`"The Southern Cross"

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# HERMANUS ASTRONOMY CENTRE NEWSLETTER

## NOVEMBER 2020

**Monthly meeting** This months **Zoom meeting** will take place on the evening of **Monday 16 November** Access and start time details will be circulated to members closer to the time. Centre chairman, Pierre de Villiers, will be talking on 'A home observatory'. See below for details.

**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?

**Meteor shower Alpha Monoceratids** Meteor showers occur when Earth intersects a stream of material (meteoroids) resulting from the disintegration of a comet (more often) or an asteroid (more rarely). Showers occur annually at the same time. From Earth they appear to radiate from a point (radiant) corresponding to the direction from which the meteoroids approached Earth. They are named for the star or constellation from which they appear to originate. There are over 20 showers visible during 2020. However, often the prospects for observation are poor. Observation conditions will be good for the Alpha (α) Monocerotid shower, this year. The shower occurs from 15-25 November from 23.00 – 04.00, the peak being on the 21st. Monoceros (the unicorn) is a faint constellation, but

easy to locate, as it lies within the so-called summer triangle formed by Sirius (Canis Major), Betelgeuse (Orion) and Procyon (Canis Minor).

## LAST MONTH'S ACTIVITIES

**Monthly centre meeting** At the Centre's Zoom monthly meeting held on 19 October, centre member, Jenny Morris, gave a presentation on 'Further unusual curvaceous wonders of Earth.' Peter Harvey reports: "he Hermanus Centre's October monthly meeting was treated to the third in a series of Jenny Morris' outstanding presentations under the banner of "Unusual Curvaceous Wonders".

Circling the globe, our eyes and senses feasted on a menu of natural geological formations with sensual contours and vivid colours to challenge any accomplished fine artist. Sweeping through many corners of the globe, the presentation guided the viewer past ridges formed by erosion, some clothed with natural greenery, some painted delicately and artistically with subtle, and occasionally not so subtle, shades of ochre, grey, brown and red. Meandering rivers isolating huge, towering statues. Wind, sand and rain leaving balancing sculptures. Occasionally the balance was so visually off-centre as to leave the impression of impossibility. Sink holes leaving caves of artistic shadow and light with varying shades of green. Even perfect symmetry with underwater sand designs is used by the puffer fish to impress his would-be bride.

What was most evident was the predominance of mother nature's limestone and quartz sandstone as her material and of her skilful use of erosion by wind, water, ice and, above all, time as the tools of her art. Such are the gifts bestowed upon us by this special and precious planet. A very big thanks to Jenny for her extensive research and beautiful presentation and especially for reminding us of the homage we owe to this our only planet."

### Interest groups

**Cosmology** At the Zoom meeting, held on 5 October, 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: L13: 'From forces to fields' and L14: 'The falling laboratory'.

**Astro-photography** Members met on 12 October in a Zoom meeting. It included a presentation by Deon Krige on image processing with Photoshop.

### Other activities

**Educational outreach**

**Analemmatic sundials at schools** Pierre de Villiers and Mick Fynn visited Lukhanyo School a couple of times during October, all those involved, following the Covid rules.. The Grade 7 learners watched a presentation on analemmatic sundials, learned how to access and use the website and also made practical use of the sundial in their school grounds.

**Presentation to Durban Centre** One 14 October, Centre member and Senior Research fellow at SANSA, Pieter Kotzé, gave a Zoom talk on 'The current status of Earth's magnetic field: Is it changing?' to the Durban Centre. Thanks to their invitation to other centres to attend, Pieter's excellent presentation was also seen by several Hermanus Centre members.

**Article in Whale Talk magazine** An article by Jenny Morris titled 'Betelgeuse: mystery of the fading star' was published in the October-November issue of the magazine.

## THIS MONTH'S ACTIVITIES

### Monthly centre meeting

This month's meeting, will take place on the evening of **Monday 16 November**. Access and start time details will be circulated to members. Centre chairman, Pierre de Villiers, will talk on 'A home observatory'. Pierre states: "The talk will describe the design philosophy, methodology, choice of materials, fabrication and installation methods used for the construction of a home observatory. All the options considered will be described and illustrated with photos where possible and the choices made will be motivated. There were many frustrating delays, *inter alia* Covid-19, but with the wisdom of hindsight there are surprisingly few things that would have been done differently if there were a second chance. A fun project with hopefully a lasting legacy."

### Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 2 November** 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: L15: 'Spacetime in zero gravity' and L 16: 'Spacetime tells matter how to move'.

