"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

NOVEMBER 2021

Monthly meeting This month's **Zoom meeting** will take place on the evening of **Monday 15 November,** starting at **18.30.** Access details will be circulated to members closer to the time. The presenter is Centre member, Jenny Morris. The title of her presentation is '**Cosmic collisions: essence of the Solar System.'** See below for details.

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?

Comet 67P/Churyomov-Gerasimenko Although comets are inherently unpredictable, this is likely to be the best one to view this year. Found in the area between Gemini and Cancer, lowish in the sky, towards the east around midnight, it is scheduled to peak on 2 November. Comets are small bodies of ice and dust which originated in the outer parts of the solar system like the Kuiper Belt and Oort Cloud. Perturbed by the gravitational effects of passing stars, they move into new orbits which bring them into the inner solar system. If their large elliptical orbits come near to Earth, they can be observed as they pass towards or away from the Sun. As solar heat melts the outer nucleus, a gas and dust coma forms around it. The solar wind then sweeps this material into the characteristic tail, which always points away from the Sun. A short-period comet (those with an orbital period of under 30 years), Comet 67P/Churyomov-Gerasimenko has a period of 6.45 years. It became well known as the destination of the Rosetta space probe in the 2000s. The lander, Philae, became the first spacecraft to land on a comet nucleus, although its awkward position meant early loss of the solar-powered communication. Despite this, many new discoveries about the physical and chemical characteristics of the comet and its coma and tail were made.

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the Zoom meeting on 18 October Dr Petri Väisänen, Director of the SAAO in Cape Town, gave an informative and very positive presentation on 'SAAO and SALT in the 2020s'. Against a background of SAAO's recent bicentenary and the upcoming 50th anniversary of the Sutherland telescope facility, Petri outlined current and future developments in astronomy in South Africa. SAAO science is focussed on understanding the fundamental physics of the universe, galactic evolution and the baryon cycle, and finding life in the universe. Thus, it is already working towards answering the questions of the decade, including: Is there another Earth somewhere? And Is there other life in the universe?

The questions of the 2020s are also being addressed with two global developments: multi-wavelength astronomy (using telescopes designed to work at different frequencies eg optical, radio to study the same phenomena) and multi-messenger astronomy (using data from non-radiation sources to answer questions eg gravity waves, neutrino observatories). Petri outlined how the variety of existing telescopes in South Africa eg SALT, MeerKAT are already contributing to both of these approaches and how new and planned installations will further strengthen South Africa's place in international astronomy.

One positive outcome of lockdown and associated advances in digital technology has been a move towards full automation of telescope operation. This has led SAAO to initiate development of the automated 'Intelligent Observatory', particularly at Sutherland. While still able to work independently, linking all the telescopes into a network will also create one huge machine.

Petri's presentation demonstrated how developments in South Africa, along with the launch of the James Webb Space Telescope and construction of several new massive telescopes in other parts of the world are taking astronomy into a new era.

Interest groups

Cosmology At the Zoom meeting, held on 4 October, Pierre de Villiers presented a summary of the transcription of the video by Erik Verlinde titled 'On cosmological evolution in a theory of emergent gravity'.

Astro-photography The 11 October meeting was cancelled.

Other activities

Educational outreach No activities took place during October.
Whale Talk article An article by Jenny Morris titled 'What would happen if the Moon disappeared?' was published in the September/October issue of the magazine**.**

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's **Zoom meeting** will take place on the evening of **Monday 15 November,** starting at **18.30.** Access details will be circulated to members. The presenter is Centre member, Jenny Morris. The title of her presentation is '**Cosmic collisions: essence of the Solar System.'**

Synopsis 'Collisions were central to the formation, evolution and final architecture of the solar system, and continue to influence it. Impacts were more common, and often much larger, during its early history. However, even now, an estimated 25 million, or so, pieces of material enter Earth's atmosphere every day. Most are small or minute and are destroyed by friction in the atmosphere, but larger impactors can reach the surface as meteorites. Rarely, a meteorite can be so large and destructive that it can cause a mass extinction of life on Earth.

Our understanding of the cause of impact craters, like those clearly visible on the Moon and a few places on Earth, has evolved. Initially believed to be created by volcanism, the advent of the atomic and space ages enabled them to be correctly identified as the result of impacts from space. Space missions also showed that impact craters are common throughout the solar system and are found on almost all rocky planets and moons as well as smaller objects, like asteroids.

Valued for their cosmic origins, meteorites are also of great scientific interest. Almost all are billions of years old, and invaluable sources of information about the early solar system. There are three main types, but their internal composition identifies that each solar system object, including asteroids, is unique.

