"The Southern Cross"

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HERMANUS ASTRONOMY CENTRE NEWSLETTER

JULY 2021

NB Changed meeting start times In order to avoid load shedding interfering with Zoom meeting times, the committee has agreed that, until further notice, all HAC meetings will begin at **18.30** instead of the current 19.00.

Monthly meeting This months **Zoom meeting** will take place on the evening of **Monday 19 July,** starting at **18.30.** Access details will be circulated to members closer to the time. The presenter is **Dr Lee-Anne McKinnell**, Managing Director of SANSA, Hermanus. See below for further details.

2021 meeting dates For your diaries. The remaining dates of the monthly meetings for 2021 are as follows: 19 July, 16 August, 20 September, 18 October and 15 November.

WHAT'S UP?

Venus and Mars in or near Leo For the whole of this month, Venus and Mars can be seen, after sunset, dancing a duet to the North-west in an around the constellation of Leo. From the southern hemisphere the crouching lion appears upside-down, but its brightest star Regulus (alpha (α) Leonis) can easily be found at the lower front corner of the eponymous animal's body. Located 79 light years away from Earth, although appearing to be a single star, it is a quadruple star system. The four stars are organised into two pairs. part of a binary system. The brightest, Regulus A, is a blue-white main-sequence star 'Regulus' is the Latin word for 'prince' or little king', possibly recognising its importance in the constellation name for the king of the animals. Regulus is the closest to the ecliptic of the brightest stars and is, thus, regularly occulted (temporarily blocked) by the Moon. Occultations by Mercury and Venus are possible, but rare. The last one was in 1959, by Venus, and the next will only be in 2044, also by Venus

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the Zoom meeting on 21 June, Dr Rob Adam, Director of the South African Square Kilometre Array (SKA) Radio Telescope project gave a very interesting and informative talk titled 'Introducing the SKA Observatory'. Part of the South African Radio Astronomy Observatory (SARAO), what was SKA SA is now formally the SKA Observatory. Rob explained how the very successful development is a consequence of a 1996 governmental philosophy of establishing big, iconic science projects as mechanisms to develop technological capabilities in developing countries. In Southern Africa, astronomy has become a so-called 'flagship science', with the SALT, HESS and SKA facilities filling what has been a geographical gap'in global astronomy coverage.

When complete, SKA will have three thousand medium-frequency dishes, located mostly in South Africa, but also in 8 other African countries, creating a massive baseline which will enable astronomers to study the early evolution of the universe. Following completion of KAT-7 in 2010, the 64 MeerKAT antennae (constructed and assembled locally) were officially launched in 2018. Work has begun on erection of next group of dishes, with completion of SKA scheduled for 2030. MeerKAT has already enabled astronomers to do pioneering work in radio astronomy, with several iconic images presented in print and other media. Rob outlined the many benefits and spin-offs which the SKA project has already conferred on South Africa, including growth of its high-tech industry, investment in science scholarship, enhancement of academic esteem in universities, technical skills development in Carnarvon and elsewhere, and schools development and general socio-economic uplift in the Carnarvon region. Its success internationally includes funding of additional SKA dishes by the Planck Institute (Germany) and establishment of other facilities at the site eg.SETI. HERA, HIRAX installations. Despite facing challenges, particularly that of managing the big data already produced just by MeerKAT, Rob's presentation demonstrated how developing countries can be a successful part of global science and astronomy.

Interest groups

Cosmology At the Zoom meeting, held on 14 June, Derek Duckitt presented the second part of a 2-part series of presentations on Loop quantum gravity by Carlo Rovelli.

Astro-photography The meeting scheduled for 14 June was cancelled to accommodate the cosmology session which load shedding had prevented being held on 7 June.

Other activities

Educational outreach No activities took place during May. However, committee members are working on a project on calculating the circumference of Earth for local schools, others in SA and, potentially, some in other countries in southern Africa

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's **Zoom meeting**, will take place on the evening of **Monday 19 July,** starting at **18.30**. Access details will be circulated to members. The presenter is **Dr Lee-Anne McKinnell,** Managing Director of the South African National Space Agency (SANSA), Hermanus. Details about the presenter and her presentation will be circulated, in due course.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 5 July** 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 normally meets on the second Monday of each month. Members are currently communicating digitally about image processing they do at home. The next meeting will take place **via Zoom** on **Monday 12 July,** starting at **18.30**.

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

Other activities **Stargazing** While no events will take place during the coronavirus pandemic, members are encouraged to submit their own images for circulation to the membership. Please e-mail them to petermh@hermanus.co.za

FUTURE TRIPS

No outings are being planned, at present.

2021 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented via Zoom. The remaining dates for this year are as follows: 19 July, 16 August, 20 September, 18 October and 15 November.

Remaining external speakers are Lee-Anne McKinnell (July), Case Rijsdijk (September) and Petri Vaisanen (October). Centre member presenters are Pieter Kotzé (August) and Jenny Morris (November). Details will be circulated closer to the time, each month.

