"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

MARCH 2022

Monthly meeting This months **Zoom meeting** will take place on the evening of **Monday 21 March** starting at **18.30.** Access details will be circulated to members closer to the time. The presenter is **Chris Stewart**, President of ASSA. His talk will be on **telescope eyepieces**. See below for further details.

2022 meeting dates For your diaries. The dates of the monthly meetings for 2022 are as follows: 21 March, 16 May, 20 June, 18 July, 15 August, 19 September, 17 October and 21 November. There will be no April meeting, as the date clashes with the Easter weekend.

WHAT'S UP?

Planetary quintet From 19 – 21 March, early risers will be able to observe all five of the naked-eye planets towards the East, at dawn. The seven day week is a legacy of the fact that these, and the Moon and Sun, were the celestial objects visible to the ancient Babylonians. Jupiter and Mercury will be seen close to the horizon, with Mars, Saturn and Venus higher in the sky. The tightest grouping takes place on 21 March. Planetary groupings of varying numbers are common. They are coincidental, but predictable, as they are created by the relative position of planets in their orbits, as seen from Earth. The apparent size and brightness each planet depends on each one's distance and characteristics. Venus is the brightest planet for two reasons: it is the closest planet to Earth and its thick atmosphere means it reflects large amounts of light. Mercury is much closer to Earth than Jupiter, but the latter appears brighter because of its much larger size and greater surface brightness (albedo). Mars is about half the size of Earth and ±78 million km away and logically, appears small. Despite this, its reddish surface is clearly visible to the naked eye.

LAST MONTH'S ACTIVITIES

Monthly centre meeting The Centre's AGM was held via Zoom on 21 February. In his report, outgoing chairman Pierre de Villiers summarised details of a very successful year, made possible via use of Zoom for monthly, cosmology, astro-photography and study group meetings. Publican of the monthly sky notes and newsletter continued, as did access to the website and Facebook page. Unfortunately, the pandemic continued to prevent educational outreach and stargazing events. Repairs needed to be done to damage by vandals to several of the solar system models along the Cliff Path. In order to reduce the risk of future damage, the planet models have been replaced with

proportionally sized images and the new and existing models displayed in the Tourism Office. Guided tours of the solar system model have started. The revised plan for the Gearing's Point Astronomy and Education Display (GPAED) has been submitted to the National Lottery Commission and a response is awaited.
Two members of the committee have resigned. Pierre thanked them, and the contusing members for their continued commitment and hard work. Pieter Koté will be joining the committee, as will two others, later in the year.

The treasurer, Laura Norris, then presented the summary finances for the year. Overall, the Centre has a healthy financial balance. The cost of using Zoom is very economic as it covers several meetings every month. Despite the membership fees remaining unchanged since 2019, several new members have joined, boosting the income form subscriptions.

Interest groups

Cosmology At the Zoom meeting, held on 7 February, Derek Duckitt presented 2 videos. Their titles were 'The physics anomaly no-one talks about: What's up with these neutrinos?' and 'Don't be afraid of dark (matter)'.

Astro-photography There was no meeting in February.

Other activities

Educational outreach Mick Fynn, assisted by others including Centre members, has been leading weekly tours of the solar system model on the Cliff Path. Tourism staff are keen to market and publicise this new addition to Hermanus attractions.
Arrangements are also underway to continue or begin work on analemmatic sundials at local primary schools.

Stargazing Pierre de Villiers reports on the first public event held for 2 years:
"Stargazing with Hermanus Hikers and Lukhanyo Primary
Nine members of the HAC conducted a very successful stargazing evening with 50+ members of the Hermanus Hikers plus 14 learners, two teachers and a driver from Lukhanyo Primary School on Tuesday 22 February at the last parking terrain on Rotary Way. The evening was unbelievably cloudless, mild and windless! The site proved very effective for accommodating such a large group and will become the default stargazing spot in future.
Mid-February is also a prime viewing time with the last of the Summer constellations still visible on the Western Horizon and the prime Winter constellations already rising in the East. A wide range of constellations, asterisms, clusters and nebulae were pointed out and viewed through binoculars and telescopes, and – where applicable - the mythological or indigenous folklore conveyed.
From West to East the objects pointed out and described included an unbelievable spectrum:

- The Pleiades (30+ binocular stars), The Hyades (50+ binocular stars), Orion (belt, sword, shield & club), Lepus, Canis Majoris (the Big Hunting dog - Sirius), Canis Minoris (the Little Hunting dog - Procyon), Canopus, False Cross, Diamond Cross, Southern Cross (Crux), Jewel Box, Omega Centauri, Carina Nebula & Southern Pleiades, Large & Small Magellanic Clouds.
- The combined "Hunting Scene" of Taurus, Orion, Lepus and the Hunting dogs were pointed out, as well as the "Summer Stripe" of Sirius, Orion's belt, Aldebaran and the Pleiades – extending a full 105° to Andromeda in Nov/Dec.
- The blue Reflection nebula around the stars of the Pleiades and the white (non-colour) Emission nebula of Orion were pointed out and explained.

