`"The Southern Cross"

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HERMANUS ASTRONOMY CENTRE NEWSLETTER

OCTOBER 2020

Monthly meeting This months **Zoom meeting** will take place on the evening of **Monday 19 October** Access and start time details will be circulated to members closer to the time. Centre member, Jenny Morris will be presenting '**Further unusual curvaceous wonders of Earth**' See below for details.

Cosmology The activities of this interest group continue on the evening of **Monday 5 October** The next two parts of the current DVD series "Black holes, tides and curved spacetime: Understanding gravity' presented by Prof Benjamin Schumacher of Kenyon College will be shown **via Zoom**. Access and start time details will be circulated to members. See below for details on the content.

2020 meeting dates For your diaries. The remaining meeting date is **16 Novembe**r.

WHAT'S UP?

Smallest full moon this year While largest full moons are probably more usually noted, it is also worth observing the other extreme. The average distance of the Moon from Earth is 384,400 km. However, it has a slightly elliptical orbit and distances range from approximately 362,600 km (perigee) to around 405,400 km (apogee). The relatively small difference in distance mean that the observed differences in the Moon's size are not large, around 12 %, but they are noticeable. When the Moon is at perigree, it appears larger than usual and is called a supermoon. The smallest full moon, this year, will occur on 31 October. It will be 406,166 km from Earth, only marginally smaller than it will be at the next full moon, on 30 November.

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the Centre's postponed Zoom monthly meeting held on 23 September, Dr Pieter Kotzé, Senior Research Fellow at SANSA gave a very informative and interesting presentation on 'Cosmic ray astronomy'. He explained how, despite being present everywhere, these high-energy charged sub-atomic particles which travel at near the speed of light, are still poorly understood. They may originate from the Sun, supernova remnants, pulsars, colliding galaxies and/or gamma ray bursts, with supernovae and other cataclysmic events currently considered to be the most likely candidates. One reason why they are difficult to track is that their interactions with magnetic fields in the solar system and beyond means that their point of location is rarely related to their actual source. Despite the challenges in finding them, both Earth- and

space-based equipment is used to detect them and analyse their characteristics. Systems include the Neutron Monitor Network which includes an instrument at SANSA in Hermanus. In fact, Hermanus has the longest continuously operating neutron monitor in the world (since 1957). Research questions being investigated by scientists include: How are the particles accelerated?, How are they released from their sources?, What do their characteristics and behaviours say about stellar evolution? Pieter is actively involved in research based on data recorded at Hermanus.

Interest groups

Cosmology At the Zoom meeting, held on 7 September, 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: L11: 'The million-body problem' and L12: 'The billion-year battle'.

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

Other activities

Educational outreach

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

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's meeting, will take place on the evening of **Monday 19 October**. Access and start time details will be circulated to members. Centre member, Jenny Morris will be presenting the third in the series on Wonders of Earth: '**Further unusual curvaceous wonders of Earth'.**

Synopsis A rainbow river... flowerpots... underwater sand circles... a split apple... rivers of stone... painted cliffs... a red lake... psychedelic tunnels which will blow your mind. These are just some of the more unusual curvaceous features found on Earth which are included in this presentation. Located in over a dozen countries across the globe and all the result of different geological and/or natural processes, each feature is visually fascinating. With all the current challenging issues we are dealing with, at present, they remind us that the that the planet on which we live is a pretty wonderful place.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 5 October** 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: L13: 'From forces to fields' and L14: 'The falling laboratory'.

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.

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

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

Other activities

Stargazing While no events will take place during the coronavirus pandemic, members are encouraged to submit their own images to petermh@hermanus.co.za for circulation to the membership.

FUTURE TRIPS

No outings are being planned, at present.

2020 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented via Zoom.

19 October	"Further unusual curvaceous wonders of Earth'. Presenter: Jenny Morris, Centre member
16 November	'Designing and building a mobile 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

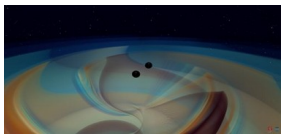
If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

ASTRONOMY NEWS\

Scientists detect first mid-sized black hole via gravitational waves 2 September: Within five years of detecting the first gravitational waves, LIGO and Virgo scientists have yet again helped advance our understanding of the cosmos. On 21 May 2019, researchers identified a unique set of gravitational waves, or ripples in the fabric of space-time, that they have not seen before. For one, the waves came from halfway across the universe, or about 7 billion light-years away, making it the most distant gravitational-wave signal ever detected. More importantly, the researchers think these gravitational waves point to the merger of two already bizarre black holes that formed a never-before-confirmed mid-sized black hole. In other words, the researchers think they have found the first direct evidence for a special breed of black hole called an intermediate-mass black hole (IMBH).


