`"The Southern Cross"

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HERMANUS ASTRONOMY CENTRE NEWSLETTER

SEPTEMBER 2020

Monthly meeting This months **Zoom meeting** will take place on the evening of **Monday 21 September.** Access and start time details will be circulated to members closer to the time. Dr Pieter Kotzé, Senior Research Fellow at SANSA Space Agency in Hermanus will be talking on '**Cosmic ray astronomy**'. See below for details.

Cosmology The activities of this interest group continue on the evening of **Monday 7 September.** The next two parts of the current DVD series "Black holes, tides and curved spacetime: Understanding gravity' presented by Prof Benjamin Schumacher of Kenyon College will be shown **via Zoom**. Access and start time details will be circulated to members. See below for details on the content.

2020 meeting dates For your diaries. Remaining meeting dates are: 19 October and 16 November.

WHAT'S UP?

Comet Howell Comet 88P/Howell peaks on 26 September and will then be visible from Southern Africa as it moves through Scorpius in the evening sky. It was discovered in August 1981 by Ellen Howell, an astronomer at the Lunar and Planetary Laboratory, University of Arizona. Comet Howell is a periodic comet ie one that has been observed more than once, enabling its orbital period to be reliably established. Strictly speaking, it is a short-period comet, one with an orbital period of under 30 years. It was again observed in 2015, and orbits the Sun every 5.5 years. It has an average size (diameter) of around 4.4km (sizes generally range from 750m up to 20 km). Typically, their length is about twice their diameter. While long-period comets originate in the Oort Cloud at the outer reaches of the solar system, short-period comets like Howell usually originate from the still very distant, but nearer Kuiper Belt. The inner boundary of this wide icy ring of material is just outside Neptune's orbit. When the fragile objects leave their icy homes, gravity accelerates them towards the Sun as comets.

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the Centre's first Zoom monthly meeting, centre member, Jenny Morris gave a presentation on "1820 and all that: Establishment of the Cape Observatory, and scientific connections with the Cape'. Johan Retreif reports: "In 1820, the Royal Navy Admiralty decided to establish an observatory at the Cape of Good Hope.

The aim of this observatory was to observe the positions of the stars visible in the southern hemisphere to enable mariners to navigate with confidence south of the equator.

Selection of a site for the Observatory was not easy, the observatory had to be visible to ships at anchor in Table Bay in order that time signals could be observed. A suitable hill was searched for and one was found, but it was in a swampy area and the area was invested with snakes. There were many delays in starting the building, which was finally commenced in 1825, the main building being completed in 1828. Jenny showed various sketches of the establishment, inter alia by John Herschel. The first photo ever taken at the Cape was taken by Piazzi Smythe, assistant to the Astronomer.

Jenny presented us with a fascinating narrative of the influence of various scientists of the time since the completion of the observatory:
George Everest – shape of the Earth
Joseph Banks – naturalist and botanist
Francis Masson – collector for Kew Gardens
John Herschel – came to the Cape to observe southern stars
Thomas Maclear – third astronomer at the Cape Observatory and the person who led the team for the second measurement of the arc of the meridian, after Col Everest indicated that the first measurements by Abbé De Lacaille may have been adversely affected by the masses of Table Mountain and Piketberg. De Lacaille's measurement indicated that the arc in the southern hemisphere was somewhat shorter than in the north.
Charles Darwin – who visited the Cape in HMS Beagle, geology of the Cape.
Richard Carrington – discovered and described solar flares.
Michelson and Morley – speed of light and a measurement of the diameter of Betelgeuse."

Interest groups

Cosmology At the first Zoom meeting, held on 3 August, Derek Duckitt presented the next two lectures in the DVD series 'Blackholes, tides and curved spacetime: Understanding gravity presented by Prof Benjamin Schumacher of Kenyon College. The topics were: L9: 'Nudge - Perturbation of Orbits' and L10: 'Resonance - Surprises in the Intricate Dance'.

Astro-photography No meeting took place in July, due to the coronavirus pandemic, although members are communicating with each other on image processing they are doing at home.

Other activities

Educational outreach

Analemmatic sundials at schools When possible, work will continue on these at several Overstrand schools.

Article in Whale Talk An article by Jenny Morris titled 'A new era for space travel' was published in the August/September 2020 issue of the magazine.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on the evening of **Monday 21 September via Zoom**. Access and start time details will be circulated to members. Dr Pieter Kotzé, Senior Research Fellow at SANSA Space Agency in Hermanus will be talking on '**Cosmic ray astronomy**'. Pieter states: 'Cosmic rays are one of the most mysterious phenomena in the universe, but unlike many enigmatic astrophysical phenomena that only exist in the depths of space, cosmic rays are all around us all the time. Most people may think the greatest, most perplexing mysteries of the universe exist several thousand light

years away, at the edge of a black hole, or inside an exploding star. In fact, some of the greatest mysteries of the universe surround us all the time. They even permeate us, sailing straight through our bodies. Cosmic rays are messengers from the broader universe; a reminder we're a part of it, and a reminder that there's still a great deal of mystery out there. In this presentation I will give a brief outline of cosmic ray astronomy, its history, and current questions that still need to be clarified.'

