"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

APRIL 2022

Monthly meeting

There is no meeting in April, as the date clashes with the Easter weekend.

2022 meeting dates: For your diaries. The dates of the monthly meetings for 2022 are as follows: 16 May, 20 June, 18 July, 15 August, 19 September, 17 October and 21 November. See above re April.

WHAT'S UP?

Seeing Venus at high noon: Observation of the planets does not always have to wit until daylight fades. Those with keen eyesight and a very careful technique will be able to see Venus in daylight on the 26th and 27th of this month. Venus is present on all the other days, too, but its small size makes it very difficult to see, particularly during the day. On those dates, however, a much large object, the Moon, will be very near Venus, visually, from Earth, and can be used as an aid to finding and seeing Venus. The observer needs to look to the North-west, moving their eyes in from the West and not the North, to **avoid any risk of looking directly at the Sun**. Beginning at eye level, look slowly upwards until the Moon is spotted. Venus will be found a tiny distance lower than the Moon. On the 26th, the Moon will be 11º West of Venus. On the 27th, the Moon will be almost directly above Venus, only 4º to the West.

LAST MONTH'S ACTIVITIES

Memorial gathering for John Saunders

On 17 March, 10 current and past members of the Centre attended a memorial gathering at the Fernkloof hall. Arranged by the Hermanus Bird Club, of which John had also been a member, the sad occasion was countered by the numerous tributes which recorded his enthusiastic nature and the many interests and activities in which he was involved during his life, both here and in the UK. In her presentation about astronomy, Laura Norris noted that John did not just take an active part in the Centre, but was the inspiration for its formation. He was chairman for many years and than a member of the committee. He was also presenter at several montlhy meetings, his enthusiasm for his chosen topics clear.

Over the years, he proposed and/or led many of its wide range of activities which have been or still are provided for both the membership and the wider Hermanus community. These included establishing a very successful committee structure, starting the newsletter and Beginners group and arranging outings to Cape Town, Sutherland and Cederberg. He was also central to the application to the National Lotteries Commission for funding for the proposed observatory (now the Gearing's Point project).

Monthly centre meeting

At the Zoom meeting held on 21 March, Chris Stewart, President of ASSA, gave a very interesting and informative presentation on 'A bit about eyepieces'. His described the numerous permutations and variations in eyepiece design and function, including the internal optics, barrel sizes and available accessories. He then made the important direct link between eyepieces and the way in which the human eye 'sees'. Eyepiece design and use needs to recognise the visual challenges of stargazing, including using only one eye, trying to see very distant, small objects clearly, all in low light and sometimes very cold conditions.. Bearing these factors in mind, he provided guidance on how to optimise the quality of observing through a telescope. Overall, deciding on what to purchase is made very challenging by the wide variety of designs, styles, accessories etc available. Chris's advice when buying eyepieces is to focus on what your particular needs are, building up a useful collection over time, rather than being distracted by and purchasing items which you find you do not use.

Interest groups

Cosmology: At the postponed Zoom meeting, held on 23 March and including members of the Pretoria Centre, Derek Duckitt presented 3 videos. Their titles were 'Is the Universe a giant black hole?','What happened before the Big Bang?' and 'Will the Big Bang repeat?'.

Astrophotography: At the Zoom meeting, held on 14 March, Centre member, Pete Scully, talked about pre=processing of astro-images.

Other activities

Educational outreach: On 3 March, Mick Fynn led a very well-attended tour of the solar system model on the Cliff Path. Participants were particularly impressed with the scale models. He also led a visit to SANSA. Work has also begun on the installation of an analemmatic sundial at Mount Pleasant Primary.

Article in Whale Talk: An article by Jenny Morris titled 'Nabta Playa: The oldest known stone henge and astronomical site' was published in the March / April 2022 issue of the magazine.

THIS MONTH'S ACTIVITIES

Monthly centre meeting: There is no meeting in April. The next meeting will take place on 16 May.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 4 April** will be shown **via Zoom,** starting at **18.30**. Details of the topic and access details will be circulated to members, in due course.

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

Astrophotography: This group meets on the second Monday of each month. Members are currently communicating digitally about image processing they do at home. The next Zoom meeting will take place on **Monday 11 April.**

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

FUTURE TRIPS

No outings are being planned, at present.

2022 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented **via Zoom**, starting at **18.30**. The remaining dates for 2022 are as follows: 16 May, 20 June, 18 July, 15 August, 19 September, 17 October and 21 November.

ASTRONOMY GEARING'S POINT ASTRONOMY EDUCATION CENTRE (GPAED)

The amended proposal has been submitted to the National Lottery Commission. A response from them is awaited.

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.

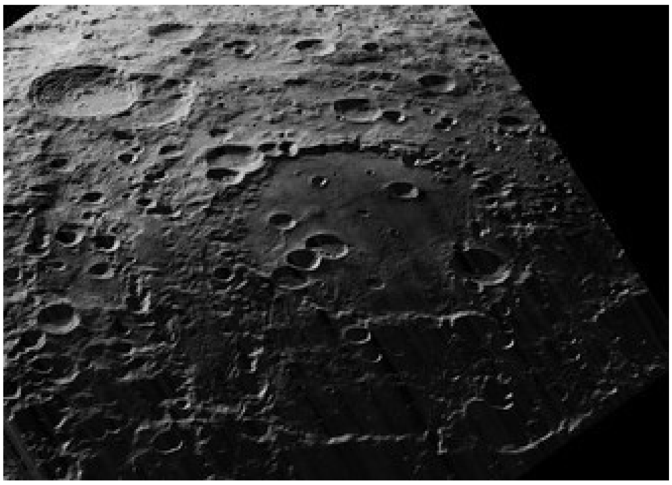
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer, 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

