"The Southern Cross"

HERMANUS ASTRONOMY CENTRE NEWSLETTER

FEBRUARY 2022

Monthly meeting This months **Zoom meeting,** starting at **18.30** on **Monday 21 February i**s the **AGM.** Access details will be circulated closer to the time.

Important notice 2021 membership renewal window closed
If you have not already renewed your membership, from this month, your details will be removed from the Centre's membership list. The implications of this are that you will no longer receive the monthly sky maps or Southern Cross newsletter, no longer be eligible to join Centre trips, and you will not be sent invitations to joint Zoom monthly or interest group meetings. All is not lost, however. You are welcome to rejoin the Centre at any time by contacting the Membership Secretary at johanretief@gmail.com

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

2022 meeting dates For your diaries. The dates of the monthly meetings for 2022 are as follows: 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?

Full moon Two of the South African heritage names for the full moon resonate with Hermanus. The February full moon, visible on the 16th is called the 'Dassie Moon'. The other is the 'Whale Moon', which will occur on 9 October. These and the other names have been given by the non-profit Centre for Astronomical Heritage, in recognition of the shared unique features of the country. The brightest object in the sky after the Sun, the Moon is often visible during daylight, depending on its phase. Lunar phases occur because, as it orbits Earth, the Moon is lit by varying angles. At new moon, the Moon's position is between Earth and Sun, with only the back side being lit, making it appear dark from Earth. In contrast, at full moon, the Moon is on the opposite side of the Sun, so the side visible from Earth is fully lit. The fact that the Moon's orbit is inclined ±5 º from that of Earth also affects the cycle: if they had the same orbit, eclipses would occur at every new and full moon. Although the Moon appears bright from Earth, this is more a function of its proximity than its reflectiveness. The Moon reflects only ±12 % of the light reaching it (compare that with Jupiter (34%) and Venus (75%).

LAST MONTH'S ACTIVITIES

Monthly centre meeting At the Zoom meeting held on 17 January, Centre member, Johan Retief, gave an absorbing presentation on 'Rocket propulsion in the 21sdt century' First, he outlined the physics which governs launching rockets into space (Newton's laws) and orbital mechanics (Kepler's laws). Following a summary of the altitude and speed of spacecraft like the ISS and Hubble Space Telescope and an overview of the Kármán Line (the sometimes disputed definition of where 'space' begins), Johan then focussed on the history, design and operation of of rockets and the different fuels which can be used to propel them into space and enable them to complete their missions. Over time, rocket design and function have progressed from very large, very expensive structures whose many parts were used only once, to a modern trend of reusing parts eg boosters and making the business of space travel increasingly economical, albeit still costly. The move towards reuse began in the 1980s with the Space Shuttle, but is now central, particularly to the work of private space companies like SpaceX. Johan finished with a summary of what the near future holds, including potential redundancy of polluting solid fuels and quick re-fuelling of returned rockets for rapid redeployment. Mars is the current next destination, but also a return to the Moon, which, some projects plan to use as a partway station to other planets.

Interest groups

Cosmology There was no meeting in January.

Astro-photography At the Zoom meeting held on 10 January, Deon Krige talked about pre-processing by nebulosity.

Other activities

Educational outreach No activities took place during January.

THIS MONTH'S ACTIVITIES

Monthly centre meeting This month's **Zoom meeting**, the **Annual General Meeting.** will take place on the evening of **Monday 21 February,** starting at **18.30**. Access details will be circulated closer to the time.

Interest group meetings

The **Cosmology** group meets on the first Monday of each month. 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 14 February.**

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: 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\

James Webb Space Telescope successfully deploys sunshield 5 January: So far, for the James Webb Space Telescope (JWST), everything's cool - and getting cooler. That is because, on 4 January, NASA's newest flagship observatory successfully deployed its sunshield, a tennis court-sized parasol that will keep its mirrors and sensitive instruments permanently shaded from the Sun. The deployment is a major milestone in the complex and risky procedure of bringing the telescope online. Since JWST launched on 25 December from French Guiana, the operations team at the Space Telescope Science Institute in Baltimore has been meticulously working to deploy each of the observatory's parts and systems from the folded-up compact configuration that it launched in.

