Lewes Astronomical Society

Newsletter - March 2024

Astronomy News, Spaceflight News, and Observational Highlights

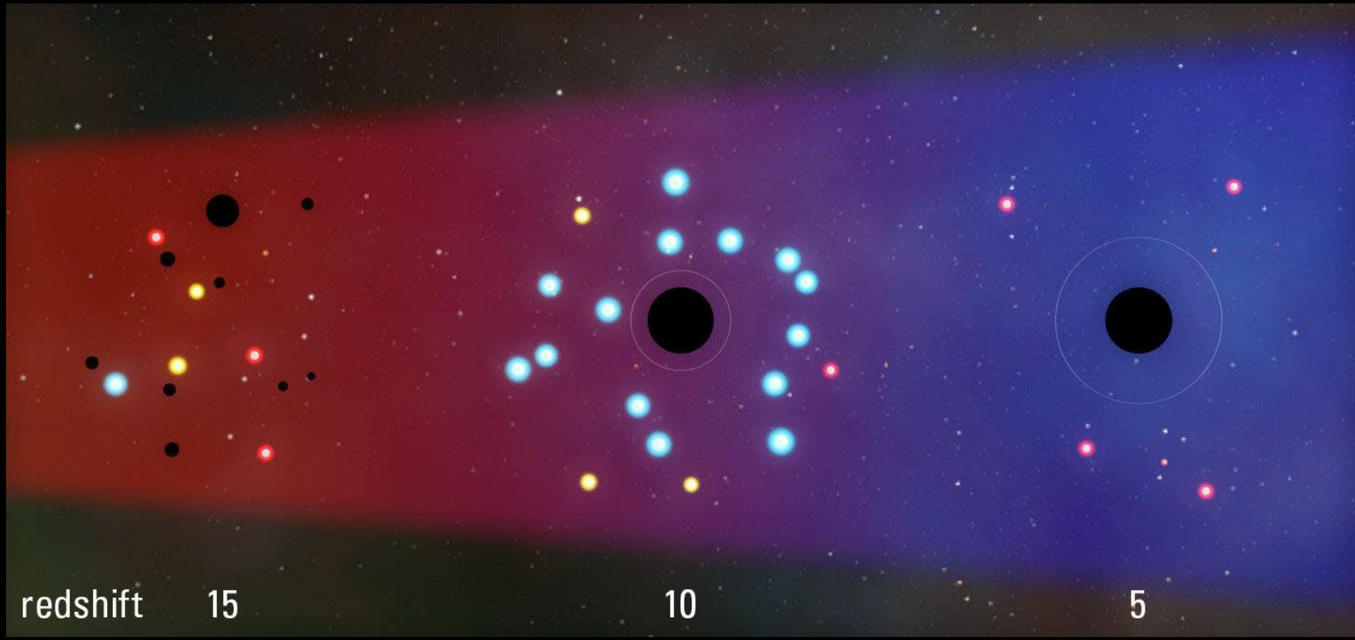
Lewes Astronomical Society

March 2024

Astronomy News

JWST turns the early Universe on its head (1)

- The established theory suggests that stars form first, then galaxies, then black holes, which grow in step with their host galaxies
- But JWST has seen arrays of small red dots (the earliest formed galaxies), compact, shining brightly in the infrared, and found in regions where massive black holes are thought to exist. This shouldn't be possible



The transition in star formation rates and black hole growth as redshift decreases from regimes where positive feedback dominates to a later epoch when feedback is largely negative
Credit: Steven Burrows, Rosemary Wyse, and Mitch Begelman

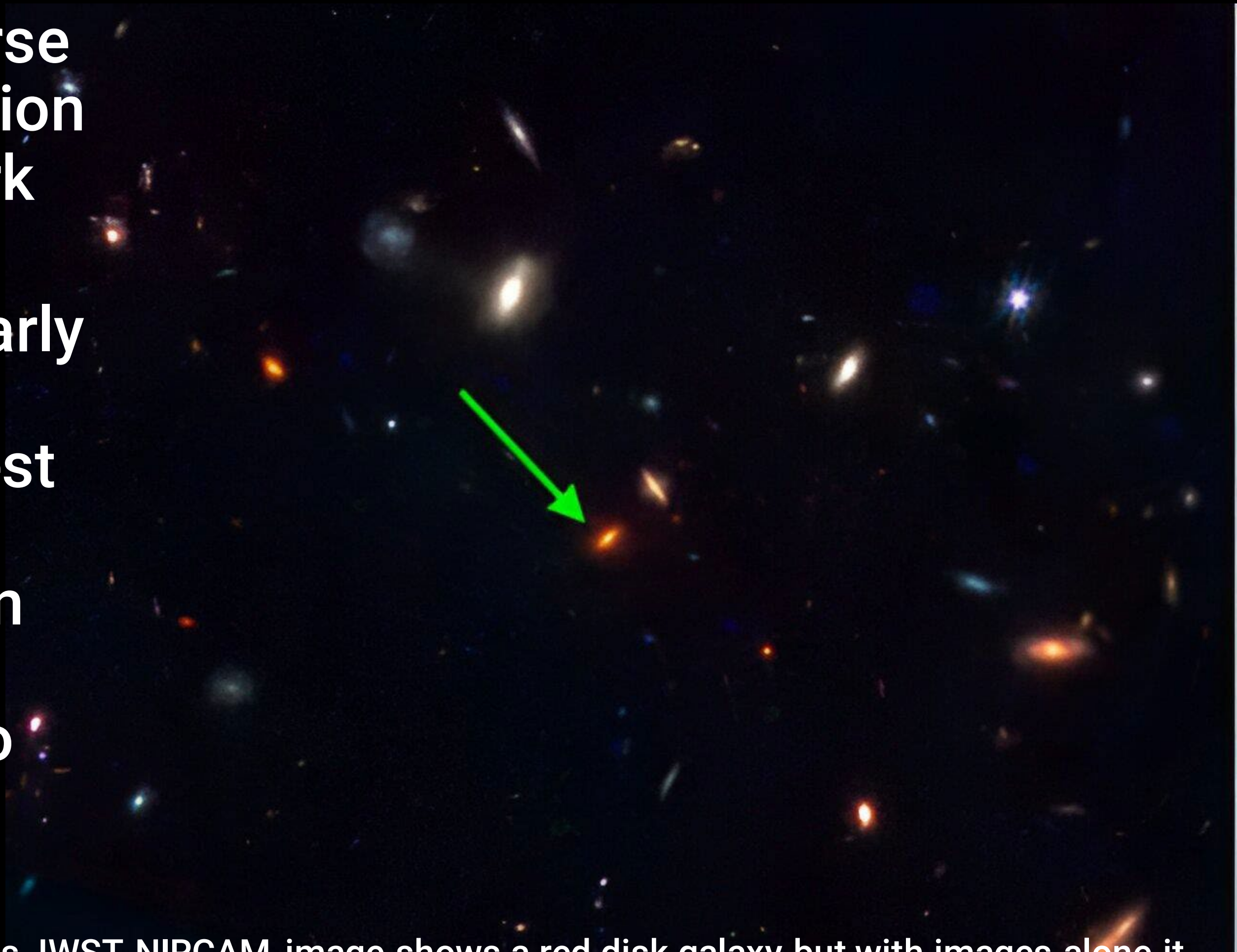
- So maybe a new theory is needed; one that takes account of these brighter than expected little red dots (galaxies), where stars are present with quasars from the beginning, and that galaxies formed later

JWST turns the early Universe on its head (2)

- To do this would mean that black holes were enablers of the first stars, before later turning off star formation
- Researchers then found that the relationship between black holes and star formation appears to be closer than expected, each building up the other in a process known as positive feedback. This key relationship lasted about 100 million years
- Then, within a billion years, when the black holes had become massive, they started depleting the gas reserves by immense radiative processes and turning off star formation. The feedback had become negative
- This process, from positive to negative feedback, happened around 13 billion years ago, roughly at redshift z=6. If computer modelling supports these ideas, then it will give astronomers an area to target their observations

A massive galaxy at the dawn of time (1)

- The current theories of the young Universe point to the fact that early galaxy formation relied on a massive concentration of dark matter
- Back in 2010, a very large but unusual early galaxy was spotted. Researchers have spent many hours using two of the largest Earth-based telescopes, at the Keck Observatory, and the VLT, to observe it in the hope of pinning down how old it actually is; but it is both too faint and too red



JWST-7329: a rare massive galaxy that formed very early in the Universe. This JWST NIRCAM image shows a red disk galaxy but with images alone it is hard to distinguish from other objects. Spectral analysis of its light with JWST revealed its anomalous nature – it formed around 13 billion years ago even though it contains ~4x more mass in stars than our Milky Way does today Credit: NASA

A massive galaxy at the dawn of time (2)

- Finally resorting to JWST, the astronomers, led by Karl Glazebrook at Swineburne University of Technology, have found that the galaxy (JWST-7329) is over 11.5 billion years old (redshift 3.2), with an even older population of stars formed at least 1.5 billion years earlier (redshift 11), roughly about 500 – 700 million years after the Big Bang
- On its own, this is not particularly unusual: galaxies have been discovered which formed within 400 – 500 million years after the Big Bang. What makes this galaxy so special is its sheer size: it has four times the number of stars of the current Milky Way
- And the current models do not support its formation; there should not have been anywhere near enough dark matter in the concentrations needed to allow this galaxy to grow so large, so early

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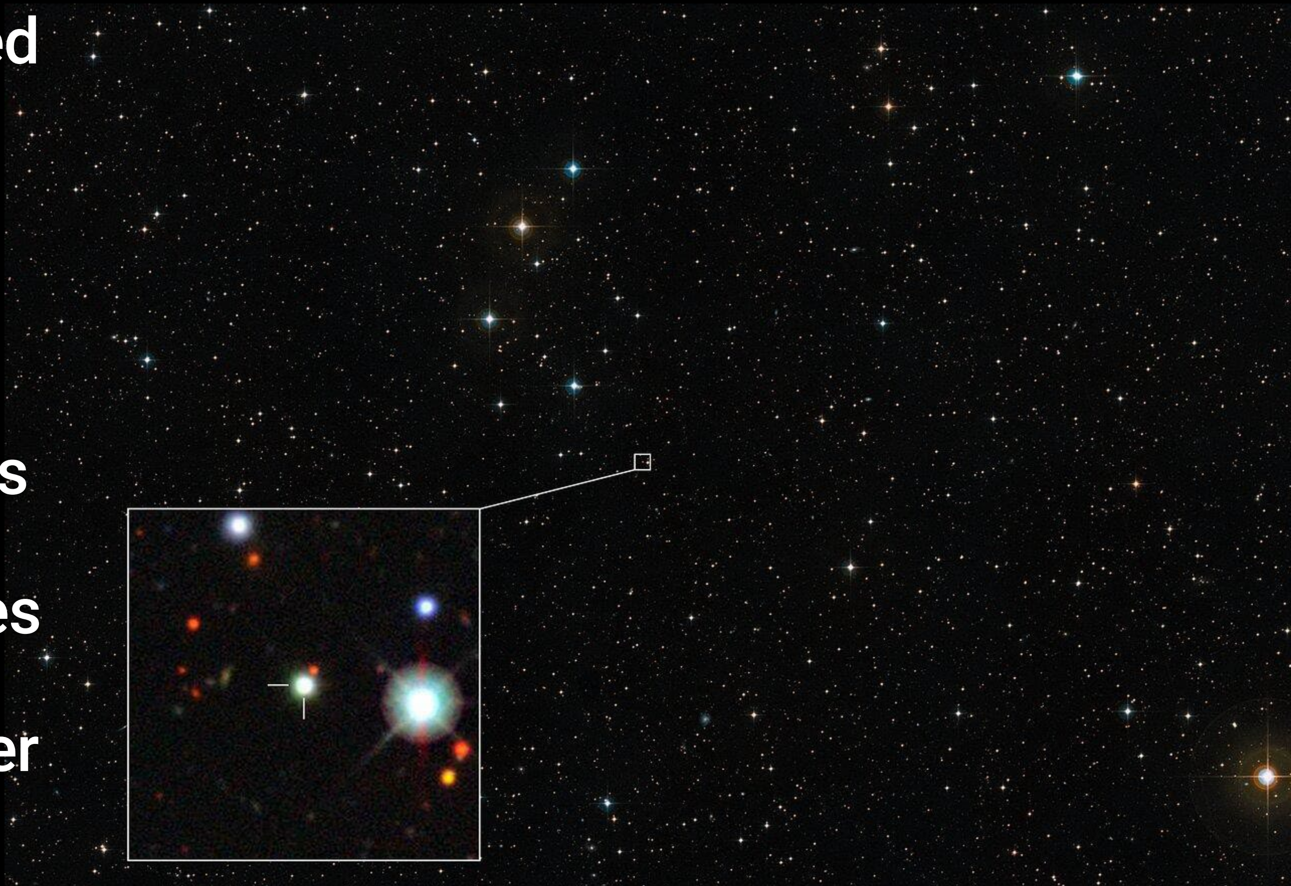
The brightest ever object identified (1)

- Back in 1980, a bright object was picked up in an image from the ESO Schmidt Southern Sky Survey. It was given the moniker, J0529-4351
- No one took much interest in it and, years later, automated data from the Gaia satellite showing J0529-4351, was passed over as being a nearby star in the Milky Way. The program, which uses machine learning to sift through the huge data sets, rejects anything brighter than previously found



This image shows the region of the sky in which the record-breaking quasar J0529-4351 is situated. Using ESO's Very Large Telescope (VLT) in Chile, this quasar has been found to be the most luminous object known in the universe to date. This picture was created from images forming part of the Digitized Sky Survey 2, while the inset shows the location of the quasar in an image from the Dark Energy Survey
Credit: ESO/Digitized Sky Survey 2/Dark Energy Survey

The brightest ever object identified (2)

