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Newsletter - July 2023

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Astronomy News

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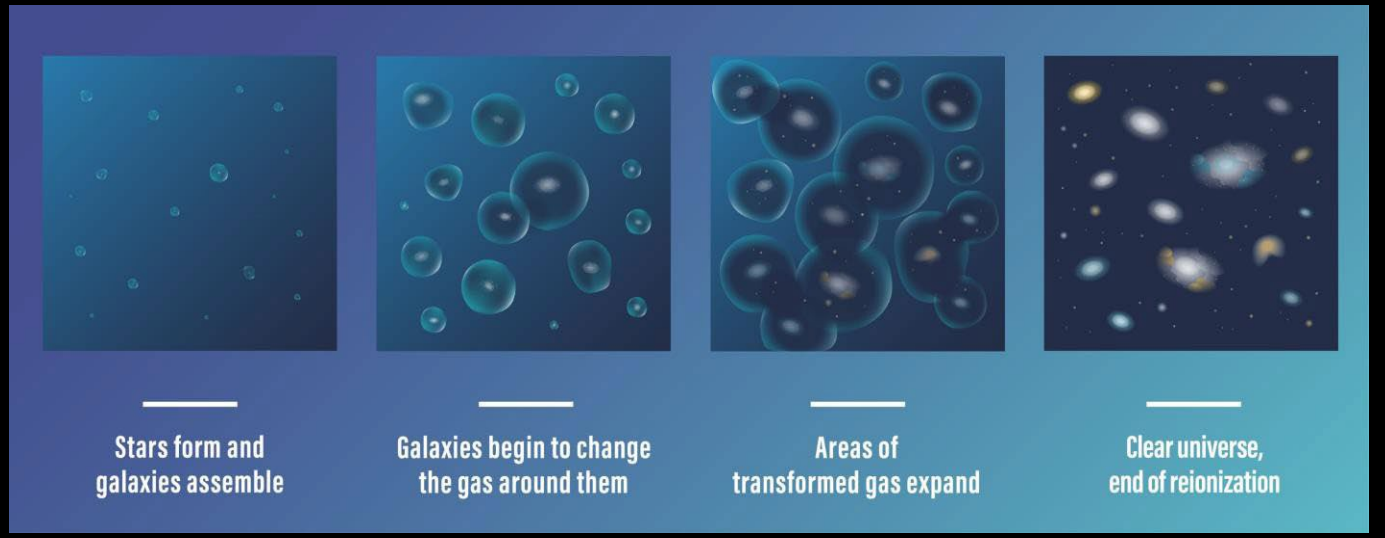
JWST looks on the Epoch of Reionisation

- After the Big Bang huge clouds of neutral gas were formed. The Universe was still hot, dense and obscure, photons could not escape
- But within a few hundred million years the Universe was transparent. Young active stars radiated out enough energy to re-ionise the dense gas and huge areas became transparent

Top right - JWST has provided evidence that galaxies that existed 900 million years after the Big Bang ionized the gas around them, causing it to become transparent. The “bubbles” of gas have a 2 million light year radius around tiny galaxies. Over the next 100 million years the bubbles grew, merged and caused the entire universe to become transparent
Credit: NASA, ESA, CSA, Simon Lilly (ETH Zürich), Daichi Kashino (Nagoya University), Jorryt Matthee (ETH Zürich), Christina Eilers (MIT), Rob Simcoe (MIT), Rongmon Bordoloi (NCSU), Ruari Mackenzie (ETH Zürich); Image Processing: Alyssa Pagan (STScI) Ruari Macken
Bottom right – credit: NASA, ESA, CSA, Joyce Kang (STScI)



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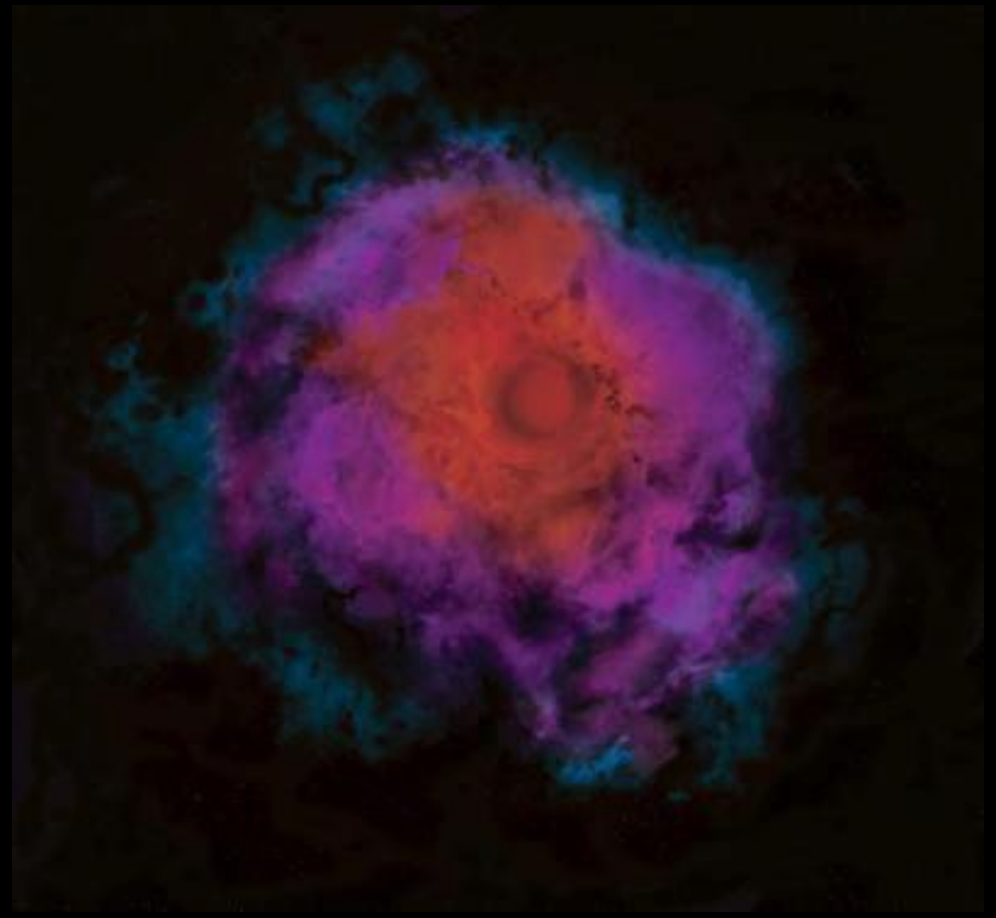
Roman Telescope could detect dark stars

- The earliest stars were massive as they didn't have any metals in their core to help generate energy
- But what if, in the early universe, Dark Matter was concentrated in clumps and attracted large clouds of hydrogen and helium
- As the clouds collapsed under the effects of gravity, Dark Matter generated the energy
- These Dark Stars would have been thousands or hundreds of thousands the size of the Sun
- Too dim to be visible to today's telescopes, the new Nancy Grace Roman Telescope may be able to find the very biggest ones



Credit: University of Utah, USA

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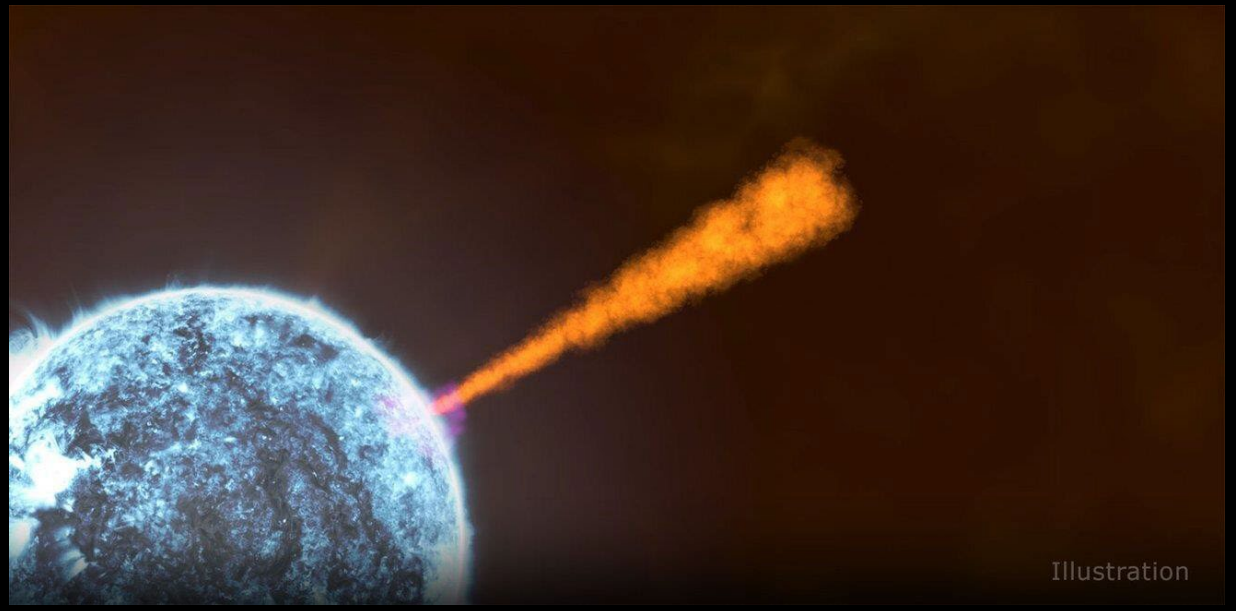
The brightest cosmic explosion

- Since it was first observed in October 2022 there have been a number of updates on the Brightest Object of All Time (BOAT)
- It was so powerful it sent shockwaves through the Earth's Ionosphere
- The intense brightness was caused as the initial burst (GRB 221009A) and jet of material dragged along was directly pointing at Earth



Credit: NASAs Goddard Space Flight Center

- What was not expected was the very long slow fade of the afterglow. It is now suspected that the narrow jet was embedded in a much wider gas outflow. Mixing caused continuous shockwaves boasting the afterglow
- See an interview with the lead researcher at: https://youtu.be/lRpzURkm84U

