Lewes Astronomical Society

Newsletter - January 2024

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January 2024

Astronomy News

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Do we live in a void? (1)

- For about a hundred years, we have known we live in an expanding Universe
- The Universe's expansion means that galaxies are moving away from each other, unless in a close relationship where gravity can instead draw them together (e.g. the Milky Way and Andromeda)
- The further away galaxies are from each other, the faster they move apart
- Sixty years ago, the discovery of the Cosmic Microwave Background (CMB) led to the development of the standard model of cosmology: the Lambda-Cold Dark Matter (ΛCDM)

El Gordo Super Cluster
Credit: NASA, ESA, J. Jee (University of California, Davis)

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Do we live in a void? (2)

- Based on this, the Hubble Constant: the relationship between a galaxy's distance and speed, should be about 70km per second per megaparsec
- This figure has recently been disputed, as a nearly 10% larger estimate than that from the CMB has been measured by using supernovae in distant galaxies. This discrepancy is called the Hubble Tension
- A new theory is attempting to reconcile the differences by suggesting that we live in a large void with below-average density. This would cause matter to flow out to denser regions of the Universe, potentially inflating local measurements
- To work, the void would have to be about a billion light years across and be about 20% less dense than the cosmological average
- The theory is controversial, as such a large void would not be expected in the standard model. However, direct observations suggest that we do live in a local void, described as a "bubble in the dough of the universe"
- Could this be the basis for alternative gravity models such as MOND?

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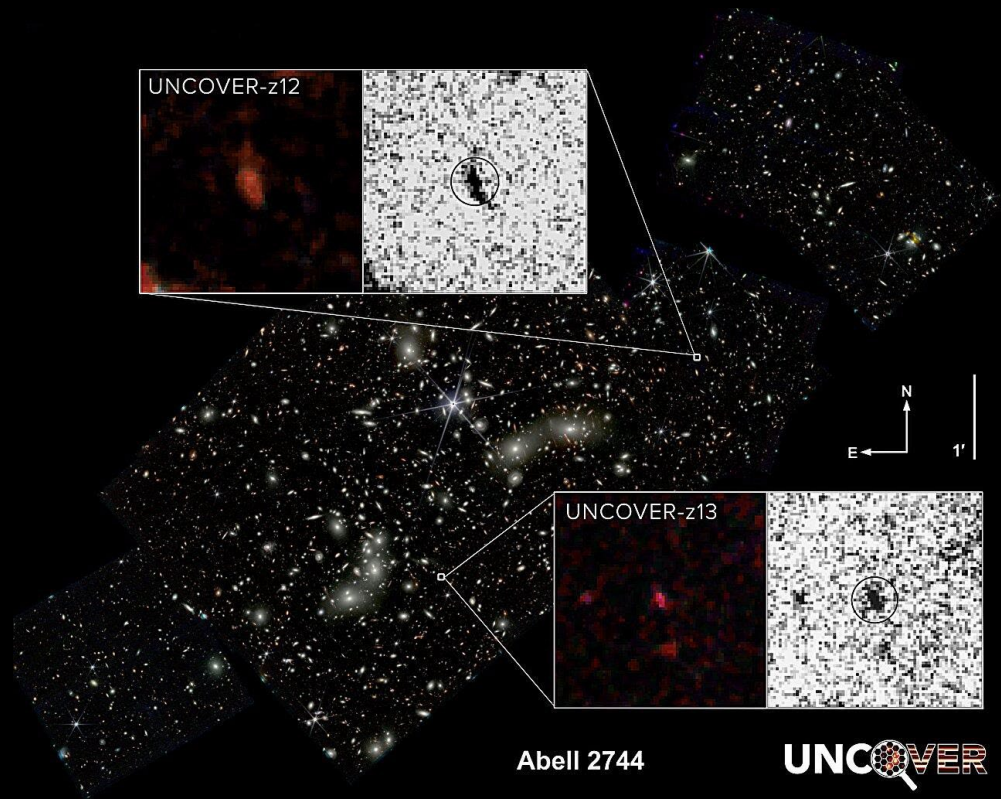
2nd and 4th most distant galaxies found (1)

- ABELL 2744 is known as Pandora's Cluster. Over 60,000 light sources were detected by JWST in one of its first deep field images, making use of gravitational lensing
- Data from JWST had suggested it contained some of the most distant and, by default, oldest known galaxies
- Now, researchers from the UNCOVER Team have confirmed that the galaxies are nearly 33 billion light years away. The team had narrowed down the search to 700 candidates before drawing up a short list of 8 to investigate



The second- and fourth-most distant galaxies ever seen (UNCOVER z-13 and UNCOVER z-12) have been confirmed using the James Webb Space Telescope's Near-Infrared Camera (NIRCam)
Credit: NASA, UNCOVER (Bezanson et al., DIO: 10.48550/arXiv.2212.04026) Insets: NASA, UNCOVER (Wang et al., 2023) Composition: Dani Zemba/Penn State

2nd and 4th most distant galaxies found (2)

- The light from the two galaxies was emitted when the Universe was about 330 million years old. During its 13.4 billion years journey, the Universe has expanded considerably, meaning that they are now 33 billion light years away
- These two galaxies are larger than the three others known to be about the same age; one is nearly 2,000 light years across (small when compared with the current Milky Way but, considering that the early universe was very compressed, surprisingly big)
- Unlike other distant galaxies, these have some shape, with appearances described as a “peanut” and a “fluffy ball”
- In future, JWST may be able to take advantage of other gravitational lensing and its advanced infrared instruments to peer even further back in time

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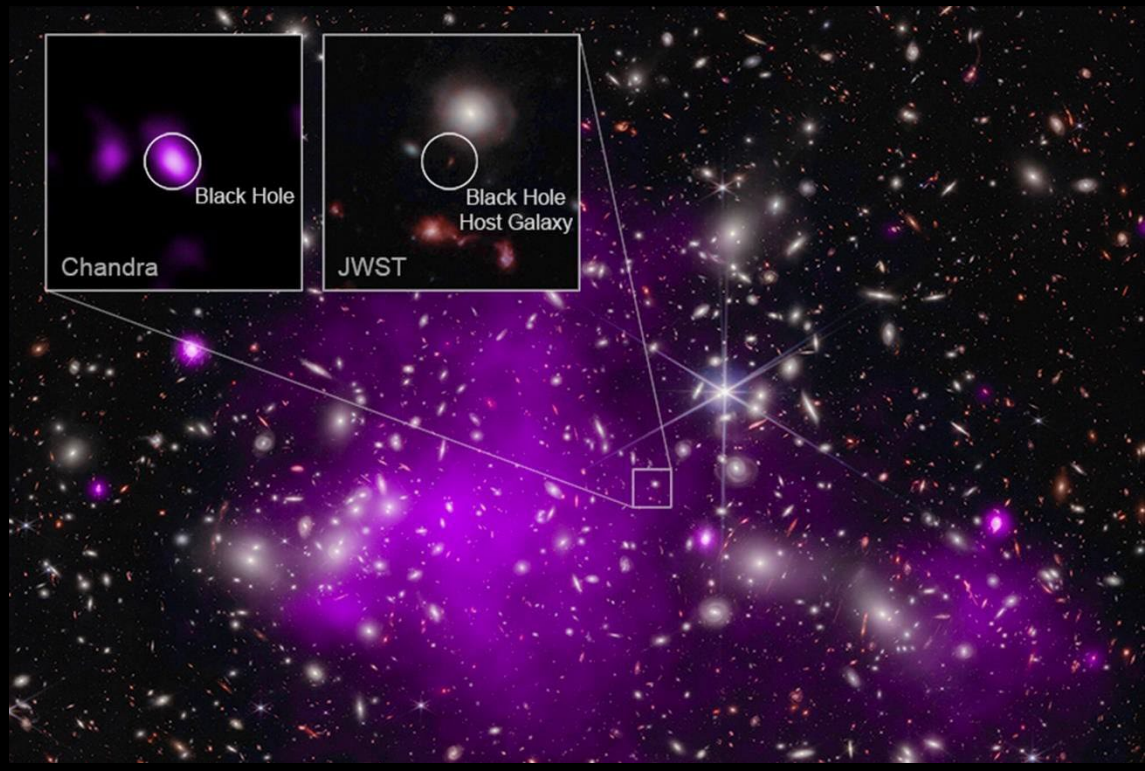
Two oldest black holes discovered (1)

- The black hole in the galaxy, UHZ1 (redshift 10.1 – 13.2 billion light years distant), has been discovered to have formed only 470 million years after the Big Bang.
- In the galaxy GN-Z11, an even older black hole, formed only 440 million years after the Big Bang, has also been discovered. GN-z11 was first discovered by Hubble in 2015, and was the furthest (oldest) known galaxy at the time. It has a redshift of 10.957 and is 32 billion light years from Earth.
- Both black holes were found using data from JWST and the Chandra X-Ray Observatory



This annotated image provided by NASA on Monday 6th Nov 2023 shows a composite view of data from NASA's Chandra X-ray Observatory and JWST indicating a growing black hole just 470 million years after the big bang. It is the oldest black hole yet discovered

Credit: X-ray: NASA/CXC/SAO/Ákos Bogdán; Infrared: NASA/ESA/CSA/STScI; Image Processing: NASA/CXC/SAO/L. Frattare and K. Arcand

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Two oldest black holes discovered (2)

- The most surprising aspect is that the black hole (a quaser) is ten times the size of the one sitting at the centre of the Milky Way, and is estimated to have between 10 and 100% the mass of its own galaxy. In comparison, Sagittarius A* weighs just 0.1% of the mass of the Milky Way.
- The best theory to describe what may have happened suggests that the black hole formed in a huge gas cloud inside a galaxy that then merged with another galaxy close by.

