity of Taurus during September, in particular the 130 Taurids and phi Taurids, which may have been responsible for some of the visual observations in the past. The 130 Taurids showed an outburst on September 15, 2019, just one night before possible weak SUT activity that year. Inspection of CAMS plots for previous years show probable activity from the September upsilon Taurids on September 23, 2014, September 22, 2017, September 10, 2019, and also possibly on September 22, 2019. Activity from the shower does not normally extend beyond one or two days.

A Carinids (CRN, #842)

The A Carinids were first identified during a video-based survey conducted in New Zealand between September 2014 and December 2016 (Jenniskens et al 2018), but mainly concentrated for all years on October 12. During the current apparition they were first detected by CAMS Namibia, Chile and South Africa on October 14, 2020 (Jenniskens 2020e). The plots are shown in Fig. 7, and indicate activity was strong during the three days from October 14-16.

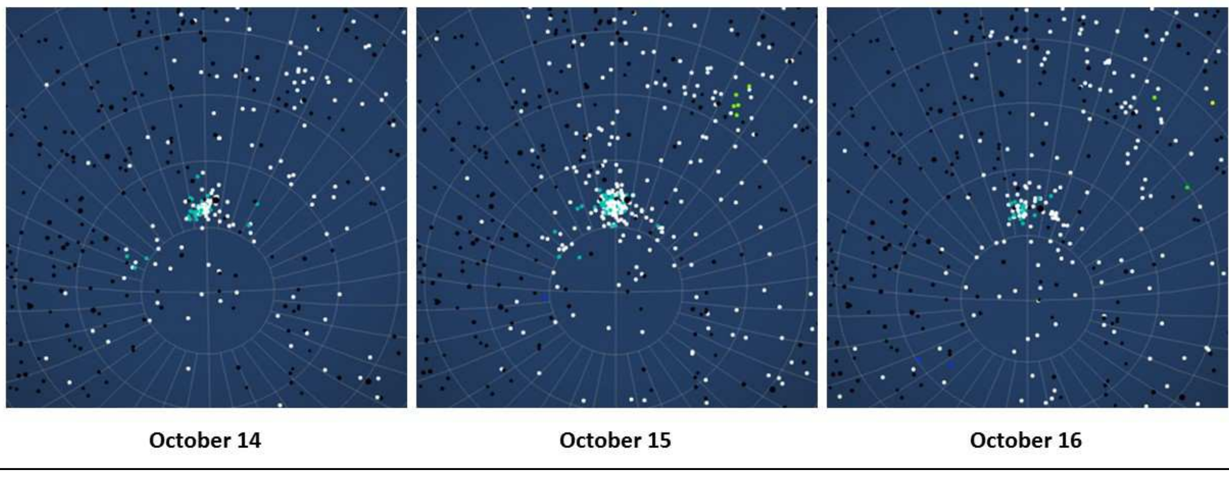

Fig 7. CAMS plots for A Carinids during the three nights the shower was most active. The radiant is immediately to the left in the frames of the bright star Canopus. In addition weak activity can be seen from a few omicron Columbids (upper right quadrant, green dots), first identified during the 2014-16 survey (Jenniskens et al 2018).

Activity ceased abruptly thereafter and by October 18 was no longer detectable above the sporadic background. Meteors radiated from RA = 98.7, Decl. = –54.3, very close to the bright star Canopus (alpha Carinae) in high inclination orbits from an as-yet unknown Jupiter Family comet. Cooper observed the shower for 1.33 hours on the morning of October 17, when activity was already in decline, seeing just one A Carinid (magnitude 1) and three sporadic meteors. Given the apparent strength of the activity at maximum it may warrant visual observation in future, coming as it does just a few days before the maximum of the Orionids.

Volantids (VOL, #758)

On New-Year's Eve 2015, CAMS New Zealand detected an outburst of meteors from a radiant at RA = 122.9 ± 4.7°, Decl. = −71.9 ± 1.9° located in the constellation of Volans (Jenniskens et al 2016). The shower was not seen since but reappeared in 2020 (Jenniskens 2020f), starting with the detection on December 28, shown in the left-hand panel in Fig. 8

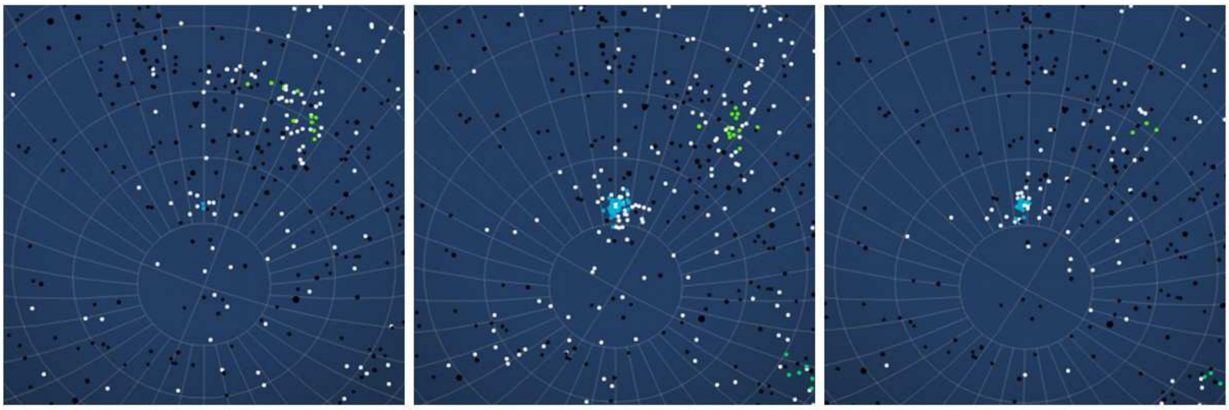

Fig 8. CAMS plots for Volantids (blue dots in centre). Green dots above right are kappa Velids, and bottom right corner are January pi Puppids, both part of the annual Puppid-Velid complex.

The shower peaked again on New-Year's Eve 2020, and lasted until January 3, 2021. Cooper conducted supporting visual observations which enabled determination of the zenithal hourly rate at maximum. Conditions were poor throughout, with occasional clouds resulting from the passage of tropical storm Chalane, as well as a near full moon, but important observations were secured on December 29/30, 2020 and December 31/January 1, 2021. Observations on the former date yielded three Volantids in 3.6 hours, which under the prevailing conditions gave ZHR = 7.9 ± 4.5, and on the night of maximum a further three members in 2.75 hours gave ZHR = 11.2

± 6.5 Volantids per hour. Other nights were clouded out. The six Volantids had a mean magnitude of 3.5, indicating that the average member is faint. Results were reported in Jenniskens and Cooper (2021).

