"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

JANUARY 2022

Monthly meeting This months **Zoom meeting** will take place on the evening of **Monday 17 January** starting at **18.30.** Access details will be circulated to members closer to the time. The presenter is Centre member, **Johan Retief.** The title of his talk is '**Spaceflight in the 21st Century**'. See below for further details.

Membership renewal for 2022

NB The amended HAC Constitution states that members have until **31 January** to renew their membership. If they have not done so by then, their names will be removed from the membership list.

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?

Orion The most conspicuous summer constellation in the southern skies is the upside-down Greek mythological hunter. Although located adjacent to Taurus, a zodiac constellation, the ecliptic does not pass through Orion and it is not part of that group. Its comparatively small size (26th largest of the 88 constellations) is compensated for by the numerous distinctive celestial objects it contains. These include two of the ten brightest stars after the Sun (red supergiant Betelgeuse (10th) and blue-white supergiant Rigel (7th)) and the huge Orion Nebula (M42) with its adjacent extension (M43). This huge (>20 ly diameter) star-forming cloud of gas and dust, located approximately 1,500 ly away, forms the main part of the hunter's distinctive sword. Orion also contains other nebulae, open clusters and double and multiple star systems. Distinctive red Betelgeuse (which forms the hunter's right shoulder) has been particularly interesting recently. Known to be a variable star whose brightness varies from magnitude 0.0 – 1.3 over a several year cycle, it has recently dimmed significantly more. One proposed explanation for this is that the massive elderly star may be close to experiencing its explosive supernova death. Whatever the cause, because it is located ±500 ly away, what is now visible to us happened approximately half a millennium ago.

LAST MONTH'S ACTIVITIES

Monthly centre meeting There was no meeting in December.

Interest groups

Cosmology At the Zoom meeting held on 6 December, Derek Duckitt presented 3 videos: 'Does anti-gravity explain dark matter?', 'The beginning of the Universe: Sir Roger Penrose on his conformal cyclic cosmology model' and 'What if our understanding of gravity is wrong?'.

Astro-photography The 13 December meeting was cancelled, due to an absence of suitable images on which to work.

Other activities

Educational outreach No activities took place during December.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's **Zoom meeting**, will take place on the evening of **Monday 17 January,** starting at **18.30**. Access details will be circulated to members. The presenter is Centre member, **Johan Retief.** The title of his presentation is **'Spaceflight in the 21st Century'.**

Synopsis More than 50 years ago, Man visited the Moon for the first time. Since then, 12 men had stepped onto the Moon, the last visit being in December 1972. The twentieth century was the first century that rockets began to take off into outer space. Developments since then have been slow but new technologies are being developed and tested, nearly on a daily basis. There is little doubt that visits to the Moon and even to Mars are in the offing within the next two or three decades. How this will happen is still not decided, but really important choices as far as rocket propulsion is concerned will have to be made in this decade. In this talk, I will review developments and also how these developments influence the choices to be made.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. There is no meeting in January. The next meeting, on the evening of **Monday 7 February** 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 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 10 January.**

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 Harvey 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

Will Lunar Vertex solve the mystery of lunar swirls? 1 December: Some lunar scientists call it the most beautiful thing on the Moon: Reiner Gamma, a white, swirling, paisley-like pattern seemingly painted on the far reaches the Moon's northwest quadrant. It is a mystery, one visible through virtually any backyard telescope. And no one knows how it or other so-called lunar swirls got there. Reiner Gamma is the most prominent of this strange class of lunar features. Lacking surface definition - swirls cast no shadows - it has baffled astronomers for a long time. Thomas Gwyn Elger wrote in 1895 that Reiner Gamma consisted of "six ill-defined white spots of doubtful nature…there is a large white marking, resembling a '[mouth] harp' in shape." Nineteenth-century selenographers Wilhelm Beer and Johann Mädler thought it a plateau. So did British lunar expert Edmund Neison. Some early maps mistakenly identified the feature as a crater. Modern science suggests any number of possibilities, all tied to the creation of a strong, highly local magnetic field that keeps the surface from weathering due to the solar wind. But the

Moon has no global magnetic field. So, just why Reiner Gamma and other such swirls are associated with local fields is still unclear, but, it is about to get clearer.

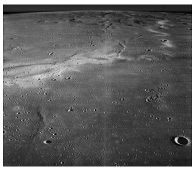

This composite image, made from Clementine data, shows how the Full Moon typically looks from Earth. NASA

David Blewett of the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland, became intrigued by lunar swirls while in graduate school but didn't get to work on them until after finishing his doctorate. He is enthusiastic about their beauty and their scientific potential."The lunar magnetic anomalies/swirls are wonderful natural laboratories that lie at the intersection of geoscience with space plasma physics," he said. "There aren't a lot of situations where 'sky science' and geoscience come together, but that's what you've got in the lunar swirls." Blewett spent years in "advocacy of the scientific wonderfulness" of lunar swirls, an effort culminating in NASA's selection, in June, of the low-cost but ambitious Lunar Vertex mission through the Commercial Lunar Payload Services (CLPS) program. ('Vertex' comes from the Latin for 'whirl' or 'eddy').