ASTRONOMY GEARING'S POINT ASTRONOMY EDUCATION CENTRE (GPAED)

Municipal agreement has been obtained for this project, which is to be located within the existing whale-watching area at Gearing's Point.. Work is underway to obtain the necessary quotes and other budgetary requirements in order to submit an amended proposal to the National Lottery Commission.

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.

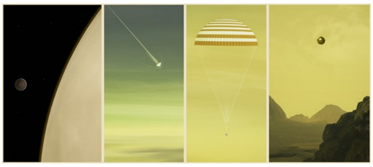
ASTRONOMY NEWS

NASA to return to Venus with two missions by 2030 4 June: After neglecting our sister planet for almost three decades, NASA is heading back to Venus - and in a big way. On Wednesday, 2 June, NASA administrator Bill Nelson announced that the agency would send two new missions to Earth's inner neighbour by 2030. One of them, DAVINCI+ is an atmospheric probe that will free fall to Venus' surface, sampling its acidic clouds and snapping close-ups of its terrain. The other, VERITAS, will study the planet from orbit with state-of-the-art radar and imaging instruments.

The news thrilled many in the planetary science community who have been clamouring for decades fro NASA to return to Venus. The last NASA mission to target Earth's sister planet was the Magellan probe, which orbited Venus from 1990 to 1994. Although the hellish world often serves as a flyby waypoint for spacecraft seeking a gravitational slingshot to more distant locales, its only dedicated visitors in the last 27 years have been ESA's Venus Exrpess and Japan's Akatsuki (or 'Dawn'). Both DAVINCI+ and VERITAS were competing in a pool of four proposals under NASA's program of low-budget ($500 million) Discovery-class missions. NASA had said it would approve up to two proposals, and one Venus mission was widely expected to make the cut. But NASA's decision to double down on Venus came as a surprise. "Everyone hoped that one of the two slots would be a Venus mission," says Justin Filiberto, who is a member of the DAVINCI+ team and a geochemist at the Lunar and Planetary Institute in Houston. "But this is incredible because it makes a mini Venus exploration program." The two proposals that missed out were the Io Volcano Observer, which would have studied Jupiter's volcanically active moon Io, and Trident, which would explored Neptune's icy moon Triton.


Two new NASA missions will study the atmosphere and surface of Venus, seen here in a composite image from Magellan and Pioneer Venus Orbiter missions. NASA/JPL-Caltech

DAVINCI+ is short for Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging; the plus sign was added when the mission's proposal was revised and enhanced in 2019. VERITAS' full name is Venus Emissivity, Radio Science, InSAR, Topography & Spectroscopy. While Venus has long taken a backseat to Mars in planetary exploration, over the past few decades, scientists have come to realize that the landscape that lies beneath Venus' perpetual layer of clouds could once have been similar to Earth's - and perhaps even supported life. A major objective of the two new missions will be to understand why these planets diverged.


When DAVINCI+ enters the Venus atmosphere, it will initially use a parachute to slow down, but then jettison it and free fall towards the surface. NASA GSFC visualization and CI Labs Michael Lentz and colleagues

When DAVINCI+ hits the Venusian cloud tops, it will become the first NASA mission to study Venus' atmosphere since 1978, and the first from any nation since the USSR's Vega missions in 1985. Its ability to directly sample its surroundings means DAVINCI+ will be able to put together a complete profile of Venus' atmosphere, layer by layer. It will also be able to sniff out interesting compounds - perhaps even phosphine, which was detected by radio astronomers last year, to much fanfare. On Earth, phosphine is produced by microbes, which lead the team to float the possibility that the Venusian clouds could harbour life; after a data processing error was found, the team revised its estimate of phosphine levels downward, which opens the door to other interesting geochemical processes. Although DAVINCI+ is not designed to survive its planned hard landing on the surface of Venus, nor the sweltering conditions it will encounter there, it will return images of the terrain taken below the cloud deck during its descent. Scientists hope to learn whether the region's rocks are made of continental granite or volcanic basalt. "The big difference there is that if there is granite, then that means there was water in the interior of Venus - whereas if it was ancient basalt, then there doesn't necessarily have to be water," says Filiberto. "So that tells a very different story about habitability."

VERITAS will likewise try to piece together Venus' geological evolution from orbit. "Determining whether Venus is actively undergoing volcanic activity and understanding what process is driving it is one of the really exciting questions I'd love to see answered," said Jennifer Whitten, a VERITAS team member and planetary scientist at Tulane University in New Orleans. It is possible that it will observe changes in volcanoes and their lava flows since Magellan and Venus Express visited, says Filiberto. Part of what makes scientists so excited is that the capabilities of the two spacecraft are highly complementary. "We have such different spatial resolution of our datasets," says Filiberto. "DAVINCI+ is going to be able to see these ancient rocks in higher resolution than VERITAS, but VERITAS is going to have global coverage, so they're going to able to put our pinpoint into context."