Bright fireballs observed by CAMS

During the course of operations CAMS detects meteors in the range m_v = –5 to +4. Occasionally very bright meteors or fireballs are also captured, which enables triangulation of the object, determination of the orbit, and location of a potential strewn field for meteorites if the object survived passage to reach the ground. Several bright events were captured as follows (events are South African Fireball Catalogue numbers):

Event 354 on July 13, Event 360 on July 27, and Event 364 on August 18. Based on prevailing winds at the time, a potential strewn field location was determined for Event 364 and a low level search was carried out, but did not produce any fragments. Images of the respective fireballs are shown in Fig. 9.

Fig 9. CAMS images for bright fireballs captured in 2020, left to right Event 354 on July 13, Event 360 on July 27, and Event 364 on August 18.

Details were published in Cooper and Mey (2020) and Cooper (2020).

Conclusions

The cameras operated as part of the global CAMS network experienced a successful first full year, participating in the first detection and confirmation of several meteor streams. Numerous factors, including power load shedding, reduced bandwidth from internet service providers, and some technical issues with reliability of camera power supplies, prevented the network from reaching its full potential. These factors will be addressed in future. The intention is also to increase the number of cameras operating depending on availability of future funding. In addition we demonstrated the usefulness of CAMS to record fireballs and determine their pre-atmospheric orbits, and in the case of potential meteorite-dropping fireballs, determine potential strewn field locations. We also demonstrated the importance of visual observations in support of video captures in order to determine magnitude distributions and zenithal hourly rates.

Acknowledgments
The authors thank Dr Peter Jenniskens, NASA Ames and SETI Institute, and CAMS Principal Investigator for his continued guidance and support, to Dave Samuels, CAMS Network Operations, for maintaining operation of the cameras, and to Pieter Stronkhorst, SARAO, for maintenance of the cameras at the Hartebeesthoek site. The first author wishes to thank Magda Streicher for her support over many years as a visual observing companion, and her contribution to the paper on the September upsilon Taurids. Thanks also to Cory Schmitz, Greenside Observatory, who provided detections and images of fireballs using an all-sky camera from his location.

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Recent Southern African Fireball Observations Events # 372-385

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

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

Event 372 – 2020 October 10 – Bela Bela, Limpopo
Observed by Marika Kock at about 18h00, duration perhaps 5 seconds, 'bright orange/red fireball with a tail, at low altitude, [perhaps] 20-30 degree angle' right to left. No sounds heard. Start and end az/alt from 140°, 30° to 39°, 10°, where it was lost beneath a line of trees. The coordinates were from RA/Dec 02h00, –54° to 00h40, +38°, path length 93°, and the path is not consistent with any known radiants. The fireball passed just above Mars, then magnitude –2.6, azimuth 73°, altitude 21°.

Event 373 – 2020 November 6 – Vereeniging, Gauteng
Observed by Christian Kriel at 02h12, while driving in direction 109°, m_v = –5, duration about 3.5 seconds, colour blue or white/blue. No disintegration. Path estimated from approximately az/alt 109°, 59° to 106°, 21°, that is from RA/Dec 09h26, –32 to 12h16, –23. Venus was 21° below left of the end point, magnitude –3 corrected for extinction, and altitude 7°. The Moon was at altitude 38° in azimuth 350°, magnitude –11.5.

Event 374 – 2020 November 25 – Krugersdorp, Gauteng
Observed by Shane Dollman at 17h30, total duration 2-3 seconds, bright flare approximately two thirds along the path to m_v = –12, after which it left a persistent train visible for a further 2-3 seconds. Yellow, blue and green colours noted. Path from az/alt 302°, 29° to 316°, 8°, or approximately RA/Dec 20h28, +12° to 19h53, +35°, from Delphinus to Cygnus. The Moon was used for comparison, at the time 82% illuminated, magnitude –11.8, altitude 58° in azimuth 37°.

Event 375 – 2020 November 25 – Cape Town, Western Cape
Observed by Jason Souma at 20h53, duration 1.5 seconds, white colour. Said to be brighter than the moon, which was then 98% illuminated, magnitude –12.1, in

azimuth 11°, altitude 39°, and the fireball passed just below the Moon. Path approximately from az/alt 357°, 30° to 288°, 40°.

Event 376 – 2020 December 3 – Spanish Farm, Western Cape
Observed by Chantel Sirakis at 01h30. Duration less than 5 seconds, colour bright white, no disintegration, as bright as the Moon, which was then 93% illuminated and magnitude –12, path from az/alt 245°, 30° to 181°, 10°, that is RA/Dec 02h36, –36° to 19h44, –66°, from Fornax to Pavo, path length 61°. When traced back the path is possibly consistent with a late Northern Taurid, or perhaps Anthelion meteor, which radiate from the same region of sky around this date.

Event 377 – 2020 December 5 – Cape Town, Western Cape
Observed by Dean Kubler at 19h39, visible for one second as a number of fragments, disappeared momentarily before brightening again for 1-2 seconds. No estimate of brightness given but Dean said 'glorious fireball, which seemed quite big and close in comparison to any stars, trailing fire and sparks'. A sketch showed the path moving left to right above the horizon between azimuth 300° to 330°.

Event 378 – 2021 January 1 – Herbertsdale, Western Cape
Observed by Marc Nicolson at 20h20, duration 1-2 seconds, bright yellow or light yellow, with yellow/orange trail, said to be brighter than the full moon, which was then 92% illuminated and 4° above the NE horizon in azimuth 61°. Path from az/alt 345°, 29° to 27°, 20°, that is RA/Dec 03h36, +25° to 06h32, +30°, path length 40°. There is a good agreement with the path originating from the direction from the sun, and may have been a Helion meteor.

Event 379 – 2021 January 11 – Germiston, Gauteng
Observed by Abraham Chishiri at 18h48, said to be brighter than the full Moon, duration 7-8 seconds, long enough to point out the fireball to a friend, path from az/alt 219°, 48° to 169°, 49°, that is 01h15, –53° to 05h18, –65° The event was sporadic. Colours were said to be white, yellow and red, initially a small glow, becoming larger and very bright, leaving a white trail, fragmented into two pieces, one very much brighter and giving a terminal flash before fading. Abraham said 'the size was like a tennis ball, beautiful, very beautiful'.

Event 380 – 2021 February 3 – Scarborough, Plumstead, Western Cape
Observed by Derek Wiid at about 19h30, duration about 3 seconds, bright yellow-white, not as large, but as bright as the Moon, which was not visible at the time and rose two hours later. The head appeared to be made up of several brighter spots or fragments, which then faded quickly without further disintegration. Moving horizontally left to right, az/alt of path from 204°, 45° to 303°, 45°, that is

approximately RA, Dec 02h16, –69° to 03h14, –04°, and the path is possibly consistent with the alpha Centaurids radiant.

