`"The Southern Cross"

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# HERMANUS ASTRONOMY CENTRE NEWSLETTER

## DECEMBER 2020

**Monthly meeting** There is no monthly meeting in December. They resume in January.

**Membership renewal for 2021**

There will be no increase in fees next year.

The 2021 fees will remain at:

Member: R160

Member's spouse/partner/child, student: R80

New members joining after 1 October 2020 will have membership until the end of 2021.

Payment can be made in cash (directly to the Treasurer), or via online transfer. The Standard Bank details, for the latter, are as follows:

Account name – Hermanus Astronomy Centre

Account number – 185 562 531

Branch code – 051001

If you make an online donation, please reference your name and 'subs' or 'membership', or it is not possible to attribute the payment to you.

**2021 meeting dates** For your diaries. The dates of the monthly meetings for 2021 are as follows: 18 January, 15 February(AGM), 15 March, 19 April, 17 May, 21 June, 19 July, 16 August, 20 September, 18 October and 15 November.

## WHAT'S UP?

**Partial solar eclipse** During a solar eclipse, the Moon blocks light from the Sun reaching Earth. They always occur at New Moon. In contrast with a lunar eclipse,. because the Moon is so much smaller than the Sun, only a narrow band of Earth is affected during a solar eclipse. An observer in the central part of the pathway experiences either a total or an annular eclipse. The later occurs when the Moon is at its farthest from Earth and does not fully cover the solar disk, leaving a ring of visible sunlight. For some distance on either side of the central pathway, observers see a partial eclipse, the extent of coverage determined by whether they are closer or further away from the central pathway. Observers in South Africa will be able to observe a partial eclipse on 14 December. shortly before sunset. Coverage of the solar disk will be greatest towards the west. In Cape Town, first contact will be at 18.51.59. Maximum solar disk coverage will be 64%.

## LAST MONTH'S ACTIVITIES

**Monthly centre meeting** At the Centre's Zoom monthly meeting held on 16 November , centre chairman, Pierre de Villiers, gave an absorbing presentation on 'A home observatory'. His description of what was involved in the project clearly showed the need for thorough background research and resulting decision-making as well as the complexities involved in the planning, design and construction of a home observatory. Factors which had to be taken into account included the overall location (a site with the least light pollution) and physical location on the chosen site to optimise the filed of view (avoiding obstructions eg trees, light sources eg street lights etc). Pierre's decision was to mount the observatory on the roof of his holiday home in Nature's Valley. Then, having decided on the type of observatory which could be physically accommodated ie a fibreglass dome, he then undertook the challenging task of identifying suitable materials for the various components, finding suitably qualified, local contractors and overseeing the work, both in person and at a distance. The dome has been built and installed and the internal pier for the telescope erected. Once all the electronic and electrical connections have been made, Pierre looks forward to both observing and imaging what he sees.

## Interest groups

**Cosmology** At the Zoom meeting, held on 2 November, Derek Duckitt presented the next two lectures in the DVD series 'Blackholes, tides and curved spacetime: Under-standing gravity presented by Prof Benjamin Schumacher of Kenyon College. The topics were: L15: 'Spacetime in zero gravity' and L16: 'Spacetime tells matter how to move'.

**Astro-photography** There was no meeting in November.

## Other activities

**Educational outreach**

**Analemmatic sundials at schools** The planned further meeting with learners at Lukhanyo Primary School was postponed.

THIS MONTH'S ACTIVITIES

Monthly centre meeting There is no meeting in December. They will resume in January.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 7 December** 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: L17: 'Matter tells spacetime how to curve' and L18: "light in curved spacetime'.

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 in the new year.

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. Dates for 2021 are: 18 January, 15 February(AGM), 15 March, 19 April, 17 May, 21 June, 19 July, 16 August, 20 September, 18 October and 15 November. Details about the presentations will be circulated to members in due course.

## 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:

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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\

**Humans have been living on the International Space Station for 20 years** 2 November: Early on 2 November 2000, two Russian cosmonauts - along with an American astronaut who once boasted he could kill a man with a knife - squeezed through a narrow hatch orbiting some 400 kilometres above Earth's surface. It took two days flying aboard a Soyuz spacecraft for former Navy SEAL Bill Shepherd, fighter pilot Yuri Gidzenko, and engineer Sergei Krikalev to reach their destination. When they finally flicked on the lights of the International Space Station, they cemented themselves as the orbiting lab's first full-time crew. As the members of Expedition 1 clasped hands in brotherly solidarity, they heralded the dawn of 20 years, and counting, of humanity's continuous presence in space.

The International Space Station (ISS) is one of the grandest engineering endeavours of all time. Nobel Prize nominee, official US National Lab, and humanity's brightest man-made star, the station is readily visible to the naked eye as it tracks across the night sky. Unlike any other satellites you may spot above, the ISS has hosted 242 people from no fewer than 19 sovereign nations since its construction began in December 1998. The station's

past residents include the first astronauts from South Africa, Brazil, Sweden, Iran, Malaysia, South Korea, Denmark, and the United Arab Emirates. The ISS has also hosted the world's oldest spacewalker, the oldest woman in space, and the first pair of spacewalking grandfathers. It has even served as the site for the first space marriage, as well as the first space marathon.