After deploying its sunshield, the James Webb Space Telescope currently looks something like this, the wings of its primary mirror still folded back. This picture was taken during final deployment tests at Northrop Grumman, Redondo Beach, California. NASA/Chris Gunn

This complex series of procedures is full of potential pitfalls, but the sunshield, in particular, was one of the trickiest parts and is crucial to the entire design of the telescope. It consists of five kite-shaped layers of an aluminium-coated film about 21 metres long and 6m wide. As the name suggests, it blocks the heat of the Sun (as well as

Earth), allowing the telescope to cool to –223 degrees Celsius. It also acts as a radiator, dissipating heat from JWST's computers and other support systems and stopping it from bleeding to its instruments. Both functions are necessary for the telescope to observe at the infrared wavelengths that will allow it to peer back in time across the universe to some of the earliest galaxies.

To deploy the sunshield in space, NASA first unfolded the sunshield's fore and aft support structures and raised the tower that the telescope itself sits on, creating room for the shield to unfold beneath it. Then, late on New Year's Eve, the team extended the booms that stretched the shield to its full width. Finally, each individual layer had to be pulled taut, or tensioned, around their frames. In all, the process involved 139 release mechanisms, 70 hinge assemblies, eight motors, 90 cables, and about 400 pulleys. NASA took a deliberate approach to the tensioning, delaying the process a couple days after two concerns arose - both related to the telescope's thermal characteristics. First, the array of solar panels was providing less power to the telescope than expected. And second, the sunshield deployment motors were hotter than expected, though not hotter than their design limits.

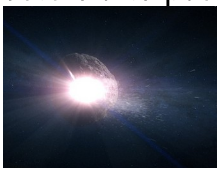

When fully folded up for launch, JWST was almost unrecognizable from its final form. NASA/Chris Gunn

To address the first issue, Northrop Grumman, which assembled JWT in Redondo Beach, California, analysed the efficiency of each solar panel in the array. While the array's factory pre-set had each panel operating at the same voltage, once in space, each one had slightly different temperatures and thus, slightly different efficiencies. The hotter they were, the less efficient. Understanding how each panel was performing allowed the team to reprogram the arrays to distribute the load more effectively between each panel — enough to power the observatory and keep the battery topped off. Then, to cool the deployment motors, the team adjusted the orientation of the telescope slightly. "They're nice and cool," said Amy Lo, JWST's lead vehicle engineer at Northrop Grumman. "We've got a lot of margin now on our temperature." After resolving both issues, the team began tensioning the sunshield layers 3 January.

The tensioning of the final layer came on the morning of 4 January, as the U.S. capital area was blanketed by a snowstorm. With cases of the omicron variant of COVID-19 soaring, most team members were working from home; only the minimum amount of staff were in the mission operations centre in Baltimore. Against the backdrop of these additional challenges, checking the sunshield deployment off the team's list was a major relief. "I'd be wiping my forehead if you could see me," said Bill Ochs, the telescope's project manager. "That was really a huge achievement for us." During the telescope's development, an engineering report identified 344 separate ways that the process could go wrong and render the telescope unable to fulfil its mission. With the sunshield fully deployed and tensioned, Ochs estimated that 70 to 75 percent of these single point failures are now behind the team.

The telescope passed another milestone today when it deployed its secondary mirrow. "This is unbelievable," said Ochs. "We're about 600,000 miles from Earth, and we actually have a telescope." The largest remaining item in the deployment procedure is to unfold the wings of JWST's 6.5-meter gold-coated primary mirror, which Ochs said the team should tackle by this weekend. By: Mark Zastrow

Spray-painting killer asteroids could redirect them away from Earth 6 January: Asteroids represent an existential threat to humankind. A collision with a 10 kilometre-sized)asteroid led to the demise of the dinosaurs some 65 million years ago. Astronomers expect other collisions with asteroids about 1 km across every 500,000 years or so. Which is why NASA and other space agencies are attempting to map the population of Near Earth Asteroids. Today, just 40 percent of these have been spotted. The goal is to build a complete picture of the threats from asteroids down to a few tens of meters in size, within the next few decades. That raises an obvious question: if we find an asteroid heading our way, what should we do next? Last month, NASA launched the Double Asteroid Redirection Test (DART) mission to test one idea. This involves crashing the spacecraft into an asteroid to change its course. Other options include attaching thrusters to the asteroid to push it off course or even ablating the rocky surface with a nuclear explosion.


Artist's concept of an asteroid breaking apart. NASA

Now, Jonathan Katz at Washington University in St Louis, Missouri, says there is a simpler and more efficient way to redirect asteroids - by painting them with a metallic coating. The idea is that the coating changes the amount of sunlight the asteroid reflects, its albedo, creating a thrust that redirects it. "Changing an asteroid's albedo changes the force of Solar radiation on it, and hence its orbit," he says. This thrust would be tiny, but Katz points out that once a small asteroid has been identified, its trajectory can be determined centuries in advance, particularly if transponders are placed on its surface to track it more accurately. So, the threat can be identified hundreds of years in advance and a small force operating over this timescale is all that would be needed.