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

**Astro-photography** This group normally meets on the second Monday of each month. Members are currently communicating digitally about image processing they do at home. The next meeting will take place **via Zoom** on **Monday 9 November.**

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.

## 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.

16 November 'A home observatory' Presenter: Pierre de Villiers, Centre chairman

## 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

**Six galaxies trapped in the web of an ancient supermassive black hole** 2 October: Astronomers have long struggled to understand how supermassive black holes could have formed in the early universe. They know these cosmic Goliaths would have needed to grow extremely fast to achieve their supermassive status so quickly (within about 1 billion years of the Big Bang). Exactly where they found huge amounts of matter to gorge on remains unclear. Now, new findings from the European Southern Observatory's Very Large Telescope (VLT) may provide the answer.

Artist's concept of the six galaxies, which may be just be the brightest galaxies in a larger group, ESO/L. Calçada

The six newly discovered old-school galaxies reside within a vast web of gas - which spans some 300 times the diameter of the Milky Way - and were observed thanks to extended observations by VLT. After analysing the data, the researchers determined they were seeing these galaxies as they existed just 900 million years after the Big Bang, when the universe was little more than 6 percent its current age. This is the first time such a close grouping of galaxies has been found within the first billion years of the universe. Also,, at the centre of galactic mosh pit sits a supermassive black hole some 1 billion times the mass of the Sun. "[Supermassive black holes in the early universe] are extreme systems, and, to date, we have had no good explanation for their existence," said lead researcher Marco Mignoli.

Scientists know there is a limit to how fast a black hole can grow: the Eddington limit. However, while that plays a part in the formation of supermassive black holes in the early universe, the real question scientists struggle with is tracking down where early black holes sourced their meals in the first place. The key likely has to do with the universe's vast cosmic web. This (literally) universal structure is woven through the entire cosmos, connecting distant galaxies, galaxy clusters, and galaxy superclusters through threads of faint gas know as filaments.

The authors behind the new study think that their supermassive black hole and its surrounding galaxies, dubbed SDSS J1030+0524, likely fed on the gas that was stockpiled in a tangled knot of cosmic web filaments. "The cosmic web filaments are like spider's web

threads," said Mignoli. "The galaxies stand and grow where the filaments cross, and streams of gas - available to fuel both the galaxies and the central supermassive black hole - can flow along the filaments." However, that just pushes the question farther back. How did these filaments first get their gas? Astronomers think that answer may be related to another long-standing astronomical mystery: dark matter. In the very early universe, normal matter was too hot to actually stick together and form gravitationally bound objects such as black holes and galaxies. Researchers think dark matter might have been a lot colder than normal matter. This means dark matter could have clumped together in the early universe, forming giant structures known as dark matter halos. The gravity from these dark structures would have went on to reel in normal matter, attracting huge amounts of gas that would allow the first galaxies and black holes to take root.

The galaxies uncovered in this new study are also some of the faintest ever observed, which means there could be many more lurking in the area. "We believe we have just seen the tip of the iceberg, and that the few galaxies discovered so far around this supermassive black hole are only the brightest ones," said co-researcher Barbara Balmaverde. By: Caitlyn Buongiorno

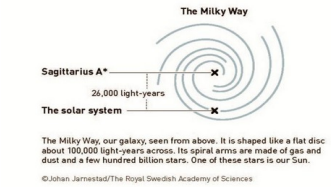
**2020 Nobel Prize in physics awarded for work on black holes** 7 October: Black holes are perhaps the most mysterious objects in nature. They warp space and time in extreme ways and contain a mathematical impossibility, a singularity – an infinitely hot and dense object within. However,if black holes exist and are truly black, how exactly would we ever be able to make an observation? This morning the Nobel Committee announced that the 2020 Nobel Prize in physics will be awarded to three scientists – sir Roger Penrose, Reinhard Genzel and Andrea Cghez - who helped discover the answers to such profound questions. Andrea Ghez is only the fourth woman to win the Nobel Prize in physics.


Artist's concept of a supermassive black hole with millions to billions times the mass of our Sun. NASA/JPL-Caltech

Roger Penrose is a theoretical physicist who words on black holes, and his work has influenced not just me but my entire generation through his series of popular books that are loaded with his exquisite hand-drawn illustrations of deep physical concepts. As a graduate student in the 1990s at Penn State, where Penrose holds a visiting position, I had many opportunities to interact with him. For many years I was intimidated by this giant in my field, only stealing glimpses of him working in his office, sketching strange-looking scientific drawings on his blackboard. Later, when I finally got the courage to speak with him, I quickly realised that he is among the most approachable people around.