The presentation will include an overview of the physical collisions fundamental to the past and continuing characteristics of the solar system, the history of our understanding of these events, characteristics of impacts and impact craters, and the significance impacts have had on human history.'

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. The next meeting, on the evening of **Monday 1 November** 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 8 November.**

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

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

Other activities **Stargazing** Whilie no events will take place during the coronavirus pandemic, 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.

2021 MONTHLY MEETINGS

Unless stated otherwise, meetings take place on the **third Monday** of each month. For the present, they will be presented **via Zoom**, starting at **18.30**. The remaining date for this year is 15 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
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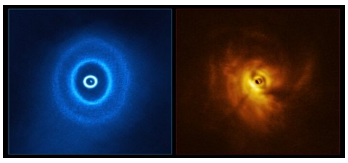
If you make an online donation, please include the word 'pledge', and your name, unless you wish to remain anonymous.

ASTRONOMY NEWS

This may be the first exoplanet found orbiting three stars 7 October: Residing 1,300 light-years away in the famous constellation Orion the Hunter is the triple-star system GW Orionis. Of its three stars, two closely orbit each other, while a third orbits the pair. These stellar triplets are young, still surrounded by a disk of dust, gas, and debris left over from their formation. This disk, called a protoplanetary disk, has caught astronomers' attention for several reasons - not least of which because it may harbour the first known exoplanet orbiting a trio of stars. The disk around GW Orionis consists of three concentric rings of material, none which align with any of the orbits of the system's three stars. Furthermore, the innermost ring doesn't even align with the other rings, and it strangely tilts and wobbles as it orbits. And finally, there's a big gap carved in the disk, which indicates that most the material there has been cleared out. Of course, researchers want to know what's going on in GW Orionis. A recent study may hold the answer: There is a so-called circumtriple planet (or planets) forming within the disk, orbiting all three stars at once.

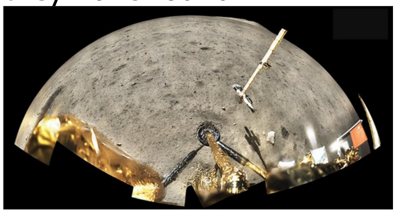


The ALMA image at left shows how the massive disk of gas and dust around GW Orionis is split into rings and gaps. At right, an image with SPHERE shows that the inner region is warped and twisted; the shadow of the inner ring is responsible for the dark spot near the centre. ALMA (ESO/NAOJ/NRAO), ESO/Exeter/Kraus et al.

Gaps in protoplanetary disks are well known for hinting that planets are forming within them. As planets pull in nearby gas and dust to grow, they naturally clear out their surroundings. In this case, researchers were not sure whether the disk's strange behaviour should be attributed to a fledgling planet or to the whirling activity of the three stars within. As it turns out, based on 3D modelling of the system, those three stars can't produce enough torque to clear out the gap in the disk we see. Instead, the researchers say, that gap is most likely due to at least one Jupiter-sized planet forming there. If confirmed, it would be the first ever exoplanet found to orbit three stars. (Although planets have been discovered in just over 30 triple systems to date, none of these worlds orbits all three stars.) The supposed planet or planets would orbit the system about 100 astronomical units (AU) from the centre (1 AU is the average Earth-Sun distance). The stars themselves are much closer together. The tightly orbiting pair are separated by just 1 AU, while the third star orbits some 8 AU from the centre of the system.

Because this research only provides indirect evidence for the first circumtriple planet, the next step will be actually spotting the strange world. Unfortunately, the authors conclude, that's tricky when dealing with a system as complex as GW Orionis. Still, more observations are coming down the pike. And just maybe they will reveal a glimpse at a truly unique young world. By: Alison Klesman

The Moon was volcanically active longer than thought, Chang'e 5 confirms 7 October: In December 2020, China's Chang'e 5 mission touched down on Oceanus Procellarum - a region of the Moon that was once a vast plain of molten lava. The site had been targeted by scientists for decades: Curiously, its surface is somewhat sparse with impact craters, suggested that its last lava flood had occurred quite recently (in lunar terms). Determining its age was one of the mission's top priorities. In all, the Chang'e 5 lander scooped and drilled 1.7 kilograms of lunar material, with its ascent stage delivering them to the grasslands of Inner Mongolia on 16 December 2020 - the first Moon rocks returned to Earth since 1976. The stash was then collected and parcelled out to several research groups. Now, nearly ten months later, scientists are beginning to report what they have found.


