Lewes Astronomical Society

Newsletter - February 2024

Astronomy News, Spaceflight News, and Observational Highlights

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February 2024

Astronomy News

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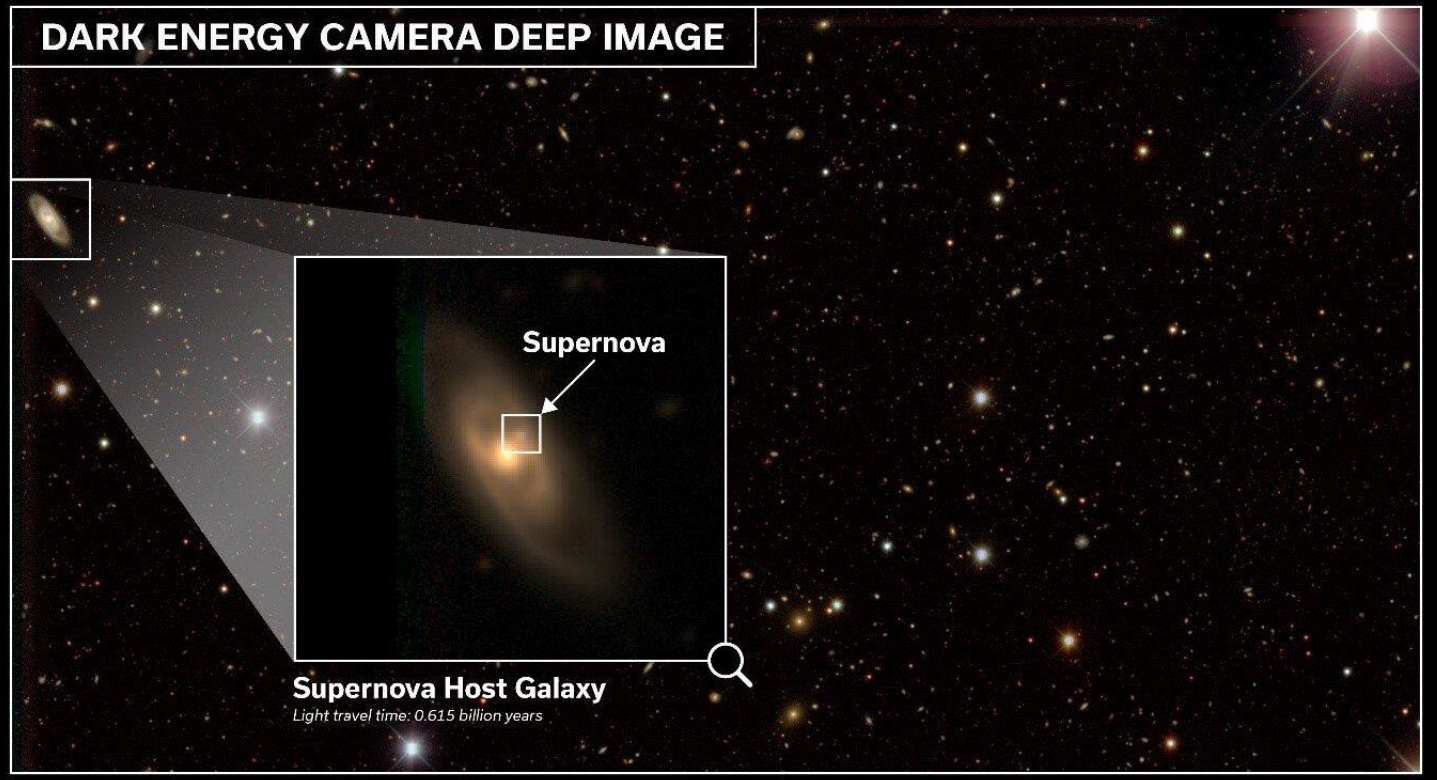
Dark Energy & the Expansion of the Universe (1)

- In 1998, scientists announced to the world that the Universe was not only still expanding, but that the expansion rate was accelerating
- This ground-breaking work relied on the analysis of 52 type 1a supernovae
- Type 1a supernovae are the result of white dwarf stars in binary systems drawing material off from their companion star



An example of a supernova discovered by the Dark Energy Survey within the field covered by one of the individual detectors in the Dark Energy Camera. The supernova exploded in a spiral galaxy with redshift = 0.04528, about 0.6 billion years light years away. This is one of the nearest supernovae in the sample. In the inset, the supernova is a small dot at the upper-right of the bright galaxy centre
Credit: DES

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Dark Energy & the Expansion of the Universe (2)

- When they reach a critical mass, they become unstable and explode as a supernova. Having the same mass, the resulting supernovae have approximately the same brightness, and so act as standard candles and distance markers
- For each supernova, the known distance is coupled with the redshift: how fast they are moving away from Earth due to the expansion of the Universe. From this, scientists are able to calculate the density of dark energy and whether it has varied over time
- The Dark Energy Survey (DES), a huge follow-up survey, has taken 10 years to complete. It involved 400 astrophysicists, astronomers, and cosmologists from over 25 institutions. Researchers have used pioneering techniques in photometry and machine learning to study 1,499 supernovae, identified from over 2 million galaxies, classifying them and measuring their light curves
- The results suggest that dark energy could have varied over time. More surveys will be needed to find a definitive answer

Dark Energy & the Expansion of the Universe (3)

- More interestingly, the survey has been used to calculate ‘w’. This parameter stands for the "equation of state" of dark energy, which describes the ratio of pressure over energy density for a substance. Everything in the universe has an equation of state
- The current theories suggest that ‘w’ should be -1. Anything more negative would indicate that we live in a “Big-Rip” universe, which would expand indefinitely at a faster and faster rate - eventually pulling apart galaxies, planetary systems, and even space-time itself
- The DES has calculated w = -0.8, which means we almost definitely don’t live in a “Big Rip” universe. There is still a level of uncertainty, but no more than a one in twenty chance. Planck had measured w at nearly -1 in comparison

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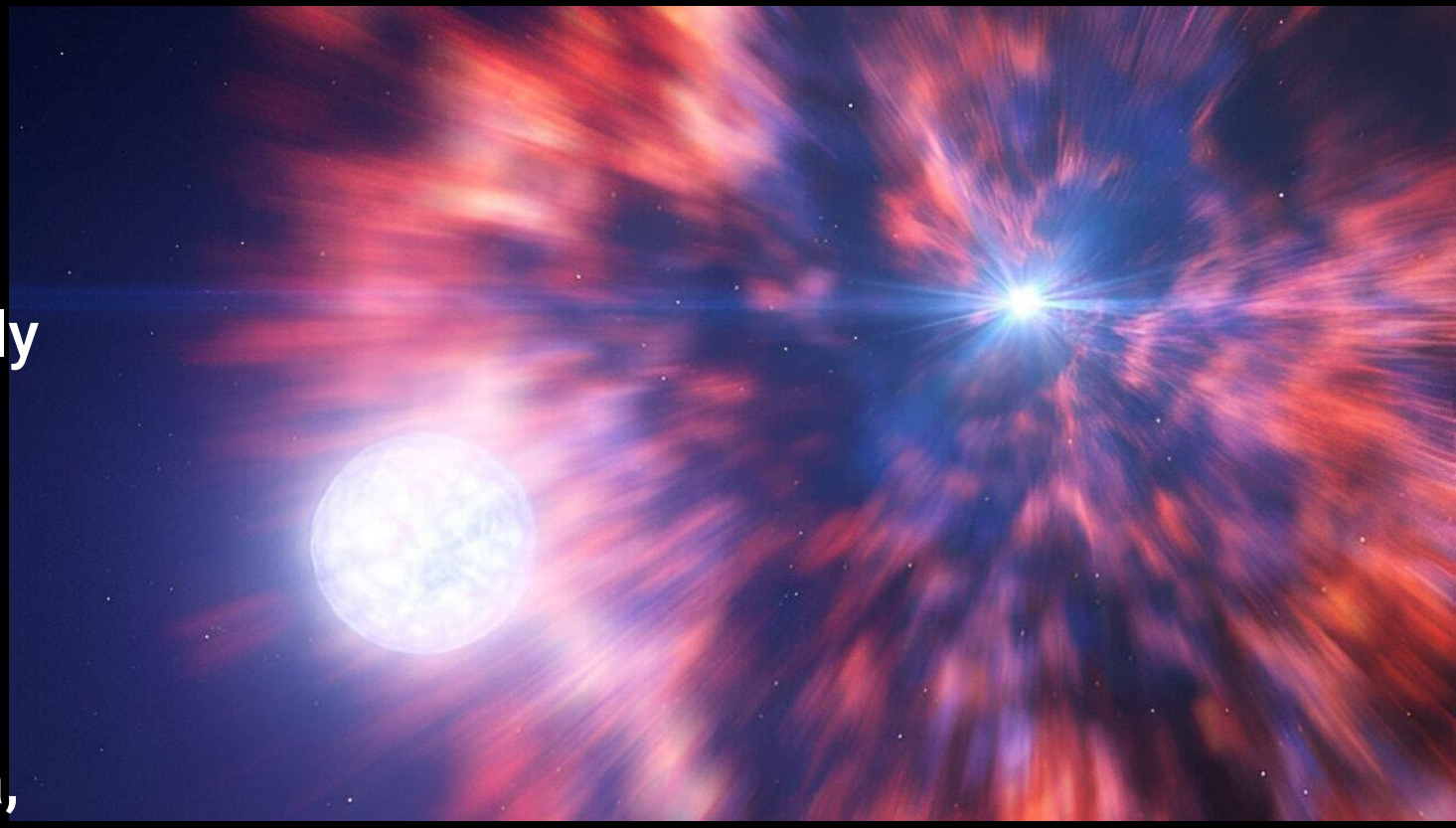
Black Holes, Neutron Stars and Supernovae (1)

- We know that both black holes and neutron stars can be formed from supernovae
- However, until now, it has only been a theory, no one has actually observed the process
- Now, astronomers have seen it happen in real time
- In May 2022, an amateur South African astronomer, Berto Monard, discovered a supernova, SN 2022jli, in the close-by galaxy, NGC 157, which is only 75 million light years away



This artist's impression is based on the aftermath of a supernova explosion as seen by two teams of astronomers with both ESO's Very Large Telescope (VLT) and ESO's New Technology Telescope (NTT)
Credit: ESO/L. Calçada

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Black Holes, Neutron Stars and Supernovae (2)

- Normally, after the explosion, the supernova quickly fades away, the observed light-curve declining a predictable steady way
- In SN 2023jli's case, it is a bit more abnormal; although the brightness has declined, it pulsates every 12 days
- What appears to be happening is that a dense object, probably a neutron star, left behind after the supernova, has started to steal gas from a companion star, which survived the explosion
- The companion star is likely to have interacted with the material blown away during the supernova, becoming bloated. As the two stars orbit each other, the neutron star passes through the hydrogen-rich atmosphere and steals some of its gas, causing changes in the observed brightness
- Watch the video at: https://youtu.be/TPImj75Zl10