Astronomers have long known that small asteroids are influenced by a similar phenomenon called the Yarkovsky effect. This is the result of the Sun heating an asteroid, which then re-emits this energy later, creating a small thrust. Others have suggested modifying this effect to redirect an asteroid away from Earth. Katz's suggestion, by contrast, generates an immediate thrust that is easier to calculate. He points out that asteroids are generally dark. So coating one with lithium or sodium metal would dramatically increase its reflectivity, turning it into an interplanetary disco ball. He calculates that about 1 kilogram of metal could coat an entire asteroid with a micrometer-thick layer that would turn the asteroid silver. The increased thrust from this reflectivity would be equivalent to changing the effective solar mass that the asteroid experiences. This in turn would change its orbit. Katz calculates the effect of this approach. "A 164 feet (50 meters) diameter asteroid may be deflected by about 1,864 miles (3000 km) in a century or 1,000 km] in [some] 30 years," he says.

More controversially, he says that this would be enough to steer a Tunguska-class impactor away from a city and towards a less populated area, such as an ocean. The Tunguska event over Siberia in 1908 was a megaton explosion thought to have been caused by a 50m diameter comet disintegrating in the upper atmosphere or a larger asteroid grazing the edge of the atmosphere. An alternative approach would be to coat one half of the asteroid to generate a stronger directed force. ""Coating one hemisphere of an asteroid in an elliptical orbit may produce a Solar radiation torque displacing it by an Earth radius in [about] 200 years," says Katz. A spacecraft in polar orbit above an asteroid that emits the metal in vapour form should be able to paint the entire body or parts of it, he claims. By: The Physics arXiv Blog

James Webb Space Telescope successfully unfolds mirrors 12 January: NASA has pulled off the most technically audacious part of bringing its newest flagship observatory online: unfolding it. On Saturday, 8 January, the operations team for the James Webb Space Telescope (JWST) announced that the observatory's primary mirror had successfully unfolded its segments - the last major step of the telescope's complicated deployment. The moment was a euphoric moment of validation for the entire team. "We're on an incredible high right now," said Bill Ochs, JWST's project manager, at a press conference. "Today represents the beginning of a journey for this incredible machine, to its discoveries that we'll be making in the future."

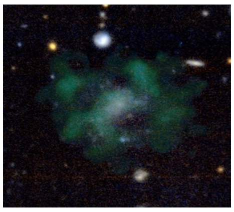

Engineers at the Space Telescope Science Institute celebrate the successful deployment of the James Webb Space Telescope. NASA/Bill Ingall's

To fit inside the nose cone of the Ariane 5 rocket that launched it, the telescope had been designed to fold up, origami-style, and unfold once in space. The approach was risky: Like a Rube Goldberg machine, every step needed to occur correctly, in order. An engineering report concluded there were 344 different ways the process could fail, dooming the $10-billion observatory. Now, NASA's big bet seems to have paid off. The elaborate deployment procedure began shortly after the 25 December launch. On 4 January, the team finished unfolding and tensioning the craft's sunshield, which will block the heat of the Sun and Earth and allow the telescope and its infrared-sensitive instruments to cool to –223 degrees Celsius.

The final major step was unfolding the telescope's primary mirror wings. JWST's 6.5-meter primary mirror consists of 18 hexagonal segments, three of which on each side were folded back at launch. Deploying them meant releasing the mechanisms holding them in place, using motors to rotate them into place, and then spending a couple hours to latch it into place. On Friday, 7 January, the JWST team carried out this delicate process for the port wing. The next day, the team tackled the starboard wing, and at 1:17 pm EST, it latched into place. At the Space Telescope Science Institute in Baltimore, JWST's base of operations, engineers cheered and traded fist bumps. "The fact that it looked easy just emphasizes that we did all the right things leading up to this moment," said Ochs.

With its mirrors now deployed, the craft is in its final form. As of Tuesday afternoon, it is just over 80 percent of the way to the L2 Lagrange point, which is just under 1.5 million kilometres away. You can track its progress at JWST's website. JWST still faces a long road before it is fully operational. The team must next align the telescope's mirrors, which should take about three months. Then it will finish commissioning all of its instruments, ensuring they are cooled and in proper working order. If all goes well, in less than six months, the telescope's first images will be revealed. By: Mark Zastrow

Researchers find more missing dark matter 23 January: The debate over galaxies without dark matter has returned. In 2018 and 2019, a series of studies lead by astronomer Pieter van Dokkum of Yale University made the case that two galaxies - NGC 1052-DF2 and NGC 1052-DF4 - are devoid of dark matter, an invisible substance that only gravitationally interacts with regular matter. Because every other well-studied galaxy seems to be chock-full of dark matter, the proposed dearth of it within DF2 and DF4 did not sit well with many astronomers. Now, although the debate is still not settled, new research lends credence to the dark-matter-less camp.