The Chang'e 5 mission landed on the Moon on Dec. 1 and lifted off 48 hours later with a stash of lunar rocks. Chinese National Space Agency's (CNSA) Lunar Exploration and Space Engineering Centre

The first major scientific paper detailing mission findings was published today. According to the team's analysis, the samples confirm the relative youthfulness of the landing site's volcanic rocks: 1.96 billion years old, give or take a few tens of millions of years. This is about a billion years younger than any of the volcanic lunar samples returned by the Apollo missions and the Soviet robotic Luna missions. The find indicates that volcanoes were erupting on the Moon as recently as 2 billion years ago - which throws a wrench into our understanding of how bodies like planets and moons form. Scientists think that when such bodies are young, radioactive uranium and thorium sink deep into their interiors. These slowly decay and release heat, which, in a large body, can keep the mantle molten for billions of years. But models suggest that an object as small as the Moon should lose all its heat quickly. "We always said that, OK, 3 billion-year-old basalts is fair enough, probably it can be sustained by this radioactive decay," says Alexander Nemchin, a geochemist at Curtin University in Perth, Australia, and one of the team's leaders. But 2 billion years is too young for current models, he says — "so now we've got a problem." Nevertheless, the result is exactly what scientists hoped for when they chose the probe's landing site, says study co-author Brad Jolliff, a planetary scientist and mineralogist at Washington University in St. Louis. "This actually shows that the main science goal was met — and that's pretty awesome."

The international team that conducted this study includes the Beijing SHRIMP Centre. (A SHRIMP, or sensitive high-resolution ion microprobe, is an instrument used for chemical analysis). "They have one of the best labs in the world," says Jolliff. "It's a really high quality lab, state-of-the-art using the best instrumentation." The team was allocated two grams of Chang'e 5's lunar soil and picked out two tiny fragments that were basaltic rock, volcanic in origin. Then they analysed various isotopes of lead, which are produced by the decay of radioactive uranium and thorium. Since these processes happen at a predictable rate, analysing how much of each isotope exists, relative to each other, allowed the team to determine the age of the samples.

In addition to revealing the age of the landing site itself, the lead isotope measurements will help researchers improve a completely different technique for understanding the Moon's history: counting impact craters. Impacts were much more common in the solar system's youth and eventually tailed off - but scientists do not know exactly how quickly that happened. Measuring the age of the lunar surface and then counting how many craters appear in a given area of that surface allows researchers to calibrate a relationship that can be applied to other surfaces: The more craters it has, the older it is. "We know that kind of in a relative way, and we've known that for many years," says Jolliff. "But to actually put numbers on that … required samples."

To date, the most accurate measurements of the age of the lunar surface that exist were linked to rock samples 3 billion years or older from the Apollo missions and the Luna robotic missions. The Apollo samples also allowed researchers to infer some ages for some young impact craters that had formed within the past billion years. "So we got the stuff less than a billion, and the stuff older than 3 billion," says Jolliff. "[But] there's this big gap of 2 billion years - from 1 to 3 billion years ago - that we had no actually calibrated surfaces. And so this result now gives us that age - and it's right in the middle!" The Chang'e 5 samples will now serve as a key data point in calibrating the crater chronology technique within that intermediate age range.


Aristarchus Crater (at centre) is a large impact crater located within Oceanus Procellarum, seen in this image from the Apollo 15 mission. The crater is also accompanied by evidence of lava flows emptying into Procellarum. It's possible that Chang'e 5 samples include fragments of the impact that formed Aristarchus, which could allow scientists to precisely determine its age. NASA

While this result is clarifying for the history of impact craters, our understanding of how magma could have been spewing from the Moon's surface as recently as 2 billion years ago is murkier - there's no clear source of heat. The simplest explanation is that there were more radioactive minerals buried deep in the Moon than models predict. However, the team says the lead isotope measurements give no indications that Chang'e 5's samples originally contained any more uranium or thorium than samples from the regions visited by Apollo and Luna. Perhaps buried radioactive material can still explain late volcanism if the minerals inside the Moon are different than scientists thought and can melt at lower temperatures, says Nemchin. However, alternative explanations may be required.

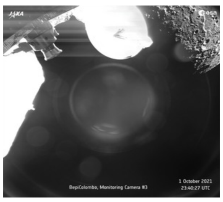
One such hypothesis is tidal heating. Perhaps the tidal force of Earth’s gravity caused the Moon to stretch and deform, heating it and keeping it molten. When the Moon was younger, it orbited closer to the Earth, which would have enhanced this effect. To test either scenario will require more analysis of the samples as well as detailed modelling. One thing is certain, say researchers: The Chang'e 5 samples - and the prospect of more sample return missions in the near-future - are likely to ignite a new wave of interest in the Moon’s volcanism. “When it’s just a suggestion, everybody tends to ignore it,” says Nemchin. “When you're facing real data that confirm it, then that kind of forces you to go back and think. Yes, we suspected that younger basalts are on the Moon. But it wasn't on the forefront of everybody’s thinking. Right now, it's probably gonna be.”