Sir Roger Penrose won half the prize for his seminal work in 1965 which proved, using a series of mathematical arguments, that under very general conditions, collapsing matter would trigger the formation of a black hole. This rigorous result opened up the possibility that the astrophysical process of gravitational collapse, which occurs when a star runs out of its nuclear fuel, would lead to the formation of black holes in nature. He was also able to show that at the heart of a black hole must lie a physical singularity – an object with

infinite density, where the laws of physics simply break down. At the singularity, our very conceptions of space, time and matter fall apart and resolving this issue is perhaps the biggest open problem in theoretical physics today.



The Milky Way, our galaxy, seen from above. It is shaped like a flat disc about 100,000 light-years across. Its spiral arms are made of gas and dust and a few hundred billion stars. One of these stars is our Sun.



Penrose invented new mathematical concepts and teqhniques while developing this proof. Those equations that Penrose derived in 1965 have been used by physicists studying black holes ever since. In fact, just a few years later, Stephen Hawking, alongside Penrose, used the same mathematical tools to prove that the Big Bang cosmological model – our current best model for how the entire universe came into existence – had a singularity at the very initial moment. These are results from the celebrated Penrose-Hawking Singularity Theorem. The fact that mathematics demonstrated that astrophysical black holes may exactly exist in nature is exactly what has energizsd the quest to search for them using astronomical techniques. Indeed, since Penrose's work in the 1960s, numerous black holes have been identified.

The remaining half of the prize was shared between astronomers Reinhard Genzel and Andrea Ghez, who each lead a team that discovered the presence of a supermassive black hole, 4 million times more massive than the Sun, at the centre of our Milky Way galaxy. Genzel is an astrophysicist at the Max Planck Institute for Extraterrestrial Physics, Germany and the University of California, Berkeley. Ghez is an astronomer at the University of California, Los Angeles. Genzhel and Ghez used the world's largest telescopes (Keck Observatory and the Very Large Telescope) and studied the movement of stars in a region called Sagittarius A* at the center of our galaxy. They both independently discovered that an extremely massive – 4 million times more massive than our Sun – invisible object is pulling on these stars, making them move in very unusual ways. This is considered the most convincing evidence of a black hole at the center of our galaxy.

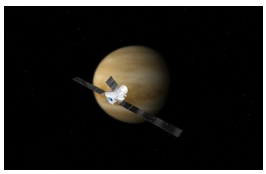

Andrea Ghez: fourth woman to win a Nobel Prize in physics. John D./ Wikipedia

This 2020 Nobel Prize, which follows on the heels of the 2017 Nobel Prize for the discovery of gravitational waves from black holes, and other recent stunning discoveries in the field – such as the 2019 image of a black hole horizon by the Event Horizon Telescope – serve as great recognition and inspiration for all humankind, especially for those of us in the relativity and gravitation community who follow in the footsteps of Albert Einstein himself.

By: Gaurav Khanna

**BepiColombo spacecraft to fly by Venus tonight, will seek signs of life** 14 October: Just a month ago, researchers announced the presence o phosphine in the clouds of Venus - an indicator that microbial life may be present on our sister planet. In a

happy coincidence, there is a spacecraft scheduled to fly by this hellish world – tonight. The European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) launched their joint BepiColombo spacecraft in October 2018 to become the third spacecraft to explore Mercury. On the way to our solar system's innermost planet, BepiColombo will fly by Venus twice . The two encounters will utilise the planet's gravity to help BepiColombo reach Mercury, but they now also provide a chance for scientists to study Venus' atmosphere up close.


The ESA-JAXA BepiColombo spacecraft cruises by Venus in this artist's concept. ESA/ATG medialab

In September, an international team of astronomers using ground-based radio telescopes showed evidence that Venus' cloud tops contain traces of phosphine. On Earth, only microbial life (and some industrial processes) create this toxic gas; there are no known non-biological processes that could make it on Venus. The observations thus raise the possibility of life on Venus. Or the gas could be due to some unknown chemical process — a less exciting but enticing alternative for scientists. The team emphasised that they are not claiming to have found life in Venus and point to follow-up research to answer that question definitively. That is where BepiColombo may come in.