At about 22:00 the reflections of the urban glow from Arabella and Kleinmond become an irritation and everyone packed up after a most enjoyable and interesting evening. The jury is still out whether the presenters or viewers enjoyed the evening most!"

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's **Zoom meeting** will take place on the evening of **Monday 21 March** starting at **18.30**. Access details will be circulated to members. The presenter is **Chris Stewart**, President of ASSA. His talk will be on telescope eyepieces.
Synopsis "As an intermediary between telescope and eye, eyepieces are critical to the functioning of any optical telescope. Their evolution has been rapid in the last few decades, creating a plethora of makes, models and designs with peculiar names. Weird marketing, plus presumably well-meaning but distorted advice in the media, simply adds to the confusion.
Thus, most users have little insight into the functioning of eyepieces, let alone their interaction with the eye and its associated limitations. Whilst this presentation can only scratch the surface of a vast subject, some myths and mysteries will be sensibly addressed. This will hopefully leave the audience with a better appreciation for the subject - and consequently more prepared to make informed choices."

Biography "Chris Stewart holds diplomas in Light Current Electrical Engineering, Datametrics, Business Management and Project management. Recently retired, he worked in R&D, Deployment and Project Management within the Telecontrol and Telecoms industries across several countries.
His interest in Astronomy and Optics started at birth - living through the exciting early years of the Space Race added impetus. He received his first telescope at age 4 (at his request, and which he promptly disassembled to determine how it worked) - and a microscope at age 5. Parts of that microscope live on as components of his Foucault tester, which has seen much use in the Telescope Making class. He purchased his first astronomical telescope at age 13, the critical parts of which have survived endless experimentation to this day.
Chris is currently President of the Astronomical Society of Southern Africa, and Director of its Instrumentation Section. He has been a member of the Society since 1976, served on the Committee of the Johannesburg Centre, run a successful ongoing telescope making class since its inception 30 years ago, was on the committee of ScopeX for its entire 18 years of existence, and was made honorary member of the Society in 2017. In 2017 he was invited to speak at the Stellafane convention in Vermont, USA - the global Mecca of amateur telescope making.
One day his observatory will be completed, though how to house the growing variety of instruments will doubtless forever remain problematic. His long-suffering wife and daughter support his interests, despite having been dragged out of bed in the early hours to help lug equipment inside."

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 7 March** will be shown **via Zoom,** starting at **18.30**. Details of the topic and access details will be circulated to members, in due course.

For further information on these meetings, or any of the group's activities, please contact Derek Duckitt at derek.duckitt@gmail.com

Astro-photography This group meets on the second Monday of each month. Members are currently communicating digitally about image processing they do at home. The next Zoom meting will take place on **Monday 14 March.**

To find out more about the group's activities and the venue for particular meetings, please contact Deon Krige at astronomy.hermanus@gmail.com

For further information, please contact Deon Krige at deonk@telkomsa.net

FUTURE TRIPS

No outings are being planned, at present.

2022 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented **via Zoom**, starting at **18.30**. The dates for 2022 are as follows: 21 March, 16 May, 20 June, 18 July, 15 August, 19 September, 17 October and 21 November.

ASTRONOMY GEARING'S POINT ASTRONOMY EDUCATION CENTRE (GPAED)

The amended proposal has been submitted to the National Lottery Commission. A response from them is awaited.

The **Friends of the Observatory campaign** was launched several years ago when preliminary work began on plans to construct an astronomical observatory in Hermanus. Over the years, members have been very generous, for which we are deeply grateful. It may seem logical to assume that, now money has been awarded by the National Lotteries Board, pledge monies are no longer needed. Unfortunately, that is not the case. NLC funds can only be used once the plans have been formally approved by the Municipality.

We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer, The Standard Bank details are as follows:

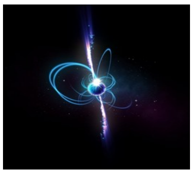
Account name – Hermanus Astronomy Centre
Account number – 185 562 531
Branch code – 051001

If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

ASTRONOMY NEWS\

Astronomers find a potentially new breed of neutron star 4 February: About 4,000 light-years from Earth, an astral entity released a large flash of radiation three times an hour, each for a minute at a time, taking researchers by surprise. "This object was appearing and disappearing over a few hours during our observations," said lead author Dr. Natasha Hurley-Walker. "That was completely unexpected. It was kind of spooky for an astronomer because there's nothing known in the sky that does that. About every 20 minutes, the object becomes one of the brightest radio sources in the sky. Likely a neutron star or a white dwarf - the dense remains of formers stars - the object also emits highly-polarized radio waves. If that was not interesting enough, Hurley-Walker also suspects the object also may have a high amount of magnetic energy which would put it in the running to be an 'ultra-long period magnetar.'