A rogue rocket will crash into the Moon this week, shedding light on cosmic impacts 2 March: On 4 March, a lonely, spent rocket booster will smack onto the surface of the Moon at nearly 10,000 kph. Once the dust has settled, NASA's Lunar Reconnaissance Orbiter will move into position to get an up-close view of the smouldering crater and hopefully shed some light on the mysterious physics of planetary impacts. As a planetary scientist who studies the Moon, I view this unplanned impact as an exciting opportunity. The Moon has been a steadfast witness to solar system history, its heavily cratered surface recording innumerable collisions over the last 4 billion years. However, scientists rarely get a glimpse of the projectiles – usually asteroids or comets – tha form these craters. Without knowing the specifics of what created a crater, there is only so much scientists can learn by studying one. The upcoming rocket impact will provide a fortuitous experiment that could reveal a lot about how natural collisions pummel and scour planetary surfaces. A deeper understanding of impact physics will help researchers interpret the barren landscape of the moon and also the effects impacts have on Earth and other planets.



The rocket is expected to crash into the large Hertzsprung crater – seen in the centre of this photo – just out of view of Earth on the far side of the Moon. *NASA/Lunar and Planetary Institute via Wikimedia Commons*

There has been some debate over the exact identity of the tumbling object currently on a collision course with the Moon. Astronomers know that the object is an upper stage booster discarded from a high-altitude satellite launch. It is roughly 12 metres long and weighs nearly 4,500 kilograms. Evidence suggests that it is likely either a SpaceX rocket launched in 2015 or a Chinese rocket launched in 2014; both parties deny ownership.

The booster may be from a Chinese Long March rocket – similar to the one seen here – launched in 2015.
A Alexander via Wikimedia Commons

The rocket is expected to crash into the vast barrier plain within the giant Hertzsprung crater, just over the horizon on the far side of the Moon from Earth. An instant after the rocket touches the lunar surface, a shock wave will travel up the length of the projectile at several kilometres per second. Within milliseconds, the back end of the rocket hull will be obliterated, with bits of metal exploding in all directions. A twin shock wave will travel downward into the powdery top layer of the Moon's surface, called the regolith. The compression of the impact will heat up the dust and rocks and generate a white-hot flash that would be visible from space if there happened to be a craft in the area at the time. A cloud of vaporised rock and metal will expand from the impact point as dust, and sand sized particles are thrown skyward. Over the course of several minutes, the ejected material will rain back down to the surface around the now-smouldering crater. Virtually nothing will remain of the ill-fated rocket.

If you are a fan of space, you may have experienced some déjà vu reading that description – NASA performed a similar experiment in 2009 when it intentionally crashed the Lunar Crater Observation and Sensing Satellite, or LCROSS, into a permanently shadowed crater near the lunar south pole. I was a part of the LCROSS mission, and it was a smashing success. By studying the composition of the dust plume lofted into the sunlight, scientists were able to find signs of a few hundred kilograms of water ice that had been liberated from the Moon's surface by the impact. This was a crucial piece of evidence to support the idea that for billions of years, comets have been delivering water and organic compounds to the Moon when they crash on its surface. However, because the LCROSS rocket's crater is permanently obscured by shadows, my colleagues and I have struggled for a decade to determine the depth of this buried ice-rich layer.

The accidental experiment of the upcoming crash will give planetary scientists the chance to observe a very similar crater in the light of day. It will be like seeing the LCROSS crater in full detail for the first time. Since the impact is going to occur on the far side of the Moon, it will be out of view for Earth-based telescopes. However, about two weeks after the impact, NASA's Lunar Reconnaissance Orbiter will begin to get glimpses of the crater as its orbit takes it above the impact zone. Once conditions are right, the lunar orbiter's camera will start taking photos of the impact site with a resolution of about a 1 metre per pixel. Lunar orbiters from other space agencies may also train their cameras on the crater.

The shape of the crater and ejected dust and rocks will hopefully reveal how the rocket was oriented at the moment of impact. A vertical orientation will produce a more circular feature, whereas an asymmetric debris pattern might indicate more of a belly flop. Models suggest that the crater could be anywhere from around 10 – 30 metres in diameter and about 2 to 3 metres deep. The amount of heat generated from the impact will also be valuable information. If observations can be made quickly enough, there's a possibility the lunar orbiter's infrared instrument will be able to detect glowing-hot material inside the crater. This could be used to calculate the total amount of heat from the impact. If the orbiter can't get a view fast enough, high-resolution images could be used to estimate the amount of melted material in the crater and debris field. By comparing before and after images from the orbiter's camera and heat sensor, scientists will look for any other subtle changes to the surface. Some of these effects can extend for hundreds of times the radius of the crater.

The impact crater will not be visible from Earth, so scientists will rely on photos from the Lunar Reconnaissance Orbiter. *NASA via Wikimedia Commons*

Impacts and crater formation are a pervasive phenomenon in the solar system. Craters shatter and fragment planetary crusts, gradually forming the loose, granular top layer common on most airless worlds. However, the overall physics of this process are poorly understood despite how common it is. Observing the upcoming rocket impact and resulting crater could help planetary scientists better interpret the data from the 2009 LCROSS experiment and produce better impact simulations. With several missions planned to visit the Moon in the coming years, knowledge of lunar surface properties – especially the quantity and depth of buried ice – is in high demand.   By: Paul Hayne, The Conversation

Astronomers traced this FRB back to a strange place- 3 March: Since 2007, astronomers have been working to unravel the mystery of brief, intense flashes of radio waves called fast radio bursts, or FRBs. In the ensuing decade and a half, they have surmised that these signals likely arise from a type of extremely magnetic neutron stars called magnetars, an extreme class of neutron stars. Magnetars' magnetic fields are 100 to 1,000 times stronger than that of a typical neutron star, and some one thousand trillion times stronger than Earth’s magnetic field. Now, recent work raises new, interesting questions about these cosmic conundrums. An international team of researchers focused on studying a particular repeating FRB has announced two major findings: First, they have traced this FRB back to an unexpected place in its home galaxy. Second, the intense flashes are so short, they must be coming from a region just a few yards across.

