Lewes Astronomical Society

Newsletter - June 2024

Astronomy News, Spaceflight News, and Observational Highlights

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June 2024

Astronomy News

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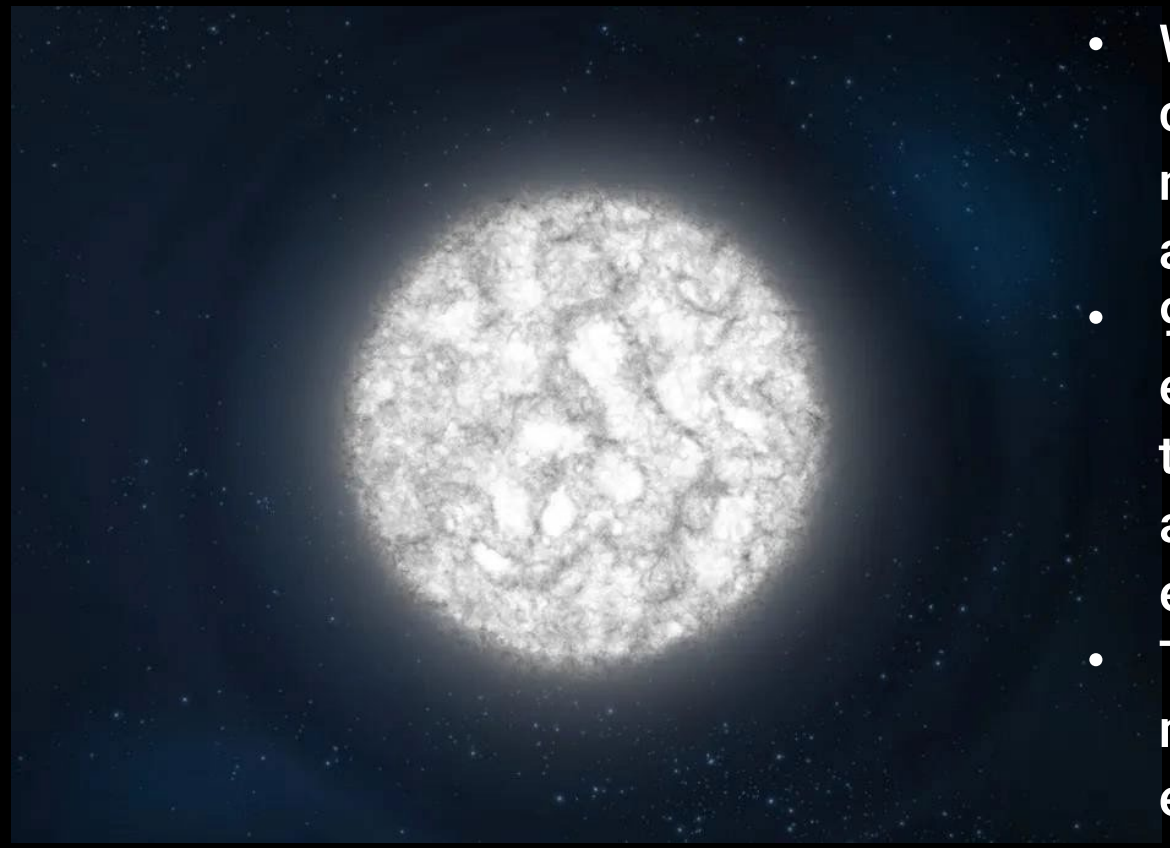
White Dwarfs and Heavy Metal (1)



White Dwarf – Artist's Impression
Credit: Sky at Night

- White Dwarfs are formed at the end of a star's life as it collapses in on itself to become a dense ball, with a mass equivalent to that of the Sun condensed down to around the size of the Earth.
- 97% of stars will eventually become WDs, making them extremely common in our own galaxy. They are known to consume various nearby objects, such as asteroids and comets (planetesimals) which hold heavy metal elements.
- The surface presence of these heavy metals, such as magnesium and calcium, has defied astrophysicists' expectations of stellar behaviour. This is because heavy metals are dense enough that they should quickly sink towards the core and should only be visible at the surface if the WD is actively eating.

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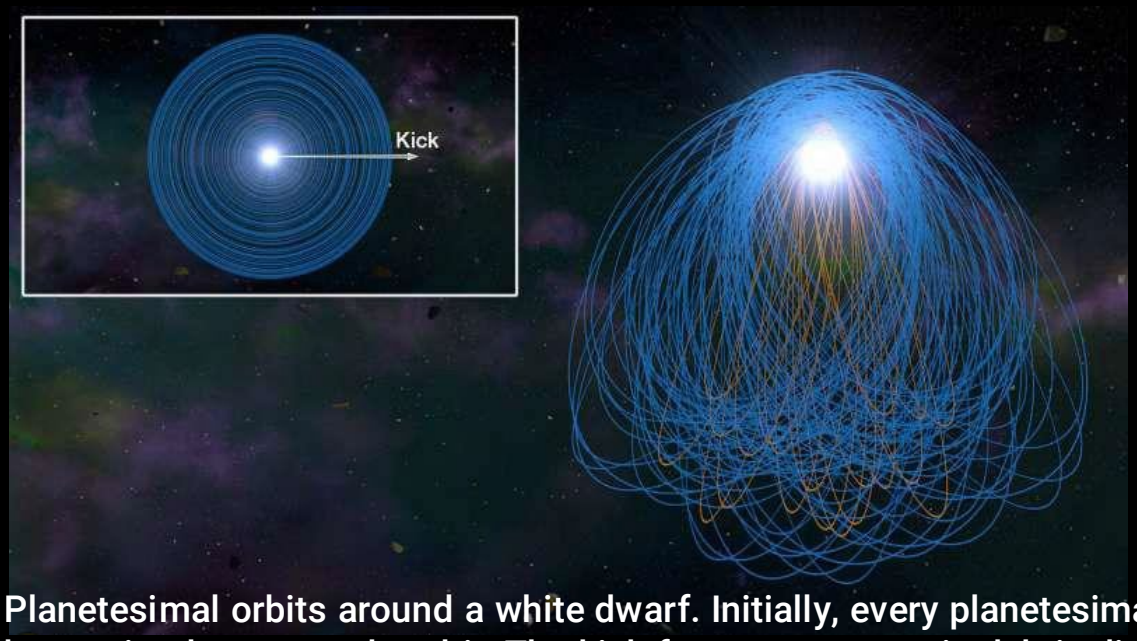
White Dwarfs and Heavy Metal (2)

- Researchers have recently paid more attention to dark spots in their knowledge of WD eating habits.
- Results from a recent computer simulation show that, during the star's transformation to WD, uneven mass loss gives the star a 'natal kick'.
- This alters the star's dynamics and creates an oval-shaped accretion disk, often with a counter-rotating orbit, causing an initial spike in the consumption of debris and a long-term rate of debris falling to the surface.



Planetesimal orbits around a white dwarf. Initially, every planetesimal has a circular, prograde orbit. The kick forms an eccentric debris disk which with prograde (blue) and retrograde orbits (orange).
Credit: Steven Burrows/Madigan Group/JILA

- The simulation found that planetesimals still had elongated orbits and moved as one coherent unit even 100 million years on from the initial kick, and that planets may also be included in the WD diet.
- These new findings help to shed light on the chemistry involved in the evolution of our solar system, explaining our past and, potentially illuminating our future.

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Citizen scientists help to discover exoplanet (1)

Artist's impression of a Binary Star System with orbiting exoplanets
Credit: NASA/JPL-Caltech/T.Pyle

- Citizen scientists are instrumental in assisting professional astronomers to detect patterns in enormous datasets, which are too large for astronomers to be able to sift through by themselves and in which computers may struggle to identify such objects as long-orbit exoplanets.
- Using data collected by NASA's Transiting Exoplanet Survey Satellite (TESS), planet hunters have now discovered a Neptune-like planet within a binary star system (a system with two stars orbiting each other).

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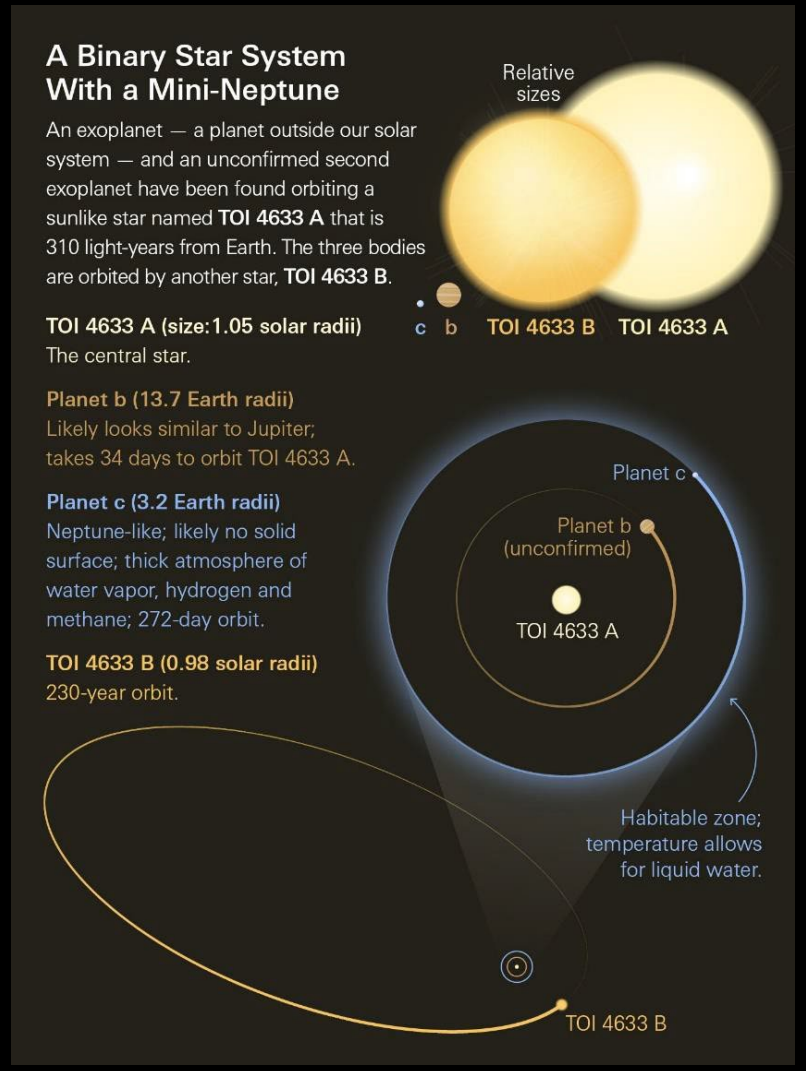
Citizen scientists help to discover exoplanet (2)

- The planet, TOI 4633c, nicknamed Percival, after a Harry Potter series character, was discovered via the “transit method” – used to identify planets with tight orbits which cause them to move more often into light-blocking positions.
- However, Percival is estimated to take 272 days to orbit its host star, meaning that it’s further out than other planets identified via this method, and is located within the “habitable” zone of its host star where liquid water may exist.



Infographic illustrating new discoveries about a multi-star, multi-planet system.
Credit: Lucy Reading-Ikkanda/Simons Foundation

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Citizen scientists help to discover exoplanet (3)

- TOI 4633c likely has an atmosphere thick with water vapor, hydrogen and methane and would not be habitable itself. However, if it were to have a moon with a solid surface, that moon may hold water and may even offer the right conditions for life to take hold.
- It will be at least 30 years before the system's two stars are far enough apart for scientists to determine whether the planets orbit the same star, or if they are split between them. Scientists hope that further research will aid our understanding of stability within binary star/planet systems.
- For more information on how you can become a citizen scientist and help to discover new planets in far-away solar systems, click the following link: https://www.zooniverse.org/projects/nora-dot-eisner/planet-hunters-tess/about/research

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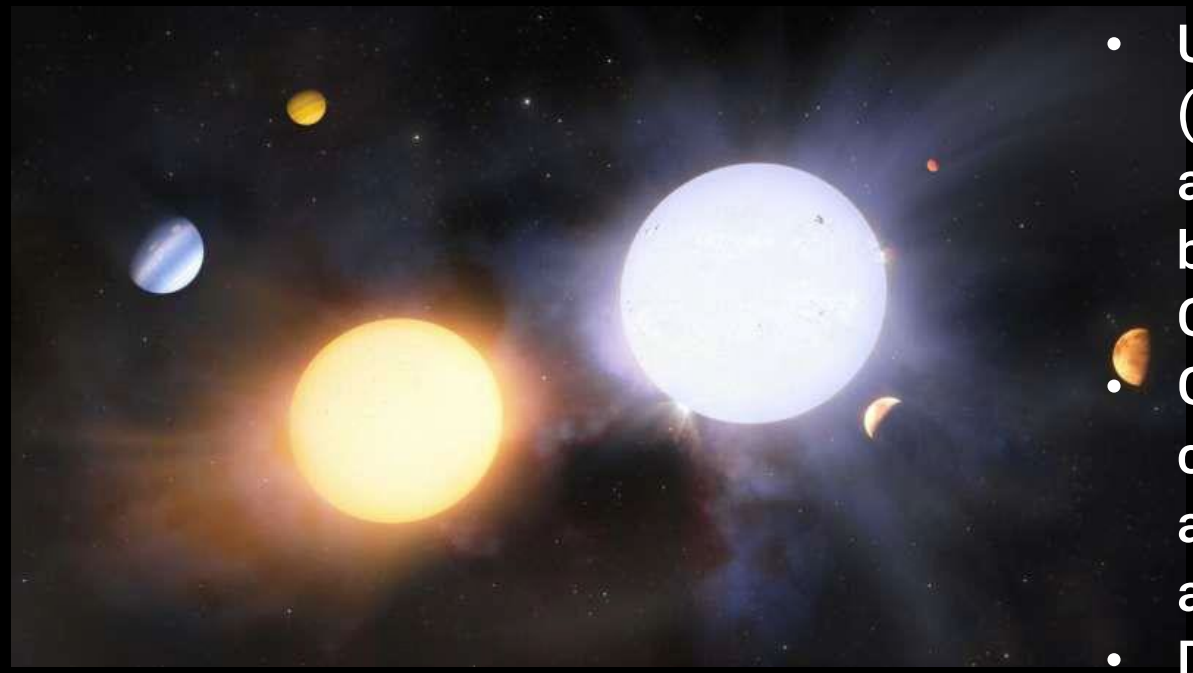
Differences in giant binary stars (1)



This artist's impression illustrates a binary pair of giant stars.
Credit: NOIRLab/NSF/AURA/J. da Silva (Spaceengine)/M. Zamani

- Using the Gemini High-Resolution Optical Spectrograph (GHOST) at the Gemini South telescope in Chile, astronomers have studied wavelengths of light from a binary star system with two giant stars: HD 138202 and CD-30 12303.
- GHOST's ability to measure stellar parameters and chemical abundance with extreme precision allowed astronomers to determine that one star has a higher abundance of heavy metals than the other.
- Dissimilarities in chemical compositions have three possible causes; they may be caused by the settling of chemical elements into gradient layers; the consumption of planetary bodies; or nonuniformity within the molecular cloud from which the stars were formed.