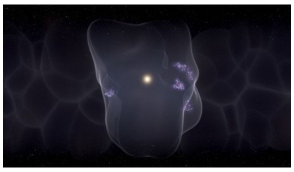


Despite 40 hours of scrutiny with state-of-the-art telescopes, the galaxy AGC 114905 appears to lack any appreciable amount of dark matter. The galaxy's neutral hydrogen gas is shown in green, while visible stars appear blue. Javier Román & Pavel Mancera Piña

The new evidence comes from a study. In it, researchers examined a galaxy named AGC 114905, which, like DF2 and DF4, is an ultra-diffuse galaxy roughly the size of the Milky Way. However, AGC 114905 contains only around one-thousandth the number of stars as our home galaxy. To determine whether this galaxy hosts copious amounts of dark matter, the researchers spent 40 hours using the Very Large Array in New Mexico to measure how quickly neutral hydrogen gas orbits around the centre of AGC 114905. If there is dark matter spread throughout, gas that's far from the galaxy's core should still rotate quickly. However, if there is no dark matter, the tenuously bound gas near the galaxy's outskirts should move at a more leisurely pace. The researchers found that the motions of the hydrogen gas within AGC 114905 can be completely explained if the galaxy only contains mass from the normal matter visible within it. And so far, the team has o't been able to identify a plausible explanation for why there is no dark matter. Stay tuned, because this saga is surely far from over. By: Jake Parks\\

The 1,000-light-year-wide cosmic bubble around Earth 13 January: Think 'bubbles', and you may think 'soap' or 'chewing gum'. Not Catherine Zucker, currently a Hubble Fellow at the Space Telescope Science Institute and a former researcher with the Harvard-Smithsonian Centre for Astrophysics. Zucker's interest in bubbles is cosmic. And she and her collaborators have found new insights about a bubble in which our solar system sits. Astronomers have long known about the 1,000-light-year-wide Local Bubble. In a new paper, Zucker and her co-authors describe it as "a cavity of low-density, high-temperature plasma surrounded by a shell of cold, neutral gas and dust." However, for years, astronomers were in the dark beyond that. The history of the Local Bubble, even its size, remained unknown. Not anymore.

Zucker and her team became accidental historians when, starting work on a different project, they found instead a kind of creation story of our local stellar neighbourhood, and provided robust confirmation of the assumption that supernovae — the explosions of dying stars - lead to the birth of other stars. This happens when the blown-out materials recombine elsewhere due to the force of gravity. What Zucker's team found, according to their paper, was "that nearly all of the star-forming complexes in the solar vicinity lie on the surface of the Local Bubble and that their young stars show outward expansion mainly perpendicular to the bubble's surface." She calls it a "eureka moment."


Artist's concept of star formation in the 500 light-years around Earth is being driven by a cosmic bubble known as the Local bubble. ILLUSTRATION: CfA, Leah Hustak (STScI)

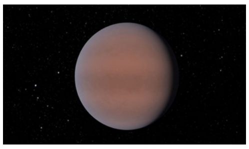
In other words, the young stars in our galactic neighbourhood are almost all due to the expansive shock waves of a series of supernovae and that process of blown-out remains recombining to birth new suns and new solar systems. The bubble - which is actually shaped more like a piece of pipe cutting through the plane of the Milky Way – seems to have formed 14 million years ago from some 15 supernovae, and the triggered star formation that is still happening today. The last such supernova took place about 2 million years ago, according to Zucker's research - a finding that matches nicely with the previously reported deposition of cosmic iron in the Earth's crust. Zucker told Astronomy that while there are "tens of millions of 'old' stars [those that are more than 14 million years old] inside the Local Bubble," there are "on the order of thousands of 'young' stars … on its surface that have been birthed by the supernovae."

It just happens that the Sun and our solar system currently sit inside this bubble. According to the team, the Sun rolled into the Local Bubble about 5 million years ago — but it likely sat in other bubbles at other times. "This work is most useful for providing the 'big picture' context for star and planet formation," Zucker says. "One takeaway that might have been missed is that this study is really the tip of the iceberg. The Local Bubble is just the first bubble whose history we have mapped out — it's the easiest one to understand first, since it's the bubble in which our Sun currently resides. However, we have clues that not just single superbubbles, but the interactions of many superbubbles, are driving the formation of young stars near our Sun."