Magnetars are the most magnetic objects in the universe. Their magnetic fields are over a thousand trillion times stronger than Earth's. Like their less magnetic cousins, pulsars, magnetars are known for emitting bursts of radiation. However, where pulsars tend to be reliable with their pulses, magnetars are a bit more erratic. Some of this erratic behaviour can be seen in fast radio bursts (FRB), sudden and intense explosions of radiation, which have been traced to magnetars. However how young magnetars reach the stage of being able to produce FRBs is a mystery. One solution is ultra-long period magnetars, which could bridge the gap. "It's a type of slowly spinning neutron star that has been predicted to exist theoretically," said Hurley-Walker. "But nobody expected to directly detect one like this because we didn't expect them to be so bright. Somehow it's converting magnetic energy to radio waves much more effectively than anything we've seen before."


An artist's impression of what the object might look like if it is a magnetar. ICRAR

These transients - objects that turn on and off - are not new to researchers, however transients can often be described as slow, appearing over a few days and disappearing within months, or fast, which appear for a brief second at a time. This strange object did neither, emphasizing its uniqueness. According to Hurley-Walker, "more detections will tell astronomers whether this was a rare one-off event or a vast new population we'd never noticed before." By: Samantha Hill

Rare Apollo lunar sample will have its opening day 8 February: In 1972, when geologist and Apollo 17 astronaut Harrison Schmitt spotted a patch of unusual orange soil on the Moon, he knew it was special, but he was not sure exactly why. "Until it was possible to look at this material in the laboratory under high resolution and analyse it, we did not know that we had found a deposit of volcanic ash," he says. Fifty years later, Schmitt still is not aware of all the discoveries his mission will yield. That's because researchers in the Apollo Next Generation Sample Analysis (ANGSA) programme are only rnow beginning to study lunar samples that had been saved for future scientists. Their projects aim to answer critical questions about the Moon's past and, as the Artemis programme prepares for launch in the next few years, lunar exploration's future.

Apollo 17's sample 73001, which was collected from a pile of debris deposited by a lunar landslide, will be opened for the first time in the coming weeks, says ANGSA researcher Charles Shearer, a research scientist at the University of New Mexico and a visiting researcher at the Lunar and Planetary Institute. This sample was stored in a Core Sample Vacuum Container (CSVC), an elaborate air-tight apparatus whose penetration has been plotted for over a year. Sample 73001 is especially valuable because it has been sealed in such a pristine state, Shearer says. "Many of the other Apollo samples may have had various amounts of contamination from Earth, so we lose part of the lunar fingerprint," he says. Schmitt, who is actively involved in the ANGSA program, feels "admiration for the people 50 years ago that decided to preserve a few of the samples in anticipation of the technology advancing significantly over time." Using modern tools to analyse 73001 will provide both information and experience handling lunar samples that will benefit upcoming missions, he says.

Schmitt and Shearer will help measure 73001's lunar volatiles - easily vaporised chemical elements that are embedded into the Moon's soil. Using a relatively new technique that identifies each substance in a material by its mass, the team can measure the volatile elements and additional compounds that decay over time in the sample. Collectively, this data provides clues as to when and how the landslide occurred - for example, whether it was caused by a seismic or an impact event. Solving the landslide mystery could also help predict the safety of human settlement on the Moon, Shearer says. "Are there going to be any sort of tectonic- or earthquake-related activities that could threaten human activities on the Moon?" he says. "Perhaps this will shed some light on that."

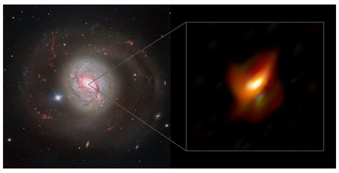

Apollo 17 astronaut Gene Cernan prepares to collect lunar sample 73001, which has remained sealed for 50 years. NASA

The researchers are also interested in understanding how lunar volatiles can be used as a resource to support human presence on the Moon. "In the past, when Apollo went to the Moon, we took everything with us," Shearer says. Eventually, however, astronauts may be able to "partially live off the land" when exploring and even venturing beyond the Moon, he says. For example, hydrogen and oxygen serve as the building blocks of water, and hydrogen and a light version of helium might be used as a rocket fuel source to power further space travel. Another ANGSA team is led by Darby Dyar, a professor of astronomy at Mount Holyoke College who studied the orange soils samples as a graduate student. As an ANGSA researcher, she is characterising volcanic glass beads in other samples to better understand the composition of the lunar interior. These pyroclastic glasses, which are smaller than a grain of salt and make up about 20 percent of the soil on the Moon, shoot out from the lunar interior during volcanic eruptions. "It's like drilling into the Moon," Dyar says. "Tiny glass samples, but giant scientific impact."