Differences in giant binary stars (2)

- Both stars are confirmed to have formed from the same molecular cloud, so the expectation was that they should display near identical compositions with any dissimilarities caused by influences post-formation.
- However, extremely deep and highly turbulent external layers and a continuous swirling of fluid on both stars makes it difficult for material to settle into layers, and material from planetary engulfment would be rapidly diluted due to thick external layers. This leaves the theory of nonuniformity within the molecular cloud as the cause of their chemical dissimilarity.
- This is the first time astronomers have confirmed that binary stars can evolve differently within the same cloud. The results challenge the reliability of the method of using stars' chemical compositions to determine whether they are formed in the same stellar nursery and means that previous theories of planetary impacts causing differences between other stars in binary systems need to be reviewed.

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Black Hole eating habits (1)

- Sagittarius A* (Sgr A*), lying at the centre of the Milky Way, and Quiescent, located in the centre of the Andromeda Galaxy, are both Supermassive Black Holes (SMBs).
- In comparison to other SMBs, they are two of the quietest eaters in the universe.
- We can tell how much matter SMBs are consuming by how much light is emitted by surrounding material just before it's swallowed and, when material is consumed in clumps, the brightness fluctuates.

This image of the Andromeda galaxy uses data from NASA's retired Spitzer Space Telescope. Multiple wavelengths are shown, revealing stars, dust, and areas of star formation. The red areas represent dust, showing the galaxy's underlying structure.
Credit: NASA/JPL-Caltech

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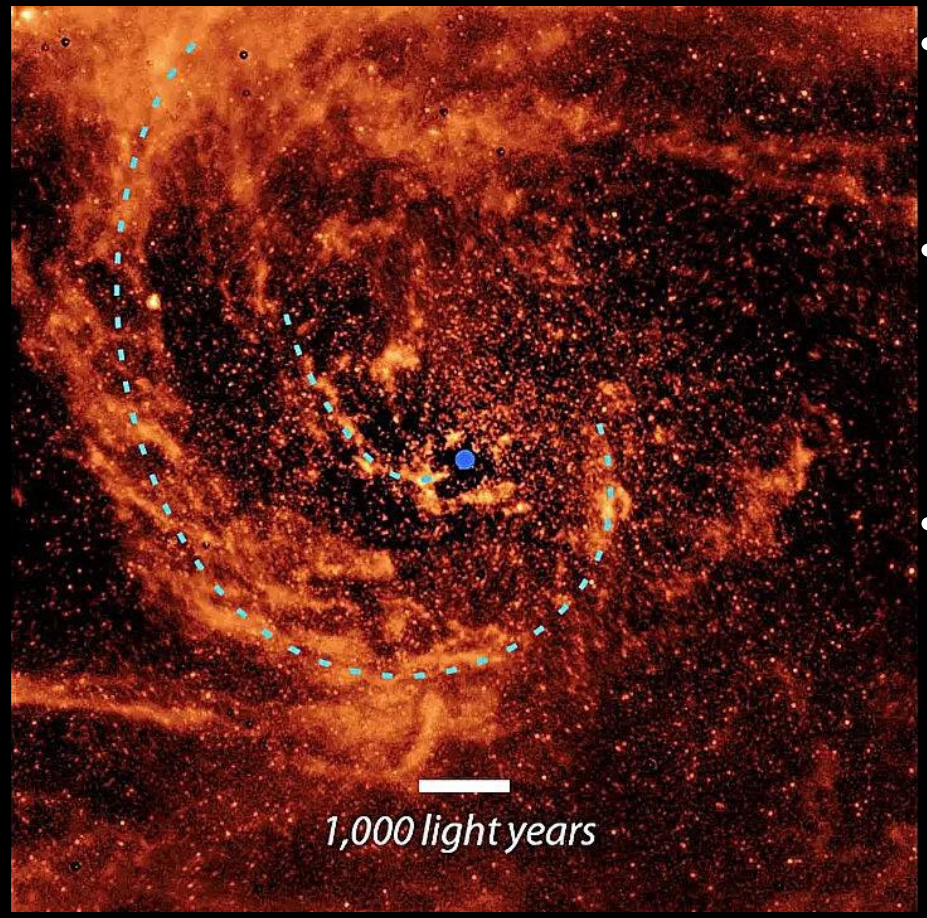
Black Hole eating habits (2)



- Using a computer simulation, scientists have investigated how Quiescent might be able to sustain its big appetite whilst remaining quiet.
- They found that a small disk of hot gas could form close to the SMB, feeding it a steady diet of material whilst being replenished by constant streams of gas and dust of a particular size and flow rate.
- By comparing their results to data collected by Spitzer and the Hubble Space Telescope over the last 20 years, the researchers found that their findings were consistent with previously identified spirals, leading to the conclusion that the spiral arms of Andromeda are feeding its SMB.

This close-up view of the centre of the Andromeda galaxy, taken by NASA's retired Spitzer Space Telescope, is annotated with blue dotted lines to highlight the path of two dust streams flowing toward the supermassive black hole at the galaxy's centre (indicated by a purple dot).
Credit: NASA/JPL-Caltech

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Merging twin quasars discovered (1)

- Quasi-stellar objects (Quasars) are a rare and extreme class of Supermassive Black Hole. They are some of the brightest objects in the known universe with extremely high luminosity and emissions of electromagnetic radiation observable in radio, infrared, visible, ultraviolet, and X-ray wavelengths.
- By combing through data collected by the Hyper SuprimeCam (HSC) Subaru Strategic Program (SPP) survey, astronomers, led by Yoshiki Matsuoka at the Ehime University in Japan, have discovered two merging quasars, named HSC J121504.42-014858.7 and HSC J121503.55-014859.3

An artist's concept of a galaxy with a brilliant quasar at its centre.
Credit: NASA, ESA and J. Olmsted (STScI)

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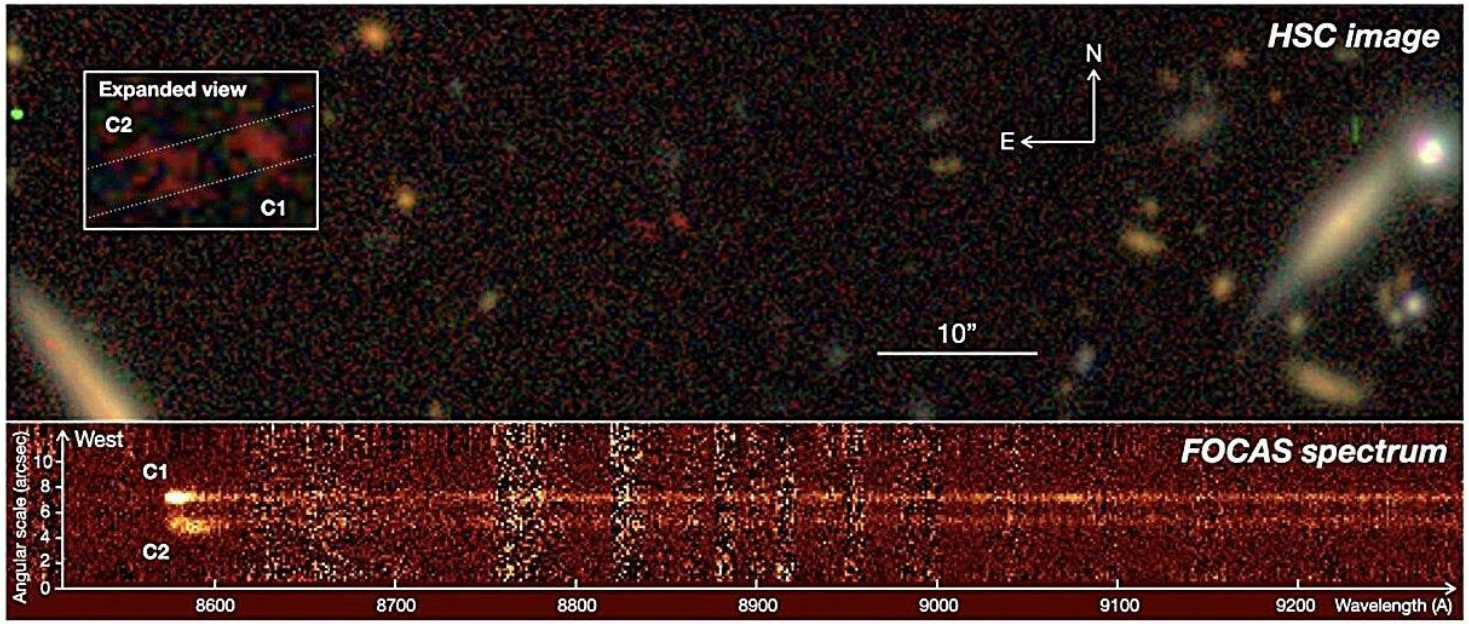
Merging twin quasars discovered (2)

- Although the quasars are approximately 39,000 light years from each other, they are likely to be in physical association, with extended structures detected in emission lines bridging the gap between them.
- The two quasars have a redshift (the stretched wavelength of light over space) of 6.05, meaning that they are the most distant quasars known to be merging.
- The team are continuing to investigate and aim to provide additional evidence for the merger.



Top: three-color (HSC r, i, and z-band) composite image around C1 and C2, the two reddest sources at the centre. The inset shows an expanded view of C1 and C2.
Bottom: two-dimensional FOCAS spectrum of C1 (upper trace of light) and C2 (lower trace), created by stacking all available data.
Credit: *Astrophysical Journal Letters* (2024). DOI: 10.3847/2041-8213/ad35c7

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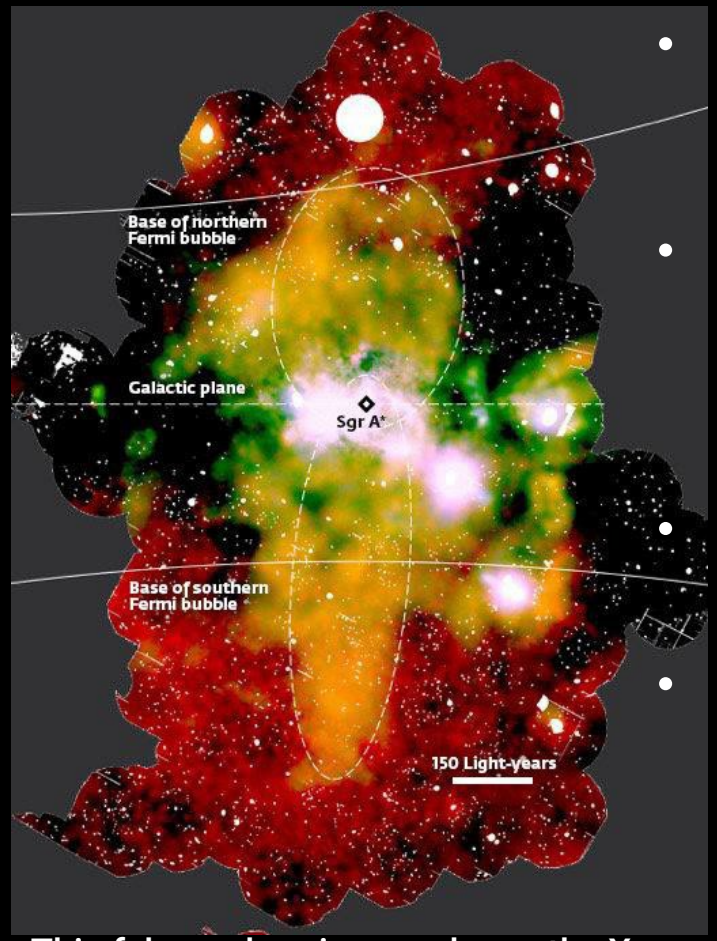
Vent discovered on Milky Way's Chimney (1)



- Sagittarius A* (Sgr A*), the Supermassive Black Hole at the centre of our galaxy, the Milky Way, may have created its own chimney through eruptions.
- Using X-ray data from Chandra and XMN-Newton and Radio emissions detected by MeerKat radio telescope, astronomers had previously identified the chimney via X-ray images and by measuring its magnetic field.
- The chimney is 26,000 light-years from Earth, beginning at the centre of the galaxy and standing perpendicular to the spiral disk.
- It is anticipated that the cylindrical walls help to funnel hot gas away from the centre, up towards a newly discovered vent 700 light-years away from the centre. As hot gas rises through the chimney, it collides with cooler gas, causing shock waves to light up the vent walls.

This false-colour image shows the X-ray emissions from the central region of the Milky Way. The colours are a measure of how energetic the X-rays are.
Credit: MPE

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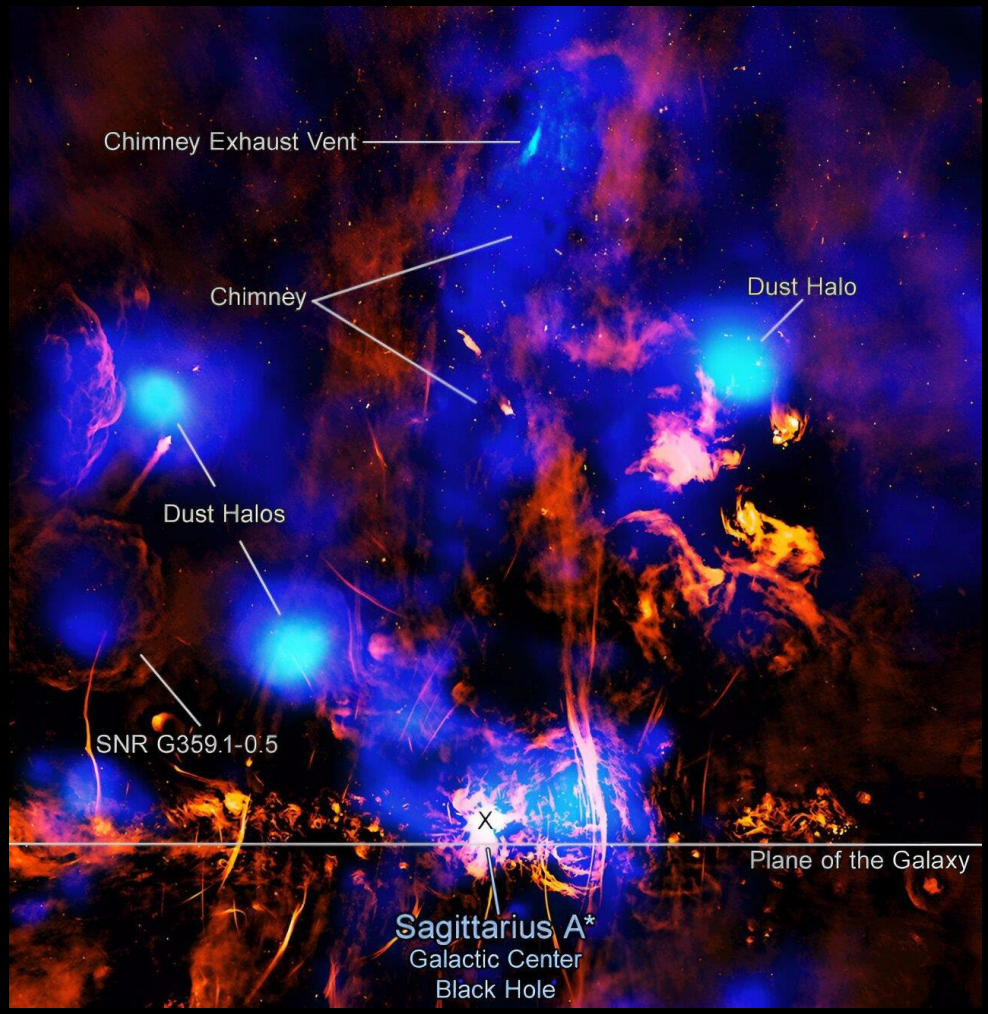
Vent discovered on Milky Way's Chimney (2)

- Due to the angle of the chimney, the left side is particularly bright as gas strikes the tunnel wall at a more direct angle.
- Activity from Sgr A*, such as infrequent X-ray flares and rare powerful releases of energy from consumed material, may have played a key part in creating the chimney, as well as the Fermi and eROSITA bubbles, which are both aligned with the chimney direction.
- It is thought that gas is kept focused by the funnelling effects of the exhaust vent near the top, assisting in the coherent structure of the bubbles.
- The origin of the bubbles is one of the biggest mysteries faced by astrophysicists, so the discovery of this chimney structure is a promising lead on figuring out their origins.