By: Mark Zastrow

BepiColombo snaps its first images of Mercury 8 October: The latest mission to Mercury is off to a great start! On 1 October, BepiColombo - a joint venture between the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) - made its closest approach to Mercury yet, snapping a few images before beaming them back to Earth. Although the new views of the solar system's innermost planet may resemble shots of Moon, they also mark the ground-breaking mission's first (but far from last) up-close images of Mercury. However, the conditions were not ideal for a photo shoot of the tiny planet, and that's because BepiColombo flew by Mercury's nightside. Still, in many of the images, large impact craters are clearly visible.

ESA/BepiColombo/MTM

BepiColombo's cameras captured a number of black-and-white images at a resolution of 1,024 by 1,024 pixels. In many of the images, pieces of the BepiColombo spacecraft are clearly photobombing the views of the diminutive planet, which, due to its proximity to the Sun, is quite difficult to investigate.


ESA/BepiColombo/MTM

Over the next few years, BepiColombo, which is comprised of two orbiters (ESA’s Mercury Planetary Orbiter and JAXA’s Mercury Magnetospheric Orbiter), will reveal as much as it can about this oft-ignored world. In particular, researchers hope to gain a better understanding of Mercury's core, surface activity, magnetic field and exosphere, and, ultimately, how the planet evolved. These new images barely qualify as the start of the multi-year expedition. BepiColombo’s primary mission does not to begin until early 2026. And to get into position, it will complete nine planetary passes (one at Earth, two at Venus, and six at Mercury). The spacecraft's next close flyby of Mercury will be 23 June 2022.

By: Hailey Rose McLaughlin

Swarm of near-Earth comets linked to recent ice giant breakup 12 October:e longest-studied comets in our solar system have inspired ancient myths, religious fervour and modern scientific controversies. Now, the discovery of 88 asteroids and meteoroids orbitally aligned with one of them, Comet Encke, suggests that they all formed from the relatively recent breakup of an even bigger, icy comet. The findings are welcomed by those who believe Comet Encke and the other products of this astronomical event are responsible for many of Earth's most violent and consequential impacts over the last 20,000 years.


Flashinmirror/Shutterstock

Comet Encke was first observed in 1786 and later identified as the source of numerous annual meteor showers. Known collectively as the Taurids, these showers light up the skies of both the northern and southern hemispheres as Earth passes through a stream of debris created by the comet. (This year, look to the stars throughout November for a glimpse of your own.) In the 1980s, however, astronomer William Napier and astrophysicist Victor Clubs suggested that objects larger than your average 'shooting star' had arrived from a similar source as the comet. Early evidence came with the discovery of half a dozen asteroids, up to 1.5 kilometres across, orbiting inside the Taurid meteor stream. According to Napier and Clube, these rocky lumps - far too large to have been left behind by Comet Encke - could be explained by the fragmentation of some giant, 62-mile-wide comet 20,000 years ago. This is comparable in size to the recently discovered Bernardinelli-Bernstein 'mega-comet', thought to be the largest in recorded history. In theory, this momentous breakup produced not just Comet Encke but an entire complex of asteroids, minor comets, pebbly debris and dust, which are today strung out in tightly bound concentric circles around the Sun.

Such a dynamic, unpredictable and well-populated complex capable of frequently getting close to Earth stoked academic imaginations; astronomers began to rewind the clock and look for evidence of Earth's interactions with the Taurids in the archaeological record and beyond. Scientist Richard Firestone, now at the Lawrence Berkeley National Laboratory, in 2007 invoked the Taurid complex to explain global climate cooling at the start of a near-glacial period called the Younger Dryas and the sudden demise of the Clovis culture, a prehistoric people thought to be the ancestors of most indigenous peoples in the Americas. Last year, a team including Napier claimed to have found their own evidence of impact during the Younger Dryas: meltglass and scorched earth deposits that appeared to mark the demise of an early hunter-gatherer community in modern-day Syria.

More recent close calls have also been linked to impactful events. In 1908, a small asteroid known as Tunguska entered the Earth's atmosphere before exploding about five miles above an uninhabited part of Russia. Millions of trees were felled, devastating an area larger than 1,900 square kilometres. Ignacio Ferrin, an astronomer at the University of Antioquia in Colombia, writes in his new book *The Next Asteroid Impact* that Comet Encke was at its minimum distance from Earth two weeks before Tunguska arrived. "That's not a coincidence," Ferrin says. "That implies they are associated, in my opinion."