European Space Agency astronaut Alexander Gerst takes in a view of Earth from the cupola on the International Space Station. NASA

The station's physical structure is also impressive: a suite of Russian living and research quarters, an American lab, a European lab, a Japanese lab, three connecting nodes, a Canadian robot arm, a multi-window cupola (with 360-degree views of Earth), and a football-field-sized truss structure, which holds four sets of solar arrays, batteries, and radiators. All those additions ad up. The ISS weighs close to 450,000 kilograms and has a habitable volume greater than a six-bedroom house of about 400 cubic metres.

Building, restocking, and crewing this colossal edifice in the sky has so far taken 37 Space Shuttle missions, 63 Soyuz flights, and even a recent trip on SpaceX's Crew DRagon. In addition, 73 Russian Progress freighters, 34 commercial Dragon and Cygnus cargo ships, nine Japanese H-II Transfer Vehicles (HTVs), and five European Automated Transfer Vehicles (ATVs) have delivered essentials such as food, water, clothes, experiments, fuel, tools, and spare parts. However, these resupply missions are not only about restocking necessities. Their cargo has also contained birthday cards, holiday gifts, specific toothpaste, a 3D printer, and even an espresso machine. Recently, a Cygnus cargo ship dropped off a new toilet (which, admittedly, is a necessity), along with Estée Lauder skincare products for an in-space advertising campaign.

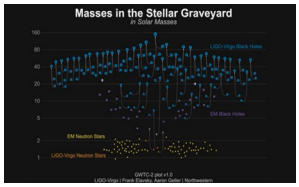
Since the initial arrival of Shepherd, Gidzenko, and Krikalev to the space station, 63 additional expedition crews have lived and worked on the ISS for periods lasting from a few months to more than a year. In the early days, rotating crews of three were dropped off and picked up by space shuttles. However, because the shuttles did not usually linger for long, the crew needed an emergency escape option. Russia sent up regular Soyuz 'taxi' flights, whose crews spent a few days working with the expedition crew, dropped off a fresh ship, then returned home in the old one. Those taxi flights permitted, for the first time, fare-paying visitors. In April 2001, engineer Dennis Tito paid $20 million to become the first commercial 'spaceflight participant', spending a week aboard the ISS. His flight, however, would not be the last.  Over the next few years, software entrepreneur Mark Shuttleworth, engineers Gregory Olsen, Charles Simonyi, and Richard Garriott, businesswomen Anousheh Ansari, and Cirque du Soleil founder Guy Laliberté also visited the station (in fact, Simonyi visited twice). Others who trained for flights included singer Sarah Brightman and former *NSYNC member Lance Bass, but those trips fell through.

When NASA retired the Space Shuttle Program in 2011, all three seats on each Soyuz flight were again reserved for expedition crews. Opportunities for paying astronauts dried up. A decade later, however, with the arrival of commercial Crew Dragon and Starliner ships, space tourism looks set for a renaissance. The Houston-based firm AxiomSpace

recently announced plans to fly former astronaut Mike Lopez-Alegria and three tourists - including actor Tom Cruise and producer Doug Liman - aboard a Crew Dragon mission to the ISS next October, where they will potentially work on a movie filmed in space. Meanwhile, Russia intends to send two tourists to the ISS, along with a professional cosmonaut, aboard a Soyuz flight in December 2021.

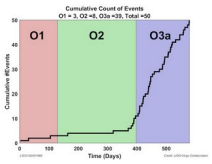
Such commercial flights must have been beyond the wildest dreams of Shepherd, Gidzenko, and Krikalev when they first boarded the infant station two decades ago. For them, the ISS was, and remains, a cutting-edge orbital lab. To date, it has supported more than 2,700 research investigations from 103 countries, ranging from subjects like life and material sciences to fundamental physics and experimental technology. In its early days, the station's full-time crews mainly consisted of Americans and Russians. But since 2006, other ISS partner nations have played an increasing important role. Astronauts from France, the Netherlands, the United Kingdom, Belgium, Canada, Japan, Italy, and Germany have all taken turns commanding the station. Over the past two decades, multiple historic achievements have been carried out on (or just outside) the ISS - including the first national spacewalks for Canada, Sweden, Italy, and the first all-female spacewalk performed last year by NASA'sChristina Koch and Jessica Meir.  By: Ben Evans

**Scientists discover a treasure trove of gravitational-wave signals**  4 November: The Laser Interferometer Gravitational-wave Observatory (LIGO) and Virgo collaborations first detected gravitational waves in 2015. Ever since, they have continued to unveil new and exciting results as more gravitational-wave events are spotted. On 28 October, the observatories announced a surge of new gravitational wave detections from their third observing run.



The 50 gravitational wave events detected by LIGO/Virgo, are categorized by initial mass of the progenitor objects and the mass of the resulting object. LIGO-Virgo/Frank Elavsky, Aaron Geller/Northwestern

The first run yielded only three events and the second run found eight. Unlike the first two runs, the recent third observing run was split into two parts. The first half stretched from April 2019 to October 2019. During this time, LIGO Virgo detected a grand total of 50 gravitational wave events. Of those signals, 39 are new binary black hole or neutron star collisions that have not been previously announced. That is more than three times the number of events detected in the first two runs combined.  There are two main causes for the abundance of signals during the most recent observing run. First, the LIGO/Virgo instruments received significant improvements, which the team estimates resulted in a 60 percent improvement in the detectors' sensitivity. On top of that, the observatories were able to operate longer without interruption, increasing the chances of picking up a signal.