Galaxy GN-z11, the most distant galaxy ever observed, is shown within the GOODS-North survey field where it was originally discovered with the Hubble Space Telescope. This galaxy is shown in red, reflecting that its light is detected in the infrared due to cosmological redshift
Credit: NASA/ESA; P. Oesch et al. (2016)

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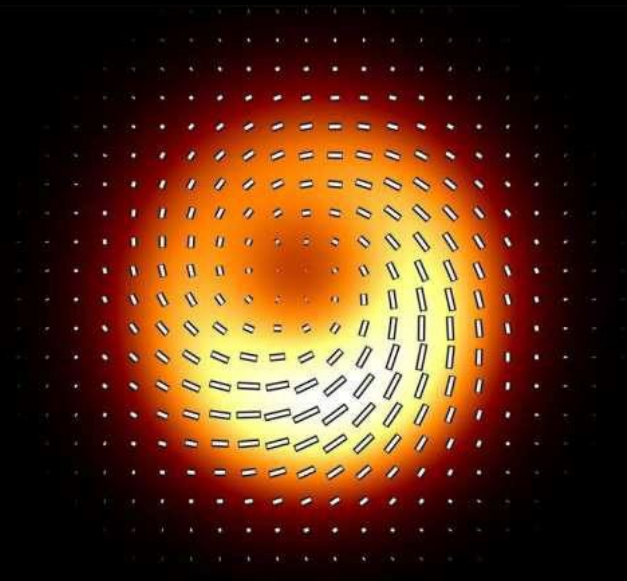
Black holes can lose energy (1)

- Einstein's Theory of General Relativity not only predicted the existence of black holes, but that they can also lose energy
- A spinning black hole will slow down over time as magnetic field lines are twisted during rotation, and that rotational energy is lost to the surroundings.
- Researchers from Princeton University have found that energy close to the event horizon of the black hole M87* is pushing outwards, not inwards. They established that it is this energy that produces jets



The black hole M87* (the asterisk designates the black hole in the middle of galaxy M87) caught the world's attention when it was first detected by the Event Horizon Telescope. Since then, Princeton astrophysicists have discovered that the twisting magnetic field around a black hole determines the tell-tale polarization spiral observed in black hole images. In particular, the direction of energy flow (from the hole to the field or vice versa) determines how the polarization twists. By measuring which way the polarization spirals, one can infer whether the magnetic field is extracting spin energy from the hole or pumping spin energy into it

Credit: Model by Andrew Chael, George Wong, Alexandru Lupsasca, and Eliot Quataert, Princeton Gravity Initiative

Black holes can lose energy (2)

- The outflow jets can be up to a million light years long: 10 times the diameter of the Milky Way
- One of the researchers, Andrew Chael, had the insight that the direction of the spiralling magnetic fields determines the direction of energy flow
- When a black hole spins, it drags spacetime around with it, and the magnetic field lines get dragged along too, slowing down the rotation and causing energy loss.
- It is hoped that the next generation Event Horizon Telescope will be able to test this theory

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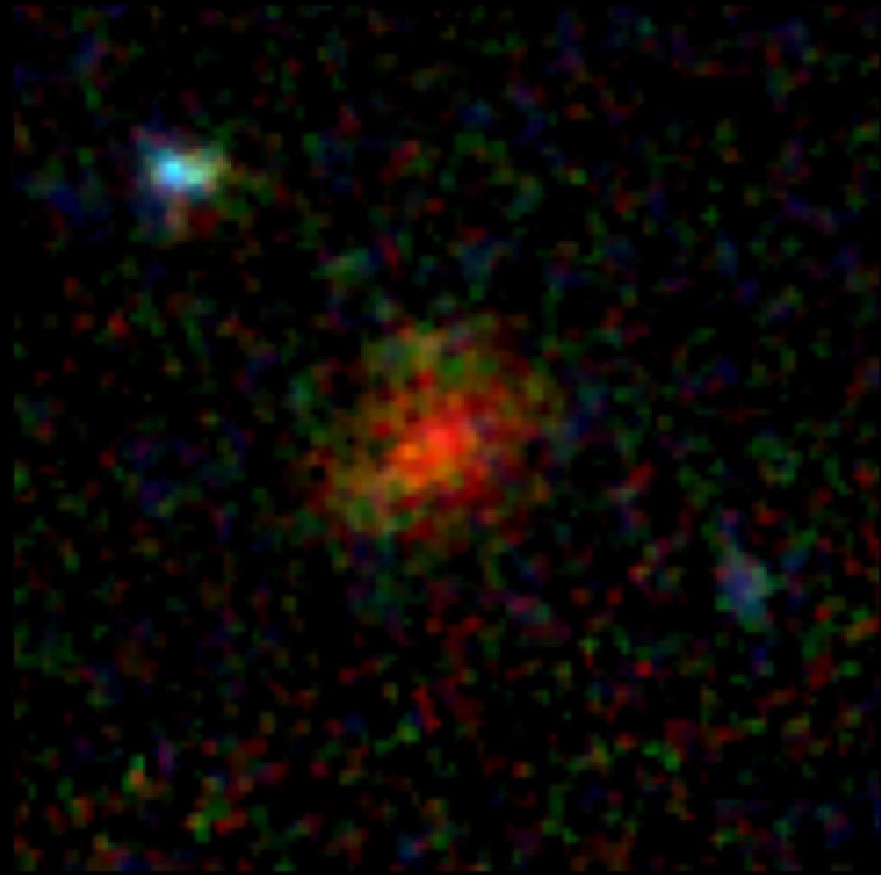
Early ghost-like galaxy reappears (1)

- Far away from the Local Group of galaxies, there are mammoth galaxies such as IC1101, which is millions of light years in diameter and contains over 100 trillion stars (enough to swallow the Milky Way, Andromeda and the space in-between). These huge elliptical galaxies have a rather unusual characteristic; they are all red and dead
- A mature galaxy like the Milky Way makes one or two new stars per year, but these elliptical giants haven't formed any new stars for billions of years
- These monsters can't be seen by Hubble as their light is sub-millimetre - between infrared and radio waves on the electromagnetic spectrum – and has been travelling towards us for over 10 billion years



Colour composite of galaxy AzTECC71 from multiple colour filters in the NIRCam instrument on the JWST
Credit: J. McKinney/M. Franco/C. Casey/University of Texas at Austin

Early ghost-like galaxy reappears (2)

- But the question is: how did such huge galaxies form so early on if they have been dead for so many billions of years?
- Galaxies in the early Universe were far more productive than they are now, but the monster galaxies would need to be forming stars many thousands of times more quickly than seen today. While the mechanism is still unknown, colliding galaxies do set off massive star-forming phases, but these are relatively short-lived and there wouldn't have been many galaxies around to collide with. Tapping into giant molecular clouds could help with production, but newly-formed stars generate large amounts of radiation which would drive off the clouds, thus stopping future star formation.
- The evolution of supermassive black holes likely killed star formation
- Why is AzTECC71 ghostlike? It is hidden by huge quantities of dust, meaning it's hard to see. It was first seen as a fuzzy blob by the James Clark Maxwell Telescope in Hawaii, which sees in wavelengths between far infrared and microwave, then by ALMA, and now by JWST seen today

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Stars at the heart of the Milky Way

