"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

DECEMBER 2021

Monthly meeting There is no monthly meeting in December. The next one will be held on **17 January 2022.**

Membership renewal for 2022
There will be no increase in fees next year.

The 2022 fees will remain at:
Member: R160
Member's spouse/partner/child, student: R80

Payment can be made in cash (directly to the Treasurer), or via online transfer. The Standard Bank details, for the latter, are as follows:
Account name – Hermanus Astronomy Centre
Account number – 185 562 531
Branch code – 051001
If you make an online donation, please reference your name and 'subs' or 'membership', or it is not possible to attribute the payment to you.

2022 meeting dates For your diaries. The dates of the monthly meetings for 2022 are as follows: 17 January, 21 February (AGM). 21 March, 16 May, 20 June, 18 July, 15 August, 19 September, 17 October and 21 November. There will be no April meeting, as the date clashes with the Easter weekend.

WHAT'S UP?

Partial solar eclipse In a year, 4-7 lunar and solar eclipses can occur, of which at least 2 and, at most, 5 can be solar eclipses. Solar eclipses occur only at New Moon and take place when the Sun, Moon and Earth are in direct alignment. Unlike lunar eclipses, which are visible everywhere experiencing night when the eclipse occurs, total solar eclipses cast a very narrow path across Earth's surface. This is because of the huge difference in size of the Sun and the Moon: the latter's small shadow falls on only a narrow band of Earth's surface. An observer in the central part of the pathway experiences either a total or an annular eclipse. The later occurs when the Moon is at its farthest from Earth and does not fully cover the solar disk, leaving a ring of visible sunlight. For some distance on either side of the central pathway, observers see a partial eclipse, the extent of coverage determined by whether they are closer or further away from the central pathway.

On the morning of 4 December, the total solar eclipse, visible from Antarctica and the south Atlantic will be visible as a partial eclipse in South Africa, with the maximum obscuration being seen in the SW Cape (± 11%). The eclipse will start at 07.42, which maximum coverage at 08.19. Last contact is a 08.58. The next solar eclipse visible from South Africa will be an annular eclipse in February 2026 while the next total solar eclipse over South Africa will occur in 2030.

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the Zoom meeting on 15 November, Centre member, Jenny Morris gave a talk titled 'Cosmic collisions: essence of the Solar System'. Peter Harvey reports: 'Early theories of the origin of our Solar System suggested that the planets, moons and other components may have originated from a molecular cloud captured by the sun, gravitationally condensing into the solid bodies we observe today. Later theories support the very existence of the system as dependent upon collisions, evidenced by the preponderance of craters on planets and moons.

The formation of our moon was formerly thought of as a captured body or a coalescence of accreted material but this has recently been disproved by Apollo missions. It is currently strongly believed to have resulted from a cataclysmic collision with a small planet. The moon itself has been subjected to much bombardment as indicated by the large number of craters. This is common to other bodies with low or non-existent atmospheres such as Mercury and most moons in the solar system. In contrast, very few craters have been detected on Venus with its very dense atmosphere.

Most impacts are from meteoroids originating from the Asteroid Belt. Interestingly, when discussing the physical characteristics of meteoric craters, Jenny informed us that visible craters were formed not by the initial impact but by the explosion of material subjected to very high pressures and temperatures. Hence almost all are circular rather than elliptical and frequently feature a central rebound feature. Of general interest to most of us, she discussed the mineral deposits raised from deep below the surface, resulting in accessible precious minerals such as gold. Also highlighted were the geological and atmospheric consequences of the massive impact of about 66 million years ago at Chicxulub which resulted in the extinction of the dinosaurs and 75% of other species around the globe. Once again, our thanks go to Jenny for her extensive research and clear presentation skills.'

Interest groups

Cosmoloy At the Zoom meeting, held on 1 November, Derek Duckitt presented 2 videos: 'New evidence against dark matter' and 'New evidence against the standard model of cosmology'.

Astro-photography The 8 November meeting was cancelled, as members were attending a stargazing event..

Other activities

Educational outreach No activities took place during November.
Whale Talk magazine An article by Jenny Morris titled 'Naming the rhythms of time' was published in the December 2021 / January 2022 issue of the magazine.

THIS MONTH'S ACTIVITIES

Monthly centre meeting There is no meeting in December.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 6 December** 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

Astro-photography This group normally meets on the second Monday of each month. Members are currently communicating digitally about image processing they do at home. The next Zoom meting will take place on **Monday 13 December.**

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 Members are encouraged to submit their own images for circulation to the membership. Please send them to Peter Havey at petermh@hermanus.co.za

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 dates for 2022 are as follows: 17 January, 21 February (AGM). 21 March, 16 May, 20 June, 18 July, 15 August, 19 September, 17 October and 21 November.

