Lewes Astronomical Society

Newsletter - November 2023

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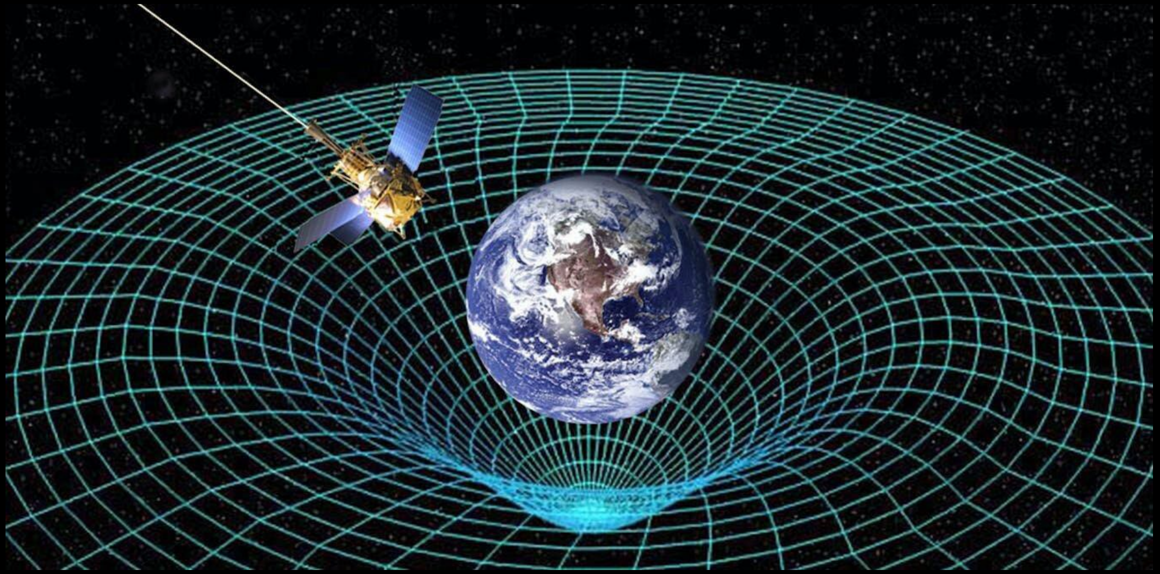
November 2023

Astronomy News

Was Einstein right? (1)

- Over a hundred years ago, Albert Einstein turned the world of physics on its head with a radical new way of looking at what gravity is – it is the distortion of space and time. In fact, space and time do not exist separately but together as "spacetime", and anything with mass, such as the Earth, stars, galaxies or galaxies clusters, warps spacetime. The heavier the mass, the deeper the gravitational well (and the higher the gravitational potential). Anything that moves in the Universe, such as a galaxy, or even a photon of light, obeys the rules laid down the 18th century mathematician, Leonhard Euler



Artist's concept of Gravity Probe B orbiting the Earth to measure space-time, a four-dimensional description of the universe including height, width, length, and time Credit: NASA

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Was Einstein right? (2)

- Over the past hundred years, Einstein’s Theory of Special Relativity, and of General Relativity have stood firm in the face of every test thrown at them. However, these theories were developed before two major discoveries, or conjectures – Dark Matter and Dark Energy; everything we see is only a tiny fraction of the whole visible universe – a mere 5%. Scientists believe that Dark Matter exists as hidden mass within the Universe and that there is approximately five times as much dark matter as normal matter. To date, only the gravitational effects of dark matter have been observed as it doesn’t interact with normal matter. But even both types of matter together make up only 30% of the Universe; the rest is Dark Energy, which counteracts gravity and causes the Universe to expand at an ever-increasing rate
- In the absence of any conclusive evidence as to what either dark matter or dark energy are, scientists need to find a better way to test Einstein’s and Euler’s theories. Does gravity act in the same way across the whole universe or is there no dark matter or dark energy and a requirement for a modified version of the theory of gravity, such as MOND (Modified Newtonian Dynamics)?

Was Einstein right? (3)

- Researchers have identified a particular smoking gun for modified gravity, known as a “gravitational slip”
- In order to test for a gravitational slip, researchers need to look across the Universe on a very large scale, at least 100 million light years. Is the way galaxies fall into gravitational wells the same as how the light from these galaxies is deflected by gravitational lensing? The comparison of the two tells us whether they are affected by gravity in the same way
- Until now, there has been no practical way of being able to measure the gravitational slip but in the near future observations made by the Euclid Space Telescope, the Square Kilometre Array (SKA), and the Dark Energy Spectroscopic Image (DESI) should start to be able to measure the “gravitational redshift” and to probe the gravitational potential by looking at how gravitational redshift distorts time. If light from a galaxy falling into a gravitational potential escapes, it is shifted to the red end of the spectrum

Was Einstein right? (4)

- A gravitational slip could be isolated if both the gravitational redshift (distortion of time) and gravitational lensing (distortion of space and time) are known
- The measurements of gravitational redshift impacts on whether the gravitational slip is due to a modification of Einstein’s laws, or a modification of Euler’s equation

- Watch a video explaining the distortion of time at: https://youtu.be/-3oFwAd08yc

- For more on DESI go to: https://www.desi.lbl.gov/
- For more on Euclid go to: https://www.esa.int/Science_Exploration/Space_Science/Euclid_overview
- For more on the SKA Observatory go to: https://www.skao.int/en

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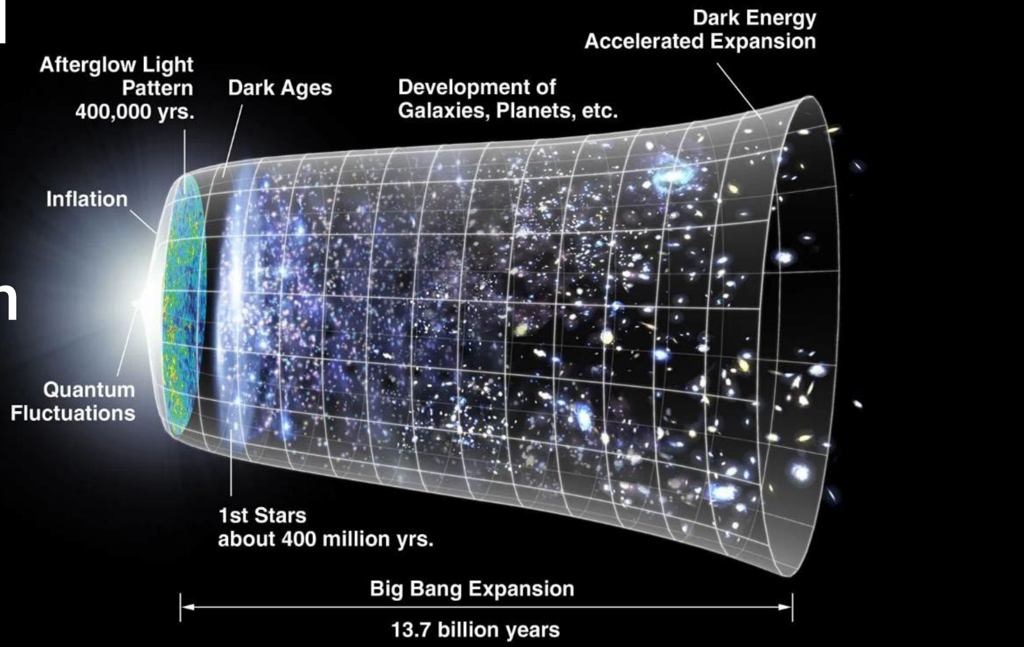
Tuning in on the Dark Ages (1)