VERITAS will use its radar to peer below the clouds and reveal the surface of Venus in unprecedented detail. NASA/JPL-Caltech

There also could be more craft joining the party soon. Later this month, ESA will select between two proposals for its next medium-sized mission - one of which, EnVision, is another Venus orbiter. Russia and India are also separately planning their own Venus missions. "Venus might get crowded in the next decade," says Filiberto. By: Mark Zastrow

Astronomers score a triple-double 14 June: Galaxies are constantly colliding, merging, and creating ever-larger structures. That is true of the Milky Way, too. Our home galaxy has devoured multiple smaller galaxies in its past. And one day, about 4.5 billion years from now, the Milky Way will also merge with the nearby Andromeda Galaxy. Astronomers study this cannibalistic cycle, called the hierarchical model of galaxy evolution, by catching distant galaxies in the act of smashing together. When galaxies merge, so do their central supermassive black holes, which each weigh millions to billions of times the mass of the Sun. During this process, gas, dust, and stars dislodged by the collision can be either flung outward and away from the merging galaxies or inward toward their cores. In the latter case, the resulting influx of material can rapidly feed the supermassive black holes, forming bright, energetic accretion disks around them. That turns them into what astronomers call active galactic nuclei or AGN.

Now, researchers have spotted a triple galaxy merger - three separate galaxies slamming together at once - in which two of the three galaxies appear to sport an AGN. This sight is incredibly rare, and astronomers know of fewer than 10 such triple mergers with dual AGNs. Two of the merging galaxies appear close together, with a third galaxy (this one a smaller dwarf galaxy) to their north. Researchers think the dwarf may have already passed through the other two galaxies, disrupting all three as they swirl together. A tail of dust and gas connecting the dwarf to the other two is visible in images, which helps astronomers trace back the galaxies' interactions thus far.

The two larger, closer galaxies have central cores that are a mere 9,100 light-years apart. That is only about one-third the Sun's distance to the centre of our Milky Way Galaxy.

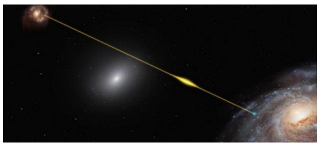
Curious about what was going on in these cores, astronomers used several observatories to peer at them in different wavelengths, including radio, infrared, optical, and X-ray light. They discovered that the two close cores are each emitting bright optical light and X-rays indicating activity from an AGN. However, one core shows stronger AGN signals than the other, while both are missing some key signs of AGN activity. "Mergers are messy. Black holes start turning on, showing AGN behaviour, and turn off again - and dust and gas can obscure what we see," explained Johnathan Williams of the University of Maryland, who led the study. Such obscuring material, he said, could explain why the cores look like AGN at some wavelengths of light, but not others. He went on to add that better understanding this system can teach astronomers how and why AGN might turn on and off during a merger, such as when there is gas and dust in their vicinity.


Astronomers have spotted a merger of three galaxies, two of which appear to contain active supermassive black holes. The system, called 2MASX J16311554+2352577, is about 820 million light-years away. VLT/MUSE R-V-B composite image

Exactly how supermassive black holes ultimately come together during a galaxy merger is still a bit of a mystery. It is one that researchers hope to soon solve, when future gravitational-wave observatories\capable of 'hearing' such events come online. "Knowing how often such mergers take place will help us know what to look for, and when we're seeing something unexpected," Williams said. For now, astronomers can only study rare examples such as this in the hopes of disentangling them. In the case of this system, Williams said, models indicate the third core might eventually be ejected altogether, which could cause the two closer cores to merge faster than they might have otherwise. The team next plans to observe this triple merger with the Hubble Space Telescope to uncover more clues. "This system combines an unusual combination of features, some puzzling aspects, and the potential to answer a number of questions about AGN and galaxy mergers," Williams concluded. "Work is ongoing and one thing is certain: More surprises lay in store." By: Alison Klesman

Discovery of 535 new fast radio bursts helps shed light on their mysterious origins 14 June: On 9 June 2021, my colleagues and I announced the discovery of 535 fast radio bursts that we detected using the Canadian Hydrogen Intensity Mapping Experiment telescope (CHIME). Detected in 2018 and 2019, these bursts of radio waves last only milliseconds, come from far across the universe, and are enormously powerful – a typical event releases as much energy in a millisecond as the Sun does over many days. Fast radio bursts are the subject of a young and emerging field in astrophysics, with only around 150 having been found before the release of our new catalogue. A lot of work has been done to understand these events, but these cosmic radio bursts remain as mysterious as when they were first discovered in 2007. Simply put: No one knows what exactly produces them. Every newly captured event is allowing astrophysicists to learn more about these weird cosmic phenomena. As this is happening, some astronomers have begun to use fast radio bursts as incredibly powerful tools to study the universe itself.