Lunar Vertex is the first of the PRISM-class missions, where PRISM stands for Payloads and Research Investigations on the Surface of the Moon. Blewett is principal investigator of the mission, which will be run by APL. However, Lunar Vertex is an international effort, with contributions from Canadensys (an aerospace company near Toronto), which is building the rover's multispectral microscope, as well as researchers in Canada, France, and Sweden. Intuitive Machines, which currently has several CLPS contracts, was awarded nearly $78 million in November to provide lander service via its Nova-C Lander. This 2024 mission is set to land where no one else has put down before: Right in the midst of Reiner Gamma. The lander will release a low-slung rover, built by Lunar Outpost in Boulder, Colorado, and both lander and rover will take magnetic and spectral measurements to determine the origin of lunar swirls - whether they formed when cometary debris struck the surface or through some other process. Lunar Vertex will have just one lunar day - that is 14 Earth days - to solve the puzzle. The solar-powered mission will not survive the frigid lunar night.

Where do lunar swirls come from? Blewett says there are three main hypotheses to explain the formation of lunar swirls. The first two ideas posit external amplification of magnetic fields during impacts on the Moon, either from the gas and dust of a comet's coma or the cloud of vapour and plasma generated by a large, basin-sized impact crater. Such large impacts throw up material, called ejecta, which, in the Moon's low gravity, can travel vast distances and converge on the impact's antipodal point on the opposite side of the Moon. During its journey, the material gets magnetised through "complicated means", says Blewett. In 1980, Peter Schultz and Leonard Srnka proposed hat a comet between 200 to 500 metres in diameter and possibly consisting of two nucleus fragments hit the Moon, creating Reiner Gamma. They even found candidate impact sites for their proposed double impactor: Goddard A and the edge of the crater O' Day. Goddard and its satellite craters are on the Moon's eastern limb in Mare Marginis, while O'Day is on the farside. However, if comets are responsible for this and other swirls, why are there not more of them? After all, as lunar researcher and author Charles Wood writes, "Various studies have shown that impacts from comets should be just as common as those from asteroids."

Additionally, one study failed to show spectral evidence at Reiner Gamma of materials usually associated with comets.

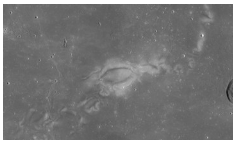

A unique photo, taken by Lunar Orbiter, shows Reiner Gamma in the foreground at left, with the Marius Hills in the background at right. James Stuby based on NASA image

If swirls are associated with impact eject from antipodal impacts, why is Reiner Gamma not antipodal to such an impact? One suggestion from Lon Hood at the University of Arizona's Lunar and Planetary Laboratory and others is that Reiner Gamma might have formed from ejecta from the crater Cavalerius. It might also be a consequence of the huge Mare Imbrium impact nearly 4 billion years ago, an idea that Hood supports. As it happens, Apollo impact breccias are the most magnetic of lunar samples, showing that impacts can induce magnetism. Referencing a 2019 paper he co-authored, Hood suspects that most lunar magnetic anomalies were caused by iron-rich ejecta produced by the impactor that created the basin. For example, "the Imbrium basin is the youngest large basin on the near side of the Moon and many of the magnetic anomalies (including Reiner Gamma) are aligned radial to this basin," he says. So instead of invoking an antipodal impact, his contention is that ejecta - now buried - deposited by the Imbrium explosion is the cause of Reiner Gamma's mysterious white markings.

Hood also says that "the iron-enriched ejecta from Imbrium converged on the lunar farside at the antipode to produce the largest group of strong anomalies on the Moon. Similar concentrations of anomalies are found opposite to several other young lunar basins." The pieces of ejecta would have been so big that they would have cooled slowly, "while they were being magnetized," Hood adds. Any pre-existing magnetic field inside the Moon would have further magnetised the ejecta. Hood says that Reiner Gamma "is perhaps the most enigmatic feature on the Moon and its origin will probably not be fully resolved for a long time." That is because, he says, the feature presents two separate problems: the origin of its magnetic anomaly and the origin of its light-colored curvilinear albedo markings. "The albedo markings are probably a secondary consequence of the magnetic anomaly," Hood adds, "but exactly how … is a continuing mystery". The Lunar Vertex mission will definitely help solve this enigma, he says.