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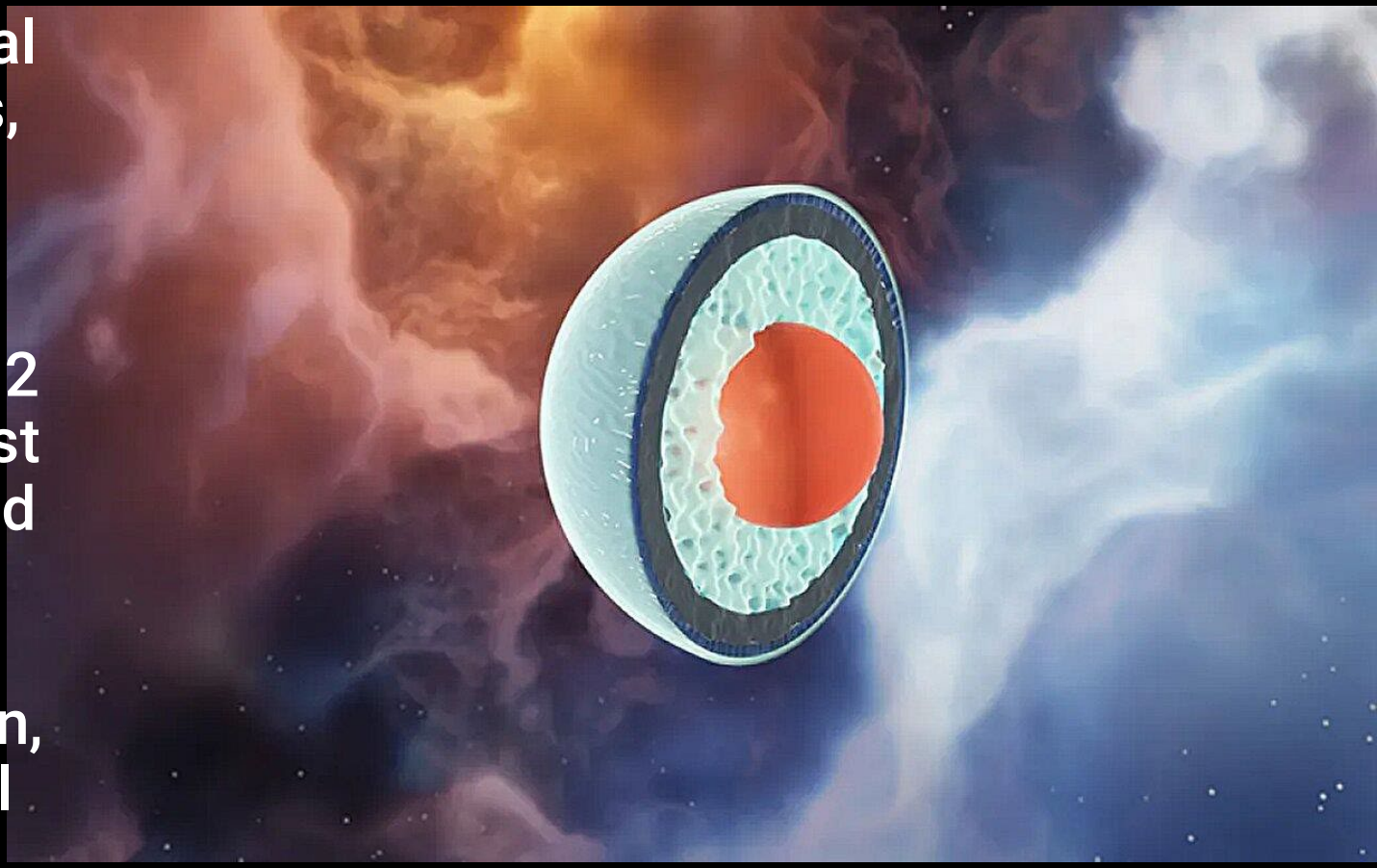
Massive Neutron Stars with Quark Cores (1)

- Protons and neutrons, the principal components of an atomic nucleus, are made up of quarks, held together by the Strong Nuclear Force (mediated by gluons). Each have three quarks: the proton has 2 up quarks and 1 down quark, whilst the neutron has 2 down quarks and 1 up quark
- A star the size of the Sun will end its life first as a Red Giant and then, after shedding its outer layers, will collapse to a White Dwarf due to not having enough fuel to sustain nuclear fusion



An artist's impression of the different layers inside a massive neutron star, with the red circle representing a sizable quark-matter core
Credit: Jyrki Hokkanen, CSC. IT Center for Science Ltd, Espoo, Finland

Massive Neutron Stars with Quark Cores (2)

- A white dwarf is incredibly dense and hot (with surface temperatures over 100,000 degrees Kelvin). One teaspoon of white dwarf material would weigh the same as the whole of Mount Everest
- About 97% of all the stars in the Milky Way will eventually become white dwarfs
- The Sun will eventually collapse to the size of the Earth. But the gravitational shrinking process is halted by electron degeneracy, the pressure exerted by the electrons, which resist being squeezed together
- However, more massive stars, over 8 times the size of The Sun, collapse further as gravity gains the upper hand, forcing electrons to bind with protons to become neutrons, with the release of a neutrino – and the neutron star is born
- Again, this is a relatively stable state, if even more dense. Using the above analogy, the Earth-sized white dwarf would now be a city-sized neutron star
- Even more massive stars are so heavy, and gravity is so great, that they continue collapsing beyond the neutron star state to become black holes

Massive Neutron Stars with Quark Cores (3)

- However, the largest neutron stars (which aren't quite big enough to become black holes) may exist in a unique state, where the neutrons are compressed into a new phase, known as cold quark matter. In this state they will cease to exist as individual neutrons. Although at the moment, this is purely theoretical, scientists believe that cold quark matter has a high probability (80-90%) of actually occurring in these massive neutron stars
- The rapid change of state can be very destabilising and could cause the star to continue to collapse and form a black hole. One scientist described the cold quark matter phase as being as stable as balancing a pencil on its point

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TDEs Brightened by Shock Dissipation (1)

- Tidal Disruption Events (TDEs) happen when a star wanders too close to a Super Massive Black Hole (SMBH) and is ripped apart
- Studying TDEs can tell astronomers a lot about the SMBHs, but much about the process is not fully understood, particularly what causes the brightest phases seen in these events
- Now, Dr Elad Steinberg and Dr Nicholas Stone, of the Racah Institute of Physics, at The Hebrew University, have created a simulation which accurately represents what is going on

A star in the midst of being disrupted by a supermassive black hole. As the star wanders past the super massive black hole, the tidal field of the black hole rips apart the star. Half of the star is flung away to infinity and the other half falls back to the black hole. The picture shows the result of the simulation carried out by Steinberg and Stone, showing the density of the infalling half (green-blue colour) as well as the heat that is generated by the shocks (white-red)
Credit: Elad Steinberg

TDEs Brightened by Shock Dissipation (2)

- It had been thought that the shredded plasma from the ill-fated star is heated by shockwaves, creating a flare brighter than a whole galaxy. The simulation shows that it is shock dissipation from a previously unexplored type of shockwave that brightens the TDE, rather than the superheated plasma
- See an animation of the simulation at: https://youtu.be/O3IWCPO_Thk

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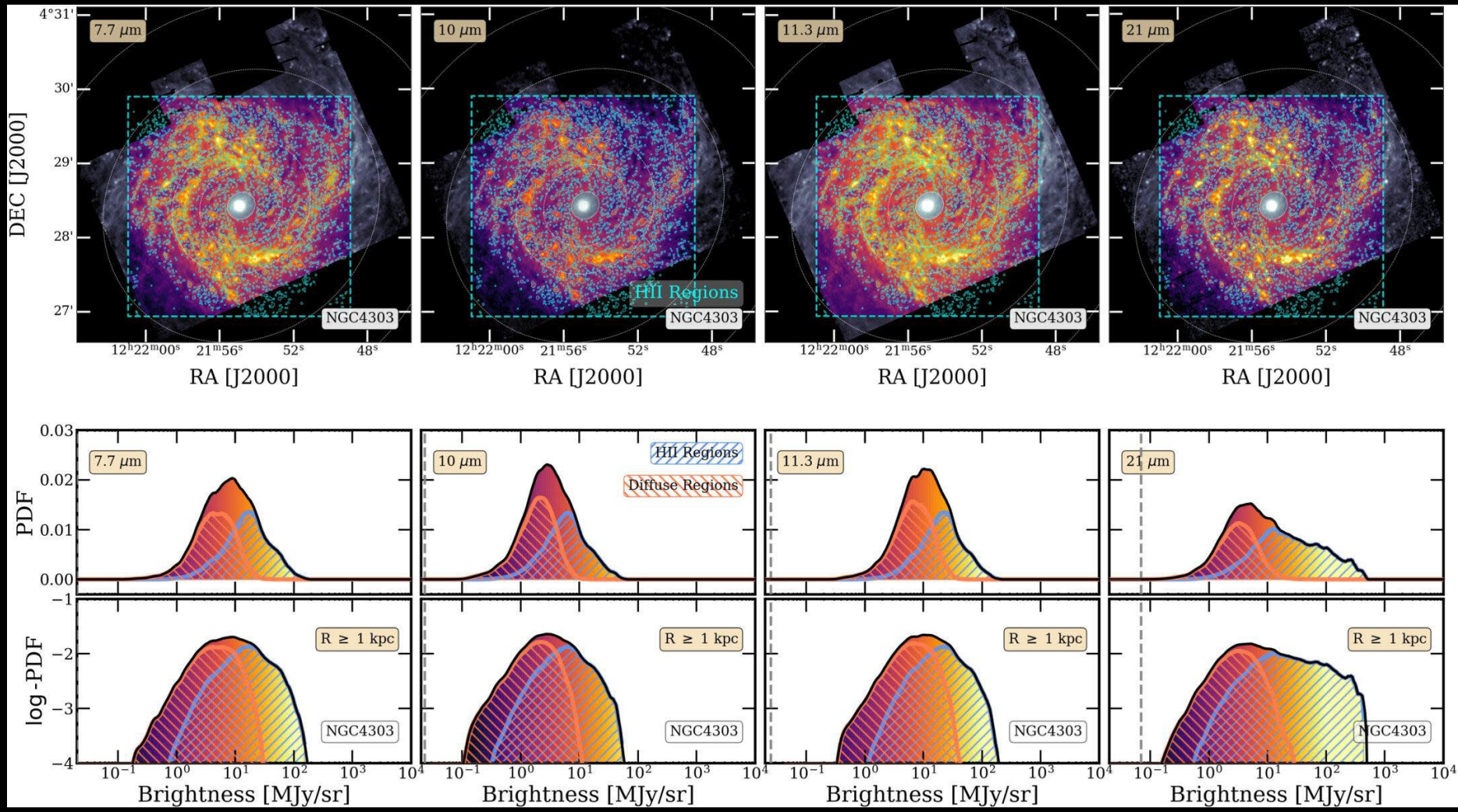
JWST Images our Dusty Neighbours (1)

The Probability Distribution Functions (PDFs) of emission of the galactic disk (r ≥ 1 kpc) after masking the centre, at 7.7, 10, 11.3, and 21 μm for the galaxy, NGC 4303, tagged by emission from within and outside of H ii regions

Top: images of the galactic disk of NGC 4303 in each MIRI filter, with the masked central region shaded.
Middle: PDFs of inclination-corrected intensity from the disk (excluding the masked central region)
Bottom: the same disk-only PDFs shown in the middle row, but now with the y-axis in log-stretch to highlight the power-law tail



Credit: The Astronomical Journal (2023). DOI: 10.3847/1538-3881/ad110d

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JWST Images our Dusty Neighbours (2)

- Dust is a vital component of galaxies. The remains of earlier generations of massive stars, dust helps with the formation of new stars and planets
- However, studying dust has been very difficult to do; and, until now, it has been seen more as a hinderance than an important subject in its own right
- JWST, using the Mid-Infrared Instrument (MIRI), has imaged 19 close-by spiral galaxies showing the distribution of dust and gas. Apart from at the centres, all the galaxies showed the same distribution patterns
- Astronomers, studying the data, have found that the galaxy disks show both a normal distribution of gas (represented in the PDF charts as a high peak) and a high distribution (appearing as a gentle slope). While the regions where star-forming nurseries reside look noticeably different, the shape and width of the distribution of diffuse gas in these galaxies stayed consistent

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Small Magellanic Cloud actually 2 galaxies (1)

- The two Magellanic Clouds are small galaxies in loose association with the Milky Way
- As our nearest neighbours they have been studied extensively, especially as they have a higher rate of star formation than the Milky Way
- Evidence first emerged in the late 1980s that the Small Magellanic Cloud (SMC) could possibly be two separate dwarf galaxies
- This has now been confirmed, with one dwarf galaxy hiding from us behind the other

VISTA's view of the Small Magellanic Cloud
Credit: ESO

Small Magellanic Cloud actually 2 galaxies (2)

- Using the new Square Kilometre Array in Western Australia, and from data collected from the APOGEE Survey, researchers have been able to establish that the two dwarf galaxies have both a different chemical composition, and slightly different velocities
- Both dwarf galaxies interact with the Large Magellanic Cloud (LMC)
- It is estimated that the nearer of the two components of the SMC is 199,000 light years from Earth, whilst the more distant is 215,000 light years away