- 380,000 years after the Big Bang, the expanding Universe had cooled enough for the protons and electrons in the hot plasma soup to bind together to form hydrogen. This allowed photons to escape and this first light is known as the Cosmic Microwave Background Radiation (CMB)
- However, it was another 400 million years before the first stars and galaxies began to form. This period is known as the Dark Ages

Credit: NASA/WMAP Science Team



- During this era, hydrogen would have absorbed some of the energy from the CMB at a particular frequency. As the Universe has expanded this frequency has shifted (the wave has been stretched) to the radio end of the electromagnetic spectrum and is probably to be found between 0.5 and 50 megahertz

Tuning in on the Dark Ages (2)

- By studying the signal, researchers hope to learn a lot more about the early Universe before the first stars. The signal is very faint, and would get absorbed or reflected by the Earth's atmosphere. Anything that made it through would be drowned by our own communications. In order to study it, researchers are proposing to listen to it on the far side of the Moon, a really quiet environment
- Taking a scientific instrument to the far side of the Moon is a major challenge. NASA and the US Department of Energy have developed a pathfinder project called Lunar Surface Electromagnetics Experiment-Night, or LuSEE-Night. LuSEE-Night will be equipped with two pairs of antennae, 6m in length, which will deployed once the probe lands and rotated to eliminate other radio noise. It will hitch a ride on Firefly Aerospace's Blue Ghost lunar lander in 2026
- A probe visiting this side of the Moon will need to survive massive temperature swings every two weeks, from 120℃ in the Sun to -130℃ in the dark. The probe would never face Earth so it would need to communicate with the Firefly's Elytra orbiter

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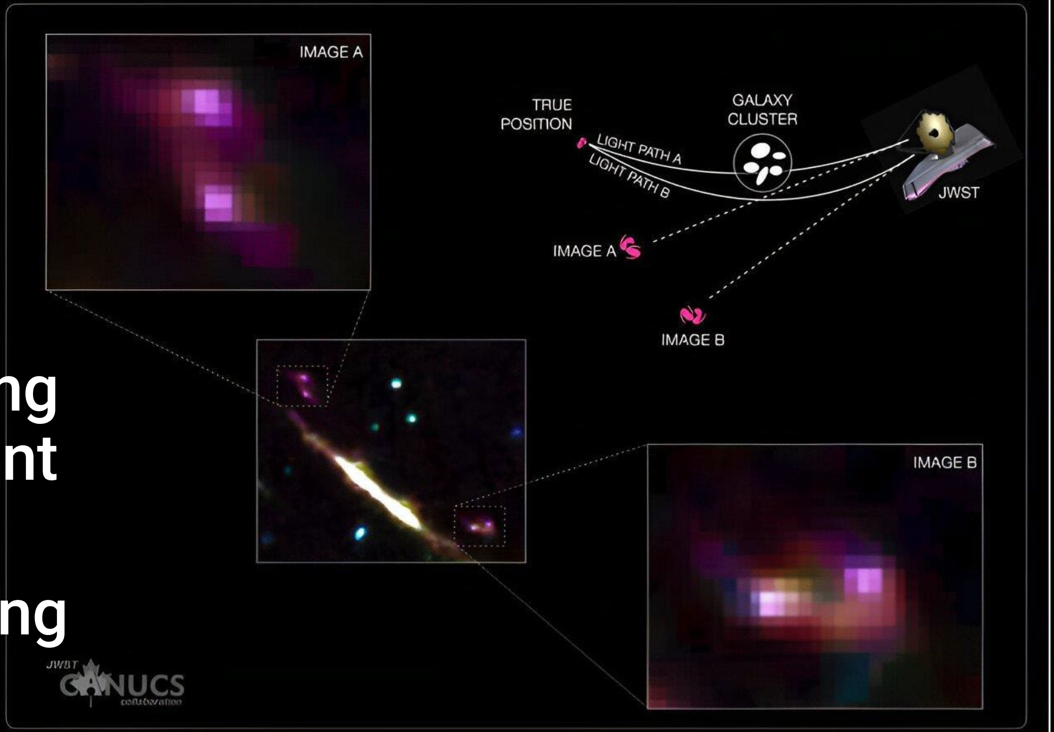
JWST witnesses growth of baby galaxies

- How galaxies evolve is one of the still unresolved great mysteries. JWST has now peeled back one of the layers by observing a baby galaxy growing due to the merger of two smaller galaxies, dubbed ELG1 and ELG2
- JWST made use of gravitational lensing by using the galaxy cluster MACS 0417 which then meant the galaxy was seen twice, even if a lot larger
- JWST was able to reveal hot young stars glowing due to the ionised hydrogen gas



The merging galaxy was taken by JWST. Einstein's gravitational lensing effect produces the two images A and B of the same system. This phenomenon is caused by the bending of light around the mass concentration of the galaxy cluster MACS 0417 between the observers and the merging galaxy pair. Light from the distant galaxy pair takes two separate pathways to reach JWST. This results in two images of the merging galaxy system. The purple hue of the light coming from the merging galaxies is due to the hydrogen gas within them that's made to glow by the large numbers of hot young stars forming within the young galaxies
Credit: Kyoto University/Yoshi Asada