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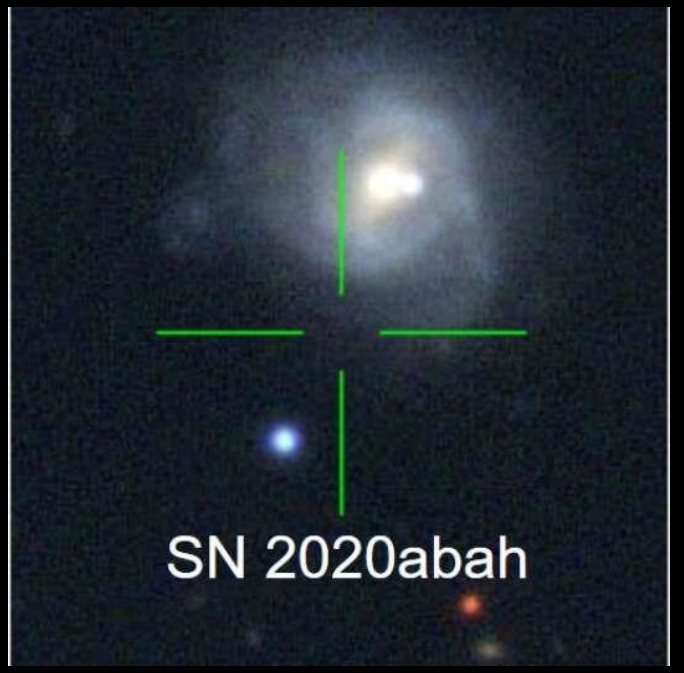
12 new Type II supernovae found

- When a star more than 8 times (and probably less than 15 times) the mass of the Sun reaches its end stage it starts converting silicon into iron. This process takes in more energy than it gives out and the star's core collapses within seconds. Once the core hits a critical density, gravity is overpowered by the nuclear force which becomes repulsive, and the matter is violently expelled outward. The core then either stabilises as a neutron star or continues to collapse into a black hole. This is a Type II supernova (SNe)
- Some Type II SNe are characterized by their unusual long rises to peak — lasting more than 40 days
- Until now only 16 "long risers" have been found but, after reviewing data, researchers have identified 12 more
- See the debris of a supernova: https://cdn.jwplayer.com/previews/CWFWMUoR



Archival images of the location of one the newfound long-rising SNe II
Credit: Tawny Sit (Ohio State University, USA) et al, 2023

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Measuring galaxy distances

- Measuring distances to galaxies has relied on three main methods:
  - Redshift – used for distant galaxies
  - Type Ia supernovae – medium to distant galaxies
  - Standard candles: Cephid and RR Lyrae variable stars – for close to medium galaxies. These rely on the relationship between periodicity and luminosity at the same elemental abundance
- There is a sub-class of the RR Lyrae, the double-period variable which account for 5% of all RR Lyrae
- These simultaneously pulsate at two different periods. The two periods are associated with stellar properties like elemental abundance and thus a period-luminosity relation independent of the elemental abundance can be established
- Measurements of period are easy increasing the precision distance by 20-fold

M3 Globular Cluster
Credit: Robert J. Vanderbei/WIKI

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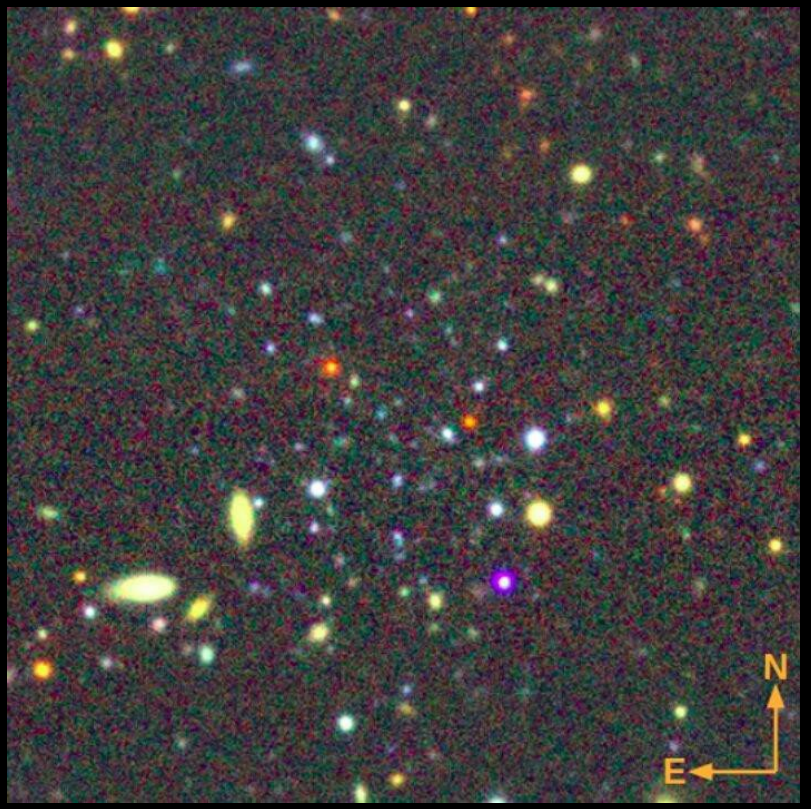
Nearby old metal-poor cluster found

- A star cluster, DELVE 6, at least 9.8 billion years old, has been found as a satellite of the Magellanic Clouds
- Situated 261,000 light years from Earth, and 65,000 light years from the Small Magellanic Cloud and 114,000 light years from the Large Magellanic Cloud, DELVE 6 is beyond the tidal radius of either Cloud. Only a few ancient star clusters are associated with either the SMC or LMC
- It has a half-light radius of 32.6 light years (the radius at which half the total light is emitted), and a metallicity below -1.17. It is also ultrafaint



False colour from the Legacy Survey Sky View
Credit: William Cerny (Yale University, USA) et al, 2023

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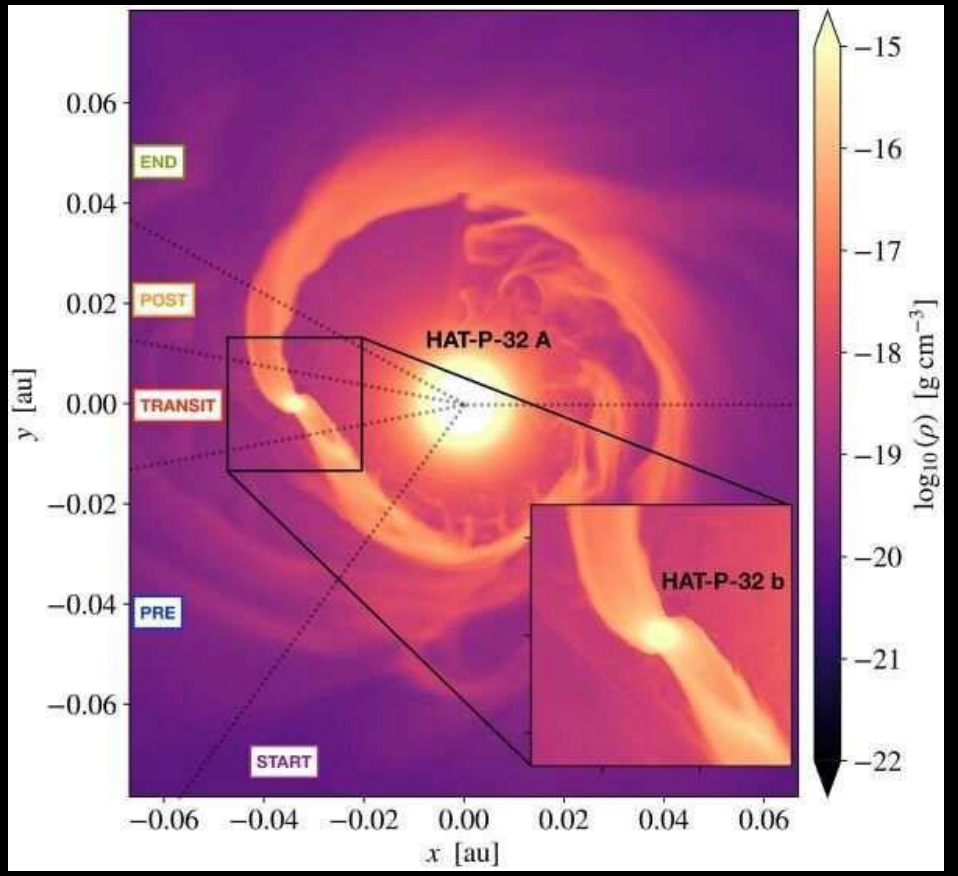
Exoplanet trailing gas in its wake

- HATS-P-32b is a gas giant exoplanet that orbits its F/G-type star (HAT-32) once every 2.16 days. It is about 0.94 times the mass but has a radius of 2.037 of Jupiter, and is about 950 light years from Earth in the constellation, Andromeda
- It is only 0.03397 AU from its star (just over 5 million km) and has a surface temperature of 1,250 K
- The high temperature is causing the exoplanet to lose large amounts of gas. Trails of helium gas stretching 50 times the radius of the planet have been observed



Simulated view of the planet HAT-P-32b orbiting its parent star, HAT-P-32A. The planet is nearly twice the size of Jupiter and losing its atmosphere through dramatic tails of helium unfurling before and behind it as it travels through space

Credit: M. MacLeod (Harvard-Smithsonian Center for Astrophysics) and A. Oklopčić. (Anton Pannekoek Institute for Astronomy, University of Amsterdam)

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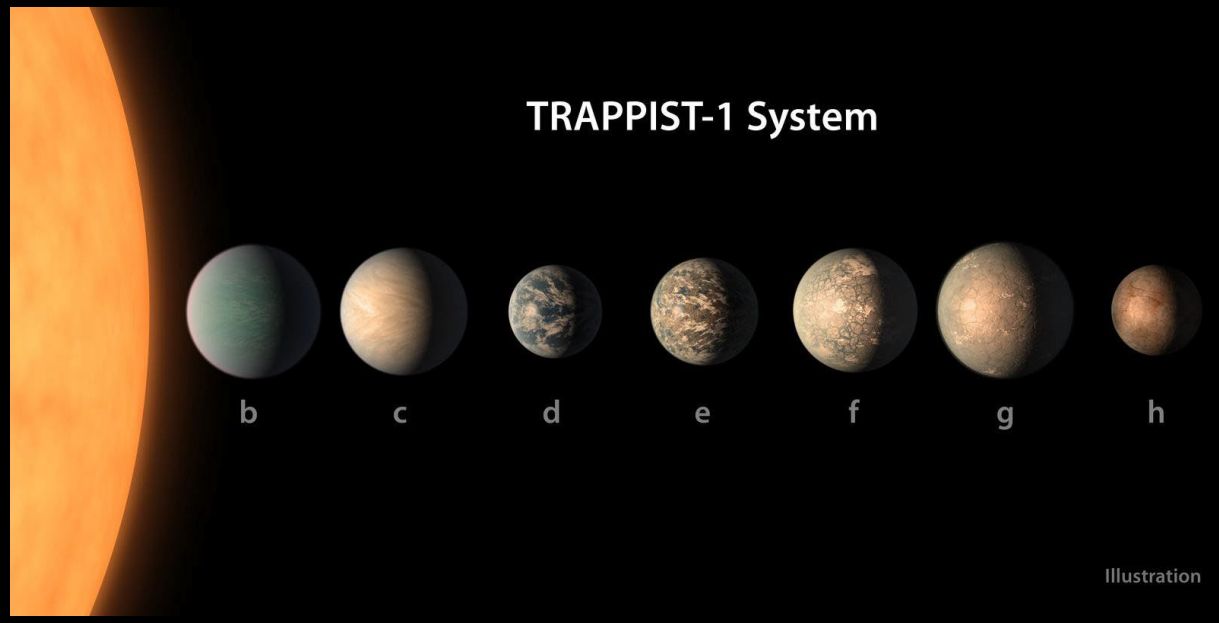
JWST studies TRAPPIST-1 exoplanets (1)