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 7 September** will be shown **via Zoom**. Access and start time details will be circulated to members. The next two lectures in the DVD series 'Black holes, tides and curved spacetime: Understanding gravity' presented by Prof Benjamin Schumacher of Kenyon College will be shown. The topics are: L11: 'The million-body problem' and L12: 'The billion-year battle'.

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 which they can do at home.

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 to petermh@hermanus.co.za for circulation to the membership.

FUTURE TRIPS

No outings are being planned, at present.

2020 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented via Zoom. Remaining dates for this year are 19 Oct, and 16 Nov. Topic and speaker details will be circulated to members closer to the time.

ASTRONOMY SELF-GUIDED EDUCATION CENTRE (ASEC)

Work continues on planning and administrative requirements for work to begin on the proposed Astronomy Self-guided Education Centre, to be located within the existing whale-watching area at Gearing's Point.

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\

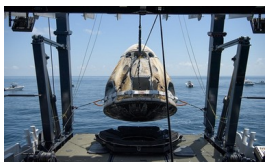
Crew Dragon safely returns astronauts to Earth, despite minor hiccup 3 August: Shortly after 2:48pm ET on Sunday 2 August , NASA astronauts Bob Behnken and Doug Hurley safely splashed down in the Gulf of Mexico after spending the past two months aboard the International Space Station (ISS). The event was not only the first water landing since 1975, it also marked the first time any astronauts have safely splashed down in a crew capsule built by a private spaceflight company - namely, SpaceX. "It's a testament to what we can accomplish when we work together to do something once thought impossible," NASA Administrator Jim Bridenstine. "Partners are key to how we go farther than ever before and take the next steps on daring missions to the Moon and Mars."


NASA astronauts, Bob Behnken (left) and Dougl Hurley (right), are all smiles post-splashdown. NASA/Bill Ingalls

The Crew Dragon left the International Space Station (ISS) at around 7:30pm ET on Saturday 2 August. After locking the hatches and departing the ISS, the capsule performed a series of engine burns throughout the night to ensure it was on the right path home. During that time, Behnken and Hurley also got their required eight hours of sleep before receiving wake-up calls from their children before re-entry. In some ways, the return trip can be even more dangerous than the initial liftoff. Initially zipping around Earth at some 27,350 kilometres) per hour, Crew Dragon first pierced through Earth's upper atmosphere. As friction slowed the craft, the temperature outside the capsule swelled to about 1,900 Celsius). Inside, thanks to heat shields on the exterior of the spacecraft, the temperature remained below 29.5 C - warm, but all things considered, quite comfortable. While the heat shields protected the blistering spacecraft, a bubble of ionized gas surrounding Crew Dragon caused an expected and temporary six-minute communications blackout. During this time, Behnken and Hurley experienced forces up to five times the strength of Earth's gravity. These forces were much more intense than those astronauts experienced during Space Shuttle missions, but they also did not last as long. When the spacecraft reached about 645 km/h), Crew Dragon deployed two drogue parachutes to further slow and stabilize the craft before setting loose its four main parachutes. These reduced the speed of the capsule to around 26 km/h. About two minutes later, Behnken and Hurley successfully splashed down in the Gulf of Mexico.


Despite concern for high winds and waves to disrupt Crew Dragon's return, the weather was near perfect during the splashdown landing. NASA/Bill Ingalls

Recovery 'fast boats' swept in immediately after splashdown, and many lookie-loos in pleasure boats converged around the site shortly after. While some of the recovery crew ensured there were no toxic fumes lingering around the spacecraft, others worked to drag the parachutes out of the ocean. Next, the recovery ship Go Navigator closed in on the capsule. A large rig on the ship plucked Crew Dragon from the water, gently placing it onboard in a dock nicknamed the 'Dragon's nest'.


SpaceX Crew Dragon Endeavor spacecraft is pulled from the Gulf of Mexico by SpaceX's GO Navigator recovery ship. It was then nestled into the "Dragon nest". NASA/Bill Ingalls

Behnken and Hurley still had quite a long wait left, however. Their exit from the capsule was delayed due to the detection of low levels of potentially toxic propellant they would have had to pass through upon departure. In an abundance of caution, recovery crews vented the fumes, and soon enough, Behnken and Hurley were helped out of the capsule. Following standard procedure, the astronauts were taken out of Crew Dragon on stretchers, but they both gave cameras the thumbs up as they were handed off to NASA's medical team. After a quick check-up, Behnken and Hurley were taken to meet with their families. Overall, Dragon was a successful flight. Over the next few weeks, scientists and engineers will check and double-check the mission and re-entry data, looking for any potential issues that still need addressed. NASA says the launch date for the first regular, fully operational Crew Dragon flight - rather than a demo mission - will be no earlier than late-September of this year. By: Caitlyn Buongiorno

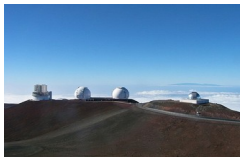
Small stars are vital to dispersing the building blocks of life 4 August: Despite peacefully floating in the night sky, stars are not docile creatures. They are churning caldrons of roiling plasma stirred by countless nuclear explosions within. Scientists know that such stellar nuclear fusion is responsible for creating many heavy elements necessary for life in the universe, such as carbon, oxygen, and nitrogen. What is less understood is how these elements escape their stars and leach out into the universe - a rather major step in the development of life itself. Now, new research suggests some of the basic building blocks of life are dispersed through the universe as low-mass stars take their dying breaths, metamorphosing into stellar remnants known as white dwarfs. The clue to this discovery comes from the realisation that some small stars are leaving behind corpses that are more massive than expected.