A cumulative count of gravitational wave events detected by LIGO/Virgo during the first, second, and first half of the third observing runs. LIGO/Virgo Collaboration

With so many new signals - 50 in total, counting previous detections - astronomers have a multitude of data to tackle when it comes to black holes and neutron stars. "We've learned more about what nature permits," said LIGO collaboration member Richard O'Shaughnessy. "We found more big black holes, smaller siblings of the massive event described in the summer and we found, too, that large black holes can be rapidly spinning." With so many questions still left unanswered about these exotic objects, O'Shaughnessy suspects even more discoveries are on the horizon. LIGO/Virgo will not be finished reporting new gravitational wave signals anytime soon. Results from the second half of the third run are currently being analysed, and a fourth run is planned to begin in mid-2022. That run will also include the Kamioka Gravitational Wave Detector (KAGRA) in Japan. By: Caitlyn Buongiorno

**Astronomers have finally found the cause of mysterious fast radio bursts** 4 November: After more than a decade of detective work, astronomers have found the best evidence yet for what is causing fast radio bursts, or FRBs. These strange blasts of radio waves, which last just milliseconds, have become one of the most exciting mysteries in astronomy. In the end, it appears the prime suspect simply turned itself in.


The CHIME telescope in Canada was first to report it had detected a fast radio burst from a magnetar near the Milky Way's centre. Andre Renard/CHIME

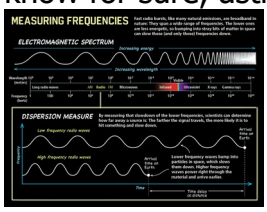
Magentars, short for 'magnetic stars', are the highly magnetic remnants of massive dead stars. Astronomers had long suspected these enigmatic beasts could be the source of FRBs. However, there have only a handful of magnetars known in our Milky Way galaxy, and they all seemed too tame to be causing these extreme signals. Then, in late April, a magnetar dubbed SGR 1935+2154 started blasting out X-rays near the centre of our galaxy, some 30,000 light-years away. As the buzz about this object built, astronomers turned their ground and space-based telescopes in its direction just in time to catch X-rays, gamma rays - and eventually, the blast of a fast radio burst. It was the first FRB ever observed in our home galaxy, as well as the first FRB accompanied by other kinds of detectable radiation. Most importantly, it's also the first FRB clearly associated with a single object. The new findings have implications beyond our galaxy, too. "This discovery paints a picture that some - and perhaps most - of these fast radio bursts from other galaxies also originate from magnetars," Christopher Bochenek, a graduate student at Caltech and study co-author, said.

For astronomers, the FRB mystery really began roughly 1.6 billion years ago, when the city-sized corpse of a dead star released a burst of radio waves heading right for Earth. The blast arrived on 24 July 2001, and it passed over our planet in just five milliseconds, carrying as much energy in radio waves as the Sun does in an entire month. Incredibly, that event went unnoticed until 2006. That's when a West Virginia University undergraduate student named David Narkevic and his adviser, Duncan Lorimer, discovered the signal hidden in archival data from the Parkes radio telescope in Australia.

This first discovery of an FRB came from so far away that its source was impossible to pin down. Some scientists even doubted it was real until other FRBs popped up in 2013. But

ever since FRBs were confirmed, astronomers have been trying to figure out what causes them. That task has been frustrating because the signals would appear without warning from distant galaxies. They also did not seem to repeat. They would appear once from some distant source and then never be seen again. However, in 2017, scientists on the Breakthrough Listen project managed to catch an FRB repeating for the first time in a dwarf galaxy some 3 billion light-years away. Since then, astronomers have tracked a handful of FRBs back to their homes in other galaxies.

Meanwhile, modelling has helped build evidence that magnetars could act as 'engines' for FRBs. As these magnetars flare, they send out blasts of energetic particles. When those particles accelerate around their star, models suggest they collide with material from previous flares. Such collisions, the researchers think, could trigger powerful shockwaves that have the stunning magnetic properties needed to produce FRBs. Yet, theory aside, all indications from watching magnetars in our own galaxy implied that these strange stars were far too docile to launch FRBs energetic enough to reach us from other galaxies. To know for sure, astronomers would have to catch a Milky Way magnetar in the act.



Roen Kelly/Discover

Hunting down Milky Way FRBs is exactly what researchers attempted with the Five Hundred Meter Aperture Spherical Telescope (FAST) in China back in April. The international team of astronomers used the new, massive, $180-million instrument to keep an eye on the magnetar SGR 1935+2154 in hopes of seeing it produce an FRB. FAST is capable of studying small areas of the night sky and can detect even very faint radio signals. This is what made the FAST team a clear favourite to be first to detect an FRB in the Milky Way. And throughout April, they tuned into the magnetar as other telescopes observed it repeatedly ejecting X-rays bursts. Then, on 27 April NASA's orbiting Neil Gehrels Swift Observatory started to detect gamma-rays coming from the magnetar. Astronomers' models had suggested that magnetars emit such signals just before an FRB. Sure enough, just a day later, a half-pipe shaped radio observatory in Canada called the Canadian Hydrogen Intensity Mapping Experiment caught a glancing blow from an FRB.