The name 'fast radio burst' is pretty on the nose. These signals are bursts of radiation in radio frequencies that last for mere milliseconds. A defining property of these bursts is their dispersion: The bursts produce a spectrum of radio waves, and as the waves travel through matter, they spread out – or disperse – with bursts at higher radio frequencies arriving at telescopes earlier than those at lower frequencies. This dispersion allows researchers to learn about two important things. First, telescopes like CHIME can measure this dispersion to learn about the stuff that radio bursts pass through as they travel toward Earth. For example, some of my colleagues were able to solve a long-standing mystery of missing matter that was scattered across the universe.


Mysterious blasts of radio waves from across the universe called fast radio bursts are getting more attention from astronomers. ESO/M. Kornmesser, CC BY-SA

Second, by measuring dispersion, astronomers can indirectly determine one of the most important pieces of information in all of astronomy: how far apart things are. The larger the dispersion measure, the more material the signal encountered. So, presumably, passing through more stuff means the burst travelled farther across the universe. The dispersion measures for fast radio bursts are so large that astronomers know the signals must be coming from outside of the Milky Way galaxy, but these estimates can be inaccurate because of the uneven distribution of matter in the universe. We therefore needed another way of finding distances to the sources of fast radio bursts to avoid assumptions on how matter is distributed and thus unlock a large amount of information and opportunities.

A striking solution to this problem came in 2017, when colleagues of mine were able to pinpoint the exact location of the source of a repeating fast radio burst in the sky. By taking images of repeating bursts on the sky, they found the specific galaxy that the bursts were coming from. Then, using optical telescopes, they determined the distance to this galaxy – approximately 3 billion light-years away from Earth. Repeating fast radio bursts make it much easier to pinpoint the host galaxies of their sources by giving researchers multiple chances to catch them. While astronomers work to answer important questions about fast radio bursts – What are they? Are repeating bursts different from single bursts? Are they all caused by the same things? – these lingering mysteries don’t stop us from putting them to good use in the meantime.

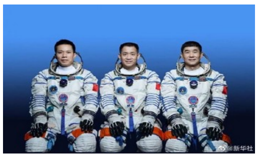
The unique properties of fast radio bursts and their host galaxies – combined with recent technological advancements like the CHIME telescope – have given researchers hope that these phenomena can be used to answer some long-standing questions about the universe. For example, some theorists have proposed that fast radio bursts can be used to study the three-dimensional structure of matter in the universe. Others have shown that the most distant bursts could be used to learn about poorly understood early moments in the evolution of the universe. However, to answer these and other questions, astronomers need a large number of fast radio bursts and their dispersion measures, strengths and locations in the sky.

This is where our new catalogue from CHIME comes in. By releasing information about 535 new fast radio bursts – including 61 bursts coming from 18 repeating sources – our team is more than quadrupling the total number of known events and pushing the field into an era of big data. With a large and growing number of measurements, all sorts of questions can finally start being addressed. Recently, student members of the CHIME collaboration began releasing studies using this catalogue. One study showed that the fast radio bursts detected by CHIME come equally from all directions – a fact that had previously been under debate. Another team studied the shapes and sizes of bursts in the catalogue and confirmed that repeating events behave differently from single bursts, pointing to multiple causes of fast radio bursts. And a third team for the first time confirmed that fast radio bursts are strongly associated with known galaxies. This means astronomers can use events to map out the structure of the universe.


One fast radio burst found by CHIME was determined to have come from the spiral arm of the red galaxy in the center of this photo, noted by the green circle. NSF's Optical-Infrared Astronomy Research Laboratory/Gemini Observatory/AURA, CC BY-SA

CHIME and other telescopes are detecting more fast radio bursts every day, but researchers are just scratching the surface of what can be learned about – and done with – these mysterious and powerful cosmic events. Colleagues of mine recently argued that attributing thousands of events to their individual host galaxies is "the most urgent observational priority for [fast radio burst] science." Finding host galaxies is very challenging, though – only 14 galaxies that host fast radio bursts have been found so far. But other telescopes, like the Australian Square Kilometre Array Pathfinder, have successfully detected and pinpointed a small number of non-repeating bursts to their host galaxies. Next-generation telescopes are being designed to combine the high-detection capability of CHIME with the high-resolution imaging of the Australian telescope. The field of fast radio burst astronomy is still in its infancy, and it is hard to predict what discoveries will be made next. I expect the future of the field to be just like these profound cosmic events: bright and fast. By: Emmanuel Fonseca, The Conversation

China successfully launches astronauts to new space station 17 June: Earth is on the cusp of gaining another orbiting laboratory. Early on Thursday morning, Beijing time, the China National Space Administration launched three astronauts to rendezvous with the core module of a new space station. This is the third launch of 11 missions planned to China's space station,Tiangong, meaning Heavenly Palace - before the end of next year.