- The TRAPPIST-1 system consists of 7 rocky planets orbiting an ultra-cool red dwarf, some 40 light years from Earth. Several of the exoplanets are in the star's habitable zone
- The TRAPPIST-Exoplanets have been studied by Hubble (Visible/UV light) and Spitzer (IR) but JWST was needed to be able to pick up heavy molecules such as carbon dioxide, methane and oxygen



Credit: NASA/JPL-Caltech/R. Hurt, T. Pyle (IPAC)

- Having already studied the first exoplanet (TRAPPIST-1b) in detail, JWST has turned its attention to the second planet (TRAPPIST-1c). It had been hoped that it would be a Venus-type planet with a thick atmosphere but JWST failed to find one. It may have a very thin atmosphere (thinner even than that around Mars) or be bare rock like TRAPPIST-1b

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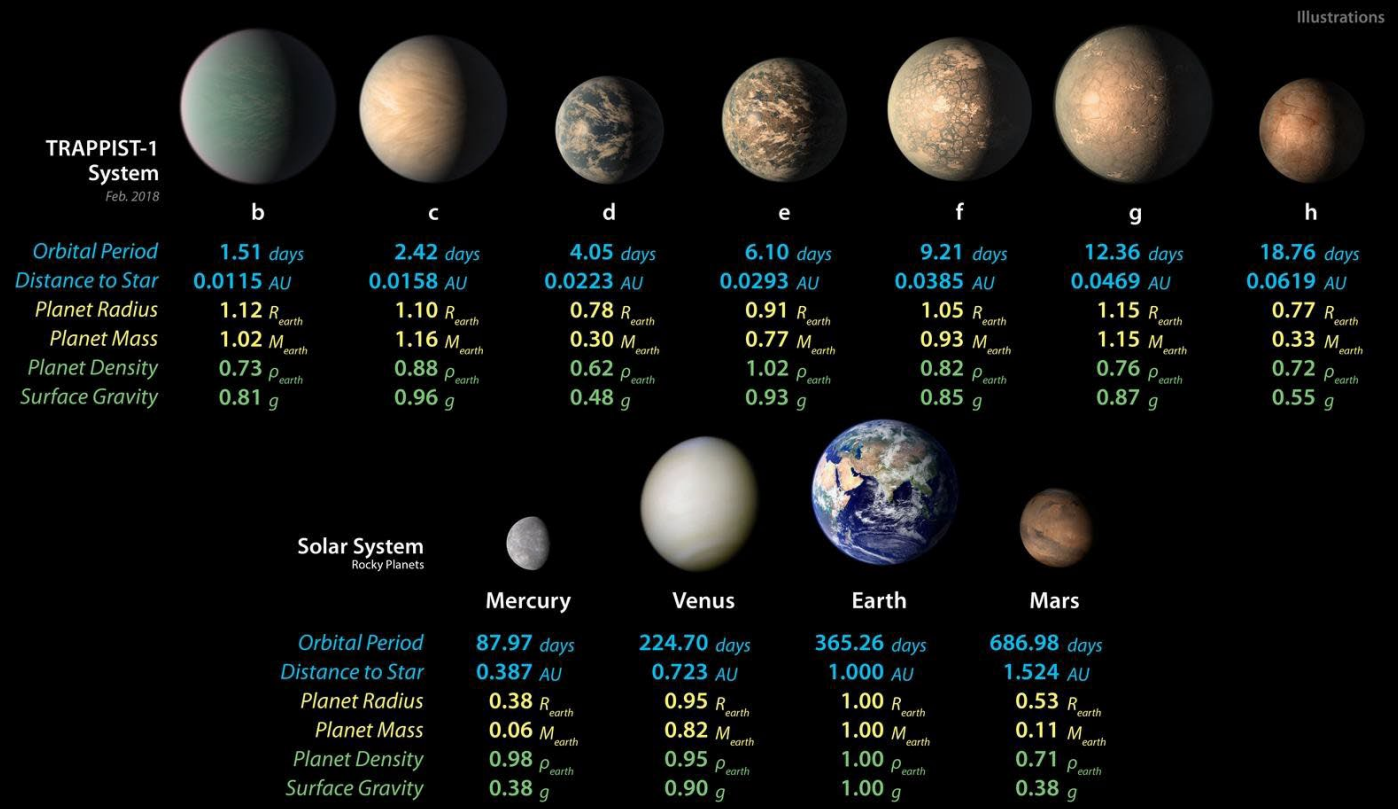
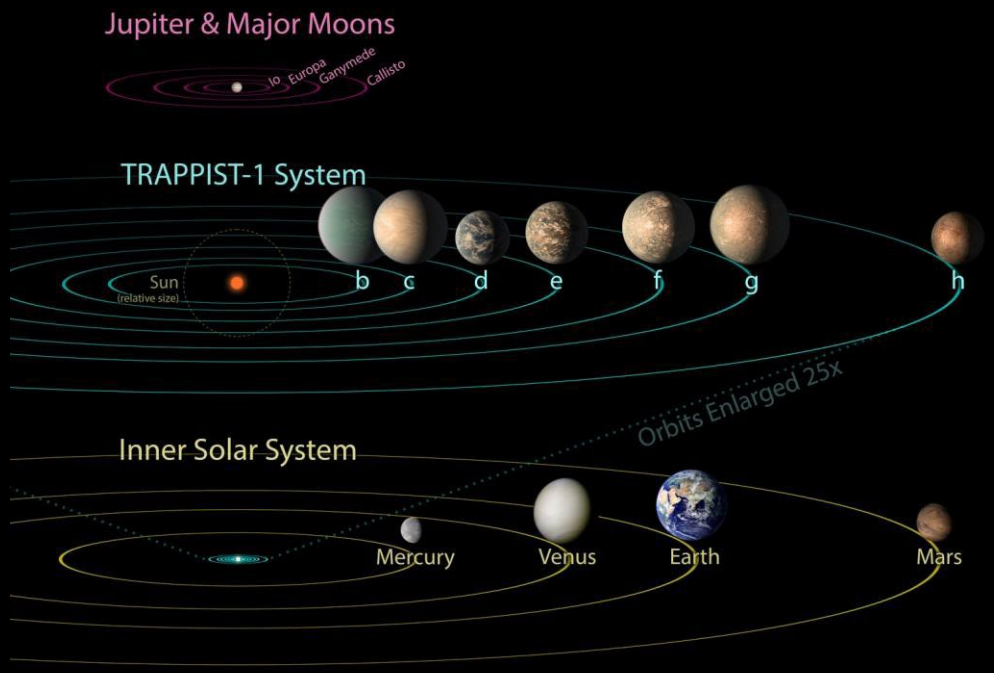
JWST studies TRAPPIST-1 exoplanets (2)





Size and orbits of TRAPPIST-1 system compared with the Solar System
Credit: NASA/JPL-Caltech/R. Hurt, T. Pyle (IPAC) (both illustrations)

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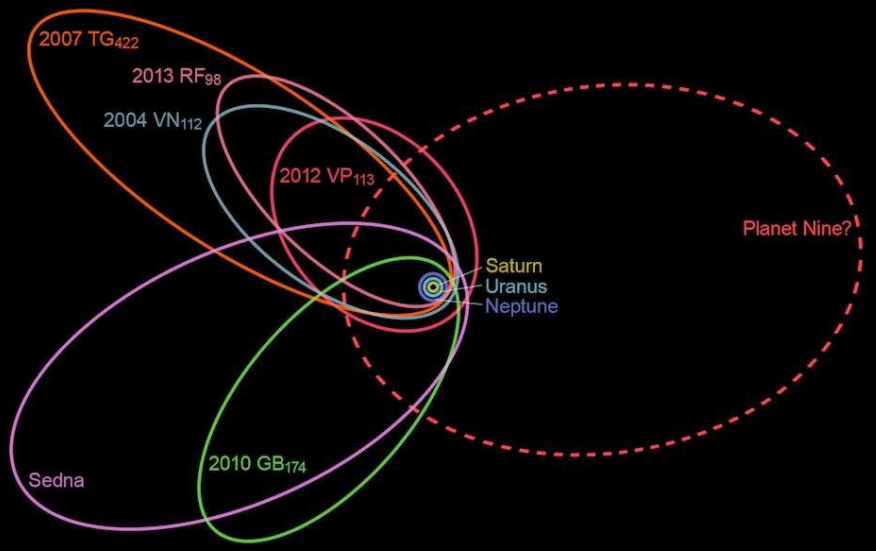
Does Planet 9 exist after all?