Region near the Milky Way's galactic centre (labelled).
Credit: X-ray: NASA/CXC/Univ. of Chicago/S.C. Mackey et al.; Radio: NRF/SARAO/MeerKAT; Image Processing: NASA/CXC/SAO/N. Wolk

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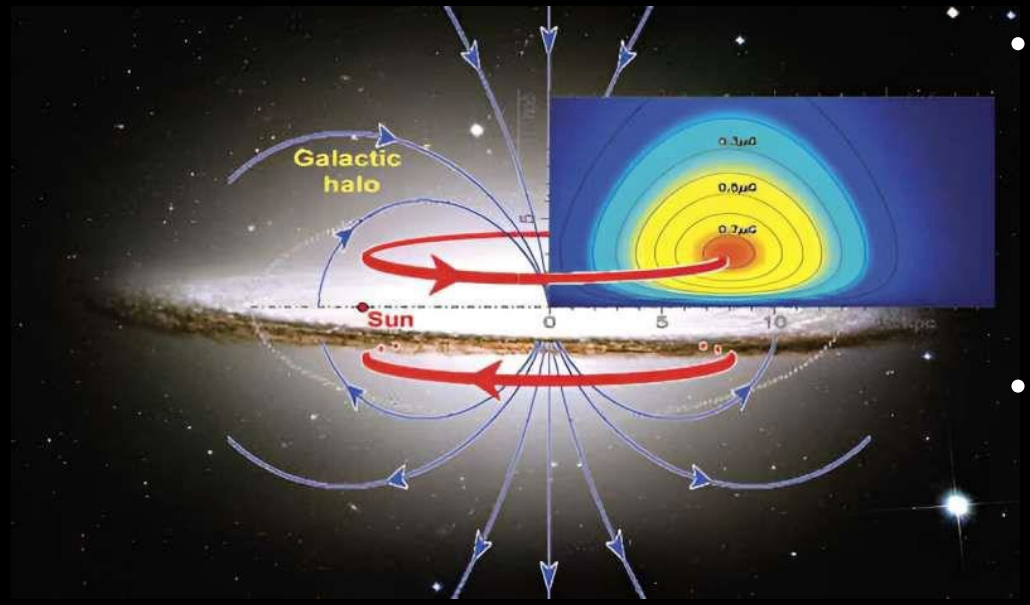
Magnetic donuts found in Milky Way (1)



Magnetic fields in the halo of the Milky Way have a toroidal structure, extending in the radius range of 6,000 light-years to 50,000 light-years from the galaxy centre. The sun is at about 30,000 light-years.
Credit: NAOC

- Understanding the large-scale magnetic field structure present in the Milky Way has posed a significant challenge for astronomers. As a key area of investigation, many world-class radio telescopes are focused on unravelling this mystery.
- A new study, published by Dr Xu Jun and Prof. Han Jinlin from the National Astronomical Observatories of Chinese Academy of Sciences (NAOC), has revealed huge magnetic toroids (doughnut-shaped magnetic fields) in the halo of the Milky Way.
- These magnetic fields are important for understanding cosmic ray movement and physical processes in space.
- Prof. Han, a leading scientist in this area, has studied the magnetic field structures along the spiral arms of the Milky Way by measuring the polarization of pulsars (rotating neutron stars) and their Faraday effects (a phenomenon that affects the polarization of light).

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Magnetic donuts found in Milky Way (2)

- In 1997, Prof. Han discovered an anti-symmetry in the Faraday effects of cosmic radio sources, indicating that the Milky Way's halo has a toroidal magnetic field structure with opposite directions above and below the galactic plane. However, determining the size and strength of these fields has been difficult.
- Astronomers suspected that the anti-symmetry could be caused by the interstellar medium near the Sun. Prof. Han proposed measuring the Faraday rotation from nearby pulsars, using data from the Five-hundred Aperture Spherical radio Telescope (FAST), and subtracting this from background cosmic sources.
- Dr. Xu collected 30 years of Faraday rotation data, and the analysis showed that the anti-symmetry exists across the entire sky, indicating that the toroidal magnetic fields extend from 6,000 to 50,000 light-years from the Milky Way's centre. This discovery provides a new understanding of the Milky Way's physics and is a milestone in the study of cosmic magnetic fields.

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Universe’s oldest stars could be close to Home (1)

- Three of the oldest stars in the universe have been discovered on the outskirts within the Milky Way’s “halo” (the cloud of stars enveloping the entire main galactic disk).
- These stars are reported to have formed between 12 and 13 billion years ago, when the first galaxies were taking shape, and each star may have once belonged to its own small, primitive galaxy before being absorbed by the Milky Way.
- Termed “SASS” for small accreted stellar system stars, the team believes that there may be more ancient stellar survivors to discover within the halo.

Milky Way Galaxy.
Credit: NASA

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Universe’s oldest stars could be close to Home (2)

- Working from star data collected from the 6.5-meter Magellan-Clay telescope at the Las Campanas Observatory in Chile, a team of MIT researchers, including several undergraduate students, were able to class these three stars as ancient due to their high abundance of hydrogen and helium and lack of other chemical elements, such as iron and barium, which had not yet formed within the early universe.
- One of the stars contained less than 1/10,000 the amount of iron to helium compared to our own Sun.
- The stars are also in retrograde motion (travelling the wrong way around the galactic centre), orbiting in completely different ways from the galactic disk and halo. This suggests that the smaller dwarf galaxies from which they likely originated fell into the Milky Way at random angles, with the stars continuing their trajectories billions of years later.
- Being in the Milky Way, the stars are far closer to us than examples of the primitive dwarf galaxies in which they formed, and so provide an excellent chance for us to study the evolution of early galaxy formation.

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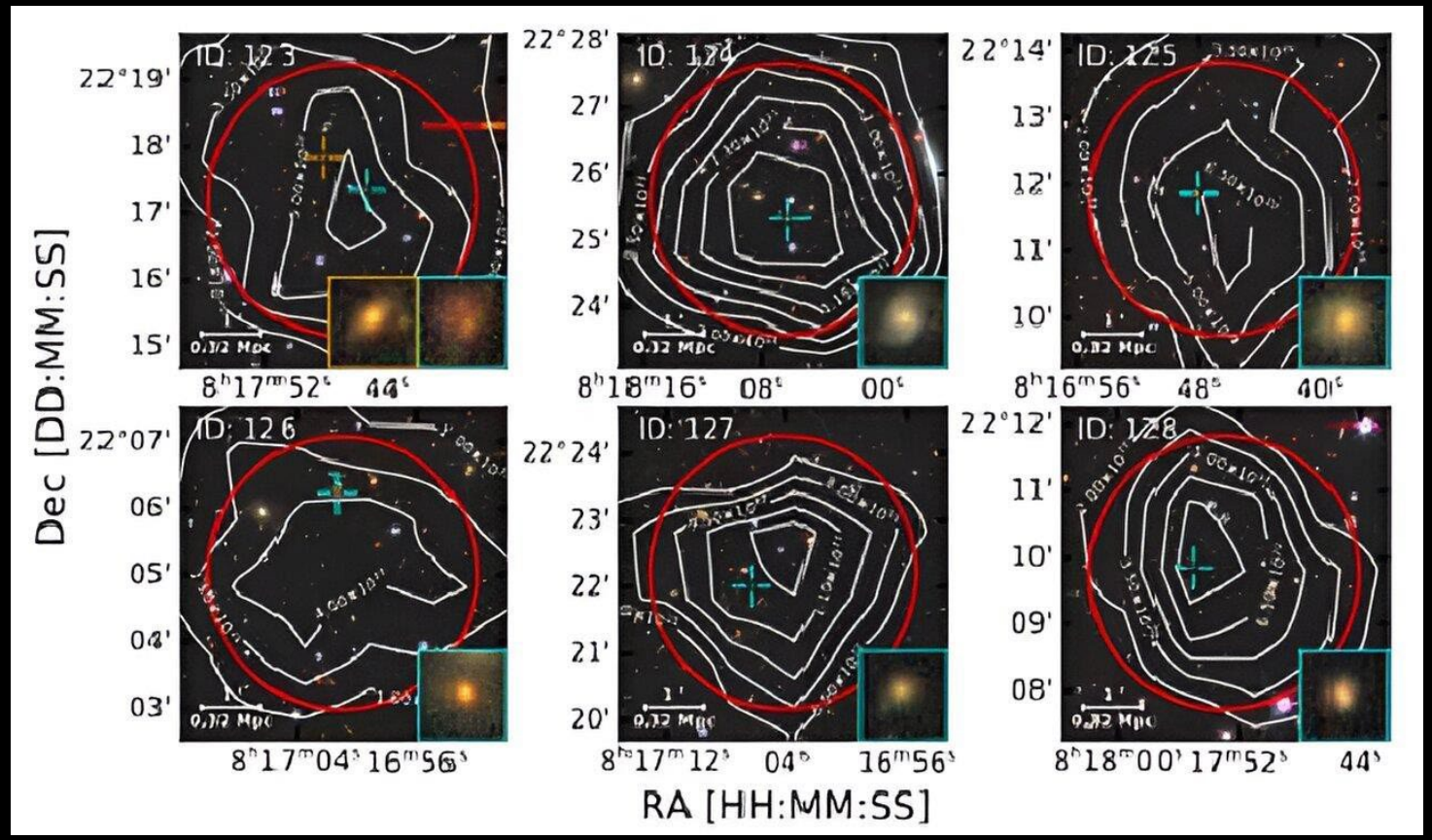
FAST finds distant gas-rich galaxies



Radio contours (white lines) overlayed on optical images. Their optical counterparts are zoomed in at bottom right corners. Red circles show the FAST resolution.
Credit: NAOC

- Using the Five-hundred-meter Aperture Spherical radio Telescope (FAST), astronomers have revealed the properties of six new high-redshift galaxies, located in the distant universe.
- Radio wave emissions from these galaxies have taken nearly the age of the Solar System to reach us and show that distant galaxies have much more star-forming gas than present day galaxies, with far greater gas reservoirs than was previously thought.

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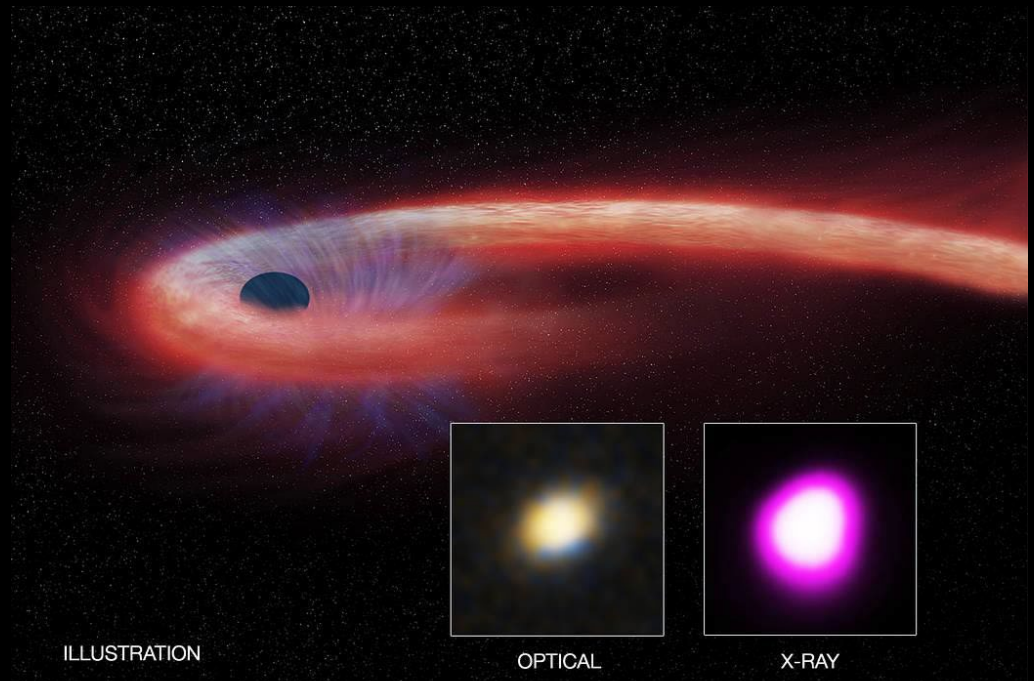
Black Hole's spin measured for the first time (1)

- Astronomers at MIT, NASA, and elsewhere have new way to measure how fast a black hole spins – by using the wobbly aftermath from its stellar feasting.
- Black holes grow mostly through accretion as material falls onto the disk, which causes them to spin up to quite high speeds. However, when black holes merge with each other, the clashing of spins may cause things to slow down.
- If a star falls onto a black hole at an offset angle, the shredded material could have a tilted spin (separate from the spin of the black hole). As the black hole pulls the disk into alignment, it wobbles before slowly settling.



This artist's illustration depicts what astronomers call a "tidal disruption event," or TDE.
Credit: NASA

- As the star is distributed by black hole's immense tidal forces, half of it is blown away and the other half is flung around the black hole, generating a scorching hot accretion disk of rotating stellar material.

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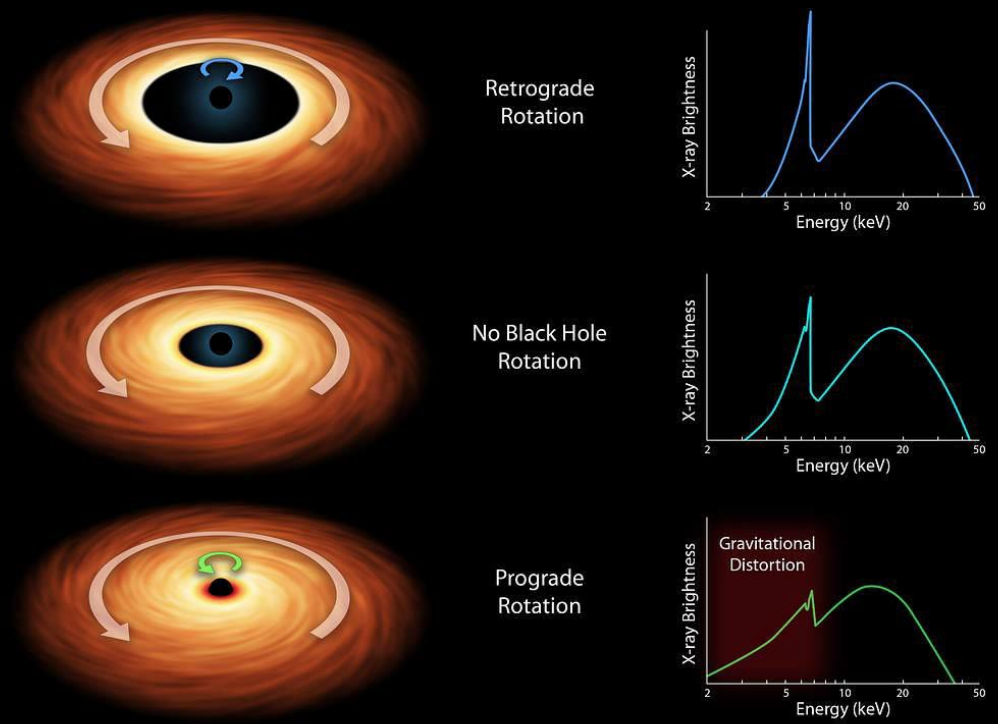
Black Hole’s spin measured for the first time (2)



Black holes are tremendous objects whose immense gravity can distort and twist space-time, the fabric that shapes our universe. These effects, consequences of Einstein's general theory of relativity, result in the bending of light as it travels through space-time.
Credit: NASA

- The new method used by researchers takes advantage of black hole Tidal Disruption Events (TDEs), where a star is torn apart by the black hole’s immense tidal forces.
- By tracking how an accretion disk’s wobble changes over time, scientists can work out how the black hole’s spin has impacted the disk and, in turn, how fast the hole was spinning.
- Analysis of a nearby black hole’s x-ray patterns following a TDE showed it was spinning at less than 25% speed of light – relatively slow.
- This research represents a significant advancement in our ability to measure and understand the properties of black holes and, as scientists survey spins, they can start to understand how black holes have evolved.