- Sagittarius-C is a huge star-forming region, about 300 light years from the supermassive black hole at the centre of the Milky Way
- An estimated 500,000 stars are in the process of being formed, hidden by clouds of dust and gas
- However, it is so dense that the whole area is bathed in intense radiation, to the extent that stars should not be being formed!
- Now, JWST has started examining the area, approximately 25,000 light years from Earth, in an attempt to understand the processes involved. Even at this range, JWST can pick out individual stars

JWST's NIRCam (Near-Infrared Camera) instrument reveals a 50 light-years-wide portion of the Milky Way's dense centre. An estimated 500,000 stars shine in this image of the Sagittarius C (Sgr C) region, along with some as-yet unidentified features
The image covers 50 light years in diameter
Credit: NASA, ESA, CSA, STScI, S. Crowe (UVA)

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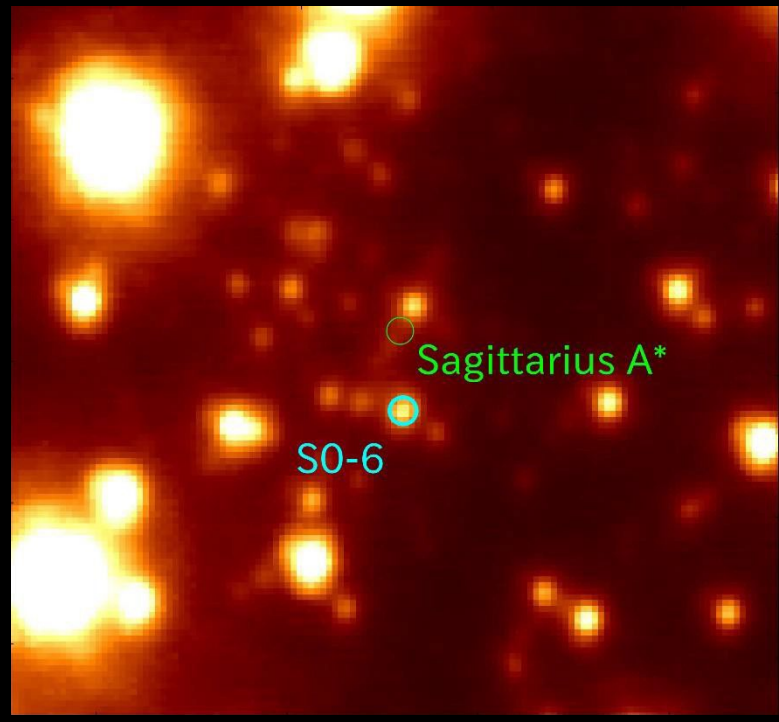
Stars at the heart of the Milky Way

- Although the area near Sagittarius A* - the supermassive black hole at the centre of the Milky Way - is busy forming new stars, no stars can be born close to the black hole, so all of the stars in its orbit must have come from further afield.
- One particular star, S0-6, has had a longer journey than most. Over the course of 8 years, researchers using the Subaru Telescope have determined that the chemical structure of the star is similar to stars found in small galaxies outside the Milky Way
- The star, now over 10 billion years old, was probably formed in a dwarf galaxy that has now been shredded by The Milky Way. The star has, therefore, travelled at least 50,000 light years to its current position, a mere 0.04 light years from the black hole



The central region of the Milky Way galaxy as captured by the Subaru Telescope. The image shows many stars in a field of view about 0.4 light-years across. The star S0-6 (blue circle), the subject of this study, is located about 0.04 light-years from the supermassive black hole Sagittarius A* (Sgr A*, green circle)
Credit: Miyagi University of Education/NAOJ)

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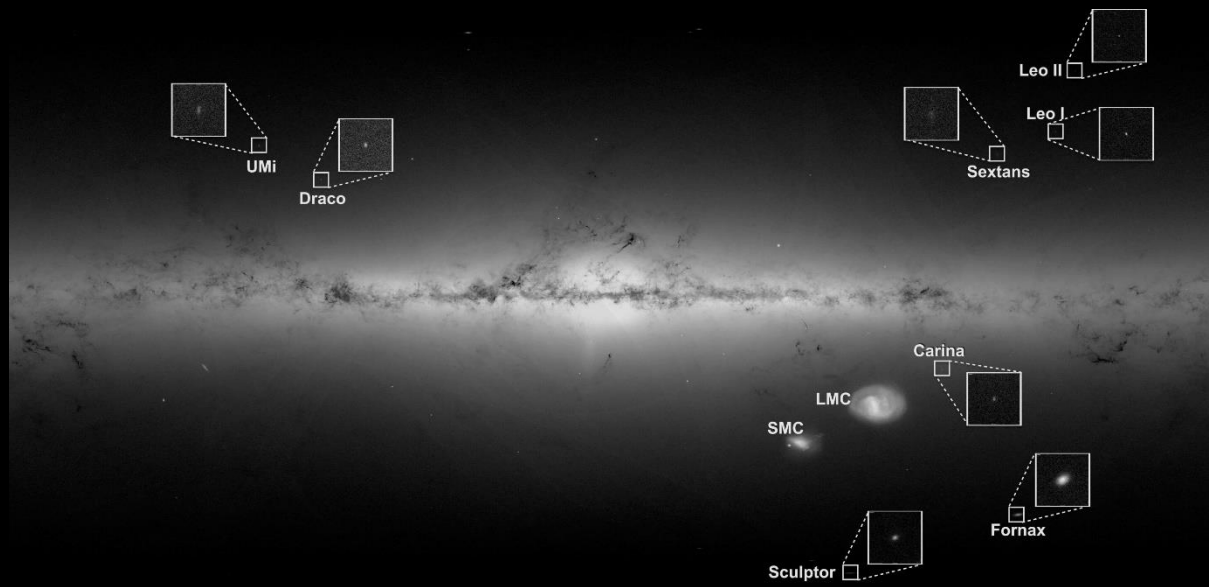
Dwarf galaxies in Milky Way are not old

- The long-established idea that dwarf galaxies in the Milky Way are old has been turned on its head by new data from GAIA
- The ancient satellite dwarf galaxies, thought to be about 10 billion years old, required large amounts of dark matter to protect them from the tidal forces of the Milky Way, and to keep them stable



Dwarf galaxies around the Milky Way Credit: ESA/Gaia/DPAC

- Based on their orbital energies, this now appears to be untrue. Objects captured earlier in the Milky Way's development would have low orbital energies, reflecting the smaller mass of the Milky Way. In fact, the dwarf galaxies have much higher orbital energies. The Sagittarius dwarf galaxy entered the halo some 5-6 billion years ago, and the other dwarf galaxies have substantially larger orbital energies than this one. Gas is stripped away making them unstable, do they have less dark matter too?

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Binary protostars caught being formed

- JWST has caught two protostars being formed close to Open Cluster IC 348, approximately 1,000 light years distant. They are sitting in an area called a Herbig-Haro object: in this case HH 797, in the constellation of Perseus
- Herbig-Haro Objects are luminous regions surrounding new stars where ejected stellar winds or gas collide with the surrounding gas and dust. The high-speed shockwave causes the dust and gas (including molecular hydrogen and carbon monoxide) to emit light in the infrared range

The NASA/ESA/CSA JWST reveals intricate details of the Herbig Haro object 797 (HH 797). Herbig-Haro objects are luminous regions surrounding newborn stars (known as protostars), and are formed when stellar winds or jets of gas spewing from these newborn stars form shockwaves colliding with nearby gas and dust at high speeds. HH 797, which dominates the lower half of this image, is located close to the young open star cluster IC 348, which is located near the eastern edge of the Perseus dark cloud complex. The bright infrared objects in the upper portion of the image are thought to host two further protostars
Credit: ESA/Webb, NASA & CSA, T. Ray (Dublin Institute for Advanced Studies)