- Researchers using the ANU 2.3-metre telescope at the Siding Spring Observatory in Australia last year identified it as a distant quasar. However, it needed the full power of the Very Large Telescope and the X-shooter spectrograph to determine that this was no ordinary quasar, but the brightest object found in the night sky
- J0529-4351 is almost 12 billion light years distant. It has a mass of 17 billion suns and eats the equivalent of one solar mass per day, making it the fastest-growing black hole ever recorded. The accretion disk surrounding the black hole is 7 light-years across, possibly the largest in the Universe. The energy released makes the quasar over 500 trillion times more luminous than our Sun
- Watch the video at: https://youtu.be/SXFvPcgMnuQ

The early hydrogen emission puzzle (1)

- The very first galaxies were highly energetic stellar nurseries. As such they would be a source of light emitted by hydrogen known as Lyman α emission
- However, during the Epoch of Reionisation, these stellar nurseries were surrounded by huge quantities of neutral hydrogen. Neutral hydrogen should absorb or scatter the Lyman α emission, making it impossible to see it now
- But this very early hydrogen emission is still visible

This image shows the galaxy EGSY8p7, a bright galaxy in the early universe where light emission is seen from, among other things, excited hydrogen atoms—Lyman-α emission. JWST's high sensitivity picks out this distant galaxy along with its two companion galaxies, where previous observations saw only one larger galaxy in its place. This discovery of a cluster of interacting galaxies sheds light on the mystery of why the hydrogen emission from EGSY8p7, shrouded in neutral gas formed after the Big Bang, should be visible at all. Astronomers have concluded that the intense star-forming activity within these interacting galaxies energized hydrogen emission and cleared swathes of gas from their surroundings, allowing the unexpected hydrogen emission to escape. This close-up view of EGSY8p7 has been newly processed, making use of NIRCam data captured with seven different near-infrared filters

Credit: ESA/Webb, NASA & CSA, C. Witten, M. Zamani (ESA/Webb)

The early hydrogen emission puzzle (2)

- JWST, using its NIRCam, may have solved the mystery: previously, a telescope such as Hubble could only refine an image to “see” one early galaxy, but JWST’s observations have now resolved the same images to show a large galaxy surrounded by many smaller ones
- It appears that a large amount of galaxy merging takes place around this period and, in the process, channels are cleared that allow the hydrogen emission light to escape
- See the video “Merging galaxies and hydrogen emission” at: https://youtu.be/YDUWoIqVzzc

A galaxy that shouldn't exist (1)

- Dwarf galaxies are the most abundant type in the Universe. Small and with less than about 100 million stars, it means they have a low luminosity. Many appear to be quite diffuse. Now, another rare type of dwarf galaxy has been found
- During a survey of a cluster of galaxies using data from the JWST Prime Extragalactic Areas for Reionization and Lensing Science (PEARLS) project, the dwarf galaxy, PEARLSDG, was spotted in an area of space where researchers weren't expecting to find anything

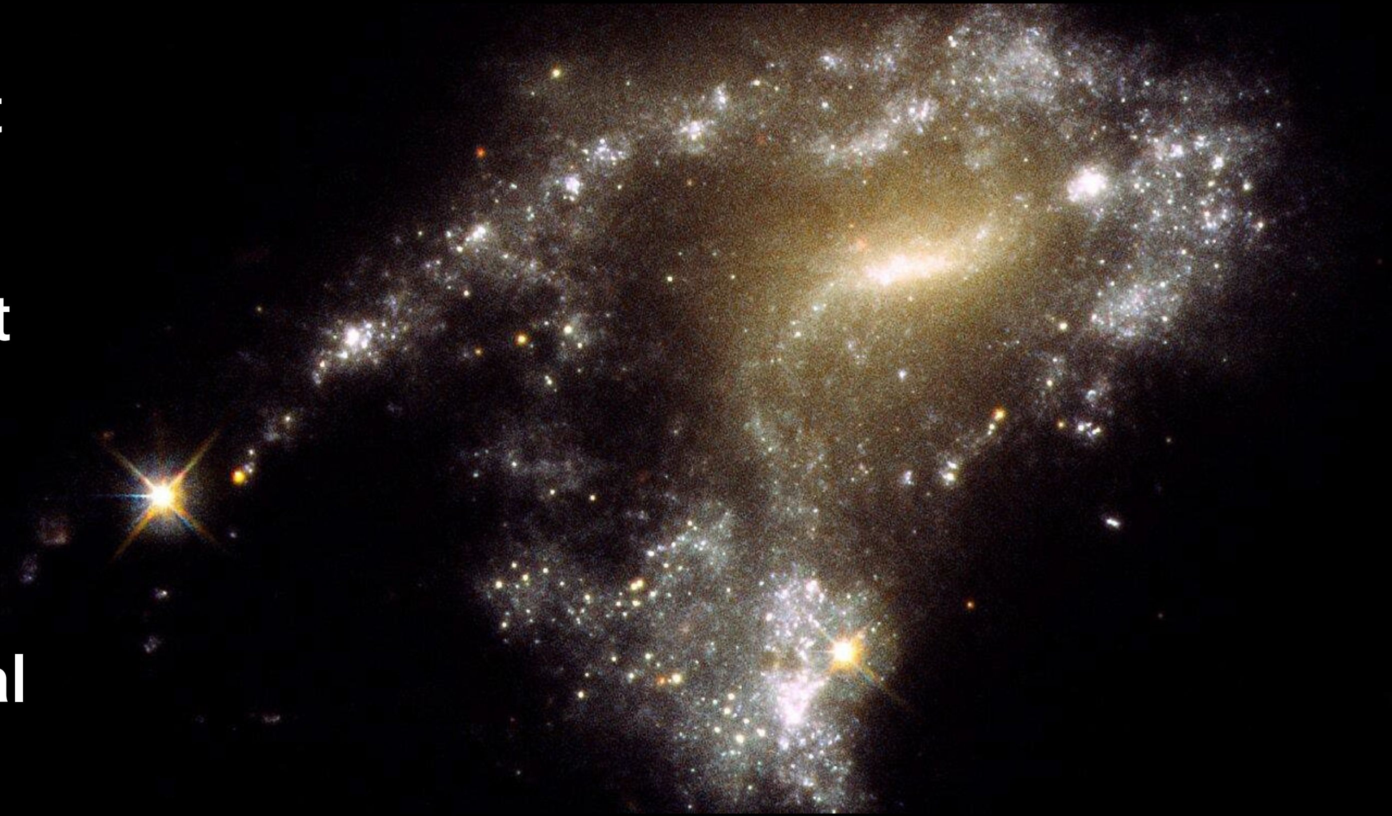
A colour-composite image of PEARLSDG made with JWST NIRCAM data. Individual stars are visible as small points of light in the image. The dull colour and lack of bright stars is consistent with old age
Credit: NASA, ESA, CSA, Jake Summers (ASU), Jordan C. J. D'Silva (UWA), Anton M. Koekemoer (STScI), Aaron Robotham (UWA) and Rogier Windhorst (ASU)

A galaxy that shouldn’t exist (2)

- And PEARLSDG turns out to be unusual; it isn’t interacting with any other galaxy and it isn’t forming any new stars, it is just an isolated quiescent dwarf galaxy with a population of old stars. Given the current knowledge of galaxy evolution, these sorts of dwarf galaxies shouldn’t exist
- Even more surprisingly, individual stars can be identified, which is amazing for a galaxy 98 million light years from Earth. Some of the individual stars have a very specific intrinsic brightness which allowed the researchers to pin down the distance

Clusters of new stars in stretched galaxy (1)

- Galaxy AM1054 325, 173 million light years from Earth, has had a bit of a run in with some neighbours. Tidal interactions with other galaxies have caused it to look a bit battered and bruised – and very misshapen
- The arms have been pulled out so that the galaxy looks more like a letter S rather than the normal spiral



Galaxy AM 1054-325 has been distorted into an S-shape from a normal pancake-like spiral shape by the gravitational pull of a neighbouring galaxy, seen in this Hubble Space Telescope image. A consequence of this is that newborn clusters of stars form along a stretched-out tidal tail for thousands of light-years, resembling a string of pearls. They form when knots of gas gravitationally collapse to create about 1 million newborn stars per cluster
Credit: NASA, ESA, STScI, Jayanne English (University of Manitoba)

Clusters of new stars in stretched galaxy (2)

- A consequence of this this interaction a burst of star formation was set off, which Hubble has been able to capture
- As many as 425 clusters have been formed along the stretched tail, which is now thousands of light years long. At these points, molecular hydrogen has collapsed under the influence of gravity and up to a million new stars are being born in each cluster

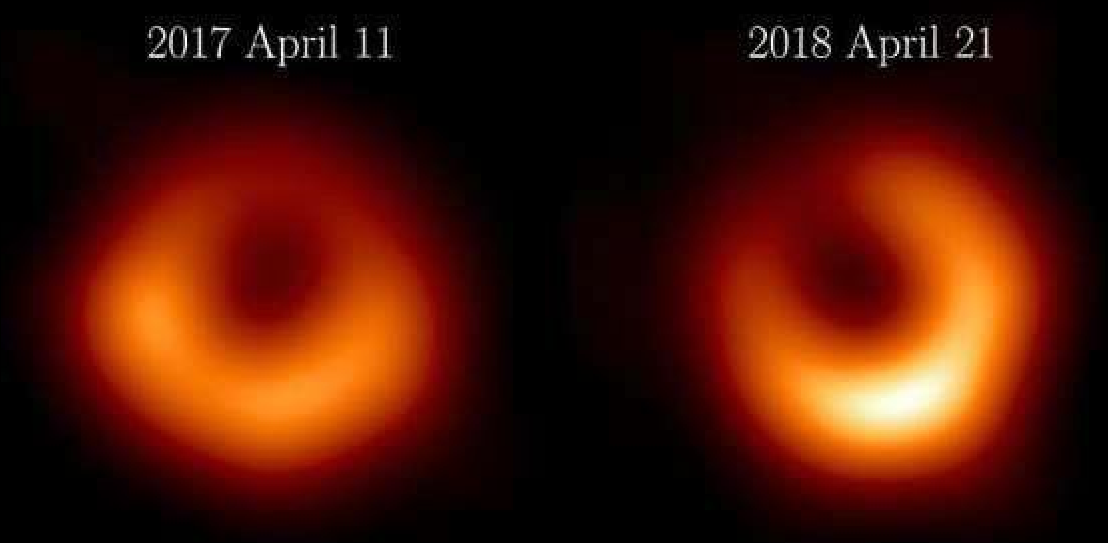
More than just passing in the night

- Hubble continues to capture some of the Universe's more spectacular sights
- Interactions between two small spiral galaxies were captured in a newly-released image
- The larger and more prominent of the two is NGC 5410, with a bright central bar and blue star-forming clusters in its arms. It is about 80,000 light years in diameter and lies 180 million light years away in Canes Venatici
- The smaller galaxy is UGC 8932. It has a blue central bar indicating a lot of young hot stars. The irregular shape is due to tidal interaction with NGC 5410, as stars stream between the two galaxies

This new NASA Hubble Space Telescope image features a pair of interacting galaxies called, NGC 5410 and UGC 8932
Credit: NASA/ESA/D. Bowen (Princeton University)/Processing: Gladys Kober (NASA/Catholic University of America)

M87 SMBH accretion disk shifts (1)

- At the heart of a massive elliptical galaxy, M87, 55 million light years from Earth, lies a supermassive black hole (SMBH)
- In April 2017, the Event Horizon Telescope consortium (EHT) made very precise observations of this black hole at the centre of M87



Credit: Event Horizon Telescope consortium

- After many months, and painstaking analysis of the data, the consortium announced they had seen a black hole (or rather the annular ring surrounding the black hole). The image, released in 2019, astounded the world by showing the bright accretion disk that surrounds the black hole

M87 SMBH accretion disk shifts (2)

- Since then, the consortium has continued to observe M87 and its black hole, and have been aided in this task by the addition of the Greenland Telescope and the Large Millimeter Telescope in Mexico (both from 2018). The Greenland Telescope had only just been commissioned. The 50m Large Millimeter Telescope is the largest single-dish steerable millimetre-wavelength telescope in the world. The EHT array has also been upgraded to observe in 4 wavebands rather than 2 in the original observation
- Images released now, using the data collected in April 2018, show that the familiar accretion disk is much the same but that the brightest point has shifted 30° anticlockwise. This is consistent with the current theories surrounding black holes and how magnetic fields affect the turbulent material
- Since then, further observations have been made in 2021 and 2022. More observations will be made this year too