Robyn Harris also saw the fireball from Plumstead, but gave the time about quarter of an hour earlier, moving parallel to the horizon from azimuth 190°, passing over Table Mountain after which it 'just disappeared' in azimuth 355°. Duration was a few seconds, bright whitish light, which Robyn said was 'long and tubular' in appearance.

Events 381 and 382 – 2021 February 5 – Wonderboom, Pretoria, Gauteng Bruce Dickson observed two fireballs in a short space of time, at 18h44 and 18h58. He was sitting under an awning at the time when both appeared to emanate from more or less overhead. The first was seen behind clouds, but estimated conservatively as magnitude –3 or brighter, duration 2-3 seconds, and burned out at az/alt 25°, 30°. The second event was seen between 6/8 clouds, magnitude approx. –8, duration 2-3 seconds, and terminated at 290°, 30°.

Event 383 – 2021 February 5 – Phoenix- KwaZulu Natal
Observed by Ashley Ramautar at 23h10, duration 3-4 seconds, as bright as the Moon which was then 47% illuminated, magnitude –11, altitude 23° in azimuth 94°. Colours seen were white and orange. Path from 180°, 45° to 170°, 45°, that is 10h18, –75° to 12h00, –72°. The event was sporadic.

Event 384 – 2021 February 7 – George, Western Cape
Observed by Anton van der Merwe at 01h55, duration 1-2 seconds, bright white, said to be brighter than the full Moon. The Moon at the time was a 24% crescent, magnitude –10, altitude 28° in azimuth 100°. The fireball passed below Canopus from right to left, and from a sketch provided the path was from RA/Dec 05h45, –53° to 04h48, –51°. The event was sporadic.

Event 385 – 2021 February 16 – Cape Town, Western Cape
Observed by Willie Koorts at 03h47 while driving on the N1 towards Cape Town, bright white fireball with descent angle 173°. Captured on a dashcam which enabled measurement of the trajectory. Morning twilight was well advanced such that no stars were visible, and calibration was done using azimuths of prominent landmarks as seen from the observing location. Duration 0.4 ± 0.1 seconds, leaving a trail which dispersed almost immediately, path from 222.3°, 11.3° to 223.0°, 7.4°, which is RA/Dec 08h13m16s, –51°44′31″ to 07h13m20s, –42°16′36″. The path is plotted in Figure 1 and may possibly have been a gamma Crucid or alpha Centaurid meteor.

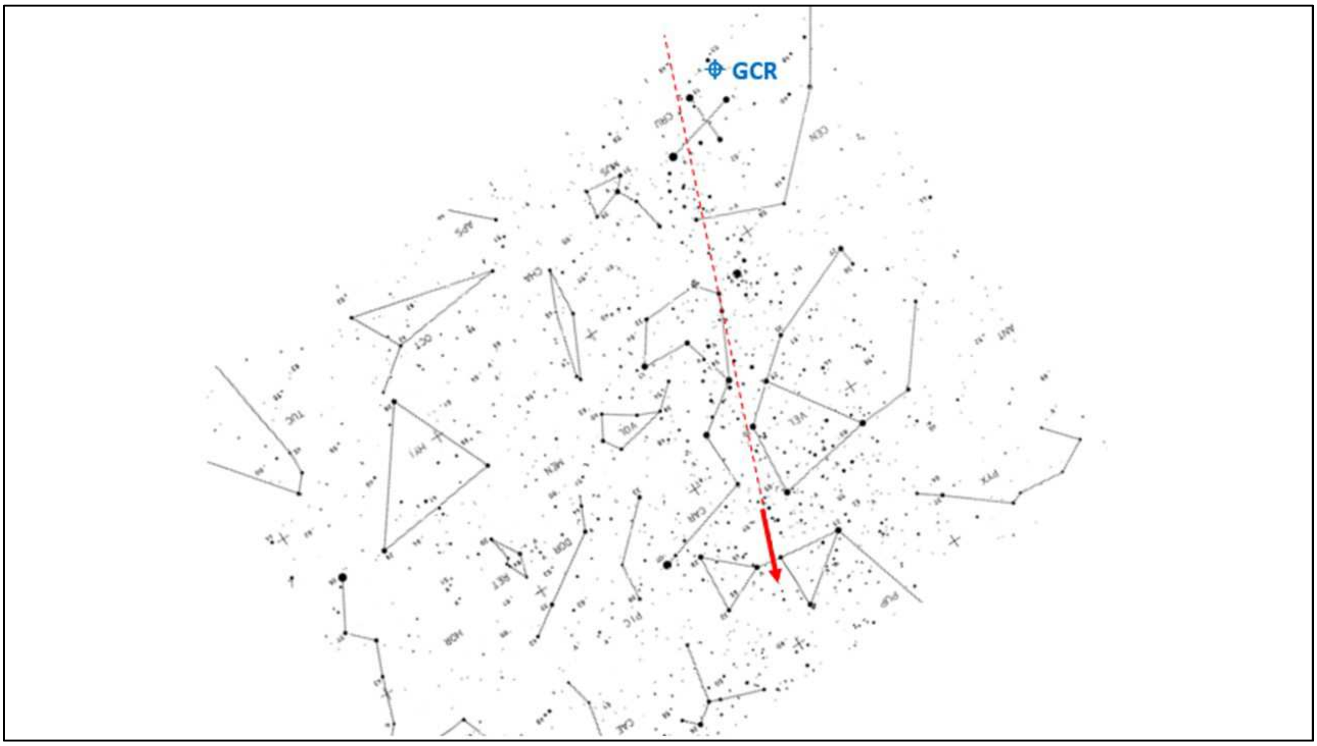


Fig 1. Path of Event 385

The alpha Centaurids were observed in 1980 during an outburst as seen from Western Australia, but since then activity has always been at low levels. Despite this the shower is known to produce occasional bright meteors, often fireball brightness. The gamma Crucids were only confirmed for the first time in 2021, when they produced meteors between February 13-16 (Jenniskens P., Outburst of Gamma Crucids in 2021 (GCR, IAU#1047), posted to Meteor News on February 15, 2021, https://www.meteornews.net/2021/02/15/gamma-crucids-2021-gcr1047/).

The radiants of the two showers are separated by 14° as shown in Figure 2, but the position of the gamma Crucids determined by CAMS is known more accurately, while that of the alpha Centaurids was determined by visual plotting. The possibility exists that the two showers may be one and the same.