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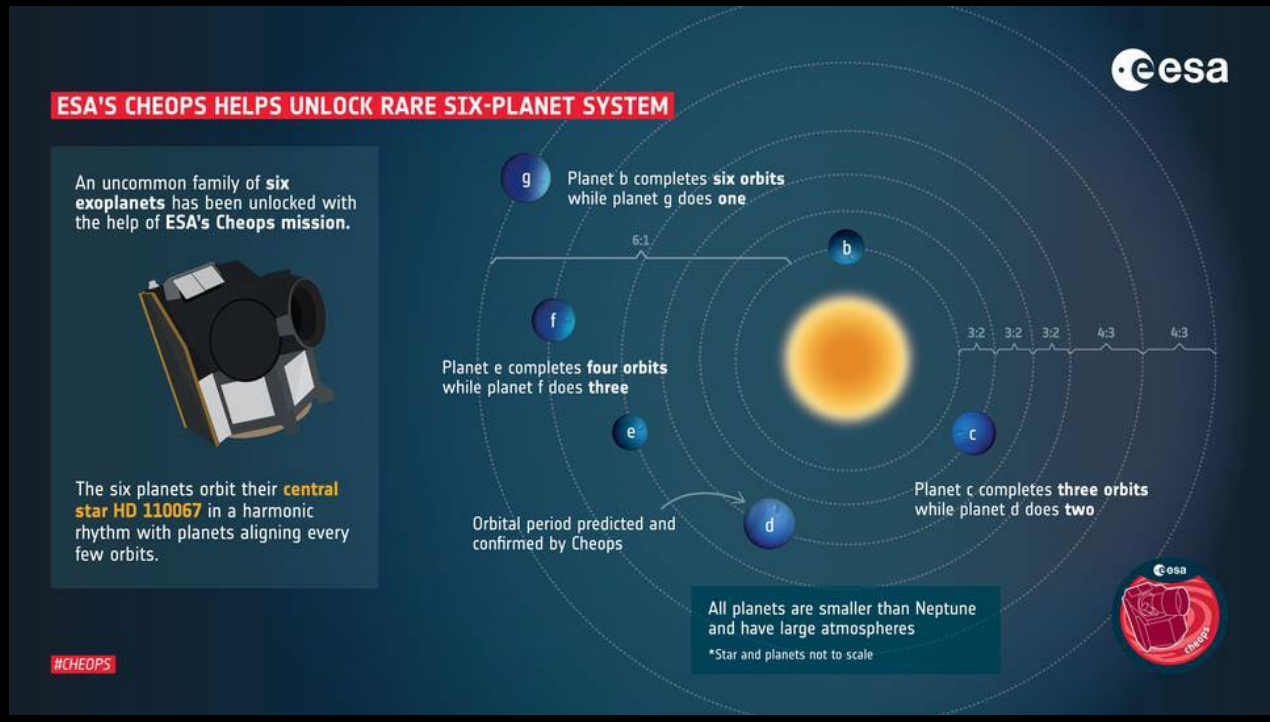
Locked in perfect resonance

- A planetary system has been discovered where 6 sub-Neptune exoplanets are orbiting their host star in perfect resonance
- Researchers, using data from NASA's TESS and ESA's CHEOPS, looked at star HD11067: positioned 100 light years away in the constellation, Coma Berenices. Analysing the data was difficult, as the number of observations of each planet was low



Credit: ESA

- The six planets form a resonant chain in pairs of 3:2, 3:2, 3:2, 4:3, and 4:3, resulting in the closest planet completing six orbits while the outer-most planet does one. When the closest planet to the star makes three full revolutions around it, the second one makes exactly two during the same time. This is called a 3:2 resonance

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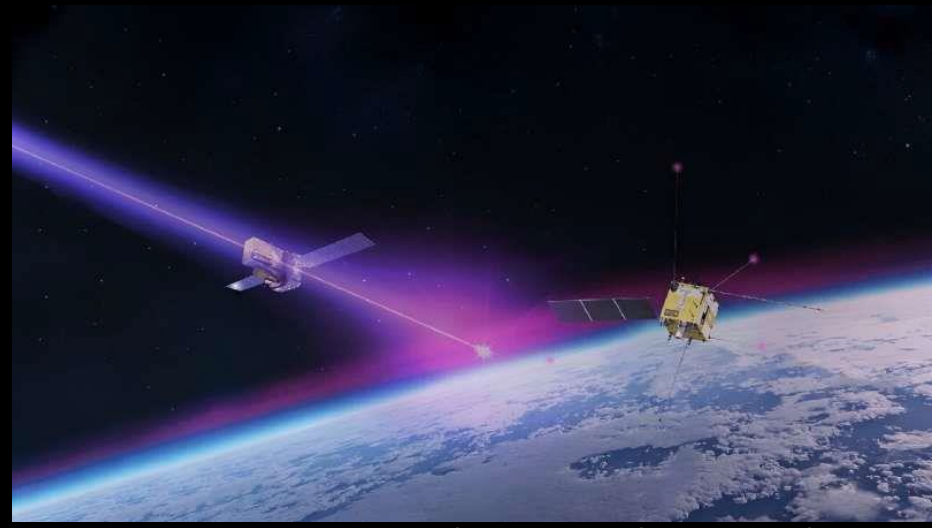
The Earth’s atmosphere affected by BOAT

- On 9th October 2022, astronomers witnessed the most powerful Gamma Ray Burst (GRB20221009A) ever recorded. Nicknamed “BOAT” (Brightest Of All Time), it was a once in 10,000-year event, and came from a galaxy about 2.4 billion light years away.
- According to analysis of data recorded by the China Seismo- Electromagnetic Satellite spacecraft (CSES), it produced a seven-minute burst which caused large disturbances in the ionosphere at about 350km above the Earth’s surface (at the boundary between the lower and upper ionospheres). If a GRB of the same strength had come from within the Milky Way, it might have had more serious consequences



An artist's impression of the powerful blast of gamma rays, caused by an explosion in the distant universe, that reached Earth on October 9 last year
Credit: ESA/ATG Europe; CC BY-SA 3.0 IGO

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Astronomy News in Brief (1)

- Seeing the first stars – now that some of the first galaxies formed have been found, attention is turning to looking for the first stars, known as Population III stars. JWST is now tasked with looking for these stars, which were likely to have been formed between 50 and 100 million years after the Big Bang. JWST will have to make use of gravitational lensing as their redshift will be about z = 20; (to date stars have been found at z = 6). These Population III stars would be huge: between 10 and 1,000 solar masses, and millions of times brighter than the Sun, with extremely short lives - ending either as supernovae, or black holes and quasars
- Gold and Platinum – it has long been suspected that gold, platinum and other lanthanides are formed when two neutron stars merge, resulting in a kilonova; this is known as the “r-process”. But the number of mergers doesn’t account for the quantity of such heavy elements in the cosmos. Researchers suspect that, in a binary system, one neutron star syphons off material from its companion through tidal interaction. The smaller neutron star is now unstable and can explode, leaving the other neutron star intact and producing the missing heavy elements

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Astronomy News in Brief (2)

- Dark Matter helps Black Holes merge – black holes in a binary system slowly spiral towards each other and, at some point, they merge. This is confirmed by the resulting gravitational waves. However, according to Einstein's Theory of General Relativity, this shouldn't happen. When the black holes get to within one parsec of each other, they should stabilise; this is known as the final parsec problem. One theory to overcome the problem is to introduce dark matter. Not any old cold dark matter, but "fuzzy dark matter". This is made up of low-scalar particles that won't interact with each other by anything other than gravity, so don't clump. Theorists still aren't convinced that this is the correct answer, but it is the best they currently have
- Giant Coma Stream – using the 4.2m William Herschel telescope in La Palma, researchers have spotted a stream of stars running between, but not connected to, galaxies. The stream, called the Giant Coma Stream, is over ten times the length of the Milky Way, but is very faint. More streams are likely to be found when the 39m ELT and Euclid come online

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Astronomy News in Brief (3)

- Spiral Galaxies don't like each other's company – the Supergalactic Plane is a massive flattened structure, over one billion light years in size. The Milky Way and all the galaxies in the Local Group and the Virgo Supercluster are members of the Supergalactic Plane. But, while there are many millions of elliptical galaxies, barred spiral galaxies, like the Milky Way, are comparatively rare. Astronomers now believe that the reason is quite simple; inside the Plane, where galaxies are likely to be relatively close together, interactions are a regular occurrence. And when this happens, spiral galaxies lose their structure and morph into elliptical galaxies. Outside the Plane and in relative isolation, spiral galaxies are much more common
- Young "teenage" galaxies are hot things – data from JWST has shown that teenage galaxies (ones that formed two to three billion years after the Big Bang) are much hotter than expected (about 50% higher than slightly older galaxies) and have formed unexpected elements, such as nickel which, being heavier than iron, is relatively uncommon and difficult to detect. Further work will be needed to understand the reason why

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Astronomy News in Brief (4)