Another spacecraft, the Japanese Venus Climate Orbiter Akatsuki, has been in orbit around Venus since 2015 to study its atmosphere. However, on 14 October, BepiColombo will fly 30 times closer closer to the planet than Akatsuki, skimming about 10,720 kilometres above the surface. Although BepiColombo was not originally intended to search for life on Venus, several instruments on the spacecraft will be used during both flybys of Venus to study the planet. Its thermal infrared spectrometer and radiometer is capable of studying the chemical composition and cloud cover of the planet's mid-altitude atmosphere. It is this instrument that may also be able to verify the observations taken from Earth, although researchers are not sure whether it is sensitive enough to do so.

However, with this first flyby just hours away, the observational plan has already been set and cannot be altered. The second flyby, set for next year, is more promising. This flyby will take BepiColombo even closer to Venus, a mere 550 km from the surface, and the team will have the time needed to revise their observations so they can better look for phosphine. If BepiColombo is able to confirm phosphine in Venus' atmosphere, the intrepid craft will have made scientific history before it even reaches its intended target.

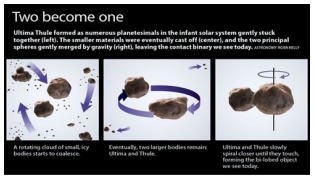
By: Caitlyn Buongiorno\

**The breezes of Arrokoth might have rejuvenated the space rock's surface** 21 October: On 1 January 2019, NASA's New Horizons spacecraft provided humanity it first close-up look at an object from the solar system's beginnings: the primordial Kuiper Belt object Arrokoth. However, it turns out, determining exactly how primordial Arrokoth is could be more complicated than it seems. In new research**,** planetary scientist Jordan K. Steckloff of the Planetary Science Institute and his colleagues assert that, while Arrokoth itself dates back billions of years to shortly after the solar system's birth, its surface may be significantly younger, having received a facelift thanks to surface 'breezes'. However,

although their new claim is undoubtedly intriguing, at least one major Arrokoth advocate wants more information before jumping on board.

Artist's concept of NASA's New Horizons spacecraft approaching Arrokoth, a Kuiper Belt object 4.1 billion miles from the Sun. NASA/JHUAPL/SwRI/Steve Gribben

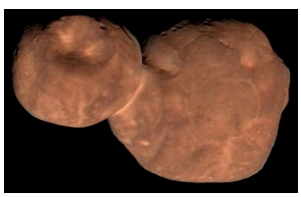
Located more than 6.4 billion kilometres from Earth, Arrokoth formed in a distant, extremely frigid region of the solar system, Steckloff states. There, the temperature hovers around –250 degrees Celsius, which is cold enough to freeze carbon monoxide and methane. According to Steckloff, early on, "Arrokoth was sort of behind a smoke screen — the thick protoplanetary disk," which helped keep it chilly. When the Sun was about 10 million years old, just a protostar still powered by gravitational contraction, it entered its T Tauri evolutionary phase. It started blowing powerful solar winds off its surface. And as the Sun's protoplanetary disk dissipated, Arrokoth's temperature began to rise. Frozen volatiles evaporated in a process called sublimation, with some, like carbon monoxide, boiling away more vigorously than others.




The Kuiper Belt object Arrokoth, seen in this composite image from New Horizons, is a contact binary, meaning it has two main lobes that gently merged together in the past. NASA/JHUAPL/SwRI

Such outgassing can change the rotation of objects like comets or asteroids, or even tear them apart. However, that did not happen to Arrokoth. Sublimation can also alter cometary surfaces. Unlike comets, Steckloff says, carbon monoxide, rather than water ice, was a major supervolatile on Arrokoth. "These molecules would have been moving fast, around 100 to 200 meters per second," he says. "The pressure of the gas at Arrokoth's surface would be, at most, a nanobar - a billionth of the pressure at the Earth's surface. But the surface gravity is also very low - about one ten-thousandth the gravity at the surface of the Earth. So, if you have fine dust, the [sublimating gas will] move it."

Given 10 to 100 million years for this process to unfold, Steckloff and his colleagues think this slow carbon monoxide 'breeze' would have made the kinds of changes to Arrokoth's surface that any earthly geologist would recognize. Steckloff admits they were slow changes, but they were "significant enough to erase topographic features on length scales of about 10 to 100 metres." The end result was the effective disappearance of impact craters 50 to 500 meters in diameter. "So, when we look at Arrokoth," Steckloff says, "the shape may be primordial, but the surface might date from a later period."