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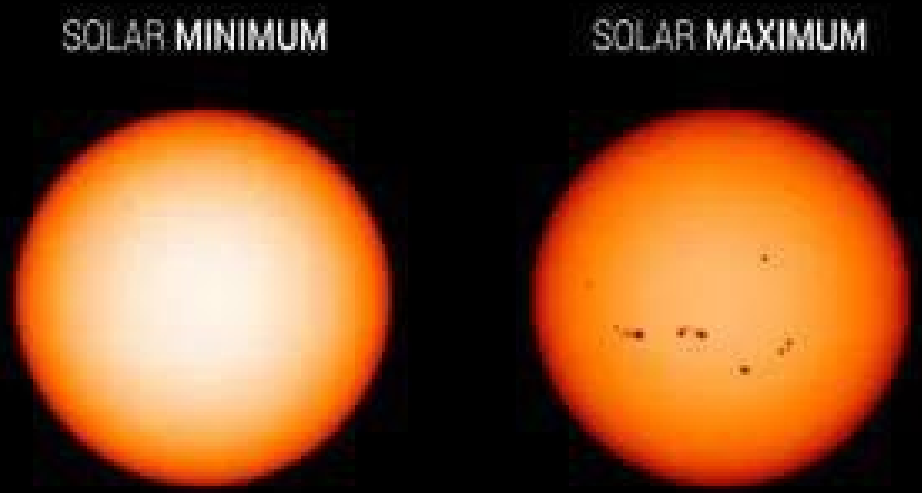
Effects of the Solar Maximum in 2024 (1)

- The Sun goes through cycles where it completely flips its magnetic field, meaning that its north and south poles switch places. This happens approximately every 11 years and is caused by the magnetic fields weakening, going to zero, and then emerging again with the opposite polarity.
- The effects can vary dramatically in intensity, with fewer sunspots at solar minimum in comparison to solar maximum.
- Sunspots appear dark on the surface of the sun because they're relatively cool in comparison to other areas (around 3,480° Celsius compared to around 5,500° Celsius). They form in areas where magnetic fields are particularly strong, hence being more common during solar maximum.



The above image displays the difference between solar minimum and solar maximum in terms of sunspot presence.
Credit: NASA's Solar Dynamics Observatory/Joy Ng

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Effects of the Solar Maximum in 2024 (2)

- At solar maximum, sunspots are found along mid-latitudes (approximately 30° north and 30° south) as can be seen in the photo provided by LAS society member, Paul Whitmarsh, taken in early May.
- They then gradually move towards the equator, where they are located during solar minimum.

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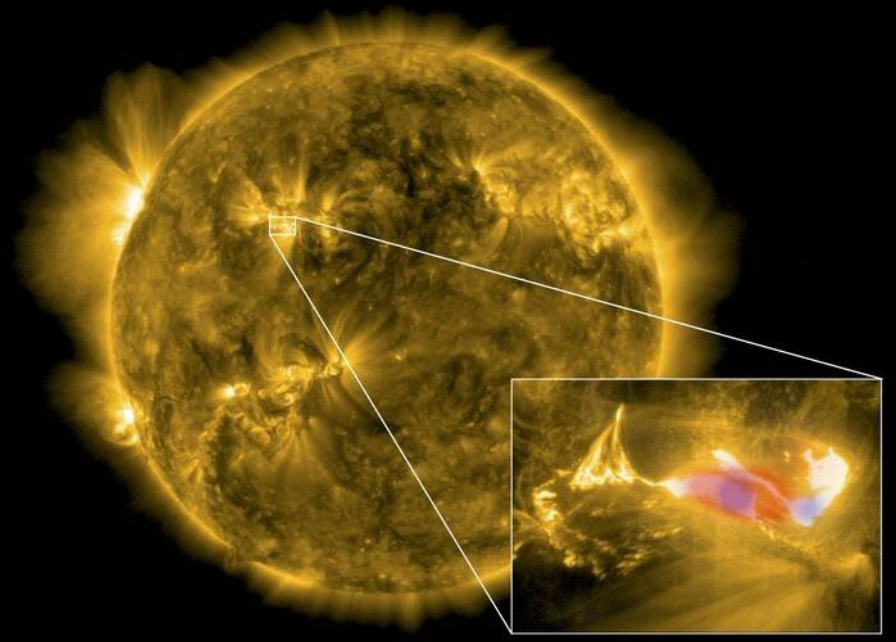
Effects of the Solar Maximum in 2024 (3)

- In May, the Sun put on a powerful solar storm, causing minor disruptions to the electric power grid, communications, and satellite positioning systems.
- It also caused the Aurora Borealis (Northern Lights) to be visible as far south as Hawaii in the northern hemisphere, and as far north as Queensland, Australia, in the south.
- There was no significant impact from the storm, but what exactly causes these disruptions in the first place?
- The answer is Solar Flares, our solar system's largest explosive events: these exist as sudden explosions of energy from the surface of the sun and occur when magnetic field lines near sunspots tangle, cross and reorganise.
- It's this sudden release of intense radiation into space that can interfere with radio communications on Earth.



A solar flare, as seen by Solar Orbiter; the blue and red colours show sources of different types of X-rays. Credit: ESA, Solar Orbiter

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Effects of the Solar Maximum in 2024 (4)

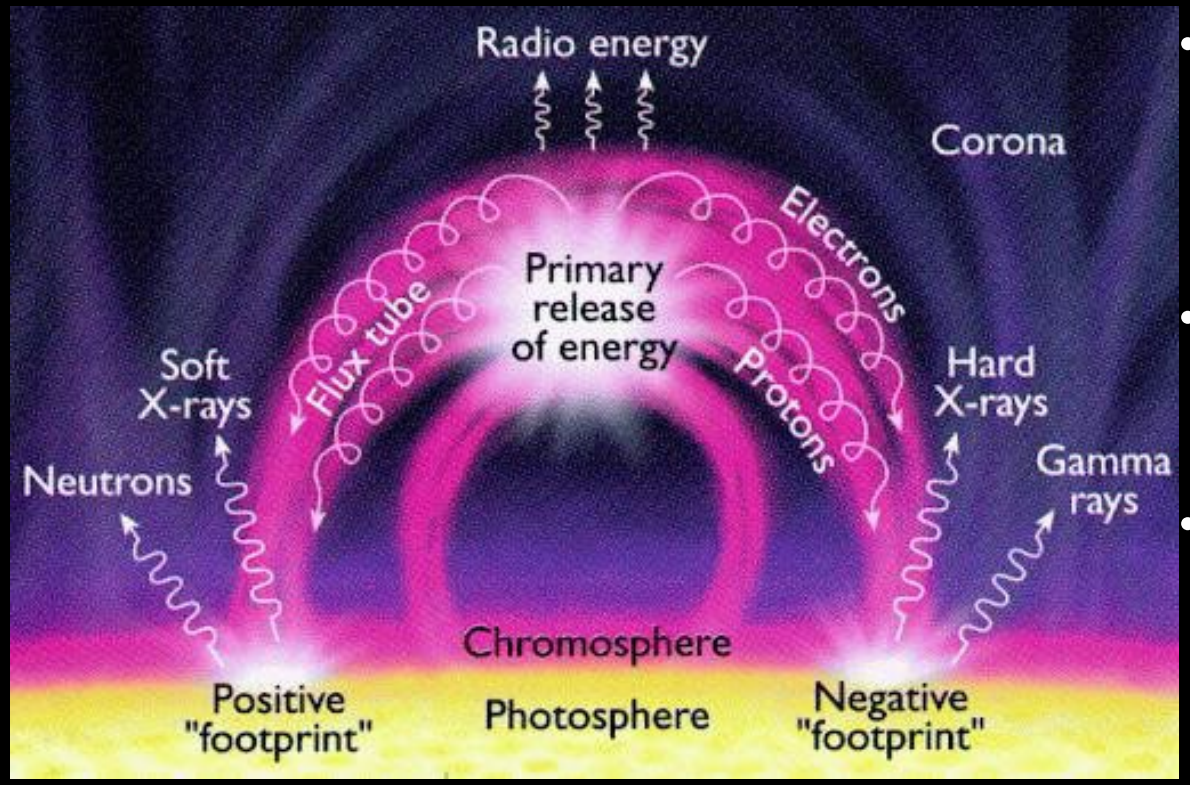

Diagram of solar flare.
Credit: Dominik Gronkiewicz

- Powerful magnetic fluctuations at the Earth's surface can also cause an increase in electrical currents to flow through power grids, pipelines, and railways lines, potentially interfering with normal operations.
- The biggest flare so far this year, and the strongest since 2005, was released on 14th May and was classified as an X8.7 flare.
- Flares are classified on a similar scale to the Richter scale for earthquakes, dividing them according to their strength. X-class is the most intense category of flares, with the smallest running from A-class, followed by B, C, M and then X. Each letter represents a 10-fold increase in energy output, so an X is ten times bigger than an M and 100 times bigger than a C.

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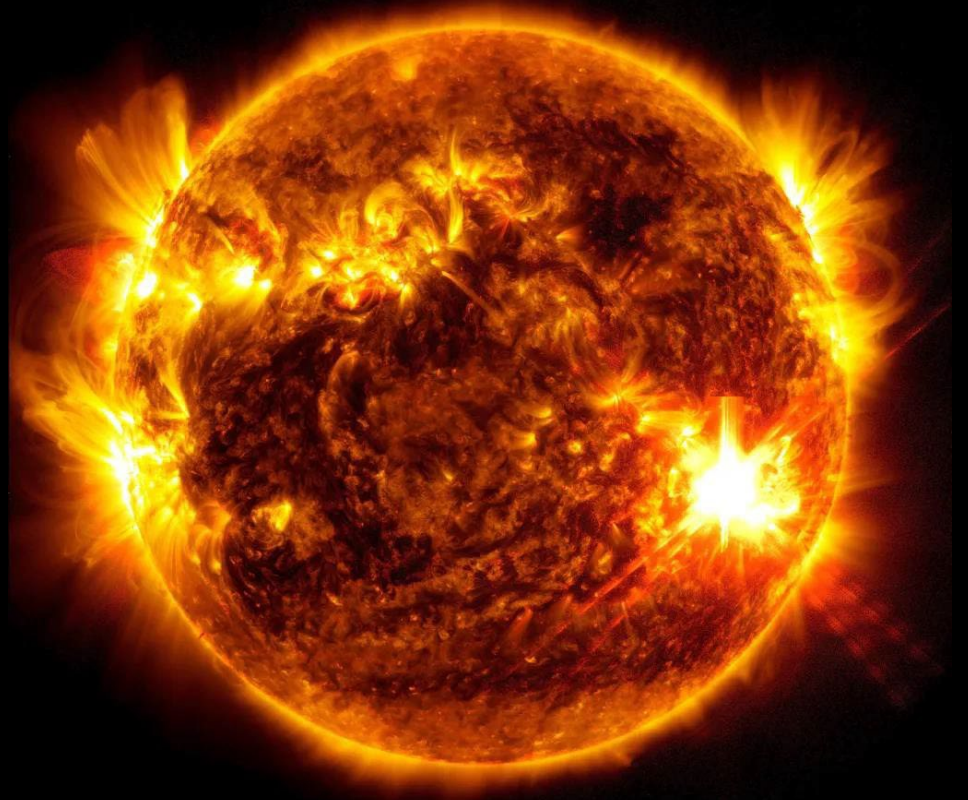
Effects of the Solar Maximum in 2024 (5)

- Solar flares can have a massive impact on planets with no global magnetic field, such as Venus.
- Without a protective magnetosphere, Venus' atmosphere is directly exposed to the solar wind, meaning that the increased flux of charged particles can strip away particles, such as oxygen and hydrogen, from the upper atmosphere, contributing to the overall loss of water from the planet.
- Solar storms also enhance ionization in Venus' upper atmosphere, increasing the density and altering the structure of the ionosphere. The thermosphere heats up and expands due to increased energy from solar storms, which affects atmospheric circulation and density.
- In summary, we're very lucky to be protected by Earth's global magnetosphere.



NASA's Solar Dynamics Observatory (SDO) image of solar flare peaking at 9:23pm EDT on 10 May, 2024.
Credit: NASA, SDO

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Effects of the Solar Maximum in 2024 (6)

- Mars also lost its global magnetic field long ago, leaving it more vulnerable to the Sun's energetic particles.
- For this reason, space agencies, such as NASA, need to determine how astronauts might be affected by solar radiation.
- NASA's MAVEN (Mars Atmosphere and Volatile EvolutioN) orbiter is managed by NASA's Goddard Space Flight Center in Greenbelt, Maryland.
- MAVEN observes radiation, solar particles, and more from high above Mars.
- When MAVEN detects a big solar flare, the orbiter's team lets the Curiosity team know so that they can watch for changes in its Radiation Assessment Detector (RAD) and help scientists to understand how radiation breaks down carbon-based molecules on the surface.
- For more information on NASA's MAVEN orbiter, watch the video by clicking the following link: https://www.youtube.com/watch?v=wRaGAA0jFFA

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Effects of the Solar Maximum in 2024 (7)

- Here are some examples of the incredible images captured of the northern lights by members of the LAS on the 10th May.

Credit: Paul Saxty

Credit: Gerard Fox

Credit: Robert Massey

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Astronomy News in Brief (1)

- "Io on Steroids" - Using the Transiting Exoplanet Survey Satellite (TESS), UC Riverside astrophysicist, Stephen Kane, has discovered a new rocky planet, named TOI-6713.01, within a star system called HD 104067. Constantly exploding with volcanoes and with a surface temperature calculated at 2,600 degrees kelvin, the new planet is around 30% larger than Earth. Similar to how Jupiter's moon, Io, is forced into an elliptical orbit around Jupiter and is squeezed by its host's gravity to the point that volcanoes are constantly erupting, the new planet is being forced into an elliptical orbit by two other planets within its system. Kane hopes that this discovery will inspire new focus into observing the effects of tidal energy on exoplanets.