- For many years, astronomers have speculated that another, as yet undiscovered, planet (Planet 9) may be present in the Solar System
- Perturbations in the orbits of some trans-neptunian objects suggest that somewhere there is a large super-Earth (between 4 and 8 times the mass of the Earth) waiting to be found. But being very dim it would be hard to detect
- In 2014, a 1m meteorite (CNEOS14) fell into the ocean. From its speed (60 km/s) it was thought to have come from outside the Solar System as no known planet could have deflected it. But by plotting the possible orbit of Planet 9 against the trajectory of CNEOS14 it appears the meteorite ran across Planet 9 about 30-60 years ago



Hypothetical orbit of Planet 9 with respect to the solar system and other extreme trans-neptunian objects
Credit: nagualdesign / Wikipedia, CC BY

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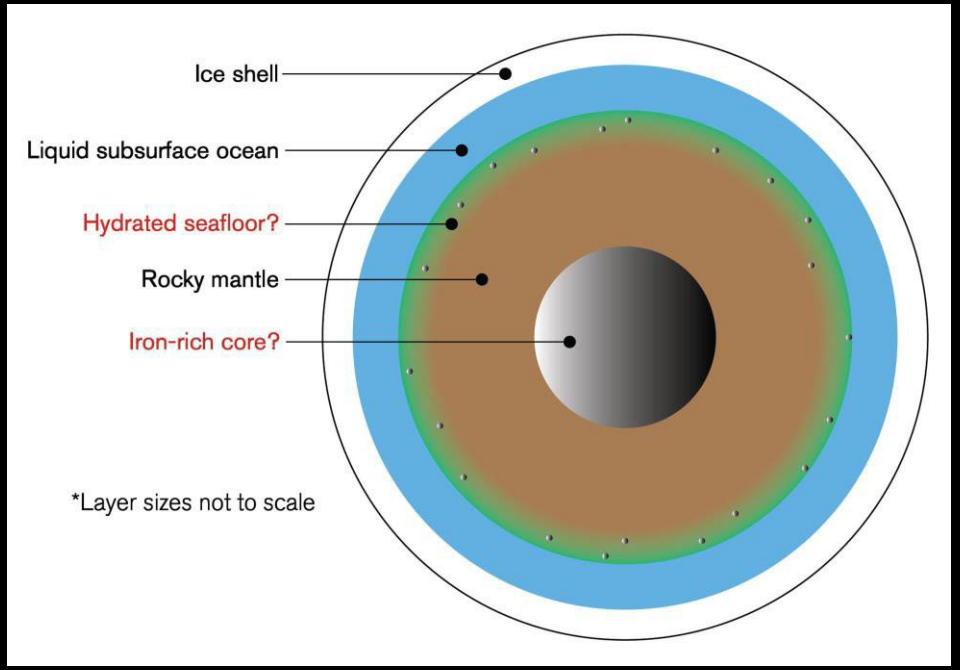
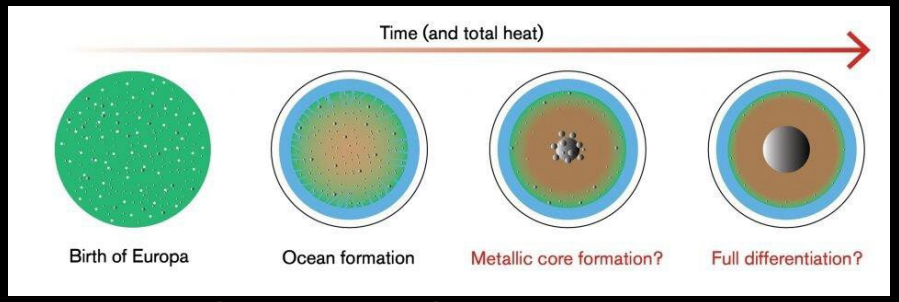
Europa's slow evolution

- Europa is one of the most promising places in the Solar System to look for possible life
- There is strong evidence it has the water, nutrients and energy required by life
- It is thought to have 4 layers: an ice shell, salt water ocean, rocky mantle, and metallic core
- Because of the cold, a new theory suggests that Europa's evolution was fairly slow
- Being small, it probably didn't have enough heat initially to form a metallic core. This came much later, through a mixture of tidal heating (from Jupiter) and heat released by chemical reactions from hydrated rocks (which produced the watery ocean in the process)





Europa Structure Credit: Kevin Trinh, Arizona State University
Europa Evolution Credit: Arizona State University

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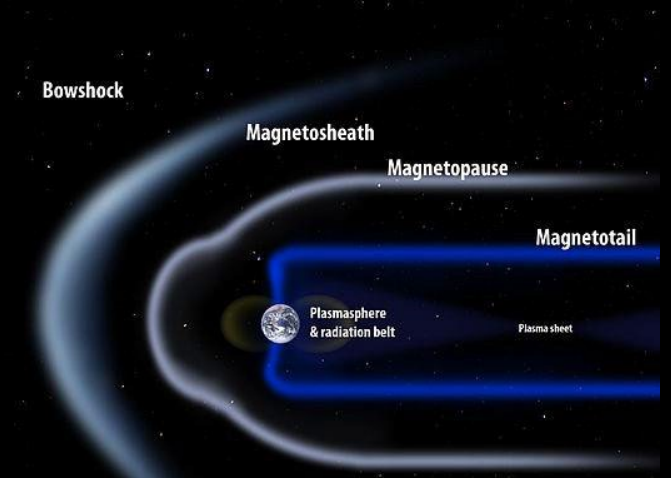
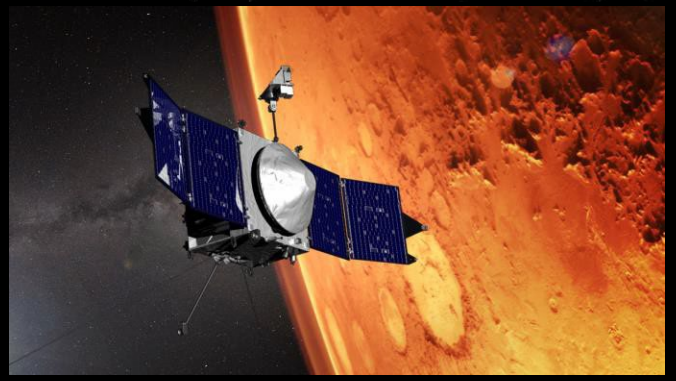
Jet streams in Mars' Magnetosheath

- If a planet has some sort of magnetic field, it will have a magnetosphere. It is the area around the planet where charged particles are affected by the magnetic field
- The magnetopause is the boundary between the planet's magnetic field and the solar wind. The magnetosheath is the region of space between the magnetopause and the bow shock of a planet's magnetosphere
- Jet streams of plasma occur in the Earth's magnetosheath but have not been seen on any other planet to date as only satellites in Earth's orbit have fast enough instruments
- Now NASA's MAVEN (Mars Atmospheric and Volatile EvolutioN) orbiter has detected these jets in the magnetosheath of Mars



Magnetosphere – no artist accreditation



The MAVEN Orbiter Credit: NASA/GFSC

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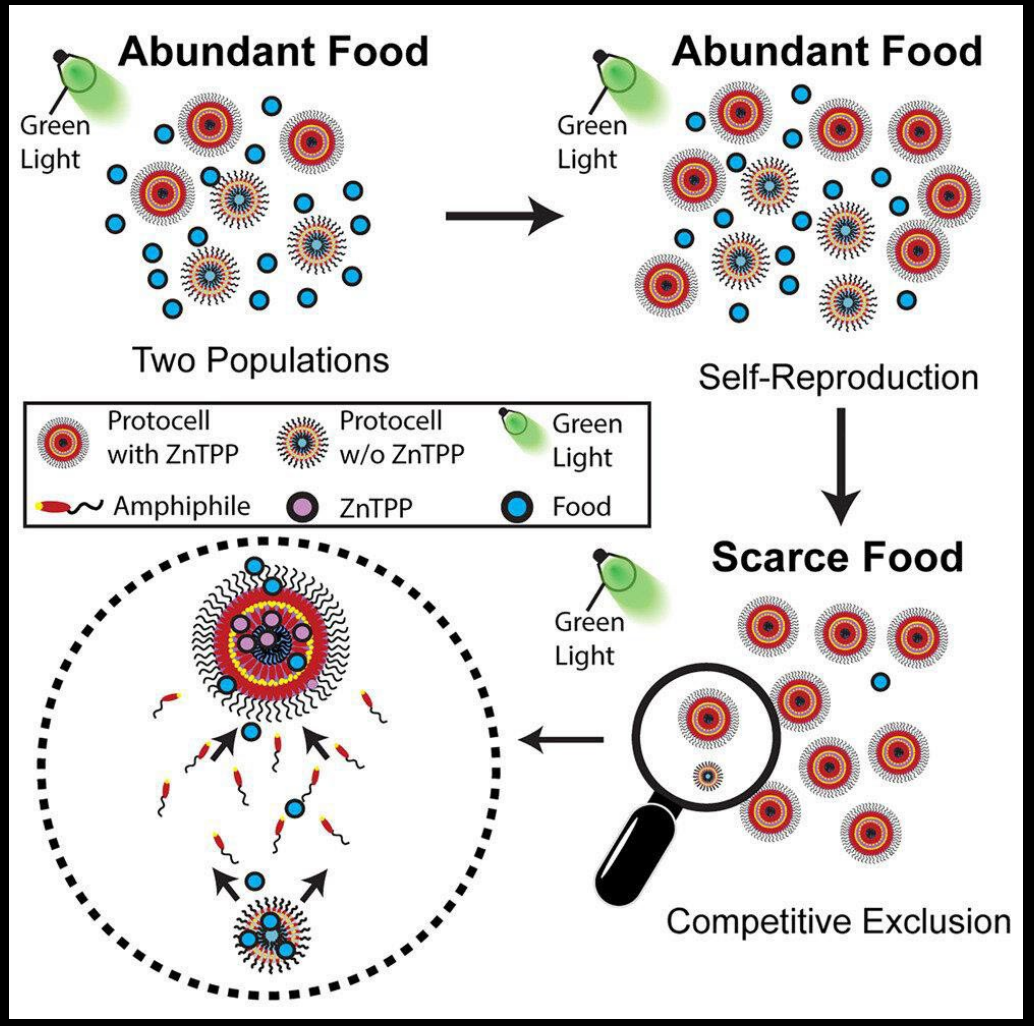
Could life develop without biochemistry?

- On Earth, carbon underpins most of life but biochemical processes are what drives life
- Researchers have created synthetic living systems (protocells) that are based on carbon but don't use biochemical processes; could they be the basis of life on other worlds?
- They act like biochemical cells. They are born, metabolize what they need, grow, move, reproduce, and perhaps even evolve
- Two new species of protocells one with the advantage of light sensitivity, the other without were pitted against each other in an illuminated environment where they had to share food. The light-sensitive "species" won



Credit: Cell Reports Physical Science (2023). DOI: 10.1016/j.xcrp.2023.101359

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Astronomy News in Brief (1)

- Dark Matter – the lack of “clumpiness” in the Universe suggests that Dark Matter is made of a (hypothetical) lightweight particle, called an Axion
- Dark Matter – interest is being shown in research suggesting Dark Matter may be fuzzy and extend much further around a galaxy. Modelling suggests that, in this form, it is similar to giant versions of Bose-Einstein condensates (BEC)
- Faintest Galaxy –MACS1149-JD1 is now officially the oldest and faintest galaxy so far detected, 480 million years after the Big Bang. Light from it has been travelling to us for 13.28 billion light years based on a confirmed redshift of 9.11. Gravitationally lensed by galaxy cluster Abell 2744 (about 4 billion light years away) made JD-1 13 times brighter
- Gravitational Waves – so far gravitational waves have only been detected when a binary system collapses (the merger of two stellar mass black holes, for instance). Now researchers believe that the turbulent energetic cocoons surrounding dying massive stars may also emit gravitational waves

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Astronomy News in Brief (2)