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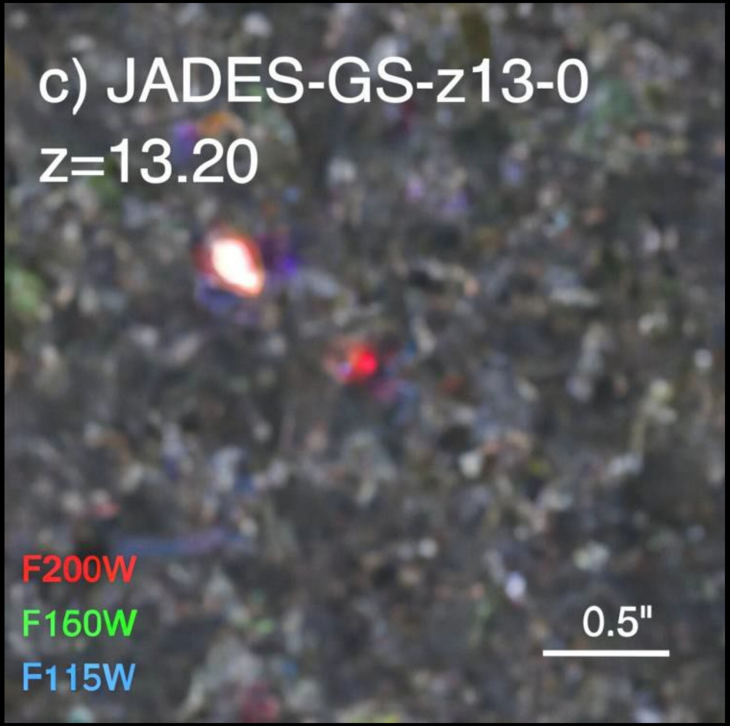
Most distant Einstein Ring imaged

Credit: NASA/James Webb Space Telescope/van Dokkum et al.

- JWST has taken a stunning image of a perfectly formed Einstein ring, which is also the most distant gravitationally lensed object ever detected. The halo of warped light is a staggering 21 billion light years distant and has been named JWST-ER1. Previously, the furthest detected object was around 14.7 billion light years away
- An Einstein ring is an extremely rare type of gravitationally lensed object, and was first predicted by Albert Einstein's theory of relativity
- Most gravitationally lensed objects form arcs or partial rings that surround the foreground object, but a true Einstein ring forms a complete circle around the closer entity; it is possible only when the distant object, foreground object, and observer are perfectly aligned

Dead or alive: there's nothing in between (1)

- When the Universe was young there were many galaxies, mostly small but some very large
- Due to high amount of hydrogen, star formation was happening everywhere
- However, observations now show that many galaxies halted star formation very early on and have never been active since – they are effectively dead ("quenched")
- What is the mechanism that stops star formation and effectively kills the galaxy?
- For clouds of hydrogen and dust to collapse it needs to be very cold; warm gas has too much energy and the pressure resists the effects of gravity
- What is warming the gas? Supernovae, active galactic nuclei, or too much starburst activity?



Colour composite JWST NIRCam image of distant galaxy JADES-GS-z13-0, which is a candidate galaxy for a supermassive black star
Credit: NASA, ESA, CSA, M.Zamani, (ESA/WEBB), JADES COLLABORATION

Dead or alive: there's nothing in between (2)

- Although supernovae are efficient at heating the surrounding gas, this heating is outpaced by cooling mechanisms if a galaxy is already large enough
- Radiation pressure from starburst activity is only a temporary phenomenon and once dissipated new star formation should start up
- Researchers have had only a few quenched galaxies to look at so far, (JADES-GS-z13-0 and MACS0417-z5BBG), discovered by JWST. The results have been inconclusive
- The search is on for quenched early galaxies to study and resolve the question

A Hubble view of NGC 685

- The Hubble Space Telescope has turned its attention to the barred spiral galaxy, NGC 685
- This is located in the southern constellation of Eridanus ("the river"), approximately 58 million light years from Earth
- At 60,000 light years across, NGC 685 is slightly over half the size of the Milky Way
- It is estimated to contain about 100 million stars, which is on the low side for a galaxy of this size
- The bright blue blobs are star clusters, and the red colouration marks interstellar dust and gas

Credit: NASA, ESA, and J. Lee (Space Telescope Science Institute); Processing: Gladys Kober (NASA/Catholic University of America)

Star-forming region in SMC studied by JWST

- Within the Small Magellanic Cloud (SMC) there is a well-known region, NGC 346, where an extraordinary amount of activity is happening and new stars are constantly being born. It is the brightest and largest such area in the whole of the SMC
- Both Hubble and JWST have imaged NGC 346 before, but in the latter's case, only in the near-infrared. Now, JWST has returned to take a view using its mid-infrared imaging camera
- A short video clip comparing the three views has been released: https://youtu.be/0Txm1fttK0o

Caption: JWST's mid-infrared image highlights bright patches of star formation, diffuse pink emission from warm dust, and blue filaments of dusty and sooty material

Credit: NASA, ESA, CSA, STScI, N. Habel, JPL, P. Kavanagh, Maynooth University

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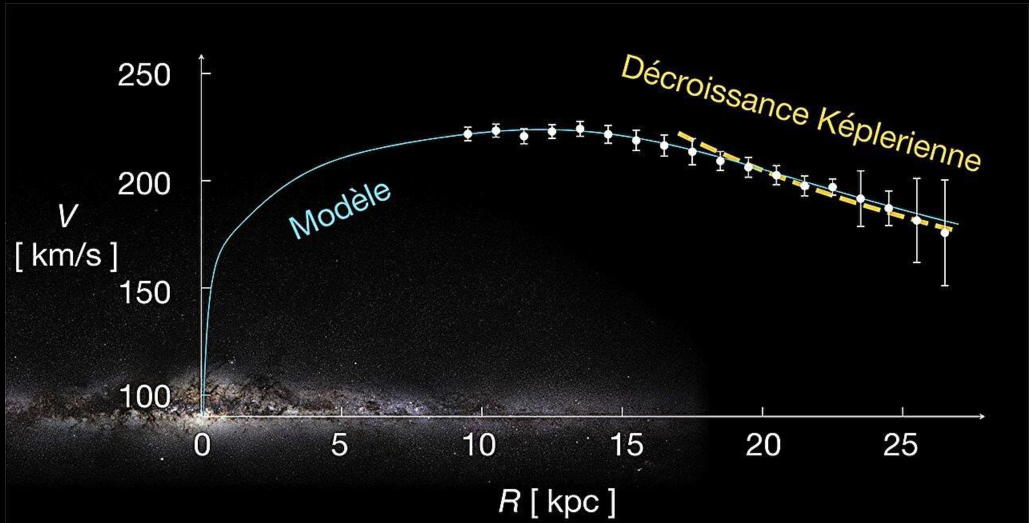
A lightweight Milky Way?