Dyar is examining the water and oxygen content of the glass beads as a record of the environment of the lunar interior. Dyar and other researchers' work suggests the inside of the Moon is not dry and oxygen-free as it was long assumed to be, challenging scientific understanding of how the Moon formed. "We're kind of groping our way backwards through prior misconceptions about the lunar interior," she says. While ideally the volcanic glass perfectly captures the conditions of the lunar interior, gas might seep into or out of the bead as it is expelled. To account for this effect, Dyar and her team take measurements at defined increments across the surface of the bead, generating a map showing any gradients that developed as it cooled. Instruments with this degree of spatial resolution were not available when Dyar first started her research. "New technology is providing me with a way to answer a question that I personally posed 40 years ago," she says.

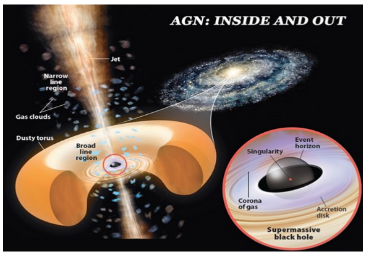
Similarly, the electronic state of the metal atoms in the bead, which provides a measure of oxygen, can change after the eruption. Charged particles in solar wind might interact with the glass on the surface of the Moon, or oxygen on Earth could react with the bead after it is returned from space. Analyzing samples like 73001 that were collected from deeper in the lunar interior and stored in preservative contraptions can help pinpoint transformations due to exposure to the lunar surface or Earth, Dyar says. This comparison of different storage methods provides valuable insight for the return to the Moon, says James Head, a professor of geological sciences and Earth, environmental and planetary sciences at Brown University, who is not part of the ANGSA program. "Are we designing these sample containers correctly? How can we better design the ones that are going to be used in Artemis to make sure that they're as pristine as possible?" he says. Furthermore, by reconstructing the various lunar processes that left their mark on these samples, the research at ANGSA helps complete the picture of the history and evolution of the Moon, Head says. "Each approach, like the landslides and the pyroclastic glasses, will fill in a little piece of the puzzle," he says. By: Sarah Anderson

Why galaxy M77's active nucleus is hiding 16 February: Astronomers using a collection of four 8.2-meter telescopes in Chile have just gotten a detailed look at the heart of galaxy M77, some 47 million light-years away. Their new image shows that the galaxy's energetic supermassive black hole, called an active galactic nucleus or AGN, is completely cloaked within a ring of gas and dust. Putting together this picture confirms via observational evidence a longstanding theory that explains the many types of feeding black holes we see at the centres of large galaxies.


At the centre of galaxy M77 (which appears at left in optical light) is a dusty disk hiding a supermassive black hole, whose light is reprocessed into infrared wavelengths, pictured at right. ESO/Jaffe, Gámez-Rosas et al.

The key to this theory, called the Unified Model, is that although we see many different signals coming from various AGN across the universe, there actually are not different types of black holes in different galaxies. Instead, the model states that all AGN are inherently the same, comprising a feeding supermassive black holes surrounded by a torus, or doughnut-shaped ring, of dust. Depending on the angle at which we're viewing the system, we might be either looking directly at the black hole down one of the open ends or instead peering through the thick side of the ring. It is ultimately these varying viewing angles that account for the different classes of AGN we see, which range from blazingly bright beacons screaming at us across the electromagnetic spectrum in the first case (also called type 1 AGN) to those that glow softly only in low-energy light, such as infrared, in the second (type 2 AGN).

M77 falls into that second class: It is a relatively dim AGN that astronomers have long suspected is shining at us through a thick, all-encompassing buffer of dust. And indeed, images have previously spotted warm dust near the centre of the galaxy. Some recent observations had suggested that perhaps the ring of dust around the black hole was too thin and not oriented at just the right angle to hide it as expected, challenging rather than supporting the Unified Model. Researchers needed a better picture of what was going on. So, they zeroed in on the galaxy's centre with an instrument called MATISSE, which combines infrared light coming from the four separate telescopes that make up the European Southern Observatory's Very Large Telescope. The technique used to combine that light, called interferometry, dramatically boosts the amount of detail visible in images. When combined with radio data from the Atacama Large Millimeter/submillimeter Array and the National Radio Astronomy Observatory's Very Long Baseline Array, the picture was clear enough to let the team map out M77's central dust by temperature and absorption to pin down exactly where the black hole sits within the dust. Their final result: The black hole is completely embedded in the thicker, ring-shaped centre of a larger, edge-on disk of dust. This highly detailed picture confirms exactly what is expected from the Unified Model.