- Gravitational Waves – binary supermassive black holes (SMBH) have never been actually observed as they are too big and much too far apart for Earth-based equipment like LIGO to detect. But gravitational waves from supermassive black hole binaries may cause changes in the patterns of pulsars and help point out SMBH candidates
- Milky Way Black Hole – Sagittarius A*, the supermassive black hole at the centre of our galaxy appears to be quiet. But around 200 years ago, it decided to go on a feeding frenzy which lasted about 18 months. The X-rays emitted have energised and lit up the surrounding molecular gas clouds
- Runaway Stars – a further 6 stars have been found that are being ejected from the Milky Way (now totals 16) by supernova explosions. Two are the fastest known moving stars at 2,285 km/s and 1,694 km/s

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Astronomy News in Brief (3)

- White Dwarf becoming a giant diamond – a White Dwarf is often composed of oxygen and carbon, and, as it cools and becomes denser, it could start crystallising into a giant diamond. Scientists think they have discovered one White Dwarf that may be old enough (HD 190412 C – 104 light years away) to be starting the process, which could take one quadrillion (one million billion) years to complete
- Betelgeuse – after the Great Dimming event of 2019-2020 when a cloud of gas and dust, expelled by the star, obscured a third of it and reduced its brightness by 60%, Betelgeuse is now 50% brighter than normal. No one knows why but it is unlikely to go supernova anytime soon
- New Circumbinary System – the second ever multiplanetary circumbinary system has been discovered. This is where a planet orbits a binary star system, just like the planet Tatooine in the Star Wars films

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Astronomy News in Brief (4)

- The Sun’s Magnetic Field – Coronal Mass Ejections (CME) are powerful enough to knock out power grids and damage satellites. Caused by the Sun’s strong magnetic field, researchers are using supercomputers to simulate the small-scale dynamos that could underpin the process and understand what is going on
- Saturn – phosphates, a key building block for life, have been found in the subsurface ocean of Enceladus
- Mars – data from the InSight lander suggest that Mars has a liquid core and mass anomalies below the planet’s surface
- Mars – NASA is using a mixture of official names and nicknames to help map the Martian surface and to help keep track of what’s been found
- Earth – the rotational pole has moved by about a metre in the last 20 years due to all the groundwater we have pumped out (about 2,150 gigatons, enough to raise the sea level by 6mm)

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Astronomy News in Brief (5)

- Earth – new theories suggest the planet may have been formed a lot quicker than currently predicted (100m years). Within a few million years the accumulation of small millimetre-sized pebbles would have produced an Earth-sized planet – with water a spin-off of the process
- Earth – the planet used to spin a lot quicker in its youth when the Moon was a lot closer. But as the Moon has drifted away, it has stolen some of the rotational energy and slowed the Earth down. However, for one billion years, the Earth was stuck with a 19-hour day before beginning to slow to its current 24 hours
- Earth – scientists have confirmed there is a link between secondary cosmic radiation and major earthquakes. Changes in cosmic radiation occur 15 days in advance of seismic activity which may help detect upcoming earthquakes
- Satellite Trails – a new tool has been developed which helps remove satellite trails from Hubble images

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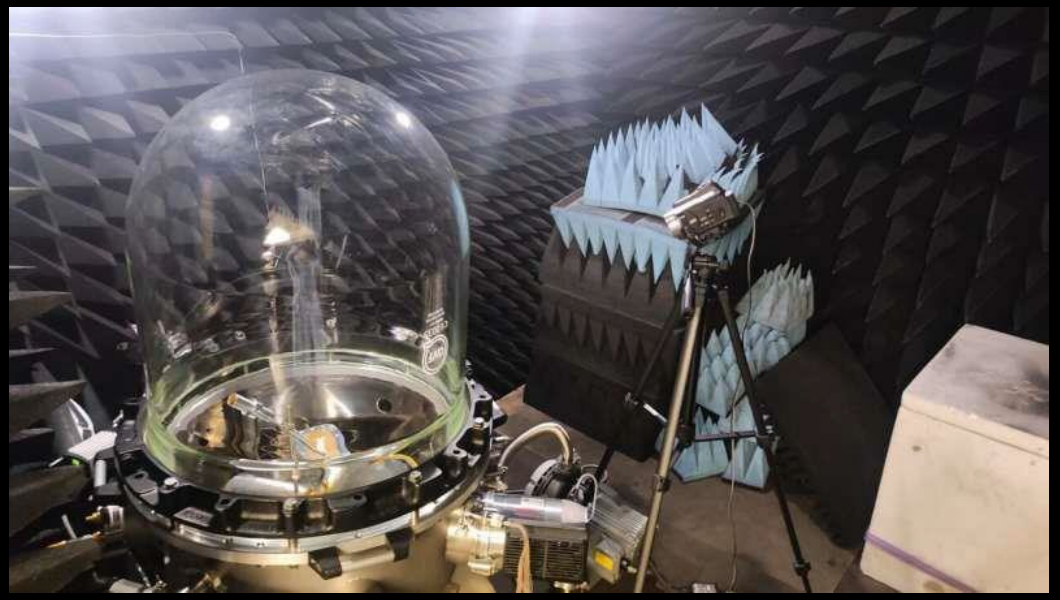
Spaceflight News

Staying in communication

- Antennae on the launcher and spacecraft play a critical role. Both provide communication from and to Earth, relaying instructions, system status, and telemetry and navigation information, and loss of signal could spell disaster
- Space vehicles carry a range of low- and high-gain antennae, from GNS and S-band to C-band and UHF



Credit: Anteral

- They must survive the rigours of launch, vibrations and wild swings in temperature. Changes in atmospheric pressure during the launch phase can cause serious lightning-like electrical discharges
- For the Miura 1 sub-orbital micro-launcher a new group of antennae, each the size of a mobile phone, is undergoing rigorous testing, under glass (to be able to change air levels) to mitigate the risk of damage from electrical discharges

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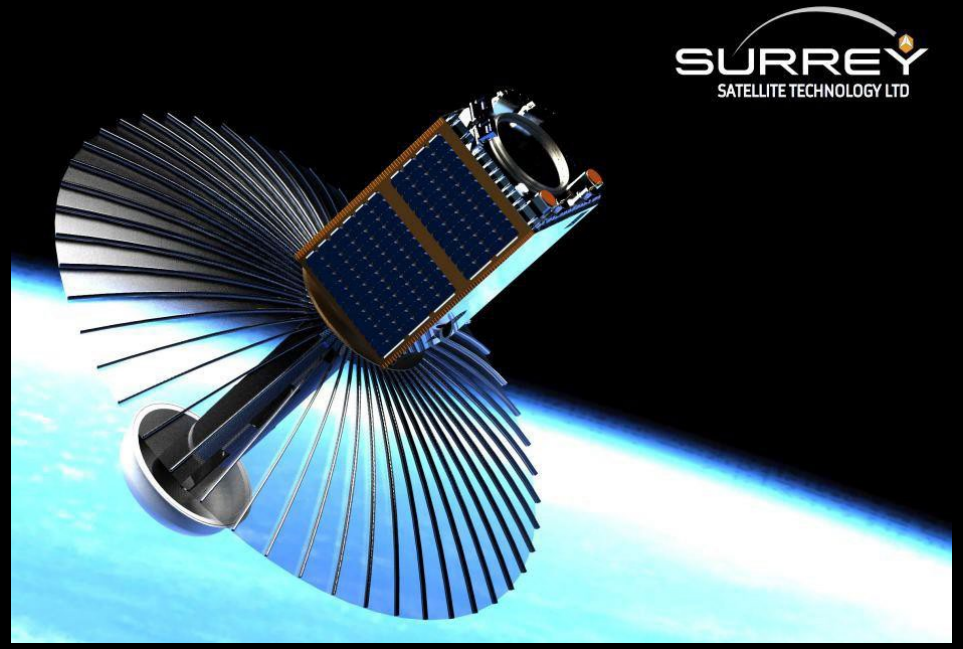
British antennae designs used in space

- Oxford Space Systems (OSS) have a reputation for designing novel antenna systems. Some of their helical antennae have made it into space on board missions launched by Lacuna
- Other designs, such as a wrapped rib antenna still wait to be used on a mission
- Now they have teamed up with Surrey Satellites Technology Ltd (SSTL) to provide the antenna on a new Synthetic Aperture Radar (SAR) satellite called CarbSAR that will orbit at a height of 520km above the Earth which will make 3D images overhead. The antenna can transmit 500MB/s of data to a ground station



CarbSAR Credit: Surrey Satellites Technology Ltd

- See the OSS antennae being developed at: https://youtu.be/6UZerFHpE0k

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Sustaining life beyond Earth

- Just how do you provide all the food and oxygen for a trip to Mars (and back) and on a Martian base?
- Remember the film, The Martian (2015) where stranded astronaut, Mark Watney (Matt Damon), creates a garden inside the Hab using Martian soil fertilized with the crew's bio-waste and manufactures water from leftover rocket fuel

Still from the film, The Martian (2015) Credit: Oscarchamps.com

- Farfetched – not that far away from reality. Supplies to Mars would be constrained so food, oxygen and water would need to be made on the way
- The ISS uses solar power (a lot of it) to convert water into hydrogen and oxygen, and another system to convert carbon dioxide into water and methane
- Artificial photosynthesis could step in simplifying the process, producing hydrogen or carbon-based fuels, or fertilizers, polymers or pharmaceuticals

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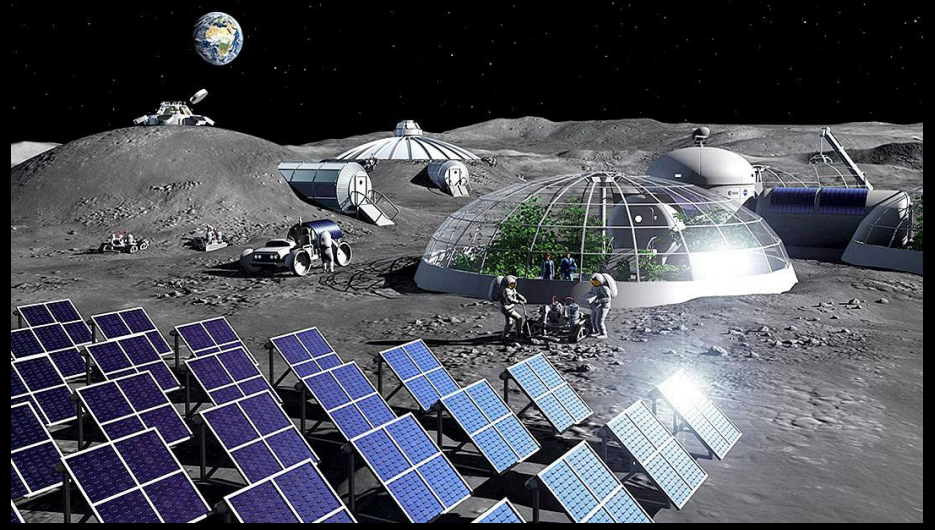
What do you do about (Moon) dust?