LIGO and Virgo have detected the heftiest black hole merger to date, Mark Myers, ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav)

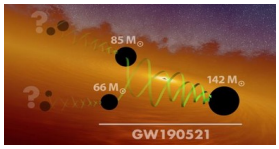
Astronomers think IMBHs fill a gap between stellar-mass black holes (which are a few to 100 solar masses and are created when huge stars collapse), and supermassive black holes (which are millions to billions of solar masses and lurk in the centres of most galaxies). Although the exact mass range of each class of black hole depends on who you ask, most astronomers agree that, at 142 solar masses, this newly formed object fits the bill for an IMBH.


Two progenitor black holes spiralling inward before merging in this simulation, producing gravitational waves detected by LIGO and Virgo. N. Fischer, H. Pfeiffer, A. Buonanno (Max Planck Institute for Gravitational Physics),

The merger signal, called GW190521, lasted only a tenth of a second, but scientists immediately realised it was extraordinary in comparison to LIGO's first detection in 2015. "This doesn't look much like a 'chirp,' which is what we typically detect," said Virgo member Nelson Christensen in LIGO's press release. "This is more like something that goes 'bang,' and it's the most massive signal LIGO and Virgo have seen." This strange signal was produced by the merger of two equally weird black holes with masses of about 66 and 85 solar masses, which raises a few questions regarding their formation.

During a typical stellar lifetime, stars are able to support their weight because internal fusion generate an outward force that balances the inward crush of gravity. However, if a star is massive enough, once it runs out of fuel, it can no longer fight gravitational collapse. Ultimately, the core of such a star collapses under its own weight before rebounding back out as a dramatic supernova. However, any star that could theoretically form a black hole between 65 to 120 solar masses, like either progenitor of this unique merger, doesn't explode as supernova. That means there should not be any black holes born from collapsing stars in that mass range.

Instead, when a star that large begins its death throes, a phenomenon known as 'pair instability' kicks in, and the star becomes unstable to the point it avoids gravitational collapse- at least, for a while. And when it does finally explode, it leaves nothing behind. (On the other end of the spectrum, stars above 120 solar masses never go supernova because they collapse directly into black holes.) "Several scenarios predict the formation of black holes in the so-called pair instability mass gap: they might result from the merger of smaller black holes," said Virgo collaboration member Michela Mapelli. "It is also possible that we have to revise our present understanding of the final stages of the star's life."



Two primary merger events might have formed the progenitor black holes detected merging to an intermediate-mass black hole. LIGO/Caltech/MIT/R. Hurt (IPAC)

That is not the only weird aspect of this gravitational wave event, though. The 'bang' Christensen mentions was picked up by the more 'catch-all' approach that LIGO and Virgo use to identify gravitational waves. Rather than humans combing through the data, algorithms seek out any signals that look odd or intriguing. While unlikely, the researchers admit the signal's strangely short duration, combined with other weird aspects, mean GW190521 could have been produced by something completely unexpected. That is part of the excitement. "What if something entirely new produced these gravitational waves?" asked LIGO collaboration member Vicky Kalogera in a Northwestern press release. "It's a tantalizing prospect."

In their paper, the scientists briefly consider what other kinds of sources could be responsible for this first-of-its-kind signal. One possibility is that the collapse of a star within our own Milky Way could have produced a similar frequency. However, researchers think that is unlikely because other indicators of a local supernova, such as neutrinos, are missing. Another possibility is the signal is the result of a cosmic string - a hypothetical defect in space-time produced in the first few moments following inflation. Or perhaps, the two progenitor black holes were not formed through mergers or stellar collapse, but instead started off as primordial black holes. While these alternative explanations are improbable, they still reveal how many potential avenues gravitational-wave research may unlock. Or, as Virgo spokesperson Giovanni Losurdo said: "The observations made by Virgo and LIGO are shedding light on the dark universe and defining a new cosmic landscape." By: Caitlyn Buongiorno

Cosmic butterfly flaps its wings in stunning detail 9 September: The butterfly-shaped NGC 2899 appears to soar through the vacuum of space in a recent image captured with the European Southern Observatory's Very Large Telescope. However, this cosmic bubble of gas, located between 3,000 and 6,500 light-years away, is not as serene as the winged insect it resembles. In reality, this planetary nebula was produced by the death of one of two stars astronomers suspect lie at its centre.


The butterfly planteray nebula ESO

Astronomers believe one of the two stars shed its outer layers at the end of its life, while the other now dances through the flow of gas from its neighbour, creating this stunning space butterfly. The gas extends up to two light-years from the nebula's centre, glowing against the backdrop of in from the Milky Way. This gas can reach temperatures of more than 10,000 degrees, thanks to radiation from the parent stars buried within. Not every planetary nebula looks like NGC 2899, though. Its so-called bipolar, or two-lobed, shape only occurs in about 10 to 20 percent of nebulae - likely those with two stars. Other planetary nebulae typically resemble a disk, ring, or sphere. By: Hailey Rose McLaughlin

The Big Freeze: How the universe will die 10 September: The cosmos may never end. However, if you were immortal, you would probably wish it would. Our cosmos' final fate is a long and frigid affair that astronomers call the Big Freeze, or Big Chill. It is a fitting description for the day when all heat and energy is evenly spread over incomprehensibly vast distances. At this point, the universe's final temperature will hover just above absolute zero.