- New data from the Gaia satellite indicates that the total mass in the Milky Way may, at two hundred billion times that of the sun (2.06 x 10^{11} solar masses), be between four and five times less than previous estimates
- This has allowed scientists to build the most accurate rotation curve for a spiral galaxy, and from this deduce the mass. Previously, it had been difficult to estimate the mass of the Milky Way due to our position within it
- The results show that the Milky Way is not a typical spiral galaxy as the rotation curve is not flat but falls away in what is known as a Keplerian decline. This suggests that the Milky Way may not have much dark matter

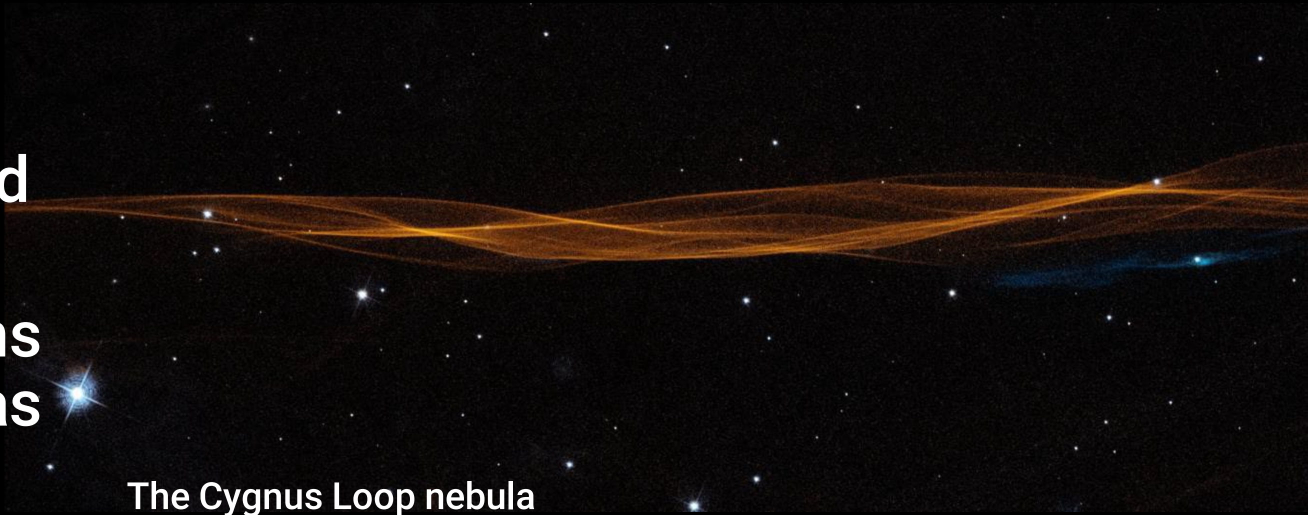


The Milky Way rotation curve representing the circular rotational speed of stars [V] as a function of distance [R] to the galactic centre. The white dots and error bars represent the measurements obtained from the Gaia DR3 catalogue. The blue curve represents the best adjustment of the rotation curve by a model including ordinary matter and dark matter. The yellow part of the curve shows the Keplerian decline with V decreasing as $R^{-½}$, which begins beyond the optical disk of our galaxy

Credit: Jiao, Hammer et al. / Observatoire de Paris—PSL / CNRS / ESA / Gaia / ESO / S. Brunier

Hubble studies a supernova bubble

- 20,000 years ago, a large star exploded. The planetary nebula left over from the supernova has continued to expand ever since
- Now 2,600 light years from the remains of the star, the Cygnus Loop nebula has a diameter of 120 light years
- Although the shockwave front is travelling at about half a million miles an hour, this is quite slow compared with other supernovae



The Cygnus Loop nebula
Credit: NASA, ESA, Ravi Sankrit (STScI)

Watch the video at:
https://youtu.be/ogcaECkxa8s

- As the supernova blast wave hits material in the interstellar medium, it is heating gas up to over a million degrees Centigrade. Neutral hydrogen glows in an orange hue while trailing ionised oxygen atoms are starting to cool and appear blue

Orion Nebula JuMBOs (1)

- The inner Orion Nebula, situated 1,400 light years from Earth, is a young star-forming region, just over a million years old. It contains thousands of new stars spanning a range of masses from 40 to less than 0.1 times the mass of the Sun
- There are many brown dwarfs; objects below seven percent of the mass of the Sun which are too small to start nuclear fusion in their cores
- Planetary-mass objects are smaller than these, starting at roughly 13 times the mass of Jupiter. JWST has found hundreds of such objects, floating freely in the nebula, not orbiting stars, with the very smallest having just 60% the mass of Jupiter or two times the mass of Saturn
- Some of these planetary-mass objects are, unusually, paired; they are termed Jupiter Mass Binary Objects or JuMBOs for short. 40 such pairs have been observed
- Although their origin is unknown the leading theory suggests that they were made around stars before being ejected

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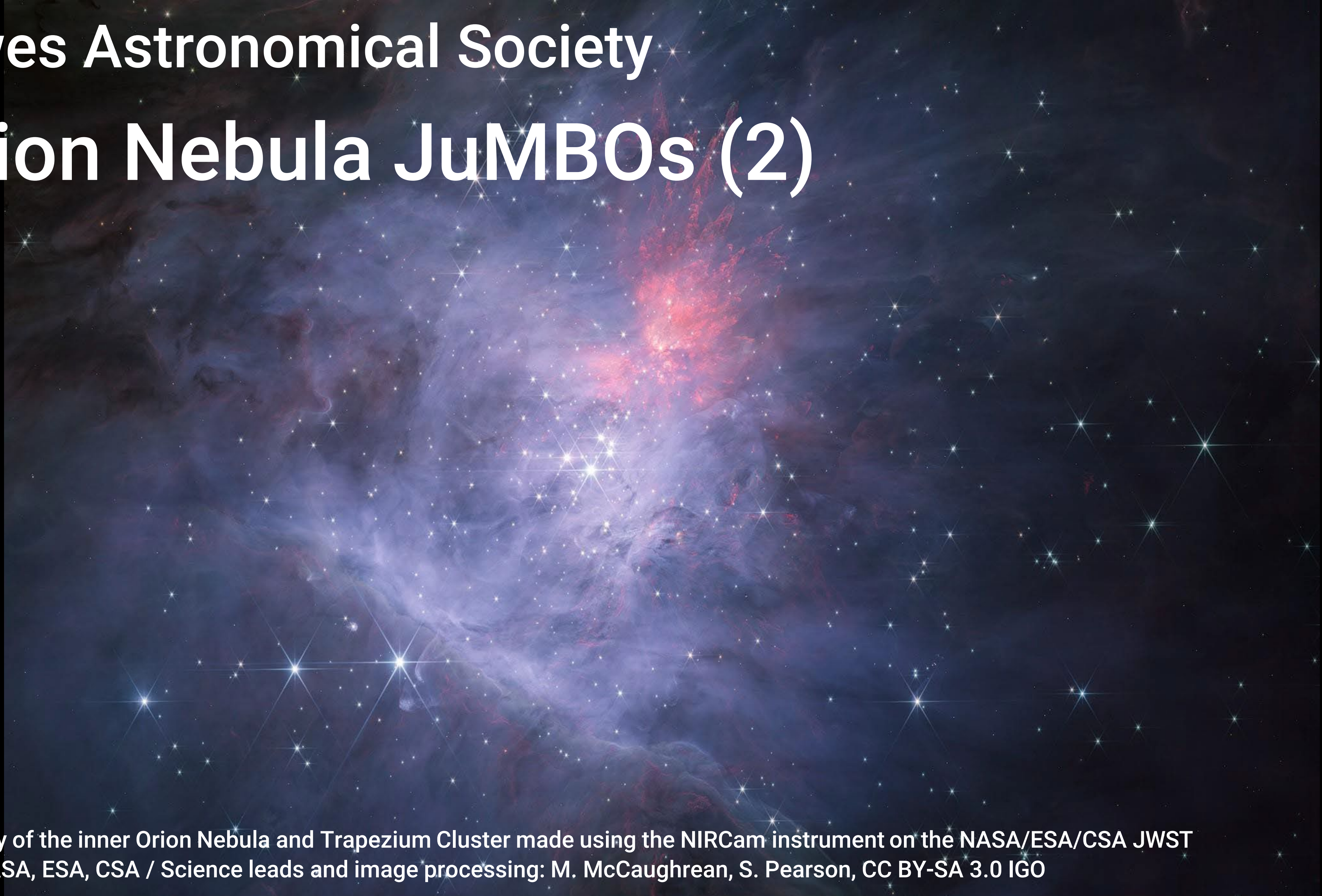
Orion Nebula JuMBOs (2)