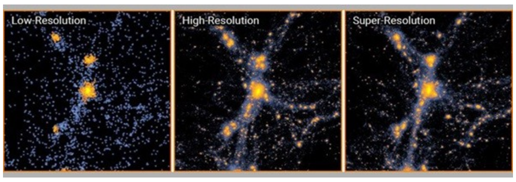


The unified model of AGN states that all AGN contain the same components, simply viewed at different angles. From the inside out, AGN contain a supermassive black hole; an accretion disk and a hot corona of gas; a fast-moving gas region; an obscuring torus of dust; and a slower-moving gas region. Some AGN have powerful jets, which may be pointed toward Earth. Astronomy: Roen Kelly

Now the trick will be to determine whether M77's black hole is indeed typical and whether the Unified Model accurately predicts what we see in other galaxies. Now that MATISSE has proven its worth, researchers can use it to peer at other AGN to observe whether they, too, match expectations. Because the evolution of galaxies and their AGN are inextricably linked, better understanding these objects will in turn lead to a more complete picture of how galaxies form, evolve, and ultimately die. By: Alison Klesman

Saving cosmology with AI 17 February: Cosmologist Francisco "Paco" Villaescusa-Navarro has a problem. "We are spending billions of dollars in ground and space telescopes to decipher the mysteries of the universe," he explains, "but we are missing most of the information that the surveys contain." The issue is that in any survey, most of the information is at the very smallest scales. For example, if you look at a picture of a forest, you will get some information, like a rough idea of how many trees are in there. Once you zoom in a bit, you can see the individual trees and get more information – say, the different species and their heights. If you zoom in even more, the amount of information explodes: You can now determine their age, health, leaf structure, distinct colourings, and more. As cosmologists work to unravel mysteries like the nature of dark matter, dark energy, and the expansion history of the universe, they often employ one of their favourite tools: galaxy surveys. These are maps of the positions and velocities of millions of galaxies, and are some of the largest collaborations in the world. For example, the Dark Energy Survey involves over 400 scientists from over 25 institutions across seven countries. While mapping only a relatively tiny fraction of all the contents of the universe, these surveys routinely provide powerful probes of cosmology.

However, almost all cosmology work involves taking these massive surveys and reducing them to comparatively simple statistical summaries, like the average spacing between galaxies or the number of galaxies at different distances. Cosmologists then connect these simple statistical summaries to the quantities they care about, like the amount of dark matter or the expansion rate of the universe. To squeeze more juice from the cosmological orange, astronomers want to be able to use the smallest possible scales, which contain most of the information in the surveys. However, while those small scales contain a lot of rich cosmological information, they are also full of non-cosmological pollution. "Many people have shown that most of the information about fundamental physics, and also about astrophysics, is on those small scales," explains Navarro, a research scientist at the Simons Foundation in New York City. "In that regime, it is hard for us to find patterns or even to develop some intuition given the complexity of the physics involved on it."



Simulations of a large volume of the universe, low resolution, and small bits of the cosmos, high resolution, and a combination of the two created using machine learning programs. Carnegie Mellon University

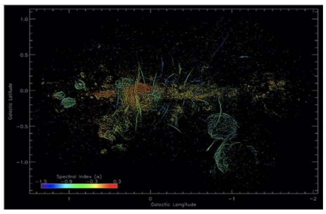
All that extra information, like the dynamics of individual galaxies or supernova explosion rates, is great if you're an astrophysicist, but an annoying contaminant if you're a cosmologist. Astronomers do not have the sophistication to separate out astrophysical from cosmological information. When two galaxies are interacting in a certain way, for example, is that an imprint from the influence of dark matter or because of feedback from giant black holes? To separate the information and get to the cosmological signal, we need better astronomers – AI astronomers. "AI has to potential to find the optimal solution that allow us to extract all the information," explains Navarro, who has worked with collaborators around the world to develop artificial intelligence methods for cosmology.

Before AI methods can be let loose on the universe, they first must be taught how to be good astronomers. For that, Navarro and his collaborators turn to simulations. Cosmological simulations incorporate knowledge of all the physics that can possibly be shoved into a single computer. The expansion rate of the universe, the gravitational tug-of-war that shapes large structures, star formation, explosions from giant black holes, magnetic fields, and more all go into a modern simulation. These simulations aim to reproduce as much of the physics in the real universe as possible and then match those simulations to observations. However, with all the messiness of small-scale physics involved, that matching is hard – unless you are an AI. "This is a simple task for AI, since it will identify patterns and find optimal solutions to problems that we do not know how to treat," says Navarro.

Navarro and his colleagues produced thousands of simulations, varying all sorts of cosmological parameters (like the amount of dark matter) and astrophysical parameters (like the strength of star formation). Then, they fed these simulations into a type of AI known as a convolutional neural network, which is designed to identify even the most subtle patterns. "[When we show] the networks many different maps or grids with different cosmologies and astrophysics, the network is learning some pattern that can be used to infer the cosmological parameters," explains Navarro. While promising, their work is just beginning. Most importantly, Navarro urges caution, explaining that AI can learn literally anything from these simulations, including patterns and connections that aren't real, like artifacts from the simulation. To test the AI, it must be run not only on simulations but on existing surveys with known results. Only then can be trusted to provide cosmological information from future datasets. However, he's excited for the future. "I think AI is just starting. We are in the phase of exponential growth," he said, "I personally don't know how far AI can bring us, but I'm pretty sure things will never be as before."