The region surrounding Sagittarius A*, the Milky Way's own supermassive black hole. NASA/JPL-Caltech/Judy Schmidt

Some 13.8 billion years ago, our universe was born in the Big Bang and it has been expanding ever since. Until a few decades ago, it looked like that expansion would eventually end. Astronomers' measurements suggested there was enough matter in the universe to overcome expansion and reverse the process, triggering a so-called Big Crunch. In this scenario, the cosmos would collapse back into an infinitely dense singularity like the one it emerged from. Perhaps this process could even spark another Big Bang, the thinking went. We would be gone, but the Big Bang/Big Crunch cycle could infinitely repeat. In the years since then, the discovery of dark energy has robbed us of a shot at this eternal rebirth. In 1998, two separate teams of astronomers announced that they had measured special exploding stars in the distant universe, called a type !a supernova, which serves as 'standard candles' for calculating distances. They found that the distant explosions - which should all have the same intrinsic brightness - were dimmer, and therefore farther away, than expected. Some mysterious force was pushing the cosmos apart from within. This dark energy is now thought to make up some 69 percent of the universe's mass, while dark matter accounts for another roughly 26 percent. Normal matter - people, planets, stars, and anything else you can see - comprises just about 5 percent of the cosmos. The most important impact of dark energy is that the universe's expansion will never slow down. It will only accelerate.

Decades of observations have only confirmed researchers' findings. All signs now point to a long and lonely death that peters out toward infinity. The scientific term for this fate is 'heat death'. However, things will be rather desolate long before that happens. "Just" a couple trillion years from now, the universe will have expanded so much that no distant galaxies will be visible from our own Milky Way, which will have long since merged with its neighbours. Eventually, 100 trillion years from now, all star formation will cease, ending the Stelliferous Era that's be running since not long after our universe first formed Much later, in the so-called Degenerative Era galaxies will be gone, too. Stellar remnants will fall apart. All remaining matter will be locked up inside black holes. In fact, black holes will be the last surviving sentinels of the universe as we know it. In the Black Hole Era, they will be the only 'normal' matter left, but, eventually, even these titans will disappear, too.

Stephen Hawking predicted that black holes slowly evaporate by releasing their particles into the universe. First, the smaller, solar-mass black holes will vanish. By a googol years into the future (a 1 followed by 100 zeroes), Hawking radiation will have killed off even the supermassive black holes. No normal matter will remain in this final 'Dark Era' of the universe, which will last far longer than everything that came before it. The second law of thermodynamics tells us that in this time frame, all energy will ultimately be evenly distributed. The cosmos will settle at its final resting temperature, just above absolute zero, the coldest temperature possible. If this future seems dark and depressing, take comfort in knowing that every earthling will have died long before we have to worry about it. In fact, on this timescale of trillions of years, even the existence of our entire species registers as but a brief ray of sunlight before an infinite winter of darkness. By: Eric Betz

New planet found orbiting a dead star 16 September: For the first time, an intact world might have been discovered around a white dwarf, suggesting that even after typical stars die, they may still host planets. White dwarfs are the cooling Earth-size cores of dead stars left behind after average-size stars have exhausted their fuel and shed their outer layers. Our Sun will eventually fade into a white dwarf after first bloating to become a red giant. The same fate awaits more than 90% of the stars in our galaxy.


The Jupiter-sized planet, WD 1856 b, is approximately seven times larger then its host star. NASA's Goddard Space Flight Centre

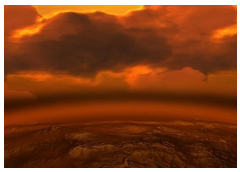
Previous research has found the remains of worlds that disintegrated when the progenitor stars of white dwarfs engulfed nearby planets during their red giant phase. This raised the question of whether any worlds might avoid this destruction and end up orbiting the resulting white dwarfs. In the new study, astronomers investigated a white dwarf in the constellation Draco about 81.5 light-years from Earth. Using NASA's Transiting Exoplanet Survey Satellite (TESS) and other telescopes, they discovered the dead star was orbited by a roughly planet-size body dubbed WD 1586 b, which has a mass at most 14 times that of Jupiter and a diameter about 10 times that of the white dwarf. The researchers suggest that in order to avoid obliteration when the progenitor star evolved into a red giant, WD 1586 b must have originally orbited its star farther away than the distance between Earth and the Sun. Later, gravitational interactions with other worlds in the remnant planetary system flung WD 1586 b into a closer orbit. It is now nearly 20 times closer to the white dwarf than Mercury is to the Sun, completing an orbit every 34 hours. "If a giant planet survived the journey close to a white dwarf, then it means that smaller planets could as well," said study lead author Andrew Vanderburg, an astronomer at the University of Wisconsin-Madison.