Neutron stars are already known for their small size, packing roughly the mass of the Sun into an object the size of Manhattan. This is one reason astronomers think FRBs may be associated with them. In this particular case, astronomers measured the bursts from their target (called FRB 20200120E) lasting as little as 60 nanoseconds, or 60 billionths of a second. That is even shorter than usual for an FRB. “That tells us that [the flashes] must be coming from a tiny volume in space, smaller than a soccer pitch and perhaps only tens of meters across,” said team co-leader Kenzie Nimmo, of ASTRON (the Netherlands Institute for Radio Astronomy) and the University of Amsterdam. These ultra-short, ultrapowerful bursts, the team notes, are similar to outbursts seen from a more run-of-the-mill neutron star, albeit a famous one: the neutron star at the centre of the Crab Nebula (M1). These similarities, the team says, corroborate the idea that the bursts they recorded are from a magnetar, as expected. Further, they suggest that perhaps there is an entire class of ultra-short FRBs, like FRB 20200120E, yet to be discovered. After all, they note, most FRB searches aren't designed to look for bursts on the scale of nano- or microseconds.

M81 is a bright, massive spiral galaxy 12 million light-years from Earth- 40 times closer than the host galaxy of the next-closest FRB. *NASA, ESA, and the Hubble Heritage Team*

That conclusion makes the team's other find even less expected. Thanks to observations of multiple bursts from FRB 20200120E using several radio telescopes, the team tracked the signals back to their point of origin on the sky. This has only been accomplished for a few other FRBs, all located in regions of distant galaxies that house young, massive stars. That makes sense if FRBs come from magnetars, which are themselves the product of high-mass stars that quickly burn through all their fuel before blasting themselves apart. FRB 20200120E, lies in the galaxy M81, a massive spiral just 12 million light-years away. That makes it the closest source of FRBs detected to date - 40 times closer, in fact, than the previous record holder. That is exciting on its own, but it is where in M81 the researchers found FRB 20200120E that is raising eyebrows: a dense, old grouping of stars known as a globular cluster.

This is not the place researchers expect to see magnetars, and not at all like the environments of all other known FRBs. Globular clusters are some of the oldest objects in the universe, full of aging stars, rather than young ones. "We expect magnetars to be shiny and new, and definitely not surrounded by old stars," explained team member Jason Hessels, also of ASTRON and the University of Amsterdam. According to the work, the location of FRB 20200120E challenges the current models of FRB emission, which state that activity in young magnetars only recently formed by a supernova powers these strange blasts. "If what we're looking at here really is a magnetar, then it can't have been formed from a young star exploding," Hessels said. "There has to be another way." That other way could be a long-predicted but never-before-seen phenomenon, in which a white dwarf - the remnant of a Sun-like star - pulls mass from a companion and ultimately tips over a cosmic weight limit, collapsing into a denser neutron star. This is called accretion-induced collapse. Although posited to be rare in a dense region of stars like a globular cluster, it is the simplest and likeliest explanation, the team says.

One other possibility, they add, is that the magnetar powering FRB 20200120E is instead the result of a binary merger between two compact objects, such as two white dwarfs, two neutron stars, or perhaps one of each. Such systems are common in globular clusters, and the result of a merger could also create a highly magnetized neutron star capable of creating FRBs. For now, the mystery of FRB 20200120E's origin remains. And regardless of the answer, this discovery indicates there are likely many ways to create the magnetars believed to power these strange objects. FRBs are continuing to teach astronomers that there is much to learn about how stars evolve - and just how much they can puzzle us, even after their deaths. By: Alison Klesman

A new idea for how dark matter came to dominate the universe 14 March: Eighty-five percent of the matter in the universe is thought to be "dark" matter invisible to humans and our scientific instruments. However, scientists do not know what dark matter is made of or how it was created in the early universe. Now, a group of researchers has proposed a new recipe for the mysterious substance: a dark matter particle colliding with an ordinary matter particle and transforming it into a new dark matter particle. This process would have continued until the universe settled at the amount of dark matter present today. "There are zillions of models to explain dark matter," said Torsten Bringmann, a physicist at the University of Oslo in Norway. "If you write down a model, it should contain a mechanism of how to produce dark matter, how to explain the one thing we know about dark matter - namely, exactly how much there is."

Stars on the edges of galaxies rotate faster than the laws of gravity predict due to an invisible substance called dark matter. *NASA/JPL-Caltech*

Scientists know dark matter must exist in part because the outer edges of galaxies are spinning faster than expected -- so fast that, based on the amount of ordinary matter in galaxies, galaxies should rip apart. Fortunately for us, they still exist. So, there must be some unseen matter helping to hold them together. Dark matter has also been indirectly observed in clusters of galaxies, which also shouldn't hold together, as well as in fluctuations in radiation from the early universe known as the cosmic microwave background. "It's pretty much convincing that there is some form of dark matter in the universe, and that it actually forms a very important component of matter," said Geneviève Bélanger, a physicist at the Annecy-le-Vieux Laboratory of Theoretical Physics in France, who did not contribute to the new paper.

Bringmann said that about 20 years ago, physicists thought dark matter was most likely made of hypothesized but unobserved weakly interacting massive particles, or WIMPs. These particles would interact with ordinary matter via the weak force, which is one of the four fundamental forces in the universe. While it is actually stronger than gravity, the weak force only has influence at the subatomic level. One-way WIMPS might have been created and destroyed in the early universe is by a mechanism called 'freeze-out'. According to this theory, dark matter WIMPs would be packed together with ordinary matter in a dense, hot space in the early universe, allowing two dark matter particles to collide and turn into two regular particles, and vice versa. As the universe expanded and cooled, regular matter particles wouldn't have access to enough energy to collide and create dark matter. The chances of dark matter particles colliding would also approach zero. "If the universe is expanding so quickly, the chances are getting slimmer and slimmer that [dark matter particles] meet," said Bringmann. Over time, the amount of dark matter in the universe would stabilise.