An artist's impression of a molten, volcanic exoplanet such as TOI-6713.01.
Credit: NASA/ESA/CSA/Dani Player

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Astronomy News in Brief (2)

- New Evidence for Planet 9 - Planet 9 was proposed to exist after a pair of astronomers at Caltech foun several objects bunched together near the edge of the Solar System. They theorized that this bunching was caused by the gravity pull of an unknown planet. Recently, researchers have tracked the movemen of long-period objects crowing Neptune's orbit and used the observations to create multiple computer simulations. Whilst accounting for forces exerted by Milky Way objects and the impact of Neptune's gravitational pull, they found that the most plausible explanation for irregular movements was interference from gravity exerted by a large distant planet. However, the simulations are not usable for plotting the location of the potential planet.
- Was Ancient Mars Similar to Earth? - Using the ChemCam instrument on NASA's Curiosity Rover, research teams have discovered unusually high levels of manganese in lakebed rocks within the Gale Crater on Mars. High concentrations of manganese oxide suggest that the rocks formed in an ancient lake environment, such as a river, delta, or shoreline. This discovery has come as a surprise due to a Mars' lack of high oxygen levels, as manganese oxide forms in oxygen-rich environments on Earth and often facilitated by microbes. Could the Gale Crater lake environment have once mirrored habitable environments on Earth today?

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Astronomy News in Brief (3)

- **Extraordinary Exoplanet Explained** - Using the James Webb Space Telescope (JWST), astronomers and scientists from MPIA have built a global temperature map of the hot, gas giant exoplanet WASP-43B. The planet orbits its host star extremely closely, taking only 27 hours to complete each orbit. This causes WASP-43B to be almost tidally locked to the star and one rotation of the planet completes in the same time as it takes to complete an orbit, meaning that one side is always facing the star. Temperatures on the dayside reach around 1250°C due to continuous illumination and violent winds transfer heat to the nightside (which is somewhat cooler at around 600°C), with temperature fluctuations influencing cloud formation and chemical reactions. It is theorized that clouds made of liquid rocks and minerals are likely to be present, raining hot lava down upon the surface. Further observations with JWST's Near-Infrared Spectrometer (NIRSpec) are planned to improve our understanding of the atmospheric composition and cloud distribution.

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Astronomy News in Brief (4)

- **How Venus Lost So Much Water** - Planetary scientists at the University of Colorado, Boulder have discovered how Venus lost its water. Venus has 100,000 times less water than Earth and, if all of its water was spread across the planet, it would form a layer only 3cm deep, compared to 3km on Earth. Billions of years ago, Venus likely had as much water as Earth, but a powerful greenhouse effect caused by carbon dioxide clouds raised surface temperatures to 480°c, evaporating all water into steam, much of which escaped into space.
- **Climate Impacted by Travelling Astronomers** - Researchers have compiled a data set of all 362 known astronomy conferences in 2019 and the corresponding travel emissions. They found that the equivalent of 42,500 tons of climate-damaging CO_2 emissions were released as a result of international travel to these conferences, with a total distance travelled of one and a half times the distance between the Earth and the Sun. Many conferences take place in Europe and America, but hybrid formats (where conferences are virtually linked) may be a viable option for reducing emissions whilst ensuring that astronomers in other countries are easily able to attend.

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Astronomy News in Brief (5)

The aurora was photographed in 2014 during a series of Hubble Space Telescope Imaging Spectrograph far-ultraviolet-light observations taking place as NASA's Juno spacecraft approached and entered into orbit around Jupiter.
Credit: NASA, ESA and J. Nichols, University of Leicester

- **Open Magnetic Field Lines Confirmed on Jupiter** - Jupiter's magnetosphere has largely closed magnetic field lines at its polar regions that loops back into the planet, preventing solar wind particles from directly interacting with the atmosphere. Data on crescent-shaped areas of open field lines on Jupiter has recently been collected by NASA's Juno Spacecraft, confirming the existence of open field lines. Models and simulations are being used to analyse these lines and their interactions with solar wind. New discoveries about Jupiter's magnetosphere may help us to better understand Earth's space environment and to improve space weather forecasting. This will be highly beneficial in protecting communications satellites and power grids from solar storms.

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June 2024

Spaceflight News

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Two new satellites join Galileo Constellation

- The European Galileo navigation system (EG), operational since 2016, is the most precise satellite navigation system in the world and the largest European constellation of satellites.
- Galileo is already integral to our everyday lives as 10% of the EU's annual GDP relies on satellite navigation, influencing rail, maritime, agriculture, financial timing services and rescue operations.
- On Sunday 28th April the European Space Agency (ESA) launched two more Galileo satellites to expand the constellation up to 30 satellites. This increases the reliability, robustness and precision of the system.
- A total of 38 Galileo satellites have been developed and tested by ESA and European industry, with the remaining 8 First Generation satellites ready to be launched soon.
- After this launch, a Second Generation of satellites will be sent up to join the constellation; expected to arrive in 2026 with the Ariane 6 launcher. The new generation are developed to revolutionise the fleet with enhanced capabilities, such as electric propulsion, more powerful navigation antenna, more and better atomic clocks, and fully digital payloads.
-

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NASA looks to scientific community for innovation (1)

- Funding is tight across many government agencies in the modern day, and NASA is no exception from the rest. The US government are no longer investing huge sums in sending people to the moon and have sliced NASA's budget by 2% relative to 2023.
- NASA's Mars Sample Return project has survived a cancellation threat by the Senate only to receive a far lower level of funding than requested, by $2.3 billion.

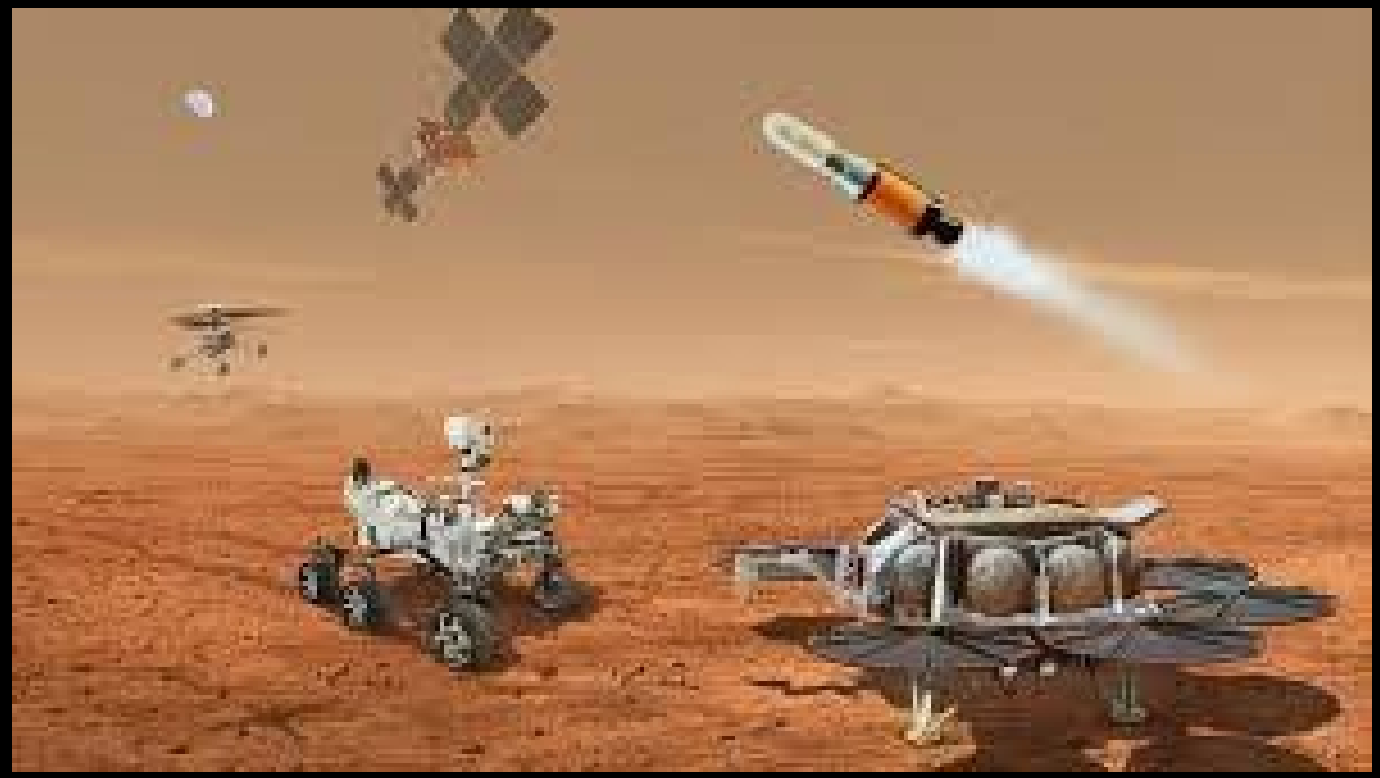

Illustration of the Mars Sample Return project in action.
Credit: NASA

- The ambitious plan was for NASA's Perseverance rover to collect rock samples from Mars' Jezero Crater, which is thought to have once held an ancient lake, and to deliver them back to Earth on NASA's Retrieval Lander.

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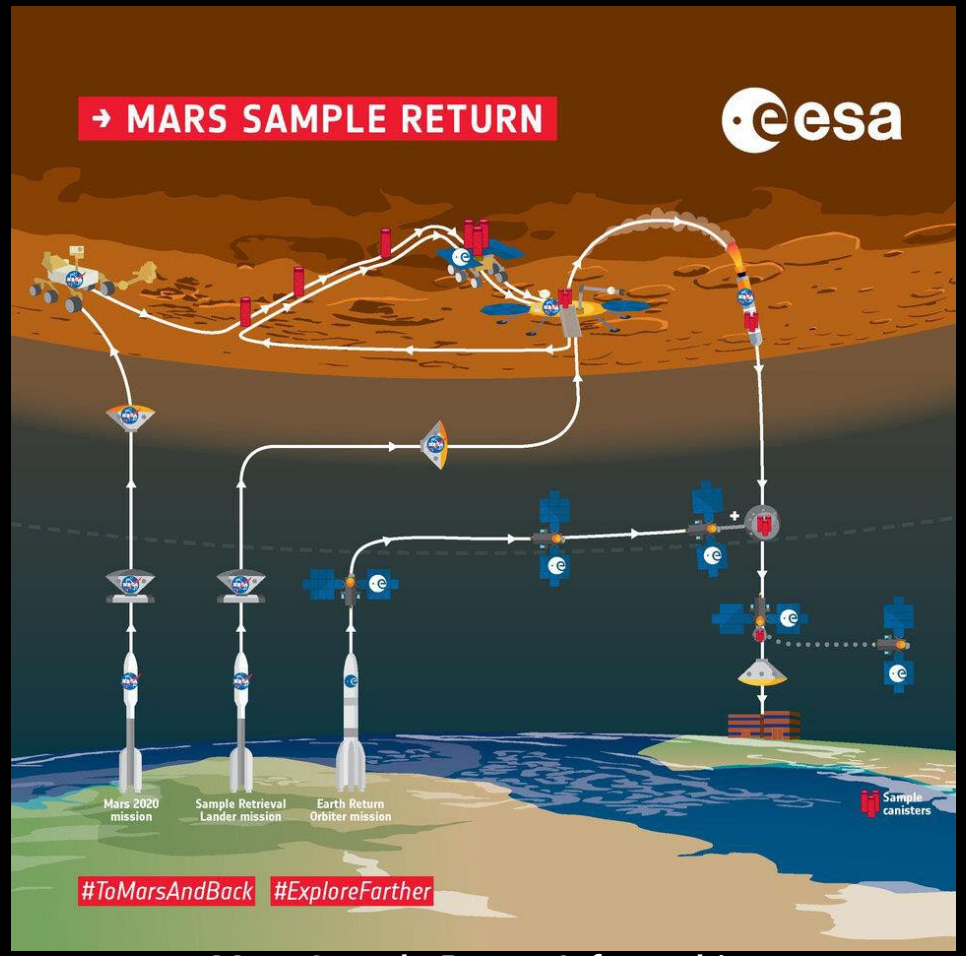
NASA looks to scientific community for innovation (2)



Mars Sample Return Infographic.
Credit: ESA

- After launching back into space, the Retrieval Lander would be intercepted by the Earth Return Orbiter, to be delivered back to Earth for analysis.
- Since minerals deposited through water are good at trapping biological material on Earth, whilst also giving an indication of climate conditions at the time the rock was formed, the mission has the potential to be scientifically groundbreaking.
- Private companies and new space powers, such as India and China, have started looking beyond the designs that have worked until now to embrace innovation and improve cost efficiency.
- NASA has now asked the scientific community to help think of innovative ideas for ways to carry out its Mars Sample Return mission, so that it may still be carried out on a lower budget.

Lewes Astronomical Society

First sighting of Double O Zero since 1990 (1)

- A lost experimental spy satellite, launched on 10th April 1974, by the U.S. Air Force's Space test program has been figuratively undercover since the 1990s.
- The Cold War-era satellite was officially called the Infra-Red Calibration Balloon (S73-7) and was just over 2 feet in diameter.
- Things went wrong shortly after launch as the balloon failed to inflate and teams lost track of its position.
- After losing sight of the satellite after launch, teams managed to track it once more before losing it again in the 1990s.