NGC 7789, otherwise known as Caroline's Rose, is an open star cluster in the Milky Way which is home to multiple white dwarfs. Guillaume Seigneuret/NASA

"Understanding of the processes by which elements heavier than hydrogen and helium are dispersed to either a star's immediate environment or to the wider universe - rather than being trapped in dense remnant cores - is still limited," Jeffery Cummings, an associate research scientist at John Hopkins said. "But we are now able to far more reliably confirm the processes with which carbon is dispersed to galaxies through evolving stars."

The international team of researchers chose to specifically focus on carbon because the origins of this life-enabling element - as opposed to others like oxygen and nitrogen - are not nearly as well understood. "We already know that most of the nitrogen in Earth's atmosphere arose in stars that did not explode, whereas the oxygen you breathe came from stars that did explode," co-author Enrico Ramirez-Ruiz, professor at the University of California, Santa Cruz, explains. "Carbon's origin is less clear; some studies place its birth in larger stars that exploded, while other studies say just the opposite."

One possibility is that supernovae are responsible for flinging most carbon into interstellar space. However, the lingering problem with this scenario is that high-mass stars - the progenitors of supernovae - are relatively rare compared to how much carbon astronomers see in the cosmos. So, perhaps low-mass stars, which end their lives as white dwarfs rather than neutron stars or black holes, also get in on the cosmic carbon fight. Indeed, some existing theories suggest that puny stars sport powerful stellar winds that blow away their outer envelopes as they transform into white dwarfs. So far, observations have failed to fully back up that claim. This new research, however, might be a step in the right direction. The astronomers examined data collected by the W.M Keck Observatory in Hawaii throughout the summer of 2018. Specifically, they focused on analysing white dwarf stars located in open clusters spread throughout the Milky Way. "Our research focused on using white dwarfs, the exposed cores of dead stars, to better understand how stars evolve and die," says Cummings. "Connecting these white dwarfs to the characteristics of the stars that died to form them is the most direct way to observe the parameters of these stars' cores at the final stages of their lives."


The W.M. Keck Observatory, seen here, is perched atop Mauna Kea in Hawaii. SiOwl/Wikimedia Commons

The researchers then traced the evolution of the white dwarfs back in time, deriving their initial masses with the help of an important relationship in astrophysics, the initial-final mass relation (IFMR), which, despite its ubiquity, still has its quirks. "The initial–final mass relation connects the mass of a white dwarf with the mass of its progenitor in the main sequence," says Ramirez-Ruiz. "By understanding this relationship, we are able to put stringent constraints on the carbon-containing mass that was ejected during the evolution of the star." Generally speaking, the more massive a progenitor star, the more massive its remnant. But the team discovered an apparent 'kink' in that relationship. Stars starting with about 1.8 to 1.9 times the mass of the Sun seem to be leaving behind larger-than-expected corpses. The break in the IFMR was noticed independently by both Cummings and the study's lead author, Paola Marigo, a theoretical astrophysicist at the University of Padova in Italy. Importantly, Cummings found the kink through observations, while Marigo uncovered it in her theoretical modelling.

According to the researchers, the fact that stars with just under two solar masses seem to produce plus-sized white dwarfs suggests these stars were still forging carbon in the final stages of their lives. This carbon was then passed into the interstellar medium by stellar winds, which is a far more gentle process than being violently propelled by supernova shock waves. This revelation places a constraint on the evolution of low-mass stars, as well as how they chemically enrich their surroundings.

This new 'low-mass star theory' of chemical enrichment does not so much compete with previous ideas as it does bolster them. It is not that low-mass stars are solely responsible for enriching their host galaxies with carbon, but they do work with their bulkier counterparts to get it done. "There is ample evidence that both exploding massive stars and low-mass stars contribute to the production and distribution of carbon in the universe," says Ramirez-Ruiz. "This is evident by looking at the fossil stellar record in the Milky Way." Ramirez-Ruiz goes on to suggest that massive stars could contribute more to carbon-enrichment early on, while low-mass stars might inject more carbon into galaxies at later times. After all, smaller stars live much longer than larger stars. "With all of the complex processing that can occur in astronomy, the production of elements is never an 'only A or only B' type of process," Cummings stresses. "Both processes are likely major contributors, and our work does not rule out the contribution of more massive stars and their supernovae."