Now, Ferrin - who previously tracked down the Chelyabinsk meteor that injured more than 1,500 people after breaking up in 2013 - has turned his attention to the Taurid complex itself. Together with Vincenzo Orofino from the University of Salento in Italy, he reanalysed a dozen papers published in the decades since Napier and Clube's original giant comet breakup hypothesis. Together, their orbital analysis of bodies increased the complex's membership from half a dozen to 88. Additionally, using a technique called secular light curves, which looks for changes in each member's brightness along its orbit, the researchers found evidence of cometary activity in 67 percent of the 51 new Taurid members they had good data on. Most of the small bodies near Earth are expected to be long dead - stony worlds dislodged from the asteroid belt. While the orbital alignment of these 88 bodies with Comet Encke itself suggests that they share similar beginnings, Ferrin also sees the material that many of them appear to be releasing into space as a 'smoking gun' for a recently shared cometary origin. Napier welcomes the findings. "Having asteroids in orbits resembling that of Comet Encke indicates either some unknown dynamical process, or that they are degassed fragments of a progenitor comet," he says. "The finding by Ferrin and Orofino that a large proportion of the co-orbiting asteroids show signs of outgassing is evidence of the latter."

What does this mean for our future encounters with the Taurids? David Asher, an astronomer at the Armagh Observatory in Northern Ireland, says the latest work is "helping to build the picture of the original Taurid [forefather] presently having lots of debris in the inner planetary system." Together with Kiyoshi Izumi from the Nippon Meteor Society in Japan, he has predicted two years in the next decade when we are likely to pass near the center of the complex: 2032 and 2036. (Mark your calendars.) While Asher looks forward to a "noticeable enhancement of fireballs," Ferrin is more concerned that the vaporizing and fragmenting Taurid asteroids might leave behind material too small for us to detect - but which could still pose danger if on a collision course with Earth. "The Tunguska cosmic body was 60 to 90 metres in diameter," he says. "We now believe that the Taurid complex may contain many more objects of that size. It is not the tame, simple and innocent complex we thought it was." By: James Romero

Martian floods filled Jezero Crater, Perseverance finds 15 October: NASA's Perseverance rover has spent the last eight months in the dry, forlorn landscape of Jezero Crater. Analysis of some of the rover's first images have confirmed that roughly 3.7 billion years ago, the crater was home to an ancient lake fed by a river - one that occasionally experienced flash floods, washing boulders into the lake from up to tens of mkilometres away.


The tantalising history of Mars' Jezero Crater, which was once home to an ancient river delta and lake, is what pushed NASA to choose the location as the landing site for its Perseverance rover. NASA/JPL-Caltech

When scientists chose Jezero Crater as the landing site for Perseverance, it was precisely because the site bor the hallmarks of an ancient lake. In its northwest corner, a channel leading into the crater ends with a fan-shaped plateau - clear evidence of a river depositing sediment into the lake, forming a delta. Now, scientists know for sure, marking their first efforts at reconstructing the history of this lost waterscape. "This is the key observation that enables us to once and for all confirm the presence of a lake and river delta at Jezero," said Nicolas Mangold, the paper's lead author and a researcher at the Laboratories de Planétologie et Géodynamique in Nantes, France.

The research is based on images taken during the rover's first three months in Jezero by two of its cameras - Mastcam-Z and the SuperCam Remote Micro-Imager (RMI). These cameras were able to zoom in on two regions roughly 2.2 kilometres away from the rover that contained exposed rocky outcrops that were not visible from orbit. Today, they look like buttes or cliffs, but their layers contain a geological record of bedrock that once lay on the bottom of Jezero's lake. One of these features, named Kodiak, is a butte west of the rover with exposed rock layers up to 25 meters high. Several places on the butte feature a distinct structure: a set of layers at a slanted angle, sandwiched between parallel rock layers above and below. "Never before has such well-preserved stratigraphy been visible on Mars," said Mangold. These slanted rock layers - known as foresets - are characteristic of former river deltas: As a river dumps mud and clay into a body of water, that sediment builds up and forms an underwater fan-shaped mound that drops off sharply away from shore. Those underwater slopes eventually become angled rock layers, like those at Kodiak. These features cannot be explained by wind erosion, the team says, confirming that Jezero was truly a lake.

To the northwest of Perseverance's landing site lies the second area featured in the study: the wall of the river delta itself, rising 60 metres above the crater floor, with four different outcrops visible from the rover's vantage point. But what surprised mission researchers was that while the lower levels are made of fine-grained, angled rock layers - similar to those at Kodiak - on top of them was a layer that included "boulders up to 5 feet across that we knew had no business being there," said Mangold. It looks as if they were simply dumped in place - carried by a flooding river, not a slow and steady one.