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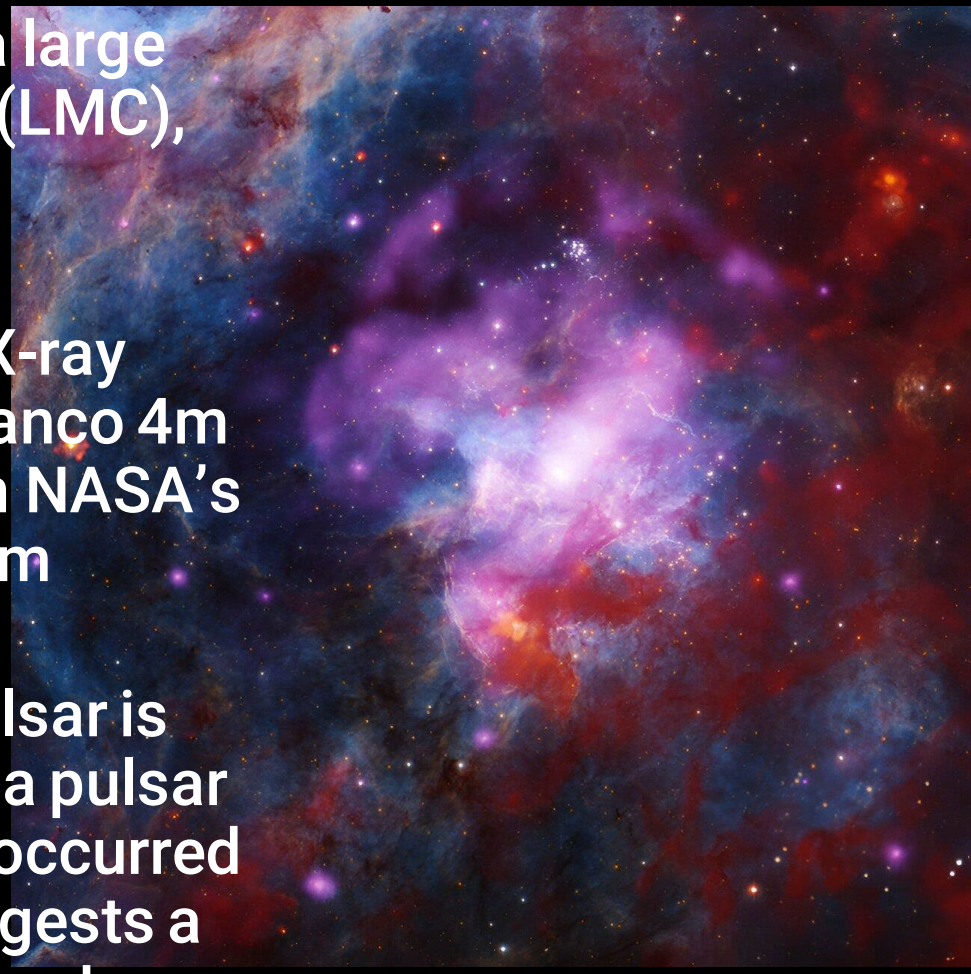
Colourful supernova in a star-forming region

- 30 Doradus B (30 Dor B) is a supernova in part of a large star-forming region in the Large Magellanic Cloud (LMC), 160,000 light years from Earth
- However, the image shows 2 exploded stars
- This image combines data from NASA's Chandra X-ray Observatory (purple), with optical data from the Blanco 4m telescope in Chile (orange and cyan), infrared from NASA's Spitzer Space Telescope (red) and optical data from Hubble (black and white)
- 30 Doradus B is about 130 light years across. A pulsar is blowing particles away, creating what is known as a pulsar wind nebula. One supernova is suspected to have occurred about 5,000 years ago but a fainter X-ray shell suggests a slightly older supernova gas explosion also happened



30 Doradus B
Credit: ESO

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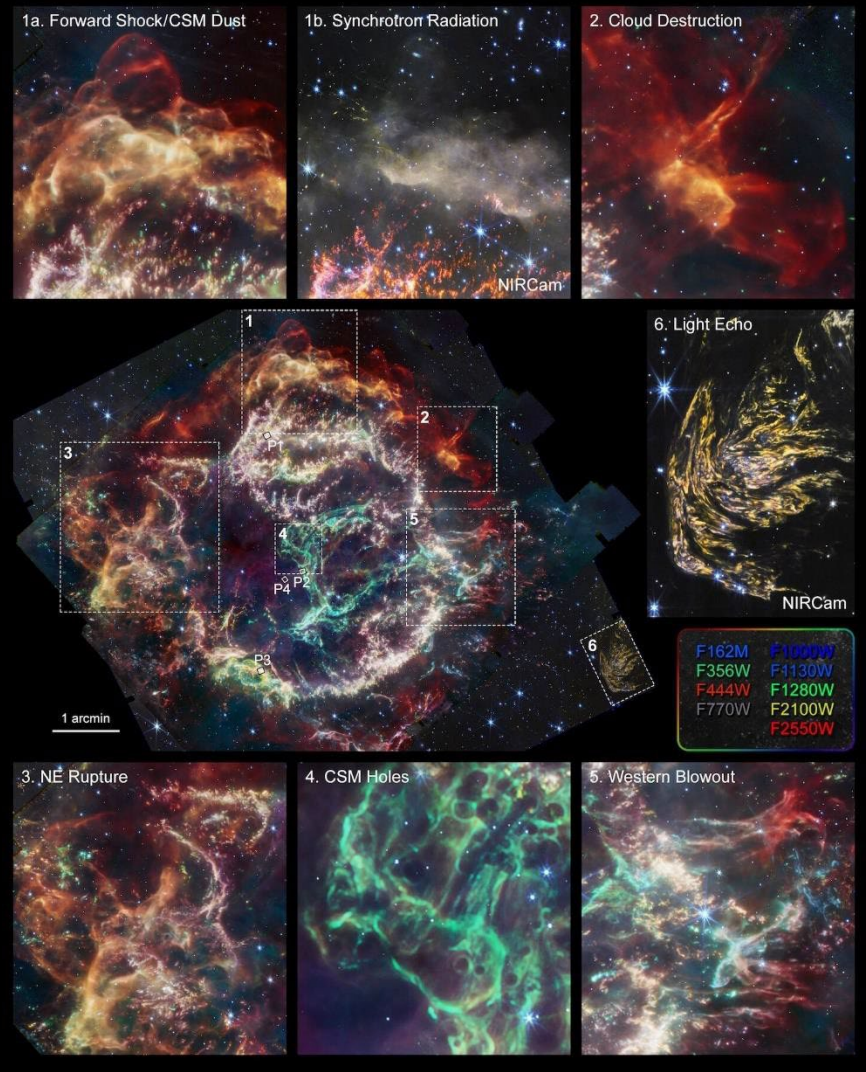
Cassiopeia A and the Green Monster (1)

- Cassiopeia A (Cas A) is a supernova remnant. When JWST looked at it in April 2023 with its Mid-Infrared Instrument (MIRI), a curious feature was noticed. Named the “Green Monster”, as it seems to resemble the huge green-coloured wall at Fenway Park (the home of the Boston Red Sox baseball team), its origins were a mystery
- Now, by using data from the Chandra X-Ray Observatory, and JWST’s Near-Infrared Camera (NIRCam), astronomers believe they have solved the puzzle



The composite image in the centre panel combines NIRCam and MIRI filters as indicated. Large boxes outlined with dashed white lines show areas of interest enlarged in the surrounding panels that use the same filters and colour scheme, with the exception of panels 1b and 6 that only use NIRCam filters. Small boxes outlined with solid white lines show the positions of the four regions of MIRI/MRS IFU spectroscopy Credit: Chandra X-ray Center/ NASA/ESA/CSA/SRSci/T. Temin (Princeton University)/ D. Milisavljevic (Purdue University)/I. De Loose (University of Gent)

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Cassiopeia A and the Green Monster (2)

- Cassiopeia A is the remains of a massive star that exploded as a supernova, about 340 years ago (although it wasn't spotted by anyone at the time)
- But, prior to this, between 10,000 and 100,000 years ago, the star ejected a huge amount of material into the surrounding neighbourhood. This, over time, has cooled down making it impossible to see at short infrared wavelengths. Debris from the supernova blast wave is hitting the edge of the ejected material and heating it up, forming the Green Monster (the green light is a false colour)
- The clumps of orange and pink colours near the centre (again both false colours) are made up of argon, neon, oxygen and sulphur
- See a short video about the Green Monster at: https://youtu.be/SnFfqPqAwAs

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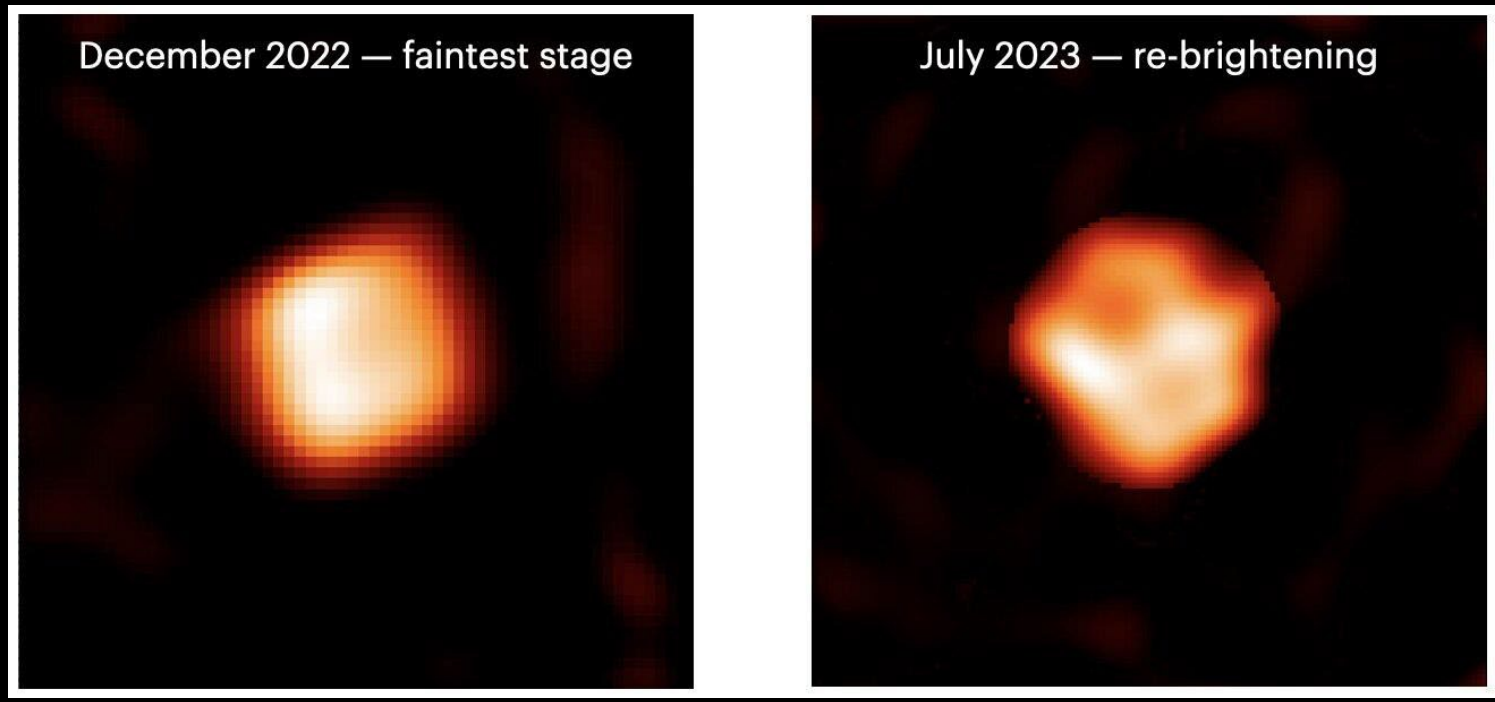
Cool Hypergiant Star Dims Unexpectedly (1)

- RW Cephei is a cool hypergiant, a huge star that is approaching the end of its life. Located some 16,000 light years from Earth, it is so large that, if it were to replace the Sun, it would reach out beyond Jupiter
- In what looks like a very similar event to that seen with Betelguese a few years ago, RW Cephei started to dim, so that observations in 2022 showed it to be only one-third as bright as previously recorded



CHARA Array false-colour images of RW Cephei from December 2022 (left) and Jul 2023 (right). The patchy appearance results from dust created by a huge ejection from the star
Credit: Georgia State University / The CHARA Array

Cool Hypergiant Star Dims Unexpectedly (2)

- Now, new observations have seen the star start to return to its previous brightness
- The reason is thought to be that there was a huge eruption of gas from the star which, as it moved away, cooled, with the dust particles blocked some of the starlight. As the cloud of dust started to dissipate, then the star reappeared
- Being so far away, the star should appear only as a single point but, by using the CHARA (Center for High Angular Resolution Astronomy) array telescopes, astronomers were able to take close-up observations. The array is 6 linked telescopes based on Mount Wilson in California and, by acting together, they work as an enormous telescope able to see things 30 times smaller than the largest conventional telescope. They could spot a human walking on the Moon