Arrokoth's surface shows a relatively uniform composition and colour, NASA/JHUAPL/SwRI

Alan Stern, principal investigator of the New Horizons mission to Pluto and Arrokoth, states that he is impressed by the ingenuity the researchers have shown. "I think they have a very innovative idea," he says. However, Stern remains cautious: "I am not sure the surface telltales are likely to be as dramatic as the paper describes." Stern notes the 'breezes' described would be only one of the processes occurring during the earliest phases of Arrokoth's formation. "There was a slow tail to accretion, to thermal evolution, to space weathering by the radiation environment, [to] effects in the disk which was still dissipating," he says. "All this was going on at once and at different time scales."

He also notes a need for follow-up work to determine whether "other Kuiper Belt objects would be similarly affected, and how we would go about determining if this is, in fact, what actually happened - either with future missions to the Kuiper Belt, or by observing comet belts around T Tauri stars and looking for telltales of this kind of process." "What remains to be seen with more detailed modelling or with these observations - either future missions or observations of stars - is to determine just how important this [surface sublimation] process really is," he adds. No matter what, Arrokoth still remains the most pristine relic of the solar system's formation ever closely examined by a spacecraft. Even if cryogenic breezes altered its surface after its initial formation, it is still about as old of a surface as we have ever seen up close. So, as researchers continue to pour over the data produced by New Horizons' historic flyby, many more surprising results are sure to follow.

By: Joel Davis

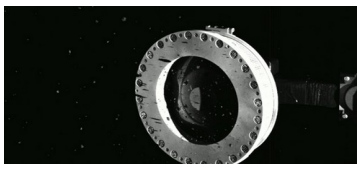
**OSIRIS-REx is literally overflowing with asteroid samples from Bennu** 23 October: OSIRIS-REx is packing up to get ready to come home, but like a lot of travellers, it is collected so many souvenirs that they won't all fit in its luggage. This highly relatable problem is a good one to have, though. It means the craft's touch-and-go (TAG) sample collection attempt on Tuesday was a smashing success.

OSIRIS-REx's touch-and-go sample collection attempt on asteroid Bennu is seen in this image. NASA/Goddard/University of Arizona

The craft navigated a boulder-strewn landscape down to the surface of Bennu, an asteroid more than 322 million kilometres from Earth. The spacecraft's cylindrical sample collection head, mounted to a robotic arm, pressed into the regolith - the surface layer of dust and rocks - for six seconds. Meanwhile, it fired a canister of nitrogen gas, which whisked material into a collecting area inside the rim of the sample head. "I must have watched it about 100 times last night before I finally got a little bit of shuteye," said Dante Lauretta of the University of Arizona, the mission's principal investigator. That night, he said, "I dreamed of a wonderworld of Bennu regolith particles floating all around me."

On Thursday, mission engineers moved the head of OSIRIS-REx's Touch-and-Go Sample Acquisition Mechanism (TAGSAM) in front of the craft's cameras to evaluate their asteroid haul. Rocks were plainly visible inside the collection head - at least 400 grams, they estimate. However, the team also saw something concerning: the mylar flap meant to seal those precious rock samples is stuck open. A handful of Bennu particles just a few centimetres wide are wedged between the flap and the sample head's inner rim.

Furthermore, timelapse imagery shows that some invaluable pebbles are escaping into space.


OSIRIS-REx's sample collection head is seen here with Bennu particles wafting out. The head's mylar flap (black bulge to the left of the inner rim) is visibly wedged open
NASA

It appears the TAGSAM head is stuffed full and literally overflowing. In one sense, that is good news. It means OSIRIS-REx collected even more material than is visible - perhaps up to two kilograms. "It's very exciting, very surprising, but overall excellent news," Lauretta said. Still, the fact that these samples are leaking out is an unwelcome development. "It's more than I'm comfortable with," Lauretta added. "I was pretty concerned when I first saw these images."

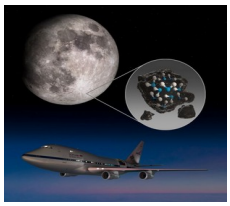
These events have injected a new sense of urgency into planning the mission's next steps. The team is currently working to stow the sample collection head inside OSIRIS-REx's secure Sample Return Capsule, which they want to do as soon as possible to minimise how much material they lose. "We are in a contingency situation we didn't expect," said Lauretta. "We were almost a victim of our own success here." The team had originally intended to take their time weighing their sample and deciding the craft's next steps. The plan was to get a precise mass measurement of the total haul on Saturday by slowly spinning the spacecraft and measuring the change in its moment of inertia. However, the team cancelled that manoeuvre to avoid jostling more loose material out of the open flap. They expect they could begin stowing the sample as early as Tuesday, but it might take up to three days.