ASTRONOMY GEARING'S POINT ASTRONOMY EDUCATION CENTRE (GPAED)

Municipal agreement has been obtained for this project, which is to be located within the existing whale-watching area at Gearing's Point.. Work is underway to obtain the necessary quotes and other budgetary requirements in order to submit an amended proposal to the National Lottery Commission.

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.

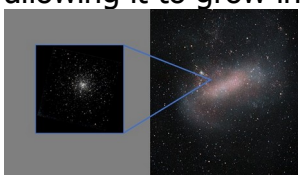
We would, therefore, be very grateful if members could either continue to contribute to the campaign or start becoming a contributor. Both single donations and small, regular monthly donations, of any amount, are welcome. Contributions can take the form of cash (paid at meetings), or online transfer,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

Astronomers confirm the Large Magellanic Cloud is a galactic cannibal 2 November: Galaxies grow by attracting and absorbing smaller galaxies, beefing up their mass along the way. We have ample evidence our Milky Way has done exactly that, as well as a roadmap to how our galaxy will continue to bulk up in the future. We already know the Milky Way is surrounded by a plethora of smaller satellite galaxies that it will eventually devour. The largest of these is the Large Magellanic Cloud (LMC). Now, researchers have shown that the galactic food chain extends even further: They have found evidence the LMC has likewise gobbled up its own share of small galaxies in its past, allowing it to grow into the sizeable satellite we see today.



The Large Magellanic Cloud (right) is the Milky Way's biggest satellite galaxy. One of its globular clusters, NGC 2005 (left), is likely the remnant of a galaxy the LMC once devoured. HLA/Fabian RR/ESO/VMC Survey/Astronomie.nl [CC BY-SA 3.0]

The evidence comes from one of the LMC's globular clusters. These are ancient, compact groups of stars that, because they are so long-lived, can provide clues about a galaxy's history. In this case, researchers studied 11 globular clusters in the LMC, comparing the mix of elements within their stars. One stood out: the cluster NGC 2005, which has fewer elements such as copper, calcium, silicon, and zinc than its brethren. That elemental difference led researchers to surmise that NGC 2005 does not have the same origin story as the other clusters. Instead, it is likely all that's left of a small galaxy the LMC gobbled up billions of years ago. Most of the unlucky galaxy was fully absorbed into the LMC, making it indistinguishable from the LMC's own stars. However, the central region of the galactic snack survived in the form of a globular cluster. The find, the team says, convincingly shows that even small galaxies can prey on each other to grow, more fully completing our picture of hierarchical galaxy evolution. By: Alision Klesman

First crewed Artemis Moon landing delayed until at least 2025 9 November: NASA administrator Bill Nelson today announced a new timeline for near-term Artemis missions, pushing back the first post-Apollo lunar landing until at least 2025. The schedule changes were driven by budgetary constraints, COVID delays, infrastructure and testing delays for the Space Launch System (SLS), and more than six months of litigation related to Blue Origin's unsuccessful legal challenge to NASA's selection of rival SpaceX as the sole winner of the lunar lander contract. "It's clear to me that the agency will need to make serious changes for the long-term success of the program," Nelson said during the Tuesday briefing. He added that the previous administration's target of a 2024 landing "was not grounded in technical feasibility."

Nelson said that after next year's Artemis 1 launch - set for February or March 2022 - the next mission, Artemis 2, will take place no later than May 2024 (instead of April 2023). Artemis 2 will be the first crewed mission to visit the Moon's vicinity in more than 50 years; however, that crew will not land. The first crewed landing, Artemis 3, will now take place no earlier than 2025, Nelson said. NASA still intends to land near the Moon's South Pole for that mission. In another startling announcement, Nelson also said that Artemis 3 will be preceded by an un-crewed landing mission as part of the Human Landing System (HLS) contract awarded to SpaceX. Although not entirely unexpected, this is the first NASA declaration of commitment to an un-crewed landing. NASA officials did not say what the

mission number will be. The un-crewed landing likely allows for more stringent tests of the reliability of the HLS, which, Nelson said, has not had enough Congressional funding.