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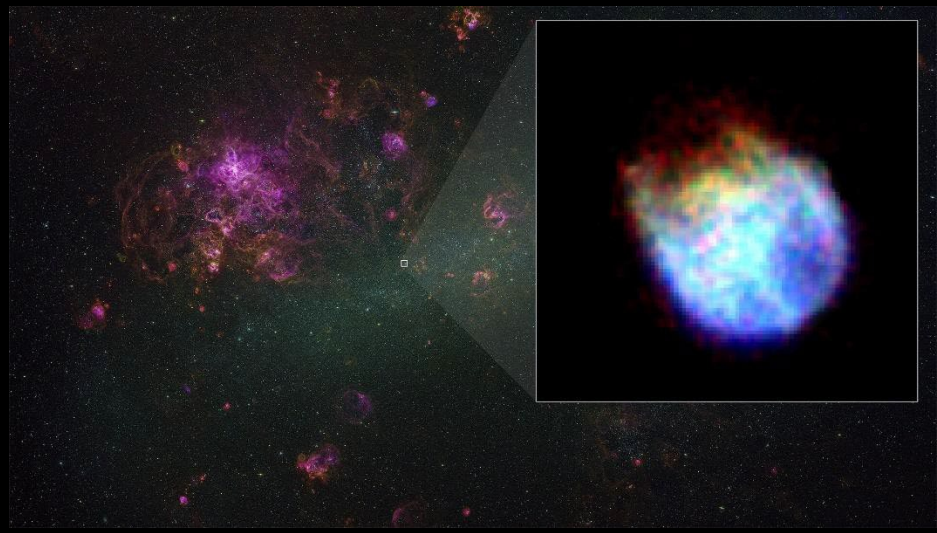
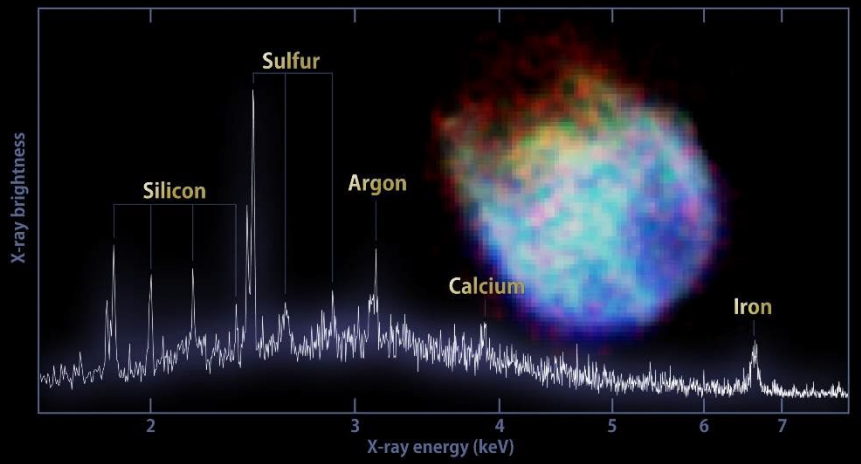
JAXA's XRISM Mission First Image (1)

- The new XRISM (X-ray Imaging and Spectroscopy Mission) observatory, which was launched on September 6th 2023, has released its first images. It has also been looking at the Large Magellanic Cloud and at N132D; a supernova remnant in the constellation, Dorado
- The supernova was created about 3,000 years ago when a massive star, roughly 15 times the size of the Sun, exploded



XRISM Resolve's Recipe for Supernova Remnant N132D



Top image: Supernova remnant N132D lies in the central portion of the Large Magellanic Cloud. At its widest, N132D is about 75 light-years across
Credit: JAXA/NASA/XRISM XTEND; background, C. Smith, S. Points, the MCELS Team and NOIRLab/NSF/AURA
Bottom image: XRISM's RESOLVE instrument captured data from supernova remnant N132D in the Large Magellanic Cloud to create the most detailed X-ray spectrum of the object ever made
Credit: JAXA/NASA/XRISM RESOLVE and XTEND

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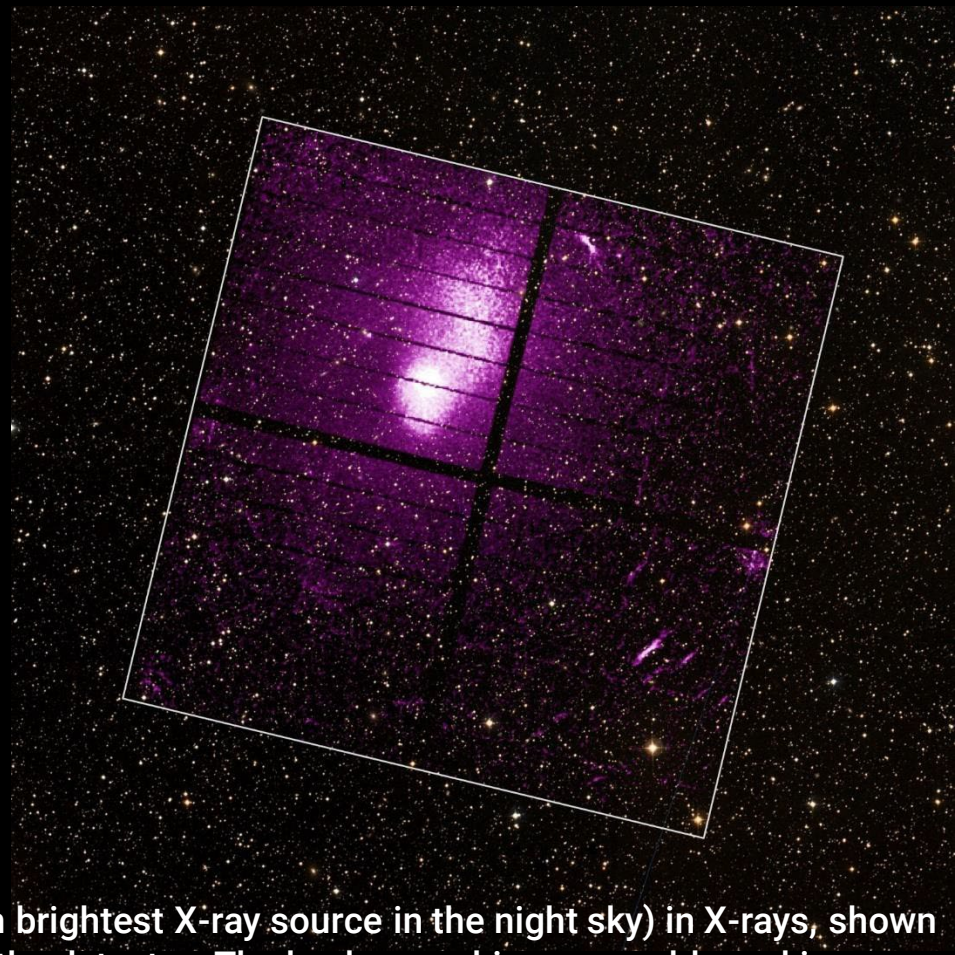
JAXA’s XRISM Mission First Image (2)

- XRISM used one of its two instruments, RESOLVE, a microcalorimeter spectrometer, to study the supernova. Cooled to within a degree of absolute zero, when an X-ray hits the 6x6 pixel detector, it warms the device by an amount related to the energy of the X-ray
- RESOLVE was able to produce a spectrum of the elements found in N132D, with silicon, sulphur, argon, calcium, and iron predominating
- XTEND, which has a large field of view, has imaged Abell 2319, a galaxy cluster located about 770 million light years away in the constellation, Cygnus



XRISM’s XTEND instrument captured galaxy cluster Abell 2319 (the fifth brightest X-ray source in the night sky) in X-rays, shown here in purple and outlined by a white border representing the extent of the detector. The background is a ground-based image showing the area in visible light. The patchy appearance results from dust created by a huge ejection from the star

Credit: JAXA/NASA/XRISM XTEND; background, DSS

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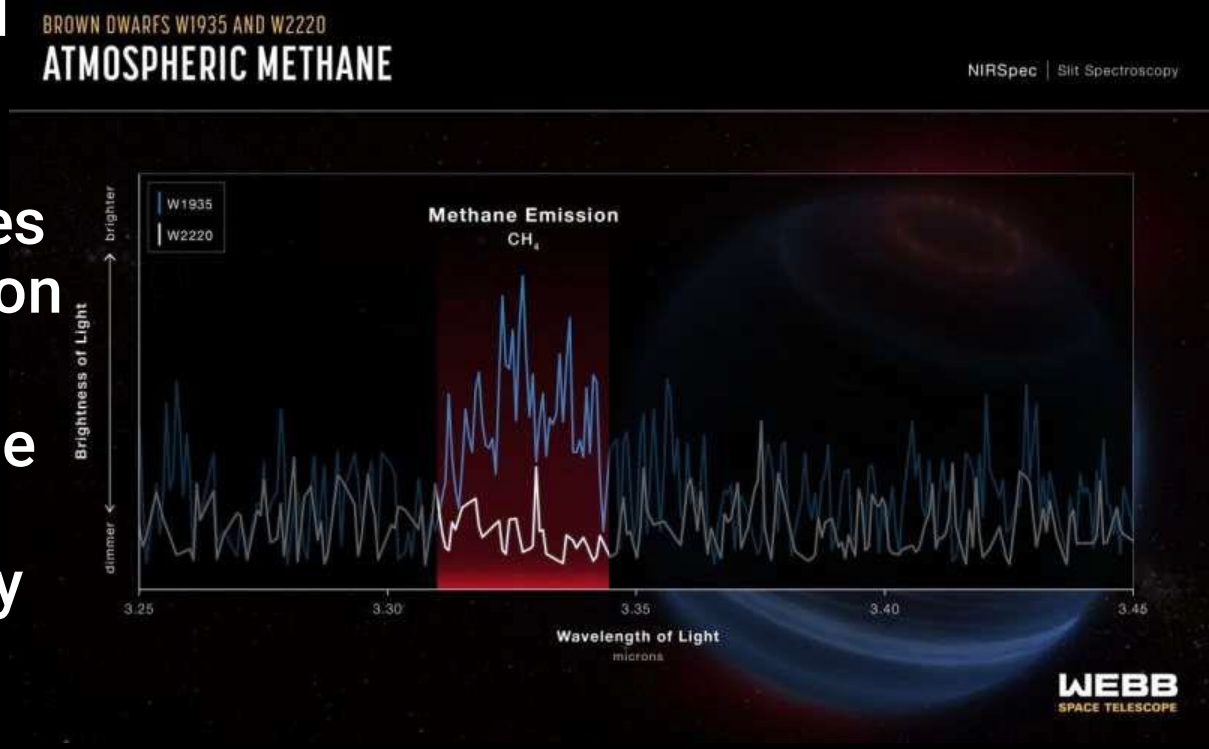
Cool Brown Dwarf with Aurorae (1)

- Brown dwarfs are sometimes called failed stars. They are far larger than gas giant planets like Jupiter, but are too small and have too little mass to create the pressures and temperatures needed for nuclear fusion
- Still, being larger than Jupiter, they can produce their own heat through the release of gravitational energy as they contract. This allows them to be seen as they faintly glow in the infrared end of the electromagnetic spectrum. They can also be warmed if they have a host star



Astronomers used JWST to study 12 cold brown dwarfs. Two of them – W1935 and W2220 – appeared to be near twins of each other in composition, brightness, and temperature. However, W1935 showed emission from methane, as opposed to the anticipated absorption feature that was observed toward W2220. The team speculates that the methane emission may be due to processes generating aurorae
Credit: NASA, ESA, CSA, Leah Hustak (STScI)

Cool Brown Dwarf with Aurorae (2)

- Aurorae have been found on brown dwarfs before. It has been speculated that this is the same process as found on Jupiter and Saturn, where the upper atmosphere is interacting with the solar winds and causing methane emission. It is also likely that both Io (Jupiter) and Enceladus (Saturn), being active moons, contribute to the aurorae
- Scientists have been studying a brown dwarf 40 light years away, W1935, using JWST, and have found aurorae. It is also emitting methane and the atmosphere gets warmer with increasing altitude. This is a surprise as W1935 is relatively cold (at about 200°C, though this is far higher than Jupiter), and doesn't have a host star. Other brown dwarfs, such as W2220, which is a near clone in terms of composition, tend to get cooler with increasing altitude and absorb methane
- What is causing both the methane emission and the aurorae remains a mystery, although it is possible that there may be an active moon that could be facilitating this