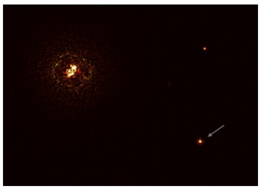
There is a third possibility for the Reiner Gamma magnetic field - and others like it - that does not involve impacts at all. This idea is an endogenic, or internal, possibility, whereby lava cooled on or near the surface at a time when the Moon had its own global magnetic field. As the molten rock solidified, it preserved a record of the field even as the lunar interior cooled and the dynamo that generated the field died. Douglas J. Hemingway and Sonia M. Tikoo suggested in 2018 that "heating associated with magmatic activity" within the Moon might have ramped up localised magnetic fields. "We suggest," they wrote, "that these rocks were likely injected into the crust in the form of dikes and subsurface channels of flowing lava and that they cooled slowly, leading to enhancement of their metal content and enabling the rocks to capture a stable record of the Moon's ancient global magnetic field." If the magnetic anomalies are endogenic, it raises questions about the volcanic and geochemical processes that produced rocks with high abundances of metallic iron, Blewett suggests. What is more, nothing in the Apollo, Luna, or Chang'e smple collections have such compositions.

Whatever their cause, it seems that localised magnetic fields shield the surface from the normal space weathering that darkens the regolith in non-magnetic areas. It is also possible that local electromagnetic effects cause the high albedo, or reflectance, of the swirl by prompting the movement of electrostatically charged dust over the swirls. How strong are those fields? Blewett says, "We don't actually know the strength of the local field down on the ground within one of the magnetic anomalies. That will be one of the major contributions of Lunar Vertex! However," he adds, "it is unlikely that the fields are strong enough to protect the surface (or people or equipment) from dangerous high-energy radiation like cosmic rays or solar energetic particles."


This snapshot shows Reiner Gamma at it looks face-on, the way observers will see it on the lunar face. NASA's Scientific Visualization Studio

Amateur astronomers do not have to wait for 2024 to explore lunar swirls. Reiner Gamma is the most impressive and easily located, but there are four other swirls that amateurs can look for on the nearside, according to John Moore's 'Features of the Near Side of the Moon'. On the eastern limb near the crater Goddard, the Mare Marginis swirls are wispy and less concentrated than Reiner Gamma. In the lunar southwest, north and east of the crater Sirsalis, is a swirl that seems to have a darker twin next to it. Not too far away, east of the crater Lohrmann, is another swirl that Moore says looks like an octopus and Blewett calls "a little swirlette shaped liked a capital omega." The hardest to spot may be a bright loop between Airy and Parrot C. Blewett also adds to the list "a diffuse bright spot between craters Dollond E and Descartes C." This is south of where Apollo 16 landed, in an area with a strong magnetic field. By: Christopher Cokinos

Giant exoplanet found around most massive planet-hosting stars known 8 December: The planet b Centauri b arguably should not even exist — but the picture above is confirmation that it does. The image, taken by the Very Large Telescope at the European Southern Observatory in Chile, shows the binary star system b Centauri at left, its two stars not quite resolved. At magnitude 4, b Centauri, located some 325 light-years away, is visible to the naked eye - though it is not to be confused with Beta (β) Centauri, which is one of the brightest stars in the sky. The arrow in the image above points to the planet. By convention, the first discovered planet in a system is given the suffix "b", which results in the unusual name: b Centauri b. It's a gas giant orbiting its host stars at a distance roughly 560 times that of Earth from the Sun. This makes it one of the most distant exoplanet orbits yet found. (The apparent rings around the star and planet are image artefacts, and the object in the upper right is an unrelated background star.)


The apparent rings around the b Centauri b binary star system (left) and its planet (right; marked by arrow) are artefacts from the coronograph used to block out light from the host stars, reducing their glare. ESO/Janson et al.

The planet's mass is roughly 11 times that of Jupiter, which places it in the upper range of objects that can still called planets. Objects with masses of 13 Jupiters or more are classified a brown dwarfs or failed stars. However, it is the two host stars that make this system truly unlike any other astronomers have yet seen: The stars have an estimated combined mass of six to 10 times that of the Sun. That may not seem like much, but it is at least twice the mass of any other known star (or stars) confirmed to host a planet. The system's larger star is of spectral type B, the second-hottest category. The problem with forming planets around such hot stars is that they emit lots of powerful ultraviolet and X-ray radiation, which ought to disrupt the planet-forming process. "Finding a planet around b Centauri was very exciting since it completely changes the picture about massive stars as planet hosts," said Markus Janson, an astronomer at Stockholm University in Sweden.