More than 50 years after the last Apollo mission, Artemis intends to send humans back to the Moon yet again. NASA

Nelson also stressed the need for more competition in the HLS program because, "after all, the Chinese space program is increasingly capable of landing" their astronauts on the lunar surface. He also vowed that NASA will be as aggressive as safely possible with their timeline to "beat our competitors with boots on the Moon" - a seemingly significant elevation in rhetoric. NASA did nix the idea of a direct SpaceX Starship landing for now. However, Nelson said, "We're glad to look at any other alternative," for future options beyond the Orion crew capsule docking with a lunar lander. Meanwhile, NASA is working to consolidate contracts and smooth production of the SLS, which has been criticized for being over budget, behind schedule, and relying on increasingly obsolete technology in a new era of reusable rockets. Nelson also stressed the agency's need for proper spacesuit design and production. James Free, associate administrator of NASA's Exploration Systems Development Mission Directorate, highlighted additional challenges, such as adding crew equipment in Artemis 2 and developing docking capacity.

Of course, all these plans, as Nelson said, depend on funding. That funding will have to take into account an increase in the cost of developing crewed versions of the Orion capsule, which will ferry astronauts to the Moon (without landing on it). Rather than a prior estimated cost of around $7 billion through the second Artemis mission, the agency predicts the true cost will be closer to $9 billion. However, Free stressed that the technology being developed now - including internationally - will serve more than just the Artemis program. That is why the investment needs to be viewed as a down payment on later science and exploration programs, such as crewed missions to Mars. Indeed, Nelson said Artemis is important in order "to learn what we need to" about humans in space "for long durations" before we venture to the Red Planet within the century. He did not, however, speak to the specific value of a long-term human settlement on the Moon, which has previously been part of the agency's public rationale. By: Christopher Cokinos

Long trips to space linked to possible brain damage 10 November: Over the past several years, scientists have published research suggesting that people's brains change after spending longer than a few months in space. These studies started because astronauts experienced issues like vision problems and swollen optic nerves upon returning to Earth after long missions. Researchers are now wondering whether these extended trips to space damage the brain. In a new study of five male cosmonauts (Russian astronauts), researchers looked at levels of different proteins in the blood that are often also seen in people with some sort of head trauma or brain disease. They found that on average, the cosmonauts had higher levels of some of the proteins in the three weeks following the mission than before.


The International Space Station orbiting Earth. NASA

Dr Donna Roberts, a neuroradiologist at the Medical University of South Carolina in Charleston who did not contribute to the new paper, said that more studies need to be done to determine if these changes are clinically significant, but that the new paper is "an example of the type of tests we need to start doing more of" to better understand the effects of the brain's changes during long-duration spaceflight. For over twenty years, humans have been visiting the International Space Station, which orbits Earth more than 320 kilometres above the planet. A typical trip lasts about six months. The space station is in free fall around Earth, so people on the space station experience a state of near weightlessness. Such 'microgravity' is thought to be the main cause of a number of changes the human body can experience while in spaceflight, including the loss of muscles and bone density.

In the last couple of years, brain imaging has also revealed a loss in volume of grey matter, which contains the cell bodies of neurons, and an increased volume of cerebrospinal fluid. Roberts, who uses imaging to study the effect of spaceflight on the brain, has published research showing that in some people who have had long missions on the ISS, their brain has moved up in their head towards the top of their skull, and cerebrospinal fluid occupies more space below and in the center of the brain. However, researchers do not know what these brain changes might mean for people's health and cognition. Dr. Peter zu Eulenburg, a co-first author of the new study, said the previous studies raised questions: "Is there any damage to the brain? Is this really harmful for the cosmonauts?"

To look for evidence of brain injuries, zu Eulenburg and his colleagues measured the levels of five different proteins in the blood of five male cosmonauts both before and after approximately six-month trips to the space station.These proteins are biomarkers that "can tell us about the status of the brain without opening up the brain," said Keisuke Kawata, a neuroscientist at Indiana University Bloomington. Kawata, who studies repetitive head impacts and did not contribute to the study, said that the best fluid for studying biomarkers is cerebrospinal fluid in the brain and spinal cord, but accessing it requires an invasive spinal tap. Drawing blood is much easier, and blood "is the second-best biological fluid to test the brain health," he said. The biomarkers in the study can be used "to indirectly evaluate the extent of damage" due to neurodegeneration or a traumatic injury, said zu Eulenburg, who is a neurologist and professor of neuroimaging at the German Center for Vertigo and Balance Disorders. Neurofilament light chain, for example, is a structural protein that maintains neurons' axons, which transmit signals to other neurons. In a healthy person, "you shouldn't be detecting much of those structural proteins in the blood," Kawata said. But if someone has a neurodegenerative condition, the proteins dislodge from the neurons and can get into the bloodstream.