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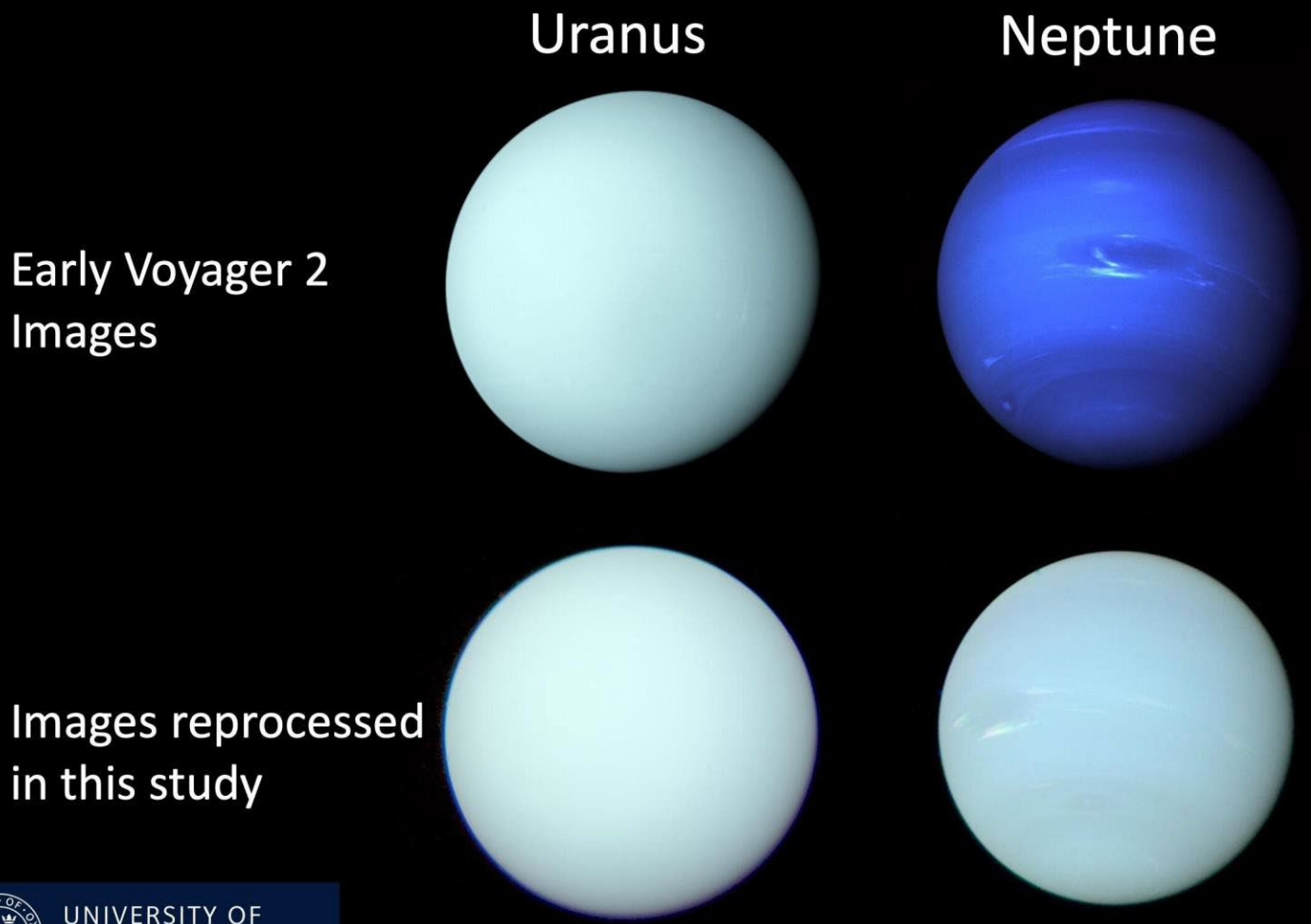
Uranus & Neptune Reveal their True Colours (1)

- Our established image of Uranus and Neptune, with the former being green and the latter a strong blue, is not accurate
- Recent studies have shown that both are actually very similar in colour: a greenish-blue hue. The original view of Uranus is not too far from the updated picture but Neptune is quite different



Voyager 2/ISS images of Uranus and Neptune released shortly after the Voyager 2 flybys in 1986 and 1989, respectively, compared with a reprocessing of the individual filter images in this study to determine the best estimate of the true colours of these planets
Credit: Patrick Irwin

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Uranus & Neptune Reveal their True Colours (2)

- The original images were derived from data from the flyby of Voyager 2 and later by Hubble's Wide Field Camera 3. The separate single-colour images were then combined to form a composite
- Neptune was strongly coloured to help highlight the clouds and other bands seen
- Using data from Hubble's Space Telescope Imaging Spectrograph (STIS) and the Multi Unit Spectroscopic Explorer (MUSE) on the European Southern Observatory's Very Large Telescope in Chile, researchers have been able to calibrate the spectrum of colours
- Neptune remains slightly bluer than Uranus, although the latter does vary in colour, becoming bluer at equinoxes and greener at solstices. This is due to the levels of methane, which absorbs red light, being more abundant at the equator than at the polar regions. In addition, thickening icy haze at the poles enhances the effect

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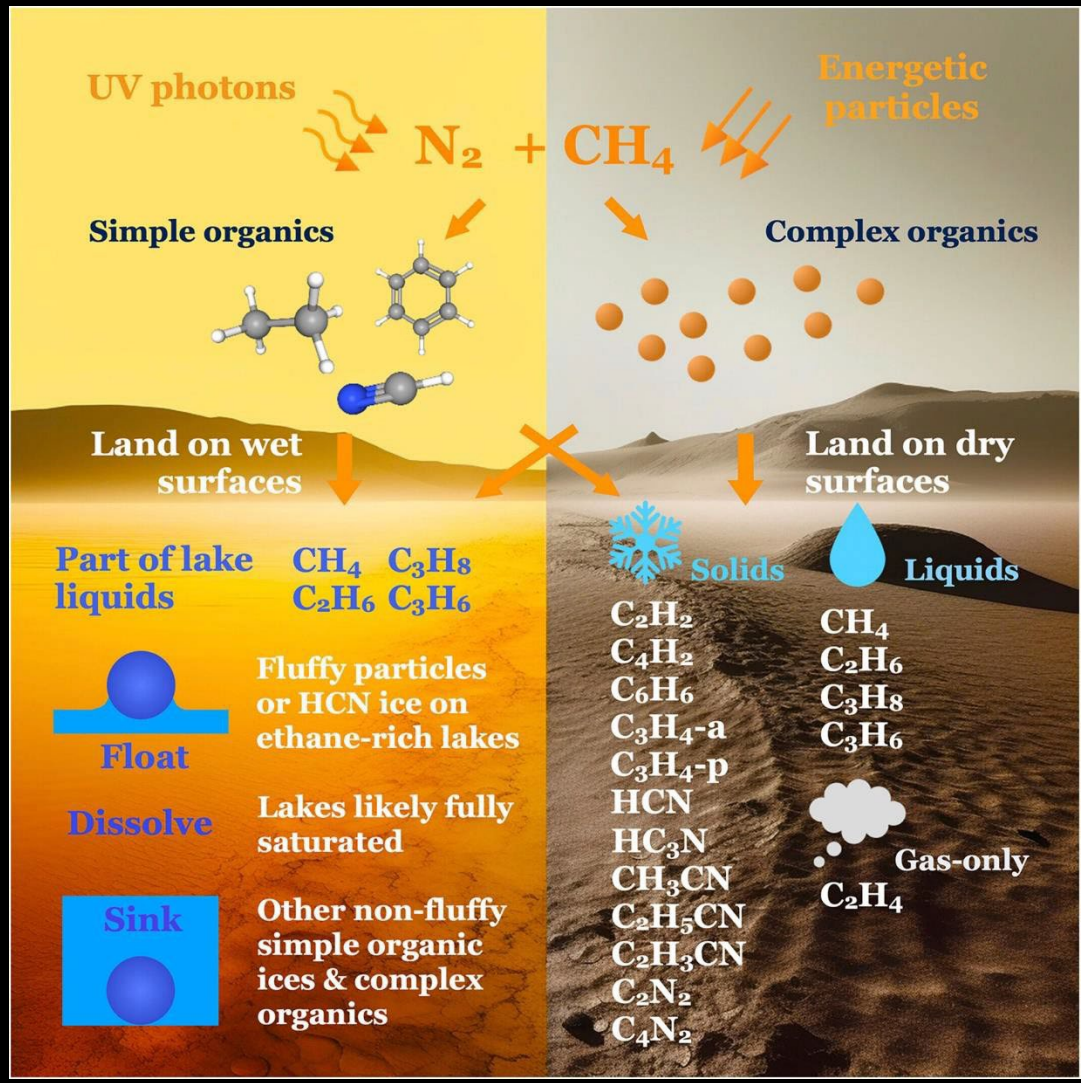
Honeycomb Islands on Titan (1)

- Saturn's largest moon, Titan, is a strange world. It has a thick orange atmosphere made up of methane and other carbon-based molecules. The surface has dark organic material surrounded by seas of liquid methane and ethane
- More mysteriously, the Cassini-Huygens mission spotted what appears to be small, bright islands in the seas. These seem to be ephemeral; lasting from a few hours to several weeks
- Researchers have been trying to work out what these are, or whether they are illusions



Summary of the fate of simple and complex organics on Titan's surface
Credit: Geophysical Research Letters (2024). DOI: 10.1029/2023GL106156

Honeycomb Islands on Titan (2)

- Now a leading planetary scientist, Xinting Yu, at the University of Texas, thinks she may have solved the mystery
- Looking at the relationship between the atmosphere, the seas and the solid materials deposited on the surface, Yu wondered if the organic molecules in the atmosphere could clump together, freeze and fall onto the surface
- If the clumps fell onto the seas, would they simply dissolve? As the seas are already saturated with hydrocarbons it seems unlikely, but they should simply sink as both methane and ethane have a low surface tension
- But if the clumps were porous, like Swiss cheese, they could float, if only for a short period. The clumps on their own may be too small to float but if they accumulated on the shore, bigger bits might break off and float off into the seas, just like glaciers calving on Earth

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Astronomy News in Brief (1)

- Heavy elements created by first stars – the huge first stars (Population III) were created at a time when the only elements in the primordial universe were hydrogen and helium (with a tiny amount of the next lightest element, lithium). Their massive size caused them to burn hydrogen at much higher temperatures and much faster than the Sun. They lived fast and died violently, as supernovae or black holes. Elements up to the size of iron are the byproducts of the nuclear reactions before the star's life ends. A resulting supernova explosion can create heavier elements, up to the largest naturally-occurring element, uranium-238, (which consists of 92 protons and 146 neutrons and is stable). Although heavier elements have been created in the laboratory, they are highly unstable, radioactive and readily decompose to lighter elements. Now scientists, studying stars in the Milky Way, where their elemental composition is well-known, have been surprised by the abundance of some of the heavier elements, such as silver and rhodium, which doesn't agree with the predictions of the nucleosynthesis process. The data suggests that these elements are the decay remnants from much heavier nuclei of more than 260 atomic mass units. These could only have come from the first stars

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Astronomy News in Brief (2)

- Oldest spiral galaxy has ripples – the oldest known spiral galaxy, BRI 1335-0417, is over 12 billion years old. Now observations using ALMA; have revealed ripples in its disk caused by vertically oscillating movement. These may well indicate how the galaxy is growing; probably through interactions with other galaxies. ALMA also discovered that the galaxy has a central bar which may be channelling material into the arms, helping fuel the rapid star formation seen. Whether a central bar is a permanent feature in spiral galaxies, (only a quarter of all spiral galaxies have them), is yet unknown
- Early galaxies shaped like breadsticks – researchers studying data from JWST, have found that most galaxies in the early universe were shaped like breadsticks, baguettes, or bananas; long and thin, not round like balls. Up to 80% of the galaxies were flat and only a minority (usually the small and least frequently-encountered) were spherical. The speculation is that these thin galaxies are caught in long filaments of dark matter on the cosmic web. Watch the short video at: https://vimeo.com/889559068

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Astronomy News in Brief (3)

- Huge radio wave circles – back in 2019, the newly completed Australian Square Kilometre Array Pathfinder (ASKAP) observed something pretty unusual: radio wave circles so large they encompass whole galaxies, with some over a hundred kiloparsecs in diameter; they have been termed Odd Radio Circles (ORCs). Now scientists think they know what they are: shells of galactic winds possibly caused by supernovae in starburst galaxies. Galaxy mergers squeeze their gas into a very small space causing a rapid rate of new star formation, especially massive stars. These explode, causing the remaining surrounding gas to be expelled at very high speeds. The resulting shockwave propels the high-temperature gas out of the galaxy, whilst a reverse shockwave sends cooler gas back into the centre of the galaxy

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Astronomy News in Brief (4)