The possible existence of WIMPs is also suggested by separate theories in particle physics. However, physicists have been using particle colliders and underground detectors to search for WIMPs for years, and they have not spotted any yet. This does not mean WIMPs do not exist. Howard Baer, a physicist at the University of Oklahoma, who did not contribute to the paper, said it is possible the WIMPS exist but are avoiding detection. However, Bélanger said that because nobody has seen a WIMP yet, "people are starting to explore alternatives to explain this dark matter." One alternative explanation for dark matter production is a 'freeze-in' mechanism. This hypothesis suggests that little to no dark matter existed at the start of the universe, and standard matter and dark matter particles are connected by some new, undiscovered force that is weaker than the weak force. In the freeze-in case, standard matter particles would collide and produce dark matter over time, eventually stabilizing at the amount of dark matter in the universe today.

Like the freeze-in mechanism, the new mechanism Bringmann and colleagues propose starts with a small concentration of dark matter particles and interactions between particles that are weaker than the weak force. However, instead of claiming standard matter collisions create dark matter, they suggest that a dark matter and standard matter particle could collide and yield two dark matter particles. This would lead to exponential growth in the amount of dark matter, as an increasing amount of dark matter collides with regular matter and produces more and more dark matter. "Once you get into this sort of self-reproductive stage, it will just explode," said Bringmann of the proposed mechanism. Bélanger said it is "a perfectly viable alternative, and it's interesting to consider."

The researchers now must fit this mechanism to a larger model of the evolution of dark matter in the early universe, said Nausheen Shah, a physicist at Wayne State University in Detroit, Michigan, who did not contribute to the new paper. Shah also said that while there needs to be more model building, the authors do introduce the basics for an intriguing simple model in the paper that could work. To test a model, researchers can search for what the model implies they should see in the universe today. Bringmann said that it might be possible to support the simple model by detecting particular distortions in the cosmic microwave background.   By: Will Sullivan, Inside Science

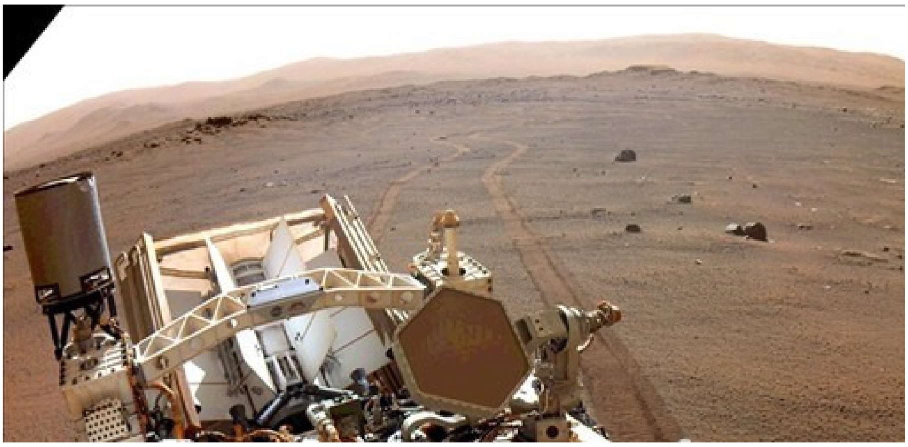
James Webb releases sharpest IR image ever taken from space- 18 March: In early February, NASA engineers began to remotely align the 18 hexagonal segments of the James Webb Space Telescope's primary mirror, which had been folded away for launch. The goal of this meticulous, three-month-long process is to perfectly position the mirror segments relative to each other, creating a single, smooth, 6.5-meter-wide surface that can gather and focus light from the distant cosmos. You may recall earlier snapshots that marked previous milestones. For example, the second of seven milestones was punctuated with a shot taken before the mirrors were fully aligned; it featured multiple images of a single star. Now, NASA has announced the fifth major alignment milestone is complete. Called fine phasing, this step helped to identify and correct small differences between individual mirror segments to bring the infrared universe into sharp, clear focus.

NASA/STScI

It worked: JWST recently snapped the infrared test image above - which focuses on the star 2MASS J17554042+6551277 - using its Near Infrared Camera (NIRCam). Not only is the star a single, clear point of light, but the telescope's optics are so sensitive that fainter background stars, and even galaxies, are clearly visible. (Note that the image was obtained using a red filter to achieve better contrast.) This beautiful stellar portrait - the sharpest infrared shot ever taken from space - verifies the telescope's optics are performing optimally. In fact, they are working so well that engineers are now confident the JWST will not only meet, but in many cases exceed, its science goals.

Two more major steps remain to complete the alignment of JWST's mirror. It is now perfectly set up for the field of view of NIRCam. However, the mirror still must be aligned for the other instruments' fields of view - which may be larger or smaller, or differently shaped. Finally, the segments will again be checked for minuscule misalignments and any lingering issues will be smoothed away. Once complete, hopefully by early May, the team plans to spend two months prepping the instruments for science. If all goes well, NASA expects that by the summer we will be awash in stunning new views of the universe. These portraits will not only reveal the surreal beauty of the cosmos in crisp detail, they will transport us back to a time when the very first galaxies were just starting to shape the universe into the place we see today. By: Alison Klesman