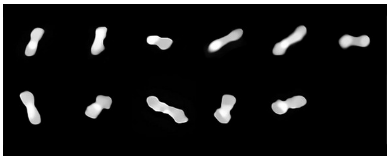

This map shows Perseverance's landing site and the outcrops featured in this study. NASA/JPL-Caltech/University of Arizona/USGS

Taken together, the various outcrops at the delta paint a broad outline of the history of Jezero's lake. The lowest - and oldest - sediment that makes up the delta was deposited by a river that flowed steadily into Jezero crater, slowly building up the delta over time. At some later time, this stable flow was interrupted by episodes of flash flooding. Based on spectral analysis of the boulders, they appear to be a match for a region in the northern highlands, as far as tens of miles away. These floodwaters would have flowed at 6 to 30 km an hour, the team estimates. These ancient Martian floods could have been triggered by intense rainfall, or a sudden melt of snow, perhaps due to a volcanic eruption or a meteor impact. Another option is that the floods were caused by glacial lakes suddenly bursting through their natural dams. Later still, the water level of the lake fell until it was no longer overflowing the crater. It was then that the river laid down the sediment layers at Kodiak. The elevation of the foresets at Kodiak varies, suggesting that the water level of the lake experienced short-term fluctuations, rising and falling as the climate and inflowing river conditions changed.

 This outcrop was once part of a river delta at the northwestern shore of a lake in Jezero Crater. NASA/JPL-Caltech/ASU/MSSS

In addition to unpacking the history of Jezero Crater, the findings also will help mission scientists plan the rest of the mission - especially when it comes to collecting and caching samples that will one day be returned to Earth. To search for signs of ancient life, the mission team will direct Perseverance to the fine-grained material in the lower rock layers - the steady buildup of material may have preserved organic matter or other biosignatures. On the other hand, drilling cores from the large boulders in the higher layers will give researchers the chance to sample material from outside of Jezero itself without having to leave the crater. These rocks will be older than those that formed in the impact itself and could offer insight into the ancient Martian interior. By: Mark Zastrow

Astronomers model the dog-bone asteroid, Kleopatra, like never before 22 October: Go fetch! It is true: 200 kilometres may be a long way for your dog to fetch this cosmic bone. However, thanks in part to two powerful telescopes, astronomers were able to inspect the dog-bone shaped asteroid Kleopatra from afar, revealing the space rock's features in unprecedented detail. Using newly obtained images taken with the European Southern Observatory's or the Very Large Telescope's (VLT) planet finder and the Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE) observatory, astronomers were able to create the best 3D model yet of the oddly shaped asteroid.

 ESO

SPHERE captured a series of images of Kleopatra as it rotated through the asteroid belt between 2017 and 2019. By imaging it at different angles, the researchers were able to get a better overall look at space rock. The observations resulted in two new studies about the far-off asteroid, which calculate the asteroid's length at about 270 km across, and detail how one of Kleopatra's lobes is larger than the other. Kleopatra is not just unusual for its shape, but also because it has two moons. The moons, named AlexHelios and CleoSelene (after the real Cleopatra's children) were discovered in 2008. The new result and resulting model has already shed some light on the correct orbits of the moons, correcting data that predicted them inaccurately.

The rotation of Kleopatra, as well as its rubble-pile form, could ultimately provide more information about how the asteroid's moons came to be. Kleopatra rotates at a critical speed, according to Frank Marchis, a SETI astronomer who published one of the studies. This speed could have been so fast that pebbles lifted off the surface, forming the two moons. As time goes on, more information about Kleopatra and other asteroids will surely emerge. Until then, the solar system's dog-bone asteroid will retain its appeal.

By: Hailey Rose McLaughlin

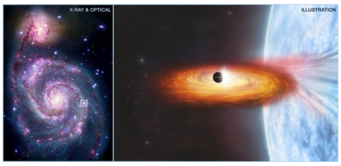
Arp 91 showcases a cosmic union in deep space 26 October: It is really "until death do us part" for the two galaxies of Arp 91. The galactic couple - NGC 5953 and NGC 5954 - are so wrapped up in each other that they've lost their original spiral shapes. The gravitational pull of lower galaxy seen in this Hubble image, NGC 5953, is dragging NGC 5954 down toward it, creating a bridge of stars, gas, and dust between them. The two galaxies live 100 million light-years from Earth, and as the galaxies continue to tug on each other, the shape of Arp 91 continues to evolve.