Although white dwarfs no longer burn fuel, they can still remain hot for billions of years. Vanderburg noted that "if a rocky planet made a similar journey to the planet we discovered, it could end up in the habitable zone of the white dwarf," the area around a star temperate enough to host water, and potentially life as we know it. All in all, these findings "could offer a way for a white dwarf to give rise to a second generation of life in a planetary system, long after the star ran out of hydrogen fuel and died." By: Charles Choi

Astronomers spy phosphine on Venus, a potential sign of life 17 September: An international team of astronomers has presented evidence that the cloud tops of Venus contain traces of phosphine - a toxic, rancid gas that is produced by microbial life (and some industrial processes) on Earth. Furthermore, they say, the chemical's presence is a mystery. No known non-biological processes can create phosphine in the conditions found on Venus. If the find is confirmed, it raises the tantalising possibility that the hellish world may harbour alien life in its weird and mysterious clouds. Alternatively, the phosphine could turn out to be the result of some unknown chemical process, which would be enticing in its own right.

The researchers behind the discovery sought to project a mix of both enthusiasm and restraint when they announced their find on 14 September. "There is a chance we have detected some kind of living organism in the clouds of Venus," said Jane Greaves, an

astronomer at Cardiff University who led the observations. "This is very exciting and was really very unexpected." "We are not claiming we have found life on Venus," MIT planetary scientist Sara Seager emphasized a few minutes later. "We are claiming a confident detection of phosphine gas whose existence is a mystery."

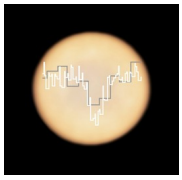

The surface of Venus is a hellscape. . ESA

The discovery puts a spotlight on the prospect of life in the Venusian clouds, which was once considered a fringe idea. In addition to igniting much debate, the detection of unexplained phosphine in the clouds of Venus has already spurred more research and unofficial proposals about how future Venus missions could hunt for more signs of alien life. "What's exciting about the phosphine discovery is that it demands follow-up," Bethany Ehlmann, a planetary scientist at Caltech who was not part of the discovery team, says. "The top three destinations to look for life in the solar system are Mars, Enceladus, and Europa - and now we should perhaps add Venus to the list."

Although the surface of Venus is hot enough to melt lead - nearly 480 degrees Celsius – Carl Sagan and Harold Morowitz proposed in 1967 that life could thrive in its clouds. After all, tens of miles above the surface, temperatures and pressures are much more Earth-like. That was before scientists discovered just how extreme Venus is. The planet’s clouds are made of at least 80 percent sulphuric acid - a corrosive, deadly compound that is thousands of times more acidic than battery acid. The idea that life could persist in those conditions, which many have doubted in the past, fell even further out of favour, astrobiologist David Grinspoon of the Planetary Science Institute (LPN) in Houston says. In fact, he adds, "it had kind of almost been forgotten about".

However, in recent years, the notion of Venusian life has made something of a comeback. In the early 1990s, NASA's Magellan probe mapped the surface of Venus with radar, revealing belching volcanoes that feed the world’s sulphuric clouds. These clouds also interact with sunlight, linking the surface, the atmosphere, and the Sun through chemistry and creating a rich cycle of activity that has no other analogue in the solar system except Earth. The energy and minerals stirred up in these clouds could provide a temperate niche that is rich in the nutrients necessary for life, says Grinspoon, who advanced this argument in his 1997 book *Venus Revealed*. "The clouds are like the ocean of Venus," he says. More recently, scientists have also learned that microbes are more adaptable than once thought. So-called extremophiles can survive and thrive in environments previously considered uninhabitable. Plus, modern climate models have also shown that early in Venus' history, the planet was a much more inviting, with stable, long-lived oceans on its surface. "You get this picture where these two habitable - and maybe inhabited - worlds [Earth and Venus] are right next door to each other for billions of years, who knows, exchanging life or evolving in parallel," says Grinspoon. So, when a runaway greenhouse effect finally overcame Venus and sterilized its surface, perhaps life took refuge in the clouds. In a recent paper, Seager and her colleagues proposed a hypothetical life cycle that would allow Venusian microbes to survive at altitudes between 48 to 60 kilometres above the surface. The idea depends on the microbes hibernating as ‘spores’ cocooned inside sulphuric acid cloud droplets, episodically falling to lower cloud layers as acid rain, before later surfing back skyward on updrafts of air.