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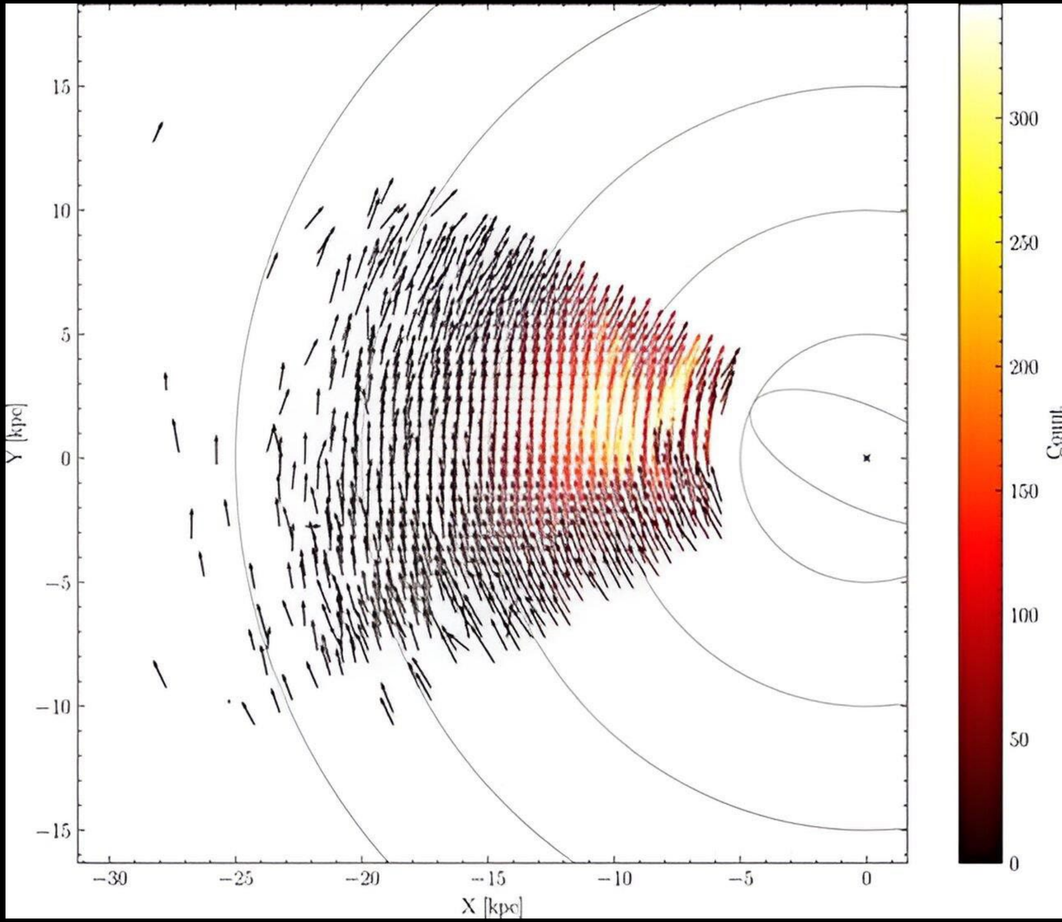
A lightweight Milky Way: part 2 (1)

- In our November newsletter, we reported on an analysis of data from the Gaia Spacecraft by researchers at the Observatoire de Paris and CNRS, which showed that the rotational curve for a spiral galaxy, like the Milky Way, was atypical. Instead of being flat, the curve falls away in what is known as a Keplerian decline. This was used to work out the mass of the Milky Way and showed that, at two hundred billion times that of the sun (2.06 x 10^{11} solar masses), it is between four and five times smaller than previous estimates



Galactocentric XY-plane map of the 33,335 stars used for calculating circular velocities, plotted in 0.5 kpc bins. The vectors represent the mean velocity of stars within each bin, colour coded by the number of stars in each bin

Credit: Monthly Notices of the Royal Astronomical Society (2024). DOI: 10.1093/mnras/stae034

A lightweight Milky Way: part 2 (2)

- Confirmation that the mass of the Milky Way is much less than previously thought has come from other scientists at MIT, looking at both Gaia and APOGEE data. Gaia studies the position, distance and motion of more than 1 billion stars in the Milky Way. APOGEE, the Apache Point Observatory Galactic Evolution Experiment, is measuring the detailed properties of more than 700,000 stars in the Milky Way; these properties include their composition, brightness, and temperature
- The researchers used 33,000 stars from APOGEE and Gaia, scattered throughout the Milky Way and out as far as 100,000 light years from the centre, to determine their circular velocity – how fast the stars are orbiting the galactic centre
- And like the earlier work, the rotation curve followed the same pattern
- When translated into the amount of dark matter that exists in the Milky Way, it looks like the core has far less dark matter than was once thought

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Fast-spinning black hole in centre of Milky Way

- At the centre of the Milky Way lies a supermassive black hole (SMBH), Sagittarius A*
- Although fairly small in comparison with the SMBHs in other galaxies, and currently quiescent, astronomers have found it is spinning extremely fast: at about 60% of the maximum theoretical speed
- At this speed it is being squashed, so resembles a spinning rugby ball from the side. This is also causing spacetime to become squashed too
- It only consumes about the equivalent of the Earth in gas and dust each year, so the normal jets of outflowing material are fairly weak. However, if it started eating, the jets could become more powerful and in turn blast material away from the centre

Chandra X-ray image of Sagittarius A* and the surrounding region
Credit: NASA/CXC/Univ. of Wisconsin/Y.Bai, et al.

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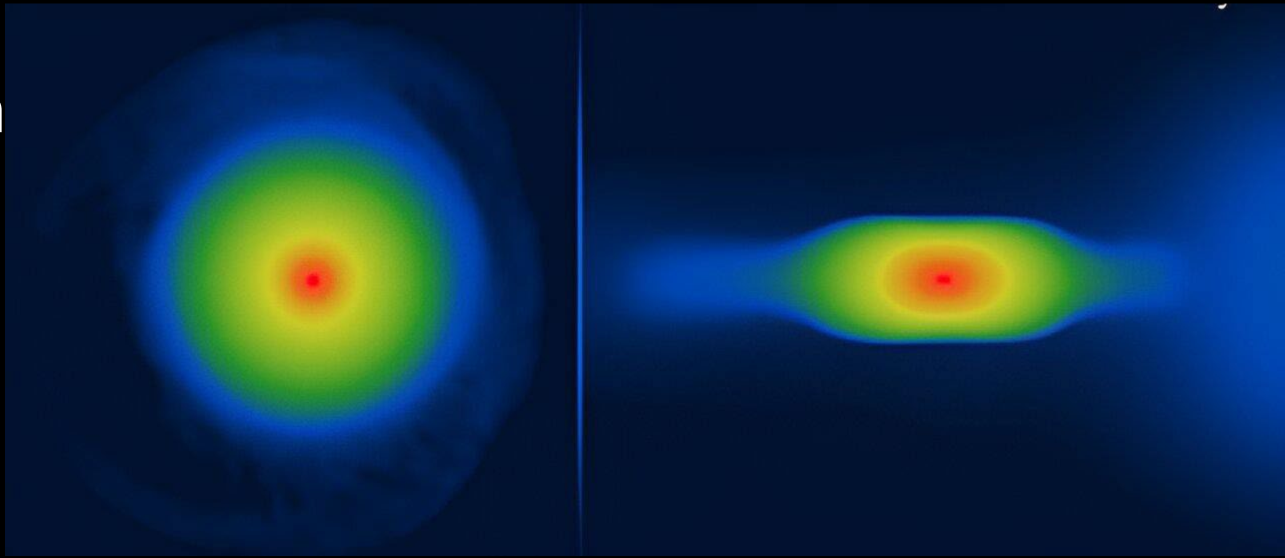
A Meerkat mystery

- The heaviest known neutron star is 2.5 solar masses, and the lightest black hole is 5 solar masses
- The Meerkat Radio Telescope in South Africa has just discovered an unknown object; heavier than any known neutron star but lighter than any known black hole
- The object is in orbit around a pulsar, PSR J0514-4002E, lying 40,000 light years from Earth in a globular cluster
- From the metronome ticks of this pulsar, researchers have estimated that the object falls in the missing mass gap between neutron stars and black holes
- See the video, "Lightest black hole or heaviest neutron star" at: https://youtu.be/MWSJ46gkLjQ

An artist's impression of the system assuming that the massive companion star is a black hole. The brightest background star is its orbital companion, the radio pulsar PSR J0514-4002E. The two stars are separated by 8 million km and circle each other every seven days Credit: Daniëlle Futselaar (artsource.nl)

Young planets modelled on Smarties (1)

- Currently, there are two main theories as to how new planets are formed from a protoplanetary disk: a relatively slow process where dust particles are attracted to each other by gravity and grow by accumulation, or from disintegration of the protoplanetary disk over a relatively short period due to disk instability

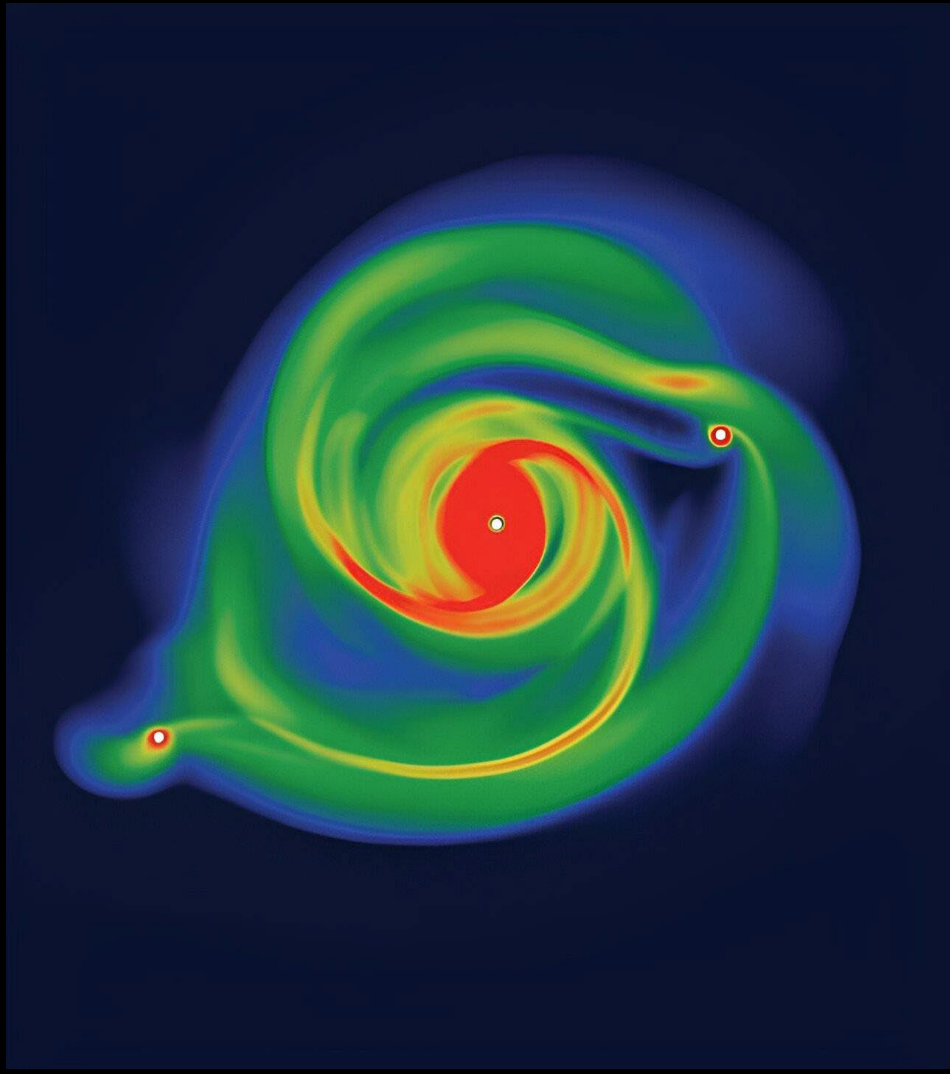


Simulated young planet as viewed from the top (left) and from the side (right) Credit: arXiv (2024). DOI: 10.48550/arxiv.2402.01432

- The latter also allows for planets to be formed far away from their host star, which is commonly seen. Researchers at the University of Central Lancashire have used computer simulations to model the theory of disk instability to see if it produced results close to observations of exoplanets. To their surprise, the modelling produced oblate spheroids, shapes like smarties rather than spheres

Young planets modelled on Smarties (2)

- Observations of young planets do appear to show they are slightly flattened, which suggests that the disk-instability theory may be the actual process used



Computer simulation of planets forming in a protostellar disk
Credit: arXiv (2024). DOI: 10.48550/arxiv.2402.01432

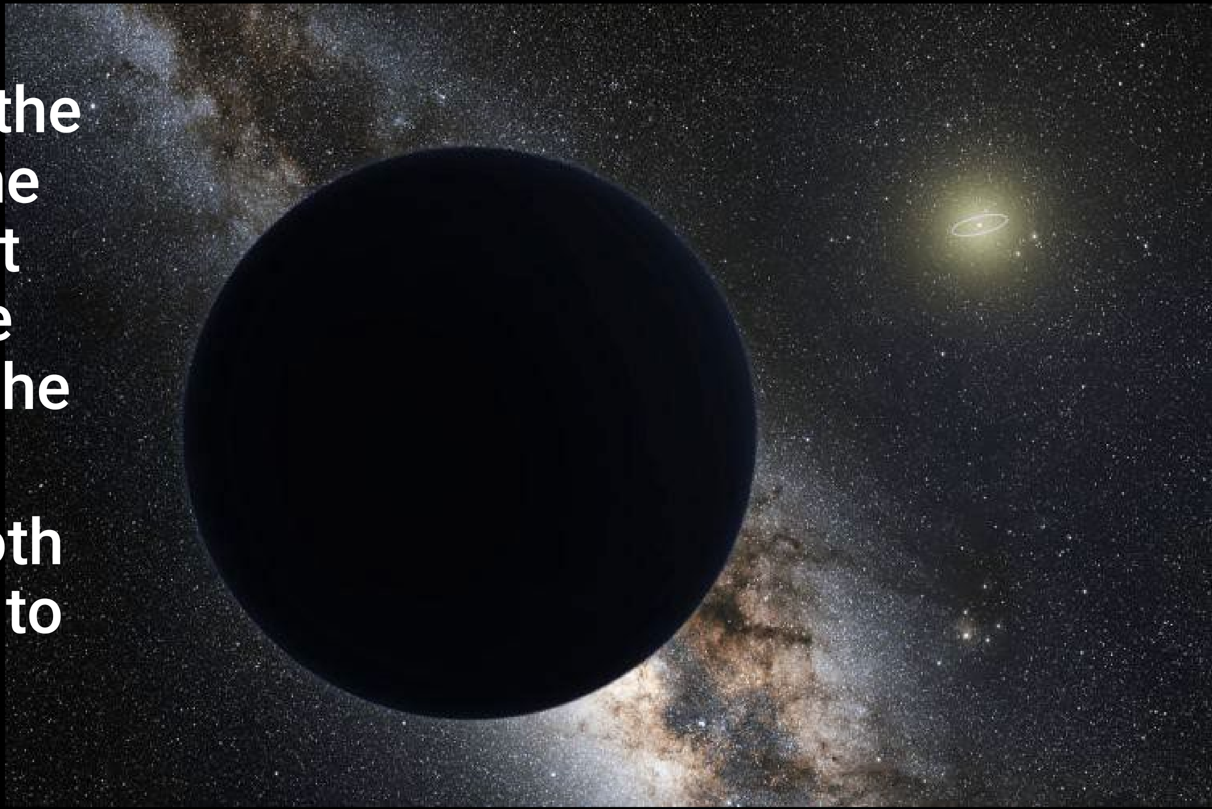
Large protoplanetary disk discovered

- Astronomers working through data from Pan-STARRS (Panoramic Survey Telescope and Rapid Response System) have identified a new, very large protoplanetary disk system about 800 light years from Earth
- The disk, which seems to be forming from the accumulation of material, is the largest so far discovered
- Nicknamed “Dracula’s Chivito”, an apparent reference to the national dish of Uruguay, the disk surrounds an A-class star which is about twice the size of the Sun but much brighter, at 11.46 solar luminosities, giving it an effective surface temperature of 8,000K
- The star is still very young and the disk very new. The disk has a mass of 0.2 solar masses, of which about 20% appear to be large grains, and stretches for about 3,300 AU