- Betelguese: spinning or not spinning – all stars spin: they have rotational momentum, but larger stars spin more slowly to conserve momentum. The most current ideas are that a red giant spins at about 1km per second and a red supergiant at about 0.1km per second. So, it has been a surprise that both ALMA and Hubble have measured Betelguese's rate as much higher: ALMA has it at 5.47 km/sec. A possible reason is a merger with a lower mass companion star. However, one team has raised doubts about the accuracy of the measurement, suggesting that it may be the convective plasma at the surface which is giving a false reading. At present it is impossible to say if this is correct or not
- GAIA could detect gravitational waves – the GAIA spacecraft has been amazingly successful at measuring the positions on stars in our galaxy, tracking their movements, and determining their distances. Now, there a proposal to use GAIA to detect gravitational waves by the effect they are likely to have on the movement of asteroids

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Astronomy News in Brief (5)

- Methane in an exoplanet's atmosphere – JWST has discovered methane in the atmosphere of a warm Jupiter exoplanet, WASP 80b; the exoplanet orbits a k-type main sequence red dwarf, approximately 162 light years distant. Methane is not particularly common as it is easily broken down under the influence of radiation from stars, so for it to exist requires either a biotic source (biological-based), or abiotic: a chemical process requiring water, carbon dioxide, and the mineral olivine. Olivine is a common mineral and is the major component of the Earth's upper mantle. However, it is unlikely to be found on this gas giant exoplanet, and this makes the discovery very interesting
- Mars glows green – ESA's ExoMars Trace Gas Orbiter (TGO) has observed the Martian atmosphere glowing green for the first time. The cause is an airglow (actually a nightglow), which is probably the result of oxygen atoms combining to form oxygen molecules at roughly 50km above the surface

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Astronomy News in Brief (6)

- Comets as source of organic molecules – comets are known to contain a rich soup of organic chemicals. The samples returned from comet Ryugu showed evidence of amino acids and vitamin B3. But, if a comet crashed onto Earth, the speed and high temperatures generated would destroy such compounds. Now, researchers believe that during the Late Heavy Bombardment (3.8 billion to 4.1 billion years ago) comets may have been slowed down by interacting with a series of planets before hitting Earth, allowing these building blocks of life to survive
- Meteorites deliver nitrogen to Earth – analysis of the Ryugu samples suggest that meteorites could have delivered nitrogen to the Earth during the early days of the Solar System

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Astronomy News in Brief (7)

- Moon rocks contain solar hydrogen – some of the rocks brought back by the Apollo astronauts have remained locked away, waiting for better instrumentation to be developed to study them. Recent research has now revealed that samples include hydrogen deposited by the solar wind
- Halley's Comet passes aphelion – on 9th December, the most famous of all comets, 1P/Halley, reached aphelion (35.14 AU or 5.3 billion kilometres), the furthest point from the Sun on its 75-year orbit. Although not visible to anyone on Earth it has a +35 magnitude and is located in the southern constellation of Hydra. At aphelion it is also travelling at its slowest: 0.91km per second
- Solar Flare – the biggest solar flare for 6 years caused a temporary radio blackout across most the United States for about two hours on 14th December

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January 2024

Spaceflight News

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Blue Origin successful mission

- Over a year after the failure and crash of the previous Blue Origin mission (Mission 23), the New Shepherd suborbital rocket was launched from Launch Site One, near Van Horn, Texas, at 10:42 am (16:42 GMT) on Tuesday 19th December
- The NS-24 mission was uncrewed but carried a payload of scientific equipment and 38,000 postcards, each of which were individually stamped with “Flown to Space”
- Following separation from the booster, which landed back at the launch site, the capsule reached an altitude of 107km - above the Karman Line of 100km, which is the internationally recognised boundary of space
- The capsule then parachuted safely back to the desert
- It was all over in 10 minutes 13 seconds

New Shepard’s booster lands on the pad during NS-24 (December 19, 2023)
Credit: Blue Origin

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Rocket Lab launches Japanese satellite

- Rocket Lab successfully launched an Electron rocket from its Mahia Peninsula launch site in New Zealand on Friday 15th December
- 'The rocket successfully carried the TSUKUYOMI-I satellite into orbit on behalf of Japanese startup Institute for Q-shu Pioneers of Space Inc', Rocket Lab said in a statement made two hours after the launch
- It was Rocket Lab's 10th launch of 2023 and the 42nd Electron Rocket launch since 2017

An Electron rocket successfully takes off from its launch site on the Mahia Peninsula, New Zealand, Friday, Dec. 15, 2023. California-based Rocket Lab launched a Japanese satellite TSUKUYOMI-I, into orbit on behalf of a Japanese start-up Institute for Q-shu Pioneers of Space Inc
Credit: Rocket Lab, via AP

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NASA test of potential Europa lander

- When NASA's Europa Clipper spacecraft arrives in 2030, it will perform a series of flybys to study the moon's surface and plumes
- If successful, it will be followed by a second mission, which will put a lander down on Europa
- However, unlike the Moon and Mars, the surface of Europa is frozen and, while it may be smooth in places, the constant tidal flexing caused by Jupiter's powerful gravitational field is likely to make the surface fractured
- NASA has started testing systems that a potential lander will require: from sky cranes and bridles, to independently controlled legs to keep the lander upright. The underside of the lander will have a "belly pan" to protect the lander and trigger the legs to take over responsibility for stability

Credit: NASA/JPL-Caltech

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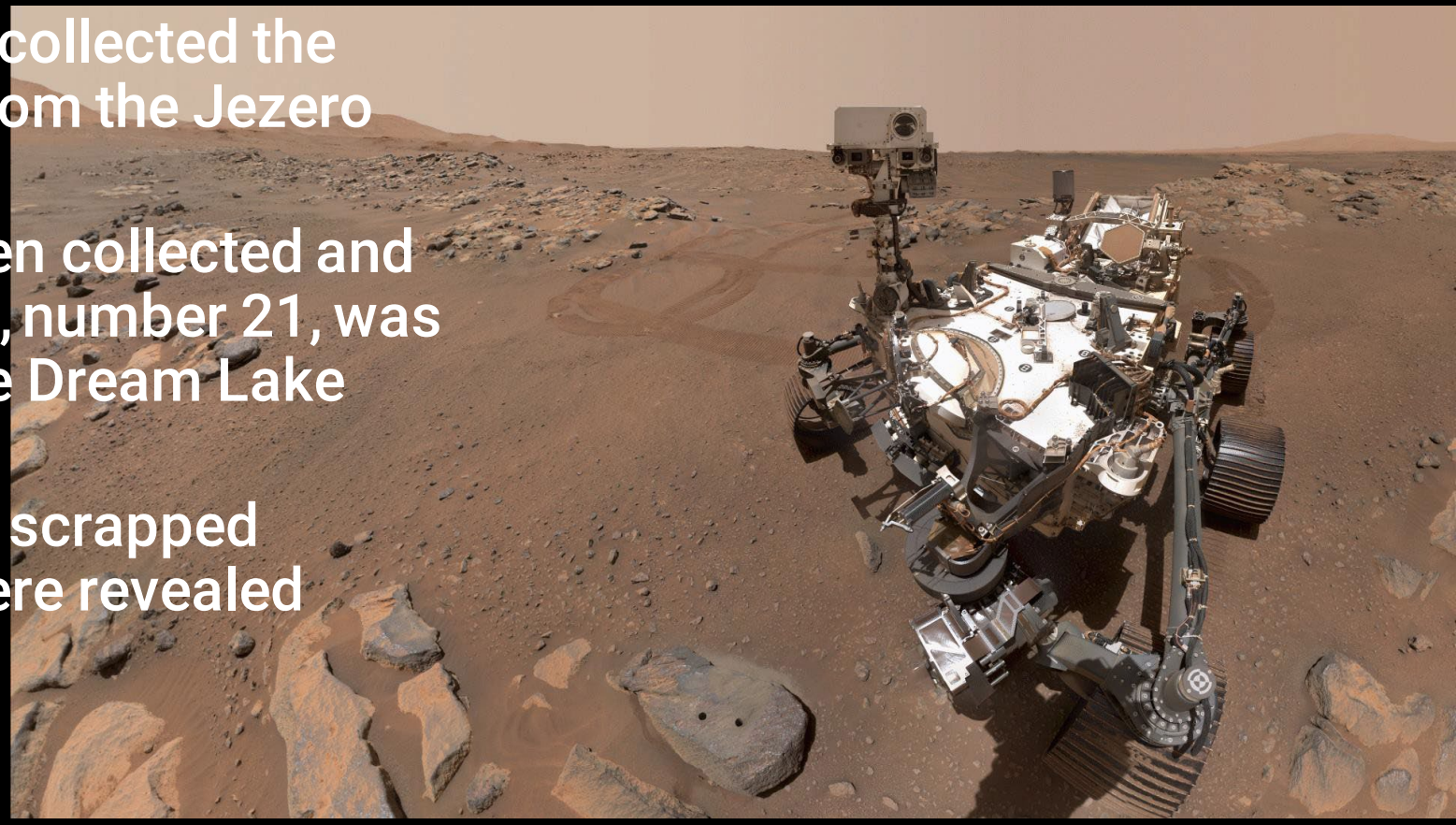
Perseverance collects youngest sample