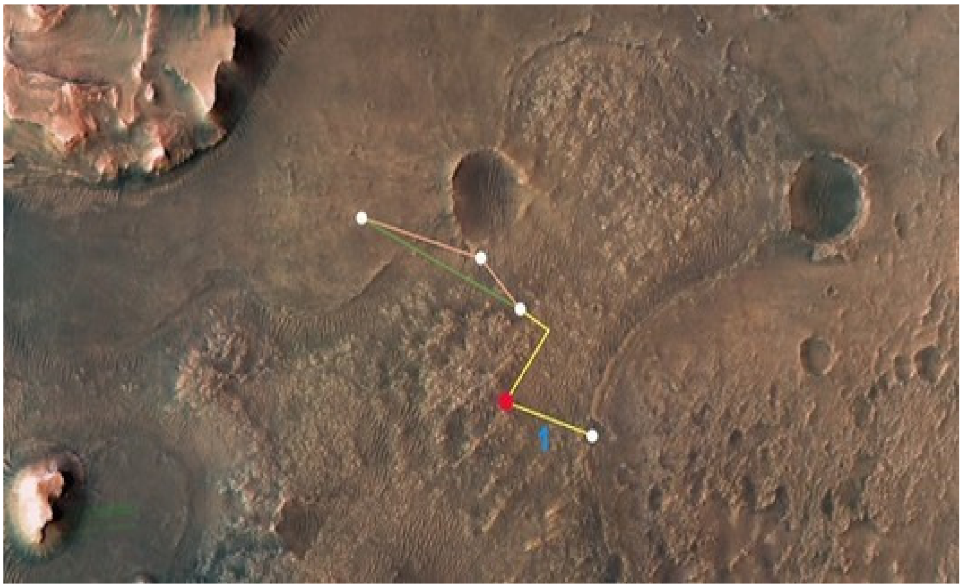
NASA's Perseverance rover begins dash to Martian delta 24 March: Time has been hard to keep track of these past few years. So it may be surprising to learn that NASA's latest rover, Perseverance, has already been traversing the Red Planet for some 13 months. Over that span, the rover has racked up a series of impressive firsts: It released the first helicopter to successfully fly on another world; it harvested oxygen from an alien atmosphere for the first time; and it collected and stored samples that will ultimately become the first Mars rocks to be sent back to Earth for further study. So far, all these feats have been achieved without the rover venturing too far from itslanding site. Now, Perseverance is finally hightailing it to one of its most tantalising destinations: an ancient river delta on the rim of Jezero Crater - a site that may have once been home to microbial life. “The delta is so important that we’ve actually decided to minimize science activities and focus on driving to get there more quickly,” said Perseverance’s project scientist, Ken Farley. “We’ll be taking lots of images of the delta during that drive. The closer we get, the more impressive those images will be.”



NASA’s Perseverance rover snapped this picture looking back at its wheel tracks on 177 March 2022, shortly after setting off for the intriguing river delta on the rim of Jezero Crater. *NASA/JPL-Caltech*

The fan-shaped delta dates back roughly 3.7 billion years, forming when a Martian river deposited sediment at the mouth of a lake that then existed in Jezero Crater. Because deltas experience both flowing liquid water and vigorous mixing, the site is thought to be an ideal location to search for signs of past microbial life. In 2020, Perseverance’s deputy project scientist Ken Williford explained: “That stuff that we find preserved right at the bottom of that beautiful delta in Jezero - that mud - is really fantastic at concentrating and preserving organic matter. And it often does that in a way that’s homogenized and jumbled up. It does not necessarily preserve those beautiful, fossilized structures that you might find at the edge of the lake. But most of the rocks on Earth that are the richest in organic matter are rocks that were formed in a muddy environment.” Perseverance set forth on its 5-kilometre trip to the delta on 14 March, and engineers plan to help the self-driving rover navigate its way there over the course of about a month.

Perseverance will not be alone on its journey. NASA's Ingenuity helicopter will scout ahead of the rover. Ingenuity’s original mission was only supposed to include about five flights over some 30 days at the beginning of Perseverance’s mission. Now, nearly a year after the rover dropped the rotorcraft on the Martian surface, Ingenuity continues to carry out sorties. Just days after its 21st flight, on 15 March, NASA extended Ingenuity’s mission through September 2022. Ingenuity took its 22nd flight on 19 March, which lasted 101.4 seconds and saw the craft fly 68 m horizontally and reach an altitude of 10 m, according to NASA’s flight log for Ingenuity. Over the course of its entire mission so far, Ingenuity has travelled more than 4,700 m, with a total flight time of roughly 40.5 minutes. Despite Ingenuity’s impressive track record, it has mostly flown over relatively flat terrain. That will change in the next several weeks.



Ingenuity has two possible routes (green and peach) it could take on
its journey to Jezero Crater's delta. *NASA/JPL-Caltech/University of Arizona/USGS*

The delta, which spans several kilometres, rises more than 40 m above the floor of Jezero Crater. Although the delta has the potential to hold many promising geological insights - possibly including signs of past microbial life - it also harbours many hazards, such as jagged cliffs, askew boulders, and sandy pockets that could all halt Perseverance's progress. "The Jezero river delta campaign will be the biggest challenge the Ingenuity team faces since first flight at Mars," said Teddy Tzanetos, Ingenuity team lead at NASA's Jet Propulsion Laboratory. "To enhance our chances of success, we have increased the size of our team and are making upgrades to our flight software geared toward improving operational flexibility and flight safety." Once at the delta, Ingenuity will scout possible routes Perseverance could take to climb to the top of the delta. The helicopter's imagery and data will also help the rover's team determine possible science targets to more closely investigate with Perseverance's advanced instrument suite and sample-collection toolkit.