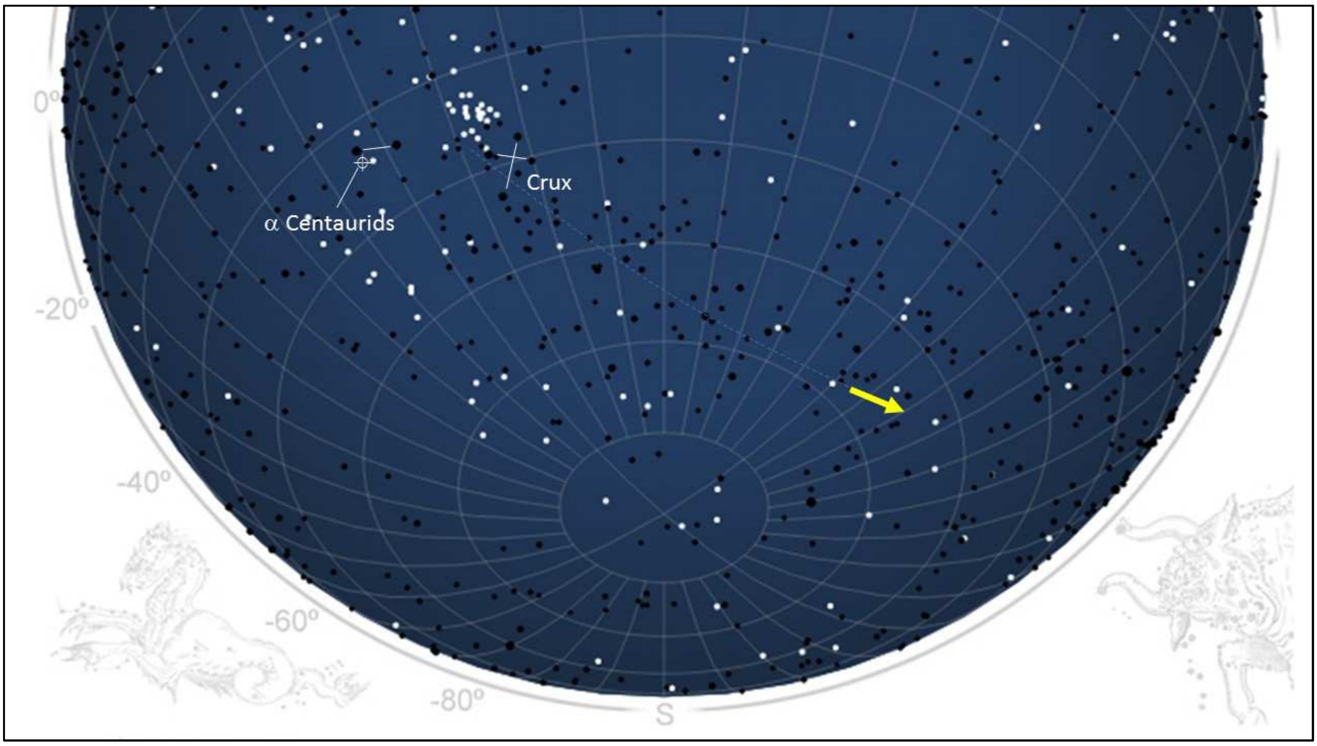


Fig 2. Radiants of the alpha Centaurids and Gamma Crucids.

Acknowledgements

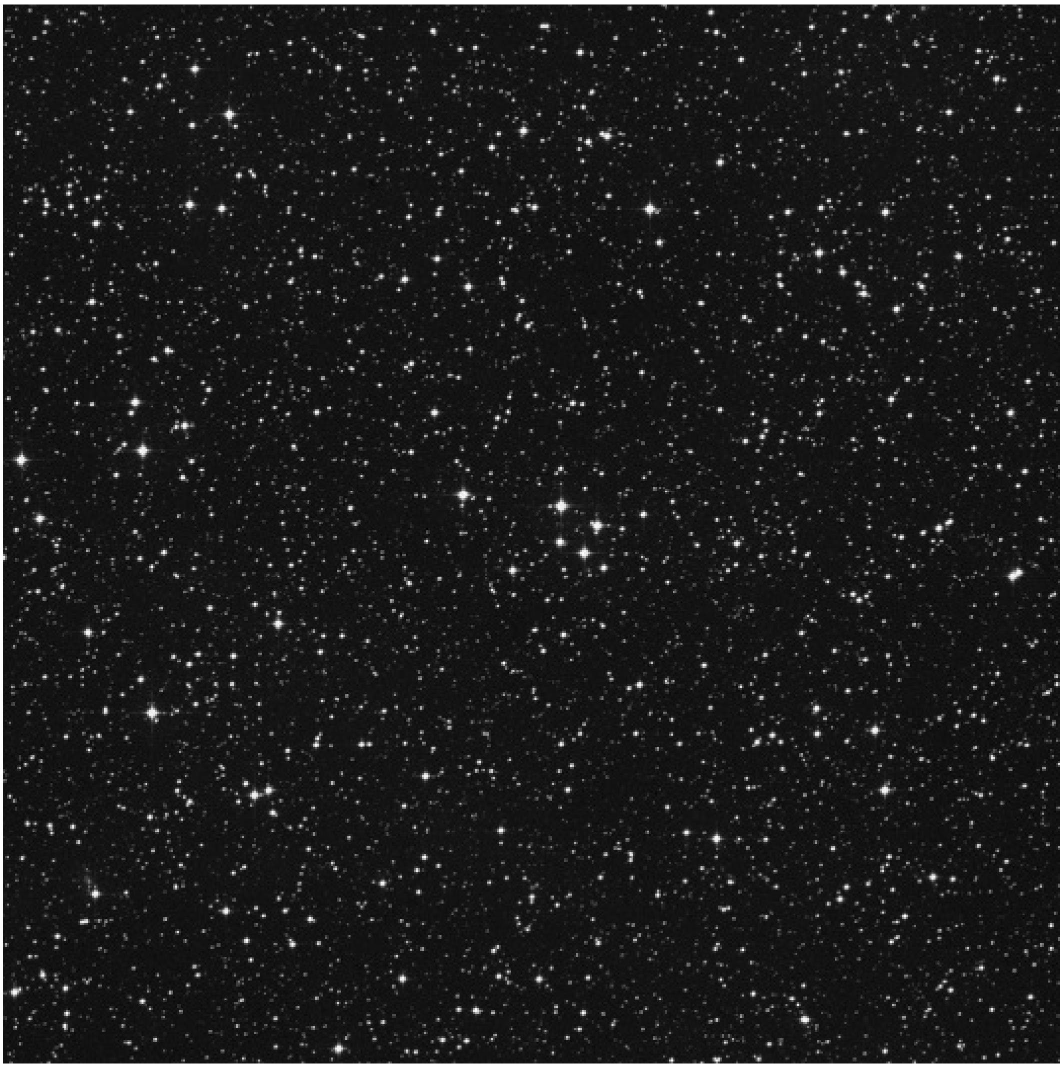
Thanks to Kos Coronaios (ASSA Observing Director) for forwarding various reports from the public posted to the ASSA forums, and to Robert Lunsford (Secretary General of the IMO) for reports submitted to the American Meteor Society fireball reports webpage.