By: Paul Sutter

Hundreds of strange filaments found at Milky Way's centre 18 February: Once thought to be artefacts that needed erasing from a researcher's scope, nearly a thousand strands located at the centre of the Milky Way galaxy now mark significant strides in astronomical research. About 25,000 light-years from Earth, the 1-dimensional filaments were first discovered in the 1980s by Northwestern University's Weinberg College of Arts and Sciences physics and astronomy professor Farhad Yusef-Zadeh, then a graduate student. At the time, Yusef-Zadeh identified only 100 strands but, with the help of technology, researchers have now pinpointed almost 10 times more and are one step closer to finding the objects' origins. According to a recent study, the strange strands are thought to be made of cosmic-ray electrons moving in a magnetic field at nearly the speed of light. They appear in equally spaced clusters or pairs covering an area of about 150 light-years. Yusef-Zadeh says the significance of the findings comes from the idea that most celestial bodies in the universe have a source of acceleration, such as black holes. However, these filaments are very high energy - and without a direct source.

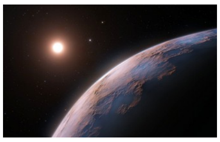

A mosaic radio image of Milky Way's Center, showing the spectral index of the large "slashes" or filaments throughout. Farhad Yusef-Zadeh/Northwestern University

In the past three years, Yusef-Zadeh and other researchers worked with the South African Radio Astronomy Observatory's MeerKAT Telescope to map a large portion of these mysterious strings. The professor notes that using this facility was beneficial because the 64 telescopes spent over 200 hours viewing the objects. The team then created a mosaic image of the filaments by putting together 20 different images taken over those three years. Yusef-Zadeh says it was challenging to combine so many datasets into one cohesive piece. "It was a huge amount of data with lots of different fields. It can be quite complicated and time consuming to align all the different fields," he says. "A lot of credit goes to Ian Heywood." Heywood, an astrophysicist at Oxford University, will soon publish a paper - co-authored by Yusef-Zadeh - using the data from the MeerKAT. He helped to compose the image as well as captured the radio transmissions of other stars and celestial bodies in the meantime.

"I've spent a lot of time looking at this image in the process of working on it, and I never get tired of it," Heywood said. "When I show this image to people who might be new to radio astronomy, or otherwise unfamiliar with it, I always try to emphasize that radio imaging hasn't always been this way, and what a leap forward MeerKAT really is in terms of its capabilities. It's been a true privilege to work over the years with colleagues from SARAO who built this fantastic telescope." To create the clearest picture, researchers isolated the strands in the images to eliminate other background objects. To do that, they borrowed an algorithm from astronomers taking images of solar loops. Yusef-Zadeh says the strands in the centre of the galaxy shared characteristics with the narrow structures we see "bursting and pulling" off the surface of stars.

Although researchers are now able to visualize these objects, knowing where they came from is a bit more complicated. Yusef-Zadeh says there are two possible candidates to explain the phenomenon. He explained that Milky Way's centre is turbulent and chaotic, which may create self-generated strands. The other possibility is that they are generated by a compact source that has yet to be identified. Later this year, Yusef-Zadeh hopes to publish another paper detailing the filaments' individual length distribution, separation, curves, and magnetism, among other characteristics. The findings could lead to a better understanding of why these objects look the way they do.   By: Samantha Hill

Third planet found around Proxima Centauri 21 February: A little over four light-years away is Alpha Centauri, the closest star system to the Sun. In August 2016, researchers announced theyhad found a long-searched-for planet around Proxima Centauri, the smallest - and closest - component of this three-star system. Then, in January 2020, astronomers spotted a second world around Proxima Centauri. Now, the star's family tree appears to be growing again: A third terrestrial planet has been found orbiting the nearest star to Earth.

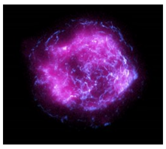

An artist's impression shows the small world Proxima d - a new planet recently discovered around the Sun's nearest neighbor. ESO/L. Calçada

This tiny planet, named Proxima d, weighing in at just one-quarter the mass of Earth, orbits Proxima Centauri every five days at a distance of some 4 million kilometres), or less than one-tenth the distance of Mercury from our own Sun. However, because Proxima Centauri is a red dwarf with only about 12 percent the Sun's mass and 14 percent its diameter, this puts Proxima d in the star's habitable zone, where conditions are just right for liquid water to potentially exist on its surface. Proxima d was discovered using the radial velocity method, during which astronomers carefully watch a star to look for subtle changes in position, which occur as the gravity of an orbiting planet tugs on its star. This is the same method used to detect Proxima Centauri's other two planets, Proxima b and c. However, these planets are more massive — in fact, Proxima d is the lightest exoplanet to date ever discovered using this method.

So, how does this new addition to the family stack up against its siblings? Proxima b, the first planet discovered around this star, is roughly the same mass as Earth and orbits every 11.2 days at a distance of 7 million km, or about 5 percent the distance Earth orbits the Sun. However, again, because Proxima Centauri is much smaller than our star, Proxima b also orbits in its habitable zone. Proxima c is different: It is a super-Earth weighing in at about six times our planet's mass, with an orbital period of 5.2 years. That puts its orbit, at about 224 million km, beyond the habitable zone.