In other words, although Ingenuity may not be vital to the success of Perseverance's main mission, it sure is helpful. "Less than a year ago we didn't even know if powered, controlled flight of an aircraft at Mars was possible," said Thomas Zurbuchen, associate administrator of NASA's Science Mission Directorate. "Now, we are looking forward to Ingenuity's involvement in Perseverance's second science campaign. Such a transformation of mindset in such a short period is simply amazing, and one of the most historic in the
annals of air and space exploration." By: Jake Parkes

Starlink satellite streaks: How big of a problem are they? 25 March: By now you have heard about the SpaceX Starlink satellite constellation currently being launched into low Earth orbit (LEO). Already, more than 2,000 satellites have arrived in their 550 kilometre orbits, with another 2,400 to be added to this Generation-1 constellation in the next few years. Furthermore, the US Federal Communications Commission (FCC) has already given SpaceX approval for the 40,000-satellite Generation-2 constellation, to be completed sometime in 2027. The final $10 billion constellation will generate over $30 billion annually from subscription and hardware sales. There is no way to stop this profitable train from leaving the station. With already a quarter of a million subscribers and millions more on the way Stalink will be a boon for connecting people with high-speed internet even from the middle of the Sahara Desert.

However, against all these successes, we must also measure a few technical downsides. At altitudes of 550 km, the orbital decay time from atmospheric friction is about 10 years.

That means after only a decade, the satellites will slow down enough to essentially fall out of orbit. According to Hugh Lewis, head of the Astronautics Research Group at the University of Southampton in the UK, SpaceX will have to launch over 4,000 of these million-dollar satellites every five years to keep up with re-entries. Meanwhile, the Sun is no friend to these satellites, either. The recent 4 February 2022, geomagnetic storm caused the deorbit of 40 of 49 Gen-1 satellites launched that day. Space weather conditions will significantly impact this untested constellation - especially as the current sunspot cycle approaches its maximum around 2025. What this all means to amateur and professional astronomers is by now a well-known story.

Starlink satellite streaks. *Satellite Streak Watcher/Anecdata.org*

When first placed into a transfer orbit minutes after launch, Starlink satellites can be as bright as magnitude 2.6 stars travelling at high angular speed. A dozen or more follow nearly the same path across the sky, like beads on a string. After a week, they have fanned out to their designated 550 km orbit and fade to about magnitude 5.5 thereafter. This spans the entire domain of apparent magnitudes easily visible with the naked eye, even in some urban environments. Many of you have by now seen Starlink satellites streaking across the twilight sky. You might have even intentionally captured them using wide-aperture star field photography - or unintentionally seen their presence while imaging through your telescope as they photobomb your picture of the Orion Nebula. Services such as Heavens-Above even provide daily forecasts of when and where to look, making it easy for you to capture them. In many ways, this is reminiscent of the Iridium flares that were so popular to watch for in the early 2000s.

However, by the time Gen-2 is complete in five years, 10 times as many streaks will cross the twilight sky and you will not even need a forecasting service to help you spot them and plan your shots! Luckily, at apparent magnitudes of 4 to 6, the satellites will be largely invisible to the light-polluted urban/suburban observer. Since twilight is generally when you are still driving to your dark site, letting your telescope cool down, or perhaps observing the brighter planets, the satellites may not actually be that problematic for amateur astronomers in the hour or so after sunset or before sunrise. However, spiritually and aesthetically, for many people, they are a horrific intrusion on what should have been a pristine moment to reflect on the majesty of space and our place in it.

For professional astronomers and NASA, however, Starlink satellites are considerably more problematic. Luckily again, the vast majority of astronomical research programs at optical wavelengths only begin well after twilight, when the sky reaches its darkest levels. Hunting for an elusive quasar or measuring the distances of high-redshift galaxies takes place long after any Starlink satellite can still be seen via the sunlight reflecting off it. (This is because at twilight, an observer on the ground may be in shadow while the Sun is still visible from high altitudes, causing reflections. Later at night, even satellites fall into shadow and no longer reflect.) However, a growing interest in surveying the entire sky for transient phenomena (such as supernovae) or near-Earth asteroids makes the twilight sky an important piece of real estate. A study published in January 2022 in the Astrophysical Journal provides an important benchmark on just how intrusive Starlink satellites can be.

According to the paper, the Zwicky Transient Facility at Mount Palomar is already affected, even with only a fraction of the final constellation in orbit. In 2021, when only some 1,000 satellites were in place, nearly 20% of the telescope's twilight images had streaks on them. This would also be the case for amateur astronomers getting an early start on photographing their cosmic quarry, from the wide-angle Milky Way to distant deep-space objects. Fortunately for asteroid hunters, at least, the facility's professional image processing software can easily eliminate these streaks, so there is little evidence of Starlink satellites compromising such science goals. With the current numbers of satellites, there was only a 1-in-3,000 chance that a streak would pass over a transient event. It would thus be very unlikely that an asteroid on a collision course with Earth would be missed.

The situation is a bit different for more sensitive telescopes, however, such as the Vera C. Rubin Observatory's 8.4-meter Simonyi Survey Telescope, currently under construction in Chile. Its 3200-megapixel camera will capture about 1,000 images of the sky in 9.6square-degree chunks - every night for 10 years. Each image can detect objects to a limiting magnitude of about 24. It is now expected that up to 30% of its images will contain at least one Gen-2 satellite track. Additionally, a single bright satellite with a magnitude of 5 would not only corrupt the pixels directly under its path across the image, but also produce a 100-pixel-wide (or greater) parallel band of saturated pixels to either side. Every 30-second twilight exposure will have at least one streak across it in the Gen-2 configuration, so that up to 3% of the image area will have to be discarded even if the satellites are dimmed to magnitude 7, equivalent to losing several months of observing time.