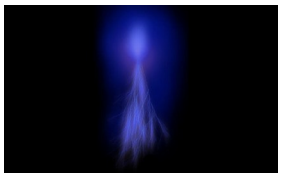
They were not the only ones to see it, either. Christopher Bochenek is a graduate student at Caltech. For his observation, he had used cake pans and some steel pipe to construct a radio observatory called STARE2 across three sites in Utah and California. Bochenek was hoping to catch an FRB from inside our Milky Way, but he says his group figured they had about a 1-in-10 chance of actually pulling it off. After CHIME's FRB detection, Bochenek checked STARE2 to see if he'd beaten the odds. "When I looked at the data the first time, I froze and was basically paralyzed with excitement," Bochenek said. "It took me a few minutes to collect myself."

It was the brightest radio signal ever detected from within our galaxy. For comparison, the previous record holder for brightest burst of radio waves in our galaxy was a pulsar in the Crab Nebula. This FRB, however, was thousands of times brighter than the Crab's radio burst."This burst was so bright that, in theory, if you had a recording of the raw data from your cell phone's 4G LTE receiver, which does detect radio waves, and if you knew what you were looking for, you might have found this signal that came about halfway across

the galaxy in your cell phone data," Bochenek said. Yet his telescope was the only one on Earth to catch the FRB head on. Despite its observations of the magnetar, FAST did not detect the actual FRB.

That raises an intriguing question: Why didn't the Chinese FAST telescope see this FRB when it is capable of witnessing signals eight times fainter than either of the other observatories? Researchers think the answer could be that their telescopic gaze was too narrow, so FAST simply missed it. Whatever the reason, astronomers think there is something to be learned about FRBs from the fact that FAST was pointed directly at the magnetar yet saw nothing, even as it erupted with X-rays and gamma rays. What exactly is that lesson? Astronomers will keep a close eye on the sky to find out. By: Eric Betz

**'Sprites' and 'elves' found frolicking in Jupiter's skies** 6 November: Lightning is a familiar sight throughout the solar system. Not only do bolts strike on Earth, but they also sizzle through the air on Venus, Mars, Jupiter, Saturn, Uranus, and (most likely) Neptune. However, lightning is not the only electrical phenomenon that can occur in a planet's atmosphere. Stunning, evanescent events called sprites and elves are sometimes seen prancing above thunderclouds on Earth. Now, NASA's Juno spacecraft appears to have captured these flashes in the stormy clouds of Jupiter, marking the first time these events have been observed on another planet.

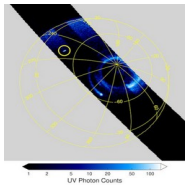

On Earth, sprites and elves appear red, thanks to the abundance of nitrogen in our atmosphere. On Jupiter, whose atmosphere is dominated by hydrogen, these phenomena appear blue or possibly pink. NASA/JPL-Caltech/SwRI

Both sprites (which stands for - get ready for it - Stratospheric/mesospheric Perturbations Resulting from Intense Thunderstorm Electrification) and elves (Emission of Light and Very Low Frequency perturbations due to Electromagnetic Pulse Sources) are a type of transient luminous event, or TLE. These strange phenomena, which only last milliseconds, are occasionally seen above thunderstorms. Although sprites may be visible with sharp, dark-adapted eyes, both phenomena are more often caught on film. Sprites were serendipitously captured by a camera for the first time in 1989, but the existence of elves wasn't confirmed until orbiting space shuttles recorded them on video in the 1990s.

Sprites typically have a round, blobby centre that sprouts tendrils of light reaching upward or downward. They can look like anything from trees and jellyfish to the fairy tale creatures for which they're named. Sprites occur when lightning bolts funnel positive charge from cloud to ground, leaving the cloud negatively charged. This, in turn, triggers activity in the atmosphere above the storm: a sprite. Unlike lightning which heats the air to incredible temperatures sprites are not hot. They are actually a cold plasma (think fluorescent light), not a bolt of electricity. They originate at altitudes around (65 km high, but their wispy filaments can reach down as low as 30 km above the ground.

Elves, on the other hand, look more like expanding doughnuts or rings. They occur higher than sprites, around 100 km above the ground, reaching diameters up to 480 km wide. Even though elves are often spotted alongside sprites, the two are not caused by the

same effect. Instead, elves form when electromagnetic pulses released during a thunderstorm slam into the ionosphere.



UVS is designed to study Jupiter's aurora. It captured a bright, brief flash (circled in yellow) high up in the planet's atmosphere - a possible TLE. NASA/JPL-Caltech/SwRI

NASA's Juno spacecraft, which has been in orbit around Jupiter since 2016, has provided researchers with a unique view of the gas giant's stunningly turbulent atmosphere. That is why scientists thought Juno would be the perfect tool to seek out TLEs, which they predicted Jupiter should have. Juno's Ultraviolet Spectrograph (UVS) delivered. This instrument looks at ultraviolet (UV) wavelengths shorter than visible light, and over the course of the past four years, it has captured 11 brief, bright flashes of UV light lasting between 0.1 and 2.5 milliseconds. Not only are the 11 flashes the first-ever lightning-like flashes recorded on Jupiter at UV wavelengths, they also appear to be the first-ever TLEs spotted on another world.