- Wide binaries support MOND – a new study of the orbital motions of widely-separated but gravitationally-bound binary stars, known as “wide binaries” supports earlier evidence for modified gravity. Where the separation between the two stars is quite small and with a sufficiently high acceleration, Newtonian or Einstein standard gravity works. But, when the separation distance becomes greater than 2,000AU and the acceleration is less than 1 nanometre per second squared, the Newtonian prediction begins to deviate, and the observed gravitational anomaly is remarkably well consistent with the MOND-type (Milgromian) gravity phenomenology

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Astronomy News in Brief (5)

- Exoplanets with little carbon dioxide may have water – trying to determine whether a distant exoplanet is possibly habitable is a difficult task. Although it is relatively easy to estimate if an exoplanet is a rocky world or gas giant, or if it lies in the habitable “Goldilocks” zone, analysing the atmosphere is much harder. But an absence of carbon dioxide may be the clue that telescopes, such as JWST, may be able to detect. If so, it may point to an Earth-like planet, rather than something akin to Venus
- Free-Floating Planets in our Solar System – it is now estimated that billions, if not trillions, of Mars-sized free-floating planets (FFPs)—also known as rogue planets, starless planets, and wandering planets, could be somewhere in the Milky Way. Could some of these have been captured by the Sun’s gravity and now be orbiting out in the Kuiper Belt, between 30 and 1,000AU? Recent studies, together with computer modelling, indicate that there could be one or more, probably further out at around 1,400AU. But how to spot them still remains the problem

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Astronomy News in Brief (6)

- Streaky Venus - The atmosphere of Venus is a hostile place. It is dominated by clouds of sulphuric acid, with water, chlorine and iron too. Their concentrations vary with height, but this doesn't explain why Venus appears patchy and streaky in UV light. Now, scientists at the University of Cambridge, have synthesised iron-bearing sulphate minerals, which would remain stable even in Venus's harsh conditions. Two candidates: acid ferric sulphate and rhomboclase, when combined, mimic what is seen in the Venusian clouds
- Returned Asteroid Sample – in September 2023, the cannister containing a small sample recovered from the asteroid Bennu, by the Osiris REx spacecraft, safely parachuted down to the desert in Utah. Since then, scientists at the Johnson Space Center in Houston have struggled to get the container opened; two of the 35 bolts that sealed the sample, keeping it safe from contamination, became jammed. Now, having made special tools out of non-magnetic surgical stainless steel, the scientists have manged to prise the cover off. The analysis of the sample can begin

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February 2024

Spaceflight News

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Bang on Target – Just Upside-Down (1)

- Moon Sniper Probe – Japan's unmanned Smart Lander for Investigating Moon (SLIM) spacecraft, touched down on the lunar surface on January 19th
- Japan became the fifth country to successfully land on the Moon
- Nicknamed "Moon Sniper" for its ability to land with precision. Aiming for an area no bigger than 100m, the probe came down only 55m from its target. Most previous probes have had a target landing area of 10km
- Prior to landing, SLIM released a pair of small autonomous probes to help record images, LEV1 and LEV2

This image provided by the Japan Aerospace Exploration Agency (JAXA)/Takara Tomy/Sony Group Corporation/Doshisha University shows an image taken by a Lunar Excursion Vehicle 2 (LEV-2) of a robotic moon rover called Smart Lander for Investigating Moon, or SLIM, on the moon
Credit: JAXA/Takara Tomy/Sony Group Corporation/Doshisha University via AP

Bang on Target – Just Upside-Down (2)

- However, serious issues were quickly reported when it appeared that the solar panels were not generating any power
- Telemetry data suggested the spacecraft was facing the wrong direction (west). Then, LEV2 (Lunar Excursion Vehicle 2), one of the two autonomous probes, sent back a dramatic image of SLIM upside down. Luckily, LEV2 was able to transmit images back to Earth using LEV1's antenna. Transmitting this way is a world's first
- One of the main engines lost thrust about 50m above the surface during the descent causing a hard landing on a crater slope and flipping the spacecraft over
- Engineers shut SLIM down with 12% of the battery life left in anticipation that the solar panels would be recharged when the Sun was at the right angle in the sky. Nine days after the landing, JAXA managed to re-establish contact with SLIM, showing that the charging has worked. SLIM won't survive a lunar night though
- In the meantime, both LEV1 (a hopping robot with an antenna and camera) and LEV2 (a baseball-sized rover with two cameras) have taken over 275 images

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New Vulcan rocket successful launch (1)

- United Launch Alliance (ULA) successfully launched the first of its new generation of rockets, the Vulcan Centaur, on Monday 8th January
- The 62m high Vulcan Centaur rocket replaces both the Atlas V and Delta IV.
- It has two stages: the first stage (Vulcan) is powered by two Blue Origin BE-4 engines, with up to six strap-on solid boosters; for this launch 2 Northrop Grumman (Graphite Epoxy Motor) GEM 63XL boosters were used. The upper (second) stage is the well-established Centaur rocket, which has been used successfully for a couple of decades. It uses two Aerojet Rocketdyne RL10C motors which have powered nearly 400 launches

Top image credit: Josh Dinner Bottom image credit: Chandan Khanna/AFP via Getty Images

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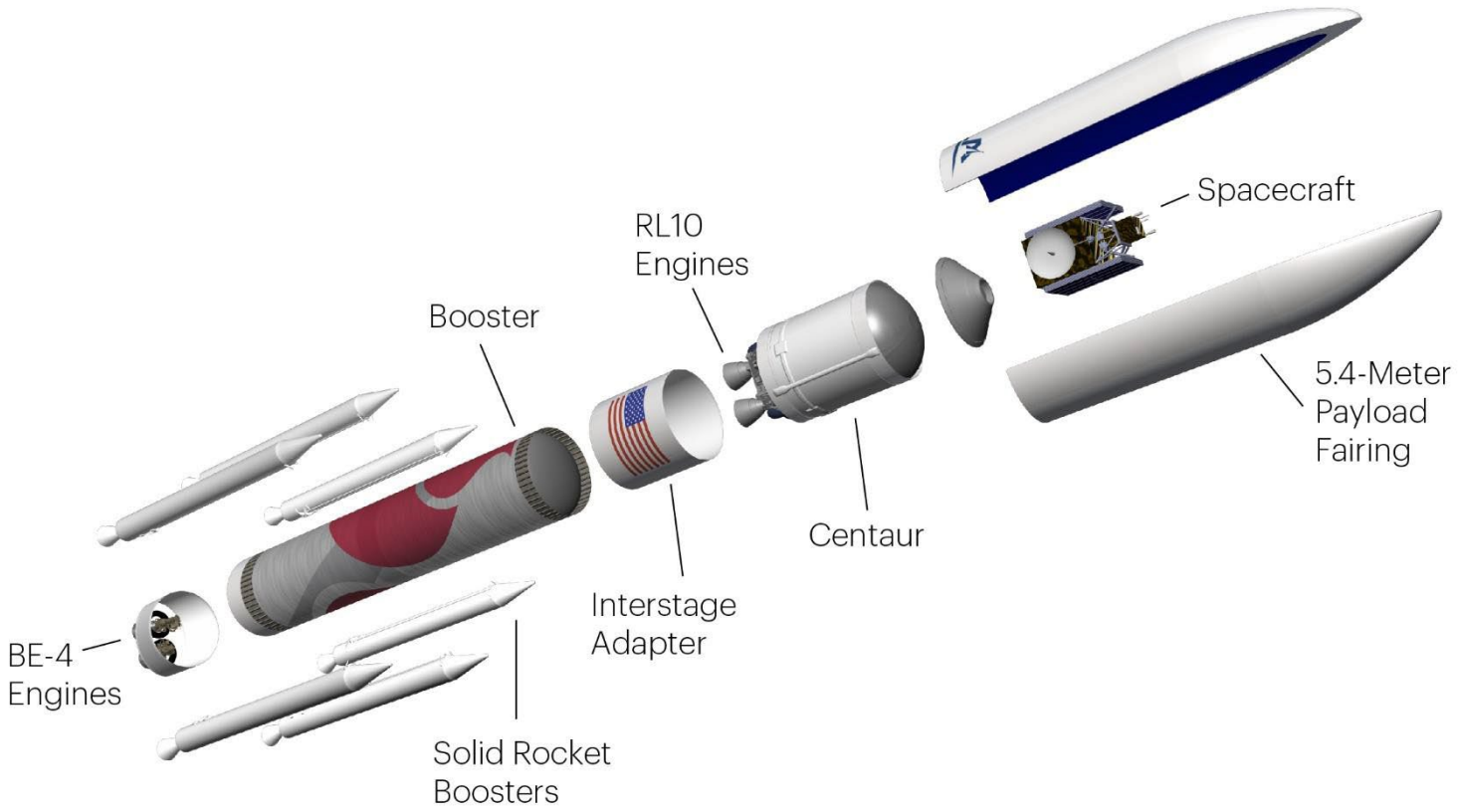
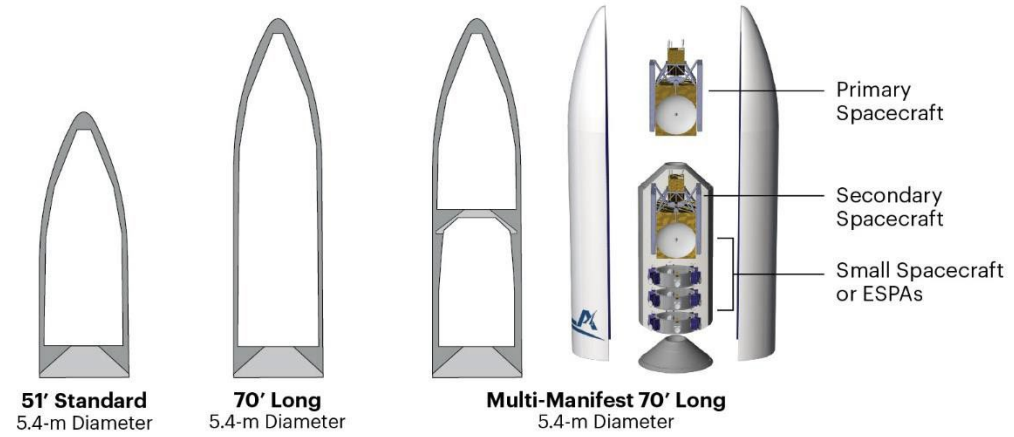
New Vulcan rocket successful launch (2)





Images courtesy of United Launch Alliance

- There are 6 launches planned for 2024

Nominal Thrust (lbs / kN)

- Vulcan Main Engine
  550,000 lbs / 2,446.3 kN
- Solid Rocket Boosters
  459,600 lbs / 2,204.2 kN
- Upper Stage
  24,000 lbs / 115.0 kN

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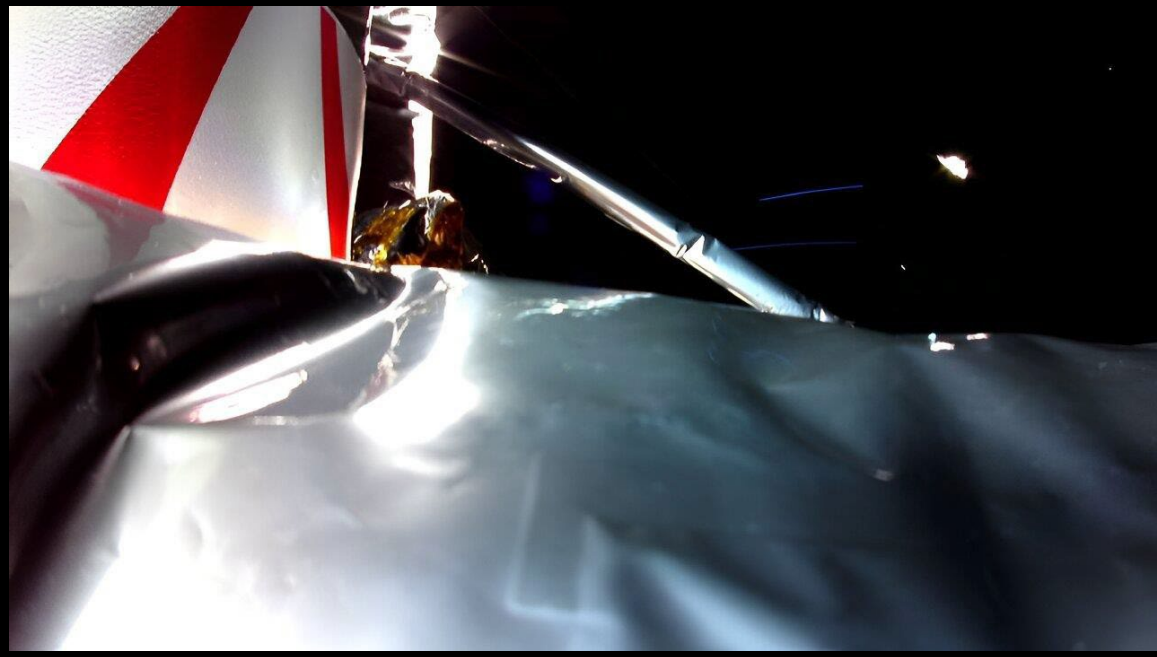
Peregrine Lunar Lander Unsuccessful (1)