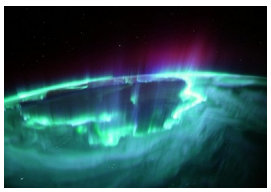
The researchers measured five proteins 20 days before launch and calculated the average level for each protein across the five cosmonauts. They then compared this to the average level one day, one week, and 20 to 25 days after the cosmonauts returned to Earth. Two of the proteins had elevated levels both one day and one week after the missions. These

levels dropped over the next two weeks, but remained above the cosmonauts' baseline level from before the missions. A third protein was not significantly elevated in the first week after returning and had dropped below the baseline after three weeks, so it was not indicative of potential brain damage. For the final two proteins, the researchers typically look at the ratio of one to the other. The ratio dropped after the cosmonauts returned, a trend that is sometimes seen in people with a neurodegenerative condition. zu Eulenburg said that the fact that some levels remained elevated for the entire three weeks was "very surprising," and the results "verified brain injury as a consequence to long-duration exposure to microgravity." "This is obviously a pilot study, but the data quality and the analytics are so robust that I have no doubt in the overall effect," he said.

The seriousness of these effects remains uncertain. Roberts said the paper contains "initial data suggesting that there is some type of injury to the brain," but cautioned that more work needs to be done to show the effect on astronauts' health. Kawata said the paper is not evidence that if you go to space, you're going to get Alzheimer's disease, for example. Both Roberts and Kawata would like future studies to measure the biomarkers for longer than three weeks after astronauts return, as well as while they are on the space station, which would help determine if the elevated levels are due to time spent in microgravity, rather than the change in gravity upon return, or the intense force experienced during landing. Roberts said understanding the cause of the elevated biomarkers would help space agencies figure out which sorts of measures would best counteract the effects. zu Eulenburg thinks time spent in microgravity is the most likely cause, since imaging studies have shown that changes in the brain don't occur for people on shorter trips, so the elevated levels might start while astronauts are still in space.

Kawata said it should not be a big problem if biomarkers are only elevated for a couple of weeks in total. However, zu Eulenburg said via email that three weeks of elevated levels are a sign of a "substantial" reparatory process. Other studies have shown that changes in the brain and cognitive effects last for at least several months after spending months in space, suggesting that elevated biomarkers could last longer than a couple of weeks. "I would feel very cautious about doing a one-year mission aboard the [space station] without sufficient countermeasures in place," said zu Eulenburg. Roberts said she feels confident that science will be able to find ways to protect astronauts from adverse effects. "Ultimately our goal is to become a multiplanetary species… but we have to be smart about it along the way. By: Will Sullivan, Inside Science

Strong aurorae dazzle astronauts on space station 12 November: In late October, NASA's Solar Dynamics Observatory captured an intense flare erupting from the Sun. A few days later, the crew of the International Space Station (ISS) saw what astronaut Thomas Pesquet called "the strongest auroras of the entire mission." Pictured here is a shot Pesquet took of the light show they saw over North America, which included "amazing spikes higher than our orbit … [and] rapid waves and pulses all over." Translated from French, Pesquet's description also reads: "Nature decided to offer us a final bouquet for our departure: the most intense aurora borealis of the whole mission… It drew a veritable crown over the north of America, with peaks that seemed to exceed our altitude, and rapid pulsations which drew blue-green waves, it looked like breathing! We flew through, our noses glued to the windows."


Crew-2 astronaut Thomas Pesquet captured this stunning image of a strong aurora above North America November 4, 2021. The beautiful light show was the result of a recent X-class solar flare. ESA/NASA–T. Pesquet

The striking show occurred because flares such as the one recently emitted from the Sun release waves of charged particles that scatter throughout the solar system. When those particles are captured by Earth's - or any planet's - magnetic field, they smack into atoms in the atmosphere, causing them to heat up and glow. The result is ethereal dancing lights high above the ground: aurorae. Their pattern and movements trace out the magnetic field, while the different colours are produced by various elements in the atmosphere. On Earth, the lights typically stretch from 130 kilometres above the surface at their lowest to hundreds or even thousands of kilometres high. October's solar flare was an X1-class event. X-class flares are the strongest, with those exceeding X10 (which are 10 times stronger than an X1 flare) considered the most extreme. Thanks to its strength, the northern lights put on a fantastic show for many living at high latitudes in the Northern Hemisphere, as well as those in many northern US states.