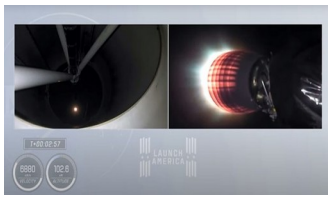
Each of the flashes originated at altitudes around 300 km. This region is above the water cloud layer in Jupiter's atmosphere, where Jovian lightning is generated, and is exactly where sprites and elves were assumed to form on Jupiter. The likely TLEs also showed the distinct signature of hydrogen emission, again matching predictions. Adding to the evidence for extraterrestrial TLEs, researchers found that the 11 flashes occurred above areas in Jupiter's atmosphere known for their roiling thunderstorms. Although no lightning strikes were observed immediately before the TLEs, the researchers say that's not unexpected, due to the way Juno's instruments were observing the area at the time. It is likely that lightning flashes did occur, the researchers say, but the bolts were simply not recorded, thanks to the way different instruments on the spacecraft observe.

Researchers are still not sure which kind of TLEs Juno saw - whether sprites, elves, or a combination of the two. They do think further Juno observations taken when the spacecraft is closer to Jupiter would help them differentiate between the two different breeds. Additionally, now that they know what to look for, the researchers think it will be easier to spot these phenomena on other planets, too. Ultimately, the goal is to use these stunning, otherworldly lights to untangle the complex behaviour of planetary atmospheres throughout the solar system - including Earth's. By: Alison Klesman

**'New era' begins with launch of SpaceX and NASA's Crew-1 mission** 15 November: What seemed impossible not long ago is now on the verge of becoming routine. A SpaceX Crew Dragon capsule successfully launched into orbit on Sunday night from NASA's Kennedy Space Centre in Florida, setting four astronauts on a course for the International Space Station (ISS). It's the second crewed launch for SpaceX this year. By Monday night, the four astronauts will rendezvous and dock with ISS. They will spend the next six months carrying out scientific experiments alongside fellow astronauts and cosmonauts who are already on board, bringing the total number of crew members on the space station to seven.

This particular Crew Dragon capsule mission is named Resilience,a nod to the extreme difficulties that were overcome to make this historic launch happen, including this year's COVID-19 pandemic. "The message that [the crew] wanted to convey is resilience,"

NASA's ISS program manager Joel Montalbano said at a briefing on Friday. "It was a hard journey to get here." It wasn't just COVID, either. For NASA and SpaceX, the difficult journey to Sunday's launch has stretched out over nearly a decade. When NASA formally retired the Sapce Shuttle Programme in 2011, the federal government decided they would focus their efforts on getting astronauts to the Moon and Mars, while paying private companies to ferry people and cargo to the space station. NASA imagined the first Commercial Crew Program flight would happen in 2016. However, SpaceX and Boeing, the companies hired for the job, were hit by a seemingly unending series of delays. In the meantime, American taxpayers were left paying for tickets on Russia's Soyuz rockets in order to get NASA astronauts to the largely US-funded space station.

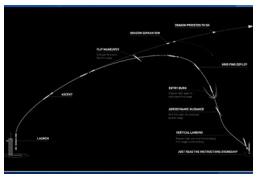

On 15 November, SpaceX's Crew Dragon successfully entered orbit around Earth, beginning the Crew-1 mission. NASA/SpaceX

However, over the past two years, SpaceX has slowly overcome its early challenges. The company is now the only contractor to successfully ferry astronauts. In May, SpaceX's Crew Dragon spacecraft successfully carried two NASA astronauts to the ISS on a demonstration mission, called Demo-2. That trip was the first time astronauts had travelled into orbit on a private spacecraft. Elon Musk's rocket company also launched an empty Crew Dragon capsule to the space station on a fully robotic test flight in March 2019. Now, nine years after the last space shuttle flew, America finally seems to have a reliable ride into orbit again. And as important as this milestone was for NASA, it also opens up the solar system for SpaceX. NASA has formally certified the company to fly astronauts into orbit, which means SpaceX can begin launching space tourists, too. "This is the culmination of years of work and effort from a lot of people and a lot of time," Benji Reed, director of crew mission management at SpaceX, said. "We have built what I think is one of the safest launch vehicles and spacecraft ever."

This week, Axiom Space, another private spaceflight company, announced that it had booked the first private astronaut trip on SpaceX's Crew Dragon. The Ax-1 mission will carr four private citizens to the ISS in late 2021. Additionally, Richard Branson's spaceflight company, Virgin Galactic, aims to send the founder to suborbital space early next year, officially kicking off their space tourism venture. SpaceX will also now start flying crewed trips to the ISS for NASA every six months. Next year, one of those missions could even include a Russian cosmonaut, the space agency announced on Friday.

Sunday's four person crew includes NASA astronauts Victor Glover, Mike Hopkins and Shannon Walker, as well as Japanese space agency (JAXA) astronaut Soichi Noguchi. Glover is a former test pilot and Navy commander with three master's degrees, as well as a legislative studies certificate from Georgetown University. He served on Arizona senator John McCain's staff before becoming an astronaut candidate in 2013. Glover will be the first Black crewmember of the ISS, which has now been in orbit for 20 years. Hopkins is a NASA astronaut who served on the ISS back in 2013 and 2014, but over the summer, he also became a colonel in the U.S. Space Force. His launch Sunday marks the military agency's first person in space. Walker also is no stranger to the ISS. She spent over 150 days there on her only trip to space ,back in 2010. While most astronauts are highly

credentialled, Walker stands out for her background in science - she holds a PhD in space physics from Rice University. She is also one of a handful of astronauts married to other astronauts. Noguchi, a JAXA astronaut, stands in truly rare company after today's launch. He has travelled to space on three different spacecraft, including the now-retired space shuttle, Russia's Soyuz capsule, and SpaceX's Crew Dragon.