In the meantime, the craft's sample head will likely continue to shed material as its moved into the capsule. The team thinks they already lost up to 10 grams of material when TAGSAM was moved into position for the photo shoot. Lauretta expects up to "tens of grams" more could be lost during the stow procedure. "I don't see a way out of that," he said. "I think we have to accept that and reoptimize." The mission team is currently working to revise their stow procedure to ensure it is as gentle as possible. However, with an estimated 400 grams of asteroid samples inside the head, even a loss of a few tens of grams, the mission would still greatly exceed its target of 60 grams. Japan's Hayabusa 2 mission to asteroid Ryugu is expected to bring back a few tens of grams, so even if OSIRIS-REx loses part of its haul, it will still bring back the largest asteroid sample ever returned to Earth by a spacecraft.

Scientists hope scrutinizing the samples will yield insight into the formation of the solar system, as well as life on Earth. They expect to have Bennu's rocks in their labs shortly after the craft delivers them to Earth on 24 September 2023. The team also expects to gain a wealth of knowledge about Bennu based on the images and data taken during the TAG attempt. For instance, researchers are currently working to identify and track individual particles within the rubble-cloud to understand their behaviour in Bennu's unique microgravity environment, said Lauretta. Another early insight: Bennu's surface material is very loosely bound. When TAGSAM touched down, the craft's momentum continued to carry it inside the asteroid, plunging its head about 48 centimetres into the

surface. The regolith barely resisted the intrusion, too, simply flowing around probe. That was much deeper than the team simulated, and probably explains why the TAGSAM got so full of material in the first place, said Lauretta. By: Mark Zastrow

**NASA's flying SOFIA telescope confirms water in the Moon's soil** 26 October: Water molecules have been detected in the Moon's surface by NASA's flying Stratospheric Observatory for Infrared Astronomy (SOFIA). Researchers found traces of the life-sustaining substance in one of the largest lunar craters visible from Earth, the Clavius Crater. This ancient impact site receives a significant portion of sunlight compared to other areas of the Moon, which suggests that lunar water might not be limited to shadowy sites at the Moon's poles. "Without a thick atmosphere, water on the sunlit lunar surface should just be lost to space," Casey Honniball, the study's lead researcher, said. "Yet somehow we're seeing it. Something is generating the water, and something must be trapping it there."


NASA's Stratospheric Observatory for Infrared Astronomy confirmed that water molecules are trapped beneath the soil in the Moon's Clavius Crater. NASA

The key to how water could survive such a harsh lunar environment may be related to another harsh reality on the Moon: micrometeorites. These small pieces of space rock - only a few hundredths of an inch or so wide - rain down on the lunar surface, potentially forming beadlike glass structures upon impact. It is these structures that the researchers think could trap and protect water molecules from sunlight. Alternatively, the researchers say, the water molecules could be caught between grains of lunar soil that shields them from sunlight. And depending on what exactly is protecting the newfound water from the Sun, scientists think astronauts may eventually be able to mine it. It is important to note that the amount of surface uncovered is still rather small. NASA compares the amount to 100 times less than is found in the Sahara Desert. So, researchers aren't quite sure what these findings mean for supporting a sustainable human presence on the Moon.

The new find marks the first time SOFIA - a modified Boeing 747 mounted with a 100-inch reflecting telescope- has looked at the Moon. Follow-up flights by the aircraft will search for additional water signatures within sunlit portions of the Moon. The results will then be used to inform future NASA lunar missions, including NASA's Volatiles Investigating Polar Exploration Rover (VIPER). By: Caitlyn Buongiorno

**Earth's biggest telescopes reopen after months of COVID closures** 26 October: After more than six months of COVID-related closures, observational astronomy is largely getting back to work. Many of the world's biggest telescopes have reopened their domes in recent weeks, returning their gazes to the heavens for the first time since the pandemic forced a global shutdown of observational astronomy in March. Other major telescopes expect to reopen soon. This wave of re-openings was buoyed by declining COVID-19 cases in Chile, especially in the Atacama Desert, a region home to many world-class observatories. US officials who manage telescopes in Hawaii and Arizona say they are also beginning to resume operations, largely thanks to significant changes in their workflows. If major observatories continue to come back online - and remain open - it will end an

unprecedented dark era in astronomy. After all, even during World War II, America's observatories kept a close eye on the skies.