ESA/Hubble & NASA, J. Dalcanton; Acknowledgment: J. Schmidt

However, massive galaxy collisions like this one take place over many millions or billions of years, meaning we will never see Arp 91 morph during our lifetimes. Still, galaxy collisions are quite common throughout the cosmos, so astronomers can assemble many snapshots and piece together a pretty good timeline detailing how such collisions play out. In fact, our own Milky Way will, one day, collide with our neighbour, the Andromeda galaxy. Such collisions typically form a new, bigger, largely featureless type of galaxy called an elliptical. Elliptical galaxies are often found near the centres of galaxy clusters, and they are generally thought to be the product of galaxy mergers just like Arp 91. The cosmos may always be changing, but it is often at a pace that's far too slow for us to observe. In this case, at least, we get a brief glimpse at the wonderful, eternal galactic union of Arp 91.

By: Hailey Rose McLaughlin

Found: The first exoplanet outside of our Milky Way 29 October: Astronomers believe they have spotted the first extragalactic exoplanet beyond our own galaxy. Residing some 28 million light-years away near the heart of the Whirlpool Galaxy (M51), the binary system M51-ULS-1 consists of either a neutron star or a black hole that's tangoing with a more standard companion star. To find the distant planet hiding in this system, astronomers relied on X-ray data rather than more standard visual observations. "We are trying to open up a whole new arena for finding other worlds by searching for planet candidates at X-ray wavelengths, a strategy that makes it possible to discover them in other galaxies," said study lead Rosanne Di Stefano of the Harvard-Smithsonian Center for Astrophysics. The new research examined three galaxies: M51, M101, and M104. The team targeted more than 200 total star systems within these galaxies using the Chandra X-ray Observatory and the European Space Agency's XMM-Newton. Within all those systems, they found only one exoplanet.


The Whirlpool Galaxy (left) in X-ray and optical light. On the right is an artist's concept of the M51-ULS-1 system with the neutron star or black hole syphoning material from its companion star. The planet is eclipsing the X-rays generated by the superheated material around the compact object X-ray: NASA/CXC/SAO/R. DiStefano, et al.; Optical: NASA/ESA/STScI/Grendler; Illustration: NASA/CXC/M.Weiss

Researchers have mainly used two methods to spot the over 4,000 confirmed exoplanets so far. The radial velocity method measures how a star slightly wobbles when an orbiting planet around it gently tugs on its stellar host. Even though stars hold considerably more mass than the planets around them, even a petite world can cause its star to move around a bit, leaving an imprint in the star's light. The transit method, on the other hand, takes advantage of a planet crossing in front of its star. This briefly dims the starlight by a detectable amount. Even though planets are much smaller than their stars, researchers can measure these small but recognizable fluctuations in brightness.

Although both the radial velocity and transit methods are clearly effective, they are only useful for finding planets out to about 3,000 light-years from Earth. That is still well within the boundaries of our Milky Way galaxy, which is about 100,000 light-years across. In order to find this first extragalactic planet, scientists opted to search for passing planets within X-ray binaries. These systems would contain either a white dwarf, neutron star, or black hole pulling in material from a companion star. As this material falls onto the exotic stellar remnant, it becomes superheated, producing X-rays. Unlike with optical light transits - where a relatively small planet only blocks a tiny amount of starlight - in such binary systems, the area where X-rays are produced is tiny enough that even a planet can block a significant portion (if not all) of the X-ray light. That means that searching for X-ray transits are detectable at a much greater distances than visual transits.

In the case of the M51-ULS-1 system, the black hole or neutron star is closely orbited by a star some 20 times the mass of the Sun. This makes the system one of M51's brightest X-ray binaries. By examining Chandra data, researchers saw that for 3 hours, the X-rays typically emanating from the system dropped to zero. According to the researchers, this suggests that a Saturn-sized exoplanet is orbiting the compact object at some 19.2 astronomical units (AU; where 1 AU is the average distance between Earth and the Sun). That is about twice as far as Saturn is from the Sun.

Of course, an exoplanet isn't the only explanation for why the X-ray signal could have been disrupted. X-ray sources can also be obscured by, say, a cloud of dust passing in front of it. The researchers did consider this explanation, too, but they ultimately concluded it was less likely than an exoplanet.Unfortunately confirming the extragalactic detection will take a long time. With such a wide orbit, the candidate won't pass in front of the source again for another 70 years.