- The Perseverance Rover has collected the youngest ever rock sample from the Jezero Crater
- To date, 23 samples have been collected and stored. The youngest sample, number 21, was discovered by Ingenuity in the Dream Lake region
- Once the top layers had been scrapped away, glassy, green grains were revealed beneath



Credit: NASA/JPL-Caltech/MSSS

- See the video at: https://cdn.jwplayer.com/previews/83qJfmmF

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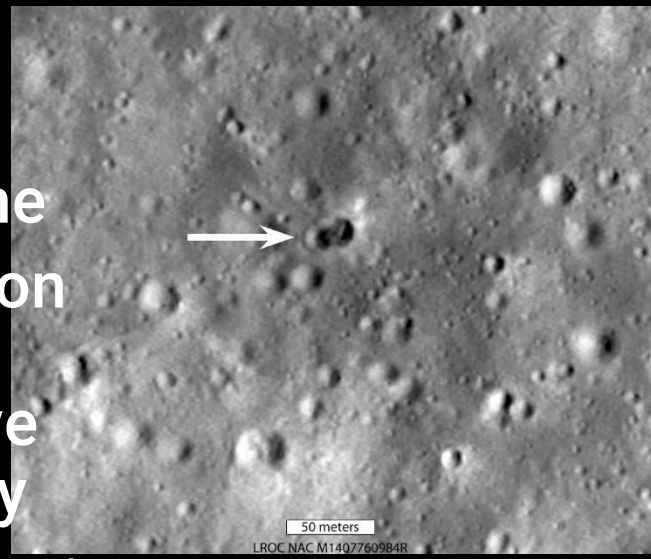
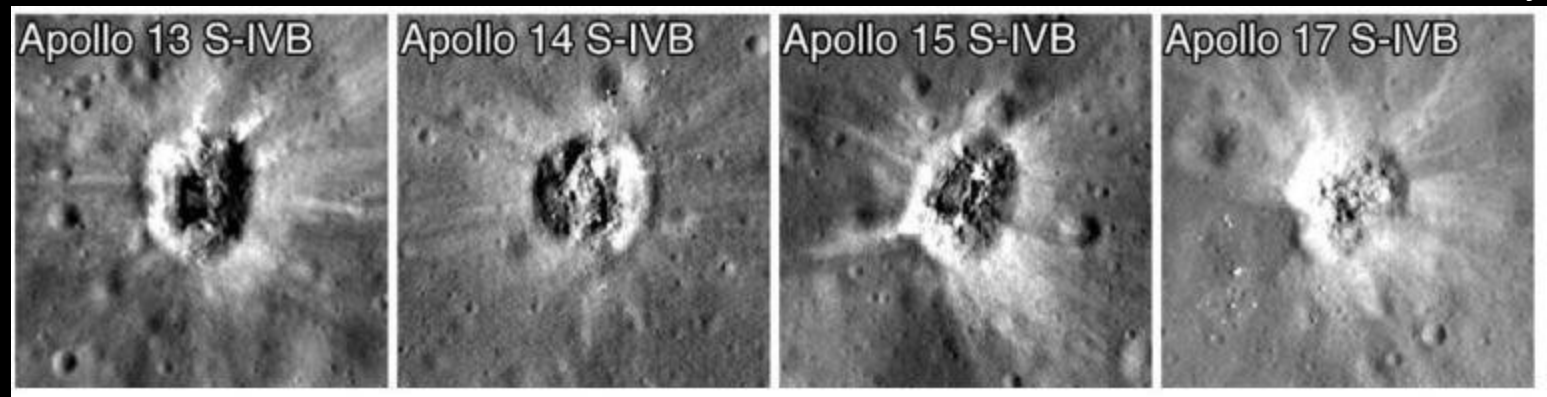
Double crater on Moon caused by rocket

- In March 2022, a new double crater was spotted on the Moon
- It had been expected that a large piece of debris was going to crash in the neighbourhood of the new craters around that time
- It was initially thought to have been the spent rocket of a Falcon 9, used to launch NASA's Deep Space Climate Observatory (DSCOVR) spacecraft on 11th February 2015, but scientist have proved that it is actually a Chinese Long March 3C rocket body from the Chang'e 5-T1 mission, launched on 23rd October 2014
- The double crater was probably caused by an unknown payload



A rocket body impacted the Moon on March 4, 2022, near Hertzsprung crater, creating a double crater roughly 28 metres wide in the longest dimension
Credit: NASA/Goddard/Arizona State University



These four images show craters formed by impacts of the Apollo SIV-B stages: crater diameters range from 35 to 40 metres in the longest dimension
Credit: NASA/Goddard/Arizona State University

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First US Moon landing in 50 years

- When the new ULA Vulcan Centaur rocket launches on 8th January 2024, it will not only be its first flight, but it will also be carrying America's first lunar lander in over 50 years
- The unmanned Peregrine, developed by Astrobotic, will reach the Moon in a few days but will wait until 25th January before attempting to land so that light conditions at the landing site are correct
- This is one of the first NASA commissions as part of the CLPS program where, on a fixed-price contract, private companies will send experiments and technologies to the Moon

Astrobotic's Peregrine lunar lander in the clean room at Astrotech in Titusville, Florida. The spacecraft will be the main payload onboard the first launch of ULA's Vulcan rocket
Credit: ULA

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First European vertical launch spaceport

- The first licenced spaceport in Western Europe capable of launching a rocket vertically is aiming to complete its first launch in 2024
- The SaxaVord Spaceport is located on the Lamba Ness peninsula on the island of Unst, the most northerly of the islands of the Shetland Archipelago
- The Civil Aviation Authority granted the licence on Sunday 17th December. However, before any launches can be undertaken, two more licences need to be granted, the Range Operating Licence and the Launching Licence
- A number of companies, including UK-based Skyrora, German-based HyImpulse, Augsburg Rocket Company, and US giant, Lockheed Martin are commercial partners

Credit: SaxaVord Spaceport

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Spaceflight News and Updates (1)

- Psyche's First Light – barely 2 months after its launch on 13th October, the Psyche spacecraft commissioning is ahead of schedule. On 4th December, the spacecraft turned on its cameras and produced its first images. In total, the commissioning test resulted in 68 images being taken
- China's Mars Samples – China is currently planning to send a manned mission to Mars in 2030. In advance of this, there are proposals to collect and return Martian samples by 2028
- Martian Rovers sit it out – with Mars moving towards solar conjunction, the various rovers and landers on Mars will be temporarily out of touch with Earth. Even though some communication could be maintained, signals would have to pass close to the Sun, and could become corrupted. Both Perseverance and Curiosity will not completely shut down, but will go on monitoring the surface conditions and weather

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Spaceflight News and Updates (2)

- Next Generation Mars Helicopters – with Ingenuity breaking all sorts of records on Mars, engineers back on Earth are already working on the next generation helicopters. For instance, the new rotor blades are 10cm longer and have been spun at 3,500 rpm (750 rpm faster than Ingenuity and 6-7 times faster than is required on Earth)
  There are several videos you can watch on success of Ingenuity and the future at: https://youtu.be/z59Fn6FadCM and https://youtu.be/xsUtq8PwZpQ and https://youtu.be/zjt3DMNqtus
- Chinese helicopter – meanwhile China is developing a Mars Sample Return mission. A very small quadcopter would be used to look for rocks (less than 100g and 500m from the lander) and recover them, returning the samples to the ascent vehicle

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Spaceflight News and Updates (3)

- Chinese Space Plane deploys “objects” – China’s new Shenlong (“Divine Dragon”) space plane – which is similar to the robotic Boeing X-37B – has placed 6 unknown objects into orbit. Shenlong is on its third mission. Based on the signals coming from some of the objects, they appear to be similar to objects released on the previous mission. The next X-37B launch is due at the end of December
- Artemis 3 Moon Mission - the U.S. Government Accountability Office has suggested that "multiple challenges" and an ambitious schedule, will delay the mission from December 2025 to sometime in 2027. Outstanding issues include detailed work on the human landing system, or HLS, which is derived from SpaceX's Starship, plus NASA's transport system to the lunar surface. Work also needs to be done on incorporating larger oxygen tanks into the new Axiom spacesuits