- Within the next few years, it is hoped that lunar bases will be established on the Moon
- NASA (Artemis Base Camp), ESA (Lunar Village) and China (International Lunar Research Station) will be a permanent presence on the Moon surface
- But before the first module is ever launched, scientists and engineers are wrestling with the problem of how to cope with lunar dust (regolith)



Artemis Moon Base Credit: NASA/ESA

- It covers the surface to a depth of up to 10m. It is fine, jagged and sharp (no weathering), and sticky (electrostatically charged by the solar wind) – and it gets everywhere. It plays havoc with sensitive equipment – life support systems, power supplies and other vital components, gets into anything that moves (rovers), and wears parts (and spacesuits) out
- Viable solutions need to be developed before long term bases are established

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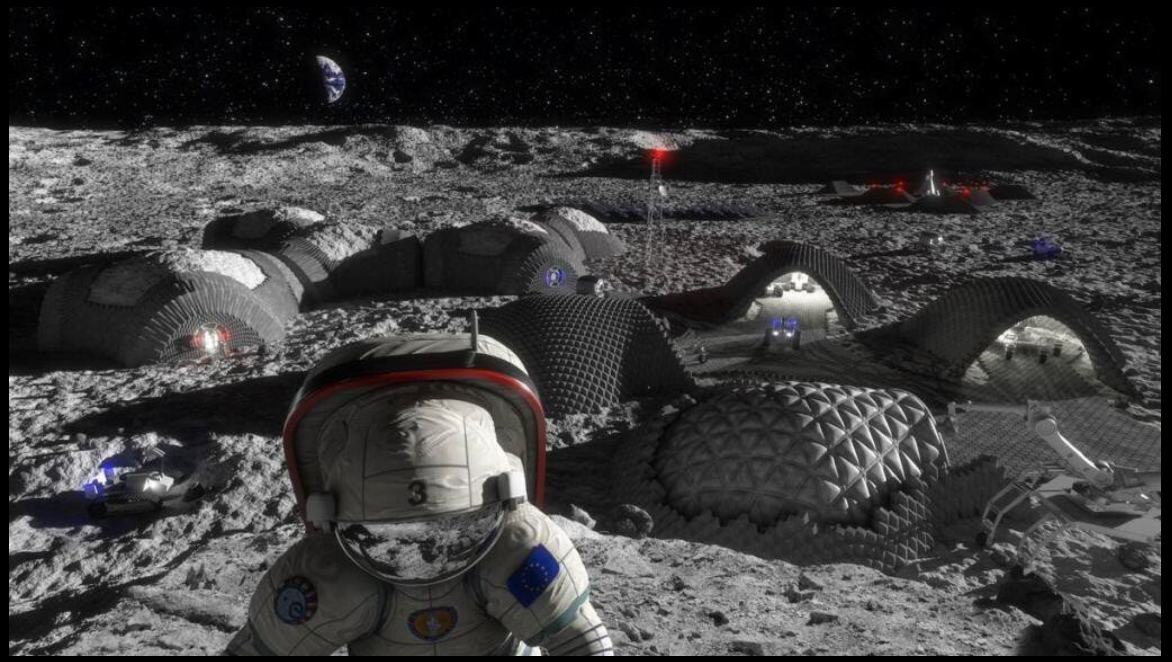
Can the Moon provide us with everything?

- Transporting resources to the Moon to run a base is expensive and challenging. But can the Moon provide us with at least some of those necessities?
- Airbus has developed a process that can use the Moon's regolith (dust) to produce oxygen and metals
- Called ROXY (Regolith to OXYgen and Metals Conversion) system, it can create not only oxygen, a resource vital for humans to breathe and also for rocket fuel, but also make metals that can be used to manufacture tools, equipment, and even structures on the Moon (which 3D printing could manufacture)



An illustration of a Moon base that could be built using 3D printing and ISRU, In-Situ Resource Utilization
Credit: RegoLight, visualisation: Liquifer Systems Group

- Watch the Airbus ROXY animation at: https://youtu.be/8Tmtm3wmPu4

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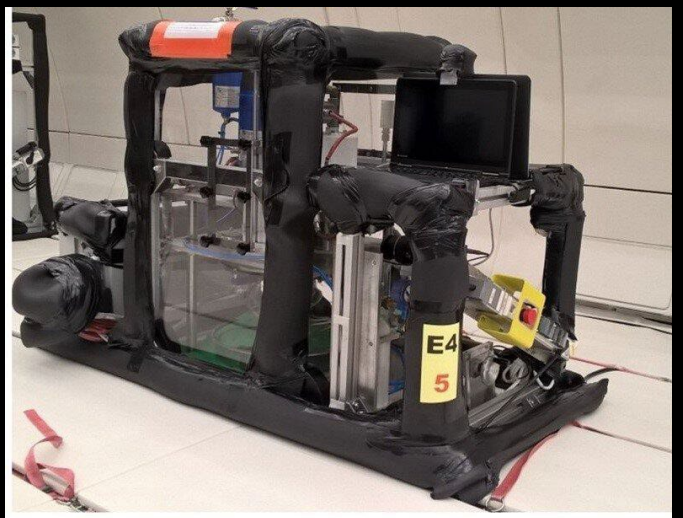
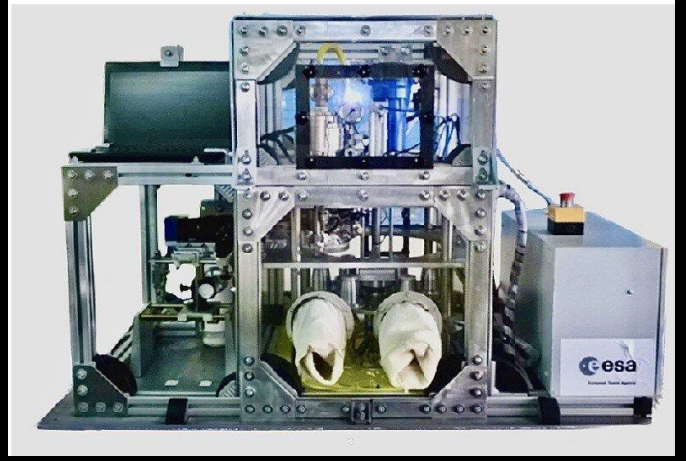
Is frying possible in space?

- You are on that long trip to Mars and you get a but peckish and fancy some French fries to go with your rehydrated food. But MacDonalds haven't yet got a restaurant open up in space. Doesn't matter, you can fry your own
- But frying is a complicated process and it is quite likely it wouldn't work without the aid of gravity. Without buoyancy pulling upwards, bubbles might stick to the surface of a potato, shielding the potato in a layer of steam, leaving them undercooked
- ESA has been looking into how frying can be done in space
- An experimental carousel-type apparatus was designed to safely operate in weightlessness and experiments were conducted on two ESA parabolic flight campaigns
- The results – frying was successful





Device to film potatoes frying in oil in microgravity Credit: ESA

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Spaceflight News and Updates (1)

- Euclid – ESAs new space telescope which is designed to explore the composition and evolution of the dark Universe, successfully launched from Cape Canaveral on Saturday 1st July at 16:12 BST on a SpaceX Falcon 9 rocket
- Miura 1 – the launch of the new mini reusable rocket on June 17th had to be aborted as the countdown reached zero as some of the umbilical cords failed to release. With wildfires a problem in Spain, the earliest new launch date will not be before September 2023
- SpaceX Gen2 Starlinks – the new generation of Starlink satellites, although 4 times as large as the first generation are about 10 times dimmer; but only when they get “on-orbit” and change their orientation. See the Fraser Cain podcast for more on why Starlink satellites are so bright: https://youtu.be/wTo_L8k_nl0
- COMPLETE – scientists are proposing sending 4 probes to various Lagrange points to study the Sun as it comes to solar maximum activity in 2032. It has yet to be assessed for possible funding

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Spaceflight News and Updates (2)

- CHEOPS – the ESA CHEOPS space telescope has successfully found four new exoplanets. The four mini-Neptunes are smaller and cooler, and more difficult to find than the so-called Hot Jupiter exoplanets
- BepiColombo – has now completed its third (of six planned) flypast of Mercury. Getting to within 236 km of the surface, it took images of the night side
- Ariane 5 – after 27 years the 117th and final mission of ESAs Ariane 5 rocket, with two communication satellites on board, will launch on July 4th
- Vulcan Centaur – United Launch Alliance's new rocket is the replacement for the Atlas V and Delta IV rockets. However, hopes that it would be ready for its first mission on May 4th were dashed when during testing of the Centaur V upper stage damage was caused. The Vulcan first stage also earlier problems. The combined rocket at Cape Canaveral will need to be destacked and modifications made to the Centaur V before the first mission launch can go ahead. Watch how the rocket is built at: https://youtu.be/tLjIR5mW-I0

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Spaceflight News and Updates (3)

- Martian Moons eXploration – this Japanese-led mission to Demos and Phobos is likely to launch next year. As part of the mission there will be a Franco-German rover which will land on Phobos. See more at: https://youtu.be/yiS6NdpEL2A
- Reusable rockets – recovery of first stage boosters is now a regularly event but engineers are investigating how to recover upper stages including the payload fairings. Mid-air retrieval using helicopters and nets are under investigation. An alternative may be a fly-back/glide-back using wings and fins
- Tractor Beams in Space – the problem with space junk and debris is an increasing problem. But engineers hope to use a fleet of specialised spacecraft to haul the debris out of the way using electrostatic charge without the need to touch it. Other proposals include pushing defunct satellites towards the atmosphere to burn up

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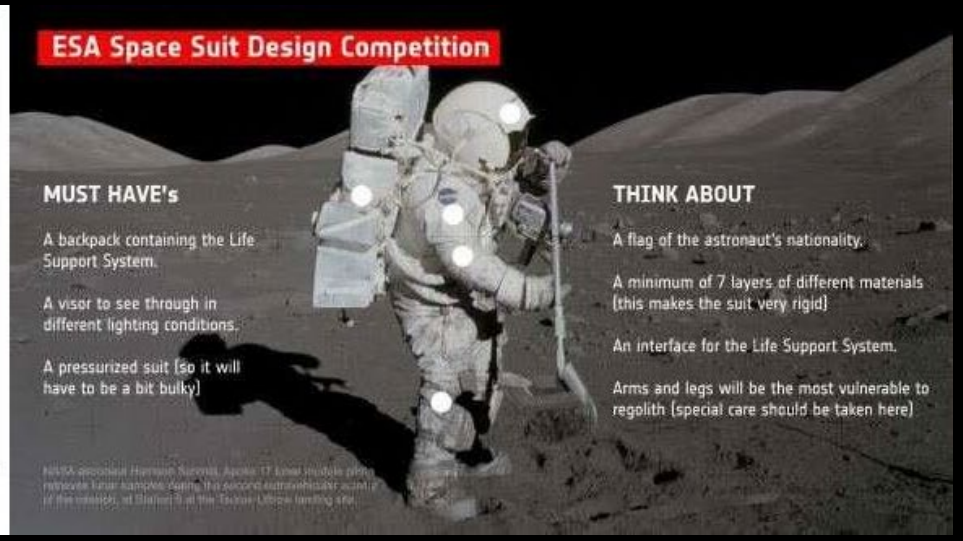
Spaceflight News and Updates (4)