Intrigued by the potential for cloud-dwelling life on Venus, in 2016, Greaves set out to search for evidence. She began her quest by researching what chemicals could be detected by radio telescopes. "She dug through the literature and found this very obscure gas that would be a unique biosignature," Seager said, referring to phosphine. "It's so obscure - no one cares about it." In June 2017, Greaves obtained time on the James Clerk Maxwell Telescope (JCMT), a radio telescope on Mauna Kea in Hawaii, training it on Venus, which naturally emits radio waves. She hoped to find a dip in brightness at a specific wavelength of light that cloud-borne phosphine would absorb. "It took about 18 months [of analysis] to convince ourselves there was a signal," said Greaves. They then followed up in March 2019 with the powerful Atacama Large Millimetre/Submillimetre Array (ALMA) in Chile, which uncovered the same phosphine signal at a higher resolution. These independent detections - at a level of about 20 parts per billion - from two different facilities gave the team confidence that the phosphine signal was real. Twenty parts per billion may not seem like a lot, but because phosphine easily breaks down when exposed to the ultraviolet sunlight, the researchers say something must be replenishing it.


Spectral data from both ALMA in Chile (white) and the James Clerk Maxwell Telescope in Hawaii (grey) superimposed on this image of Venus taken by ALMA. ALMA (ESO/NAOJ/NRAO), Greaves et al. & JCMT (East Asian Observatory)

On Earth, phosphine is generated by microbes in oxygen-free environments that are rather unpleasant by human standards – inside the gust of penguins, for example. Absent of life, the production of phosphine requires great temperatures and pressures, and typically a source of hydrogen to react with. The team does not think Venus can provide all three. However, phosphine has been detected in the hydrogen-rich atmospheres of Jupiter and Saturn, where it's generated deep inside the gas giants in conditions far more extreme than those found on Venus. "The presence of phosphine is telling us something interesting," Ehlmann says. "Either there's something about the chemistry of Venus' atmosphere we don't understand, or - the far more extraordinary claim - maybe there's a biological source."

Some researchers are sceptical of the detection itself; perhaps the signal is from another chemical masquerading as phosphine. The research paper was initially rejected for publication, says Seager, but, she adds, the techniques the team used were standard to radio astronomy. Compounds typically absorb at numerous wavelengths, and together, they create a unique, recognizable chemical fingerprint. However, the team has identified phosphine by absorption at only a single wavelength — one that is also shared by sulphur dioxide. This gives some researchers pause. "As a geochemist, I always worry about detection from one peak," says Justin Filiberto, a geochemist at LPI. "A single line is a coincidence, not a detection," adds Kevin Zahnle, an astrobiologist at NASA Ames Research Centre in Mountain View, California.

The team behind the new find agrees that more phosphine lines should be sought to confirm its presence. They also argue they can rule out sulphur dioxide based on their current observations. If it were a signal from sulphur dioxide, they say, other spectral lines should have been present, which they did detect. This is convincing to some. However, "I'm told there has been much scepticism, including from journal referees, about the

detection," tweeted Chris Lintott an astrophysicist at the University of Oxford "JCMT and ALMA were not made to look at things as bright as Venus and this is a difficult observation." However, Greaves and radio astronomers Anita Richards of the University of Manchester "know JCMT and ALMA very well," Lintott added. "I bet the detection is real."


The temperature on Venus' surface is 465 degrees Celsius, but some suspect its clouds could play host to some acid-loving microbes. ESO/M. Kornmesser

If the phosphine detection is confirmed, could there be some non-biological process that is missing from the team's models that could explain it? The researchers tried modelling the complex atmospheric chemistry of Venus to see if they could explain the levels of phosphine they detected. They could only reproduce a signal about a thousandth as strong as what they observed. More exotic ideas fell short, too, including lightning and meteorites. The team also argues that observed volcanic activity on Venus cannot account for all the phosphine. However, Filiberto thinks that conclusion may be premature.

He has co-authored two papers in the last year reporting evidence of fresh lava flows on Venus' surface. That would mean the planet "is a lot more volcanically active than we thought," he says. "And we don't know what gases are coming out of those volcanoes." (An independent team at ETH Zurich and the University of Maryland reported further evidence of Venusian volcanism in July.) These volcanoes could be pumping phosphine directly into the atmosphere, Filiberto says. They could also be belching hydrogen, which might allow phosphorus acid from the atmosphere to react and form phosphine, thanks to the high temperatures near the surface. "I don't think we can discredit this at this point and say it can't be volcanoes, or at least that there can't be a volcanic contribution."

There is also the intriguing possibility that the chemistry of Venus is simply stranger than expected. "The team, I think, did a nice job in kind of presenting a set of first-order models," says Ehlmann. "But now we can dig a little deeper and consider weird chemistry." For instance, she says, perhaps the modelled chemical reactions behave differently in Venus' extremely acidic environments, or maybe air moves between atmospheric layers in unexpected ways. Then again, maybe the chemistry is not even really that strange, given how little we know about surface conditions on Venus. "Phosphine is easy to make," tweeted Lee Cronin, an inorganic chemist at the University of Glasgow. "Rocks [could] get thrown into the air by some process and react in the atmosphere," he added. "There are just so many…possible options." There is also the possibility the phosphine is coming from a totally unknown source. Sarah Hörst, a planetary scientist at Johns Hopkins University, point out, in a tweet, that in the early 1980s, astronomers detected carbon monoxide on Saturn's moon Titan. Models failed to explain that find for decades. Then in 2008, the Cassini mission discovered that another Saturnian moon, Enceladus, had cracks on its surface that were spraying water into space, effectively injecting it into Titan's atmosphere. Researchers had not included that possibility in their models. "The less you know about an atmosphere," Hörst tweeted, "the harder it is to use a model to draw conclusions about it, and the more careful you have to be about how you use it."