Streicher Asterisms

Magda Streicher

STREICHER 46 – DSH J0823.2-2503
Puppis

In this very busy star-filled field of view a nifty little grouping stands out well. A neat trapezium, or trapezoid, of similar magnitude shiny white coloured stars was picked up a degree north-east of the galaxies NGC 2566 and IC 2311. The brighter top north star is listed as SAO 175716. A very faint listed Leda 81081 galaxy is situated close to the southern faint star.

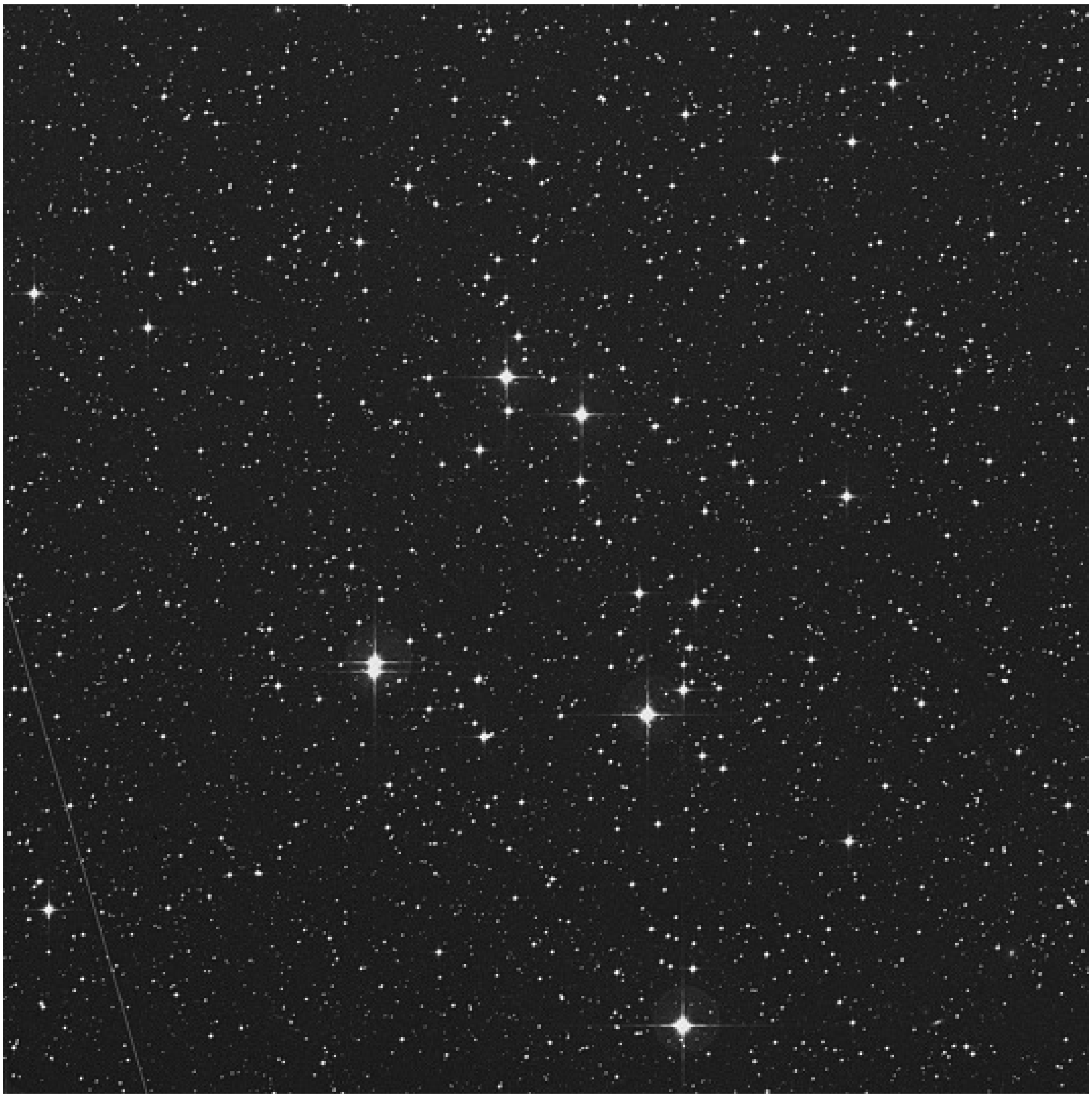


OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 46 DSH J0823.2-2503	Asterism	08h23m.14	-25°03'.06	8	4.5'

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

STREICHER 47 – DSH J0828.4-1728
Pyxis

More than a handful of slightly brighter stars compile a loose grouping amongst the sprinkled faint star field. At first glance these do not give the impression of being an asterism, but from another perspective the elongated string of stars strings clearly along from north to south, with a lovely brighter look-a-like double star towards the eastern end.