- Astronaut Brains – studies have shown that for astronauts who spend more than two weeks in space there are significant changes in the brain's physiology with an increase in the ventricle size. It takes about three years for brains to recover
- ESAs New Spacesuits – in preparation for any possible future manned spaceflight, ESA has held a spacesuit (extra-vehicular activity suits) design competition. There were 90 submissions and judges have picked the 5 winners



Credit: ESA

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JWST and Hubble latest photos 1

- The Tarantula Nebula in the LMC is one of the largest and brightest star-forming regions in the Local Group of galaxies
- It is dominated by the R136 starburst region densely filled with young, energetic stars (blue region in this image from JWST)
- The enormous amount of energy generated is shaping the whole nebula, creating bubbles of gas. Pressure should be decreasing star formation but fluctuating magnetic fields are stirring it all up

Credit: NASA, ESA, CSA, STScI, Webb ERO Production Team)

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JWST and Hubble latest photos 2

- The jellyfish galaxy JO206 trails across this image from the NASA/ESA Hubble Space Telescope, showcasing a colourful star-forming disk surrounded by a pale, luminous cloud of dust
- JO206 lies over 700 million light-years from Earth in the constellation, Aquarius
- Jellyfish galaxies are so-called because of their resemblance to their aquatic namesakes. In the bottom right of this image, long tendrils of bright star formation trail the disk of JO206, just as jellyfish trail tentacles behind them

Credit: ESA/Hubble & NASA, M. Gullieuszik and the GASP team

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JWST and Hubble latest photos 3

- A small globular cluster, NGC 6544, in the constellation Sagittarius, and close to the vast Lagoon Nebula has been imaged by Hubble. It is 8,000 light years from Earth. For the image date from two of Hubble's instruments was used, the Advanced Camera for Surveys and Wide Field Camera 3

Credit: NASA

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JWST and Hubble latest photos 4

- New images from JWST have shown, for the first time, starlight from two massive galaxies hosting actively growing black holes – quasars – seen less than a billion years after the Big Bang. The two quasars, HSC J2236+0032 and HSC J2255+0251, have redshifts of 6.40 and 6.34 respectively, which indicates the universe was approximately 860 million years old
- These black holes are a billion times the size of the Sun and the host galaxies a further hundred times the mass, a ratio similar to that found in today's universe

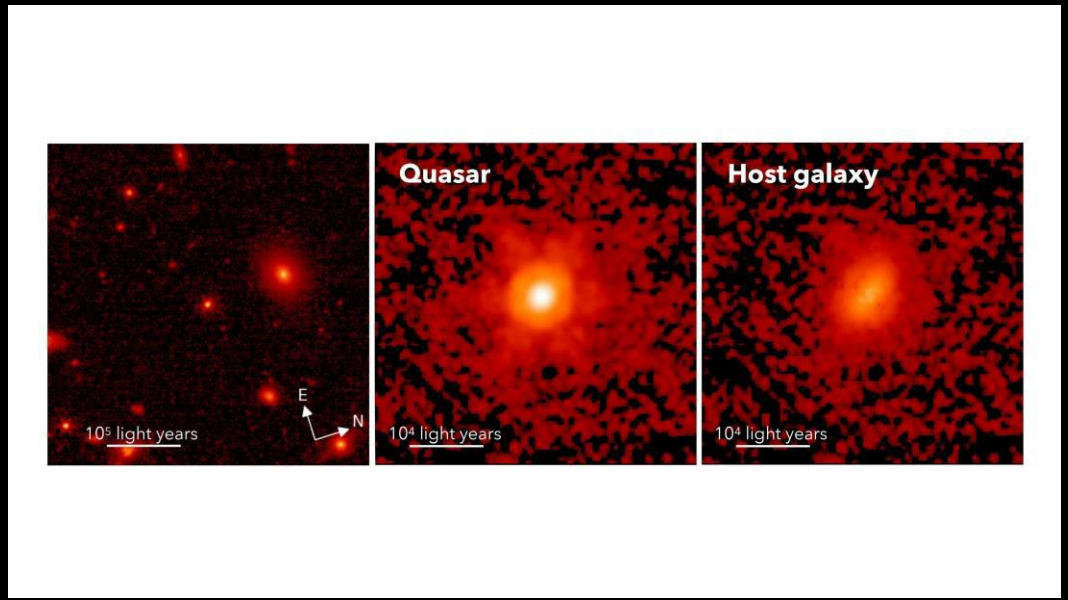

Image of HSC J2236+0032

Credit: X. Ding (Kavli IPMU), M. Onoue, J. Silverman, et al

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JWST and Hubble latest photos 5 (1)

- Astronomers using JWST discovered evidence of complex organic molecules in a galaxy (SPT0418-47) more than 12 billion light-years away. This is the most distant galaxy in which these molecules are now known to exist
- Spectroscopic data from the JWST suggest that the obscured interstellar gas in SPT0418-47 is enriched in heavy elements, indicating that generations of stars have already lived and died
- The galaxy observed by JWST shows an Einstein ring caused by a phenomenon known as gravitational lensing. In this case the distant galaxy was magnified by a factor of about 30 to 35 by gravitational lensing

The galaxy lines up almost perfectly with a second galaxy only 3 billion light-years away from our perspective on Earth. In this false-colour JWST image, the foreground galaxy is shown in blue, while the background galaxy is red. The organic molecules are highlighted in orange

Credit: J. Spilker / S. Doyle, NASA, ESA, CSA

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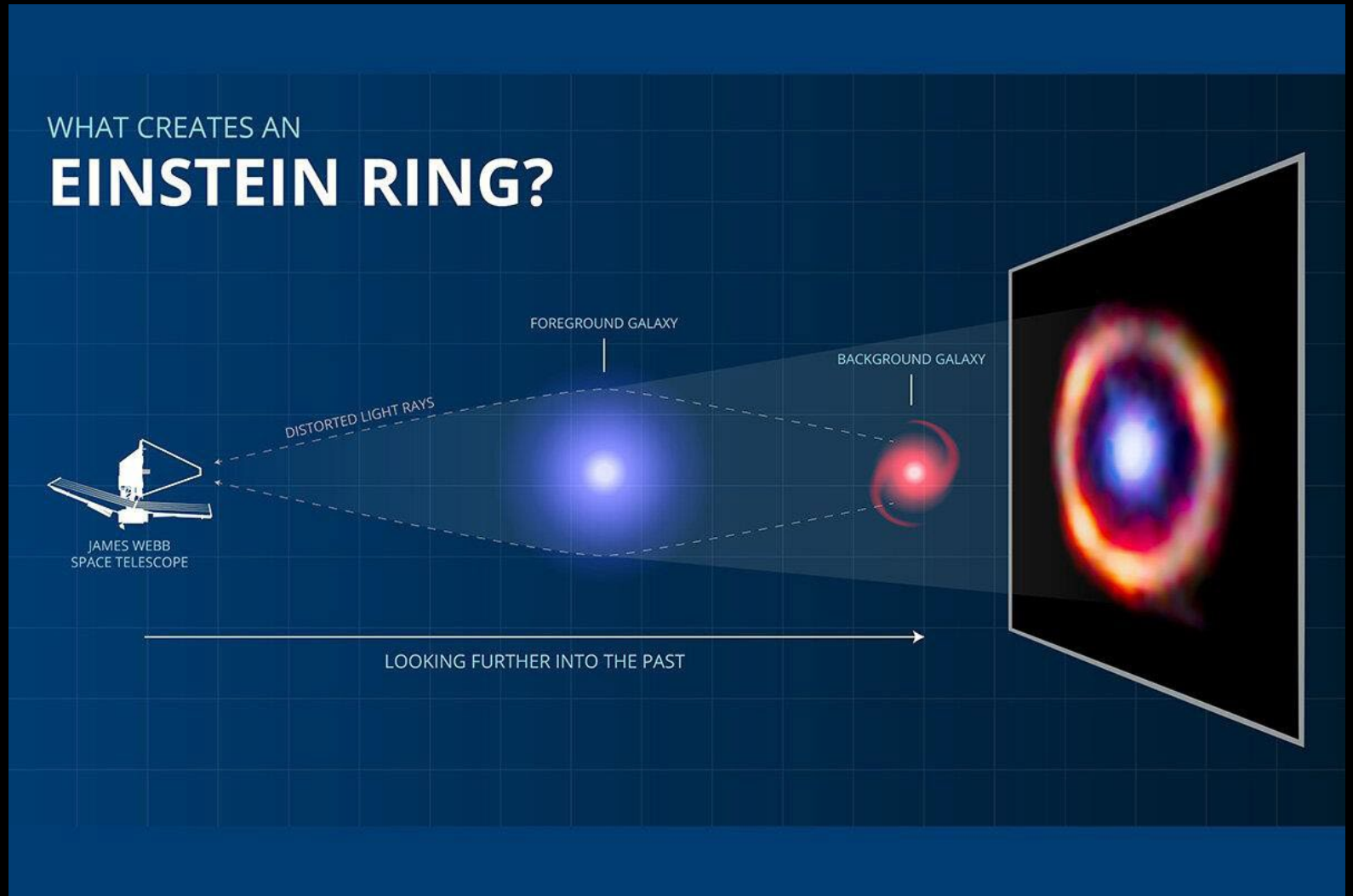
JWST and Hubble latest photos 5 (2)



Gravitational Lensing in action

Credit: J. Spilker / S. Doyle

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Observational Highlights

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July 2023 dates

- 1st July – Neptune is stationary before starting retrograde motion
- 9th July – Venus is at its brightest (mag -4.473) but will only be 8° above the western horizon when it is first visible (21:39 BST) before quickly sinking
- 18th/21st July – long period Comet 2021 T4 (Lemnon) is at opposition (18th) and then nearest to Earth (21st) at 0.54 AU. Magnitude between +7 and +8. It will reach perihelion on 31st July (1.48 AU) and conjunction on 9th November
- 22nd July – Pluto is at opposition. A 12” or larger telescope will be needed to find it due south between the constellations of Capricornus and Sagittarius and by M75
- 30th July – Southern Delta Aquariids meteor shower peak. Maximum observable numbers at zenith will be about 10 – 12 per hour; they are quite slow (40 km/s). The radiant is at its highest above the southern horizon at 03.15 BST on the morning of 31st July, and after the Moon has set. A Southern Hemisphere target