The find raises the possibility that b Centauri b formed through a different process than conventional theory predicts. That theory is a bottom-up model called core accretion, in which dust grains in the protoplanetary disk - which surrounds the fledgling star - begin glomming on to each other. Eventually, these snowballing dust grains grow to form concentrated planetary cores that begin to capture more rocky debris. If they're massive enough, they can start collecting gas to form an atmosphere. Perhaps a planet as massive as b Centauri b formed through a top-down process, more like a star: The planetary disk itself could have been large enough to support the existence of a gas cloud that eventually collapsed under its own weight, directly forming a planet.

This artist's concept depicts b Centauri b orbiting at 560 times the Earth-Sun distance - an orbit comparable to the average distance from the Sun of the dwarf planet Sedna. ESO/L. Calçada

Astronomers have reason to think there may be many more planets like b Centauri b that have been previously overlooked. That is because most large direct imaging surveys to date have focused on Sun-like stars. There are also some planet candidates that have not yet been confirmed that orbit even more massive stars. Those include M51-ULS-1, a recent candidate discovered in the galaxy M51 that may be orbiting a binary system with a mass of at least 20 solar masses. "We have always had a very solar system centric view of what planetary systems are 'supposed' to look like," study co-author Matthias Samland, an astronomer at the Max Planck Institute for Astronomy in Heidelberg, Germany, said. However, he says, over the last decade, the diversity of discovered planetary systems has forced us to "widen our historically narrow view. This discovery adds another exciting chapter to this story, this time for massive stars." By: Mark Zastrow

Technosignature from Proxima Centauri - and why astronomers rejected it 9 December: On 29 April 2019, the Parkes Radio Telescope in New South Wales, Australia, picked up an unusual signal while searching for signs of intelligent life elsewhere in the universe. The telescope was observing Proxima Centauri, the nearest star to the sun and host to a number of exoplanets that are potentially habitable. The search was part of a project called Breakthrough Listen, which is hunting for technosignatures from other civilizations. These searches gather vast amounts of data. So, the first task is to filter the interesting signals from the background. In theory, a technosignature must have two important properties. The first is that it must be confined to a narrowband of frequencies with high information content, just like radio broadcasts on Earth. No known natural process can produce signals like this. The second is that the frequency of the signal must drift in a way that is consistent with the motion of an exoplanet relative to the Earth. The drift is the result of the relative accelerations which causes a slight Doppler shift. So, Sofia Sheikh at the University of California, Berkeley and colleagues created a filter that automatically separates signals with these properties from all the others the telescope picks up. They found over 4 million of them.


Located in Austrailia, the CSIRO Parkes Radio Telescope picked up the strange signal stemming from Proxima Centauri. CSIRO/A. Cherney

To help pick out false alarms, the telescope regularly switches from its target to point in other directions. That allowed Sheikh and co to discount any signals that continued in both periods. That left just 5160 hits. The team further filtered out any signals in the range of known radio transmitters and any with a drift that corresponds to the motion of satellites. That left a single unexplained event. The team describes it as a narrowband signal with characteristics broadly consistent with a technosignature, which appeared during a 2.5 hour period of observation but only when the telescope was pointing towards Proxima Centauri. "The event does not lie within the frequency range of any known local radio-frequency interference, and has many characteristics consistent with a putative transmitter located in another stellar system," say Sheikh and co. They called this signal of interest Breakthrough Listen Candidate 1 or BLC1 and it has been the subject of an extraordinary investigation.

Attributing a signal to an alien civilisation is the hypothesis of last resort. Before that, every conventional explanation has to be explored and refuted. So Sheikh and co undertook a remarkable investigation into the possibility of complex but conventional explanations. They began by re-observing Proxima Centauri earlier this year, exactly two years after the first observation, to replicate as far as possible the initial observing conditions. During these observations, they found no evidence of a signal similar to BLC1. They then re-examined the possibility that a moving transmitter nearby could be the source — a car, train, helicopter, plane, balloon etc. Perhaps such a moving transmitter could reproduce the observed drift on BLC1.

The problem with this explanation is that BLC1 appeared for several hours. The team could find no reasonable trajectory that reproduced the drift for such a long period of time. "It is extremely difficult to construct a continual motion path that could persist as exhibited by the measured signal, even by varying the speed along the route," they concluded. They came to a similar conclusion that satellites could not be the source. Low Earth Orbit satellites move too quickly to be observed over such a long period. And geostationary satellites do not drift. Neither could have produced BLC1. Then there are deep space probes in distant parts of the Solar System. The team was able to rule them out because none are in line with the telescope and Proxima Centauri and so could not be the source. Next, the team looked for drifting signals, similar to BLC1, in data that had been originally rejected by their filtering algorithm. This required the researchers to visually inspect the data, looking for patterns similar to BLC1. Amazingly, they found four examples of BLC1-like signals with a signal-to-noise ration so low that they had failed to reach the detection threshold of their algorithm.