Colour (giy) PS1 image of Dracula's Chivito
Credit: arXiv (2024). DOI: 10.48550/arxiv.2402.01063

Where is Planet Nine? (1)

- For several decades, astronomers have speculated that there is another planet in the Solar System waiting to be discovered. The reason for this speculation is the apparent strange motions and orbits of some of the minor planets and smaller objects within the Kuiper Belt
- Perturbations in the orbit of Uranus led both Urbain Le Verrier and John Couch Adams to independently predict the position of an unknown planet. Shortly afterwards, in September 1846, Johann Gottfried Galle, using Le Verrier's calculations, made the first observations of the planet which was subsequently named Neptune



Artist's illustration of Planet Nine with the Sun and orbit of Neptune (ring) in the distance
Credit: ESO/Tomruen/nagualdesign

Where is Planet Nine? (2)

- Now, Dr Mike Brown and a team of researchers from Caltech have used data from Pan- STARRS to eliminate about 78% of the possible places Planet Nine could be found in
- Even though Planet Nine has not been located, an estimate of its potential size (6.6 Earths) and distance from the Sun (500 AU) has been calculated from the effects it seems to be having on the other KBOs
- The next step forward may be to wait for the completion of the Vera C. Rubin Observatory in Chile in 2026, and the Legacy Survey of Space and Time (LSST) program. One of the objectives for the LSST is to identify near-Earth asteroids (NEAs) and small planetary bodies within our solar system
- See the video on the search for Planet Nine at: https://youtu.be/2UZKME9WP9M
- See the video on “Do we know there is a Planet 9” at: https://youtu.be/n8UNkvIa_zc

Does life exist on the gas giants’ moons? (1)

- For the past twenty years, there has been a lot of speculation that the larger moons of both Jupiter and Saturn may have life in their large underground oceans of water
- On Earth, water is a prerequisite for life. It has been expected that large reservoirs of water would be ideal places to find life if it exists anywhere else in the Solar System. These reserves are, in some cases, huge; the amount of subsurface water on Titan may be up to twelve times the total found on Earth
- And that could be the problem

An artist’s rendering shows a Dragonfly quadcopter landing on the surface of Saturn’s moon Titan, unfolding its rotors and lifting off again to survey the landscape and atmosphere
Credit: Steve Gribben/Johns Hopkins

Does life exist on the gas giants’ moons? (2)

- Looking at Titan, researchers led by Catherine Neish of Western's Institute for Earth and Space Exploration were interested in how much organic matter could be available to life in these waters. Likely, organic molecules could only form on the surface of the moons through the effects of the Sun’s radiation, from the host planet itself, or delivered by comet impacts
- These impacts would melt the surface ice, allowing it to mix with the organic molecules. Over time, this now-denser liquid would seep through the ice to the subsurface oceans
- Using assumed rates of impacts of comets of different sizes, the researchers were able to determine how much organic-saturated water would reach the interior. And the answer is virtually nil. In the case of Titan, it probably is less than 7,500kg of glycine, the simplest amino acid, a year. Glycine, like all biomolecules, is built on carbon

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Does life exist on the gas giants moons? (3)

- The situation on the other moons is even less encouraging, as Titan is by far the most organic-rich moon in the Solar System
- Hopefully, the proposed Dragonfly mission to Titan in 2028 will help to confirm or repudiate these findings, as well as answer a host of other questions
- See the video of the Dragonfly mission at: https://youtu.be/msiLWxDayuA
- Read NASA's article on the final mission design work for Dragonfly at: https://science.nasa.gov/missions/dragonfly/nasas-dragonfly-to-proceed-with-final-mission-design-work/

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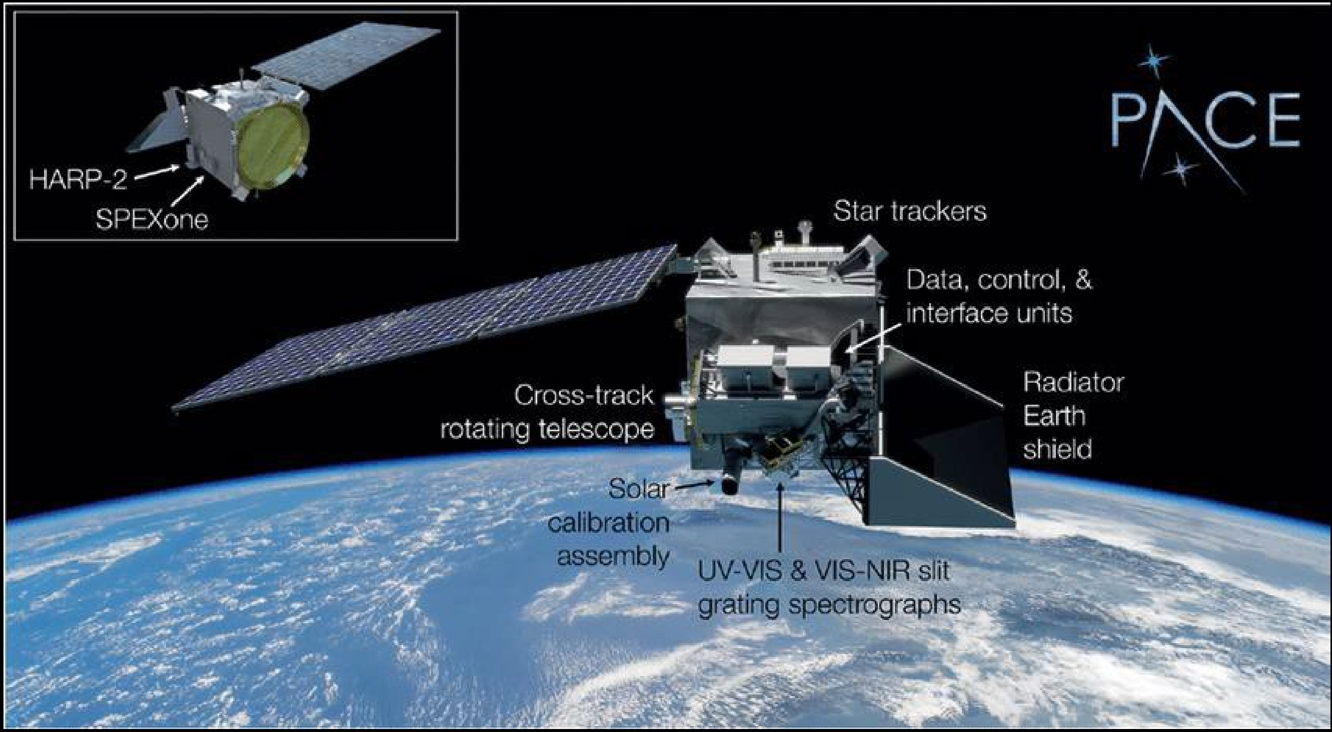
Earth’s health monitored by PACE (1)

- The launch of a new satellite on top of a SpaceX Falcon 9 rocket, especially one which looks back towards the planet from an Earth orbit, is now an everyday event
- But this satellite is different. PACE is NASA’s new billion-dollar eye-in-the-sky looking at our troubled planet, from the deepest oceans to the tops of the clouds
- Orbiting high above the ISS, at 677km above the surface, the major focus of PACE (Plankton, Aerosol, Cloud, Ocean Ecosystem) is to study the world’s oceans



The PACE observatory. Visible features of OCI (and spacecraft) identified in the main panel. The direction of flight is away from the reader. Placement of the two multiangle polarimeters shown in the inset, with the micrometeoroid orbital debris shield covering the propellant tank coloured gold
Credit: NASA

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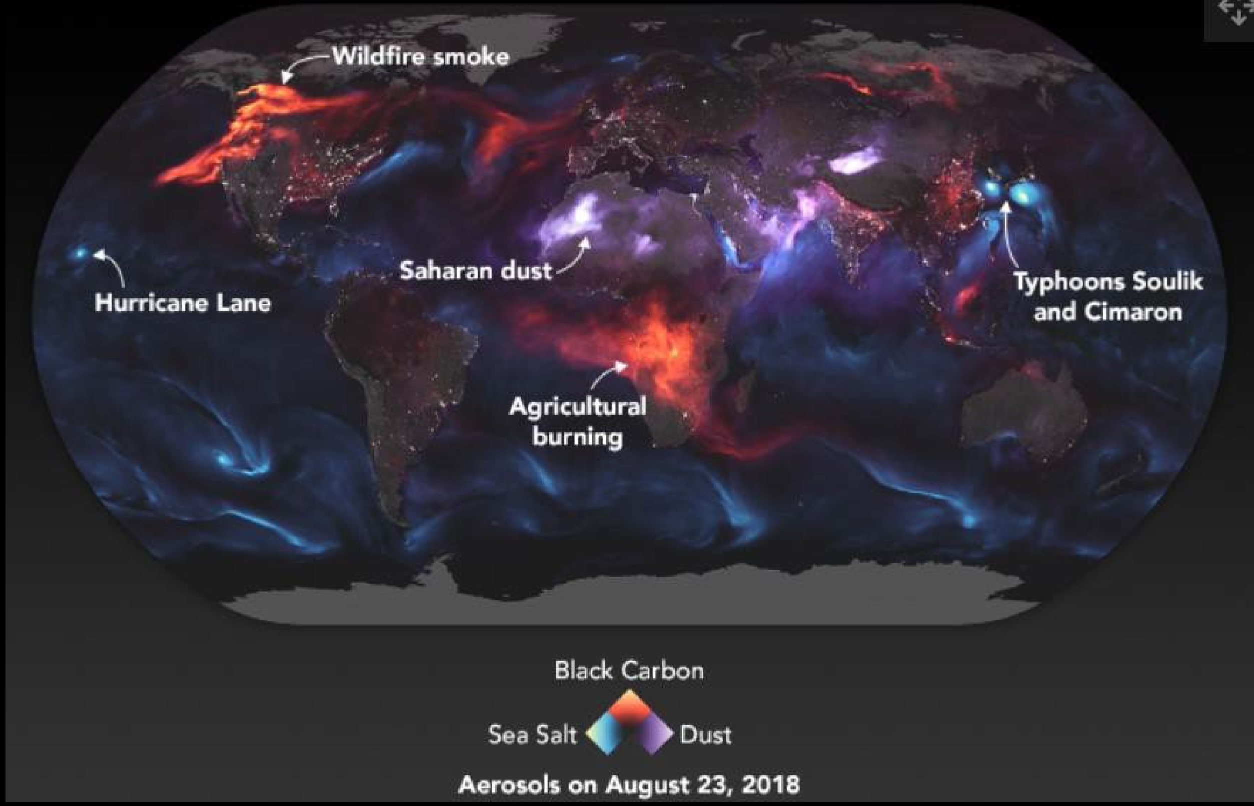
Earth’s health monitored by PACE (2)

- Key is how the phytoplankton that is at the heart of the marine ecosystem moves and changes, as this is vitally important in understanding how it can control the way carbon cycles through the seas. It is also vital to study how the different forms of phytoplankton are growing, as some are harmful
- The other main focus is on the atmosphere, especially the levels of particulates such as those given off by forest fires, and how the air quality is affected as climate change continues



Aerosol distribution in 2018: Credit: NASA

- Particulates, like dust, can also warm up the atmosphere and affect cloud formation

Astronomy News in Brief (1)

- Dark Matter hanging off the Cosmic Web – researchers using the 8.2m optical-infrared Subaru Telescope have indirectly observed, through its interaction with gravity, dark matter from the massive filaments that make up the Cosmic Web, in the Coma Cluster, 320 million light-years away
- SETI powers on – the search for extraterrestrial intelligent life goes on. The Very Large Array in New Mexico has been recently upgraded, with all 27 radio telescopes receiving new equipment allowing them to perform non-stop observations. There have also been upgrades to the Allan Telescope Array, north-east of San Francisco with an antenna redesign and new, high-end computers to help speed up the processing. As Bill Diamond, President and CEO of the SETI Institute, said, “It's not that old tried, true and tired query, are we alone? Rather, it's more like just how crowded is it?"