Full survey of the inner Orion Nebula and Trapezium Cluster made using the NIRCam instrument on the NASA/ESA/CSA JWST
Credit: NASA, ESA, CSA / Science leads and image processing: M. McCaughrean, S. Pearson, CC BY-SA 3.0 IGO

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Planet Nine – or MOND? (1)

- The wandering of the planets across the sky has been observed for millennia. Their movement relative to the fixed background of stars led to the concoction of increasingly elaborate models to uphold the old Ptolemaic Geocentric view of the Solar System, which envisioned that the Sun, Moon, and planets all circled the Earth. The heliocentric model later developed by Galileo, Copernicus, and Kepler eventually superseded it
- It is now known that the planets move in elliptical orbits around the Sun. However, a number of inconsistencies in the planetary orbits have led to further major discoveries
- Neptune was only found by Urbain Le Verrier due to its gravitational influence of Uranus

An artist's impression of a Kuiper Belt object (KBO), located on the outer rim of our solar system at a staggering distance of 4 billion miles from the Sun
Credit: NASA

Planet Nine – or MOND? (2)

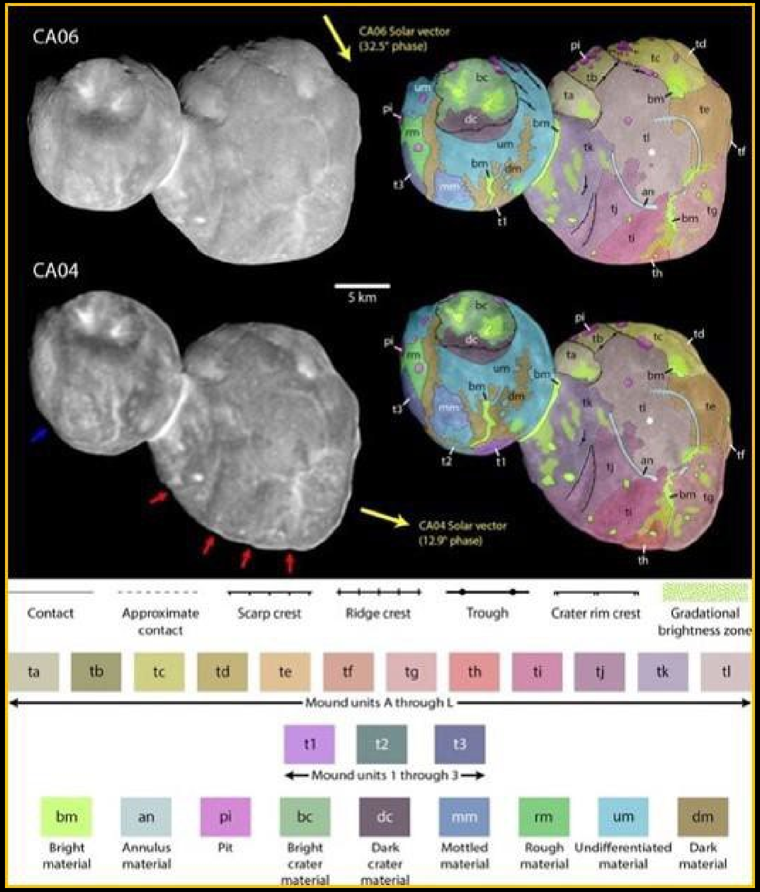
- The minute precession of Mercury, which could not be explained by Newton’s Theory of Gravity, was an early and successful test of Einstein’s Theory of General Relativity
- In the deep parts of the Solar System, the behaviour of a number of Trans Neptunian Objects, their clustering, and the tilt of their orbits relative to the Ecliptic has given rise to speculation that these events are due to the influence of a yet-to-be-discovered Planet Nine. Modelling has suggested that Planet Nine would need to be about five times the mass of the Earth and be orbiting at a distance of between 360 and 520 AU from the Sun
- Now, Prof. Harsh Mathur (Cape Western University) and Assoc. Prof. Katherine Brown (Hamilton College) have suggested that the evidence used for the search for Planet Nine may also be explained by the modified law of gravity, which was originally developed to understand the rotation of galaxies. This theory is known as Modified Newtonian Dynamics (or MOND)

Planet Nine – or MOND? (3)

- MOND has been developed from Newton's Law of Gravity. When the gravitational acceleration, predicted by Newton's law, becomes small enough, MOND dictates that a different gravitational behaviour will take over
- By applying MOND on a galactic scale, the need for dark matter is removed
- However, Mathur and Brown noticed that if they applied MOND on a smaller scale, such as to the Solar System, and not just galaxies like the Milky Way, it could explain precisely the clustering that astronomers have observed
- The current work is in the early stages of development, and the results are too small and few as to be regarded as definitive, but it does open up a new avenue to explore

Arrokoth – a Kuiper Belt Object (KBO) (1)