For now, the team behind the phosphine detection is letting the rest of the community digest their work, as well as waiting to see if someone else can explain it. "When I first

heard about it, honestly, I was very sceptical too," says Seager. When the team's models failed to find a non-biological explanation for the phosphine, she admits to having mixed feelings. "Dare I even say, we wanted it to go away," she says. "Like, no one wants to be out there claiming there's life." "And when we got better data," Seager adds, "eventually I had to [say], 'Wow, this is real.'" Now that the work is out there, the team is prepared - even eager - for other researchers to challenge their assumptions. So far, Seager thinks many of the critiques being raised are already addressed by the team in their analysis. "The team has had years … to digest this, and to criticize, and to work through our self-criticism," she says. "We've had reviewers take months to give us more criticisms. So, we've had a long time to sort of cycle through all these. It's been interesting, watching everybody trying to digest this in a day or two, right? All their questions are legit and natural, but they do need to read the paper."

Many scientists argue the most straightforward way to definitively confirm phosphine is to go to Venus and sample it. Fortunately for Venus exploration advocates , a flurry of potential mission are already being planned. NASA has funded a team to study the concept of a flagship mission to Venus that would include Balloons that float through the atmosphere, similar to the European/Russian Vega missions in 1985. The team's mission concept will be considered as part of the ongoing Planetary Science and Astrobiology Decadal Survey - a once-a-decade process that outlines the field's consensus on funding priorities for the next 10 years. A strong recommendation from the Decadal Report, due out by March 2022, is the surest path for NASA to greenlight a Venus mission.


The Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy (VERITAS) spacecraft, seen here in this artist's concept, NASA/JPL-Caltech

The space agency is also currently considering two proposals that target Venus as part of its low-budget Discovery-class mission programme: an orbiter called VERITAS and an atmospheric probe called DAVINCI+. Fillberto, who is a member of the DAVINCI+ team, says the probe could directly detect phosphine as it descends through the dense venusian atmosphere. NASA administrator Jim Bridenstine also seemed to throw his weight behind Venus exploration on Monday, tweeting "It's time to prioritize Venus." Bridenstine went on to call the discovery of phosphine on Venus "the most significant development yet in building the case for life off Earth."

It is not just NASA and academia who have their sights set on Venus; private organizations do, too. Breakthrough Initiatives, a foundation focused on the search for extraterrestrial life created by Russian tech magnate Yuri Milner, announced on Tuesday it was funding a team led by Seager (including Ehlmann and Grinspoon, among others) to investigate the possibility of sending a new mission to Venus. The effort is still in the earliest of stages, with a formal kickoff meeting set for 18 September. And although the team members signed up for this mission development project a while back, Seager says she could not tell them about the phosphine paper until just before it was published. Seager's team also has been talking to the private space company Rocket Lab, which had been independently pursuing their own missions to Venus, with ambitions to launch as soon as 2023. When Rocket Lab got word of the phosphine detection, the company and its CEO Peter Beck even offered to give Seager's team a lift there. Rocket Lab's booster is designed for small satellites, so their spacecraft would be smaller in scale than a NASA

flagship mission, but a fast, cheap, and targeted mission could beat the NASA missions by years. Besides, Ehlmann says, "you don't need a Cadillac spacecraft to do good Venus science."

While detecting Venusian life itself would be challenging, detecting organic molecules - a strong indicator of life - "is actually not that tricky. You can do that measurement relatively straightforwardly. You just need sufficient time in the Venus atmosphere." Grinspoon, however, is reluctant to push phosphine as the sole motivation for a mission to Venus before the detection has undergone more scrutiny. By: Mark Zastrow

Microbes could survive on planets with all hydrogen atmospheres 17 September: Microbes can survive and grow in 100 percent hydrogen atmospheres, suggesting life could potentially evolve on a much broader range of alien worlds than is often considered, a new study finds. Hydrogen is the most common element in the universe. While astronomers have not yet detected any rocky exoplanets with hydrogen atmospheres, they expect such atmospheres to exist, especially around exoplanets known as super-Earths, which have more mass and therefore stronger gravitational pulls than Earth does. Since hydrogen is the lightest of all gases, hydrogen atmospheres should prove much puffier than Earth's, extending so far from the planet's surface that they should be the easiest rocky exoplanet atmospheres to detect, researchers said. However, "astronomers typically do not think of hydrogen-dominated planet atmospheres as conducive to life," said study lead author Sara Seager, a planetary scientist at MIT in Cambridge. There was little previous research on how well life could grow in hydrogen-rich atmospheres, save for microorganisms known to depend on hydrogen gas to survive.