Astronomy News in Brief (2)

- What do JUMBOs orbit? – the discovery of pairs of large planet-sized objects, apparently free-floating and unattached to a star, was announced in 2023. At least 40 pairs of Jupiter-sized objects were found in the Orion Nebula, giving rise to the nickname of JUMBOs. Further analysis suggests that these objects do not orbit a faint brown dwarf star, as was proposed at the time of their discovery, but spin around each other
- Missing super Earth-sized exoplanets – analysis of the many thousands of solar systems so far discovered has revealed a relative lack of exoplanets which are about twice the size of the Earth; this is known as the radius gap. There are many planets both much larger and smaller. Initially, it had been thought that this was probably due to evaporation of part of a planet’s atmosphere due to irradiation. Now, a new theory suggests the likely cause is the migration of planets inwards and outwards during the early years of solar system formation. Could this be why we don’t have a super-Earth (rocky) planet in our Solar System?

Astronomy News in Brief (3)

- Water found on asteroids – NASA’s now retired Stratospheric Observatory for Infrared Astronomy (SOFIA), which was based in a modified Boeing 747 airplane, still provides exciting new findings. Scientists looking at data from four silicate-rich asteroids have identified the mid-infrared spectral signatures of water on two of them, Iris and Massalia. The amount of water is about the same as found on the sunlit Moon; roughly 340cc per cubic metre
- MIMAS’s ocean world – astronomers trawling through the legacy data from the Cassini probe have discovered that Mimas, one of Saturn’s smaller moons at only 400km in diameter, has an ocean of water lurking 20 – 30 km below its heavily-cratered surface. The ocean is estimated to be relatively young, between 5 and 15 million years. It occupies about half the volume of Mimas, although this would only represent about 1.3% of the volume of the Earth. It was discovered because of an unexpected irregularity in the orbit of Mimas

Astronomy News in Brief (4)

- OSIRIS-Rex bonus sample – it took months to get the lid off the container with the sample from the asteroid Bennu, but it was worth the wait. Scientists revealed that they have managed to recover 121.6 grams of material, over twice of what was planned for
- Not all Moon dust is the same – the Moon is covered in dust, and everything on it is covered by it. The Apollo astronauts found that it stuck to them, and was very uncomfortable if it came into contact with skin. The reason is that it is electrostatically charged and, not being weathered by the elements as on Earth, is very sharp-edged. However, researchers looking at the Moon have noticed that in one particular region, Reinder Gamma, the rocks appear to be more reflective. This has led to speculation that this area has magnetic anomalies and that the rocks and dust may be magnetised. NASA is already planning to send an autonomous rover to the region in the next couple of years

Astronomy News in Brief (5)

- Massive telescope for the Moon? – over the next few decades, NASA is planning to establish a permanent lunar presence: the Artemis Base Camp. This will allow facilities to be built, taking advantage of the “quiet nature” of the lunar environment. A team from the Goddard Space Flight Center has sketched the first design of a future Long-Baseline Optical Imaging Interferometer (LBI), for imaging at visible and ultraviolet wavelengths. Already selected for Phase One of development, the Artemis-enabled Stellar Imager (AeSI) could be based on the far side of the Moon where there is relative radio silence (hidden from Earth’s noise). Such a telescope could help study stellar magnetic activity, the nuclei of active galaxies, directly observe rocky exoplanets and look for signs of life, and even image black holes

Astronomy News in Brief (6)

- 6 Exoplanets and a Misbehaving Dwarf Star – TOI-1136 is a dwarf star a mere 270 light years from Earth. In 2019, astronomers, using TESS, discovered a planetary system around the star. Now researchers following up the TESS discovery have confirmed that at least 6, and possibly 7, planets are orbiting TOI-1136. Using multiple telescopes, they have found that the planets range from between 2 and 4 times the size of Earth. All orbit their star within 88 days, meaning that they are closer than Mercury is to our sun. Apart from being an unusual planetary system in terms of the sizes of the planets and how close they are to each other, the star is comparatively young at 770 million years old. As such it will still be going through its toddler tantrums and prone to bouts of massive radiation outbursts

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Spaceflight News

"Houston, the Odysseus has landed" (1)

- At 23:23, on 22nd February 2024, the U.S. returned to the Moon; "Odysseus", the first American spacecraft to land on the lunar surface for over 50 years, and the era of Apollo, successfully touched down. In doing so, it also became the first privately-developed spacecraft to land on the Moon
- After an almost flawless flight, and a successful main engine burn behind the Moon to put Odysseus into a 92 km high circular orbit on 21st February, the descent was as gripping as that famous landing on 20th July 1969. First, the laser rangefinders failed, and without these the landing would have to be scrubbed

Publicity still showing what Odysseus would hopefully look like following its successful landing
Credit: Intuitive Machines

- Luckily, one of the six NASA experiments was intended to test a new radar system. The NDL (Navigation Doppler Lidar) package was pressed into service to replace the broken rangefinders

“Houston, the Odysseus has landed” (2)

- The landing was put back by two hours whilst a software patch was installed to allow the NDL package to take over the work. In addition, the decision was taken to move Odysseus to an intermediate orbit of 30km above the surface, rather than the planned 10km, to allow more time to sort out any potential problems
- The actual descent went to plan, although communication with Odysseus was lost shortly before touchdown. A nervy 15 minutes had to be endured before the first faint signal was received from the Moon to say that Odysseus was safe

Photograph of Odysseus taken shortly after entering lunar orbit
Credit: Intuitive Machines

- It was several hours before Intuitive Machines was able to confirm that they were in communication with Odysseus, were downloading data, had good telemetry and the spacecraft was solar charging

"Houston, the Odysseus has landed" (3)

- These initial telemetry readings proved to be wrong and the spacecraft has ended up on its side
- It appears that Odysseus's final approach had been a good deal faster than the planned walking pace, and it may have broken one its six legs on the rough landing or hit a rock, tipping it over. The spacecraft is thought to be resting against a rock, lying on a slope, or stuck in a crevasse
- Most of the solar arrays seem to be working and some of the antennas are still pointing back to Earth but data transfer will be slower than planned
- All the active payloads appear to be in good condition and able to collect data
- In spite of being able to charge up its batteries, Odysseus is not designed to survive the extreme cold of a lunar night and its mission life is about one week

This image from NASA shows Intuitive Machines CEO Steve Altemus holding a model of Odysseus to show its position on its side during a press conference at Johnson Space Center in Houston
Credit: Agence France-Presse/Getty Images

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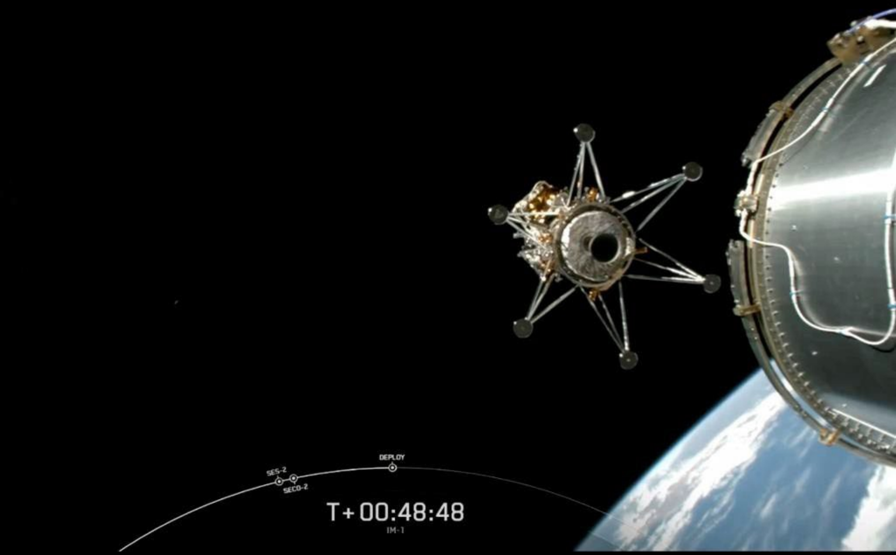
"Houston, the Odysseus has landed" (4)

- Odysseus landed within 1km of its target, the 69km impact crater called Malapert A, 300km from the south pole. This area has not been visited before by NASA, although the Indian lunar lander, Chandrayaan-3, successfully landed near the south pole on 23rd August 2023
- The decision to land there was taken to investigate the possibility of water being trapped as ice in the deep craters. The first manned Artemis mission is planned to land near the south pole in 2026
- Odysseus carries 6 scientific instruments as part of NASA's CLPS programme (Commercial Lunar Payload Services). Essentially, NASA has outsourced the delivery of lunar missions to private companies (rocket = SpaceX and spacecraft = Intuitive Machines)

This image taken by Odysseus's Terrain Relative Navigation camera shortly after lunar orbit insertion shows the Bel'kovich K crater in the northern equatorial highlands
Credit: Intuitive Machines

“Houston, the Odysseus has landed” (5)

- For this mission, NASA commissioned Intuitive Machines (IM), a private concern in Houston, Texas, to build a new lunar lander, Nova-C. The first craft was named “Odysseus”. NASA paid IM $118m
- The instruments carried as part of the CLPS programme include:
- A set of cameras (called SCALPSS) to study how rocket exhaust interacts with the lunar surface
- A new type of fuel gauge to accurately record how much fuel is remaining
- Laser Retroreflective Array (LRA) to determine where the lander is



This image from video provided by SpaceX via NASA TV shows Intuitive Machines' lunar lander separating from the rocket's upper stage and heading toward the moon, on February 15th 2024
Credit: SpaceX-NASA TV via AP

“Houston, the Odysseus has landed” (6)

- The launch from Cape Canaveral atop a SpaceX Falcon 9 rocket on 15th February was completely successful and relatively uneventful, putting the spacecraft on a 6-day trajectory to the Moon
- During the journey, two pre-planned small mid-course manoeuvre trajectory corrections were made. These helped not only keep the spacecraft on course but also stabilised it to prevent it tumbling
- The spacecraft is powered by the VR-900 engine and fuelled using liquid methane and liquid oxygen, a first for this kind of journey
- Odysseus stands 4.3m tall and is 1.57m wide

Odysseus folded up in the payload bay of the Falcon 9 before the fairings cover it
Credit: SpaceX

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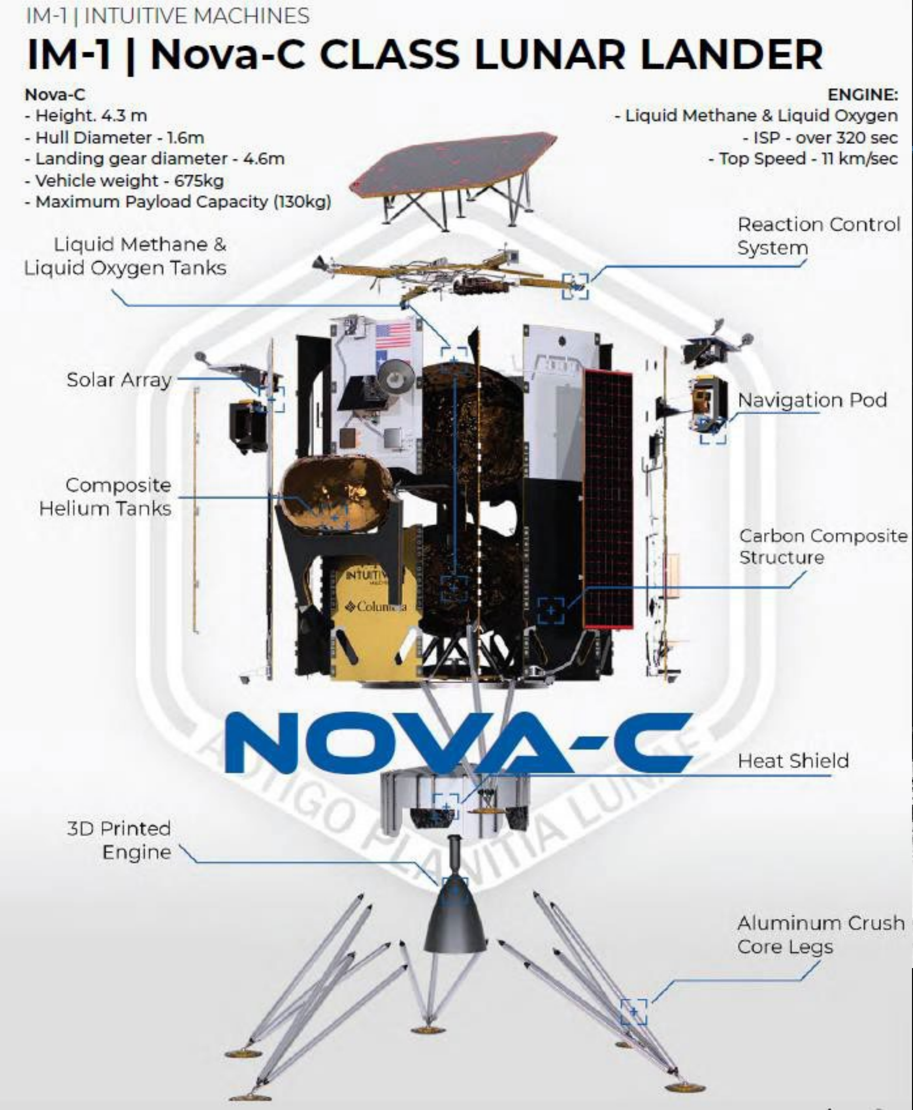
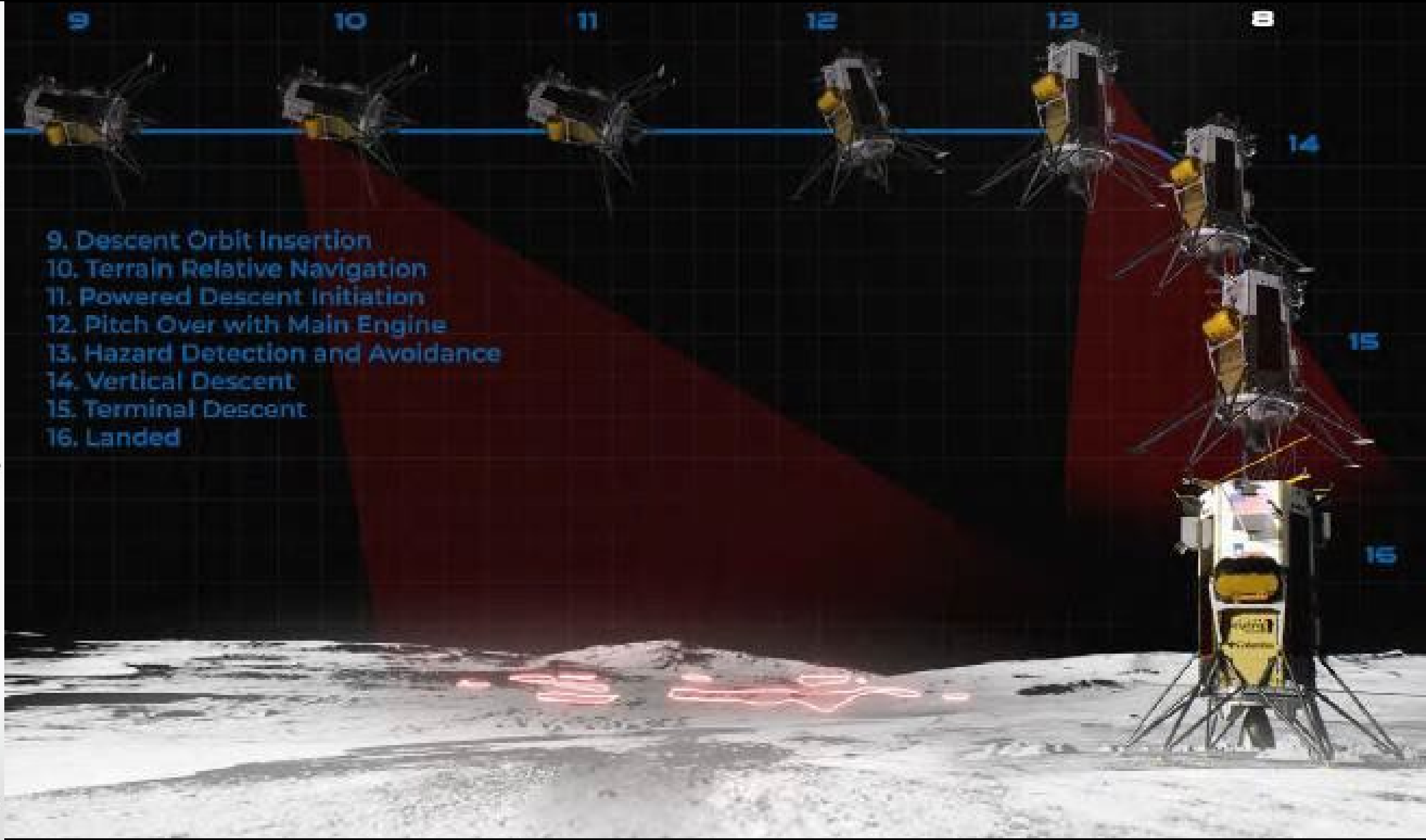
"Houston, the Odysseus has landed" (7)