They then looked for similar signals in the data gathered from other stars, some 7000 observations in total. Again, amazingly, they found 1 example of a signal similar to BLC1. "All five of these 982 MHz signals from different days are fainter than BLC1; three of them conclusively appear in the off-sources, while two of them are inconclusive," say Sheikh and co. These five signals point to an alternative explanation - that BLC1 Is a complex form of radio interference that just happened to appear at the time the team were observing Proxima Centauri. If this were true, thought the researchers, there ought to be other examples of similar patterns at other frequencies. So, again, they went back to the original data and found 36 signals at other frequencies that looked like BLC1 but that had been filtered out by the search algorithm as obvious radio interference. These signals had "strikingly similar morphology to blc1". Finally, the team looked for mirror images of the BLC1 signal—in other words signals with negative drift rates. Sure enough, they found 27 mirrored lookalikes. All these appeared in data from observations when the telescope was pointing away from Proxima Centauri. To determine the possible origin of these signals, the team looked at their common properties, whether they could be part of a harmonic sequence from a parent signal or had a more complex relationship.

That is when the origin became clear. They all appeared to be multiples of frequencies used in common clock oscillators. That meant the signals were almost certainly generated by the interaction of ordinary digital electronic devices, probably from the radio frequency environment of the telescope facility itself. In other words, the telescope was probably picking up its own radio frequency interference, albeit a complex and rare example of it. The team have yet to identify the precise origin but say that should be possible with future studies. That is interesting work that reveals just how challenging the search of extraterrestrial technosignatures will be. BLC1 will contribute in its own way to future research. As a result of this work, Sheikh and co have produced a checklist of steps that astronomers will have to work through whenever they find a signal of interest, to rule out the possibility of this kind of complex interference.

It also raises important questions about data storage. A feature part of this work was the ability to reanalyse data that had originally been discarded as noise. That's a significant amount of data that is hard to store. Just how much of this should be stored in future, in what format and for how long is up for debate. However, Sheikh and co have shown how important it can be: "Here we have learned that neglecting to consider the entire operable bandwidth of a receiver can have serious consequences." If humanity is to have confidence in future observations, the forensic analysis of BLC1 is likely to be foundational.

By: The Physics arXiv Blog

How DART will help NASA combat doomsday asteroids 9 December: As if 2021 was not chaotic enough, an asteroid is currently careening its way into our neighbourhood this week. However, despite what doomsdayers and internet memes suggest, we do not have much to worry about concerning 4660 Nereus.


NASA/The Aerospace Corporation

NASA classifies asteroids or comets that come within 1.3 astronomical units (AU; where 1 AU is the average Earth-Sun distance) of our planet as near-Earth objects (NEOs). A potentially hazardous object (PHO) is one that gets even closer at 0.5 AU, or about 75 million kilometres. On a cosmic scale, that is not very far, which is why NASA keeps a close eye on both NEOs and PHOs. However, in terms of being a tangible risk to our planet, these objects are still usually far enough away to not pose a threat. Keep in mind that the Moon resides roughly 385,000 km from Earth, or roughly 1/200th the distance to the most far-flung PHOs. As for 4660 Nereus, this space rock is on a path that will bring it within 3.9 million km of Earth, or about 10 times farther out than the Moon. Even at its next closest approach - expected in 2060 - the asteroid will only get within about three times the Earth-Moon distance.

Nevertheless, NASA and other space agencies aren't eager to wait for a truly dangerous, locked-on asteroid or comet before they develop a contingency plan. That is why, on 24 November, NASA launched its Double Asteroid Redirection Test (DART) - the first full-scale mission meant to test technology for redirecting an incoming space rock. As part of the mission, DART will strike a moonlet, called Dimorphos, that orbits Didymos, which is an asteroid with an orbital distance ranging between 1 AU and 2.27 AU. DART will strike Dimorphos when the pair is within 11 million km of Earth with a speed of roughly 6 kilometres per second. "DART is turning science fiction into science fact and is a testament to NASA's proactivity and innovation for the benefit of all," said NASA Administrator Bill Nelson. "In addition to all the ways NASA studies our universe and our home planet, we're also working to protect that home, and this test will help prove out one viable way to protect our planet from a hazardous asteroid should one ever be discovered that is headed toward Earth."