The Magellan Clay telescope. Anna Frebel/MIT

Earlier this year, an Astronomy magazine analysis showed that over 100 of Earth's largest telescopes temporarily shuttered their doors closed due to the COVID-19 pandemic. By late March, observational astronomy had almost completely shut down. The closures reveal a little-realised truth about modern astronomy. Even in 2020, most observatories are not fully automated. Telescopes have grown dramatically larger and more complex in recent decades. They have also been pushed to more remote locations, farther and farther from civilisation's expanding light pollution. Basic tasks like swapping the instruments and cleaning the mirrors on these behemoths can require a small village of engineers, technicians, observers, medics, cooks, groundskeepers, and more. In Chile, where many of the world's biggest observatories are now located, the telescopes are so far away from cities that employees cannot just commute to the mountain each night.

They have to live on campus part-time. Even the astronomers using the instruments typically travel to the observatories during their awarded observing nights. This reality forced observatories to shut down in the early days of the pandemic. There was no way to abide by social distancing rules and effectively run the telescopes. In interviews back in March, observatory directors said they expected telescopes to be offline for at least three to six months. That's largely how the pandemic played out for them.

A number of observatories did manage to change their workflows enough to feel safe reopening during the summer. In recent weeks, many of the remaining observatories have likewise reopened. The only telescopes little impacted were the small, survey telescopes that run robotically, or with minimal support. These scan the skies for transient objects - the field's term for unexpected and brief astronomical objects and events. For example, the Catalina Sky Survey in Arizona never stopped searching for asteroids. Also astronomers kept the Las Cumbres Observatory network of robotic telescopes hunting for both supernovae and space rocks. Hopefully, that was enough to avoid any major gaps in the observational record.

Luckily for the field, those survey telescopes did not pick up any once-in-a-lifetime objects that would leave astronomers agonizing over what might have been. "I'm sure we've missed a few things," says John S. Mulchaey, director of the Carnegie Observatories, which runs some of the world's largest and most historically important telescopes. "But for most of astronomy, you don't miss that much. For those of us studying galaxies in the distant universe, they're gonna be there next year. They're gonna look the same." Mulchaey says he did ponder how tragic it would have been if Betelgeuse went supernova. Early in the year, astronomers were mystified by the behaviour of the dying red supergiant star in the constellation Orion. "That doesn't seem likely, but we haven't had a visible supernova in our galaxy in 400 years or something," he says.

Early on, astronomers were also worried about their ability to detect potentially dangerous near-Earth asteroids. New asteroid detections did decline initailly, according to Kelly Fast, NASA's program manager for Near-Earth Object Observations. However, as smaller observatories found ways to reopen, those detections eventually started going back up. "Most stuff that would have been done this year can be done next year," Mulchaey says. "It means it takes an extra year to get to the answer, but that's not that bad in the scheme of things."

Although not a light-gathering observatory, LIGO, the Laser Interferometry Gravitational-Wave Observatory, was forced to shut down its observing run a month early due to COVID-19. LIGO was planned to be offline for upgrades until 2022, but the pandemic is causing delays that could extend the process even longer. Processing the data from the last observing run is also taking longer than expected. "There are delays due to supply chain issues, changes in how vendors work, and teams learning to work in a COVID-safe way," says LIGO spokesperson Patrick Brady. They will likely not know until next year whether the pandemic has postponed LIGO's ability to tune back into gravitational waves again.

Even as major observatories continue to come back online, many will not be operating at 100 percent for the foreseeable future. Large telescopes often have their instruments changed multiple times a night as they start new observing runs Observatory directors say that changing instruments just will not be possible in many cases now, as they have had to learn to work with dramatically reduced staff. Sometimes, they even have to find ways for one person to do tasks that would usually take an entire team. Astronomers no longer physically travel to the telescopes from during their observing nights, either. Also, public tours have also been cancelled, robbing observatories of vital revenue and access to potential donors. Maintenance has also been delayed. Large telescope mirrors often stretch more than a dozen feet across and sit exposed to the outdoors all night long, gathering dust. That means observatories have to regularly clean and recoat their mirrors, or else they wi ll gradually lose their light-gathering abilities. "One aspect that has suffered at the [Hobby-Eberly Telescope] and other large telescopes is that our mirror cleaning and segment re-aluminisation are way behind schedule," says Steven Janowiecki, an astronomer at the McDonald Observatory who serves as the observatory's science operations manager. "Those processes require people to be in close proximity and have been significantly reduced since March. That will have long term impacts on our light-collecting ability - perhaps 5 to 15 percent - but we'll still be observing." By: Eric Betz

**Philae's tumbling landing shows Comet 67P has areas with fluffy snow** 29 October: The Philae lander's awkward landing six years ago exposed some of the oldest, most pristine ice in the solar system, and showed that in some areas, the comet's snow is packed so loosely it is mostly empty space -- more like cotton candy than the rocks it resembles, according to Laurence O'Rourke's new research. "Every time we go look at a comet nucleus in person, in situ, we find something we haven't thought of, something we didn't expect. So that's the preface of everything: comets are weird," said Gal Sarid, a planetary scientist at Science Systems and Applications in Lanham, Maryland, who was not involved in the research.