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Summer magic in the Deep South 1

- If you have a clear unrestricted view of the southern horizon and a good pair of binoculars or small telescope, the constellations of Sagittarius, Scutum and Serpens Cauda will be rewarding
- Messiers 69 (mag +7.7), 70 (+7.9) and 54 (+7.6) are three globular clusters in a line in Sagittarius
- West of M54 is the brighter cluster M55 (+6.3)
- One of the brightest clusters though is M22 (+5.1) and at a higher altitude

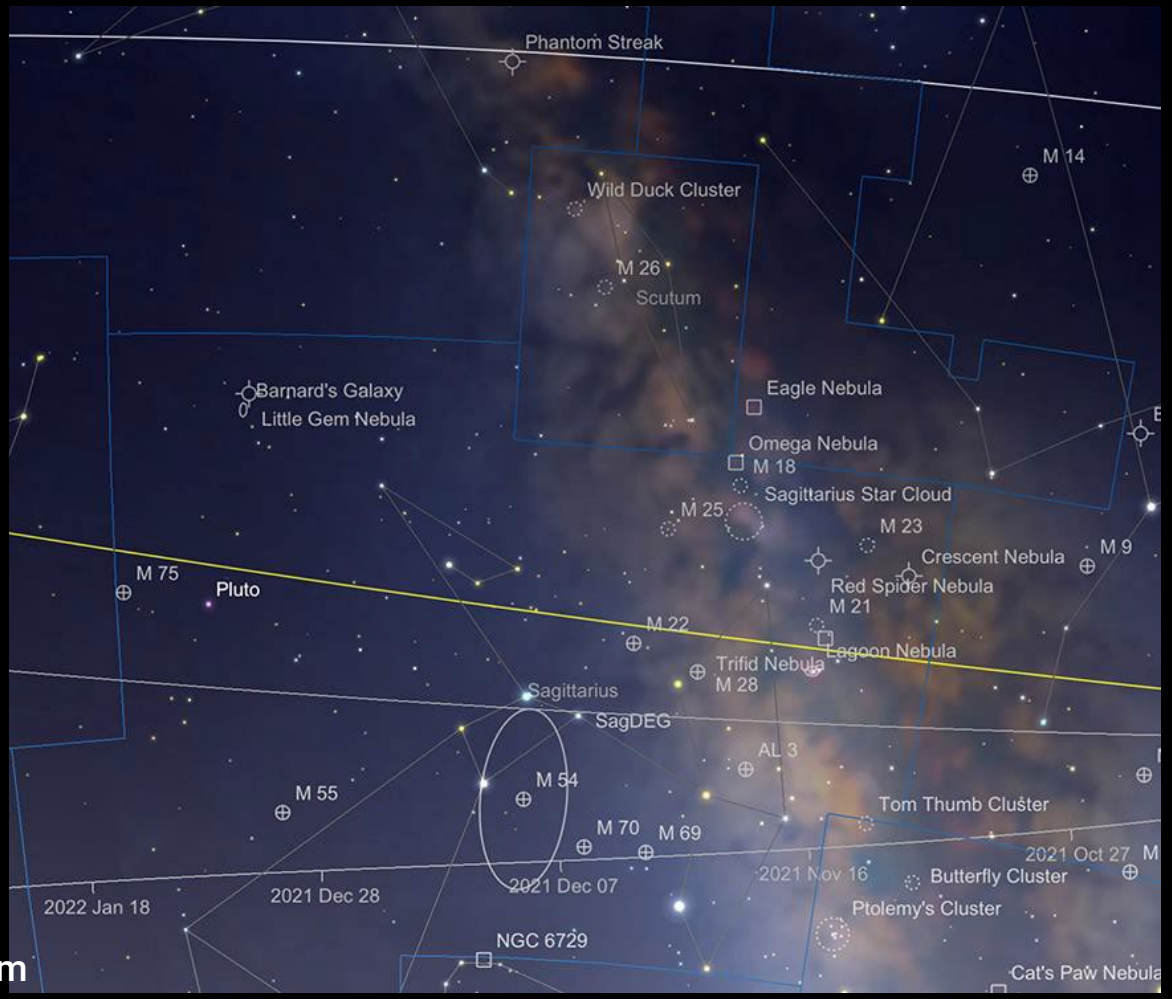

Image created for Sky Safari Credit: 2010-2016 Simulation Curriculum Corp.com

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Summer magic in the Deep South 2

- 11° east of M55 but higher in the sky is the compact cluster M75 (+8.5)
- Close by is the slightly dimmer cluster, M28 (+6.8), which is stunning seen with a small telescope or binoculars

M28 (above)
and M55, M75, and M22 left to right in image on the left

Credit: NASA/ESA

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Summer magic in the Deep South 3

- In the heart of Sagittarius lie four stunning nebulae – Trifid (M20, +6.3), Lagoon (M8, +6.0), Omega or Swan (M17, +6.0) and Eagle (M16, +6.4) – the latter just over the border in Serpens Cauda and famous for the Pillars of Creation

Trifid and Lagoon Nebulae (Ljubinko Jovanovic)

Omega Nebula (ESO)

Eagle Nebula (ESO)

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Summer magic in the Deep South 4

- Finally, in Scutum, lies the famous Wild Duck Cluster (M11, +5.8)
- There are plenty of other lesser known clusters and nebulae in these three constellations to search for on a dark clear night
- Drift further north and look out for Vega in the constellation of Lyra. Just to the south lies the Ring Nebula (M57, +8.8)
- Next month – the Summer Triangle
- Happy Hunting!

Above:
Wild Duck Cluster
(ESO)

Left:
The Ring Nebula
(NASA, ESA and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration)

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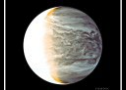
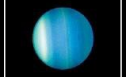
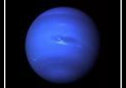
Planets (for evening of 1st/morning of 2nd July)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	04:23	21:01	12:42			-2.33	NO
	VENUS	08:32	23:26	15:59	West	14° ◊	-4.45	YES
	MARS	08:51	23:36	16:14			+1.72	NO
	JUPITER	01:50	16:12	09:01	East	22° ▫	-2.24	YES
	SATURN	00:02	10:24	05:13	South	26° ▫▫	+0.80	YES
	URANUS	02:14	17:28	09:51			+5.83	NO
	NEPTUNE	00:35	12:21	06:28			+7.87	NO

* = Highest point at Dawn (02:39 - last visible sighting)

** = Highest point at Dusk (23:26 - first visible sighting)

◊ = Highest point when first visible (21:44)

◊◊ = Highest point when first visible

▫ = Highest point when last visible (04:19)

▫▫ = Highest point when last visible (03:47)

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Deep Sky Objects 1 (for evening of 1st/morning 2nd July)

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
M45	The Pleiades (Taurus)	Open Cluster	01:49	18:25	10:07	East	13°	+1.3
M31	Andromeda Galaxy (Andromeda)	Galaxy	***	***	07:03 *	East	44°	+3.4
IC4665	Open Cluster (Ophiuchus)	Open Cluster	17:40	06:43	00:11	South	44°	+4.2
C14	Double Cluster (Perseus)	Open Cluster	***	***	08:44 *	North-East	39°	+4.3
NGC6633	Open Cluster (Ophiuchus)	Open Cluster	18:16	07:28	00:52	South	45°	+4.6
IC4756	Graff's Cluster (Serpens Cauda)	Open Cluster	18:33	07:34	01:04	South	44°	+4.6
M5	Globular Cluster (Serpens Caput)	Globular Cluster	15:26	03:54	21:40 **	South-West	36°	+5.7
M33	Triangulum Galaxy (Triangulum)	Galaxy	22:45	17:11	07:58 *	North-East	29°	+5.8
M13	Great Globular Cluster (Hercules)	Globular Cluster	12:31	09:35	23:03 **	South	75°	+5.8
M12	Globular Cluster (Ophiuchus)	Globular Cluster	17:14	05:03	23:08 **	South	37°	+6.1
M3	Globular Cluster (Canes Venatici)	Globular Cluster	11:12	04:56	20:04 **	West	46°	+6.3
M15	Globular Cluster (Pegasus)	Globular Cluster	20:49	11:00	03:54 *	South-East	48°	+6.3
M92	Globular Cluster (Hercules)	Globular Cluster	***	***	23:38	South	82°	+6.5
M10	Globular Cluster (Ophiuchus)	Globular Cluster	17:35	05:02	23:18 **	South	35°	+6.6
M2	Globular Cluster (Aquarius)	Globular Cluster	21:58	09:57	03:58 *	South-East	35°	+6.6

* = Highest point at Dawn (02:39 - last visible sighting) ** = Highest point at Dusk (23:26 - first visible sighting)
◊ = For bright objects highest point pre-Dusk - first visible sighting) *** = circumpolar

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Deep Sky Objects 2 (for evening of 1st/morning 2nd July)

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
M81	Bode's Galaxy (Ursa Major)	Galaxy	***	***	16:14 **	North-West	43°	+6.9
M101	Pinwheel Galaxy (Ursa Major)	Galaxy	***	***	20:21 **	North-West	62°	+7.9
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	***	***	19:09 **	West	45°	+8.2
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	***	***	19:48 **	West	54°	+8.4
M57	The Ring Nebula (Lyra)	Planetary Nebula	***	***	01:14 *	South	72°	+8.8
NGC2403	'Spiral' Galaxy (Camelopardalis)	Galaxy	***	***	13:56 **	North	64°	+8.9

Twilight ends (1st), Twilight starts (2nd)	Twilight	Civil	Naut	Astro
Sunset (1st), Sunrise (2nd)	Ends	22:03	23:11	
Moon rises (1st), Moon sets (2nd)	Starts	04:00	02:50	

	Rises	Sets
Sun	04:46	21:17
Moon	19:48	01:39

* = Highest point at Dawn (02:39 - last visible sighting) ** = Highest point at Dusk (23:26 - first visible sighting)
◊ = For bright objects highest point pre-Dusk - first visible sighting) *** = circumpolar

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Brown Lunation Numbers

numbered from first New Moon in 1923

Phases of the Moon

Phase	Date	Time	Lunation
FULL MOON	3rd July	12:38	1243
LAST QUARTER	10th July	02:47	1243
NEW MOON	17th July	19:31	1244
FIRST QUARTER	25th July	23:06	1244

Credit: Sean Smith/NASA