After the Crew Dragon capsule launched into orbit, the rocket booster performed a series of manoeuvres to land successfully at sea on a drone ship, where it was recovered for the next launch. SpaceX/NASA

Now that NASA has so many astronauts on board the International Space Station, the agency plans to begin a heavy, six-month itinerary of scientific experiments. Roughly 28 kilograms of scientific experiments were launched on the Crew Dragon on Sunday and another haul of science experiments are set to be delivered on the next Cargo Dragon resupply mission. "We hope to double the amount of crew time going into science and research," Costello said during a briefing. "We'll have easier access to our crew members both pre and post flight." That access will let NASA researchers do more in-depth studies of how space changes astronauts' bodies. The astronauts will be experimenting on themselves more than ever, starting with a study of how nutritional changes in their diets might prevent negative effects of spaceflight.

Another experiment, called Genes in Space 7, will study how sleep cycles change in space. "On orbit, when you have 16 day-night cycles every day it can be a bit confusing to the body," Costello said. To learn more, the crew will study how fruit flies react to the environs of the space station. That's just the beginning. Each of the four astronauts is expected to devote significant amounts of time to experiments over the next six months, prompting Costello to dub it a 'new era' of space station research. As SpaceX' Crew Dragon - and eventually Boeing's Starliner - continue increasing the space station's population in the coming years, many new discoveries are likely to come. By: Eric Betz

**Famed Arecibo radio telescope to be decommissioned after cable failures** 19 November: After fifty-seven years of cutting-edge research, the iconic Arecibo radio telescope has reached the end of the road. Due to two cable failures in the past three months, outside engineering firms have concluded the telescope cannot be repaired - at least, not without risking the total collapse of the 900-ton receiving platform onto the dish below, the lives of workers, and further damage to existing buildings onsite. As a result, the U.S. National Science Foundation (NSF), which owns the facility, has decided to decommission Arecibo, the organization announced today.

Engineers are now "working against the clock" to develop a plan for a controlled decommissioning, said Ralph Gaume, the NSF's astronomy division director. That could come in the form of a demolition using explosives, according to a report from one of the three engineering firms that have been working to try to save the facility after the failure of an auxiliary cable on 10 August. That cable slipped out of its socket at one of the three support towers that surround the observatory, tearing a 35 metre gash in the dish below.

In the aftermath, engineering efforts focused on ensuring that the rest of the auxiliary cables did not suffer similar failures, as some had started to slip more than half an inch.


Both failed cables were anchored to the southeast observing tower (at left). This image shows additional damage to the reflector dish, enlarging the gash left by the previous auxiliary cable failure. University of Central Florida/Arecibo Observatory

Then, on 6 November, one of the main cables attached to that same support tower collapsed. The main cable had seen some of its strands break, but engineers did not think a full failure was an immediate threat, as the remaining load was still within its design capacity. "I don't think anyone understood that, clearly, the cable had deteriorated much below just those broken wires," said Ashley Zauderer, NSF's Arecibo program officer. Engineers concluded that the main cable failure removed the safety margin necessary to conduct repairs and stabilisation, which had been set to begin just days later. Another cable failure at the same support tower would push the cables beyond their design capacity, likely leading to a full collapse. The only path forward would have been to demonstrate that the remaining cables could handle an increased load by testing them. But such tests would require placing workers at risk, as well as increase the chances of a total collapse, reported the engineering firm Thornton Tomasetti.

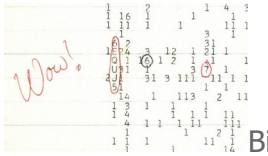
The loss of Arecibo is a major blow for the radio astronomy community and leaves a gaping hole in capabilities. "I'm pretty crushed," Scott Ransom, an astronomer at the National Radio Astronomy Observatory and member of the NANOGav (North American Nanohertz Observatory for Gravitational Waves) project, tells Astronomy. NANOGrav uses Arecibo and the Green Bank Telescope in West Virginia to search for signs of gravitational waves by looking for telltale disruptions in the timing of pulsars. "This is a huge blow to NANOGrav, as about one half of our gravitational wave sensitivity comes from Arecibo," Ransom says. "And because it is so much more sensitive than GBT, it will be impossible to replicate the timing precision we get, even if we use a lot more time at GBT."

Radio telescopes are already completely booked up, too, so it will be harder than ever for astronomers to get observing time, Yvette Cendes, a radio astronomer at the Harvard–Smithsonian Center for Astrophysics, tells Astronomy. The Very Large Array can do a lot of the same science as Arecibo, but Cendes says VLA gets twice as much time requested as it has available. Plus, Arecibo had unique capabilities - even though the Five-hundred-meter Aperture Spherical Telescope in China has supplanted Arecibo as the largest radio telescope in the world, it does not yet have the capability to transmit and act as a radar. "So you're out of luck for radar mapping of planets and asteroids if that was your field," says Cendes. The loss of Arecibo is also "a huge blow to Puerto Rico," says Ransom. It is a huge source of pride for the island. And the observatory has helped educate and inspire basically every kid on the island for many decades."