Zucker compares the process to ploughing snow. If one or more superbubbles is "piling up gas in the same region of space … we should get even more enhanced star formation at those intersecting surfaces." And, in fact, one such bubble, called Perseus-Taurus, is interacting with our Local Bubble "at the site of the Taurus molecular cloud" - home to known protoplanetary disks. The European Space Agency's Gaia star-mapping mission was crucial in providing the precise data needed to discover the star-formation nuances of the Local Bubble - what Zucker has been calling an "origin story." Luckily, you do not need access to high-end data to connect to this work. "The two clusters of stars that hosted the supernovae are still around and they are about 15 to 16 million years old," says Zucker. "They currently lie near the edge of the Local Bubble's shell." (At the time, the supernovae were getting underway, these clusters were in the thick of the action.) You can point your telescope toward those local star-forming regions. One is in Taurus, the other is in Ophiuchus, home of the Ophiuchus Nebula. Looking into those areas gives you a chance to bear witness to the history and continuance of star birth in our Local Bubble.

By: Christopher Cokinos

Water vapour found on exoplanet in Neptune Desert 14 January: It is no place you would want to go to fill up your water bottle or take a swim, but TOI-674b has water vapour. "We think we see water vapour on TOI-674 b, which is really exciting," said University of Kansas doctoral student Jonathan Brande.


TOI-674b orbits its red dwarf host star about every two days. Despite its close orbit, the super-Neptune, seen in this artist's concept, has water vapor in its atmosphere. NASA/JPL-Caltech

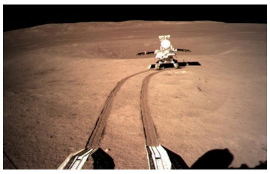
The world is a super-Neptune some 23 times the mass of the Earth, located in the southern constellation Antlia, 150 light-years from us. It's one of just a few detections of water vapor for this class of exoplanets. However, TOI-674b is most notable for where the planet is located: close to its host star, zipping around the red dwarf about once every 2 days. Neptune-like planets are so rare here that astronomers refer to this orbital region as the Neptune Desert. Researchers are not sure why short-orbit Neptunes are rare, but suspect that such planets typically migrate outward. If they stay in close, their atmospheres should be stripped by radiation from their host star, making the detection of water vapor on TOI-674b very unexpected.

At a temperate 360 degrees Celsius, the world may seem like an "oasis," joked Brande. However, do not book your beach vacation just yet, as it's still unclear just how much water exists in the world's air. Understanding that has implications for how and where planets like TOI-674b form. In particular, it should place the planet's origin on one side of the water ice line, which is located at the distance from a young, hot, still-forming star where the temperature is cool enough for solid ice to form. "Planets forming closer to their host stars inside the water ice line should have less atmospheric water than those forming further away, outside the water ice line," Brande told Astronomy. If researchers can identify how much water is present in the atmosphere of TOI-674b, they can figure out whether it formed inside or outside the water ice line, he said. "In either case, it almost certainly didn't form this close to the star and needed to migrate into its current orbit somehow."

Brande and his advisor, University of Kansas astronomer Ian Crossfield, identified the atmospheric water in spectra of the planet's atmosphere obtained by the Wide Field Camera 3 instrument aboard the venerable Hubble Space Telescope. The observations were taken during three separate transits, when the planet passed in front of its host star. During transits, some light from the host star filters through the planet's atmosphere before it reaches us. By seeing which wavelengths of light the atmosphere's molecules absorb, scientists can determine what chemicals are there. The size of the large planet transiting a relatively small star made atmospheric measurements easier than might otherwise be the case. The team was able to rule out alternative explanations for the signal, like methane.

Exoplanets like TOI-674 b can help us better understand our own Neptune and Uranus, which also have a history of migrating vast distances across our solar system. In some respects, it's easier to detect the various chemicals in the atmosphere of hotter worlds in distant solar systems because the gases are excited by so much radiation from their host star. In contrast, Uranus and Neptune are pretty cold, leaving astronomers unsure of their precise compositions. The recently deployed James Webb Space Telescope holds the promise of making more precise measurements of atmospheres across an array of exoplanets. When it comes to TOI-674b, JWST could reveal more details about the world's atmospheric composition, including the presence of clouds and heavier elements, and how much water it really has. This should help Brande and others understand where and how this planet formed - and perhaps bring us one step closer to understanding our own solar system's ice giants. By: Christopher Cokinos