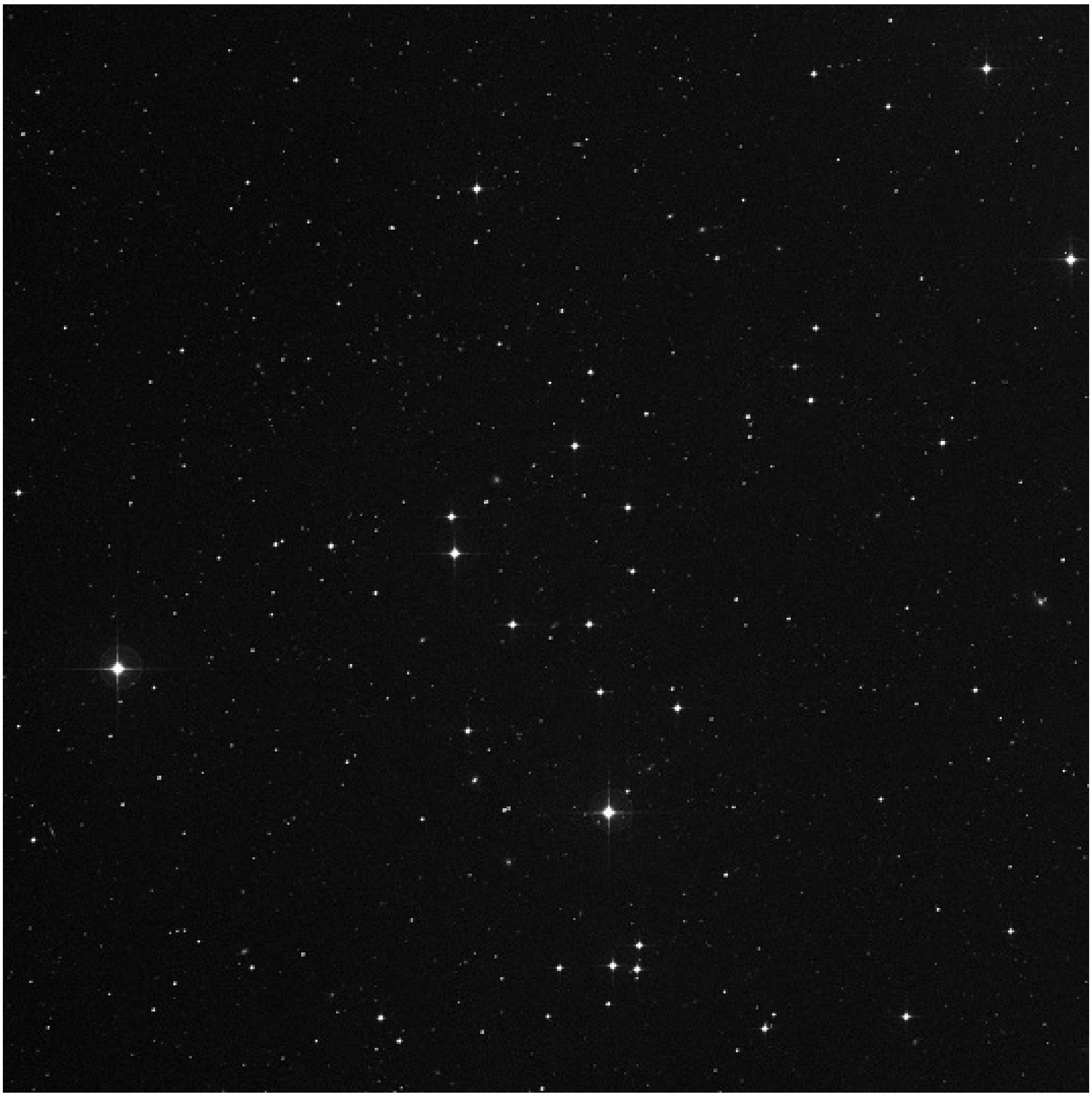


OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 47 DSH J0828.4-1728	Asterism	08h28m.24	-17°28'.24	10	17'

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

STREICHER 48 – DSH J0008.6-2547
Sculptor

This asterism could be called nothing else but the circle of friends so to speak. Lovely impression with two near perfect circles together forming the figure 8, or perhaps an S-shape. In the wider field of view this extended grouping of mostly yellow-coloured stars draws immediate attention. On the southern edge the brighter magnitude 8-star displays a lovely deep orange colour, through the telescope. The edge-on galaxy NGC 24 is situated only a degree further north.

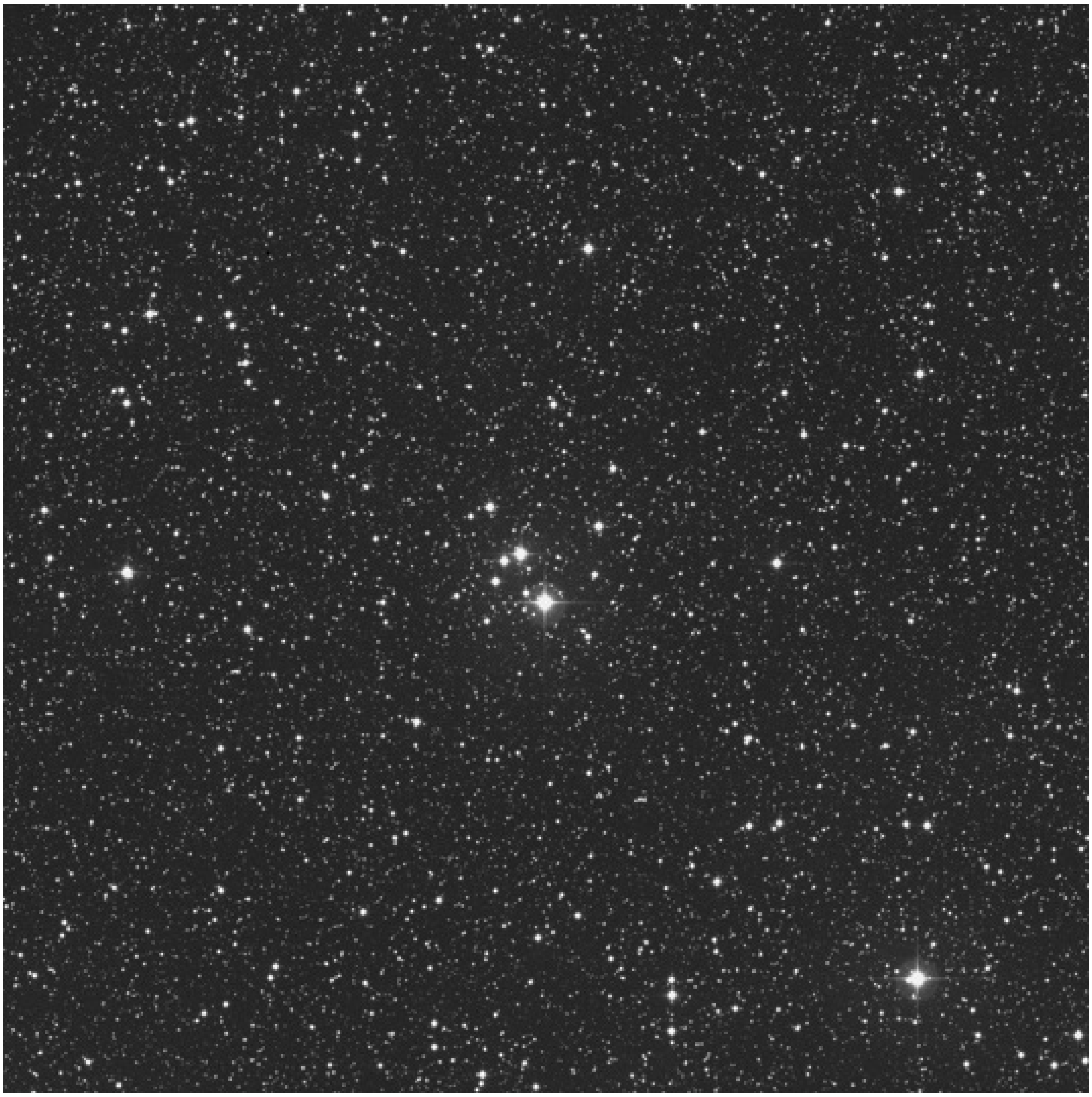


OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 48 DSH J0008.6-2547	Asterism	00h08m.40	-25°47'.15	10	8'

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

STREICHER 49 – DSH J2002.8+1056
Aquila

One of the very first asterisms I searched out was this fine gathering of stars standing out strongly against the star field. This tight handful of stars sprays out in two layers towards the north-east from the brighter shiny white coloured magnitude 6.9-star on the south-western edge. This unique grouping is a gem, with the brighter star listed as HD 190070.