New research shows that planets with all hydrogen atmospheres may be able to host microbial life. sdecoret/Shutterstock

In the new study, researchers investigated how well two different kinds of microbes grew in the lab in 100% hydrogen: the bacterium E. coli, which lacks a nucleus, and yeast, which possesses one. Although neither microorganism normally lives in environments dominated by hydrogen, the scientists found both could reproduce, switching from their preferred oxygen-consuming metabolism to less efficient anaerobic processes. Their growth rates were slower in hydrogen atmospheres, perhaps due to the lack of energy the microbes would normally get from oxygen. E. coli reached numbers roughly half those they would have in regular air, and yeast was hundreds of times less abundant than it would otherwise have been. The researchers noted that although E. coli is a relatively simple microbe, it could generate 45 different gases such as ammonia and nitrous oxide. Such gases might serve as potential signatures of life if detected in exoplanet atmospheres. Next-generation telescopes that are capable of analysing rocky exoplanet atmospheres will come online in the next several years, they added. By: Charles Choi

Astronomers find evidence of an extragalactic exoplanet 24 September: Since the first detection of the first exoplanet in 1992, astronomers have found thousands of others. Indeed, they estimate that the Milky Way is home to 40 billion worlds. So, it is easy to imagine that planets must be common in other galaxies, particularly those that seem similar to our own. However, when it comes to spotting these planets, there is a problem. Other galaxies are so far away and the stars crammed into such a small region

of space, as seen from Earth, that it is hard to identify individual ones let alone the effects of any planets around them. So extragalactic planets have sadly eluded astronomers. Now, Rosanne Di Stefano at the Harvard-Smithsonian Center for Astrophysics along with several colleagues, say they have found a candidate planet in the M51 Whirlpool galaxy some 23 million light years from Earth near the constellation of Ursa Major. This alien world, christened M51-ULS-1b, is probably slightly smaller than Saturn and orbits a binary system at a distance of perhaps ten times Earth's distance from the Sun.

The M51 Whirpool Galaxy NASA, ESA, S. Beckwith (STScI) and the Hubble Heritage Team (STScI/AURA)

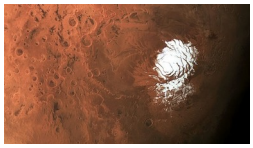
The observation was possible because of a special set of conditions. The planet's host binary system consists of a neutron star or black hole which is devouring a massive nearby star at a huge rate. The infall of stardust releases huge amounts of energy, making this system one of brightest sources of X-rays in the entire Whirlpool Galaxy. Indeed, its X-ray luminosity is roughly a million times brighter than the entire output of the Sun at all wavelengths. However, the source of these X-rays - the black hole or neutron star - is tiny. That means a Saturn-sized planet orbiting a billion kilometres away can completely eclipse the X-ray source, should it pass directly in front in the line of sight with Earth.

On 20 September. 2012, that iss exactly what appears to have happened. Fortuitously, the orbiting Chandra X-ray Observatory was watching at the time. The X-ray source dimmed to nothing and then reappeared, the entire transit lasting about 3 hours. At the time, nobody noticed because the data sets from Chandra weren't being searched for such short variations. However, when Di Stefano and colleagues looked, the tell tale signs were clear to see. There are various reasons why an X-ray source can dim in this way. One is the presence of another small star, such as a white dwarf, that eclipses the X-ray source. The team says M51-ULS-1b cannot be a white dwarf or other type of star because the binary system is too young for such an object to have evolved nearby. Another potential explanation is natural variation, perhaps because of an interruption to the material falling into the black hole or neutron star. Di Stefano and co say in these cases, the luminosity changes in a characteristic way, with higher energy light frequencies changing more quickly than lower energy ones, and switching back on in a different way.

However, in this case, all the light frequencies dimmed and reappeared at the same time, suggesting an eclipse. "It is approximately symmetric, and has a shape typical of transits in which the source and transiting object have comparable size," they say.Now that the first planet candidate in another galaxy has emerged, Di Stefano and co say others are likely to be found quickly. The team scoured just a portion of the X-ray data from Chandra to find this new planet candidate. There is plenty more where that data came from. "The archives contain enough data to conduct surveys comparable to ours more than ten times over," say the team. "We therefore anticipate the discovery of more than a dozen additional extragalactic candidate planets in wide orbits." By: The Physics arXiv Blog

Salty lakes found beneath Mars' surface 28 September: Two years ago, planetary scientists were abuzz with the potential discovery of a subsurface lake on Mars - buried deep beneath layers of ice and dust at the planet's south pole. Now, new research adds more weight to that possibility, suggesting there is not just one but several briny lakes.