From left: Taikonauts Tang Hongbo, Nie Haisheng, and Liu Boming. CNSA

The Shenzhou-12 spacecraft blasted off from the Jiuquan Satellite Launch Center in the Gobi Desert on 17 June. Aboard the rocket were three astronauts: Nie Haisheng, Liu Boming, and Tang Hongbo. About six and a half hours later, they became the first Chinese astronauts - or taikonauts - to enter to enter the Tiangong space station via the Tianhe core model, which launched at the end of April. While none of the crew was aboard China's first manned space flight in 2003, Nie was a backup for the mission. He later joined the crews of two more Chinese missions: Shenzhou 6 in 2005 and Shenzhou 10 in 2013. At 56 years old, Nie is now the oldest taikonaut to venture to space. Liu is also a veteran astronaut, having previous flown to space as part of the Shenzhou 7 mission in 2008. During that mission, another crew member preformed China's first spacewalk, while

Liu handed him a flag to wave for viewers - making Liu the second taikonaut to touch space. Today's flight is Tang's first trip to space. However, since being selected to China's astronaut program in 2010, he has been training for the opportunity.

Nie, Liu, and Tang will remain on board Tiangong for about three months to continue preparing the space station for full operations. Their work will mainly involve installing equipment and testing vital function like waste management and life support. They are also scheduled to conduct two spacewalks. "This flight mission is the first manned mission to the space station under construction," Nie said at a press conference before the flight. "We are challenged of course," the astronaut said while reflecting on their ambitious list of tasks. "My colleagues, Liu Boming and Tang Hongbo, would certainly agree that we will work together to conquer those difficulties." Tiangong is expected to operate for at least a decade. Once built, the station will serve a similar role as the International Space Station, becoming an advanced orbiting laboratory for both China and partner countries. Already, nine of the planned experiments have international partners signed on. However, whether or not foreign astronauts will also join future taikonauts on the station is yet to be determined. By: Caitlyn Buongiorno

Astronomers confirm there's a third type of supernova explosion 28 June: Supernovae occur when stars explode. When you think of a supernova, the type you most likely imagine is a Type II or core-collapse supernova. This type of cosmic blast happens when a star about 10 times the mass of our Sun (or more) detonates at the end of its life, leaving behind either a neutron star or a black hole. The other type of supernova, Type I, occurs when the remnant of a Sun-like star, called a white dwarf, siphons material from a nearby companion. Matter piles up on the white dwarf's surface and, once it tips over a certain mass limit, a runaway thermonuclear explosion rips the white dwarf apart. However, calculations dating back to 1980 show that there should be a third type of supernova, called an electron-capture supernova. This type of explosion occurs only to stars in a narrow mass range - 8 to 10 solar masses - which straddle the line between quietly evolving into white dwarfs and explosively birthing neutron stars or black holes when they die.

Electron-capture supernovae also produce neutron stars like some type II supernovae. However, before the star can die, magnesium and neon atoms that have piled up in its core begin capturing the free-floating electrons around them, which are responsible for the outward pressure keeping the star's core stable. As the electrons are absorbed, it reduces that outward pressure, causing the star's inner regions to collapse into a neutron star while the outer regions simultaneously blast outward as a supernova explosion. In March 2018, Japanese amateur astronomer Koichi Itagaki spotted a new supernova in the galaxy NGC 2146, which lies roughly 30 to 40 million light-years away in the constellation Camelopardalis. Now, researchers have analysed the blast and announced it neatly fits the profile of an electron-capture supernova.


Hubble image of probable electron-capture supernova SN 2018zd (large white dot at right) within the galaxy NGC 2146. NASA/STScI/J. DePasquale and Las Cumbres Observatory

What is unique about this new supernova, called SN 2018zd, is that astronomers were able to compare Hubble and Spitzer space telescope images of its host galaxy before and after the explosion. This helped them identify the likely progenitor star that precipitated the blast. “That was one of the key components that had never been done for other candidate electron-capture supernovae - they had never had a viable identified progenitor star, the star that explodes,” said study co-author Alex Filippenko of the University of California, Berkeley. This time, though, astronomers were able to compare both the star and the light from its supernova blast to the expected profile of an electron-capture supernova.

The observations fit expectations perfectly, matching all six expected criteria for such an event. First, the progenitor was a type of red giant, or ageing star, called a super-asymptotic giant branch star. These stars are between 8 and 10 solar masses and are believed to be the progenitors of electron-capture supernovae. Second, that progenitor had shed much of its mass prior to exploding, puffing away its outer layers into a cloud of material around it. Third, that material showed the unique chemical composition expected to precede an electron-capture supernovae: abundant helium, carbon, and nitrogen, but little oxygen. Fourth, the explosion itself was weaker than would be expected for a core-collapse supernova. Fifth, the explosion’s light behaved how astronomers expected it would for an electron-capture supernova: The light lingered for more than 100 days as material in the shock wave hit the outer layers the star had previously blown off, generating a long-lasting glow before dropping off. Finally, the composition of the material left behind - particularly the presence of stable nickel but not radioactive nickel (the latter of which is common after core-collapse supernovae) - is also what astronomers expect from an electron-capture supernova.