The Moon's farside has sticky soil, Yutu-2 finds 20 January: The farside of the Moon is a far different place from the nearside. It has a more rugged surface, chock-full of craters. It is nearly devoid of the smooth, solidified-lava oceans that dot the side that faces us. And it has a different composition, with fewer radioactive elements. Now, you can add 'stickier soil' to that list. In a paper, Chinese researchers give an update on the Yutu-2 rover, which touched down on the Moon in 2019 with Chang'e 4, the first ever mission to land on the lunar farside. The team says that one of the most striking things Yutu-2 has encountered is how clumpy, or 'cloddy', the lunar soil has been. Images taken by the Chang'e 4 lander and the rover of its wheels show that much of its fine metal mesh is covered in dirt that it has picked up as it rolled across the lunar surface. That may seem a small detail, but it is scientifically intriguing: It stands in sharp contrast to the experience of Yutu-2's predecessor, Yutu, which landed on the nearside in 2013. Though both rovers have nearly identical designs, the original Yutu never had any large clumps of dirt gather on its wheels in over 2.5 years of exploration - only some fine dust stuck to the metal wheels thanks to static cling.

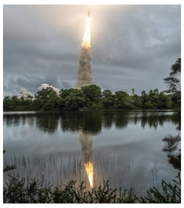

Yutu-2 rolls off Chang'e 4 lander onto the lunar surface, January 2019. CNSA

The researchers write that this difference in soil is likely related to the conditions on the lunar farside. Though scientists haven't settled exactly why, volcanic activity on the farside appears to have ceased earlier than on the nearside, meaning the surface of the farside is older than the nearside. When lunar soil - called regolith - is exposed to the harsh conditions of space for millions of years, it absorbs repeated impacts from micrometeorites, a process called space weathering. These impacting particles do not just pulverize the dirt into finer particles, they also melt them and fuse them into larger, irregular-shaped glassy globs, called agglutinates. This, the Yutu-2 team says, is probably why the farside soil is so clumpy: Agglutinates' irregular shapes are able to interlock with each other more easily, forming large clods. Because the farside's lunar surface is older and more weathered, it makes sense that it has a higher level of agglutinates. Yutu-2 is the first explorer - human or robotic - to tread on the regolith of the farside to find out.


A cute rocky bunny prepares to chow down on a carrot

Despite the dirt on its wheels, Yutu-2 is still roving the Moon, having passed the one 1-kilometre mark (0.62 mile) earlier this month. The milestone came shortly after it trekked to a curious rock that researchers had spotted in on the horizon in images. The mission team dubbed it a 'mysterious hut' and others called it "moon cube". It was, of course, just a rock, but one that, from up close, turned out to be rabbit-shaped, complete with a meal of carrots. It was a fitting coincidence, considering that 'Yutu' means Jade Rabbit, the 'rabbit in the Moon' of Chinese folklore. By: Mark Zastrow

Meet the James Webb Space Telescope, NASA's next-gen goliath 25 January: When the historic Hubble Space Telescope launched in April 1990, the world waited with bated breath as Hubble soared to the heavens, promising to give the world a window to the cosmos like never before. Unfortunately, the first pictures Hubble returned to Earth were disappointing - instead of pointlike, stars were surrounded by large fuzzy halos. As it turned out, the telescope's primary mirror was just a fraction too flat, by less than the width of a human hair. NASA was determined to fix their flagship instrument. In 1993, astronauts mounted a repair mission, installing new optics and a new instrument onto the telescope. Today, Hubble's fuzzy vision is just a blip on an otherwise awe inspiring 30-year history observing the universe.


NASA launched JWST aboard an Arianespace's Ariane 5 rocket NASA/Chris Gunn

Yet when it came time for a new flagship telescope, that mistake weighed heavily on scientists' minds. First discussed before Hubble had even launched, the James Webb Space Telescope (JWST) was originally envisioned to launch in 2007. But delay after delay pushed the telescope's inauguration back again and again - much to the disappointment of professional and amateur astronomers alike. Their patience was finally rewarded, however, on the morning of 25 December 2021. JWST took off from Europe's Spaceport in Kourou, French Guiana. Yesterday, the telescope finally reached its new home in space at the L2 Lagrange point, nearly 1.6 million kilo meters from Earth. This powerful new tool promises an even deeper window to the cosmos than Hubble — revealing the universe as it existed more than 13 billion years ago. However, that is not all JWST has to offer.