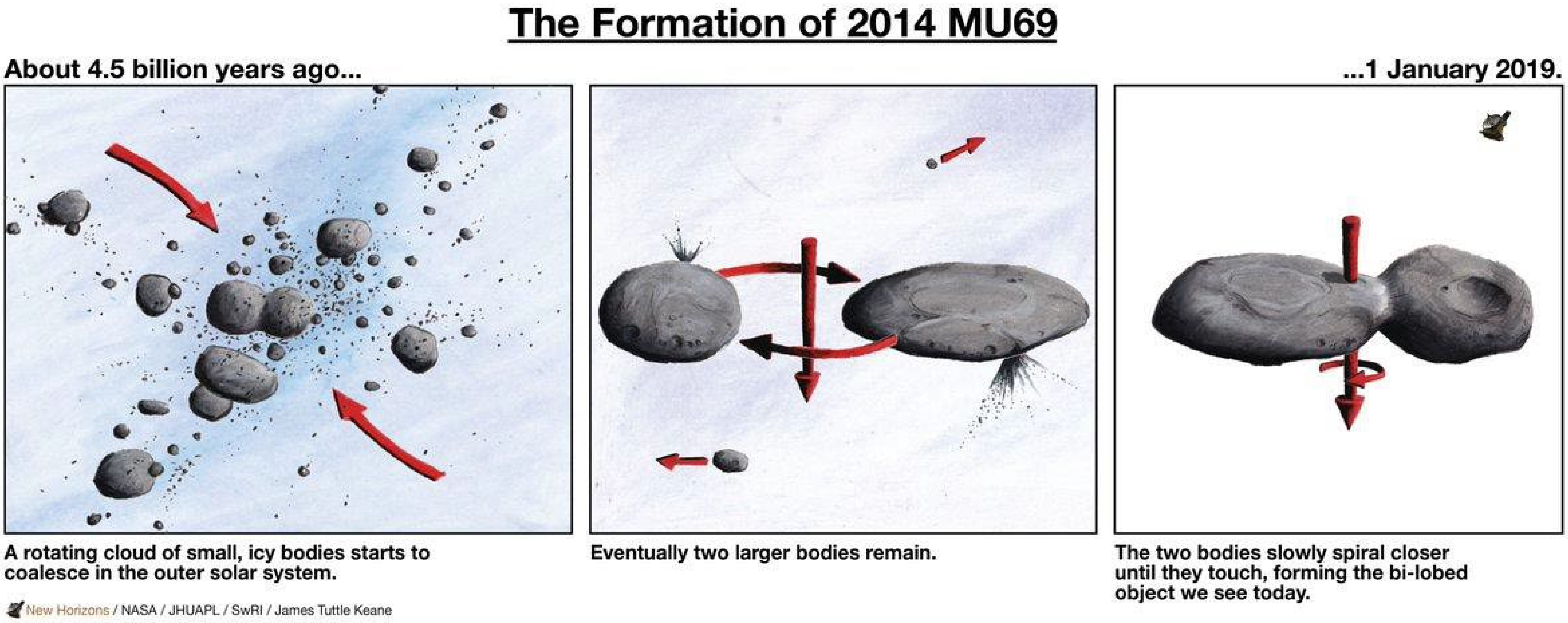
- In 2019, the New Horizons probe flew past the first new Kuiper Belt object to be visited after Pluto. The double-lobe object is dominated by large mounds, at least 12 in number on the larger lobe (Wenu) and 3 more on the smaller lobe (Weeyo), approximately 5km long
- New research indicates how Arrokoth was formed; suggesting that the mounds are similar enough to have a common origin, and may be the building blocks of a planetesimal
- NASA's Lucy mission to the Trojan asteroids of Jupiter may provide further evidence of pristine planetesimals, which could contribute to the understanding of accretion of planetesimals elsewhere in the ancient Solar System



Credit: Courtesy of SwRI

Caption: According to a new study led by Southwest Research Institute (SwRI) Planetary Scientist and Associate Vice President Dr. Alan Stern, the large mound structures, that dominate one of the lobes of Arrokoth, are similar enough to suggest a common origin. Credit: courtesy of SwRI

Arrokoth – a Kuiper Belt Object (KBO) (2)



An illustration depicting the hypothesised formation sequence of Arrokoth

Credit: New Horizons/NASA/JHUAPL/SwRI/James Tuttle Keane

OSIRIS-Rex sample from Asteroid Bennu

- The sample container from the OSIRIS-Rex mission to the asteroid Bennu, which returned to Earth on 24th September, was designed to hold around 60 grams of material. When examined, the capsule has over 70 grams of rock and dust outside the sampler head alone – and that is before the sealed container is opened (at the moment 2 of the 35 fasteners are stuck and cannot be removed)
- It had been thought that the asteroid was a solid rock. However, it seems to be more like a pile of rubble, held loosely together by gravity. So, when the collection mechanism tried to scoop up a few pieces, it stirred up clouds of dust, swamping the spacecraft, and hence the extra bonus material

A view of the outside of the OSIRIS-REx sample collector. Sample material from asteroid Bennu can be seen on the middle right. Scientists have found evidence of both carbon and water in initial analysis of this material. The bulk of the sample is located inside. A full length video of the findings can be viewed at: https://youtu.be/oFvIuSpACQA
Credit: NASA/Erika Blumenfeld & Joseph Aebersold

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A Martian dust devil

- A video of a dust devil in the Jezero Crater on Mars was captured by Perseverance on 30th August 2023
- Although a lot weaker than their counterparts on Earth, Martian dust devils do help distribute dust around the planet
- The pictures were taken from a range of about 4km. The dust devil was estimated to be moving at speeds up to 20km/hr. It has been estimated to be about 2km in height, although only the bottom 118m is visible in the video, and about 60m wide at its base
- See: https://youtu.be/YIuCEWQUJoM

The lower portion of a Martian dust devil was captured by one of the Navcams on NASA's Perseverance Rover on 30th Aug 2023, the 899th Martian day, or sol, of the mission. The video, which has been enhanced in order to show maximal detail, was sped up 20 times and composed of 21 frames taken four seconds apart
Credit: NASA/JPL-Caltech

Astronomy News in Brief (1)

- Pulsars may make dark matter glow – as yet there is no confirmation that dark matter actually exists, less what it actually is. However, the scientific community is leaning towards it being a particle called an axion. If this is the case researchers suggest that dark matter may reveal itself in the form of a subtle additional glow coming from pulsating stars
- Spinning black hole – the huge black hole at the centre of M87, some 55 million light years from Earth in the constellation Virgo, and which was imaged in 2019, is spinning. Studies of the relativistic jet of radiation and particles blasting from the black hole's poles have shown it to be oscillating like a pendulum on an 11-year cycle, due to the gravitational interaction of the spinning black hole. Watch a short video clip of the sharpened view of the black hole at: https://cdn.jwplayer.com/previews/40PXnsBj
- Sienna Galaxy Atlas – using data from the NOIRLab telescopes, astronomers have created a detailed atlas of 383,620 nearby galaxies

Astronomy News in Brief (2)