Numerous Starlink trails crisscross this image of the Milky Way. *Satellite Streak Watcher/Anecdata.org*

The situation may be far worse for NASA and Department of Defence satellites. Simple maths dictates that 4,000 satellites in Gen-1 spread across a shell with a radius of 550 km leads to an average distance between satellites of about 400 km. For the Gen-2 constellation, this distance is only about 120 km. In February 2022, NASA and the National Science Foundation both submitted letters to the FCC warning that the Gen-2 constellation dramatically increases the collision hazard for LEO spacecraft and satellites. Although SpaceX has equipped each satellite with a collision avoidance system, these have not been tested to show they are scalable from the Gen-1 to the denser Gen-2 constellation. The letters also pointed out that about 20,000 of the Gen-2 satellites would be below the orbit of the International Space Station, thus greatly complicating the ability to find launch windows for the safe transit of cargo and crew missions. Even orbiting observatories are not immune to catching the glint of Starlink satellite reflections. Such reflections may interfere with NASA's fleet of Earth-observing satellites and could double the number of Hubble Space Telescope images that contain satellite streaks - currently 8% of all images.

SpaceX is continuing with its creation of Gen-2 and will use its Starship to accelerate these launches by 2023 or 2024. For now, nothing has altered their business model. All it seems we can do is cross our fingers that a killer asteroid doesn't sneak by in the twilight sky, or that what physics may ordain as the inevitable satellite collision does not also involve loss of life. In 2017, I created a citizen scientist project called Satellite streak Watcher. The intent is to collect images of Starlink satellites streaking across the sky or obscuring targeted deep-sky objects. Over time, this archive will document the degradation of the sky by these satellites. So far, 432 observers have contributed 125 images taken with smartphones, DSLR cameras, and through their telescopes. I invite you to contribute your own examples. All you will require is a steady tripod and a DSLR for the best wide-field results; or you can submit through-the-eyepiece examples of satellites photobombing your favourite deep-sky object! Professional astronomers are following this problem and accumulating
their own archival imagery.

By: Sten Odenwald

Hubble spots the farthest star ever seen- 30 March: The Hubble Space Telescope has imaged the most distant star ever seen. Astronomers identified the supersized star - which almost certainly died in a fiery explosion nearly 13 billion years ago - thanks to a phenomenon known as gravitational lensing. "It took this wonderful cosmic coincidence," said astronomer Michelle Thaller of NASA's Goddard Space Flight Centre. "Everything was lined up perfectly. A nearby cluster of galaxies was lensing space, actually bending space into this natural telescope." Such gravitational lenses are not always so powerful, said Brain Welch, a PhD candidate at the Johns Hopkins University who led the study. "Typically, you know, if you have a lensed galaxy, it would be magnified by a factor of a few to perhaps ten." But here, the configuration was just right, leading to an individual star at the edge of the lensed galaxy being magnified by a factor of thousands. In this case," said Welch, "we just got really lucky with the alignment."

Located 28 billion light-years away (thanks to the expanding universe), 12.9-billion-year-old Earendel, is 50 - 500 times as massive as the Sun and many times brighter. *SCIENCE: NASA, ESA, Brian Welch (JHU), Dan Coe (STScI) IMAGE PROCESSING: NASA, ESA, Alyssa Pagan (STScI)*

The new-found but long-dead star is officially designated WHL0137-LS. However, the researchers have given the ancient beacon the nickname "Earendel", which is an Old English word meaning "morning star" or "rising light". Just a few years ago, Hubble glimpsed another extremely far-off star named Icarus, which shone when the universe was some 9.5 billion years old, or 30% its current age. However, Earendel smashes the record Icarus once held. Earendel lived roughly 12.9 billion years ago, when the universe was just 6 percent its current age. "When the light that we see from Earendel was emitted, the universe was less than a billion years old," said Victoria Strait, a postdoc at the Cosmic Dawn Centre in Copenhagen. "At that time, it was 4 billion light-years away from the proto-Milky Way, but during the almost 13 billion years it took the light to reach us, the universe has expanded so that it is now a staggering 28 billion light-years away."

Earendel shines millions of times as brightly as the Sun and might have weighed as much as 500 solar masses. However, the researchers think it was more likely between about 50 and 100 solar masses. "Stars like that don't live a long time," said Thaller. "So, we're seeing light from a star that probably itself only lived a couple of million years. It blew up long, long ago." "So, it's kind of this wonderful gift from the universe," she added. "A chance to look back in time. A chance to learn more about where we came from, what things were like around here billions and billions of years ago.

Moving forward, Hubble senior project scientist Jennifer Wiseman is hopeful that "as we study it more, [we'll] learn about how it was formed, what it's made of, and start understanding how the earliest stars in the universe contributed to their galaxies and to subsequent generations of stars like our own Sun." "Studying Earendel will be a window into an era of the universe that we are unfamiliar with, but that led to everything we do know," said Welch. "It's like we've been reading a really interesting book, but we started with the second chapter, and now we will have a chance to see how it all got started."