NSF officials said that the decision to demolish the radio telescope was necessary to save the rest of the observatory's infrastructure, including a lidar facility and the visitor and education centre, which serves as a hub for outreach. One of the three firms working on Arecibo believed that repairs would be possible if commenced immediately - and if the observatory was willing to risk a collapse. However, that would endanger the visitor's

centre and other buildings that sit below one of the support towers, said Gaume, leaving demolition as the only safe option. Given that the struggle in recent years to secure funding for Arecibo, Cendes is not optimistic that the facility will be replaced anytime soon. "There's probably something symbolic in the US's ageing infrastructure for science in all this," says Cendes. For many astronomers, the news is an emotional gut punch, as well. "I'm really sad," said Ransom. "Feels like I'm losing a beloved friend." By: Mark Zastrow

**Sun-like star identified as the potential source of the Wow! Signal** 23 November: The Big Ear Radio Telescope in Delaware, Ohio, was disassembled in 1998 having operated for over 30 years. It was replaced by a golf course. Big Ear was never the world's biggest radio telescope, nor its most sensitive. Big Ear nevertheless made one of the most famous observations in the history of astronomy, one that untill this day has never been explained. Throughout the 1970s, Big Ear searched for signals from extraterrestrial civilizations. On 15 August 1977, it found one - a strong, intermittent signal lasting for 72 seconds, that stood out from the background noise like a searchlight.



Big Ear Radio Observatory & North American Astrophysical Observatory

The team quickly ruled out a terrestrial origin or a broadcast from a satellite. Nevertheless, the signal was so powerful and unusual that Jerry Ehman, the astronomer who analysed the data print out, annotated the signal with the word "Wow!". The director of the observatory, John Kraus, later gave a detailed account of the observation: "The WoW" signal is highly suggestive of extraterrestrial intelligent origin, but little more can be said until it returns for further study," he wrote, in a letter to the astronomer Carl Sagan. The Big Ear team continued to observe the same part of the sky, as have others, but the Wow! signal never returned. Nor has anything like it been observed in any other part of the sky. Kraus and others have even searched for stars that could be the source of the signal: "We checked star catalogues for any Sun-like stars in the area and found none," wrote Kraus. To this day, the Wow! signal remains unexplained and unrepeated. That is why the discovery this week of a probable source is significant news. The finding is the result of some clever sleuthing by an amateur astronomer and the creation of a fabulous new 3D map of the galaxy.

First, some background. Back in 2013, the European Space Agency launched the Gaia space observatory to map the night sky - to determine the position, the distance, and the motion of stars with unprecedented accuracy. So far, Gaia has mapped some 1.3 billion stars, allowing astronomers to begin creating the most detailed 3D map ever made of our galaxy. The mission is expected to continue until 2024. Gaia's new star map has significantly improved our understanding of the galaxy and the stars within it and this gave amateur astronomer Alberto Caballero an idea. The Gaia database is now significantly more detailed than the star catalogue that John Kraus studied in the 1970s. Perhaps the new database might reveal the source of the Wow! Signal, he reasoned.

So Caballero repeated the search, looking for Sun-like stars among the thousands that have been identified by Gaia in this region of the sky. By Sun-like, he means stars that share the same temperature, radius, and luminosity. The search returned just one candidate. "The only potential Sun-like star in all the WOW! Signal region appears to be

2MASS 19281982-2640123," says Caballero. This star sits in the constellation of Sagittarius at a distance of 1800 light-years. It is an identical twin to our Sun, with the same temperature, radius, and luminosity. Of course, Caballero's work does not mean that 2MASS 19281982-2640123 must have been the source. He points out that there are many stars in that region of the sky that are too dim to be included in the catalogue. One of these could be the source.


PanSTARRS/DR1

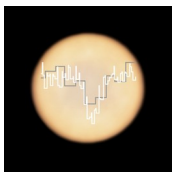
There are some 66 other stars in the catalogue that Caballero identified as potential candidates but with less strong evidence. These match the Sun's temperature but data about their luminosity and radius is currently incomplete. So, future data releases from Gaia and other mapping projects may yet reveal them as matches. However, for the moment, 2MASS 19281982-2640123 is our best bet and a good candidate for future study. Caballero says an obvious goal would be to look for signs of exoplanets orbiting this star. It could also be prioritized for study in the radio part of the spectrum. In the meantime, astronomers may amuse themselves by finding a friendlier name for 2MASS 19281982-2640123. Perhaps during a round of golf on the course that now sits on the site of the Big Ear radio observatory. By: The Physics arXiv Blog

**Prospects for life on Venus dim in reanalysis of phosphine data** 24 November: The debate over phosphine on Venus rages on. On 14 September, a team of researchers led by Jane Greaves of Cardiff University announced an exciting find in the cloud tops of Venus: traces of a chemical called phosphine at the level of 20 parts per billion (ppb). On Earth, this gas is produced in nature by microbial life. The team argued no non-biological process could produce the gas on Venus at the levels they had detected - raising the tantalising possibility that microbes could populate the temperate upper atmosphere of Venus. Since then, the scientific process has been in full swing, with astronomers looking to reproduce the results both in archival data and in fresh observations. The results have so far been mixed - but have led to the original team downgrading some of their claims.