However, one thing is for sure, there is still much to learn about low-mass stars and their evolution, as well as the role they play in the chemical enrichment of their host galaxies. Cummings says astronomers need to intensely study stars ranging from about one to two times the mass of the Sun, as well as the white dwarf remnants they leave behind. "Whilst I do hope to be involved at some level in future work of this nature," the researcher says, "I am just as excited about the prospect of this current study inspiring a younger astronomer to take the lead." By: Robert Lea

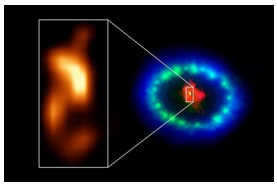
Hot 'blob' points to a neutron star lurking in Supernova 1987A 6 August: On 24 February 1987, an unexpected cosmic explosion rocked the astronomical community. Dubbed Supernova 1987A (SN 1987A), the fiery event - triggered by the implosion of a massive star - was the closest observed supernova to Earth since the invention of the telescope. It did not occur in our galaxy, though. SN 1987A self-destructed within the Large Magellanic Cloud, which is a satellite galaxy of the Milky Way that resides some 170,000 light-years from Earth. Nonetheless, SN 1987A was still so bright that naked-eye observers could see it for several weeks. The extraordinary sight of a nearby supernova lingering in Earth's night sky is not the only thing SN 1987A bestowed upon us. It also gave astronomers an unprecedented opportunity to investigate what triggers supernovae, as well as how such powerful blasts ripple through their surroundings. In fact, we can see the shockwave from SN 1987A still speeding outward today, interacting with clouds of dust that encircle the original site of the cosmic explosion. However, an enduring mystery remains: What did SN 1987A leave behind? According to new research, the answer is likely a neutron star.


Astronomers have found new, compelling evidence that Supernova 1987A harbors a neutron star (blue-white) within a newly imaged 'blob' of extremely hot dust (red), as seen in this artist's concept. NRAO/AUI/NSF, B. Saxton

For quite some time, astronomers have assumed SN 1987A initially left behind a neutron star. That is because a few hours before the supernova's light reached us, they detected an influx of neutrino particles washing over Earth, as would be expected if a supernova erupted nearby. These nearly unstoppable particles zip straight through the dense material present during a budding supernova - unlike light, which gets held up for a bit. In

fact, SN 1987A was the very first time scientists ever detected neutrinos from beyond our solar system. However, even though these neutrinos almost certainly came from the birth of a neutron star in SN 1987A, astronomers are not sure whether that neutron star lives on, or rather quickly collapsed into a black hole. Despite decades of monitoring the site, observers have yet to find convincing signs of a compact object lurking near the center of SN 1987A. At least, until now.

Astronomers report they have found compelling evidence that SN 1987a is still harbouring a neutron star, which would make it the youngest such stellar corpse yet known. (The previous record holder, called Cassiopeia A, is estimated to be about 330 years old.) The astronomers carried out the study using the Atacama Large Millimeter/submillimeter Array (ALMA) - a radio telescope in Chile that's able to peer through obscuring dust. These new, extremely high-resolution images revealed a hot 'blob' lurking in the core of SN 1987A.

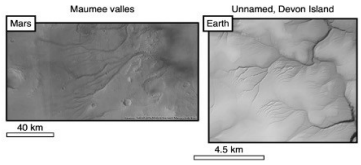

The Atacama Large Millimetre/submillimetre Array (ALMA) captured high-resolution images to reveal a hot, slightly off-centre 'blob' (inset to left) within the core of Supernova 1987A. The material seen by ALMA in radio wavelengths is coloured red and yellow. Hubble's visible view is displayed in green, and Chandra's X-ray view is shown in blue. ALMA (ESO/ NAOJ/NRAO), P. Cigan and R. Indebetouw; NRAO/AUI/NSF, B. Saxton; NASA/ESA

However, the blob itself is not the neutron star. Because neutron stars compress about 1.4 times the mass of the Sun into a sphere roughly 25 km) wide, they are impossible to see directly. Instead, the newly discovered blob seems to be a giant gas cloud that dramatically outshines its surroundings, and it's located right where astronomers think SN 1987A's neutron star should be. "There has to be something in the cloud that has heated up the dust and which makes it shine," explained coauthor Mikako Matsuura of Cardiff University. At its longest, the blob spans about 4,000 astronomical units - where one astronomical unit is the average Earth-Sun distance - and it's estimated to have a temperature of some 5 million degrees Celsius "That's why we suggest that there is a neutron star hiding inside the dust cloud," Matsuura added.

This blob is not exactly at the centre of SN 1987A, though; it is slightly offset. However, that is not a bug in the theory, that is a feature. Astronomers have long suspected that SN 1987A exploded asymmetrically, flinging more material in one direction than the other. Per Newton's third law of motion, such an asymmetric blast would have 'kicked away' the neutron star in the opposite direction at hundreds of miles per second. So, by simply calculating how far the neutron star traveled through space during the past 30-some years, the astronomers can predict its offset from the center of SN 1987A. As it turns out, it is precisely where they found the blob in the ALMA images. By: Yvette Cendes

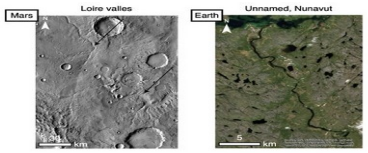
Rivers on ancient Mars might have flowed beneath sheets of ice 7 August: The evidence that water once existed on Mars is unmistakable: The planet is covered in valleys that appear carved by flowing water. For decades, these epic ravines and branching riverbeds beckoned planetary scientists to imagine a 3.5-billion-year-old world that was both warm and wet, covered with lakes and rivers - possibly hosting an environment conducive to life. However, new research suggests Mars might not have been the balmy paradise scientists once envisioned. Now, the evidence seems to suggest that rivers may

not have covered its surface, but instead flowed deep under large sheets of ice.To come to this conclusion, the researchers performed a statistical analysis of the shapes and patterns of 66 networks of valleys on Mars, which are composed of over 10,000 individual valleys. They then compared these to similar features on Earth. They found that 14 of the Martian sites appeared to have characteristics reminiscent of above-ground rivers, but 31 seemed to be carved out by either glacial or subglacial meltwater, more like terrain found near former glaciers on Earth.