- The Vulcan Centaur launch was to be only part of an historic day in US Spaceflight
- The payload for the launch was Astrobotic's new Peregrine Lunar Lander, which was planned to land on the Moon on 23rd February, a first for a private company, and the first US Moon landing in nearly 50 years
- Unfortunately, things started to go wrong shortly after separating from the Centaur Upper Stage
- Astrobotic reported that they were having difficulties getting the solar panels aligned and were using battery power, which would only last a couple of days



The first photo snapped by Astrobotic's Peregrine moon lander in space showing the damage to the insulation
Credit: Astrobotic via X

Peregrine Lunar Lander Unsuccessful (2)

- Later, it was announced that a faulty valve had caused a propellent leak. This was causing the lander to tumble and prevented it aligning the solar panels
- With a major leak, the mission to land on the Moon had to be aborted. However, the spacecraft was able to continue on its flight and, by Sunday 14th January was 389,000km (242,000 miles) from Earth. The trajectory took the spacecraft back to Earth where it burnt up during a controlled re-entry over the South Pacific, about 400 miles south of Fiji, on 18th January
- The lander had been carrying scientific equipment and other items for both NASA and other private organisations. Astrobotic powered up all the payloads, and 4 of the 5 NASA payloads were able to complete their intended missions
- One controversial item that didn't make it to the Moon was a capsule containing human remains (including some of the original Star Trek actors). The proposal to leave the remains on the Moon upset members of the Navajo Nation, for whom the Moon is sacred and who regarded it as a "profound desecration"

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There are no Motorway Services in Space!

- Bland, pre-packaged meals are OK for a couple of days, or even the two-week round trip to the Moon, but what about a year-long flight to Mars?
- Dieticians and nutritionists have devised a more fulfilling meal: a tasty vegetarian salad
- Based on what could be grown on the voyage, and balanced by the needs to use not too much water or fertiliser in the process, researchers devised a meal based on soybeans, poppy seeds, barley, kale, peanuts, sweet potato, and/or sunflower seeds
- This would provide most of the minerals and micronutrients in order for the astronauts to stay healthy
- And, of course, on Mars, you can always grow potatoes (see: 'The Martian' film)

This salad made up of soybeans, poppy seeds, barley, kale, peanuts, sweet potato, and sunflower seeds could be the optimal meal for men on long-term space missions
Credit: ACS Food Science & Technology (2023)

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International Collaborators Study X-Rays

- On 9th January, the Einstein Probe lifted off from the Xichang Satellite Launch Center in China on top of a Long March 2C rocket. It has been placed in an orbit 600km above the Earth
- The Einstein Probe is a collaboration between the Chinese Academy of Sciences (CAS), the European Space Agency (ESA) and the Max Planck Institute for Extraterrestrial Physics (MPE)
- The Probe will survey the entire sky looking for new X-ray sources using two specific instruments: the Wide-field X-ray Telescope (WXT) and the Follow-up X-ray Telescope (FXT)
- The eye of WXT has hundreds of thousands of fibre optics allowing it to survey one-tenth of the sky in one view, the FXT has a narrower, more sensitive focus

The Einstein Probe Credit: ESA

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Venting Oxygen caused Starship Explosion (1)

- Elon Musk has announced that the second flight of the Starship prototype on 18th November could have reached orbit if it had been carrying a payload (although it was never intended to)
- The flight lasted 8 minutes and included stage separation. The Super Heavy Booster (first stage) shut down and separated smoothly but about half a minute later exploded, (it was due to jettison in the Gulf of Mexico and not be recovered)
- The second stage (Starship) was apparently performing within the tolerance limits, but then exploded just over 8 minutes into the flight at a height of 148km and a speed in excess of 20,000kmph

Stage separation Credit: SpaceX

Venting Oxygen caused Starship Explosion (2)

- The explosion was caused by liquid oxygen, the excess of which was being vented off. If a payload had been carried the liquid oxygen would have been used to fuel the engines
- Elon Musk is cautiously optimistic that the third flight will reach orbit, given the smoother performance of the last prototype
- Currently, all flights of the Starship are grounded until the FAA has completed their investigation and given the all-clear
- SpaceX are hoping the test flights will be completed in the coming months, and the production version will be able to launch the next generation of Starlink satellites by the end of the year
- Although the current prototype Starship is the largest rocket ever to be launched, at 122m high, version 2 could be over 140m and a version 3 is planned to be nearly 150m tall
- Relive the launch at: https://cdn.jwplayer.com/previews/zPUic9NL

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Ingenuity Makes its Last Flight

- Ingenuity, the pioneering ultralight Martian helicopter, has taken its last flight
- During its 72nd flight on 18th January, communication was temporarily lost. It is believed Ingenuity made a hard landing, damaging one of its four rotor blades
- Expected only to be able to make a maximum of five flights, Ingenuity kept on going and going. During its time on Mars, it has covered over 17.7km of ground, flown upwards of 24m in altitude, and spent over 2 hours aloft
- Only 1.8kg in weight, everything about Ingenuity was ground-breaking. NASA is already developing larger models for future missions

The shadow of a damaged rotor on NASA's Mars helicopter Ingenuity, was taken after its 72nd flight
Credit: NASA/JPL-Caltech

See the video at:

https://cdn.jwplayer.com/previews/fEfcFq6w

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Spaceflight News and Updates (1)

- OSIRIS-REex morphs into OSIRIS-APEX – now that the OSIRIS-REx spacecraft has completed its primary mission to the asteroid Bennu, it has been targeted at another asteroid, Apophis. Apophis will make a near-Earth fly-by in April 2029 and the spacecraft will be there to study it. Unlike Bennu, which is a carbon-rich "C-type" asteroid, Apophis is an "S-type", with lots of silicates and nickel and iron. Apophis will come to within 30,000km of the Earth, and given its size (340m) it may be visible in some parts of the world
- Aditya-L1 – the Indian solar probe has entered its halo orbit around the Sun, four months after being launched. Based at L_1, it will observe coronal mass ejections and study particles in the Sun's upper atmosphere
- US and Russia cooperation – in spite of the on-going fallout of Russia's invasion of Ukraine, both NASA and Roscosmos (Russia's space agency) have agreed to keep on working together to take crews to the ISS and to maintain it until at least 2025. At least one Russian cosmonaut and one American astronaut will always be present on the ISS at the same time

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Spaceflight News and Updates (2)

- Third time lucky – Japan have announced that they will try and launch their new H3 rocket on 15th February. The previous two launches ended in failure: the first when the solid boosters failed to ignite and the second when multiple failures forced a self-destruction
- Pin-hole thruster getting ready for space – if you are manoeuvring a small satellite in space, you don't need a large engine; a very gentle push is all that is required. ESA have commissioned IENAI Spain to produce a palm-sized thruster which could be just the answer. Called "Athena" (Adaptable, THruster based on Electrospray powered NAnotechnology), it has 7 arrays each with 500 pin-hole emitters which spray out a conductive salt (using a non-toxic liquid) via an electrostatic field up to 20km/sec. 6 thrusters could be fitted on the face of a 10cm cube satellite. With the design work complete a prototype should be available by the end of 2024. In the future the technology could be developed to orientate satellites up to 300kg

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Spaceflight News and Updates (3)

- SpaceX – the first launch of 2024 took place on Tuesday 2nd January when a Falcon 9 rocket, with 21 LEO Starlink satellites took off from the Vandenberg Space Force Base in California. 6 of the satellites feature “direct-to-cell” communications to eliminate dead zones, (the first one sent a message 6 days after launch). The second launch of the year was carried out on Wednesday 3rd from Cape Canaveral Space Launch Complex 40 with a Falcon 9 carrying a Swedish telecom satellite for Ovzon, which is headed for a geostationary orbit. SpaceX hopes to be able to launch 2 rockets a week from Complex 40 this year. See the launch that took place on 7th January at: https://cdn.jwplayer.com/previews/Nn9Utsx9

  Meanwhile, the record-breaking Falcon 9 booster, which had made 19 flights, was severely damaged after being recovered on 23rd December. The booster landed successfully back on board the ocean-going platform, but then was hit by high winds and rough seas, toppling the rocket and splitting it in two. The top half was lost overboard but engineers hope to be able to reuse the Merlin engines

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Spaceflight News and Updates (4)

- Artemis III delayed again – NASA has announced that Artemis III, the manned lunar lander flight, has been delayed again and is now not scheduled to take place until September 2026. Part of the problem is supply chain issues, especially with the SpaceX Starship programme, which is tied into the landing systems
- Self-eating rocket – no, this isn't an early April Fool's joke! Engineers at the University of Glasgow have developed and tested a prototype self-eating rocket. The autophage rocket engine consumes the polyethylene plastic parts of the fuselage as fuel. This would reduce the need for propellent by a fifth, allowing a larger payload to be carried and would also decrease the amount of space debris. The team have test fired the Ouroborous-3 autophage engine, producing 100 newtons of thrust in a series of controlled experiments, showing it could be throttled, restarted, and pulsed on and off. It produces a stable burn using a mixture of gaseous oxygen and liquid propane. See the video of the test at: https://youtu.be/GL9wODPvtDU

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February 2024

Observational Highlights

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February 2024 dates

- 2nd February – Mercury at aphelion @ 0.47AU (17:01) – not visible, too low
- 8th February – Mars is 4°12’ north of the Moon (06:31) – not visible, too low
- 8th February – Mercury in conjunction with the Moon - 3°12’ (22:00) – not visible
- 11th February – Saturn in conjunction with the Moon - 1°48’ (00:40) – not visible
- 14th February – Comet C/2021 S3 (PANSTARRS) passes perihelion (1.32AU); not visible until 23rd February in Serpens Cauda (23° above SE horizon – 05:38)
- 12th February – Lunar occultation of Neptune (07:16) – Southern Hemisphere only
- 15th February – Jupiter in conjunction with the Moon - 3°09’ (08:16); visible from 17:36, 51° above southern horizon, setting @ 23:58
- 16th February – Uranus is 3° south of the Moon (02:00)
- 28th February – Mercury at superior conjunction (08:52) – not visible

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South Downs Dark Skies Festival 2024

- Brighton i360 Dark Skies Stargazing Pod Journey
  10th February @ 18:00 (–18:45)
  Talk by Dan Oakley – “Dark skies, infinity and beyond”
- Star Party on Brighton Seafront
  10th February @ 17:30 (– 20:00)
- Stargazing at Findon Place
  10th February @ 19:00 (– 21:00)
- Dark Skies Walk – Midhurst
  10th February @ 19:00 (– 21:00)
- Dark Skies Walk – Bignor
  16th February @ 19:00 – 21:00
- See: https://www.southdowns.gov.uk/dark-night-skies/dark-skies-festival/

Credit: Pablo Rodriguez/South Downs National Park

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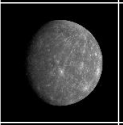
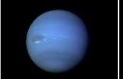
Planets (information for 1st February)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	06:54	14:59	10:57			-0.51	NO
	VENUS	05:57	14:03	10:00	South-East	8° ▫	-3.89	YES
	MARS	06:43	14:45	10:44			+1.31	NO
	JUPITER	10:25	00:43	17:34	South	52° ◊	-2.31	YES
	SATURN	08:39	18:59	13:49			+0.97	NO
	URANUS	10:47	01:53	18:20	South	56° **	+5.74	YES
	NEPTUNE	09:11	20:49	15:00	South-West	22° **	+7.94	YES

* = Highest point at Dawn (06:13 - last visible sighting)

** = Highest point at Dusk (18:12 - first visible sighting)

▫ = Highest point when last visible (07:13)

◊ = Highest point when first visible (17:12)