Inside the Nova-C Lunar Lander and Landing Trajectory Plan
Credit: Intuitive Machines

First view of Dream Chaser space plane

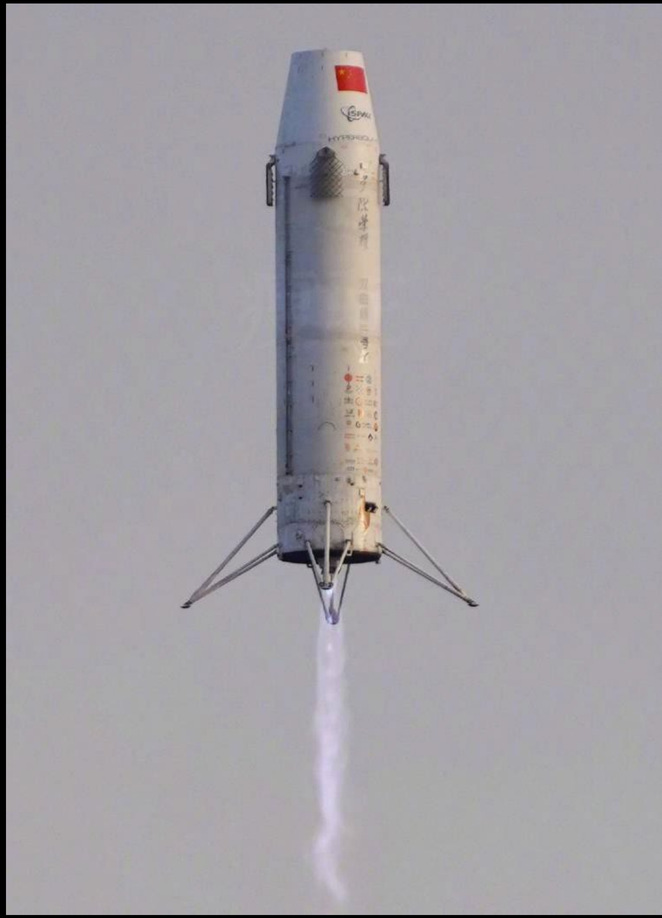
- Sierra Space, a private Colorado-based space company, and NASA unveiled the new Dream Chaser space plane on 1st February. The private space plane is due to fly to the ISS later this year
- The robotic space plane has two parts, the main reusable structure, called “Tenacity”, and a cargo module, called “Shooting Star” were seen stacked, as if ready for launch standing 16.8m tall. Dream Chaser will be launched on a Vulcan Centaur rocket

Sierra Space's Dream Chaser space plane "Tenacity" and its cargo module "Shooting Star" are seen at NASA's Neil Armstrong Test Facility in Ohio
Credit: Josh Dinner/Space.com

- Before the flight though a lot more testing will need to be done, it has just passed the mechanical vibration test to see if it can withstand the rigours of the launch
- Built to transfer cargo, it is expected to be able to complete at least 15 missions

China's reusable rocket

- In a brief 22 second mission, China demonstrated that it can launch and recover a rocket
- On 26th January, the Kuaizhou reusable technology test rocket was launched from its take-off area, hovered for 9 seconds, and landed back safely on the pad
- Chinese state-owned CASIC Rocket Technology Company, also known as Expace, carried out the test
- Expace is known for solid booster expendable rockets and there had already been two such powered missions this year before the reusable rocket test. The Kuaizhou rocket is liquid oxygen-methane powered. Another state-owned spinoff, CAS Space, is planning its own test flight next year
- See a short video of the test flight at: https://cdn.jwplayer.com/previews/kPXtvy0F



A Kuaizhou reusable prototype rocket during a short-duration launch and landing test in January 2024
Credit: KevinJamesNg

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Space Launch System (SLS) test firing

- NASA continues to test the Space Lunch System (SLS) rocket in preparation for the Artemis lunar missions
- The latest tests were a hot fire of Aerojet Rocketdyne's new RS-25 engine, simulating the conditions in a real flight, varying the power demands from 80% to 113%, and engine durations ranging from 500 to 650 seconds
- The new RS-25 engines will be used on missions from Artemis 5 onwards. The first 4 missions use reconditioned Space Shuttle engines which can only reach 109% power levels
- Once the tests are signed off, the go-ahead will be given for the production of 24 new RS-25 engines

NASA completed a full-duration, 500-second hot fire of an RS-25 certification engine January 17th, continuing a critical test series to support future SLS missions to the moon and beyond
Credit: NASA/Danny Nowlin

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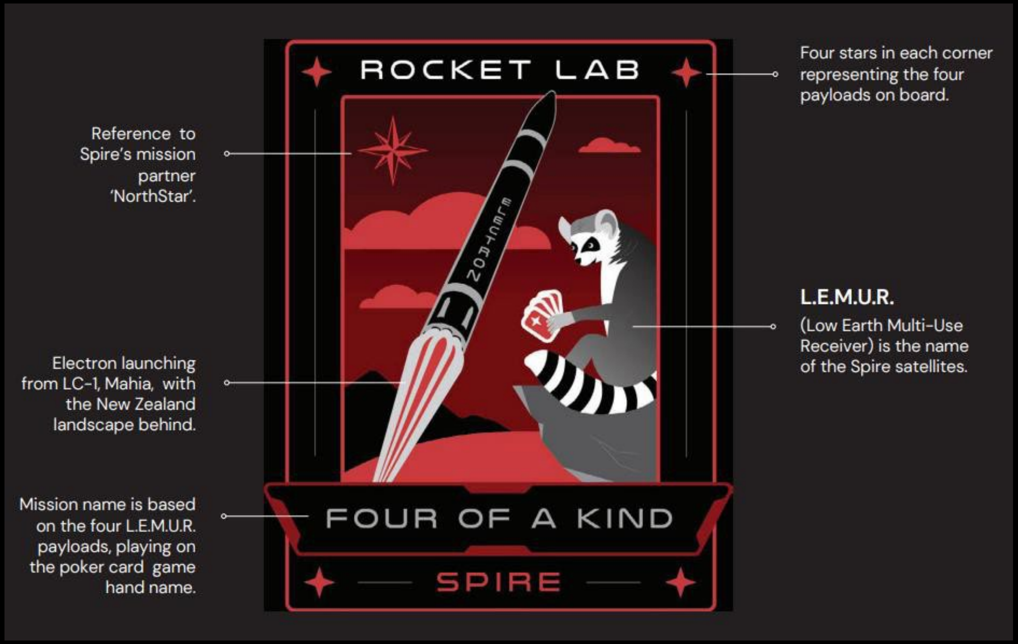
Rocket Lab launches 4 LEO satellites (1)

- U.S. Rocket Lab successfully launched 4 Lemur space situational awareness (SSA) satellites into a 530km high orbit on 31st January from their New Zealand launch site



Rocket Lab first mission of 2024 saw the Electron launch vehicle lofting four Space Situational Awareness (SSA) satellites into low-Earth orbit from the Māhia Peninsula in New Zealand
On the left is the mission patch
Credit: Rocket Lab

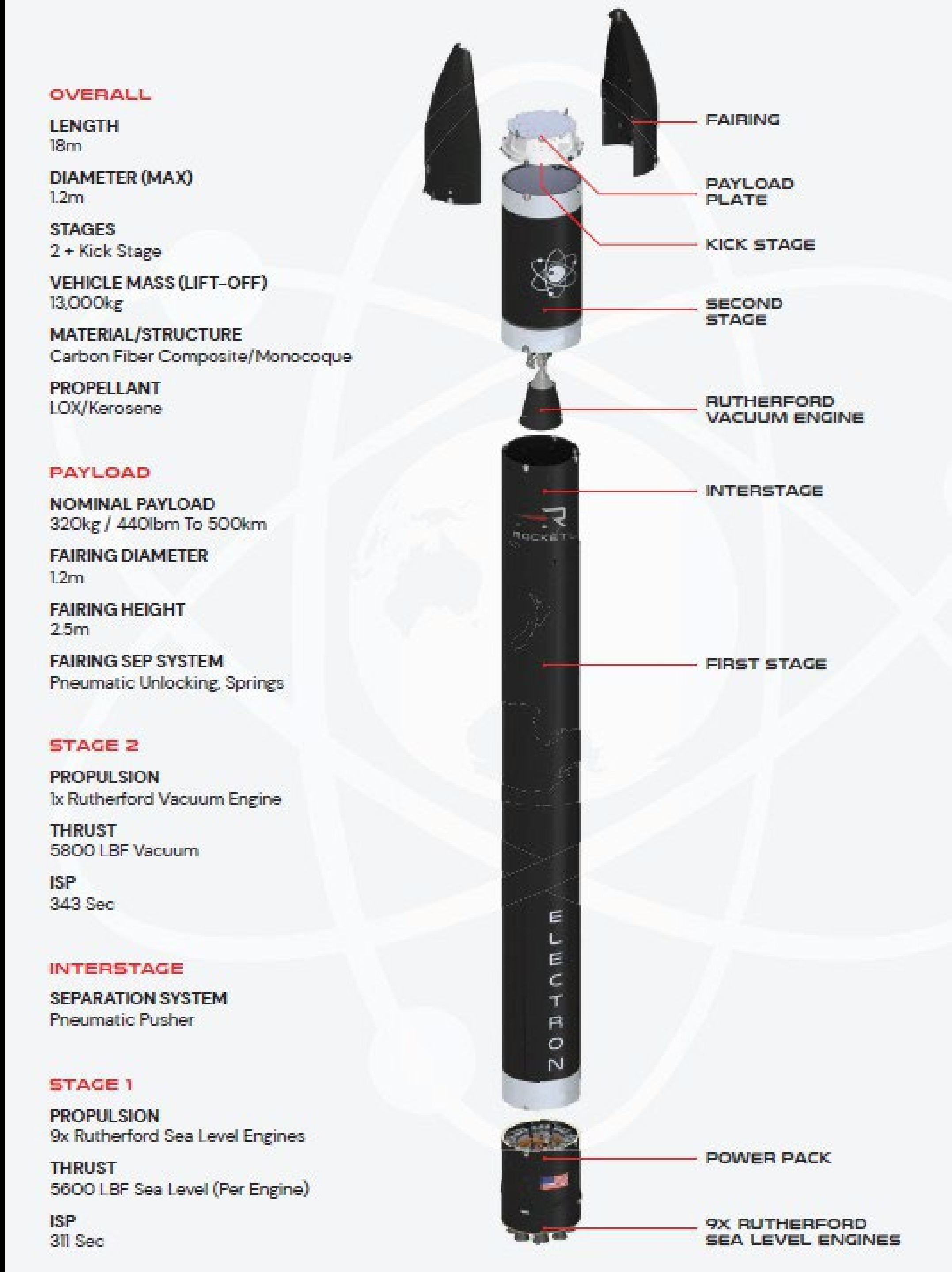
Rocket Lab launches 4 LEO satellites (2)