The Crab Nebula, result of a supernova was also likely an electron-capture supernova. NASA, ESA, NRAO/AUI/NSF and G. Dubner (University of Buenos Aires)

The researchers say SN 2018zd has provided the first solid evidence that electron-capture supernovae really exist. Now, they hope to use this example as a template to identify other such supernovae that pop off in the sky. Proving that electron-capture supernovae are out there ultimately helps astronomers better understand the life cycles of stars. “It is teaching us about fundamental physics - how some neutron stars get made, how extreme stars live and die, and about how the elements we’re made of get created and scattered around the universe,” said co-author Andrew Howell of Las Cumbres Observatory and UC Santa Barbara, who leads the Global Supernova Project to observe supernovae.

While the team is largely looking to a future in which we better understand the deaths of massive stars, SN 2018zd is also providing clues about another event from the distant past: The supernova of AD 1054, which created the famous Crab Nebula (M1) and its central pulsar. Astronomers have long suspected this supernova was an electron-capture supernova. In fact, it was previously the best-fitting example of such a supernova, despite the lack of complete records - at that time, there were no telescopes, spectrometers, or other instruments that could help observers characterize the explosion or progenitor star. Nonetheless, the Crab does fit several of the criteria for an electron-capture supernova: the neutron star it left behind, the chemical composition of the nebula, and way the ancient records detail how its light steadily lingered in the daytime sky for 23 days and remained visible at night for nearly two years before dropping off. Furthermore, the way the nebula's filaments continue to slowly expand over time indicates they're moving through a cloud of material, likely shed from the progenitor star before the blast.

With the observation of SN 2018zd, the team now thinks they have uncovered the strongest evidence yet linking the Crab to an electron-capture supernova. Seeing the Crab in this new light could help researchers better develop their model of electron-capture supernovae by providing an example of how they evolve in the centuries after they explode. And that, in turn, will reveal more about the galaxy and universe we inhabit, including how the flashy deaths of massive stars fling the building blocks of life across the cosmos. By: Alison Klesman

The future of satellites lies in the constellations 30 June: When Sputnik 1, the first satellite, was launched by the Russians in 1957, low Earth orbit was a lonely place. Today, just six decades later, the space around Earth looks far different. Thousands of satellites whiz around our planet at varying altitudes at speeds approaching 32,000 km per hour. Of the more than 11,000 satellites that have ever been launched, there are roughly 3,000 currently active, according to the Union of Concerned Scientists' Satellite Database. That number could pale in comparison to the satellite population by the end of the decade, though. Some estimates show that more than 100,000 satellites could orbit our planet by 2030, an exponential increase that has many scientists worried.


FoxPictures/Shutterstock

The steep rise in satellite numbers will likely come largely from so-called satellite constellations, groups of dozens or even hundreds of small satellites united in a common task. The most well-known of these is likely SpaceX's Starlink constellation, which delivers internet access to remote places. The company has over 1,500 satellites currently in orbit, and founder Elon Musk plans for tens of thousands one day. They will share space with satellites from dozens of companies and nations, put there to enable communications, provide weather data, take photos, carry out experiments and more. These satellite swarms could bring internet access to remote villages, enable scientists to keep tabs on climate change with new precision and more. However, they could also interfere with astronomers' ability to watch the night sky, and pose new hazards to manned missions to space. Space is certainly going to get more crowded soon - the effects of which will remain to be seen.

There are two factors likely to drive the explosion in satellite numbers. One is the advent of private spaceflight companies, which have provided the rockets needed to bring large numbers of satellites to orbit. The other is CubeSats, small, modular satellites that are cheaper to build, and easier to take to orbit than traditional custom-built satellites. Because they are small, it costs far less to take a CubeSat weighing perhaps a few dozen pounds to orbit than a larger satellite weighing over a thousand pounds. Also, CubeSats, unlike built-to-order satellites, can be manufactured quickly and more cheaply. Those cost efficiencies have made it feasible for companies like SpaceX to imagine creating and launching thousands of satellites in just a few years.

Satellite swarms offer a few key advantages over traditional satellites, especially for communications and internet access. Normally when a satellite orbits Earth, it must go extremely quickly, meaning it will not stay in range to deliver, say, broadband for long. Geostationary satellites solve this problem by orbiting exactly as fast as the Earth does, but the tradeoff is that they must remain very far away:33,577 km versus a few hundred for low Earth orbit. That means transmissions take far longer and need more power - not ideal when you are trying to ensure fast internet access. A constellation of many satellites can stay in low Earth orbit while ensuring that one or several of its members is in range of ground-based transmitters and receivers at all times. That means the constellation can talk to, or keep an eye on, the same places on Earth at all times. With enough satellites, the constellation could reach every point on the planet 24/7 - the ultimate goal of many satellite constellation providers.