These aquifers would represent the first known Martian bodies of liquid water - albeit extremely salty water. Taken with other recent discoveries - such as lakes beneath the surface of the dwarf planet Ceres - it is part of a growing picture that liquid water is more widespread in the solar system than previously thought.


The potential underground salt lake reported in 2018 is located near Mars' permanent south polar ice cap. USGS Astrogeology Science Center, Arizona State University, INAF

In 2018, an Italian team of researchers announced evidence of salt water beneath the southern polar cap of Mars: the radar sounder of the ESA Mars Express orbiter had detected unusually bright, reflective patches below the ice. This, the researchers argued, could be a lake of liquid water 0 kilometres across that melted from the ice cap and was trapped beneath it, over a kilometre beneath the surface. On Earth, similar lakes form beneath glaciers, where heat from the ground and the pressure of the glacier above melt some of its ice. Although Mars is too cold for pure water to remain in liquid form below its glaciers, it could do so if it were extremely salty with a much lower freezing point, the team says. This briny mixture may be filled with perchlorates, salts dissolved from rocks.

However, it was not a slam-dunk case. Mars is not very geologically active, and it's not clear whether the planet's interior can supply the amount of heat to create a lake of that size. Now, the team is back with a new study that they say bolsters their argument. The team returned to data from the Mars Express radar sounder, called MARSIS (Mars Advanced Radar for Subsurface and Ionospheric Sounding). This time they analysed a dataset of 134 radar profiles, compared to 29 in their previous study. They also brought a new approach, adapting radar techniques used by satellites orbiting Earth to image buried geological features. Their analysis looks not just at how bright an area is but other metrics as well, such as how the signal strength varies, indicating how smooth the reflecting surface is. Previously, this method has found subglacial lakes in Antarctica, Greenland and the Canadian Arctic. By running their analysis on sounding data collected by the spacecraft over the previously-identified bright area and comparing it to surrounding regions, the team could see major differences in their characteristics that suggested the presence of liquid water, strengthening the evidence that the original bright patch is indeed a salty lake. In addition, they spotted other, smaller areas that met their detection criteria for liquid water - or came close, suggesting they are ponds or mucky sediments. The prospect of these underground, salty lakes also add an intriguing wrinkle to the debate about whether life could exist on Mars today. The extreme salt content does not sound hospitable for life, but some researchers think it could be possible. By: Mark Zastrow

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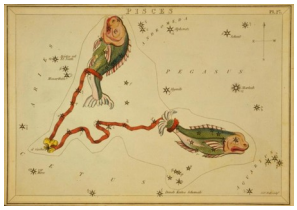
DID YOU KNOW?

Zodiac constellations 8: Pisces

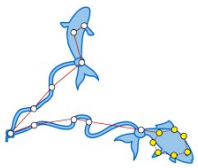


Although the two fish form the 14th largest constellation, the V-shape of Psices (Latin for 'fish") is not prominent. It lies between Aquarius to the west and Aries further east. It is another of the group of water-related constellation in the 'Water' or 'Sea' region of the sky.

The Sun is in Pisces from mid-March to late-April ie at time of vernal (spring) equinox in the northern hemisphere. It contains the point where the Sun crosses the celestial equator from the south into the northern hemisphere on 20 March, each year. It is he point where the zero hours line of right ascension (celestial longitude) and 0 degrees declination (celestial latitude) intersect. Although also known as the first point of Aries, this label proves that orbital mechanics are not fixed. When the system was first established, the vernal equinox occurred when the Sun was in Aries. However, the woblle of Earth caused by precession means that this point is gradually moving west along the celestial equator. Its present position in Pisces will also change and it will enter neighbouring Aquarius in ca 2600 CE.

Piisces has its origin in Babylonian astronomy. In later Greek mythology Pisces represents Aphrodite and her son Eros who transformed themselves into fish, tied themselves together with a rope and plunged into Euphrates to escape the monster Typhon.

Notable features include:



- The Circlet: a ring of seven stars forming the body of one of the fish (yellow dots in diagram)

- M74: a face-on spiral galaxy 30 million ly away. It was discovered in 1870 by the Frnech astronomer Pierre Mechain. It contains many clusters of young stars and associated nebulae, evidence of large regions of star formation. In 2003 Robert Evans discovered a Type ll supernova of a red supergiant in its outer regions. Through a telescope the galaxy appears as a rounded glow with bright centre
- Piscids meteor shower: active from September to October. Its meteors are mostly slow and longish lasting. It is not always recognised as a discreet shower; the activity may be general background from anthelion radiants (a broad weak source of meteors caused by particles of inetrplanetary dust which move faster than Earth entering atmosphere as they overtake us).

Sources: Ridpath, I (Ed) 2012 Oxford dictionary or astronomy Oxford, OUP, Ridpath, I (Ed) 2006 Astronomy London, Dorling Kindersley, 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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