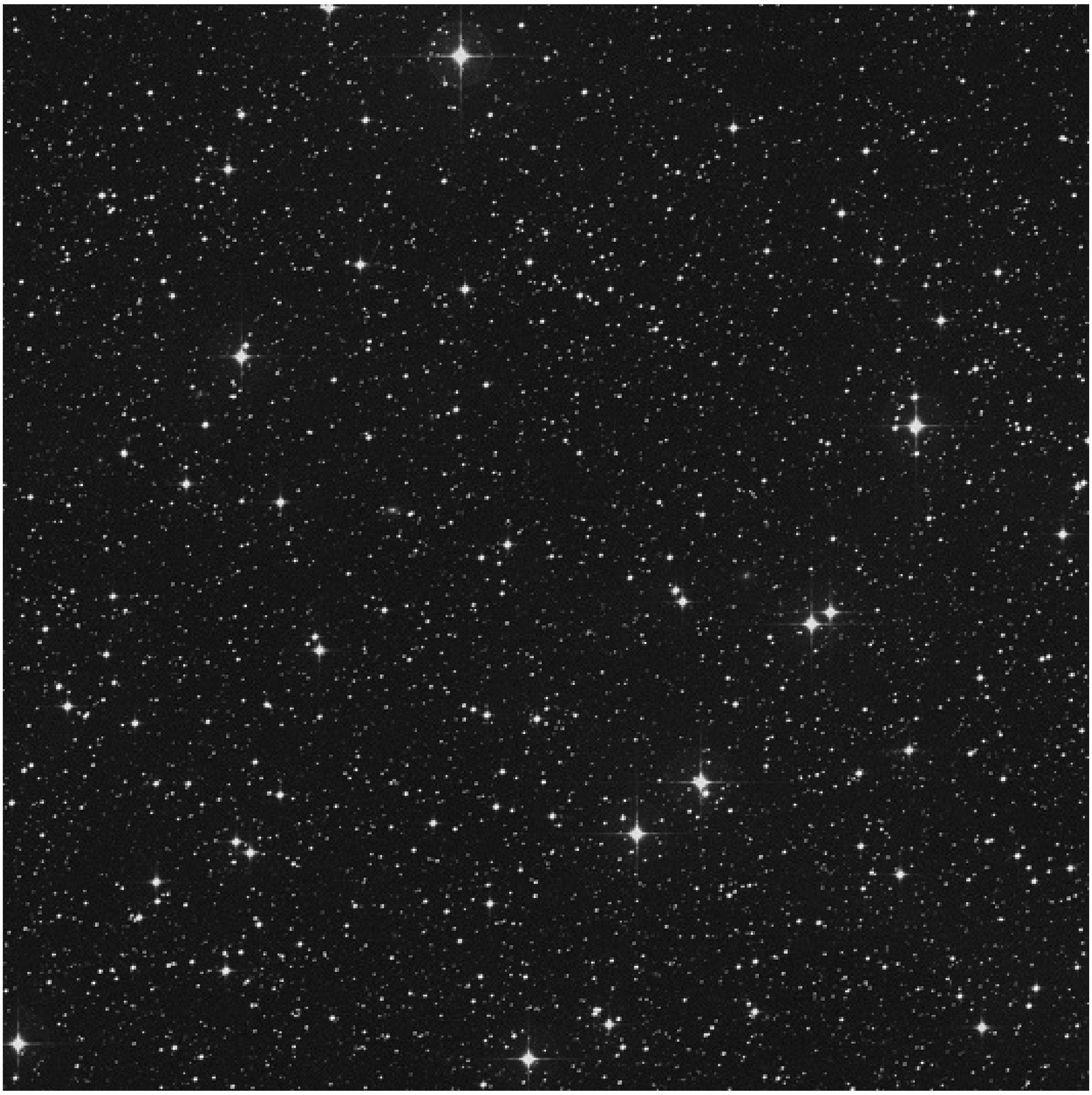


OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 49 DSH J2002.8+1056	Asterism	20h02m.52	+10°56’.12	8.8	6’

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

STREICHER 50 – DSH J0911.2-3558
Pyxis

At first this star field seems not to be very interesting, but no fewer than a dozen pairs of look-a-like double stars can be seen in this somewhat strange-looking star field. Nothing outstanding in terms of a classify asterism, perhaps, but noticeably different. The star field towards the south-west is characterised by a long string of brighter stars slightly more outstanding. The look-a-like pairs in this wide field comprise both bright and faint components. The planetary nebula NGC 2818 is situated a degree south east.