Aurorae are only one type of space weather, which can affect everything from the normal function of orbiting satellites to astronaut health and safety. According to the National Oceanic and Aatmospheric Administration (NOAA), this particular flare even caused a strong radio blackout, largely affecting South America, on 28 October. Understanding space weather, including the aurorae and other effects they produce, can help us to better understand our Sun, which entered its most recent solar cycle, cycle 25, just over a year ago. Determining when outbursts and storms will occur, as well as what their effects might be, can also help space agencies protect equipment and people outside Earth's blanketing atmosphere, whether they are orbiting the planet or travelling through the solar system. By: Alison Klesman

Near-Earth asteroids could supply future meteor showers 16 November: Every day, thousands of small rocks - dust grain- to pebble-sized - cross paths with Earth's atmosphere and burn up. More organised collisions, known as meteor showers, are visible to us when the planet passes through whole clouds of rocky debris. These fragments were long thought to come strictly from comets whose crusts had been heated by the Sun and cracked open. However, early in 2019, NASA's ISORIS-Rex spacecraft (short for Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer) captured images from the near-Earth asteroid Bennu that flipped that line of thinking on its head. The images showed small bits of rock launching off the asteroid's surface. Some of the rock fell back to the surface and some went into orbit around Bennu for several days, but about 30 percent was ejected with enough speed that its pieces escaped the asteroid's gravity and began to orbit around the Sun. "This was surprising," says Robert Melikyan, a graduate student at the University of Arizona's Lunar and Planetary Laboratory. "Bennu doesn't have a lot of volatile material that can heat up and break up the way comets do." Melikyan and a team of researchers modelled the evolution of the asteroid's dust cloud in a study earlier this year and found that the particles both spread out around Bennu's orbit and follow a similar elliptical path around the Sun.


Bennu ejecting particles from its surface on 19 January 2019. NASA/Goddard/University of Arizona/Lockheed Martin

To explain what was happening, scientists considered that the Sun also bakes Bennu's rocky surface much like it does a comet. The rocks there experience the full force of that heat for about two hours, then cool down as Bennu completes its rotation and faces the cold vacuum of space, says Melikyan. This large range of temperatures is believed to cause stresses and fractures that break Bennu's rocks with enough force to eject some of them off the surface. In addition, scientists speculate that the very small grains of meteorites that hit the asteroid's surface on a regular basis and at high speeds also send many of these fractured pieces aloft. "The chance that these particles will brush up against Earth's atmosphere is quite high [in the] next century when Bennu's orbit is predicted to be closer to Earth," Melikyan says. His team modelled Bennu's orbit to a high degree of accuracy for the years between 1788 and 2135. The simulation shows that the first particle will brush against Earth's atmosphere in the year 2101. Around 2130 and onwards, the model shows a significant increase in meteor showers, with the largest predicted to happen on 24 September 2182.

The authors of the study note that even the 2182 shower would be rather underwhelming, says Andrew Rivkin, a planetary astronomer at the Johns Hopkins University Applied Physics Laboratory who was not involved with the study. "However, the particles would be rather large compared to typical meteors, so they would probably produce impressive fireballs if they were observed," Rivkin says. The best vantage point for the "2182 Melikyan Storm" (mark it in your calendar now!) will be from the southern region of South Africa, where a person might be able to see up to 140 meteors over a one-hour period, says Melikyan.

Today, the Geminid and Quadraritid meteor showers are the only major meteor showers that could potentially come from asteroids; it's possible that their sources are asteroid-like comets instead. "Astronomers have generally classified asteroids and comets as fundamentally different for most of the last few hundred years," Rivkin says. "But we've come to the realization over the past decade or so that at least some objects straddle the line between them." Like Bennu, other asteroids could cause meteor showers if they get close to the Sun, where temperature swings can break their rocks and form clouds of debris. Of course, the farther away asteroids are from Earth, the better. However, if they do get close enough and eject small rocky materials, the resulting meteor showers could be a nice way to see material from asteroids that once orbited in the belt of space between Mars and Jupiter - or even beyond. "The possibility for this type of activity on near-Earth asteroid Apophis during its close approach in 2029 could produce a very beautiful meteor shower," Melikyan says.

In the meantime, there's still a lot to learn about asteroids. "There is a lot of diversity in asteroids and unexpected processes going on that we don't fully understand," Rivkin says. "Learning that Bennu was ejecting material was a huge surprise, but we don't yet have enough data to know how common that behaviour is." By: Theo Nicitopolous

White dwarfs devouring exoplanets reveal exotic types of rock 17 November: With over 4,000 exoplanets identified within our galaxy alone, it can be tempting to imagine that at least a few resemble Earth. However, in truth, scientists have a difficult time figuring out what these bodies are made of - and thus whether they mirror our own planet's composition. To tackle the quandary, astronomer Siyi Xu of the NSF's NOIRlab and geologist Keith Putrika of California State University looked not at exoplanets themselves, but instead at the dead stars that gobbled them up. Dealing another blow for the habitable worlds hunt, Earth-like objects were not at the top of the menu for white dwarfs.