The first satellite constellations actually date back decades. The Global Positioning System, or GPS, relies on a network of at least 24 satellites orbiting Earth, maintained by the US government. Today, everything from smartphones to mapping apps to financial systems rely on GPS to operate. Similar systems, like the European Union’s Galileo Network and Russia’s GLONASS also rely on their own groups of satellites. On the commercial side, the privately-owned Iridium network of 66 spacecraft has been providing satellite phone coverage for more than two decades. Today, many of the satellites in orbit are involved in communications. That holds true for satellite constellations as well, many of which are aimed at providing internet access, à la Starlink. Europe’s O3b began offering satellite internet to clients in 2014 using its own network of spacecraft. OneWeb, which has partnered with Airbus, plans to launch a total of 900 satellites in coming years to flesh out its own internet network. China, meanwhile, recently announced plans to put some 13,000 satellites in space to establish its Gouwang internet program.

However, it is not all about the internet in space. San Francisco’s Planet Labs is using nearly 200 Dove satellites to continually photograph the entire planet. These images allow them to provide pictures of Earth’s surface at 3 to 5 meters resolution, updated multiple times a day in some cases, the company says. They’re aiming to nab clients in industries ranging from agriculture to research to infrastructure. Spire, another imaging and space-based monitoring company, offers services like ship and aircraft tracking and weather monitoring using its proprietary satellite network. GHGSat’s satellites track emissions on Earth, searching for methane leaks and other sources of greenhouse gases. The company hopes to have 10 satellites in orbit by the end of 2022. Another company, Cloud Constellation, is attempting to solve another problem entirely. The startup hopes to convince companies to store their data in orbit, in servers aboard its satellite swarm.

An exponential increase in the number of metal boxes flying through near-Earth space poses a number of risks, some more obvious than others. Some come from astronomers, who worry that swarms of satellites will interfere with their observations of deep space. Those concerns were put on display almost immediately after SpaceX began launching Starlink satellites to orbit. A photo taken at the Lowell Observatory in Arizona in May 2019 reveals dozens of bright streaks obscuring the sky as Starlink spacecraft flew overhead. The photo is a bit of an exaggeration, as the satellites continued to spread out after launch, but it could be a harbinger of the crowd to come. More satellites could also mean more radio frequency transmissions flying about the atmosphere. In addition to looking visible light, astronomers monitor the sky across much of the electromagnetic spectrum, including in radio frequencies. Radio waves can travel through things that block light, like dust, meaning astronomers can see things otherwise obscured. Images of new galaxies, pulsars, quasars, and the first-ever image of a black hole have come thanks to radio telescopes.

More satellites in orbit also increases the odds of collisions. Two spacecraft smashing into each other at speeds of tens of thousands of miles an hour might lead to the dreaded Kessler Syndrome, a feedback loop of destruction that could render Earth orbit a no-fly zone for decades. The process is simple: An initial collision creates a cloud of thousands of pieces of debris whipping around the planet. Some of these pieces hit other spacecraft, creating more debris, and the result is a cascade of satellite mayhem. The resulting cloud of debris might be dense enough that any spacecraft put into orbit would be destroyed, putting a premature end to the satellite era. That eventuality could be averted by ongoing efforts to clean up low-Earth orbit, where an estimated 12,000 trackable pieces of debris already circulate. Some of those are from past satellite accidents, such as the 2009 collision between a defunct Russian satellite and an Iridium satellite. While the odds of a spacecraft being damaged by debris remain slim, it's still cause for caution. The International Space Station has been moved on multiple occasions to minimise the risk of being hit by nearby objects.

More satellites above us could also result in changes to our planet. A recent study estimates that Starlink's satellites alone may bring more aluminium into the upper atmosphere upon re-entry than meteoroids do. That extra metal may damage the ozone layer, some scientists speculate, further harming the environment. It is a reminder of one of the fundamental principles of satellite operation: What we put up into orbit will someday come back down to Earth. By: Nathaniel Scharping

Hubble waylaid by computer fault 30 June: NASA engineers are working to diagnose a computer glitch that has put the Hubble Space Telescope out of commission. The good news is that the core scientific instruments and the telescope itself remain in good health. There are on-board backups for the systems suspected to be at fault, which are part of an assemblage of components called the Science Instrument Command and Data Handling (SI C&DH) unit. However, so far, Hubble's team has not identified which piece of hardware is at the root of the failure and turning on those backups will be an intricate procedure that is risker than some of the steps tried so far.


Astronauts repair the Hubble Space Telescope during the first servicing mission to the observatory in 1993, flown by the space shuttle Endeavour. NASA

The issue emerged on 13 June when its payload computer - which manages the science instruments - ground to a halt. This prompted the main computer to put the instruments into a 'safe mode'. Telescope controllers attempted to restart the payload computer the next day, but ran into the same problem. Initially, the Hubble team suspected a faulty memory module, but switching to a backup memory module did not resolve the issue. Attention then shifted to components of the payload computer itself. In tests on 23 and 24 June, NASA turned on the backup payload computer for the first time since it was installed during a shuttle service mission in 2009. However, that did not fix the problem, either: Hubble was still getting errors writing to and reading from the memory modules.