One of the first independent analyses looked at decades-old data taken by NASA's Pioneer mission, which dropped several probes into Venus' atmosphere in 1978. While they could not make a definitive confirmation, they found signs of gases that are consistent with phosphine. However, multiple teams have found less-promising results. One study of data from the Infrared Telescope Facility on Mauna Kea in Hawaii failed to reproduce the original detection, putting an upper limit on phosphine of 5 parts per billion. Another pre-print questioned the original team's analysis methods. A thid study argued that the team had confused the spectral signature of phosphine with that of sulphur dioxide, which absorbs light around the same wavelength. "Astronomers are a bit like piranhas, aren't they?" says Kevin Zahnle, an astrobiologist at NASA Ames Research Centre who was sceptical of the original detection. "That was fast."

The debate is not over yet. As a result of the third study, staff scientists at the Atacama Large Millimetre/Submillimetre Array (ALMA) in Chile - one of the radio telescopes used to detected the original phosphine signal - found a calibration error in the data they had supplied to Greaves' team. Speculation swirled for weeks after ALMA staff pulled the data

from their public archive to reprocess it. On 16 November, Greaves' team announced thae results of their re-analysis using the corrected ALMA data. They once again found a phosphine signal - but at much reduced levels. In some areas of the planet, it may peak at around 5 ppb, but on average, phosphine is only present at 1 ppb - much less than the original detection of 20 ppb. Still, they argued that sulfur dioxide could not have produced the spectral feature they saw, as sulfur dioxide absorbs light over a much narrower range of wavelengths than their detection.


The original spectral data from the Atacama Large Millimeter/submillimeter Array in Chile (white) - as well as the James Clerk Maxwell Telescope in Hawaii (grey) - is superimposed on this image of Venus (also taken by ALMA).

Reduced levels of phosphine open the door to other explanations besides life, say researchers like Justin Filiberto, a geochemist at the Lunar and Planetary Institute in Houston. While he says he thinks it is still possible phosphine exists on Venus, "I think [the possibility of] life is starting to unravel." However, there is now a discrepancy between the data from ALMA and the other radio telescope Greaves' team used – the James Clerk Maxwell Telescope (JCMT) on Mauna Kea. The detection from JCMT still stands at around 20 ppb. The researchers say more observations will be needed over a longer period of time to understand why. Perhaps the level of phosphine periodically rises and falls due to some unknown geological or atmospheric process — which would be exciting, even if it is not alien life. Regardless of the outcome, the fast follow-up work is an example of exciting science at a breakneck pace, say researchers. "From a scientist's perspective, it's kind of cool to watch this happen in real time," says Filiberto. "This is what we do." By: Mark Zastrow

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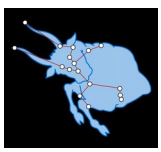
## DID YOU KNOW?

### Zodiac constellations 10: Taurus


The Latin 'bull' is a prominent constellation. The 17th largest of the constellations, it is located between Aries and Gemini. One of the oldest known constellations, it contains two of the nearest open clusters to Earth, Hyades and Pleaides. Hyades cluster outlines the bull's face while its brightest star, Aldebaran, marks the glinting red eye. Taurus also contains part of Gould's Belt, a ring-like Milky Way structure of hot, young bright stars which forms a band around the sky. Estimated to be only around 50 my old ,the ring of young stars and inter-stellar material is tilted ±18° to the galactic plane. Its existence was established in 1879.


Taurus is the only constellation crossed by the galactic equator, the celestial equator and the ecliptic ecliptic. It dates to the Early Bronze Age when it, then, marked Sun's location during the spring equinox. Its related Importance to agriculture influenced many bull mythologies, including in Babylon. In Greek mythology, the bull was the disguise adopted by Zeus to carry off princess Europa of Phoenicia to Crete, swimming across the Mediterranean with her on its back.

The Sun passes through Taurus from mid-May to late-June.

Notable features include:

- Alpha Tauri: Aldebaran (Arabic for 'the follower' (of Pleiades)). The red giant is 65 ly away, half the distance of rest of cluster's stars.
- Hyades open cluster(left): the nearest major star cluster to Earth, at 150 ly. It contains about 200 stars and is estimated to be around 660 million years old. Like Pleiades, binoculars identify more stars than only naked eye observation.
- Pleiades open cluster (M45): also known as the Seven Sisters, six of which are visible with the naked eye. 400 ly away, it is around 100 million years old and contains over 500 stars. It includes many types of stars of varying colours and magnitudes. Binoculars show many more stars than are visible with the naked eye.
- Crystal Ball Nebula (NGC 1514): south-east of Pleiades in the southern hemisphere. It was discovered in 1790 by William Herschel who showed that planetary nebulae not collections of stars, but a central star surrounded by nebulous cloud. In 1864, William Huggins's spectral analysis showed the nebula to be uminous gas, not stars.

- Crab nebula (M1): a supernova remnant of the 1054 supernova. It was named in 1844 by Lord Rosse for its crab-like filaments. A large telescope is needed in order to observe any detail.
- Hind's Variable Nebula (NGC 1555): a reflection nebula discovered in 1852 by English astronomer John Russell Hind. It includes T Tauri, a young, irregular variable star, also discovered by Hind.
- Taurid meteors: radiate from a point north (from the southern hemisphere) of Pleiades from early-October to end-November. It includes both the Northern and Southern Taurids. Its parent body is comet Encke, the comet of the shortest known period (3.3 yrs). The shower's long duration and relatively low activity indicate that the stream is ancient and well dispersed.

Taurus can be observed from the southern hemisphere during the summer months.

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

For more information on the Hermanus Astronomy Centre and its activities, vvisit our website at www.hermanusastronomy.co.za

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