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Spaceflight News and Updates (4)

- Ariane 6 successful firing – Arianespace's new Ariane 6 rocket successfully completed a 7-minute hot-fire of its new Vulcain 2.1 engines on 23rd November. Only the core stage, and not the boosters, were fired. The test consumed nearly 150 tonnes of liquid oxygen and liquid hydrogen fuel. Now, engineers will pore over the data before moving to the next stage and the first launch: due between mid-June and end of July 2024. See the test at: https://cdn.jwplayer.com/previews/AuBD9hf2
- SLS successful engine firing – the third test firing of the RS-25 engine, which will be used to power the SLS on future moon missions, was successfully carried out on 29th November. The 650 second hot-firing lasted longer than would be needed operationally, and was pushed to 113% power level (above the 111% needed briefly to put the SLS in orbit). The first four Artemis missions will be powered by 16 holdover space shuttle engines before newly-produced RS-25 engines takeover for later missions

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Spaceflight News and Updates (5)

- SpaceX Starship – whilst the launch of the second Starship ended in a fireball when the upper stage self-destructed, SpaceX are viewing the mission as a major step forward. Lift-off and the first stage were a success with all engines firing. The new first stage separation process worked too and, importantly, the redesigned launch pad survived the lift-off pretty much intact. This means that the process of preparing for the next launch can get under way, once the issues with the second stage are understood and fixed – and when the FAA gives the all-clear! SpaceX have already carried out a static fire test of the next upper stage (Starship 28) – see https://cdn.jwplayer.com/previews/bkfaobjb
  Many more successful launches will be needed, plus the introduction of techniques, such as in-flight refuelling, before the first manned mission

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Spaceflight News and Updates (6)

- Gaelic Cuisine gets a lift-off – a small private company, HyPrSpace (a consortium of the Italian defence firm, Leonardo, and French IY firm, Thales), has received partial funding from the French Government to get a new, low-cost rocket into space. Designed to launch satellites up to 250kg, the rocket, called “Baguette-One”, should go into space in 2026
- Voyager 1 – engineers are working to fix an issue with one of the probe’s three computers: the Flight Data System (FDS) is failing to communicate with the Telecommunications Unit (TMU) meaning that data is being sent back to Earth
- Hubble – was put into safe mode on 23rd November due to an on-going gyro issue. This was the third time Hubble had been put into safe mode in under 4 days, when one of the three remaining gyros started giving false readings. Hubble continues to work and is still sending down amazing images

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January 2024

Observational Highlights

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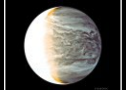
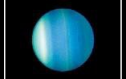
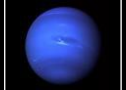
Planets (information for 1st January)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	06:26	15:01	10:43			+0.53	NO
	VENUS	04:54	13:46	09:20	South-East	16° ▫	-4.06	YES
	MARS	07:12	14:57	11:04			+1.39	NO
	JUPITER	12:25	02:35	19:30	South	51°	-2.63	YES
	SATURN	10:35	20:42	15:39	South	24° ◊	+0.95	YES
	URANUS	12:49	03:56	20:33	South	56°	+5.68	YES
	NEPTUNE	11:12	22:47	16:59	South	35° ◊◊	+7.91	YES

* = Highest point at Dawn (06:32 - last visible sighting)

** = Highest point at Dusk (17:32 - first visible sighting)

◊ = Highest point when first visible (16:56)

◊◊ = Highest point when first visible (17:32)

▫ = Highest point when last visible (07:36)

▫▫ = Highest point when last visible

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100 Deep Sky Objects - 1 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
Cr50	The Hyades (Taurus)	Open Cluster	16:57	03:45	21:43 ◊	South	55°	+1.0
M45	The Pleiades (Taurus)	Cluster with Nebulosity	17:02	03:43	21:03 ◊◊	South	63°	+1.3
NGC1980	Open Cluster (Orion)	Cluster with Nebulosity	19:02	02:41	22:51	South	33°	+2.5
C33	The Eastern Veil Nebula	Nebula	17:32	23:27	17:32 **	West	49°	+2.7
M44	Beehive Cluster (Cancer)	Open Cluster	20:06	06:37	01:59	South	58°	+3.1
M31	Andromeda Galaxy (Andromeda)	Galaxy	17:31	01:50	17:59	South	80°	+3.4
IC1396	The Elephant Trunk (Cepheus)	Cluster with Nebulosity	17:32	06:32	17:32 **	North-West	66°	+3.5
M42	Orion Nebula (Orion)	Cluster with Nebulosity	19:21	02:21	22:51	South	33°	+4.0
NGC2264	The Christmas Tree Cluster (Monoceros)	Cluster with Nebulosity	19:03	04:50	23:56	South	49°	+4.1
NGC2232	Open Cluster (Monoceros)	Open Cluster	20:13	03:14	23:44	South	34°	+4.2
NGC1981	Open Cluster (Orion)	Open Cluster	19:17	02:24	22:51	South	34°	+4.2
NGC1977	Running Man Nebula (Orion)	Open Cluster	17:32	04:41	23:19	South	53°	+4.2
C14	Double Cluster (Perseus)	Open Cluster	17:32	06:32	19:36	North	83°	+4.3
M47	Open Cluster (Puppis)	Open Cluster	22:46	03:06	00:56	South	24°	+4.4
M39	Open Cluster (Cygnus)	Open Cluster	17:32	23:16	17:32 **	West	63°	+4.6

* = Highest point at Dawn (06:32 - last visible sighting) ** = Highest point at Dusk (17:32 - first visible sighting)
◊ = Bright object first visible sighting (16:57) ◊◊ = Bright object first visible sighting (17:02)

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100 Deep Sky Objects - 2 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
NGC1499	The California Nebula (Perseus)	Bright Nebula	17:32	04:48	21:55	South	75°	+5.0
M35	Open Cluster (Gemini)	Open Cluster	17:35	05:14	23:25	South	63°	+5.1
NGC6871	Open Cluster (Cygnus)	Open Cluster	17:32	23:42	17:32 **	West	43°	+5.2
M34	The Spiral Cluster (Perseus)	Open Cluster	17:32	03:28	19:58	South	81°	+5.2
NGC869	h Per Cluster (Perseus)	Open Cluster	17:32	06:32	19:35	North	83°	+5.3
NGC2281	Open Cluster (Auriga)	Open Cluster	17:32	06:32	06:32 *	North-West	27°	+5.4
M37	The Auriga Salt-and-Pepper	Open Cluster	17:32	05:32	23:08	South	71°	+5.6
NGC7686	Open Cluster (Andromeda)	Open Cluster	17:32	00:59	17:32 **	West	82°	+5.6
NGC752	Open Cluster (Andromeda)	Open Cluster	17:32	02:05	19:14	South	77°	+5.7
M5	Globular Cluster (Serpens Caput)	Globular Cluster	02:23	06:32	06:32 *	South-East	34°	+5.7
M13	Great Globular Cluster (Hercules)	Globular Cluster	23:28	06:32	06:32 *	East	50°	+5.8
M48	Open Cluster (Hydra)	Open Cluster	22:34	04:32	01:33	South	33°	+5.8
M33	Triangulum Galaxy (Triangulum)	Galaxy	17:32	01:02	18:50	South	69°	+5.8
M50	The Heart-Shaped Cluster (Monoceros)	Open Cluster	21:45	02:59	00:22	South	30°	+5.9
NGC2169	The "37" Cluster (Orion)	Open Cluster	18:34	04:14	23:24	South	54°	+5.9

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100 Deep Sky Objects - 3 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
NGC2301	Open Cluster (Monoceros)	Open Cluster	20:34	03:48	00:11	South	39°	+6.0
NGC7000	The North American Nebula (Cygnus)	HII Region	17:32	21:45	17:32 **	West	57°	+6.0
M36	The Pinwheel Cluster (Auriga)	Open Cluster	17:32	05:19	22:52	South	73°	+6.0
IC405	The Flaming Star Nebula (Auriga)	Nebula	17:32	05:00	22:32	South	73°	+6.0
M46	Open Cluster (Puppis)	Open Cluster	23:40	02:22	01:01	South	24°	+6.1
NGC884	chi Per Cluster (Perseus)	Open Cluster	17:32	06:32	19:39	North	83°	+6.1
NGC7160	Open Cluster (Cepheus)	Open Cluster	17:32	06:32	17:32 **	North-West	73°	+6.1
NGC1746	Open Cluster (Taurus)	Open Cluster	17:32	03:55	02:20	South	62°	+6.1
NGC1545	Open Cluster (Perseus)	Open Cluster	17:32	06:32	21:37	South	89°	+6.2
M3	Globular Cluster (Canes Venatici)	Globular Cluster	22:09	06:32	06:32 *	South	66°	+6.3
NGC6940	Open Cluster (Vulpecula)	Open Cluster	17:32	22:42	17:32 **	West	43°	+6.3
M15	Globular Cluster (Pegasus)	Globular Cluster	17:32	21:52	17:32 **	South-West	38°	+6.3
NGC7243	Open Cluster (Lacerta)	Open Cluster	17:32	23:42	17:32 **	West	70°	+6.4
NGC1528	Open Cluster (Perseus)	Open Cluster	17:32	06:32	21:39	North	89°	+6.4
NGC457	The Dragonfly Cluster (Cassiopeia)	Open Cluster	17:32	06:32	18:36	North	82°	+6.4