Researchers discovered Proxima d using a new instrument called the Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations, or ESPRESSO, on the European Southern Observatory's Very Large Telescope in Chile. Now that the instrument has shown its mettle, astronomers are hoping to use it to uncover many more terrestrial worlds perhaps much like our own, both close to and far from home. By: Alison Klesman

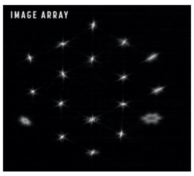
NASA's newest X-ray telescope snaps its first science image 23 February: Two weeks before the highly anticipated launch of the James Webb Space Telescope on Christmas day last year, NASA put a different telescope into space. The Earth-orbiting Imaging X-ray Polarimetry Explorer, or IXPE, is designed to study the opposite end of the electromagnetic spectrum from Webb, focusing on high-energy light from extreme objects such as supernovae, pulsars, and black holes. Furthermore, IXPE is NASA's first dedicated mission to measure the polarization, or orientation, of the X-ray light it receives, revealing information about the magnetic fields in the environment that created it. This gives astronomers a whole new way to look at the cosmos.


NASA/CXC/SAO/IXPE

Now, IXPE has released its first image. The target? Cassiopeia A, a supernova remnant that appeared in the sky in the latter half of the 17th century after its progenitor star dramatically blew itself apart. The remnant, which now measures some 10 light-years across, sits about 11,000 light-years away. This particular image shows data from IXPE, taken between January 11 and 18, in magenta. The colour's saturation reflects the intensity (energy) of the X-ray light it observed, with more saturated areas mapping where the highest-energy light is emanating. It is overlaid with additional X-ray observations made by the Chandra X-ray Observatory in blue.

Astronomers are now working with the new IXPE data to map out the polarisation of light across the remnant. It is the first time this quantity will be measured in Cassiopeia A, and will "unveil the mechanisms at the heart of this famous cosmic accelerator," said Roger Romani, an IXPE co-investigator at Stanford University. That is because the highest-energy X-rays from objects like Cassiopeia A are emitted when electrons are accelerated by intense magnetic fields, and measuring polarization tells us about the nature of the magnetic field affecting those electrons. Understanding where and how strongly this acceleration is happening will help researchers better understand what takes place when massive stars explode - a process that ultimately seeds our galaxy with the building blocks of the next generation of stars, planets, and life-forms. By: Alison Klesman

The James Webb Space Telescope sees stars 24 February: The James Webb Space Telescope (JWST) has opened its eyes to the stars. The mosaic is of a single star repeated in 18 images to bring the telescope's 18 hexagonal mirror segments into alignment. NASA announced the blurry star pictures were collected by the instrument earlier this month. While nowhere near the breathtaking images we expect from the telescope later this year, this alignment is a crucial step in getting the individual segments to act as one mirror. The completed first stage of the process is called 'Segment Image Identification'.



The image is a mosaic of 18 versions of the same star arrange in the shape of a hexagon taken by the James Webb Space Telescope. NASA/STScI/J. DePasquale

To collect the data from the stars, the telescope was adjusted in 156 positions in prediction of the star's location in an area "about the size of the moon," according to Marshall Perrin, deputy telescope scientist for Webb and astronomer at the Space Telescope Science Institute. Within the first six hours, researchers were able to identify the target star and then the images were formed into one composite picture. The process took 25 hours and, in total, Webb collected 1,560 images of the star. Now that the image is arranged in the correct order, the second phase of the project, called "Segment Alignment," will begin. This phase will bring the stars into focus by correcting any large mirror setting errors. The final phase, "Image Stacking," will bring the 18 individual spots of light to one point, creating a single image. Completion is expected in the next several weeks. Soon after, JWST will kick start its science discovery missions. By: Samantha Hill

SpaceX defends Starlink over collision concerns 25 February: It has been a mixed few months for SpaceX's Starlink constellation. The company continues to ramp up deployments of the internet service-providing satellites, which with today's launch, will push the number in orbit close to 2,000. However, the company has also drawn increasing scrutiny, with both China and NASA recently raising concerns about Starlink's potential to cause collisions with other objects in low-Earth orbit. Now, SpaceX is seeking to assuage some of these concerns. In a statemtn posted on its websiteon 22 February, SpaceX pledged it is "committed to maintaining a safe orbital environment, protecting human spaceflight, and ensuring the environment is kept sustainable for future missions to Earth orbit and beyond." The company argued that it has designed Starlink to be a safe and sustainable system and revealed details about how its satellites act autonomously to avoid collisions - details that it had previously only hinted at, or that analysts had suspected. "This is certainly the most detailed explanation SpaceX have given of their procedures," Jonathan McDowell, an astrophysicist at the Harvard-Smithsonian Center for Astrophysics, told Astronomy. "It is welcome, although a couple years later than it could have been."