- The satellites, built and operated by San Francisco-based Spire Global "*will be the first to simultaneously monitor all near-Earth orbits from space, delivering a radically enhanced level of SSA services to the global satellite community, with timely and precise information for space object detection, tracking, orbit determination, collision avoidance, navigation and proximity alerts*" Rocket Lab announced
- The first stage of the 18m high Electron was also recovered after being parachuted back down to the sea. This was the Electron's 43rd mission

Top: Rocket Lab prepares to haul the first stage of its Electron launcher onto a recovery boat
Credit: Rocket Lab via X
Bottom: Rocket Lab Launch Complex 1 on Māhia Peninsula in New Zealand
Credit: Business Wire

Rocket Lab Electron Rocket

- Electron's 44th mission, launched on 18th February, has put the Japanese ADRAS-J probe into orbit. The Active Debris Removal by Astroscale-Japan (ADRAS-J) is due to locate and analyse the remains of an old Japanese H2A rocket, which has been in orbit for over 15 years. The probe will take images of the old rocket to determine its condition. This experiment is the first part of a programme aimed at removing large debris of Japanese origin from space



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Japan’s new H3 rocket launches (1)

- A year after the first launch of Japan’s new generation H3 rocket ended in failure, the second liftoff was a complete success with the payload of 2 small Earth-observation satellites (CE-SAT-IE and TISAT) and the 2,600kg mass simulator called the Vehicle Evaluation Payload-4, placed in orbit
- The launch took place from the Tanegashima Space Center off the coast of Japan, which is the equivalent site of Cape Canaveral, on 17th February

Japan's H3 rocket launches from Tanegashima Space Center on its second-ever liftoff, on February 17th 2024
Credit: JAXA

- The H3 medium lift expendable rocket is due to replace the elderly H-2A, which has been flying for over 20 years, by the end of 2024

Japan’s new H3 rocket launches (2)

- Developed by JAXA and Mitsubishi Heavy Industries, the H3 has two configurations, depending on the payload fairing, and stands at either 57m or 63m tall
- The first stage is powered by two or three new liquid hydrogen-liquid oxygen LE-9 engines. The second stage uses an improved variant of the LE-5B-3 engine, previously used on the earlier H-1 and H-2 rockets
- With the addition of up to 4 solid boosters, the new H3 can put 6.5 tonnes into a geostationary orbit
- Further developments could soon see a H3 Heavy being built, to compete with both the SpaceX Falcon Heavy and ULA Delta IV Heavy
- The cost of a H3 launch is only about 50% of that for the H-2A

Blue Origin debuts New Glenn rocket

- Blue Origin have unveiled their new rocket, the New Glenn, at Launch Complex 36 (LC-36) at Cape Canaveral Space Force Station, before launch later this year
- Now the rocket will undergo a complex series of tests such as cryogenic fuel loading, pressurisation, and venting
- The 98m high rocket features a reusable first stage (which will land on a sea-based platform roughly 1,000km downrange in the Atlantic Ocean). The first stage will be powered by 7 Blue Origin BE-4 engines. These use liquified oxygen and liquified natural gas and are the most powerful engines of their kind since the Saturn V F1s

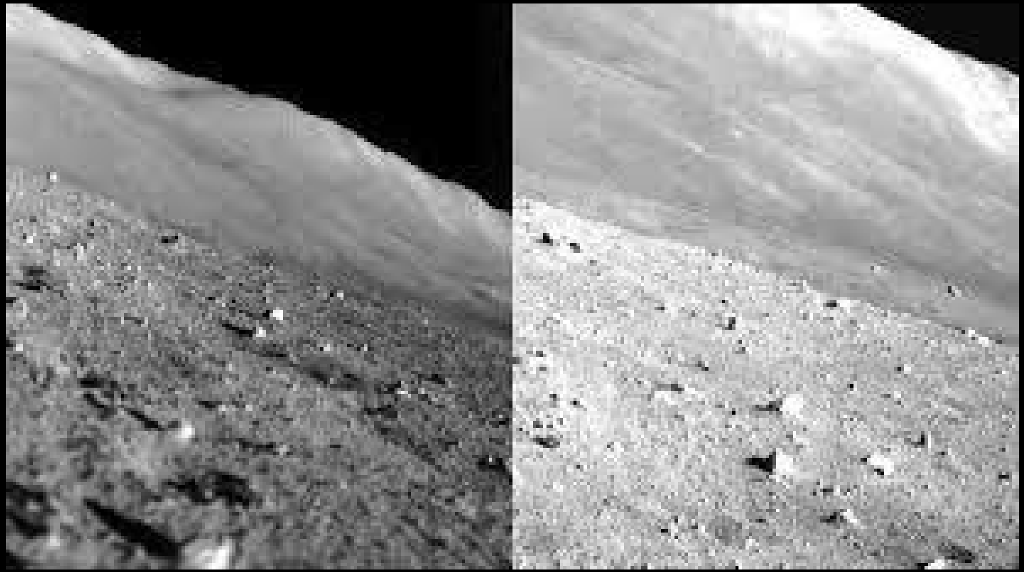
The New Glenn rolled out and upended at LC-36 on February 21st 2024
Credit: Blue Origin

Spaceflight News and Updates (1)

- Chinese solid fuel rocket – solid fuel rockets aren’t new but, with the exception of strap on boosters, are not used these days; liquid propellants are more efficient and easier to control. However, a Chinese company, Orienspace, has just launched three meteorology satellites into low Earth orbit using a completely solid fuel rocket. The 30m, 400 tonne Gravity-1 used three stages and four additional boosters to lift the payload into space from a converted cargo ship moored off China’s Shandong Province
- Tracking the lunar landers – spotting where a lunar lander has touched down on the surface of the Moon can be quite difficult. They are small and until Japan’s SLIM lander came down within a few metres of its target (albeit upside down), the landing zone accuracy was measured in kilometres. Now NASA intends to fit Laser Retroreflective Arrays (LRAs) into all future landers that are part of the Commercial Lunar Payload Service (CLPS) initiative. These will be cheap, easy to fit, and make locating the lander very simple

Spaceflight News and Updates (2)

- SLIMs successful analysis of rocks – in spite of being upside down, Japan's SLIM lunar lander has been able to use its multi-band spectral camera to study rock composition. In all 10 close-by rocks have been imaged, all named after breeds of dogs. Scientists are hoping the analysis will lead to understanding the origins of the Moon. Even better news was received when SLIM was successfully reawakened after being put into hibernation during the freezing lunar night



Dramatic view of an upside-down SLIM, which survived the freezing lunar night, new photographs of the surrounding surface Credit: JAXA

Spaceflight News and Updates (3)

- US Government-controlled Starship – the US Department of Defense (DOD) has approached SpaceX with a view to taking control of a future Starship for launches involving secretive or highly-dangerous missions. The Starship would be "government-owned and government-controlled". Meanwhile, the third prototype Starship (Booster 10 and Ship 28) has been placed into position on the launch pad. SpaceX is waiting for the FAA to give the green light for this new launch, with the FAA having just completed its investigation into the second flight. SpaceX hope that it will be able to launch the third prototype during March 2024
- Fancy a year in space – NASA is hoping to run more year-long astronaut missions and is looking to recruit more volunteers. Should any member of LAS apply, get selected, complete training and be sent into space, we will waive their annual membership fee!

March 2024

Observational Highlights

March 2024 dates

- 3rd March – (3) Juno Minor planet (+8.6) at opposition (18:00)
- 17th March – Neptune in conjunction with the Sun (11:00)
- 20th March – Spring Equinox (03:04)
- 24th March – Mercury reaches greatest eastern elongation (19°)
- 25th March – Penumbral lunar eclipse (04:53 – 09:32) – not visible
- 31st March – British Summer Time begins (01:00)

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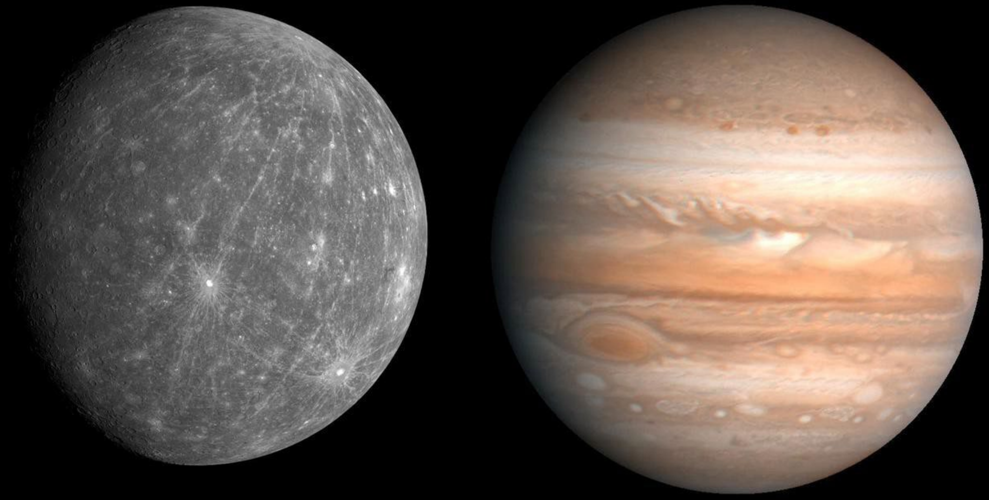
Last chance to see the planets

- By April, all the planets will either not be visible or will only be very poorly placed (too low or too near the Sun) to be seen
- This month only three planets remain on view:
  - Mercury – gradually emerging from the Sun’s glare as the month progresses. Best seen around mid-month, magnitude -1.1 and maximum 7° above the horizon. It will slowly fade later and sink lower down
  - Jupiter – will now start to sink rapidly towards the horizon as the month progresses. Still bright at -2.1 and visible after sunset in the western sky. It will continue to be visible but low down into early April
  - Uranus – closely placed to Jupiter, it will follow its neighbours decline but will not be visible by the end of March



Credit: NASA

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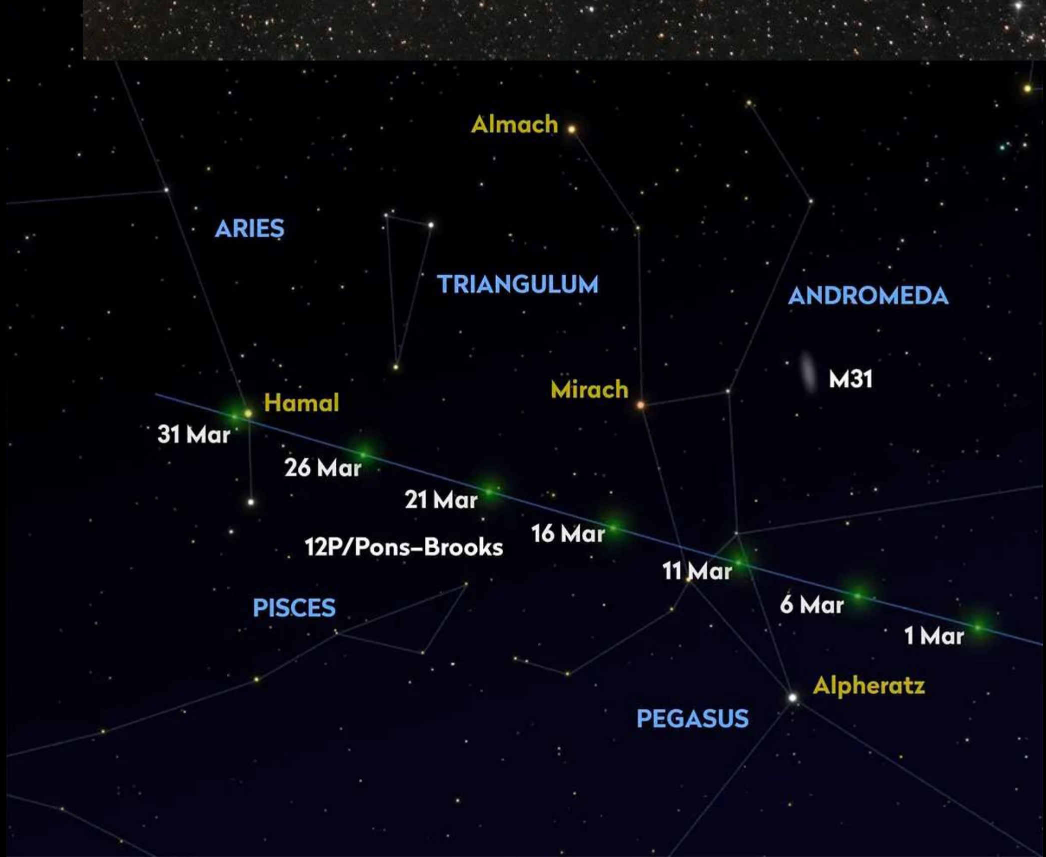
Comet 12P/Pons-Brooks



- The periodic comet, 12P/Pons-Brooks, comes back to visit us every 71 years
- This year will see it reach perihelion on 21st April and will be closest to Earth on 2nd June (1.55 AU, 232 million km)
- During March it is predicted to brighten from 7.1 to 5.2 making it almost visible to the naked eye but will sink lower in the sky
- It will track from Andromeda to Pisces during the month starting above the WNW horizon
- Nicknamed the "Devil Comet", it outburst last July with the gas and dust producing two horns

Top: Image captured by José J. Chambo on 3rd February 2024
Bottom: Credit: Pete Lawrence/ BBC Sky at Night Magazine

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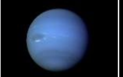
Planets (information for 1st March)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	06:56	17:38	12:17			+0.71	NO
	VENUS	05:59	15:14	10:36			-3.83	NO
	MARS	05:53	14:52	10:23			+1.19	NO
	JUPITER	08:39	23:12	15:56	South-West	45° ◊	-2.07	YES
	SATURN	06:51	17:24	12:08			+1.10	NO
	URANUS	08:54	00:01	16:28	South-West	44° ◊◊	+5.82	YES
	NEPTUNE	07:18	19:01	13:09			+7.96	NO