If M51-ULS-1 is a planet, however, the Saturn-sized object has a rather tumultuous history. The presence of a neutron star or black hole means that once upon a time, the system was home to not just the current companion star, but also another dying star. This doomed star would have burned through all of its fuel before erupting as a supernova, bathing any planets nearby with intense radiation. Furthermore, because the system's massive current companion star is still kicking, it is entirely possible that this extragalactic exoplanet may be forced to withstand another nasty supernova in the future

By: Caitlyn Buongiomo

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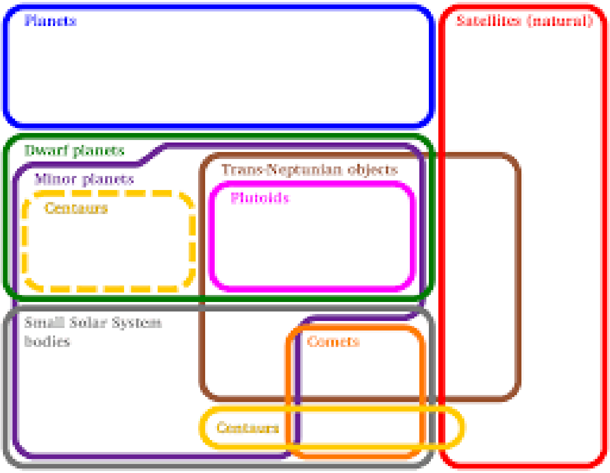
DID YOU KNOW?

Solar system objects Part 4: Overview (4)

Minor planets



These are objects which orbit the Sun, but which are not planets or exclusively classified as comets. Often regarded as referring only to asteroids, minor planets, be definition, also include dwarf planets, trojans, Centaurs, Kuiper Belt objects and other trans-Neptunian objects. Asteroids make up the majority of minor planets. Around a million minor planets, mostly asteroids, are recorded at the Minor Planet Centre.

The term 'minor planet' has a confusing history and meaning. In use since the early 19th century, the first minor planet to be discovered was Ceres (1801). The label became synonymous with both the names 'asteroid' and 'planetoid' (the latter used mainly for the larger objects). Until recently, all these names refereed to objects located in the asteroid belt, between Mars and Jupiter. However, complications arose following the discovery of many minor planets beyond Jupiter's orbit, especially trans-Neptunian objects. The latter are generally not considered to be asteroids, which challenges the previous interchangeability of the terms 'minor plant' and 'asteroid'.

The situation has been addressed, but not resolved. In 2006, the International Astronomical Union agreed that the term 'minor planet' becomes the more general 'small solar system body'. However, it was also agreed that 'minor planet' could still be used. The Minor Planet Centre's name has not changed, and their traditional system of numbering and naming which distinguishes between minor planets and comets is still in place.

Small solar system bodies (SSSB)

These are objects which meet only the first of the three criteria required to be a planet. That is, they orbit the Sun, but are not massive enough to be rounded by their own gravity or to have cleared the neighbourhood around them of smaller objects. This means that, by definition, SSSBs are objects which are not planets, dwarf planets or a natural satellite (moon). The term was first defined at the 2006 meeting of the International Astronomical Union.

The category includes all comets, classical asteroids (in the asteroid belt), except the dwarf planet Ceres, the trojans (asteroids sharing planetary orbits and gravitationally locked to them eg Jupiter's trojans), the Centaurs (bodies between Jupiter and Neptune with unstable orbits resulting from gravitational influences of the giant planets), and trans-Neptunian objects except dwarf planets. No minimum size has been agreed for SSSBs. This means they include all material down to meteoroids, they smallest macroscopic bodies in orbit around the Sun.

Except for the largest, whose mass makes them spheroidal, moons and SSSBs differ from each other not by size, but by orbit. While moons orbit round planets, SSSBs orbit round the Sun. Confusingly, SSSBs can have their own moons, and some do. It is possible that some of the larger SSSBs may, in future be reclassified as dwarf planets, if they are found to be massive enough to be in hydrostatic equilibrium and be spherical in shape.

Most SSSBs are are located either in the asteroid belt or the much more distant Kuiper belt. Smaller concentrations are found in other locations. These include near-Earth objects, trojans, Centaurs, comets and scattered disc objects (in the Kuiper belt region, but have highly eccentric orbits).

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, universetoday.com

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COMMITTEE MEMBERS

Pierre de Villiers	(Chairperson, GPAED)	028 314 0830
Laura Norris	(Treasurer)	028 316 4453
Peter Harvey	(Secretary, Sky notes)	028 316 3486
Jenny Morris	(Vice-chair, events co-ordinator, newsletter)	071 350 5560
Mick Fynn	(Educational outreach)	082 443 0848
Derek Duckitt	(Cosmology group co-ordinator, website editor)	082 414 4024
Deon Krige	(Astro-photography, youth robotics project)	028 314 1045

Non-committee members with roles:

Johan Retief	(Membership)	028 315 1132