NASA's DART craft is on a direct course to Dimorphos. The mission will determine whether striking an asteroid head-on is a successful way to redirect their course. NASA/ Johns Hopkins, APL/Steve Gribben

DART is expected to reach the pair of asteroids sometime between 26 September and 1 October 2022. Afterwards, scientists will study how the kinematic impact changes the system. They suspect, based on calculations, that the head on collision will simply shorten Dimorphos' orbit around Didymos by several minutes, enough for researchers to measure it from ground-based telescopes. "We have not yet found any significant asteroid impact threat to Earth, but we continue to search for that sizeable population we know is still to be found. Our goal is to find any possible impact, years to decades in advance, so it can be deflected with a capability like DART," said Lindley Johnson, planetary defence officer at NASA Headquarters. By: Caitlyn Buongiorno

James Webb Space Telescope will carry out science from a special spot 14 December: On 22 December, the largest and most powerful space telescope ever built is scheduled to hurtle into space from a launch point near Kourou, French Guiana. It will spend a month travelling roughly a million and a half kilometres from Earth to a special spot called the second Lagrange point, or L2. L2 is just 1% farther away from the sun than Earth is, forming a straight line with the star and planet. As Earth orbits the sun, so does L2 at the same speed, as if they were both attached to the sun by the same string. The telescope will travel in an ovular orbit around L2 - from the perspective of the sun, Webb's orbit would look like a halo behind Earth. From this position, the telescope will observe the faint, distant light travelling through space from the earliest galaxies to form in the universe around 13.5 billion years ago. Webb will also learn more about the chemistry of the atmospheres of planets outside the solar system, the surface composition and evolution of bodies inside the solar system, and much, much more


The James Webb Space Telescope mirrors sit outside a testing chamber in 2011. David Higginbotham/NASA

Part of the reason the telescope will be able to capture such distant signals and observe closer objects with a high level of detail is because of its destination. "At L2, we can meet all our challenging, top-level science requirements that require this thing to be supersensitive," said Paul Geithner, the deputy project manager for Webb. Other places in space do not have the same helpful alignment with the sun and Earth. So, what is it about L2 and its alignment that make for an ideal telescope location? L2 is named after Joseph Louis-Lagrange, an Italian-French mathematician who published a paper in 1772 detailing a particular solution to a simplified version of the otherwise unsolvable "three-body problem." The problem Lagrange studied was how do two large bodies (such as the sun and Earth) and a third smaller body move around each other in space?

There are five such Lagrange points in space where, relative to the two larger bodies, the smaller body would remain in the same place. For Earth and the sun, Earth and the third body would always be the same distance from each other and orbit the sun at the same speed. Small bodies remain relatively motionless at these points because the gravitational forces of the sun and Earth and the centripetal force pulling the third body inward as it orbits the sun balance out. So, Webb will not have to use as much energy to orbit L2 as it would in other orbits. Geithner said they will only have to burn some fuel every three weeks to maintain orbit and that it's easier and more efficient to orbit L2 than to stay exactly at the point. "It's just a conspiracy of the sun and Earth's gravity that [L2] is a happy place to go," said Geithner. L2 is one of three Lagrange points on a straight line with Earth and the sun. All three points are semi stable, meaning that objects orbiting these points gradually drift away. The fourth and fifth Lagrange points are along Earth's orbit of the sun and are equidistant from the sun and Earth. These points are fully stable, so they attract things like asteroids and space dust. Stéphanie Lizy-Destrez, a professor of space systems at the Higher Institute of Aeronautics and Space in Toulouse, France, said that L4 and L5 in the Earth-moon system "are very crowded, they have a lot of objects there. So, it means if you want to send a satellite there, you have to manoeuvre it a lot."

Scientists did not just pick L2 for fuel efficiency's sake. Webb's instruments need to stay at a steady, cold temperature to make accurate measurements. The telescope will be detecting very faint infrared light, and any other source of light or heat (like the sun, moon and Earth) would interfere with the measurements. Webb is equipped with a shield the size of a tennis court that will keep the telescope and instruments (which are facing away from the sun) close to minus 400 degrees Fahrenheit, while the side facing the sun will be close to 200 F. Since L2 orbits the sun at the same speed as Earth, the shield can protect the instruments from the sun, Earth and the moon at the same time. "We can always keep everything on one side of the sunshield and just have deep space on the other for the telescope and the instruments to look at," said Geithner.

Beyond the specific benefits L2 offers for fuel efficiency and sunshield positioning, its location far from Earth is generally helpful for Webb. One reason is that the telescope's measurements won't get interrupted by large objects passing by. The Hubble Space Telescope, for example, orbits Earth every 90 minutes, losing sight of what it's observing every 45 minutes when Earth blocks its view. "By getting away from Earth, you've got this big area you can point the telescope to and stare at things for a long time to record a really faint object," said Geithner. You can make infrared observations from Earth's surface, but Earth's atmosphere can get in the way. "If you want to look at the stars, you need to be in the void to be sure there's no light that disturbs your measurements," said Lizy-Destrez. The heat in the atmosphere "totally dominates your background -- it's like trying to see a firefly in front of a searchlight," said Geithner.