By: Jake Parkes

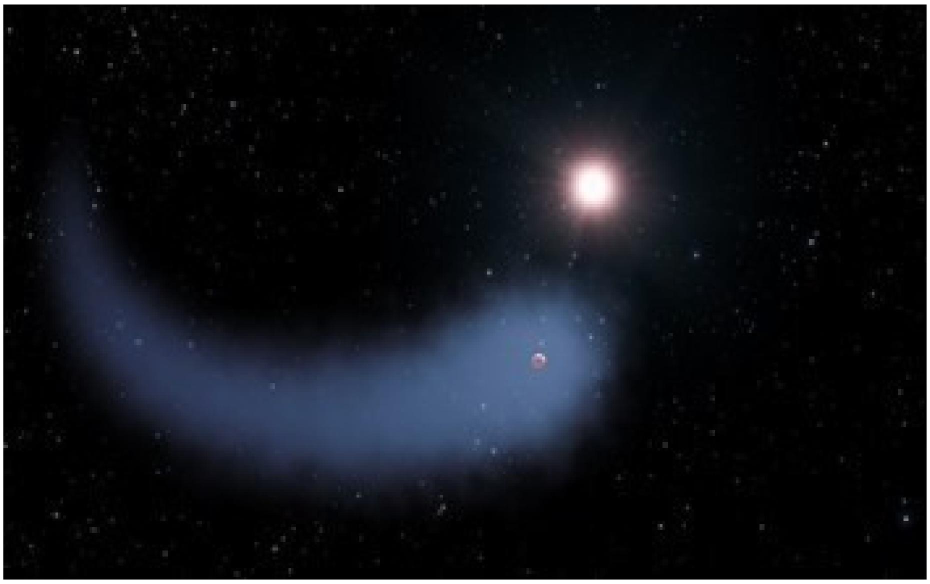
Astronomy's exoplanet boom crests 5,000 confirmed worlds 30 March: Over 400 years ago, Galileo shattered humanity's understanding of the cosmos when he realized that Earth wasn't the centre of the universe, and that our world orbited the Sun, proving Nicolaus Copernicus' theory from the 1500s correct. A mere century ago, astronomers believed the Milky Way comprised the entire universe. It was not until 1925, when Edwin Hubble was able to measure the distance to a star in what became the Andromeda galaxy, that humanity discovered that our 'universe' was only one galaxy in a cosmic ocean. In 1995, astronomers discovered the first exoplanet orbiting another Sun-like star in the Milky Way, further displacing our solar system as unique. Now, just a few decades later, scientists have confirmed over 5,000 exoplanets within our galaxy.

NASA/JPL-Caltech

The new record was reached on 21 March when 65 new exoplanets joined the NASA Exoplanet Archive. The archive tracks exoplanet discoveries that have been published in peerreviewed papers and marks them 'confirmed' when they are spotted or verified with multiple techniques. "It's not just a number," said Jessie Christiansen, science lead for the archive. "Each one of them is a new world, a brand-new planet. I get excited about every one because we don't know anything about them." NASA keeps track of what kind of exoplanets are being found as well. About 35% of the worlds in the archive are Neptune-like, meaning they are similar in size to our solar system's ice giants. However, these worlds may orbit significantly closer to their stars, creating 'warm' Neptunes. Some 31% of planets are super-Earths while another 30% are gas giants like Jupiter. The final 4% are small, rocky worlds.

While exoplanets are often compared to the worlds in our own backyard, there are plenty of strange planets dotting our galaxy. These bodies are certainly one of a kind: **WASP-76 b** In 2013, the European Southern Observatory's Very Large Telescope (VLT) trained its eyes on an exoplanet known as WASP-76 b. This exoplanet, some 640 light-years away, is tidally locked to its star, meaning one side sees endless sunlight while the other perpetual night. Temperatures on the dayside climb to over 2,400 degrees Celsius, meanwhile the nightside sits around a cool 1,500 C. The extreme temperature difference has some strange effects on WASP-76 b's weather. On the dayside, the temperatures are so great that even metals - such as iron - evaporate. Strong winds, caused by the temperature difference, are believed to carry the iron vapour to the nightside where it condenses and rains down to the surface.

WASP-12 b Unlike most of the exoplanets on this list, WASP-12 b's fate is already sealed. Some 1,400 light-years away, this exoplanet orbits a mere (3.5 million kilometres from its host star, a distance so close that the sun is tearing the world apart. The enormous tidal forces caused by the star's gravity have distorted this gas giant into an egg shape. Astronomers estimate that in a mere 10 million years, the star will completely cannibalize the planet. **TrES-2 b** For the darkest skies in the known universe, look no further than TrES-2 b, the planet of eternal night. At just 1.5 times the mass of Jupiter, this alien world reflects less than 1% of sunlight, making it blacker than coal. No planet or moon in our solar system is as dark as this world. However, because its atmosphere is as hot as lava, some researchers suspect a red glow might break through the darkness - an eerie sight for any passing visitors.



An artist's impression of the comet-like cloud of hydrogen surrounding Gliese 436 b as it orbits its star. *NASA, ESA, STScI, and G. Bacon*

Gliese 436 b Here on Earth, ice is accompanied by freezing temperatures, but on Gliese 436 b, where temperatures can reach almost 540 C, ice burns. Orbiting its star at just 4 million km), Gliese 436 b has retained its atmosphere thanks to its Neptune-like size.

However, the same gravity that allows it to hold on to its atmosphere creates enough pressure to force water into a solid state despite the world's high temperatures - similar to how carbon becomes a diamond under strong enough pressure. But this new form of solid water is likely to be vastly different to the ice we are familiar with on Earth. **PSR B1620–26 b,** The oldest known planet in the Milky Way, PSR B1620–26 b orbits a pair of burned-out stars. Surviving the death of not just one but two stars is an impressive feat for the 13 billion-year-old world. And given its age, the world shows that the first planets likely formed rapidly after the Big Bang, possibly within the first billion years.

These are just a taste of the strange worlds in the universe. While NASA has confirmed 5,000 exoplanets, another 6,000 candidates are still waiting to be recognised by NASA's Exoplanet Archive. With an estimated 100 billion exoplanets in the Milky Way alone, there are plenty more discoveries awaiting us in the decades to come.   By: Caitlyn Buongiorno
Source of these and further astronomy news items: www.astronomy.com/news

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

COMMITTEE MEMBERS

Pierre de Villiers	(GPAED project, Vice-chairman)	028 314 0830
Laura Norris	(Treasurer)	028 316 4453
Peter Harvey	(Secretary, Sky notes, newsletter)	028 316 3486
Mick Fynn	(Educational outreach)	082 443 0848
Derek Duckitt	(Chairman, Cosmology group co-ordinator, website editor)	082 414 4024
Pieter Kotzé	(Events co-ordinator, newsletter)	082 581 3233

Non-committee members with roles:

Deon Krige	(Astro-photography)	028 314 1045
Johan Retief	(Membership)	028 315 1132