Debris from a former rocky planet spirals into a white dwarf in this artist's concept. NOIRLab/NSF/AURA/J. da Silva; Image processing: M. Zamani and M. Kosari (NSF's NOIRLab)

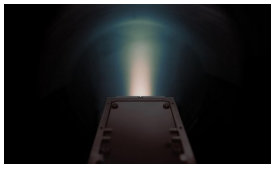
Stars exist thanks to a balancing act between the inward crush of their gravity and the outward pressure from their internal nuclear fusion. When a regular star depletes most of the hydrogen fuel in its core, the outward pressure drops and it begins to tip toward collapse. However, such a star can get a second wind during its red giant phase, when fusion moves out from the core, making the star's core contract and its outer shells expand. This increases the star's temperature enough that it is able to fuse helium into carbon. After this phase, stars like the Sun cannot get hot enough to 'burn' carbon or oxygen. Instead, they completely blow off their outer layers, leaving behind a dense core composed of carbon and oxygen. A thin envelope of helium and hydrogen usually remains, hugging the surface of the stellar cinder. This atmosphere is only a few hundred meters above the surface - so transposing it on Earth would place it below the tops of skyscrapers.

This thin atmosphere is the key to the new study: Because these white dwarf atmospheres are only composed of hydrogen and helium, any other material seen must have come from foreign bodies - such as planets or asteroids. The study looked at 23 so-called polluted white dwarfs within 650 light-years of our system and reconstructed the specific pollutants. The results were not just out of this world, they were out of this galaxy. Xu and Putrika found that the white dwarfs were polluted with material much more exotic than we see within the inner planets of our own solar system - or even in the other 4,000 exoplanets identified in the Milky Way so far. In fact, the researchers even had to create a few new names to describe the rock types they saw. "Some rock types might melt at much lower temperatures and produce thicker crust than Earth rocks," said Putirka, "and some rock types might be weaker, which might facilitate the development of plate tectonics."

The researchers even think one of the white dwarfs devoured an object with an Earth-like composition. Utimately, the differences in observed rock types compared to anything seen in our own solar system drove the researchers to wonder if Earth-like objects truly are rare. And if they are, is there a reason that Earth seems so different than our exoplanetary neighbours? Because of the natural variation in certain elements as one moves further from the galactic centre, the researchers suggest in their paper that "some parts of the

galaxy are more disposed to forming Earth-like planets than others." So, perhaps we're just lucky? By: Caitlyn Buongiorno

Iodine propulsion systems take flight in space 19 November: Right now, there is a unique spacecraft orbiting our planet. Its secret is the iodine propellant it uses to manoeuvre in space. The spacecraft, launched in 2020, is a type of miniaturized satellite called a CubeSat, weighing about 20 kilograms, and it is the first satellite to use iodine to convert electrical energy to ion propulsion. The mission could pave the way for a new generation of smaller, cheaper spacecraft, according to a recent paper.


A satellite iodine electric propulsion system firing in a vacuum chamber. Courtesy ThrustMe

More importantly, iodine fuel may also make it easier to equip more low-earth orbit (LEO) satellites with propellant, which could reduce the amount of future space junk, said plasma physicist Dmytro Rafalskyi, who is one of the paper's authors and works for the French aerospace and research company ThrustMe. Presently, most small satellites orbiting Earth lack propellant. That's because the most common systems are either too expensive or too big to attach to a small satellite. Without propulsion, defunct satellites remain in space, adding to the tens of thousands of useless chunks of space debris. Iodine-powered spacecraft could make a difference. "In 10 years, the majority of LEO satellite propulsion systems will use iodine, I hope," Rafalskyi said. "Nowadays [space exploration is] not sustainable at all because you can't, for example, de-orbit easily."

Rafalskyi and his team have designed an ion propulsion system that would fit inside a cube measuring about 4 inches on a side. That's about half the size of the next smallest system, Rafalskyi said. Ion propulsion is considered one of the most efficient ways to power spacecraft and is used by many larger commercial satellites. Right now, nearly all ion propulsion relies on xenon gas to generate fuel, which is rare and expensive to produce. Iodine, on the other hand, is both more prevalent and more efficient for smaller ion propulsion systems, the team reported. Rafalskyi and colleagues launched their system on board a CubeSat on Nov. 6, 2020, and have since conducted a series of successful maneuvers. The team calculated that their iodine system has an efficiency of 60% compared to the typical 40% seen in the smallest xenon systems.