Sending a satellite to L2 also is not as difficult as it is to send one to some other places. While L2 is a million and a half kilometres from Earth, that' i a relatively small distance on the scale of the solar system – it is only 3% of the minimum distance between Earth and Mars. To get further into space would require a larger rocket at lift-off, or a smaller telescope. Plus, unlike sending a satellite to another planet, which requires a very specific launch window, Webb can launch any morning, except for a few days a month when escaping the moon's gravitational tug would require extra fuel. Geithner said that L2 is actually easier to get to than the moon, which is only a quarter of the distance to L2. Webb can mostly coast to L2 once it escapes Earth's gravity, whereas a satellite headed to the moon would need to brake as it gets pulled in by the moon's gravity. L2 is relatively easy to get to, requires little energy to orbit, and allows the instruments to make uninterrupted, high-quality measurements of the early universe. "It was just the most efficient and sensible place to put something like this," said Geithner. "L2 is kind of this Goldilocks place."   By: Will Sullivan, Inside Science

The James Webb Space Telescope is finally in space 27 December: Astronomers around the world received a great gift this 25 December, relief, as NASA's $10 billion James Webb Space Telescope (JWST) rode safely to space on an Ariane 5 booster from Europe's Spaceport in Kourou, French Guiana. The liftoff marked the end of a development full of delays and cost overruns - and the beginning of the telescope's month-long journey to its destination nearly 1.5 million kilometres from Earth. Along the way, the telescope will carry out the intricate and risky process of unfolding itself - it was meticulously designed to fold up to fit inside the rocket fairing - and deploying its components and systems. When it reaches the L2 point, where Earth and the Sun's gravity cancel out, JWST will keep station as its instruments cool to their working temperatures. Then, in six months, if nothing goes wrong, JWST will begin its ambitious mission to sight the first galaxies and characterise alien worlds.


The James Webb Space Telescope rockets to space, folded up inside the fairing of an Ariane 5 rocket. NASA/Bill Ingalls

JWST originated in a 1996 report put together by a panel of astronomers attempting to plan the successor to the Hubble Space Telescope. It was originally envisioned to launch in 2007 with a price tag of $500 million. After 14 years of delays and a ballooning price tag that, at times, threatened to swallow NASA's astrophysics budget whole, JWST has emerged as the most powerful space telescope ever built. It is a joint project between NASA, the European Space Agency, and the Canadian Space Agency. Its 6.5-metre, hexagonal, segmented mirror is shielded from the heat of the Sun by a five-layer sunshield that will allow the telescope to cool to –223°C. These frigid conditions will minimize interference at the infrared wavelengths that JWST is designed to observe, allowing the telescope to seek the redshifted light of primordial galaxies and penetrate the dusty shrouds of nebulae to see young stars.


The space telescope separates from the upper stage of Ariane 5 booster. NASA

For some astronomers who have much riding on JWST - including observing proposals already accepted and planned - the approaching launch brought a sense of foreboding. This only grew as final delays pushed the launch deeper into the holiday season, adding another layer of stress to a holiday break already thrown into havoc by the omicron variant of COVID-19. JWST arrived 12 October via cargo ship at the spaceport in French Guiana, on schedule for an 18 December launch date. This slipped to 22 December after an incident during launch preparations, when a band suddenly unclamped itself and jolted the entire observatory, requiring additional checks. Then, a communications problem from the telescope to ground support arose; it was traced to a bad cable and pushed the launch to 24 December. Finally, bad weather forced a postponement to the morning of 25 December.

In the end, the successful launch was a moment of holiday cheer for astronomers and space enthusiasts. "Webb is a shining example of the power of what we can accomplish when we dream big, tweeted US President Joe Biden. "We've always known that this project would be a risky endeavour, but with big risk comes big rewards." The euphoria was tempered by the knowledge that the intricate process of unfolding the telescope is yet to come. "[T]his is just the beginning for the Webb mission," said Gregory L. Robinson, JWST programme director. "Now we will watch Webb's highly anticipated and critical 29 days on the edge."

Perhaps the riskiest steps are the deployment of the sunshield and the mirror wings. However, there are many other issues that could doom the observatory. An engineering review identified 344 such weaknesses, known as single point failures - three times as many as a Mars landing wrote Thomas Zurbuchen, head of NASA's science division, earlier this year. "Those who are not worried or even terrified about this are not understanding what we are trying to do," he added. By: Mark Zastrow

Alien antimatter crashes into Earth 29 December: In March 2021, after years of analysing and confirming data, astrophysicists reported that the IceCube Neutrino Observatory, a detector buried at the South Pole, had picked up an unusual signal in 2016. It suggested that a particle called an anti-neutrino had crossed space and time - originating far beyond our galaxy - before smashing into Antarctica and releasing a particle shower in the ice. According to the Standard Model of particle physics, every known type of particle has an antimatter counterpart (though there's hardly any trace of antimatter in the universe today). More than 60 years ago, future Nobel laureate Sheldon Glashow predicted that if an anti-neutrino - the antimatter answer to the nearly massless neutrino - collided with an electron, it could produce a cascade of other particles. The "Glashow resonance" phenomenon is hard to detect, in large part because the anti-neutrino needs about 1,000 times more energy than what's produced in the most powerful collides on Earth.