Mars-Earth comparisons. Grau Galofre et al. (2020), Figure 4a. Left: Context Camera (CTX) mosaic, NASA/JPL/MSSS/Caltech Murray Lab/Esri; Right: Arctic DEM hillshade, Polar Geospatial Center, University of Minnesota

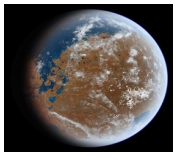
The above images highlight the similarity between Mars' Maumee Valles channels and Earth's Devon Island in Canada. Devon Island is a landscape that was once covered in glaciers, suggesting the channels in Maumee Valles likely have a similar origin story. These branching patterns of tributaries are characteristic of the channels of meltwater that form beneath glaciers and rush downhill, cutting into the landscape.



Grau Galofre et al. (2020), Figure 4c. Left: THEMIS mosaic, ASU/NASA/USGS/Esri; Right: Esri Maxar

This pair of pictures shows the similarities between Mars' Loire Valles and an unnamed river in Nunavut, Canada. Both show highly sinuous valleys meandering through the terrain. The widths of the channels also sometimes changes suddenly - from broad to narrow and back again - a characteristic of subglacial rivers.

In the past, some researchers thought such features could be explained by groundwater seeping to the surface and eroding away the ground. The process, called sapping, might have formed the theatre-like channels found in canyons in the Western United States, like Arizona's Grand Canyon. However, others have questioned whether springs could really spew enough water to erode the strong bedrock of Mars. Glacial meltwater is a more likely explanation for these large valleys, the team argues, as only three of the 66 valleys they analysed shared similar traits to known sapping systems on Earth.


Artist's concept of a warm Mars with surface bodies of water, Ittiz/Wikimedia Commons

The researchers say their findings of a frigid ancient Mars are also in line with climate simulations, which do not agree with the 'warm and wet' hypothesis for how the Red Planet used to be. Instead, they suggest Mars was largely covered in snow and ice, especially at higher altitudes. That does not necessarily dash all hopes of finding evidence of ancient life on Mars , like NASA's Perseverance rover aims to do beginning next year.

Massive ice sheets may actually be more hospitable in one respect: they would have offered organisms protection from hazardous radiation that Mars' weak magnetic field cannot keep out. By: Mark Zastrow

Arecibo down, but not necessarily out, following cable failure 14 August: The Arecibo Observatory just cannot catch a break. Early Monday morning, a 3-inch thick cable that supports a platform high above the radio telescope failed, striking and damaging the dome that houses its receiver and tearing a 30.5 metre gash in the observatory's main dish. No one was injured in the incident, observatory officials say, which occurred at 2:35 am local timeile the telescope was tracking, according to a log maintained by Arecibo's Phil Perillat. "This was certainly an unprecedented event," said observatory director Francisco Cordova during a Zoom call with reporters on Friday.


Arecibo Observatory's massive radio dish has a 30m gash in it UCF/Arecibo

The telescope is offline while Arecibo staff assess the damage. "The last couple of days have really been focused on ensuring the structural integrity of the facility, making sure that the staff continues to be safe," Cordova said. What caused this cable to fail is still unknown. The cables were expected to last for another 15 to 20 years, Cordova said. However, this one broke with no warning, says Ramon Lugo, the director of the Florida Space Institute at the University of Central Florida (UCF), which co-manages the Puerto Rican facility, in an email to Astronomy. "We have done numerous inspections of the cables following the hurricanes, most recently Isaias, and the multitude of earthquakes we have experienced this year," Lugo adds. But Cordova did not rule out the possibility that those events could have contributed to the cable failure. Observatory officials say they are confident the damage will be repaired, but don't yet have a schedule. "We are starting the peak period of hurricane activity in the Caribbean," says Lugo, "which is another unknown variable to the timeline." The cable failure is the latest setback for the observatory, which had its budget slashed in November 2017 just two months after being struck by category-4 Hurricane Maria. The facility is still repairing Maria-related damage to one of its transmitters. It was also shaken by a swarm of earthquakes at the end of 2019 and early 2020. Then, just this month, Tropical Storm Isaias slammed into the facility. Though, thankfully, these events did not cause major damage.


The failed cable was an auxiliary, anchored to the SE supporting tower. NAIC

Arecibo, with its 300m dish that spans some 20 acres, is one of the most famous telescopes in the world - featured in movies like the 1997 adaptation of Carl Sagan's novel Contact (where Jodie Foster uses it to search for alien life) and the 1995 Bond movie Goldeneye where it explodes and crushes the film's villain). Its fame is matched by its scientific reputation: built in 1963, Arecibo remains the second largest radio telescope in the world and continues to be a scientific workhorse. In recent years, it has been overtaken in size by the Five-hundred-meter Aperture Spherical Telescope (FAST) in SW

China, which is currently being commissioned and calibrated. Although FAST should surpass Arecibo in receiving capabilities, it is not yet able to transmit radio waves as powerfully. By sending radio signals into space, Arecibo acts as a planetary radar that can image potentially hazardous near-Earth asteroids. It also searches for other celestial objects. 2016 had a major find when it uncovered the first repeating fast radio burst - powerful objects that are among the most mysterious in the cosmos.