* = Highest point at Dawn (05:24 - last visible sighting)
** = Highest point at Dusk (18:59 - first visible sighting)
▫ = Highest point when last visible
◊ = Highest point when first visible (18:01)
▫▫ = Highest point when last visible
◊◊ = Highest point when first visible (18:59)

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
Cr50	The Hyades	Taurus	Open Cluster	18:29	01:13	18:29 ◊◊	South	54°	+1.0
Cr39	Collinder 39	Perseus	Open Cluster	18:29	05:54	18:29 ◊◊	West	72°	+1.2
Mel20	The Alpha Persei Cluster	Perseus	Open Cluster	18:29	05:54	18:29 ◊◊	West	72°	+1.2
M45	The Pleiades	Taurus	Cluster with Nebulosity	18:31	01:26	18:31 ◊◊	South-West	58°	+1.3
Cr256	Collinder 256	Coma Berenices	Open Cluster	19:05	05:46	01:48	South	65°	+1.8
NGC1980	Open Cluster	Orion	Cluster with Nebulosity	18:46	22:45	18:55	South	33°	+2.5
C33	The Eastern Veil Nebula	Cygnus	Nebula	00:54	05:24	05:24 *	East	34°	+2.7
Cr65	Collinder 65	Orion	Open Cluster	18:52	02:10	18:52 ◊◊	South	54°	+3.0
Cr359	Collinder 359	Ophiuchus	Open Cluster	01:05	05:31	05:31 ◊	South-East	36°	+3.0
Mel186	Melotte 186	Ophiuchus	Open Cluster	01:04	05:31	05:31 ◊	South-East	36°	+3.0
M44	Beehive Cluster	Cancer	Open Cluster	18:53	03:53	22:00	South	58°	+3.1
M31	Andromeda Galaxy	Andromeda	Galaxy	18:58	21:54	18:58 **	West	40°	+3.4
IC1396	The Elephant Trunk	Cepheus	Cluster with Nebulosity	18:59	05:24	05:24 *	North-West	43°	+3.5
Cr399	Brocchi's Cluster	Vulpecula	Open Cluster	00:55	05:24	05:24 *	East	39°	+3.6
M42	Orion Nebula	Orion	Cluster with Nebulosity	18:59	00:32	18:59 **	South	33°	+4.0

* = Highest point at Dawn (05:24 - last visible sighting)
** = Highest point at Dusk (18:59 - first visible sighting)
◊ = Bright object last visible sighting after dawn
◊◊ = Bright object first visible sighting before dusk

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC2264	The Christmas Tree Cluster	Monoceros	Cluster with Nebulosity	18:59	00:54	20:01	South	49°	+4.1
Cr62	Collinder 62	Auriga	Open Cluster	18:59	02:18	20:36	South	79°	+4.2
Cr464	Collinder 464	Camelopardalis	Open Cluster	18:59	05:24	19:06	North	71°	+4.2
IC4665	Open Cluster	Ophiuchus	Open Cluster	00:37	05:24	05:24 *	South-East	39°	+4.2
NGC1977	Running Man Nebula	Orion	Open Cluster	18:59	00:35	18:59 **	South	53°	+4.2
NGC1981	Open Cluster	Orion	Open Cluster	18:59	00:37	18:59 **	South	34°	+4.2
NGC2232	Open Cluster	Monoceros	Open Cluster	18:59	23:19	19:48	South	34°	+4.2
C14	The Perseus Double Cluster	Perseus	Open Cluster	18:59	05:24	18:59 **	North-West	60°	+4.3
M47	Open Cluster	Puppis	Open Cluster	18:59	23:06	20:56	South	24°	+4.4
Cr106	Collinder 106	Monoceros	Open Cluster	18:59	00:24	19:57	South	45°	+4.6
IC4756	Graff's Cluster	Serpens Cauda	Open Cluster	01:30	05:24	05:24 *	South-East	34°	+4.6
M39	Open Cluster	Cygnus	Open Cluster	02:26	05:24	05:24 *	South-East	39°	+4.6
NGC6633	Open Cluster	Ophiuchus	Open Cluster	01:13	05:24	05:24 *	South-East	36°	+4.6
NGC2244	Open Cluster	Monoceros	Open Cluster	18:59	00:10	19:52	South	44°	+4.8
NGC1499	The California Nebula	Perseus	Bright Nebula	18:59	03:53	18:59 **	South-West	63°	+5.0

* = Highest point at Dawn (05:24 - last visible sighting)
** = Highest point at Dusk (18:59 - first visible sighting)
◊ = Bright object last visible sighting after dawn
◊◊ = Bright object first visible sighting before dusk

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
Cr107	Collinder 107	Monoceros	Open Cluster	18:59	00:11	19:57	South	43°	+5.1
M35	Open Cluster	Gemini	Open Cluster	18:59	01:18	19:29	South	63°	+5.1
M34	The Spiral Cluster	Perseus	Open Cluster	18:59	23:32	18:59 **	West	59°	+5.2
NGC6871	Open Cluster	Cygnus	Open Cluster	23:09	05:24	05:24 *	East	44°	+5.2
NGC869	h Per Cluster	Perseus	Open Cluster	18:59	05:24	18:59 **	North-West	60°	+5.3
Cr97	Collinder 97	Monoceros	Open Cluster	18:59	00:07	19:51	South	45°	+5.4
NGC2281	Open Cluster	Auriga	Open Cluster	18:59	03:24	20:08	South	80°	+5.4
M37	The Auriga Salt-and-Pepper	Auriga	Open Cluster	18:59	01:36	19:12	South	71°	+5.6
NGC7686	Open Cluster	Andromeda	Open Cluster	18:59	21:03	18:59 **	North-West	34°	+5.6
Cr89	Collinder 89	Gemini	Open Cluster	18:59	01:16	19:38	South	62°	+5.7
M5	Globular Cluster	Serpens Caput	Globular Cluster	00:50	05:24	04:41	South	41°	+5.7
NGC752	Open Cluster	Andromeda	Open Cluster	18:59	02:25	18:59 **	West	49°	+5.7
M11	Wild Duck Cluster	Scutum	Open Cluster	02:40	05:24	05:24 *	South-East	22°	+5.8
M13	Great Globular Cluster	Hercules	Globular Cluster	19:32	05:24	05:24 *	South-East	74°	+5.8
M33	Triangulum Galaxy	Triangulum	Galaxy	18:59	00:07	18:59 **	West	41°	+5.8

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◊ = Bright object last visible sighting after dawn
◊◊ = Bright object first visible sighting before dusk

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M48	Open Cluster	Hydra	Open Cluster	18:59	00:32	21:33	South	33°	+5.8
M50	The Heart-Shaped Cluster	Monoceros	Open Cluster	18:59	22:59	20:22	South	30°	+5.9
NGC2169	The "37" Cluster	Orion	Open Cluster	18:59	00:18	19:28	South	53°	+5.9
IC405	The Flaming Star Nebula	Auriga	Nebula	18:59	04:33	18:59 **	South	73°	+6.0
M36	The Pinwheel Cluster	Auriga	Open Cluster	18:59	04:49	18:59 **	South	73°	+6.0
NGC2301	Open Cluster	Monoceros	Open Cluster	18:59	23:49	20:11	South	39°	+6.0
NGC7000	The North American Nebula	Cygnus	HII Region	02:52	05:24	05:24 *	East	41°	+6.0
M12	Globular Cluster	Ophiuchus	Globular Cluster	00:15	05:24	05:24 *	South	36°	+6.1
M46	Open Cluster	Puppis	Open Cluster	19:40	22:22	21:01	South	24°	+6.1
NGC884	chi Per Cluster	Perseus	Open Cluster	18:59	05:24	18:59 **	North-West	61°	+6.1
NGC1746	Open Cluster	Taurus	Open Cluster	18:59	02:39	18:59 **	South	62°	+6.1
NGC7160	Open Cluster	Cepheus	Open Cluster	18:59	05:24	18:59 **	North-East	44°	+6.1
NGC1545	Open Cluster	Perseus	Open Cluster	18:59	05:24	18:59 **	West	77°	+6.2
M3	Globular Cluster	Canes Venatici	Globular Cluster	21:07	05:24	03:05	South	67°	+6.3
NGC6940	Open Cluster	Vulpecula	Open Cluster	01:05	05:24	05:24 *	East	35°	+6.3

* = Highest point at Dawn (05:24 - last visible sighting)
** = Highest point at Dusk (18:59 - first visible sighting)
◊ = Bright object last visible sighting after dawn
◊◊ = Bright object first visible sighting before dusk

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M38	The Starfish Cluster	Auriga	Open Cluster	18:59	05:59	18:59 **	South	74°	+6.4
NGC457	The Dragonfly Cluster	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	53°	+6.4
NGC1528	Open Cluster	Perseus	Open Cluster	18:59	05:24	18:59 **	West	76°	+6.4
NGC1647	Open Cluster	Taurus	Open Cluster	18:59	01:51	18:59 **	South-West	56°	+6.4
NGC1662	Open Cluster	Orion	Open Cluster	18:59	01:07	18:59 **	South	48°	+6.4
NGC7243	Open Cluster	Lacerta	Open Cluster	03:26	05:24	05:24 *	East	34°	+6.4
IC1805	The Heart Nebula	Cassiopeia	Cluster with Nebulosity	18:59	05:24	18:59 **	North-West	62°	+6.5
IC1848	The Soul Nebula	Cassiopeia	Cluster with Nebulosity	18:59	05:24	18:59 **	North-West	65°	+6.5
M92	Globular Cluster	Hercules	Globular Cluster	23:30	05:24	05:24 *	South-West	75°	+6.5
NGC129	Open Cluster	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	47°	+6.5
NGC654	Open Cluster	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	56°	+6.5
NGC2539	Open Cluster	Puppis	Open Cluster	19:40	23:20	21:30	South	26°	+6.5
M10	Globular Cluster	Ophiuchus	Globular Cluster	00:36	05:24	05:24 *	South	33°	+6.6
M29	The Cooling Tower	Cygnus	Open Cluster	22:04	05:24	05:24 *	East	43°	+6.6
NGC1444	Open Cluster	Perseus	Open Cluster	18:59	05:24	18:59 **	West	73°	+6.6

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC1027	Open Cluster	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	63°	+6.7
NGC1342	Open Cluster	Perseus	Open Cluster	18:59	03:45	18:59 **	West	63°	+6.7
NGC2129	Open Cluster	Gemini	Open Cluster	18:59	00:54	19:21	South	62°	+6.7
NGC2343	Open Cluster	Monoceros	Open Cluster	18:59	22:42	20:28	South	28°	+6.7
NGC2423	Open Cluster	Puppis	Open Cluster	19:21	22:32	20:57	South	25°	+6.7
NGC6709	Open Cluster	Aquila	Open Cluster	01:17	05:24	05:24 *	South-East	36°	+6.7
NGC7789	The Caroline's Rose	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	42°	+6.7
NGC2175	Open Cluster	Orion	Cluster with Nebulosity	18:59	00:49	19:29	South	59°	+6.8
NGC6811	The Hole in a Cluster	Cygnus	Open Cluster	01:17	05:24	05:24 *	East	55°	+6.8
NGC7023	The Iris Nebula	Cepheus	Nebula	18:59	05:24	18:59 **	North-East	41°	+6.8
M52	The Cassiopeia Salt-and-Pepper	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	41°	+6.9
M67	Open Cluster	Cancer	Open Cluster	18:59	02:49	22:11	South	50°	+6.9
M81	Bode's Galaxy	Ursa Major	Galaxy	18:59	05:24	05:24 *	North	86°	+6.9
NGC1502	Open Cluster	Camelopardalis	Open Cluster	18:59	05:24	05:24 *	North	73°	+6.9
NGC6960	The Western Veil Nebula	Cygnus	Supernova Remnant	00:55	05:24	05:24 *	East	34°	+7.0

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC7635	The Bubble Nebula	Cassiopeia	HII Region	18:59	05:24	18:59 **	North-West	40°	+7.0
M27	Apple Core Nebula	Vulpecula	Planetary Nebula	01:13	05:24	05:24 *	East	36°	+7.4
M103	Open Cluster	Cassiopeia	Open Cluster	18:59	05:24	18:59 **	North-West	55°	+7.4
NGC6888	The Crescent Nebula	Cygnus	HII Region	22:04	05:24	05:24 *	East	35°	+7.5
M14	Globular Cluster	Ophiuchus	Globular Cluster	01:12	05:24	05:24 *	South-East	32°	+7.6
M53	Globular Cluster	Coma Berenices	Globular Cluster	21:27	05:24	02:35	South	57°	+7.7
M107	Globular Cluster	Ophiuchus	Globular Cluster	00:57	05:24	05:24 *	South	25°	+7.8
M101	The Pinwheel Galaxy	Ursa Major	Galaxy	18:59	05:24	03:26	North	86°	+7.9
M78	Reflection Nebula	Orion	Reflection Nebula	18:59	22:41	19:07	South	39°	+8.0
M110	Galaxy	Andromeda	Galaxy	18:59	21:11	18:59 **	West	39°	+8.1

Twilight	Civil	Naut	Astro		Rises	Sets
Ends	18:14	18:52	19:31	Sun	06:42	17:41
Starts	06:09	05:31	04:52	Moon	23:16	08:29

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Lewes Astronomical Society

Brown Lunation Numbers

numbered from first New Moon in 1923

Phases of the Moon

Phase	Date	Time	Lunation
NEW MOON	10th March	09:00	1252
FIRST QUARTER	17th March	04:10	1252
FULL MOON	25th March	07:00	1252
LAST QUARTER	2nd April	04:14	1252

Credit: NASA
Data credit: Time and Place