A Falcon 9 rocket on Feb. 21 carries 46 Starlink satellites to orbit. SpaceX

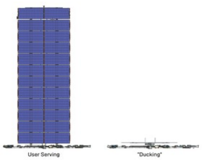
Astronomers and dark sky advocates have long raised concerns about Starlink, which seeks to provide broadband internet access to anywhere in the world. The satellites leave bright trails through astronomical images and are especially visible to the naked eye shortly after they are launched, before they ascend to their operational orbit. However, SpaceX's statement comes as concerns about collisions are getting more attention. On 3 December of last year, in a rare move, China submitted a complaint to the United Nations Committee on the Peaceful Uses of Outer Space, saying that the nation's crewed space station had to perform a manoeuvre to avoid a potential collision with a Starlink satellite on two separate occasions, 1 July and 21 October of last year. (McDowel verified the orbital manoeuvres with public tracking data.)

In a 28 December press briefing, a Chinese Foreign Ministry spokesman accused the U.S. of ignoring its obligations under the Outer Space Treaty, Bloomberg reported. That treaty holds that nations that have signed it bear the responsibility for supervising their country's activities in space, whether done by a national space agency or a commercial operator. Then, on 7 February, NASA's human spaceflight divisio submitted a letter to the Federal Communications Commission raising concerns about Starlink's plan for its second-generation constellation, for which SpaceX is seeking approval to launch 30,000 more satellites. In the letter, which was first reported by Space News, NASA said a megaconstellation of that size would raise the risk of collisions in space that could threaten its satellites and astronauts. The agency also said that glints of reflected sunlight could interfere with its space telescopes and Earth-observing satellites.

A Falcon 9 rocket with 58 Starlink satellites aboard launches from Cape Canaveral in Florida on June 13, 2020. SpaceX

SpaceX says one way it prevents Starlink satellites from becoming defunct obstacles in space is by launching them to very low orbits to do their initial system checks, just 210 kilometres high. By comparison, the International Space Station and China's Tiangong station orbit around 400 km. At 210 km, spacecraft experience significant drag from stray air molecules and will lose momentum and re-enter the Earth's atmosphere within days. That way, if a satellite fails to come online and is unable to fire its thrusters to boost itself to a higher orbit, it quickly falls out of space. SpaceX experienced one risk of this strategy on 3 February when it launched a batch of 49 Starlink satellites into the middle of a solar storm. Flares from the Sun enhanced activity in Earth's magnetic field, warming the atmosphere and causing it to expand outward. SpaceX said the Starlink craft experienced an atmospheric drag force that was up to 50 percent stronger than usual. As a result, 38 of the 49 satellites fell out of orbit and were destroyed, potentially costing the company tens of millions of dollars. "Despite such challenges, SpaceX firmly believes that a low insertion altitude is key for ensuring responsible space operations," it said in Tuesday's statement. (For its next Starlink launch on 21 February, it used a slightly higher orbit.)

SpaceX also reiterated in its statement that it has chosen 550 kilometewa as the operational altitude for Starlink craft - and not any higher - because at that altitude, spacecraft will naturally re-enter the atmosphere due to drag within a few years. By contrast, a Starlink satellite at 750 kilometres would take about half a century to re-enter. SpaceX also shed light on how Starlink satellites autonomously avoid collisions - a capability it has previously touted but offered few details about. This became a point of speculation after China's complaint. McDowell noted that in one of the two incidents where China moved its space station, the Starlink satellite appeared to have also taken avoiding action; in the other, the Starlink satellite did not change course. It was unclear whether SpaceX would have notified China's space agency about the manoeuvre, raising the possibility that both craft could inadvertently maneuver closer to each other.



The normal configuration of a Starlink satellite features its solar panel array in an upright 'shark-fin' configuration (left). When it makes a close pass by another object, it can lower its array to reduce the chance of a collision (right). SpaceX

On Tuesday, SpaceX said that if public tracking data shows a Starlink satellite has a 1 in 100,000 chance of a collision with another craft, it automatically "assumes manoeuvre responsibility" and autonomously takes avoiding action. If the other satellite is operated by a different organization, the Starlink satellite always manoeuvres to avoid - it never leaves it up to the other craft. If data indicates a "high-probability conjunction with another manoeuvrable satellite," SpaceX says it coordinates any manoeuvres with that satellite's operator. SpaceX also said that Starlink satellites can "duck" as they pass by another object by lowering their shark-fin solar panels so that they face the oncoming craft edge-on, reducing its profile and the chance of a collision by a factor of four to ten. McDowell says that he is happy to see SpaceX disclose more of its operational practices, but that the company could still be "a lot less vague" on some details - for instance, what exactly the 1-in-100,000 threshold translates to in terms of distance in practice, and exactly how much of a berth Starlink satellites give the ISS and Chinese space station.

By: Mark Zastrow

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