- Young cluster at heart of Milky Way – a star cluster, IRS13, which is close to the supermassive black hole, Sagittarius A* (Sgr A*) at the centre of the Milky Way, has been found to be extremely young, with many of the stars less than 500,000 years old. The cluster defies the normal logic: high levels of radiation and tidal forces present in this part of galaxy should prevent the cluster from existing
- Studying a white dwarf left at the heart of a planetary nebula – many stars, such as our Sun, will end their lives as white dwarfs. As the stars start to die, they eject a huge amount of material and this becomes the planetary nebula surrounding the dead remains (white dwarf). Studying a white dwarf allows researchers to determine the size of the star during its lifetime, as there is a specific relationship between its birth mass and death mass: this is known as the initial-final mass relation. A star like the Sun will lose about 50% of its mass; a larger star eight times the size of the Sun will lose 80% of its mass. Scientists studying the central star in M37 determined that the white dwarf is 0.85 solar masses, which means the original mass was 2.8 solar masses

Astronomy News in Brief (3)

- Ozone Hole – measurements of the ozone hole over Antarctica have shown that it is at almost the largest ever recorded, nearly three times the size of Brazil. The size of the ozone hole varies during the year but reaches its maximum between mid-September and mid-October. Later in the year the temperature in the stratosphere warms up, weakening and breaking down the polar vortex which then allows the ozone levels to return to normal. Although it is as yet too early to confirm why the hole is so big, one possible reason is the eruption of Hunga Tonga-Hunga Ha'apai in January 2022. The event has injected a lot of water vapour into the atmosphere which has only recently reached Antarctica. This will have cooled the stratosphere, thus increasing the polar vortex, and preventing air masses from being exchanged with more temperate latitudes. The water vapour can increase the polar stratospheric clouds where chlorofluorocarbons (CFCs) can react and accelerate ozone depletion. Although the Montreal Protocol of 1987 mandated the phasing out of production and consumption of CFCs, they are still present in the atmosphere and will be for many decades to come

Astronomy News in Brief (4)

- Earth hit by supernovae – in the recent past (3 million and 7 million years ago) blasts from relatively close by supernovae hit the Earth. By using the radioactive isotope 60-Fe, which is produced by supernovae, a team of researchers at the University of Illinois was able to determine the approximate astronomical distances to the blasts, which they refer to as Pliocene Supernova (SN Plio, 3 Mya) and the Miocene Supernova (SN Mio, 7 Mya). For SN Plio, the likely distance was between 163 and 212 light years; for SN Mio, approximately 359 light years distant. At these distances it is not thought any major harm occurred

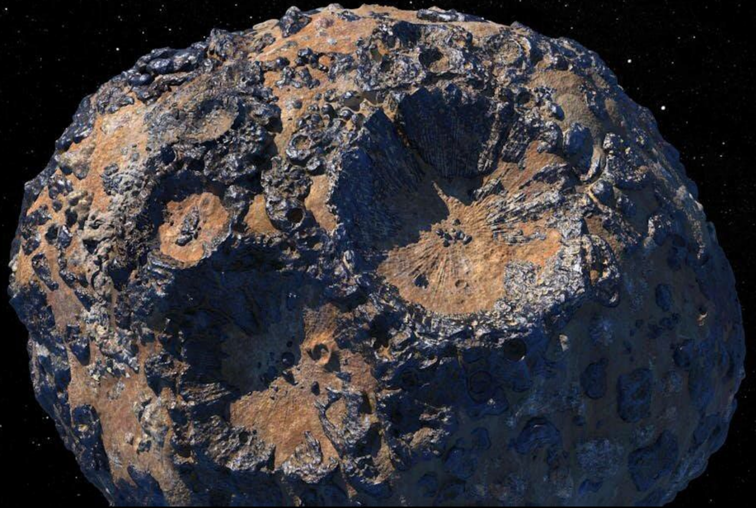
November 2023

Spaceflight News

Psyche (1) – the asteroid

- The asteroid 16 Psyche is approximately 280km long and 232km wide with a surface area of about 165,800 square kilometres
- It orbits between 378 and 497 million km from the Sun, taking 5 years to complete an orbit
- It is thought to be made mainly of metals (30-60%) - iron, nickel (with traces of gold, silver and platinum) and rock (silicates). This will give it a dull-grey appearance
- It is the largest of the nine metal-rich (M-class) asteroids so far found. It was discovered in 1852 by Italian astronomer Annibale de Gasparis (Psyche is the Greek Goddess of the Soul). It was the 16th asteroid to be identified

The best images of Psyche, from the HARISSA survey taken using the Very Large Telescope (VLT)
Credit: ESO/LAM



Artist's impression of Psyche
Credit: NASA/JPL-Caltech/ASU

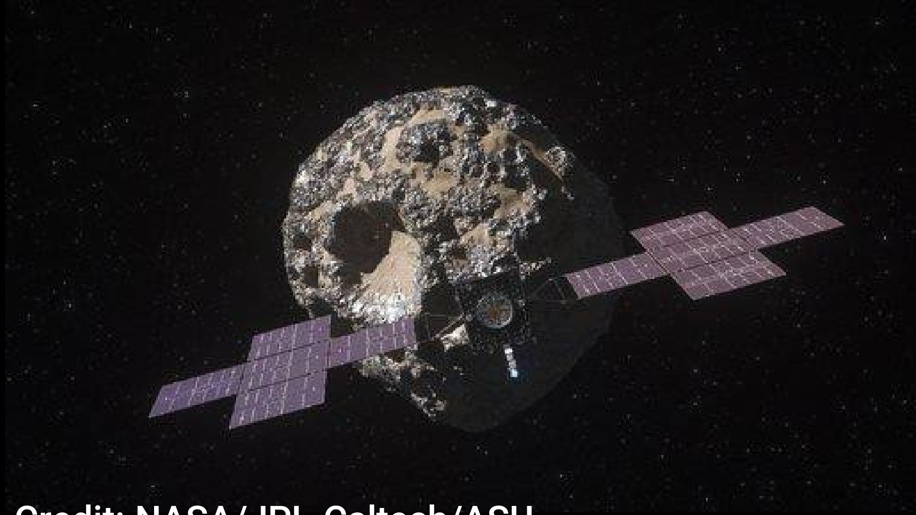
Psyche (2) - Launch

- NASA's Psyche space probe was launched from Pad 39A at the Kennedy Space Centre, Cape Canaveral at 14:19 GMT on Friday 13th October, following a delay due to high winds on a 3.6 billion kilometre journey to the asteroid, Psyche
- The spacecraft will take 6 years to reach the metal-covered asteroid (July 2029). Originally planned to launch in 2022 with a timeline of 4 years, the delay due to software issues has added 2 years onto the time it will take to get there
- In 3 years times it will swoop past Mars to get a gravity assisted boost

A SpaceX Heavy Falcon rocket lifts off from Launch Complex 39A at Cape Canaveral carrying the Psyche spacecraft
Credit: NASA/Aubrey Gemignani