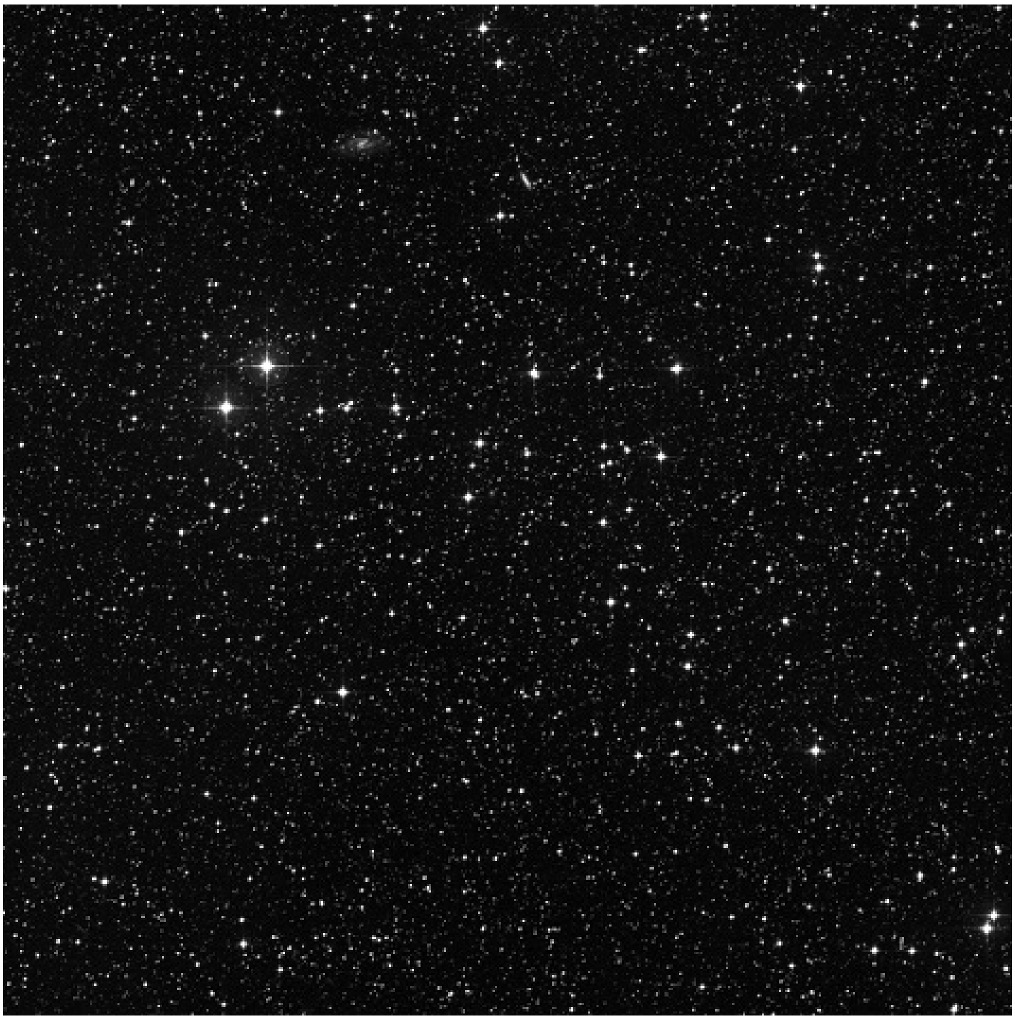


OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 50 DSH J0911.2-3558	Asterism	09h11m.14	-35°58’.24	8.3	33’

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

STREICHER 51 – DSH J1810.4-5629
Ara

It is not unusual, when in the bush at night, to share the space around your telescope with the ever-present night creatures. Searching for asterisms, I could hardly believe my eyes when I stumbled across a small miracle in the far south-western corner of the constellation Telescopium. The grouping consists of fifteen stars resembling a praying mantis looking back with a pair of white stars situated on the north-eastern part of the visible star field. The brightest star is magnitude 7, the northern "eye", so to speak is listed as HD 165987. The group is situated 10’ south of the galaxy IC 4679, and only 12’ from the edge-on galaxy LEDA 90296, both which can be spotted in the DSS picture below.



OBJECT	TYPE	RA	DEC	MAG	SIZE
STREICHER 51 DSH J1810.4-5629	Asterism	18h10m.28	-56°29’.42	11	28’

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

Recent Webinars

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

With the advent of CV19, these Colloquia and Seminars are being presented to wider audiences via Zoom and other virtual systems. The editor has started by identifying what would originally been "local" Colloquia and Seminars; not easy as there are now Webinars on interesting topics from around the globe! In time we will either return to the traditional Colloquia and Seminars or many will become Hybrid session.

For this issue the Editor has selected a few local Webinars.

Webinar 1 Cosmic Beasts and where to find them
Speaker: Dr Jacinta Delhaize (University of Cape Town, South Africa)
Date: 18 February, 2021
Time: 11h00 SAST

Abstract: I will summarise the results of our recent paper (Delhaize et al., 2021) on the discovery of two giant radio galaxies (GRGs) in the MeerKAT International GHz Tiered Extragalactic Exploration (MIGHTEE) survey. GRGs are the largest single objects in the Universe and are relatively rare, with fewer than 850 currently known. Only around 7% of these have sizes greater than 2Mpc, yet we have detected two such objects within a 1 square degree field in MIGHTEE-COSMOS Early Science observations.

Only the cores of these GRGs were clearly visible in previous high resolution observations with the VLA. However, the unprecedented surface brightness sensitivity of the new MeerKAT telescope allowed the diffuse emission of the large-scale jets and lobes to be detected for the first time. We calculate a very small probability of finding two or more such GRGs in the field, supporting the hypothesis that the sky density of GRGs is likely much higher than previously thought. The two GRGs presented here may be the first of a new population to be revealed through surveys like MIGHTEE, which provide exquisite sensitivity to diffuse, extended emission

Webinar 2 Outbursting X-ray transients: recent multi-wavelength results
Speaker: Dr Itumeleng Monageng(University of Cape Town, SAAO)
Date: 25 February, 2021
Time: 11h00 SAST

Abstract: In this presentation I will discuss recent results of X-ray binaries obtained with multi-wavelength facilities. In the first part of the talk I will discuss the results of a weekly monitoring campaign of the new Galactic black hole low-mass X-ray binary transient, MAXI J1631-479, during its 2018/19 outburst. The multi-wavelength campaign was carried out with the MeerKAT radio interferometer and X-ray observations from Swift and MAXI. I will discuss the variability observed and physical interpretation of it.

In the second part of the talk I will present recent results of the outbursting Be X-ray binary, SXP91.1, which is located in the Small Magellanic Cloud. The data from the monitoring campaign of this object was obtained using the optical telescopes, SALT and OGLE, together with X-ray observations from Swift. I will show the analysis performed on these data, where we have studied the variability of the circumstellar disc and how it interacts with the neutron star.

Webinar 3 Optical Design of segmented mirror telescope and development of phasing system
Speaker: Dr Annu Jacob, the Inter-University Centre for Astronomy and Astrophysics, Pune, India
Date: 4 March, 2021
Time: 11h00 SAST

Abstract: Astronomy today is in the path of constructing large telescopes. Due to several manufacturing and maintenance difficulties, modern-day large telescopes of size more than 8 to 10m are usually made of segmented mirrors. India is also aspiring to create a large optical-NIR observing facility. Before embarking to such a complex project, technology needs to be demonstrated and the techniques behind such a system should be thoroughly understood. Several activities have been undertaken at the Indian Institute of Astrophysics Bangalore with these motivations, including developing a small 1.3m class prototype segmented mirror telescope (PSMT). As a part of the talk, I will briefly discuss the optics design of PSMT and a potential design for the proposed large 10m optical-NIR telescope named NLOT. I will also explain the associated studies on the effect of segmentation, sensitivity/tolerance, and error budget estimation.

For any segmented mirror telescope to work analogues to a corresponding monolithic telescope, all the mirror segments needs to aligned, focused and preferably phased. Measuring alignment and focusing errors are usually carried by making use of a customized Shack Hartman device. Whereas precise determination of the phasing (piston) error is critical, it requires a specialized technique. Unless mirror segments are phased, the segmented telescope will not provide the indented diffraction-limited performance. Therefore, we have carried extensive study and laboratory experimentation on two different phasing schemes, one based on hack-Hartman working in the physical optics domain and the other based on the Pyramid sensor. In my presentation, I will briefly explain these phasing techniques and the results of simulations and experimentations

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