JWST will carry out a broad range of scientific investigations over the course of its life, which is currently expected to last at least five years by conservative estimates. But Hubble was only predicted to have a lifetime of 15 years and has so far thrived for twice that long. The telescope is tasked with a wide range of goals, from finding the first galaxies and luminous objects formed after the Big Bang to observing the evolution of stars and galaxies to searching for new hopefully habitable planetary systems.

Designed before scientists knew much about exoplanets, JWST luckily has the right instruments to determine the atmospheric composition of Earth-like exoplanets. Until now, scientists have been using other telescopes, including Hubble's infrared instruments, to observe enormous, Jupiter-sized exoplanets. Because of their size, these larger exoplanets are more easily spotted (but researchers have reason to suspect that they aren't the most common exoplanets in the universe). JWST will extend out exoplanet observation capabilities, allowing scientists not only to peer at larger Jupiter-sized planets, but also investigate climate and habitability on smaller, Earth-like rocky worlds orbiting small, cool, and often active red dwarf stars.

In addition to expanding exoplanet research, JWST will allow astronomers to observe some of the earliest stars and galaxies, which scientists think formed just a hundred million years or so after the Big Bang. As the universe expands, their light becomes redder as its wavelength stretches out - a phenomenon known as cosmological redshift. Because of this, the light emitted from the most distant objects, billions of light-years away, stretches into the infrared portion of the spectrum. This primordial light will enter JWST's state-of-the-art mirror - designed to pick up these longer wavelengths —-and get sent to the infrared instruments aboard the telescope for analysis. Studying these early galaxies will provide clues to what our universe was like in its infancy. From there, JWST can examine the evolution of galaxies. Why do we have the variety of galactic structures we see today? What is the nature of galaxies and the supermassive black holes that sit at their hearts? By looking at galaxies throughout the history of the universe, from early days to the present, astronomers will be able to start answering these questions.


NASA installs the JWST's scientific instruments. NASA/Chris Gunn

NASA and its global partners the European Space Agency and the Canadian Space Agency teamed up to make JWST a technological marvel. This $10 billion telescope is equipped with a suite of science instruments cryogenically chilled to about–234 degrees Celsius. Let's take a brief look at these 'cool' JWST instruments:

Near-Infrared Spectrograph A spectrograph disperses or separates of light into different wavelengths. This is called a spectrum. JWST will analyze an object's spectrum, such as an exoplanet, to determine its mass, temperature, and chemical properties. Near-Infrared Camera You are not seeing double: JWST's has two identical near-infrared cameras. These cameras will focus on detecting light from nearby galaxies, early star and galaxy formation, and even closer-to-home Kuiper Belt objects. Mid-Infrared Camera and Spectrograph In addition to spectroscopy, JWST's sensitive detectors will observe the light from distant galaxies and stars to determine their distance. It will also take beautiful astrophotography! Fine Guidance System No one wants to get lost in space! Observing from 1 million miles away at a stable point called L 2, JWST's Fine Guidance System will precisely determine its location and where to point its mirror and cameras. Near-Infrared Imager and Slitless Spectrograph Another apparent double, this spectrograph will work to detect the universe's "first light," emitted from those first primordial stars that existed a few hundred million years after the Big Bang. The cutting-edge technology from JWST's Slitless Spectrograph will also detect exoplanets and their atmospheric properties, such as water or carbon dioxide.


One of the JWST's primary mirror segments Photo by Drew Noel

NASA and its partners collaborated for decades to engineer the sharpest tools for JWST. However, these innovative instruments are only part of what make it such a feat of engineering. JWST's remarkable primary mirror is its own eye-catching piece of hardware. The mirror is composed of 18 hexagonal segments called hexapods, each motorized by its own actuator that can adjust that segment's orientation. To maximise accuracy, the hexapods have six degrees of freedom. The 18 segments act as one mirror with a total diameter of 21.3 feet. (6.6 meters). The beryllium metal mirror, finished with a 1,000-atom-thick coat of gold, is optimized to work under extremely cold temperatures:–220 C. JWST's primary mirror is so powerful it can spot a penny at a distance of about 38.6 km It is also extremely smooth, says Amber Straughn, NASA Deputy Project Scientist for Webb Communications. "If the mirror could stretch across the continental United States, the bumps would only be a few inches tall" she says


Earth's last glimpse of JWST as it heads to its new home in space. Arianespace, ESA, NASA, CSA, CNES

Despite what you may have heard, JWST is not considered a replacement for Hubble. Instead, the two telescopes were designed for different purposes, filling in one another's blind spots. "Webb will complement Hubble to provide a full spectrum of understanding about stars and exoplanets," says Kevin Stevenson, an astrophysicist at John Hopkins Laboratory. One example of this complementary partnership is a technique called transmission spectroscopy. As a planet transits, or moves across, its host star, some of that starlight travels through and is absorbed by the planet's atmosphere, while the rest travels unhindered through space. When JWST observes the transit, scientists can determine which wavelengths of light were absorbed by the planet's atmosphere because they will be missing from the final spectrum the telescope collects.