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100 Deep Sky Objects - 4 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
M38	The Starfish Cluster (Auriga)	Open Cluster	17:32	05:20	22:44	South	75°	+6.4
NGC1647	Open Cluster (Taurus)	Open Cluster	17:32	03:15	22:02	South	58°	+6.4
NGC1662	Open Cluster (Orion)	Open Cluster	17:32	02:38	22:04	South	50°	+6.4
NGC2539	Open Cluster (Puppis)	Open Cluster	23:40	03:20	01:30	South	26°	+6.5
IC1848	The Soul Nebula (Cassiopeia)	Cluster with Nebulosity	17:32	06:32	20:07	North	80°	+6.5
IC1805	The Heart Nebula (Cassiopeia)	Cluster with Nebulosity	17:32	06:32	19:49	North	79°	+6.5
NGC654	Open Cluster (Cassiopeia)	Open Cluster	17:32	06:32	19:00	North	78°	+6.5
NGC129	Open Cluster (Cassiopeia)	Open Cluster	17:32	06:32	17:46	North	80°	+6.5
M92	Globular Cluster (Hercules)	Globular Cluster	03:16	06:32	06:32 *	East	48°	+6.5
M2	Globular Cluster (Aquarius)	Globular Cluster	17:32	20:50	17:32 **	South	27°	+6.6
NGC1444	Open Cluster (Perseus)	Open Cluster	17:32	06:32	21:05	North	88°	+6.6
M29	The Cooling Tower (Cygnus)	Open Cluster	17:32	01:22	17:32 **	West	48°	+6.6
NGC2423	Open Cluster (Puppis)	Open Cluster	23:21	02:32	00:56	South	25°	+6.7
NGC2343	Open Cluster (Monoceros)	Open Cluster	22:13	02:42	00:27	South	28°	+6.7
NGC2129	Open Cluster (Gemini)	Open Cluster	17:44	04:50	23:17	South	62°	+6.7

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100 Deep Sky Objects - 5 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
NGC1027	Open Cluster (Cassiopeia)	Open Cluster	17:32	06:32	19:59	North	79°	+6.7
NGC7789	The Caroline's Rose (Cassiopeia)	Open Cluster	17:32	06:32	17:32 **	North-West	83°	+6.7
NGC1342	Open Cluster (Perseus)	Open Cluster	17:32	03:32	20:48	South	76°	+6.7
NGC2175	Open Cluster (Orion)	Cluster with Nebulosity	18:05	04:45	23:25	South	59°	+6.8
NGC6811	The Hole in a Cluster (Cygnus)	Open Cluster	17:32	20:36	17:32 **	West	45°	+6.8
NGC7023	The Iris Nebula (Cepheus)	Nebula	17:32	06:32	17:32 **	North-West	71°	+6.8
M67	Open Cluster (Cancer)	Open Cluster	21:32	06:32	02:10	South	50°	+6.9
NGC1502	Open Cluster (Camelopardalis)	Open Cluster	17:32	06:32	21:24	North	78°	+6.9
M52	The Cassiopeia Salt-and-Pepper	Open Cluster	17:32	06:32	17:32 **	North-West	77°	+6.9
M81	Bode's Galaxy (Ursa Major)	Galaxy	17:32	06:32	06:32 *	North-East	86°	+6.9
NGC6960	The Western Veil Nebula (Cygnus)	Supernova Remnant	17:32	23:15	17:32 **	West	46°	+7.0
NGC7635	The Bubble Nebula (Cassiopeia)	HII Region	17:32	06:32	17:32 **	South-West	77°	+7.0
M27	Apple Core Nebula (Vulpecula)	Planetary Nebula	17:32	21:25	17:32 **	West	33°	+7.4
M103	Open Cluster (Cassiopeia)	Open Cluster	17:32	06:32	18:50	North	80°	+7.4
NGC6888	The Crescent Nebula (Cygnus)	HII Region	17:32	00:59	17:32 **	West	46°	+7.5

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100 Deep Sky Objects - 6 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
M53	Globular Cluster (Coma Berenices)	Globular Cluster	01:22	06:32	06:32 *	South	57°	+7.7
M101	The Pinwheel Galaxy (Ursa Major)	Galaxy	17:32	06:32	06:32 *	North-East	81°	+7.9
M78	Reflection Nebula (Orion)	Reflection Nebula	19:27	02:37	23:02	South	39°	+8.0
NGC246	The Skull Nebula (Cetus)	Planetary Nebula	17:32	20:04	18:04	South	27°	+8.0
M110	Galaxy (Andromeda)	Galaxy	17:32	01:06	17:57	South	80°	+8.1
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	23:03	06:32	06:09	South	80°	+8.2
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	23:01	06:32	06:32 *	South	63°	+8.4
M56	Globular Cluster (Lyra)	Globular Cluster	17:32	21:42	17:32 **	West	32°	+8.4
M71	Globular Cluster (Sagitta)	Globular Cluster	17:32	20:54	17:32 **	West	29°	+8.4
NGC1245	Open Cluster (Perseus)	Open Cluster	17:32	06:32	20:31	South	86°	+8.4
M82	The Cigar Galaxy (Ursa Major)	Galaxy	17:32	06:32	06:32 *	North-East	80°	+8.4
M1	The Crab Nebula (Taurus)	Planetary Nebula	17:32	04:17	22:50	South	60°	+8.4
M49	Galaxy (Virgo)	Galaxy	01:29	06:32	05:48	South	47°	+8.4
M64	The Black Eye Galaxy (Coma Berenices)	Galaxy	00:50	06:32	06:15	South	60°	+8.5
M63	The Sunflower Galaxy (Canes Venatici)	Galaxy	23:22	06:32	06:11	South	81°	+8.6

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100 Deep Sky Objects - 7 (Information for 1st January)

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
M104	The Sombrero Galaxy (Virgo)	Galaxy	03:55	06:32	05:58	South	27°	+8.6
M57	The Ring Nebula (Lyra)	Planetary Nebula	17:32	21:50	17:32 **	West	30°	+8.8
NGC6543	The Cat's Eye Nebula (Draco)	Planetary Nebula	17:32	06:32	17:32 **	North-East	82°	+8.8
M60	Galaxy (Virgo)	Galaxy	01:25	06:32	06:02	South	50°	+8.8
M66	Galaxy (Leo)	Galaxy	23:55	06:32	04:39	South	52°	+8.9
M77	Galaxy (Cetus)	Galaxy	17:32	23:33	19:59	South	39°	+8.9
NGC2403	'Spiral' Galaxy (Camelopardalis)	Galaxy	17:32	06:32	21:34	North	75°	+8.9
M87	Virgo A Galaxy (Virgo)	Galaxy	01:07	06:32	05:49	South	51°	+8.9
M86	Galaxy (Virgo)	Galaxy	01:01	06:32	05:45	South	52°	+8.9
M43	De Mairan's Nebula (Orion)	HII Region	19:52	01:51	22:51	South	33°	+9.0
M32	Galaxy (Andromeda)	Galaxy	17:32	01:04	17:59	South	80°	+9.0

Twilight	Civil	Naut	Astro
Ends	16:43	17:25	18:05
Starts	07:21	06:39	05:59

	Rises	Sets
Sun	08:00	16:03
Moon	20:40	11:05

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◊◊ = Bright object first visible sighting (17:02)

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Brown Lunation Numbers

numbered from first New Moon in 1923

Phases of the Moon

Phase	Date	Time	Lunation
LAST QUARTER	4th January	03:30	1249
NEW MOON	11th January	11:57	1250
FIRST QUARTER	18th January	03:52	1250
FULL MOON	25th January	17:54	1250

Credit: Sean Smith/NASA