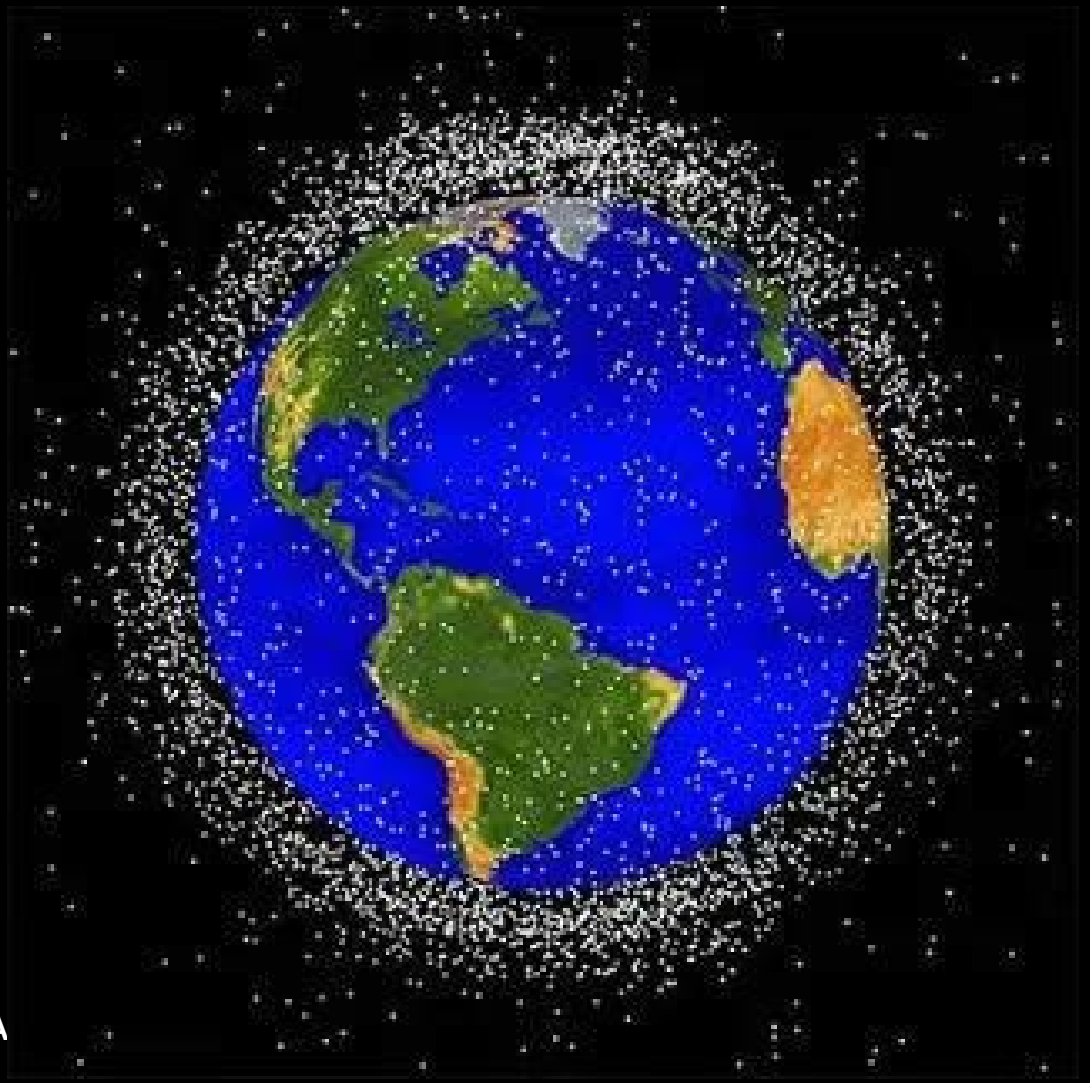


Illustration of space debris surrounding Earth.
Credit: NASA

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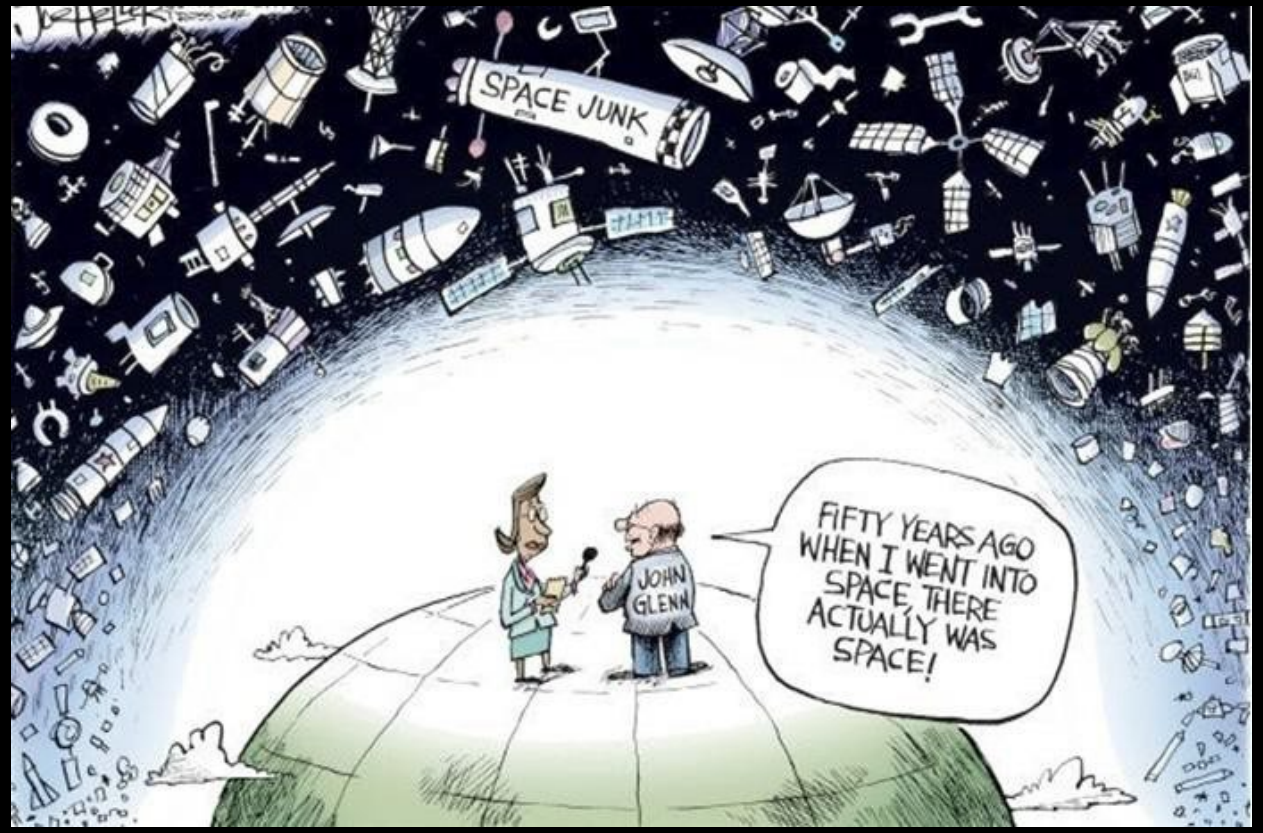
First sighting of Double O Zero since 1990 (2)



- For 25 years, analysts responsible for tracking all human-made objects saw nothing of the balloon, so it was thought to be lost as “space junk”.
- Due to its size and non-metal nature, S73-7 is harder for radars to detect, and the 20,000+ pieces of equipment hurtling through Earth’s orbit is already a lot for scientists to keep up with.
- This discovery marks a triumph for analysts in the 18th Space Defence Squadron, because too many lost objects increase the risk of collisions due to excess debris.
- Hopefully, the team will now be able to keep track of the spy satellite, but Never Say Never Again.

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Could SpaceX rocket plans harm coastline? (1)

- SpaceX is raising concerns from neighbours and environmental groups about the effect of its planned launches of up to 90 rockets from a Santa Babara County military base by 2026.
- During a California Coastal Commission hearing, US Space Force officials outlined its own plans to multiply the number of launches from the base to more than 120 a year by 2026, an overwhelming majority of which would be conducted by SpaceX.
- In 2023, SpaceX breached an agreement with the commission that limited the number of launches to 6. They are now seeking an agreement to do 36 launches a year, increasing to 90 in 2026.

Credit: Unsplash/CCO Public Domain

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Could SpaceX rocket plans harm coastline? (2)

- Environmental groups are concerned that more frequent launches may result in permanent changes as marine life, including sea otters, western snowy plovers, California least terns and California red-legged frogs may flee their nests and homes.
- Monitoring of the area has shown that some animals react to blast offs in this way, but that they return soon after with no long-term impacts yet observed.
- “Most animals can adapt to infrequent incidents, but exposure to more frequent stressful incidents can change their biology, as well as their behaviour,” stated Duncan Leitch, a professor of integrative biology at UCLA.
- The long-term knock-on effects may see drastic changes to the ecosystem if even one species permanently vacates the area, and environmental groups are asking the commission to prevent the increase for this reason.

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Could SpaceX rocket plans harm coastline? (3)

- SpaceX acts as a contractor for US Space Force, but only 25% of rockets launched into space by SpaceX are carrying payloads for the Department of the Defense with the vast majority being for the company's own benefit.
- With this in mind, commissioners are questioning why SpaceX can dispense with permits, as well as how concentrating so much communication power into one company can benefit national security.
- SpaceX don't send their own representatives to committee meetings, and their case is often put forward by US military officials.
- Commissioner Justin Cummings stated that "it would be really important that a representative from SpaceX comes to the meeting," and that "we're going to have to continue to hit significant obstacles in achieving a federal consistency ruling without having SpaceX".

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Blue Origin flies oldest astronaut to Space (1)

Credit: Blue Origin

- Blue Origin, owned by Amazon billionaire Jeff Bezos, has resumed its suborbital tourism flights after a nearly two-year hiatus.
- Launching from Blue Origin's Launch Site One in West Texas at 09:36am CST on 19th May, the New Shephard's single-stage hydrogen-fuelled rocket held 6 adventurers, including Ed Dwight, a former Air Force pilot once slated to be the US's first black astronaut.
- Tickets to ride the New Shephard are believed to cost around $500,000, but Dwight's seat was sponsored by the non-profit Space for Humanity, with support from the Jaison and Jamie Robinson Foundation.

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Blue Origin flies oldest astronaut to Space (2)

- After a brief journey beyond the Karman Line (the internationally recognised boundary of space at 100 kilometres/62 miles above sea level), the passengers enjoyed a few minutes of weightlessness before re-entering the atmosphere and landing via parachute-assisted touchdown a few thousand metres from the launch pad.
- One of the capsule's parachutes failed to deploy, resulting in a bit of a bumpy landing. Luckily, the capsule was designed to be able to land with two, and the mission was deemed a success.

One of the Blue Origin capsule's three parachutes failed to fully inflate, possibly resulting in a harder landing than expected.
Credit: Blue Origin

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Blue Origin flies oldest astronaut to Space (3)

‘This is a life-changing experience, everybody needs to do this.’ Ed Dwight exclaimed after his Blue Origin Flight to space.
Credit: Blue Origin

- The mission, NS-25, marked Blue Origin’s 7th human flight and resumed operations following a rocket mishap in 2022, which was identified by a federal investigation as an overheating engine nozzle.
- Dwight was over the moon upon his return to Earth, having long-awaited the opportunity he was denied in the 1960s. After his subsequent exit from the military in 1966 due to racial politics, he became a renowned sculptor, focusing on Black history.

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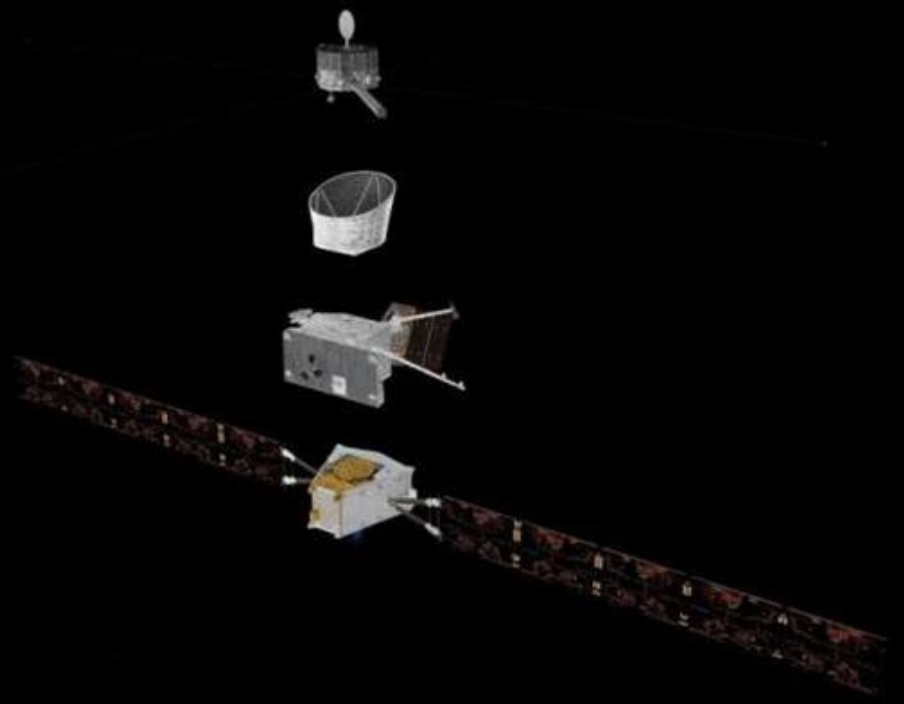
Faulty Thrust on BepiColombo (1)

- BepiColombo is a three-part spacecraft consisting of two scientific probes and the Mercury Transfer Module.
- It was launched on 20th October 2018 as a joint ESA/JAXA mission to Mercury. It's currently nearing the end of its 7-year journey, with a Mercury arrival date scheduled in late 2025.
- During its one-year nominal mission, BepiColombo will endure temperatures in excess of 350°C whilst it studies the planet's composition, geophysics, atmosphere, magnetosphere, and history.



Exploded view of the BepiColombo spacecraft components.
From bottom to top these are: the Mercury Transfer Module, Mercury Planetary Orbiter, Sunshield and Interface Structure, and Mercury Magnetospheric Orbiter.
The spacecraft are shown with solar arrays and instruments deployed.
Credit: ESA/ATG medialab

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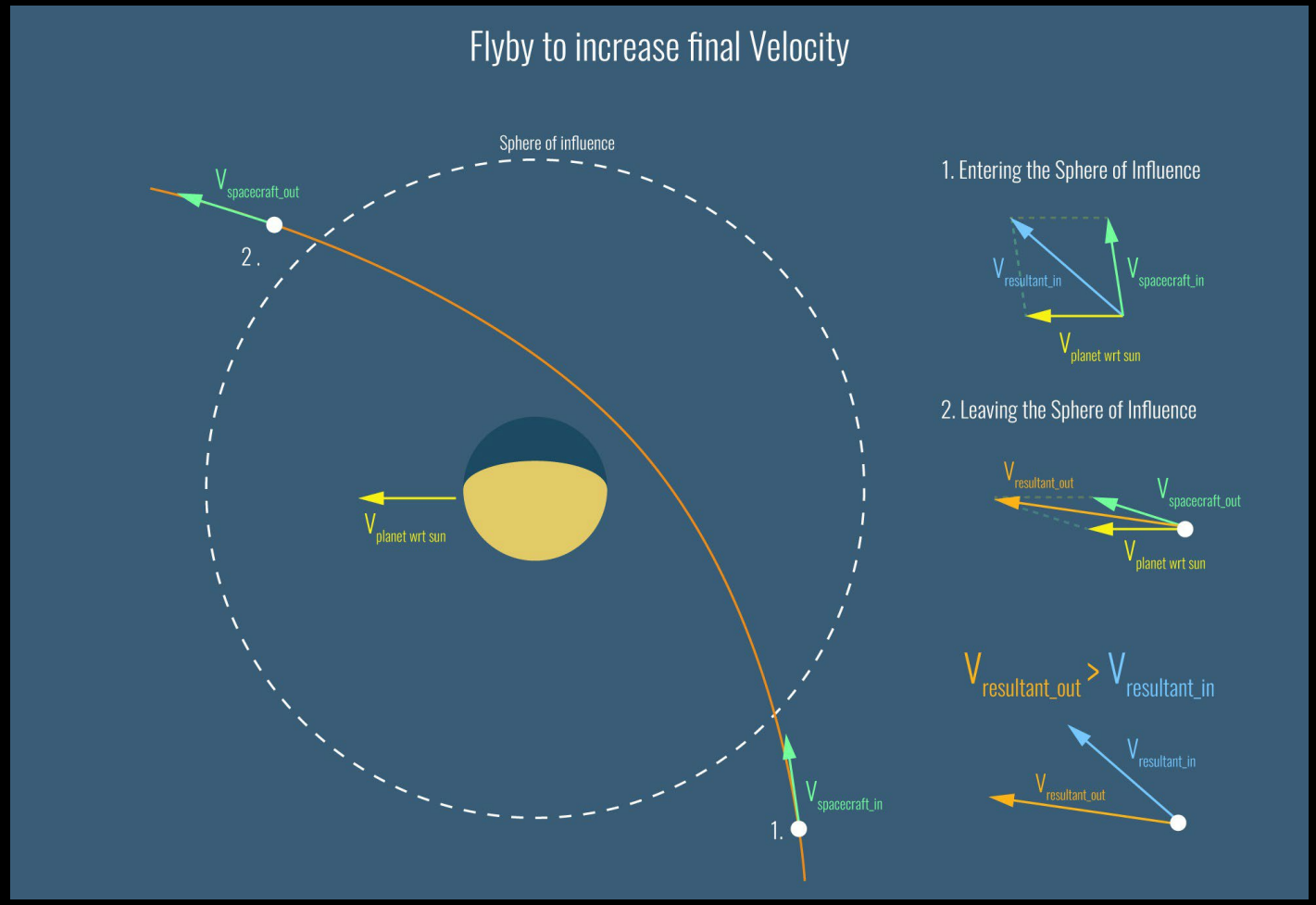
Faulty Thrust on BepiColombo (2)



Credit: ESA

- The solar arrays and electric propulsion system on the Mercury Transfer Module are used to generate thrust during the complex journey from Earth to Mercury.
- In using the thrusts, the satellite can decelerate/accelerate to make its braking flybys more effective during its nine planetary visits: one at Earth, Two at Venus and six at Mercury itself. These flybys will assist BepiColombo in entering Mercury's orbit.