While this technique is not new, JWST's infrared capabilities will allow researchers to perform transmission spectroscopy at infrared wavelengths, while Hubble's forte is observing these changes at ultraviolet (UV) wavelengths. Scientists can ultimately combine JWST observations with Hubble's to draw conclusion about an exoplanet's atmosphere - and its potential habitability. By: Emily Lehnardt

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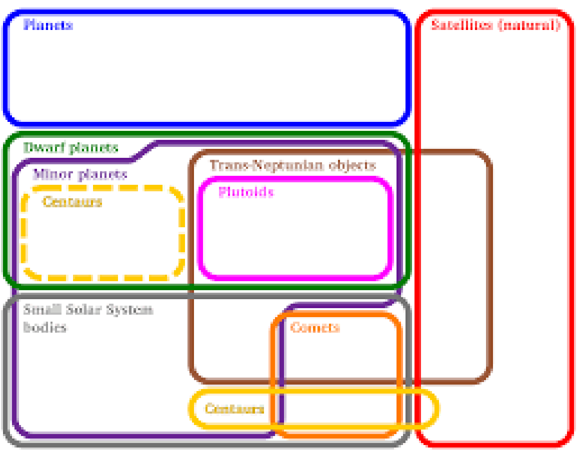
DID YOU KNOW?

Solar system objects Part 7: Overview (7)

Comets



A comet is an icy, small solar system body in orbit around the Sun. The name derives from the Greek *kometes* meaning 'long haired'. They are thought to originate in the very distant Oort Cloud and the less distant Kuiper Belt. From the outer reaches of the solar system their orbits are influenced by the gravitational influence of passing stars into new orbits that bring them into the inner solar system. Each year, over 200 comets are seen with telescopes and space satellites, but only a few become bright enough to be visible with the naked eye. Almost 7,000 comets are known.

Cometary nuclei range from a few hundred to tens of kilometres across. They are composed of loose collections of ice, dust, small rocky particles and molecules of organic compounds. They are among the least reflective objects in the solar system, their surfaces usually dry and dusty, while the ice is buried inside.

When far from the Sun, a comet's nucleus of frozen and shines by reflecting sunlight. Nearer the Sun, solar radiation and the solar wind affect the integrity of the nucleus. As it warms and melts, it begins to release gas and dust. This outgassing produces a visible coma and sometimes a tail. It is the presence of this atmosphere which distinguishes comets from asteroids, as well as their differing origins (asteroids originated inside Jupiter's orbit). A small percentage of asteroids are thought to be extinct cometary nuclei.

The coma is the envelope of gas (mostly water) and dust that surrounds the nucleus. It often has a tear-drop shape, created by the solar wind flowing round the comet. Comas doe not usually form before the comet is 3-4 AU from the Sun. Comas Coma length can reach 100,000 km, while tails can extend up to an astronomical unit (150,000 km).

A cometary tail contains dust and gas released from the comet's head. Not all comets develop a tail, but when they do they are always directed away from the Sun. They do not normally develop until the comet is within about 2 AU of the Sun. Tails have two components: the gas (ion, plasma) tail and the dust tail. Gas tails consist of ionised gas carreid away from the coma by the solar wind. Usually straight, they often appear bluish or greenish, a result of light emission from ionised carbon monoxide. In contrast, dust tails appear yellowish because it shines by reflected sunlight. The are often noticeably curved. Dust tails are usually shorter than gas trails, but not by much. The consist of microscopic - sized solid particles which are pushed away from the comet's head by radiation pressure. Despite their great sizes, comas and tails have very low densities, and background stars can be seen through them.

There are two types of comets. Long period comets have orbital periods of over 200 years, many of a thousand year, or more. Probably originating in the Oort Cloud, these make up around 90% of all known comets. They have nearly parabolic orbits. In contrast, the orbital periods of periodic comets are shorter. They probably originate from the Kuiper Belt. They will have been observed more than once, and their orbital period accurately calculated. Their orbits are affected by the gravitational effects of the giant planets, esp Jupiter. They enter elliptical orbits, which makes them return on a regular basis. There are two sub-classes of periodic comets. Short-period comets have orbits of under 30 years, while intermediate-period comets eg Halley have orbital periods from 30 – 200 years.

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

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