Arecibo is also a key member of the NANOGrav project (North American Nanohertz Observatory for Gravitational Waves), which monitors pulsars - spinning stars with huge magnetic fields that produce beams of radiation - hoping to detect gravitational waves that disrupt the metronomic regularity of their sweeps. The team thinks they are closing in on a detection within the next couple of years, making Arecibo's damage especially painful, says Scott Ransom, one of NANOGrav's founders and an astronomer at the National Radio Astronomy Observatory. "We observe about half of the pulsars in the array with Arecibo, and so we won't get data on any of them until the telescope is back online. And that is likely to take months and possibly up to a year, maybe longer if there is worse damage than we know," says Ransom. "So, it could be quite bad for us in the short term. And if the National Science Foundation (NSF) - historically the observatory's main funder - "decides that it is too expensive to fix, that would be a total disaster," he adds.

The cable that failed is not one of the three main cables that support Arecibo's receiving platform above the dish. It is one of many auxiliary cables installed a little over 20 years ago. When this cable failed, it came out of its socket atop the platform's southeast supporting tower, which set the entire telescope oscillating for three minutes, according to Erillat's log. The failure also twisted the platform that is used to access the dome, according to a statement released by UCF. On the ground, the scale of the damage to the dish seems immense, but when viewed from above, the wound is relatively small compared to its full size, affecting about 250 of the dish's roughly 40,000 reflecting panels. However, what worries some astronomers the most is the state of the sensitive receiving equipment at the telescope's focus, housed in what's called the Gregorian dome, which is suspended above the dish. Photos posted by Erpillat appear to show tears in several of its panels. "If it was just the dish [below] that was damaged, you could still receive - it's just going to be less sensitive because you have less area," says Yvette Cendes, a radio astronomer at the Harvard–Smithsonian Centre for Astrophysics in Cambridge, Massachusetts. "If something in [the dome] got damage, then that is a very different question," she says. "And obviously now it's a question of safely checking all the other cables." "If the dome has significant damage or can't move properly, that could cause much more difficult repairs," adds Ransom. "It is all quite worrisome." Observatory officials are still assessing whether it is safe for a team to get to the dome for closer inspection, but they are not overly concerned about the its overall state. "We don't expect to find damage inside the Gregorian dome," Cordova said on Friday. "Certainly, there is damage to the exterior aluminium panels, [but] that was not done to the actual room inside the Gregorian that has all of the critical equipment."

Lugo is confident that Arecibo will bounce back. "We have the complete support of both NSF, [which] is responsible for the Observatory, and our NASA stakeholders to make the needed repairs to return to full operational capability," Lugo said, citing verbal conversations and emails. However, exactly how those repairs will be funded remains unclear. "NSF supports Arecibo and the researchers who work there," said Robert Margetta, a spokesperson for the agency. "We will work with them to assess the next

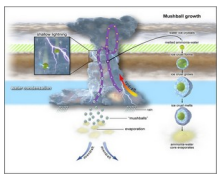
steps forward and address the situation. We cannot comment on potential funding at this time." In a statement, NASA said that after UCF assesses the damage to Arecibo, NSF would "consult with stakeholders, including NASA, to determine how to proceed."

Arecibo has faced a series of existential crises ever since a 2006 NSF review recommended drastic cuts to its funding, or even close the facility in favour of other high-priority astronomy projects. Though scientists and enthusiasts rallied to save Arecibo from this threat, in 2013, NSF began considering selling the facility. In 2017, NSF decided to continue funding it, but at a much reduced level - slashing its $8.2-million contribution to Arecibo's annual $12-million operating budget to just $2 million. This served as a lifeline to allow the facility to seek other sources of revenue. One such revenue source came in the form of a four-year, $19-million grant from NASA in September 2019. The grant provided funding to continue monitoring potentially hazardous near-Earth objects. That same month, NSF also gave Arecibo $12.3 million to make improvements to the facility, including finishing the repairs from Hurricane Maria. Some astronomers have taken comfort in these recent investments as a hopeful sign that the US government is not prepared to walk away from Arecibo anytime soon. Lugo acknowledges the challenges that the observatory has faced in recent years, he says the Arecibo team and the local community have both shown resilience and continue to make progress. By: Mark Zastrow

Jupiter weather forecast: Lightning with a chance of mushballs 14 August: During late summer, the U. is often hammered by roiling storms and buffeted by icy hail. On Jupiter, it is always thunderstorm season. Scientists have known about lightning on the gas giant since the Voyager spacecraft spotted it in 1979. Now, observations made by the Juno sapcecraft, which is currently orbiting the planet, are tweaking our understanding of where and how Jupiter produces its lightning, as well as is accompanying weather.