Rafalskyi sees a lot of potential for iodine, but admits that there are still obstacles to overcome before it can reach full potential. For example, Rafalskyi said iodine is corrosive, which could destroy sensitive electronics within the satellite over time. "So there are obstacles like that, and a lot of engineering problems still, which need to be solved," he said. "But … as soon as we show it's possible and it can work in space, I believe that people will follow." By: Jessica Orwig, Inside Science

Space law has not been changed since 1967 30 November: On 15 November 2021, Russia destroyed one of its own old satellites using a missile launched from the surface of the Earth, creating a massive debris cloud that threatens many space assets, including astronauts onboard the International Space Station. This happened only two weeks after the UN General Assembly First Committee formally recognised the vital role that space and

space assets play in international efforts to better the human experience – and the risks military activities in space pose to those goals.

The UN First Committee deals with disarmament, global challenges and threats to peace that affect the international community. On 1 November, it approved a resolution that creates an open-ended working group. The goals of the group are to assess current and future threats to space operations, determine when behaviour may be considered irresponsible, "make recommendations on possible norms, rules and principles of responsible behaviors," and "contribute to the negotiation of legally binding instruments" – including a treaty to prevent "am arms race in space". The are two space policy experts with specialities in space law and the business of commercial space. We are also the president and vice president at the National Space Society, a non-profit space advocacy group. It is refreshing to see the UN acknowledge the harsh reality that peace in space remains uncomfortably tenuous. This timely resolution has been approved as activities in space become ever more important and – as shown by the Russian test – tensions continue to rise.


The International Space Station is a great example of how space has, for the most part, been a peaceful and collaborative international arena. NASA/Roscosmos

Activities in space are governed by the 1967 Outer Space treaty, which is currently ratified by 111 nations. The treaty was negotiated in the shadow of the Cold War when only two nations – the Soviet Union and the US – had spacefaring capabilities. While the Outer Space Treaty offers broad principles to guide the activities of nations, it does not offer detailed "rules of the road." Essentially, the treaty assures freedom of exploration and use of space to all humankind. There are just two caveats to this, and multiple gaps immediately present themselves. The first caveat states that the Moon and other celestial bodies must be used exclusively for peaceful purposes. It omits the rest of space in this blanket prohibition. The only guidance offered in this respect is found in the treaty's preamble, which recognizes a "common interest" in the "progress of the exploration and use of space for peaceful purposes." The second caveat says that those conducting activities in space must do so with "due regard to the corresponding interests of all other States Parties to the Treaty." A major problem arises from the fact that the treaty does not offer clear definitions for either "peaceful purposes" or "due regard."


Current actions in space are governed by the 1967 Outer Space Treaty that was developed within the UN, seen here. Basil D Soufi/WikimediaCommons, CC BY-SA

While the Outer Space Treaty does specifically prohibit placing nuclear weapons or weapons of mass destruction anywhere in space, it does not prohibit the use of conventional weapons in space or the use of ground-based weapons against assets in space. Finally, it is also unclear if some weapons – like China's new nuclear capable partial-orbit hypersonic missile – should fall under the treaty's ban. The vague military

limitations built into the treaty leave more than enough room for interpretation to result in conflict.


Non-military satellites, like those taking images for weather forecasts, can also serve important military functions. NASA Goddard Spaceflight Center/Flickr, CC BY

Space has been used for military purposes since Germany's first V2 rocket launch in 1942. Many early satellites, GPS technology, a Soviet Space Station and even NASA's space shuttle were all either explicitly developed for or have been used for military purposes. With increasing commercialization, the lines between military and civilian uses of space are less blurry. Most people are able to identify terrestrial benefits of satellites like weather forecasts, climate monitoring and internet connectivity but are unaware that they also increase agricultural yields and monitor human rights violations. The rush to develop a new space economy based on activities in and around Earth and the Moon suggests that humanity's economic development on space will only increase. However, satellites that provide terrestrial benefits could or already do serve military functions as well. We are forced to conclude that the lines between military and civilian uses remain sufficiently indistinct to make a potential conflict more likely than not. Growing commercial operations will also provide opportunities for disputes over operational zones to provoke governmental military responses.

While there has not yet been any direct military conflict in space, there has been an escalation of efforts by nations to prove their military prowess in and around space. Russia's test is only the most recent example. In 2007, China tested an anti-satellite weapon and created an enormous debris cloud that is still causing problems. The International Space Station had to dodge a piece from that Chinese test as recently as 10 November 2021. Similar demonstrations by the US and India were far less destructive in terms of creating debris, but they were no more welcomed by the international community. The new UN resolution is important because it sets in motion the development of new norms, rules and principles of responsible behavior. Properly executed, this could go a long way toward providing the guardrails needed to prevent conflict in space.