Erick Beiser/ICECUBE/NSF

IceCube's detection is evidence that cosmic accelerators in space could readily propel high-energy particles. "It's only possible with a natural accelerator, not ground-based accelerators," says physicist Lu Lu of the University of Wisconsin-Madison, who led the analysis and helped confirm data from the 2016 event. "No one had ever directly observed the resonance before." She says the detection is exciting for at least two reasons. First, it confirms predictions by the Standard Model in physics. Second, it shows that by using IceCube, researchers can treat the cosmos as a natural, high-energy laboratory in which to probe new physics. "It opens a new window on neutrino astronomy," she says.

By: Stephen Ornes

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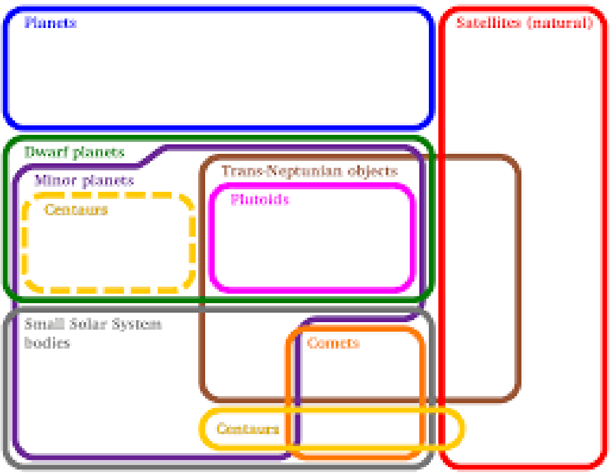
DID YOU KNOW?

Solar system objects Part 6: Overview (6)

Centaurs



This group of unusual bodies in the outer solar system is named after the creature from Greek mythology with the upper body of a human and the lower body and legs of a horse. This dichotomy seems to usefully reflect the dual characteristics found in these objects.

They are small solar system bodies (SSSBs) which orbit the Sun between Jupiter and Neptune. They tend to have unstable orbits because they are not bound by orbital resonances and cross or have crossed the orbits of one or more of the giant planets.

There is lack of agreement among different astronomical organisations regarding the criteria for classifying objects as a Centaur. Consensus needs to be reached before the features and numbers of known Centaurs can be determined.

The first Centaur to be discovered were Chiron (1977) and Pholus (1992). The diameters of known centaurs vary from 50 – 300 km, but there are possibly smaller undiscovered ones, too. Estimates of their numbers vary widely. Chariklo, the largest known centaur has a diameter of 260 km. Discovered in 1997, it is as big as a mid-sized main-belt asteroid, and is known to have a ring system.

The origin of Centaurs is still being debated. The Kuiper Belt is one candidate. Simulations show that the orbit of some Kuiper Belt objects can be disturbed, resulting in it be expelled and becoming a Centaur. In contrast, their extreme orbital characteristics also suggest that they could come from the scattered disc. However, the colours of Centaurs do not match those of other SDOs.

These strange bodies typically behave with the characteristics of both comets and asteroids. Many have comet-like dust comas. These seem to form when their orbits bring them closer to the Sun.

It is not possible to observe this small, distant objects. However, information on their surface colour and composition, and their possible origins is obtained from spectral analysis. They tend to be either blue-grey or very red in colour. Theories ascribe their colour either to differences in origin and/or composition, or to differences in degrees of space weathering from radiation and/or cometary activity.

Plutoids

This category was created within the dwarf planet category by the International Astronomical Union, in 2008. They are dwarf planets that are further from the Sun than Neptune. Thus, all dwarf planets, except Ceres (which is located in the asteroid belt), are plutoids. Creation of this category was a response by the IAU's agreement to decide on a name for trans-Neptunian dwarf planets similar to Pluto.

The physical definition of a plutoid is the same as that for a dwarf planet. Its only difference relates to the location of objects. Thus, Pluto, Eris, Haumea and other dwarf planets are also plutoids. However, Ceres is not. It has been deemed to be unique. The IAU, thus, agreed that there is no need to create a category for Ceres-like dwarf planets.

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, iau.org

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