Artist's rendition of shallow lightning like Juno spacecraft spotted in storms on Jupiter's dark side. NASA/JPL-Caltech/SwRI/MSSS/Gerald Eichstädt/Heidi N. Becker/Koji Kuramura

Earth's clouds, which are made of water vapour, can become electrically charged and generate lightning. When enough charge is built up within the cloud, it sparks a lightning bolt. Jupiter has water clouds, too, but they are fairly deep in its atmosphere between 45 to 65 km below the visible cloud tops, where the temperature is almost freezing. However, Juno spotted shallow lightning striking much higher, about 25 km above where these water clouds are thought to exist. At that altitude, temperatures drop below –88 degrees Celsius) which is far too cold for liquid water or water vapour.

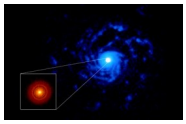

This artist's illustration outlines how Jupiter produces 'shallow lightning' and 'mushballs'. NASA/JPL-Caltech/SwRI/CNRS

Jupiter's atmosphere contains much more than just water. One of those components is ammonia, which makes great antifreeze. Based on the shallow lightning sightings, researchers now think that Jupiter's deeper thunderstorms fling water closer to the cloud

tops, where it mixes with ammonia and forms clouds capable of developing electric charge. There's one more consequence of these strange, ammonia-water storms: ammonia-water hail, known on Jupiter as 'mushballs'. On Earth, hail forms when an airborne drop of water freezes into a core. This frozen drop then gets tossed around within thunderclouds by high winds, gaining more and more ice layers. Eventually, it gets too heavy for the winds to keep it afloat and it falls down to the ground. The cores of Jupiter's hail are water-ammonia slushballs rather than hard, icy pellets (remember, ammonia acts as antifreeze, so the balls are slushy instead of solid ice). These, too, are flung around thunderstorms, gathering layer after layer of ice, until they're too heavy and fall lower in the atmosphere, where warmer temperatures evaporate them. Such mushballs are the slushy solution to an ongoing problem: Jupiter's missing ammonia. For some time, scientists have noticed small 'pockets' in Jupiter's atmosphere that are strangely devoid of ammonia, despite it being so widespread. If the ammonia in these regions is swept up by thunderstorms and dropped lower into the atmosphere - below where we can detect it - as mushballs, the conundrum disappears. By: Alison Klesman****

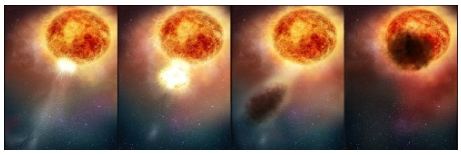
ALMA discovers spiral arms in a planetary nursery 17 August: After a baby star is born, it is encircled by a dense cloud of gas and dust called a protoplanetary disk. These disks create new worlds. However, the birth of a planet is not a tidy process, as is clearly evident in this new image taken of a protoplanetary disk around the young star RU Lup in the Lupus constellation. Unlike the protoplanetary disks surrounding stars like HL Tau and TW Hydrae, RU Lup sports sweeping spiral arms that circle a more compact inner disk. The centre of this so-called 'mini-galaxy' extends some 60 astronomical units (AU), which is about twice the diameter of Neptune's orbit. Although that may seem large at first blush, the mini-galaxy's arms stretch out to nearly 1,000 AU. Astronomers had previously observed RU Lup using the Atacama Large Millimetre/millimetre Array (ALMA), which indicated unusual gas structures extending beyond the disk. "That's why we decided to observe the disk around the star again, this time focusing on the gas instead of the dust," astronomer and lead author Jane Huang of the Centre for Astrophysics said. "[This find] suggests that we have likely not seen the full diversity and complexity of planet-forming environments."

ALMA's high-resolution images of protoplanetary disks around young stars have revolutionised scientists' understanding of how planets form. However, this new image highlights there is a lot they still do not know. If other stars host similar extended protoplanetary disks, it would indicate that planet formation is far more chaotic than previously thought. As for how the spiral arms were created, Huang and her team suggest a few ideas. They say it is possible that the disk is too massive - unsurprising given its extreme reach - and may be collapsing under its own gravity. Determining exactly how much mass the disk contains is difficult, but the its luminosity indicates it's one of the most massive such disks in the region. Alternatively, RU Lup may have an unseen companion - either a second star or an extremely massive planet. Such an interloper could explain the disk's spiralled ripples, the researchers say. While not the most likely explanation stunning arms around RU Lup, using the Very Large Telescope, some scientist think that an exoplanet twice the mass of Jupiter might be orbiting the star at 200 AU.


A 'mini-galaxy' surrounding a star. Image: Atacama Large Millimeter/submillimeter Array (ALMA). ALMA (ESO/NAOJ/NRAO), J. Huang and S. Andrews; NRAO/AUI/NSF, S. Dagnello

Alone, however, none of the scenarios completely explains the observations. "There might be unknown processes happening during planet formation that we have not yet accounted for in our models," said co-author Sean Andrews. "We will only learn what they are if we find other disks out there that look like RU Lup." By: Caitlyn Buongiorno

A stellar 'sneeze' could explain Betelgeuse's dimming 20 August: Earlier this year, Betelgeuse stumped scientists with its bizarre dimming. For over a century, astronomers have studied the supergiant star in Orion. While Betelgeuse is known to regularly vary in brightness over a period of about 420 days, the most recent dimming was so extreme that it was noticeable to the naked eye. On top of that, the star also appeared to get bent out of shape. Now, new research outlines the likely cause: the ejection of hot, dense gas which quickly cooled into dust, blocking much of the southern part of Betelgeuse.