The UN Committee on the Peaceful Uses of Outer Space has been addressing space activities since 1959. However, the remit of the 95-member committee is to promote international cooperation and study legal problems arising from the exploration of outer space. It lacks any ability to enforce the principles and guidelines set forth in the 1967 Outer Space Treaty or even to compel actors into negotiations. The UN resolution from November 2021 requires the newly created working group to meet two times a year in both 2022 and 2023. While this pace of activity is glacial compared with the speed of commercial space development, it is a major step in global space policy.

By: Michelle L.d. Hanlon, Greg Autry The Conversation

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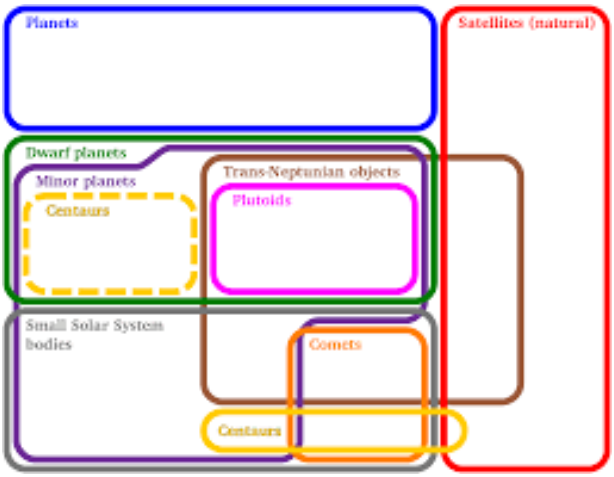
DID YOU KNOW?

Solar system objects Part 5: Overview (5)

Trans-Neptunian objects (TNO)



This category relates to the physical location of object in the solar system., not to its shape or orbital characteristics. It includes any minor planet or dwarf planet which orbits the Sun at a greater average distance than Neptune. Neptune is 30.07 astronomical units (AU) from the Sun. (One AU is the distance between Earth and the Sun: ±150,000 km. Typically, TNOs are located in the Kuiper Belt and scattered disc. They also include objects not confined to these regions. At least a dozen minor planets with obits up to 150 AU are known. They are called extreme trans-Neptunian objects (ETNOs)

The first TNO discovered was Pluto (1930). Although only marginally smaller then Eris, Pluto remains the largest known TNO. Clive Tombaugh, its discoverer, continued searching ,f or several years, for more, but found none. For a long time, no one else followed his example because then planet Pluto, was assumed to be the only major object beyond Saturn. It took until 1992 to discover the next TNO in direct orbit around the Sun. After this, systematic searches for other objects beyond Neptune began. Hundreds of TNOs were found, with diameters ranging from 50 – 2,500 km. Eris was discovered in 2005. It was this which sparked the debate on whether these large objects should be classed as planets or not. Nicknamed Farout, discovery of the most distant solar system object was announced, in 2018. It is about 120 AU away from the Sun.

Over 1,000 TNOs have been found. Of these, at least 100 moons have been discovered orbiting trans-Neptunian objects. TNOs tend to be either grey-blue or very red in colour. They are thought to be composed of mixtures of rock, amorphous carbon and volatile ices such as water and methane, and coated in organic compounds.

TNOs are classified into two large groups according to their distance from the Sun and their orbital parameters. Kuiper Belt objects (KBOs) include those 30 - 55 AU from the Sun. Pluto is a KBO. They usually have close to circular orbits. KBOs are subdivided into two groupings: resonant TNOs (locked into resonant orbits with Neptune) and classical KBOs (not affected by Neptune). The second TNO group is scattered disc objects (SDOs) The scattered disc contains objects further from the Sun, with very eccentric and inclined orbits. Their orbits can extend to over 100 AU. The large dwarf star Eris is an SDO.

The huge distances of TNOs from Earth limits the extent to which they can be studied. This has resulted in conclusions which have later had to be amended eg Eris was considered larger than Pluto until the New Horizon's 2015 flyby. It also means that confirming whether some objects proposed to be dwarf planets can be classified as such is a challenge and a slow process.

Sources: Ridpath, I (Ed) 2012 Oxford dictionary of astronomy 2nd rev ed,, Slotegraaf, A and Glass, I (Eds) 2020 Sky guide: Africa south, britannica.com, en.wikipedia.org

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