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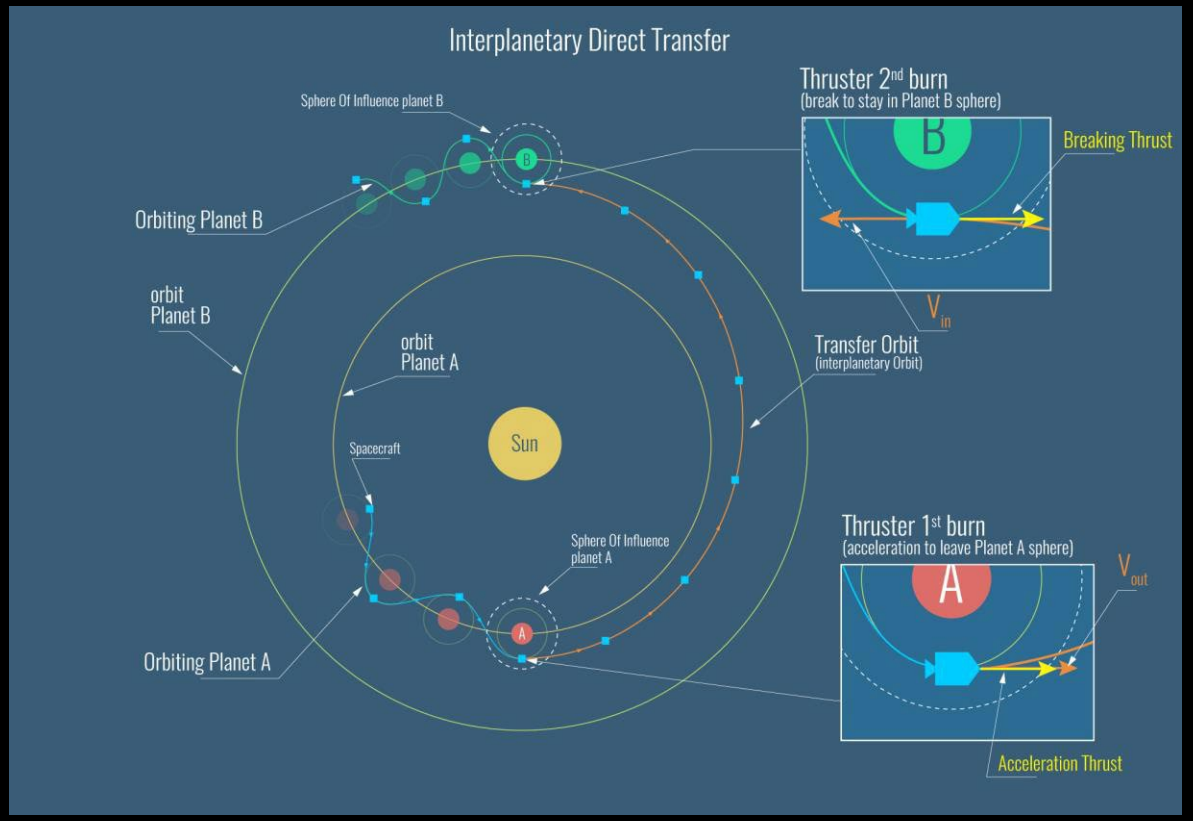
Faulty Thrust on BepiColombo (3)

- On 26th April, as the satellite was scheduled to begin its next manoeuvre, the Transfer Module failed to deliver enough electrical power to the spacecraft's thrusters.
- By 7th May, a combined team from ESA and the mission's industrial partners had restored the thrust to approximately 90% of its previous level but, with the Transfer Module's available power still lower than it should be, full thrust can't yet be restored.
- The current priorities of the team are continuing to try and identify the root cause of the issue and to maintain stable spacecraft propulsion at the current power level.
- Further updates will be shared as new information becomes available.



Infographic to explain thruster use.
Credit: ESA

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Einstein Probe captures first images (1)

Einstein Probe “In a Nutshell”.
Credit: ESA

- The Einstein Probe, launched on 9th January 2024 by the Chinese Academy of Sciences (CAS), has returned its first images to Earth, showcasing the satellite’s innovative lobster-eye optics designed for X-ray sky monitoring.
- Featuring two primary instruments: the Wide-field X-ray Telescope (WXT), which can capture nearly one-eleventh of the celestial sphere in a single shot, and the Follow-up X-ray Telescope (FXT), which provides detailed observations of short-lived X-ray events detected by WXT.
- Early data highlights the Einstein Probe’s ability to detect and monitor dynamic high-energy events, such as neutron star collisions, supernovas, and black hole activities.

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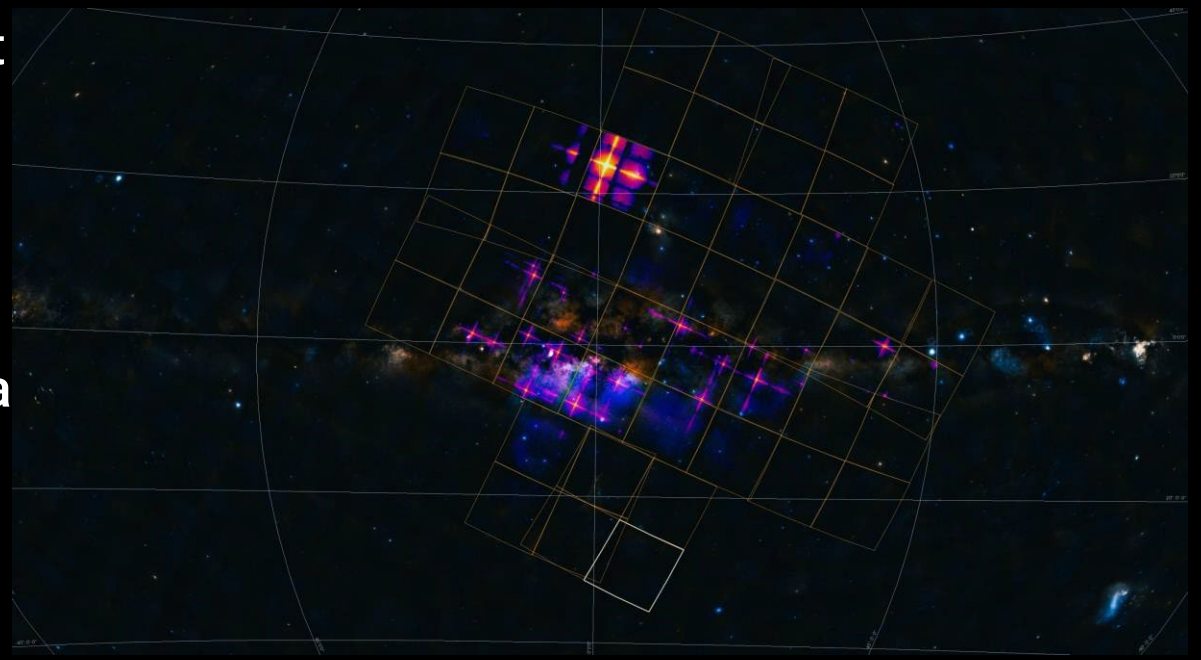
Einstein Probe captures first images (2)

- The WXT allows the satellite to scan the entire night sky in just three orbits by utilizing 12 modules with lobster-eye technology and has already detected 15 transient X-ray sources.
- The FXT has observed various X-ray emitting objects with its two telescopes, including supernova remnants and nebulae, with a successful follow-up observation of an X-ray event first spotted by WXT.
- The Probe will begin routine science observations for its three-year mission from mid-June, after completing its in-orbit calibrations.
- The mission compliments the studies of XMN-Newton and XRISM, paving the way for ESA's future NEWAthena mission, which aims to be the largest X-ray observatory ever built.



Einstein Probe's wide eyes capture the Milky Way in X-ray light.
Credit: EPSC, NAO/CAS; DSS; ESO

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Boeing's Starliner set for 1st June launch (1)

NASA astronauts Suni Williams (L) and Butch Wilmore (R) will be the first humans to travel aboard the Boeing Starliner into space

- Boeing's Starliner is now set for launch on June 1st atop an Atlas V rocket from Cape Canaveral Space Force Station's Space Launch Complex 41, with Barry "Butch" Wilmore and Sunita "Suni" Williams as commander and pilot for the much-delayed spacecraft.
- Starliner will dock to the International Space Station (ISS) for around 8 days, before returning to Earth for a parachute and airbag-assisted landing in the Southwestern United States.
- Having first been ordered a decade ago by NASA, the flight is the final test before Starliner takes up regular service for NASA, providing a second option for human space flight in addition to SpaceX's Dragon vehicles.
- The mission has not been a smooth ride so far, with numerous setbacks in the form of a failed uncrewed test flight to the ISS in 2019 and blocked valves forcing postponement on the launchpad in 2021, but the empty vessel finally reached the ISS in May 2022.

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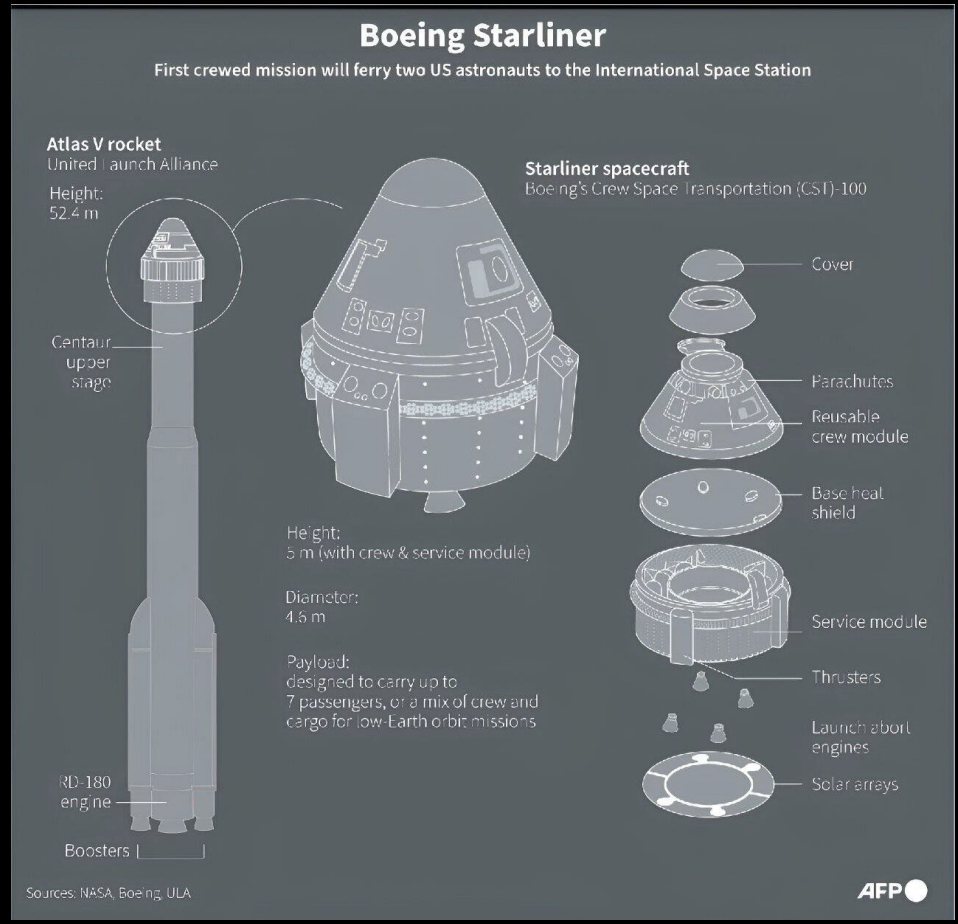
Boeing's Starliner set for 1st June launch (2)

- The process has been one of embarrassment for Boeing as they were predicted to beat SpaceX's Dragon to become the next crewed rocket.
- NASA associate administrator, Jim Free, predicted the mission would not be "hiccup-free" prior to the original launch date on 6th May, and he wasn't wrong.
- The first attempt at a launch on 6th May was dramatically called off just two hours before launch, when the astronauts were already strapped into their seats, after a new safety issue was identified.
- Engineers noticed audible buzzing from a liquid oxygen relief valve on the Atlas V rocket and, upon further investigation, the unusual vibrations were thought to be a sign that valve parts might be wearing down to the point of failure.
- The launch date was reset to 17th May.



Graphic on the Boeing Starliner, which will make its first crewed mission to the International Space Station on the Atlas V rocket

Lewes Astronomical Society

Boeing’s Starliner set for 1st June launch (3)

A United Launch Alliance Atlas V rocket with Boeing’s CST-100 Starliner spacecraft aboard is seen as it is rolled out of the Vertical Integration Facility to the launch pad at Space Launch Complex 41.
Credit: NASA/Joel Kowsky

- Prior to the rescheduled date, a new problem emerged in the form of a small helium leak in the service module, which holds instruments used to control and operate the spacecraft.
- Boeing stated that the helium is used in the thruster systems and is not combustible or toxic.
- Liftoff was rescheduled for 21st May.
- Again, prior to the launch, NASA announced that the date would need to be delayed until 25th May, to allow for further assessment of the helium leak, however, this has since been updated to 1st June while teams continue to work on Starliner’s performance.
- Backup launch dates are set for the 2nd, 5th, and 6th of June. It seems they may be needed.

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Spaceflight News and Updates (1)

- Intercropping Martian Vegetables - Crop systems analysts at Wageningen University and Research in the Netherlands have been looking into whether intercropping is a viable option for optimizing vegetable production on Mars. It is considered unsustainable for future colonists to rely on soil or fertiliser delivered from Earth so, in their study, researchers grew test plants in simulated Martian soil in a greenhouse. Intercropping is a form of planting which encourages symbiotic nutrient exchange between plants, allowing them to grow stronger together than alone. Tomatoes, carrots and green peas were chosen for the study and, as was anticipated, all 3 plants grew well in their greenhouse. Tomatoes grew bigger and had more potassium in pots with other tomato plants and peas but intercropping decreased yields for peas and carrots, which preferred to grow alone. They also found that adding sand to the soil in some of the pots increased yields.

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Spaceflight News and Updates (2)

- **Successful launch for NASA's PREFIRE mission to study polar energy loss** - NASA's Polar Radiant Energy in the Far-InfraRed (PREFIRE) mission has been successfully launched from Launch Complex 1 in Māhia, New Zealand on an electron rocket, 25th May. The mission aims to capture measurements over the poles that can only be gathered in space, to improve our understanding of how much of Earth' heat is lost to space from the polar regions. The launch has been named "Ready, Aim, PREFIRE", and will be followed by a second CubeSat mission launch several weeks later, named "PREFIRE and Ice", also from New Zealand on an Electron rocket.
- **Starship's next launch set for 5th June** - SpaceX have announced that Starship, the world's most powerful rocket, is set for its next test flight on 5th June. This will be the fourth test for the mega rocke which is vital to NASA's plans for landing astronauts on the Moon this decade. All three previous attempts have resulted in the rocket's destruction, but the company states that this is an acceptable trial and error cost in its development. The most recent launch in March, earlier this year, saw Starship successfully lift off and reach orbital velocity, but lost contact with SpaceX during re-entry. This time, SpaceX hopes to achieve a soft splashdown for the booster stage in the Gulf of Mexico, and a "controlled entry" for the upper stage.