▫▫ = Highest point when last visible

◊◊ = Highest point when first visible

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
Cr50	The Hyades	Taurus	Open Cluster	17:39	01:43	19:41 ◊◊	South	55°	+1.0
Mel20	The Alpha Persei Cluster	Perseus	Open Cluster	18:12	06:13	19:57	South	87°	+1.2
Cr39	Collinder 39	Perseus	Open Cluster	18:12	06:13	19:59	South	88°	+1.2
M45	The Pleiades	Taurus	Cluster with Nebulosity	17:44	01:37	18:58 ◊◊	South	63°	+1.3
Cr256	Collinder 256	Coma Berenices	Open Cluster	20:59	06:36	03:42 ◊	South	65°	+1.8
NGC1980	Open Cluster	Orion	Cluster with Nebulosity	17:59	00:39	20:49 ◊◊	South	33°	+2.5
NGC1980	Open Cluster	Orion	Open Cluster	18:22	02:01	22:12	South	33°	+2.5
C33	The Eastern Veil Nebula	Cygnus	Nebula	02:48	06:13	06:13 *	East	24°	+2.7
Cr359	Collinder 359	Ophiuchus	Open Cluster	02:29	06:20	06:20 ◊	South-East	29°	+3.0
Mel186	Melotte 186	Ophiuchus	Open Cluster	02:58	06:20	06:20 ◊	South-East	29°	+3.0
Cr65	Collinder 65	Orion	Open Cluster	18:05	02:14	20:39 ◊◊	South	54°	+3.0
M44	Beehive Cluster	Cancer	Open Cluster	18:06	05:47	23:54 ◊◊	South	58°	+3.1
M31	Andromeda Galaxy	Andromeda	Galaxy	18:11	23:48	18:11 **	West	65°	+3.4
IC1396	The Elephant Trunk	Cepheus	Cluster with Nebulosity	18:12	06:13	18:12 **	North-West	45°	+3.5
Cr399	Brocchi's Cluster	Vulpecula	Open Cluster	02:49	06:13	06:13 *	East	29°	+3.6

* = Highest point at Dawn (06:13 - last visible sighting)
** = Highest point at Dusk (18:12 - 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 February)

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M42	Orion Nebula	Orion	Cluster with Nebulosity	18:12	00:20	20:49	South	33°	+4.0
NGC2264	The Christmas Tree Cluster	Monoceros	Cluster with Nebulosity	18:12	02:48	21:55	South	49°	+4.1
Cr62	Collinder 62	Auriga	Open Cluster	18:12	04:12	20:36	South	80°	+4.2
Cr464	Collinder 464	Camelopardalis	Open Cluster	18:12	06:13	19:06	North	78°	+4.2
NGC2232	Open Cluster	Monoceros	Open Cluster	18:12	01:13	21:42	South	34°	+4.2
IC4665	Open Cluster	Ophiuchus	Open Cluster	02:31	06:13	06:13 *	South-East	32°	+4.2
NGC1981	Open Cluster	Orion	Open Cluster	18:12	00:23	20:49	South	34°	+4.2
NGC1977	Running Man Nebula	Orion	Open Cluster	18:12	02:39	20:49	South	53°	+4.2
C14	The Perseus Double Cluster	Perseus	Open Cluster	18:12	06:13	18:12 **	North-West	81°	+4.3
M47	Open Cluster	Puppis	Open Cluster	20:40	01:00	22:50	South	24°	+4.4
M39	Open Cluster	Cygnus	Open Cluster	18:12	21:14	18:12 **	North-West	40°	+4.6
Cr106	Collinder 106	Monoceros	Open Cluster	18:12	02:18	21:51	South	45°	+4.6
NGC6633	Open Cluster	Ophiuchus	Open Cluster	03:07	06:13	06:13 *	South-East	28°	+4.6
IC4756	Graff's Cluster	Serpens Cauda	Open Cluster	03:24	06:13	06:13 *	South-East	25°	+4.6
NGC2244	Open Cluster	Monoceros	Open Cluster	18:12	02:04	21:46	South	44°	+4.8

* = Highest point at Dawn (06:13 - last visible sighting) ** = Highest point at Dusk (18:12 - 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 February)

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC1499	The California Nebula	Perseus	Bright Nebula	18:12	02:11	19:17	South	75°	+5.0
M35	Open Cluster	Gemini	Open Cluster	18:12	03:13	21:23	South	63°	+5.1
Cr107	Collinder 107	Monoceros	Open Cluster	18:12	02:05	21:51	South	43°	+5.1
NGC6871	Open Cluster	Cygnus	Open Cluster	01:03	06:13	06:13 *	East	34°	+5.2
M34	The Spiral Cluster	Perseus	Open Cluster	18:12	01:26	18:12 **	South	81°	+5.2
NGC869	h Per Cluster	Perseus	Open Cluster	18:12	06:13	18:12 **	North-West	81°	+5.3
NGC2281	Open Cluster	Auriga	Open Cluster	18:12	05:18	22:02	South	80°	+5.4
Cr97	Collinder 97	Monoceros	Open Cluster	18:12	02:01	21:45	South	45°	+5.4
NGC7686	Open Cluster	Andromeda	Open Cluster	18:12	22:57	18:12 **	West	57°	+5.6
M37	The Auriga Salt-and-Pepper	Auriga	Open Cluster	18:12	03:30	21:06	South	71°	+5.6
NGC752	Open Cluster	Andromeda	Open Cluster	18:12	04:19	18:12 **	South-West	73°	+5.7
Cr89	Collinder 89	Gemini	Open Cluster	18:12	03:10	21:32	South	62°	+5.7
M5	Globular Cluster	Serpens Caput	Globular Cluster	00:21	06:13	06:13 *	South	41°	+5.7
M13	Great Globular Cluster	Hercules	Globular Cluster	21:26	06:13	06:13 *	South-East	66°	+5.8
M48	Open Cluster	Hydra	Open Cluster	20:28	02:26	23:27	South	33°	+5.8

* = Highest point at Dawn (06:13 - last visible sighting) ** = Highest point at Dusk (18:12 - 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 - 4 (Information for 1st February)

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M33	Triangulum Galaxy	Triangulum	Galaxy	18:12	02:01	18:12 **	South-West	64°	+5.8
M50	The Heart-Shaped Cluster	Monoceros	Open Cluster	19:39	00:53	22:16	South	30°	+5.9
NGC2169	The "37" Cluster	Orion	Open Cluster	18:12	02:12	21:22	South	54°	+5.9
IC405	The Flaming Star Nebula	Auriga	Nebula	18:12	02:58	20:30	South	73°	+6.0
M36	The Pinwheel Cluster	Auriga	Open Cluster	18:12	03:17	20:50	South	73°	+6.0
NGC7000	The North American Nebula	Cygnus	HII Region	18:12	19:43	18:12 **	North-West	33°	+6.0
NGC2301	Open Cluster	Monoceros	Open Cluster	18:28	01:43	22:05	South	39°	+6.0
NGC7160	Open Cluster	Cepheus	Open Cluster	18:12	06:13	18:12 **	North-West	49°	+6.1
M12	Globular Cluster	Ophiuchus	Globular Cluster	02:09	06:13	06:13 *	South-East	32°	+6.1
NGC884	chi Per Cluster	Perseus	Open Cluster	18:12	06:13	18:12 **	North-West	81°	+6.1
M46	Open Cluster	Puppis	Open Cluster	21:34	00:16	22:55	South	24°	+6.1
NGC1746	Open Cluster	Taurus	Open Cluster	18:12	01:53	20:18	South	62°	+6.1
NGC1545	Open Cluster	Perseus	Open Cluster	18:12	06:13	19:35	South	89°	+6.2
M3	Globular Cluster	Canes Venatici	Globular Cluster	23:01	06:13	04:59	South	67°	+6.3
NGC6940	Open Cluster	Vulpecula	Open Cluster	02:59	06:13	06:13 *	East	24°	+6.3

* = Highest point at Dawn (06:13 - last visible sighting) ** = Highest point at Dusk (18:12 - 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 February)

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M38	The Starfish Cluster	Auriga	Open Cluster	18:12	03:18	20:43	South	75°	+6.4
NGC457	The Dragonfly Cluster	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North-West	74°	+6.4
NGC7243	Open Cluster	Lacerta	Open Cluster	18:12	21:40	18:12 **	North-West	46°	+6.4
NGC1662	Open Cluster	Orion	Open Cluster	18:12	00:36	20:02	South	50°	+6.4
NGC1528	Open Cluster	Perseus	Open Cluster	18:12	06:13	19:29	North	89°	+6.4
NGC1647	Open Cluster	Taurus	Open Cluster	18:12	01:13	20:00	South	58°	+6.4
IC1805	The Heart Nebula	Cassiopeia	Cluster with Nebulosity	18:12	06:13	18:12 **	North	80°	+6.5
IC1848	The Soul Nebula	Cassiopeia	Cluster with Nebulosity	18:12	06:13	18:12 **	North	80°	+6.5
NGC129	Open Cluster	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North-West	67°	+6.5
NGC654	Open Cluster	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North-West	75°	+6.5
M92	Globular Cluster	Hercules	Globular Cluster	01:14	06:13	06:13 *	South-East	65°	+6.5
NGC2539	Open Cluster	Puppis	Open Cluster	21:34	01:14	23:24	South	26°	+6.5
M29	The Cooling Tower	Cygnus	Open Cluster	23:58	06:13	06:13 *	East	33°	+6.6
M10	Globular Cluster	Ophiuchus	Globular Cluster	02:30	06:13	06:13 *	South-East	29°	+6.6
NGC1444	Open Cluster	Perseus	Open Cluster	18:12	06:13	19:04	North	88°	+6.6

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC6709	Open Cluster	Aquila	Open Cluster	03:11	06:13	06:13 *	East	27°	+6.7
NGC1027	Open Cluster	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North	79°	+6.7
NGC7789	The Caroline's Rose	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North-West	63°	+6.7
NGC2129	Open Cluster	Gemini	Open Cluster	18:12	02:48	21:15	South	62°	+6.7
NGC2343	Open Cluster	Monoceros	Open Cluster	20:07	00:36	22:22	South	28°	+6.7
NGC1342	Open Cluster	Perseus	Open Cluster	18:12	06:13	18:46	South	76°	+6.7
NGC2423	Open Cluster	Puppis	Open Cluster	21:15	00:26	22:51	South	25°	+6.7
NGC7023	The Iris Nebula	Cepheus	Nebula	18:12	06:13	18:12 **	North-West	46°	+6.8
NGC6811	The Hole in a Cluster	Cygnus	Open Cluster	03:11	06:13	06:13 *	East	45°	+6.8
NGC2175	Open Cluster	Orion	Cluster with Nebulosity	18:12	02:43	21:23	South	59°	+6.8
NGC1502	Open Cluster	Camelopardalis	Open Cluster	18:12	06:13	19:22	North	78°	+6.9
M67	Open Cluster	Cancer	Open Cluster	19:30	04:47	00:09	South	50°	+6.9
M52	The Cassiopeia Salt-and-Pepper	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North-West	59°	+6.9
M81	Bode's Galaxy	Ursa Major	Galaxy	18:12	06:13	01:13	North	86°	+6.9
NGC7635	The Bubble Nebula	Cassiopeia	HII Region	18:12	06:13	18:12 **	North-West	59°	+7.0

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Lewes Astronomical Society

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC6960	The Western Veil Nebula	Cygnus	Supernova Remnant	02:49	06:13	06:13 *	East	24°	+7.0
M103	Open Cluster	Cassiopeia	Open Cluster	18:12	06:13	18:12 **	North-West	74°	+7.4
M27	Apple Core Nebula	Vulpecula	Planetary Nebula	03:07	06:13	06:13 *	East	26°	+7.4
NGC6888	The Crescent Nebula	Cygnus	HII Region	23:58	06:13	06:13 *	East	35°	+7.5
M14	Globular Cluster	Ophiuchus	Globular Cluster	03:06	06:13	06:13 *	South-East	26°	+7.6
M53	Globular Cluster	Coma Berenices	Globular Cluster	23:21	06:13	04:29	South	57°	+7.7
M107	Globular Cluster	Ophiuchus	Globular Cluster	02:51	06:13	06:13 *	South-East	22°	+7.8
M101	The Pinwheel Galaxy	Ursa Major	Galaxy	18:12	06:13	05:20	North	86°	+7.9
M78	Reflection Nebula	Orion	Reflection Nebula	18:12	00:36	21:01	South	39°	+8.0
M110	Galaxy	Andromeda	Galaxy	18:12	23:05	18:12 **	West	64°	+8.1

Twilight	Civil	Naut	Astro		Rises	Sets
Ends	17:25	18:05	18:44	Sun	07:35	16:50
Starts	07:00	06:20	05:41	Moon	23:04	09:55

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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
LAST QUARTER	2nd February	23:18	1250
NEW MOON	9th February	22:59	1251
FIRST QUARTER	16th February	15:00	1251
FULL MOON	24th February	12:30	1251

Credit: NASA

Data credit: Time and Place