This graphic illustrates how the southern region of Betelgeuse might have grown fainter during late 2019 and early 2020. The first two panels, as seen by the Hubble Space Telescope in ultraviolet light, show a blob of plasma being ejected from the star. In the third panel, the ejected gas rapidly cools into dust as it expands outward. In the final panel, the dust cloud obscures light from the southern quarter of the star. NASA, ESA, and E. Wheatley (STScI)

During January 2019, everything with Betelgeuse seemed normal. Then, a short time later, the star began to dim. By February 2020, it was just two-thirds its normal brilliance. The cause of Betelgeuse's dip in brightness initially baffled astronomers. With this new research, they have charted a timeline of events leading up to the star's dramatic dimming. They were able to do this because, beginning in January 2019, the Hubble Space Telescope periodically observed Betelgeuse in the ultraviolet wavelength, revealing new aspects of the stellar monster. From September to November of 2019, the historic space telescope spotted signs of dense blobs of sizzling material moving through the star's atmosphere. And by December, ground-based telescopes started to witness the star dimming. "We think this [ejected] gas cooled down millions of miles outside the star to form the dust that blocked the southern part of the star imaged in January and February," lead author Andrea Dupree said. "Only Hubble gives us this evidence [of what] led up to the dimming," Dupree added.

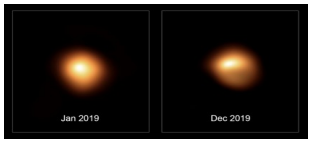


Image comparing Betelgeuse before and after its dimming. Both observations were taken with the Very Large Telescope's SPHERE instrument. ESO/M. Montargès et al.

Although scientists might have solved the case of Betelguese's dimming, the goliath star is not done confusing astronomers just yet. For one, the mass ejection that caused the dimming did not erupt from one of the star's poles - which is where gravity should be weakest, thus making it easier for material to escape the star's clutches. "We don't know how [star's like this] loose mass," Dupree says. "Is it a nice wind that just goes out slowly forever or does it come out in puffs and bursts?" Furthermore, NASA's Solar Terrestrial Relations Observatory (STEREO) captured additional observations of Betelgeuse that showed another, smaller dip in the star's brightness. And this one occurred nearly a year

before Betelgeuse should be reaching a minimum. "It shouldn't be doing this," Dupree says. "[But] maybe it's going to be a little bump." With consistent observations of the star dating back 150 years, it is not unusual for Betelgeuse to start getting faint and quickly brighten back up. Nonetheless, Dupree plans to observe Betelgeuse again through August and September, during the star's expected maximum, to monitor for more unexpected outbursts. By: Caitlyn Buongiorno

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DID YOU KNOW?

Zodiac constellations 7: Aquarius

Although large, the 10th ranked constellation by size is not a prominent constellation. The water-bearer (Latin 'water- carrier' or 'cup-carrier') is visualised as a youth, or sometimes an older man, pouring water from a jar. From the jar, some stars form the water, streaming towards constellation Piscis Auistrinus. It is located in the so-called 'Sea region' or 'Water region' of the sky, so-named for the profusion of constellations with watery associations eg Cetus (whale), Pisces (fish), Eridanus (river).

It is one of oldest zodiac constellations. In the Babylonian star catalogue, it represents the god Ea, who was commonly depicted as holding an overflowing vase. Images ppeared in cylinder seals dating to 2,000 BCE. In ancient Egypt, Aquarius was associated with the annual flooding of the Nile. Aquarius is associated with two Greek myths. In one, it is associated with Prometheus who built a ship with his wife, Pyrrha, to survive an imminent flood. They sailed for 8 days before grounding on Mount Parnassus. The other describes Aquarius as a beautiful shepherd boy, Ganymede, who attracted Zeus. Zeus sent down his eagle or became an eagle to carry him to Mount Olympus where he became a waiter to the gods. The eagle was represented by the nearby constellation of Aquila.

The Sun passes through Aquarius from Late-February to mid-March. In the Early Bronze Age it contained the winter solstice, but this has moved to Sagittarius as a result of precession of the equinoxes. Several Aquarian stars are known to have planetary systems. Gilese 876, one of nearest stars to Earth (15ly) was the first red dwarf found to have planets. TRAPPIST-1 with its seven rocky planets, which were found in 2017, is also in Aquarius.

Notable features include:

- Saturn nebula (NGC 7009): a planetary nebula. Although generally visible through binoculars, a telescope shows faint extensions similar to Saturn's rings.

- Helix nebula (NGC 7293): one of the largest planetary nebula by apparent size. Visible through binoculars, at a distance of 300ly, it is considered to be closest planetary nebula to Earth.
- Three Messier objects: M2: a globular cluster, M72: a globular cluster and M73: an open cluster.
- Eta Aquarid meteor shower radiates from the area of the jar from late- April to mid-May, peaking in early May annually. Especially prominent in the souther hemisphere, it has an average of 35 ver meteors /hr at its peak. It is produced by debris from Halley's comet. The very fast meteors often leave persistent trains. Its first recorded discovery was in China in 401 CE.

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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