Lewes Astronomical Society

Spaceflight News and Updates (3)

- Ariane 6 Launches - Arianespace and ESA are targeting a window between 15th June and 31st July 2024 for Arian 6's first flight. As Europe's newest rocket, Ariane 6 will be taking on many space missions with unique objectives, destinations, and with unique teams to carry them out back on Earth. The rocket will be used for launching new satellites with missions to study Earth, space, or to test new technologies in orbit. On its historic first flight, Ariane 6 will carry four CubeSats into space to test the rocket's versatility.
- Hopping robot designed for asteroid exploration - The SpaceHopper project was launched two and a half years ago as an ETH focus project for Bachelor's degree students and has now been continued as a regular research projects by five Master's degree and one doctoral student. To test the robot's capabilities under zero gravity conditions, the researchers took it on a European Space Agency parabolic flight. Please click the following link to watch the video: https://www.youtube.com/watch?v=8I4fe9VaQQg

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Spaceflight News and Updates (4)

- **Twelve countries sign Zero Debris Charter** – On 23rd May, the European Space Agency, along with 12 nations, signed the Zero Debris Charter at the ESA/EU Space Council, confirming their commitment to the long-term sustainability of human activities in Earth orbit. The Charter aids the effort to become debris neutral in space by 2030 and represents the first time that countries have subscribed at a national level. Austria, Belgium, Cyprus, Estonia, Germany, Lithuania, Poland, Portugal, Romania, Slovakia, Sweden, and the United Kingdom has all pledged to adhere to the charter, boosting Europe as a leader in clean space. Since the launch of the Charter at ESA's Space Summit in Seville, Spain, in November 2023, more than 100 organisations, including national space agencies, leading satellite manufacturers, space start-ups, and astronomical societies, have confirmed their intent to sign.

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June 2024

Observational Highlights

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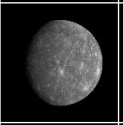
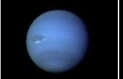
Planets (information for 1st June)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	04:15	19:27	11:51			-0.82	NO
	VENUS	04:49	20:52	12:50			-3.91	NO
	MARS	03:04	16:31	09:48			+1.05	NO
	JUPITER	04:26	20:03	12:15			-1.98	NO
	SATURN	02:07	13:12	07:39	South-East	13° ▫	+1.17	YES
	URANUS	04:03	19:26	11:44			+5.85	NO
	NEPTUNE	02:22	14:15	08:18			+7.91	NO

* = Highest point at Dawn (02:48 - last visible sighting)

** = Highest point at Dusk (23:07 - first visible sighting)

▫ = Highest point when last visible (03:42)

◊ = Highest point when first visible

▫▫ = Highest point when last visible

◊◊ = Highest point when first visible

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
Cr302	The Antares Cluster	Scorpius	Open Cluster	23:51	01:41	00:46	South	12°	+1.0
Mel20	The Alpha Persei Cluster	Perseus	Open Cluster	22:12	03:42	03:42 ◊	North-East	21°	+1.2
Cr39	Collinder 39	Perseus	Open Cluster	22:12	03:42	03:42 ◊	North-East	22°	+1.2
Mel111	The Coma Star Cluster	Coma Berenices	Open Cluster	22:25	03:42	22:25 ◊◊	South-West	58°	+1.8
Cr256	Collinder 256	Coma Berenices	Open Cluster	22:25	03:42	22:25 ◊◊	South-West	58°	+1.8
C33	The Eastern Veil Nebula	Cygnus	Nebula	23:07	02:48	02:48 *	East	56°	+2.7
Mel186	Melotte 186	Ophiuchus	Open Cluster	22:53	03:01	02:21	South	42°	+3.0
Cr359	Collinder 359	Ophiuchus	Open Cluster	22:53	03:01	02:21	South	42°	+3.0
M31	Andromeda Galaxy	Andromeda	Galaxy	01:11	02:48	02:48 *	North-East	28°	+3.4
Cr439	The Elephant Trunk	Cepheus	Cluster with Nebulosity	23:07	02:48	02:48 *	North-East	61°	+3.5
Cr399	Brocchi's Cluster	Vulpecula	Open Cluster	23:07	02:48	02:48 *	South-East	57°	+3.6
Cr349	Open Cluster	Ophiuchus	Open Cluster	23:07	02:48	02:06	South	44°	+4.2
Cr464	Collinder 464	Camelopardalis	Open Cluster	23:07	02:48	23:07 **	North-West	37°	+4.2
C14	The Perseus Double Cluster	Perseus	Open Cluster	23:07	02:48	02:48 *	North-East	29°	+4.3
M24	Delle Caustiche	Sagittarius	Asterism	01:31	02:48	02:37	South	20°	+4.6

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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 - 2 (Information for 1st June)

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M25	Open Cluster	Sagittarius	Open Cluster	22:28	02:48	02:48 *	South	20°	+4.6
M39	Open Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	East	60°	+4.6
NGC6633	Open Cluster	Ophiuchus	Open Cluster	23:07	02:48	02:48 *	South	45°	+4.6
Cr386	Graff's Cluster	Serpens Cauda	Open Cluster	23:07	02:48	02:48 *	South	44°	+4.6
NGC6871	Open Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	South-East	66°	+5.2
NGC869	h Per Cluster	Perseus	Open Cluster	23:07	02:48	02:48 *	North-East	29°	+5.3
NGC7686	Open Cluster	Andromeda	Open Cluster	23:37	02:48	02:48 *	North-East	43°	+5.6
NGC6882	Open Cluster	Vulpecula	Open Cluster	23:07	02:48	02:48 *	South-East	58°	+5.7
M5	Globular Cluster	Serpens Caput	Globular Cluster	23:07	02:48	23:35	South	41°	+5.7
M13	Great Globular Cluster	Hercules	Globular Cluster	23:07	02:48	01:02	South	75°	+5.8
M11	Wild Duck Cluster	Scutum	Open Cluster	23:07	02:48	02:48 *	South	32°	+5.8
Cr29	Collinder 29	Perseus	Open Cluster	23:07	02:48	02:48 *	North-East	26°	+5.9
M16	The Eagle Nebula	Serpens Cauda	Open Cluster	01:02	02:48	02:39	South	25°	+6.0
NGC6605	Open Cluster	Serpens Cauda	Open Cluster	01:19	02:48	02:36	South	24°	+6.0
M17	The Omega Cluster	Sagittarius	Open Cluster	01:48	02:48	02:41	South	23°	+6.0

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC7000	The North American Nebula	Cygnus	HII Region	23:07	02:48	02:48 *	East	64°	+6.0
M12	Globular Cluster	Ophiuchus	Globular Cluster	23:07	02:48	01:07	South	37°	+6.1
Cr350	Collinder 350	Ophiuchus	Open Cluster	23:07	02:48	02:08	South	40°	+6.1
NGC7160	Open Cluster	Cepheus	Open Cluster	23:07	02:48	02:48 *	North-East	60°	+6.1
NGC884	chi Per Cluster	Perseus	Open Cluster	23:07	02:48	02:48 *	North-East	29°	+6.1
M15	Globular Cluster	Pegasus	Globular Cluster	22:44	02:48	02:48 *	South-East	36°	+6.3
NGC6940	Open Cluster	Vulpecula	Open Cluster	23:07	02:48	02:48 *	South-East	57°	+6.3
M3	Globular Cluster	Canes Venatici	Globular Cluster	23:07	02:48	23:07 **	South-West	64°	+6.3
NGC457	The Dragonfly Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	35°	+6.4
NGC7243	Open Cluster	Lacerta	Open Cluster	23:07	02:48	02:48 *	East	54°	+6.4
NGC6604	Open Cluster	Serpens Cauda	Open Cluster	00:41	02:48	02:38	South	26°	+6.5
Cr26	The Heart Nebula	Cassiopeia	Cluster with Nebulosity	23:07	02:48	02:48 *	North-East	31°	+6.5
Cr34	The Soul Nebula	Cassiopeia	Cluster with Nebulosity	23:07	02:48	02:48 *	North-East	29°	+6.5
NGC129	Open Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	42°	+6.5
NGC654	Open Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	35°	+6.5

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M92	Globular Cluster	Hercules	Globular Cluster	23:07	02:48	23:07 **	South-West	75°	+6.5
M10	Globular Cluster	Ophiuchus	Globular Cluster	23:07	02:48	01:17	South	35°	+6.6
M29	The Cooling Tower	Cygnus	Open Cluster	23:07	02:48	02:48 *	East	66°	+6.6
M2	Globular Cluster	Aquarius	Globular Cluster	23:53	02:48	02:48 *	South-East	25°	+6.6
NGC6709	Open Cluster	Aquila	Open Cluster	23:07	02:48	02:48 *	South	49°	+6.7
NGC1027	Open Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	31°	+6.7
NGC7789	The Caroline's Rose	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	43°	+6.7
NGC7023	The Iris Nebula	Cepheus	Nebula	23:07	02:48	02:48 *	North-East	64°	+6.8
NGC6811	The Hole in a Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	East	77°	+6.8
M18	Open Cluster	Sagittarius	Open Cluster	02:26	02:48	02:40	South	22°	+6.9
NGC1502	Open Cluster	Camelopardalis	Open Cluster	23:07	02:48	02:48 *	North	26°	+6.9
M52	The Cassiopeia Salt-and-Pepper	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	49°	+6.9
M81	Bode’s Galaxy	Ursa Major	Galaxy	23:07	02:48	23:07 **	North-West	52°	+6.9
NGC225	The Sailboat Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	41°	+7.0
NGC7635	The Bubble Nebula	Cassiopeia	HII Region	23:07	02:48	02:48 *	North-East	50°	+7.0

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC6960	The Western Veil Nebula	Cygnus	Supernova Remnant	23:07	02:48	02:48 *	South-East	57°	+7.0
NGC7063	Open Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	East	55°	+7.0
NGC663	Open Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	35°	+7.1
NGC6823	Open Cluster	Vulpecula	Open Cluster	23:07	02:48	02:48 *	South-East	58°	+7.1
NGC7380	The Wizard Nebula	Cepheus	Open Cluster	23:07	02:48	02:48 *	North-East	53°	+7.2
NGC7082	Open Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	East	60°	+7.2
Cr418	Open Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	South-East	66°	+7.3
NGC6819	Open Cluster	Cygnus	Open Cluster	23:07	02:48	02:48 *	South-East	73°	+7.3
M103	Open Cluster	Cassiopeia	Open Cluster	23:07	02:48	02:48 *	North-East	36°	+7.4
M27	Apple Core Nebula	Vulpecula	Planetary Nebula	23:07	02:48	02:48 *	South-East	56°	+7.4
NGC6888	The Crescent Nebula	Cygnus	HII Region	23:07	02:48	02:48 *	South-East	67°	+7.5
M14	Globular Cluster	Ophiuchus	Globular Cluster	23:07	02:48	01:58	South	35°	+7.6
C9	The Cave Nebula	Cepheus	HII Region	23:07	02:48	02:48 *	North-East	53°	+7.7
M53	Globular Cluster	Coma Berenices	Globular Cluster	23:07	02:48	23:07 **	South-West	52°	+7.7
M107	Globular Cluster	Ophiuchus	Globular Cluster	23:07	02:40	00:53	South	26°	+7.8

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
NGC2726	Galaxy	Ursa Major	Galaxy	23:07	02:48	02:48 *	North-West	43°	+7.8
M101	The Pinwheel Galaxy	Ursa Major	Galaxy	23:07	02:48	23:07 **	North-West	82°	+7.9
M26	Open Cluster	Scutum	Open Cluster	23:07	02:48	02:48 *	South	29°	+8.0
M110	Galaxy	Andromeda	Galaxy	01:50	02:48	02:48 *	North-East	29°	+8.1
NGC6885	20 Vulpeculae Cluster	Vulpecula	Duplicate	23:07	02:48	02:48 *	South-East	58°	+8.1
M94	'Spiral' Galaxy	Canes Venatici	Galaxy	23:07	02:48	23:07 **	West	67°	+8.2
M56	Globular Cluster	Lyra	Globular Cluster	23:07	02:48	02:48 *	South-East	67°	+8.4
M71	Globular Cluster	Sagitta	Globular Cluster	23:07	02:48	02:48 *	South-East	53°	+8.4
M51	Whirlpool Galaxy	Canes Venatici	Galaxy	23:07	02:48	23:07 **	West	76°	+8.4
M82	The Cigar Galaxy	Ursa Major	Galaxy	23:07	02:48	23:07 **	North-West	53°	+8.4
M49	Galaxy	Virgo	Galaxy	23:07	02:48	23:07 **	South-West	38°	+8.4
M64	The Black Eye Galaxy	Coma Berenices	Galaxy	23:07	02:48	23:07 **	South-West	53°	+8.5
M63	The Sunflower Galaxy	Canes Venatici	Galaxy	23:07	02:48	23:07 **	West	71°	+8.6
NGC6543	The Cat's Eye Nebula	Draco	Planetary Nebula	23:07	02:48	02:48 *	North	73°	+8.8
M57	The Ring Nebula	Lyra	Planetary Nebula	23:07	02:48	02:48 *	South	71°	+8.8

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

Object	Name	Constellation	Type	↗	↘	Highest	Direction	Alt	Mag
M60	Galaxy	Virgo	Galaxy	23:07	02:48	23:07 **	South-West	42°	+8.8
NGC2403	'Spiral' Galaxy	Camelopardalis	Galaxy	23:07	02:48	23:07 **	North-West	39°	+8.9
M66	Galaxy	Leo	Galaxy	23:07	02:48	23:07 **	South-West	33°	+8.9
M86	Galaxy	Virgo	Galaxy	23:07	02:48	23:07 **	South-West	42°	+8.9
M87	Virgo A Galaxy	Virgo	Galaxy	23:07	02:48	23:07 **	South-West	42°	+8.9
NGC6539	Globular Cluster	Serpens Cauda	Globular Cluster	23:43	02:48	02:25	South	31°	+8.9
M32	Galaxy	Andromeda	Galaxy	01:57	02:48	02:48 *	North-East	28°	+9.0
M85	Galaxy	Coma Berenices	Galaxy	23:07	02:48	23:07 **	South-West	46°	+9.1
M40	Winnecke 4	Ursa Major	Double Star	23:07	02:48	23:07 **	North-West	40°	+9.1
M96	Galaxy	Leo	Galaxy	23:07	02:07	23:07 **	West	27°	+9.2

Twilight	Civil	Naut	Astro		Rises	Sets
Ends	21:49	22:53	-	Sun	04:49	21:04
Starts	04:05	03:01	-	Moon	02:25	14:48

* = Highest point at Dawn (02:48 - last visible sighting) ** = Highest point at Dusk (23:07 - first visible sighting)

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Lewes Astronomical Society

Phases of the Moon

Brown Lunation Numbers

numbered from first New Moon in 1923

Phase	Date	Time	Lunation
NEW MOON	6th June	13:37	1255
FIRST QUARTER	14th June	06:18	1255
FULL MOON	22nd June	02:07	1255
LAST QUARTER	28th June	22:53	1255

Credit: Vito Technology, Inc.

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