The Philae lander arrived on the surface of Comet 67P nearly six years ago, but it did not land quite right. Its harpoon failed to attach it to the comet's surface as planned, so Philae bounced twice and flipped on its side, only to lose power in the dim light. It also had

difficulty drilling into the comet surface. Philae transmitted data to the Rosetta orbiter for three days before going dark. Scientists led by O'Rourke pored over thousands of pictures during the next year and a half before they finally found Philae's resting place. No one knew exactly how it came to rest where it did, because scientists couldn't see all the impact points. When he scrutinised the images, O'Rourke saw something unusual. "In all the images I've seen, everything looks bright. But this one just looked a bit more artificial or 'manmade,'" he said.

Today, O'Rourke and colleagues describe the two locations where Philae tumbled like a cartwheeling gymnast, carving out comet chunks in the process. Its windmill motions scraped off the fluffy surface and boulders of 67P and exposed fresh, bright reflective ice. The marks of Philae's passage revealed that the ice was not firm at all, but rather more like cotton candy or fresh alpine powder. If you pressed down on it, it would compress easily, which is what happened when Philae bumped it, O'Rourke said. "When you go outside and you put your foot into the snow, it is very soft at first, and then it gets harder as you compress it more," he said. The material is cohesive, but it is nearly 80% empty. If Earth snow is like a regular block of cheese, the comet snow where Philae landed is more like a block of Swiss cheese, "or cheese that has been eaten inside by a mouse," Sarid said. "The cheese is the same, but the compressive strength is different."

O'Rourke and the Philae team say the results could have implications for future comet missions, or even missions to harvest material from the dirty snowballs left over from the birth of the Sun and planets. "Rosetta changed our understanding of comets, and how they work and how they wake up and go back to sleep," O'Rourke said. "But for Philae, even years later, to give us this insight into the inside of a comet, that's really quite special." By: Rebecca Boyle

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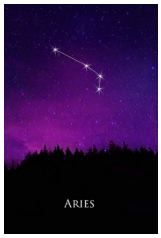
## DID YOU KNOW?

### Zodiac constellations 9: Aries




'The ram' is the second smallest zodiac constellation, ranked 39th in size of the 88 constellations. Located between Pisces and Taurus, it is not very prominent, having only four bright stars. Of these three form its most recognisable feature. Alpha, beta and gamma Arietis form a crooked-line asterism. Historically Aries was depicted as a crouched (lying down) ram with its head turned towards Taurus.


Since Babylonian times, the constellation has been a ram. In contrast to modern times, Babylonian Ari, named for a god, was the final station along the ecliptic. In ancient Egypt, Ari was associated with the god Amon-Ra, a man with a ram's head who represented fertility and creativity. In Greek mythology, Aries was the ram whose golden fleece hung on an oak tree in Colchis on the eastern shore of the Black Sea. Jason and the Argonauts undertook their epic voyage to return fleece to Greece. Despite evidence of its historic existence, Aries was only fully accepted as a constellation by Ptolemy during the Hellensitic era.

In ancient Greece, over 2,000 yrs ago, the northern hemisphere's vernal (spring) equinox lay near the border of Aries and Pisces. Because of this, Aries was described as 'indicator

of reborn Sun'. Precession has now moved this point through Pisces and almost into Aquarius. However, this point, where ecliptic crosses O deg on celestial equator is still called 'first point of Aries' despite its in accuracy. The Sun passes through Aries from late-April to mid-May, but is still associated with spring.

Aries has several stars with known exoplanets.

Notable features include:

- Alpha Arietis: named Hamal, the Arabic for 'ram' or 'head of lamb', is an orange giant of magnitude 2, located 66 ly away. It is visible through binoculars.
- Gamma Arietis: one of several double stars in Aries, this pair is nearly equal in size. A telescope will identify both components.
- The few deep sky objects are faint, but include several pairs of interacting galaxies are visible with a telescope.
- Meteor showers including Daytime Arietids (May – July) are associated with the Marsden group of comets. Unusually, the parent body may be asteroid Icarus.

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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