NASA is now looking at other onboard equipment to find the culprit. One possibility is the Command Unit/Science Data Formatter (CU/SDF), which formats and routes data onboard and for transmission to the ground. The team is also investigating the power regulator for potential voltage spikes or drops. Both the CU/SDF and the power regulator have backups that may be called into service in the coming days. "This procedure would be more complex and riskier than those the team executed last week," NASA said, referring to trying the backups for the payload computer and memory modules. "To switch to the backup CU/SDF or power regulator, several other hardware boxes on the spacecraft must also be switched due to the way they are connected to the SI C&DH unit." The team is already preparing for that process, reviewing the operations procedures and commands for testing in a simulator, NASA said.

Such glitches are not unprecedented on Hubble. The current CU/SDF is a replacement for one that failed in 2008. That failure forced a switch to the backup in a procedure similar to the one currently under consideration. Fortunately, it was successful. Even better, a shuttle servicing mission was already scheduled; by delaying it, NASA got the opportunity to build a replacement SI C&DH unit. The telescope's gyroscopes - which were also replaced during that 2009 service mission - have been acting up, as well. In October 2018, one of those gyros, which help keep the telescope stabilised during observations, stopped working, and its backup failed to come online. However, after rotating the telescope and cycling the backup gyro through different modes, the team was able to recover it. Hubble fell into safe mode again just four months ago due to a bug in a telescope software update that created a permissions error. That was quickly patched and Hubble resumked normal operations within a week. So far, none of these issues have proven fatal. And while they are a steady reminder that the fabled observatory will not be around forever, scientists hope it has many years of operations ahead of it. "   By: Mark Zastrow

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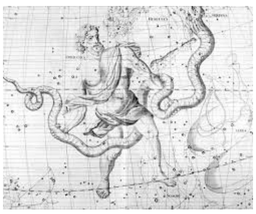
DID YOU KNOW?

Zodiac constellations 17: Ophiuchus

The name Ophiuchus means 'the serpent holder or bearer' in Greek, and represents a man holding a snake or serpent. The serpent is the constellation Serpens, which Ophiuchus divides into two parts. The man's head adjoins Hercules' head in to the north (in the northern hemisphere) while his feet rest on Scorpius to the south. From the southern hemi-sphere, the man is upside down, his feet haning down from the scorpion.

It is a large constellation, ranked 11th largest of the 88 constellations. It straddles the ecliptic and is thus, a zodiac constellation. However, it was the constellation sacrificed for the comfort of being able to divide the ecliptic into 12 equal parts.



Although one of Ptolemy's 48 constellations, there is no evidence that Ophiuchus was a constellation before classical times. In Greek mythology, it was seen as the god Apollo, struggling with the huge snake which guarded the Oracle of Delphi. Roman mythology identified it with Asclepius, the god of medicine, who had power to revive the dead. Hades, god of the Underworld feared that this ability endangered his trade in the souls of the dead. He asked Zeus to strike Asclepius down with a thunderbolt. Instead, Zeus placed Asclepius among the stars, where he holds a snake, the symbol of healing.

The Sun passes through Ophiuchus during the first half of December. It is located opposite Orion along the celestial equator. Because of its proximity to the Milky Way, it contains many deep sky objects, mostly globular clusters, but also several nebulae. The seven Messier objects in Ophiuchus are all globular clusters.

Notable features include:

- Alpha Ophiuchi (Raselhague - 'head of the serpent charmer'); the brightest star in the constellation is 49 ly away.
- Rho Ophiuchi: an impressive multiple star; a central star with another on each side plus a fourth. Binoculars identify the larger stars, but a telescope is needed to observe the fourth one.
- Rho Opiuchi Nebula: a faint nebula surrounding Rho Opiuchi.
- M10 and M12: both globular cluster. Visible through binoculars, the are visually the best of the seven globular clusters catalogued by Messier in Ophiuchus.
- Other globular clusters: M9, M14, M19, M62, M107
- NGC 6633: an open open cluster visible through binoculars.

- NGC 6240 (Butterfly Galaxy): an unusual galaxy merger remnant and starburst galaxy 400 million ly away. It has two supermassive black holes 6,000 ly apart. Its presence was confirmed by the Chandra X-ray Observatory. The black holes are scheduled to merge in about 1 billion years. It has an unusually high rate of star formation, a consequence of the heat remaining from the galaxy merger process and the black holes. It is this feature which makes it a starburst galaxy.
- IC 4665: an open cluster visible through binoculars.
- Barnard's star: the second closest star to Sun. It is 5.9 ly away and has a luminosity 2,000 times less than the Sun. Discovered in 1916 by the American astronomer E E Barnard, it has the largest proper motion of any known star.
- Ophiucids meteor showers: the weak, ill-defined activity occurs during May and June. It is not recognised by some as a discrete shower, but as possibly due to general activity from the anthelian radiant.

Sources: Ridpath, I (Ed) 2012 Oxford dictionary or astronomy Oxford, OUP, Ridpath, I (Ed) 2006 Astronomy London, Dorling Kinderslety, en.wikipedia.org

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