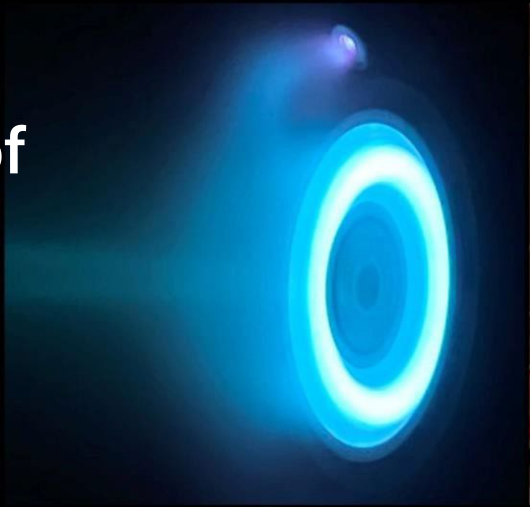
Watch the launch at: https://youtu.be/-GQe8gC-GYs

Psyche (3) - Spacecraft



Credit: NASA/JPL-Caltech/ASU

- The Psyche spacecraft measures 24.8m by 7.3m with the main body at 3.1m by 2.4m. It weighed 2,747kg at launch, approximately 40% (1,085kg) is the xenon fuel
- The tennis court-sized solar panels provided 21kW of electricity when leaving Earth, but will drop to between 2.3 and 3.4kW when in orbit around Psyche
- Propulsion is provided by 4 Hall-effect thrusters. These will use the energy from the solar panels to produce magnetic and electric fields



Hall Thruster Credit: NASA/JPL-Caltech

- These, in turn, are used to expel the xenon gas, leaving a glowing blue trail. Each Hall thruster is used separately, and the energy generated is only 240 millinewtons of thrust (the same as an AA battery) but enough in the emptiness of space to accelerate the probe to thousands of miles per hour

Psyche (4) – Mission goals 1

- The 21-month mission will try to find out whether 16 Psyche really is the core of a destroyed planet and was, initially, hot and molten before slowly cooling and solidifying like the core of our planet, or if it was never hot in the first place
- Another aim is to find out how old the surface is, and to discover when the outer layers were lost. In addition, by studying the chemical composition, the hope is to gain a better understanding of the early evolution of the Earth
- The spacecraft carries three scientific instruments to investigate 16 Psyche:

1. multispectral imager - consisting of a pair of identical cameras equipped with filters and telescopic lenses to photograph the surface of the asteroid in different wavelengths of light, visible and near infrared
2. gamma ray and neutron spectrometer – this will help scientists determine the chemical elements that make up the asteroid’s surface material
3. magnetometer - will look for evidence of an ancient magnetic field deep within 16 Psyche. A remnant field would provide strong evidence for a planetary core

Psyche (5) – Mission goals 2 & communications

- Psyche will also carry out X-band gravity science investigation. By analysing the X- band radio waves the spacecraft communicates with, scientists can measure how asteroid Psyche affects the spacecraft's orbit. From that information, scientists can determine the asteroid's rotation, mass, and gravity field, providing clues about the composition and structure of Psyche's interior
- The spacecraft will communicate with Earth with four antennas: one 2 metre (6.5 feet) fixed high-gain antenna and three small low-gain antennas. Like all NASA interplanetary missions, Psyche will send data and receive commands through the Deep Space Network (DSN) which has three ground stations around Earth to talk with and track spacecraft
- It will also trial the use of the new Deep Space Optical Communications (DSOC). Communication will be via near-infrared lasers – designed to carry between 10 and 100 times more data than the traditional radio links

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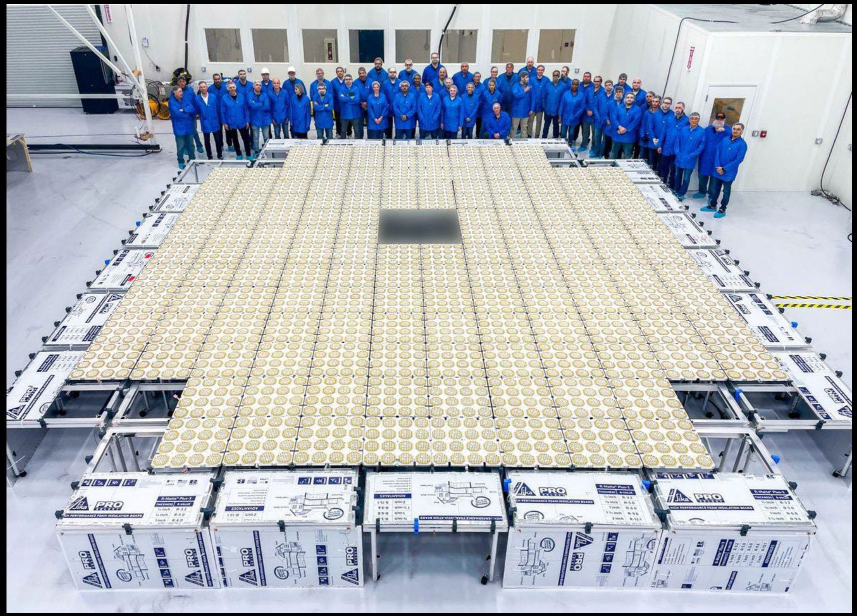
Twinkle, twinkle…the brightest of them all!

- Over the past few years there has been a huge outcry – and controversary – surrounding the light pollution (and potential space debris hazard) caused by swarms of communication satellites in low Earth orbit. Already there are over 5,000 Starlink satellites, out of an initial plan of 12,000 (and the total could eventually reach 42,000). With other companies rushing to launch their own fleets, there could be up to 100,000 satellites in orbit by 2033
- One company, AST SpaceMobile, has, on the face of it, got more modest plans – just 90 satellites in total. The problem is that each of the proposed BlueWalker 3 satellites will be huge, and, unless modified, will also be one of the brightest manmade objects in the night sky, at a magnitude of +0.4



BlueWalker 3 prototype prior to launch in September 2022
Credit: AST SpaceMobile

Watch BlueWalker 3 race across the sky at:
https://cdn.jwplayer.com/previews/yR3u4yuR

Amazon enters the communication race

- The first two prototype satellites of the Kuiper Project were launched from the Kennedy Space Centre at Cape Canaveral on an United Launch Alliance (ULA) Atlas V 501 rocket on 6th October. The rocket was making its 99th successful launch and deployed the satellites into a 500km high orbit
- The 2 prototypes, called Kuipersat-1 and Kuipersat-2, will test the communications links with Earth, deploy their solar panels, and confirm that all instruments are operating correctly and at the desired temperatures. At the end of the mission, they will be de-orbited and burn-up in the atmosphere
- Amazon plan to have 3,236 satellites in orbit by the end of July 2029

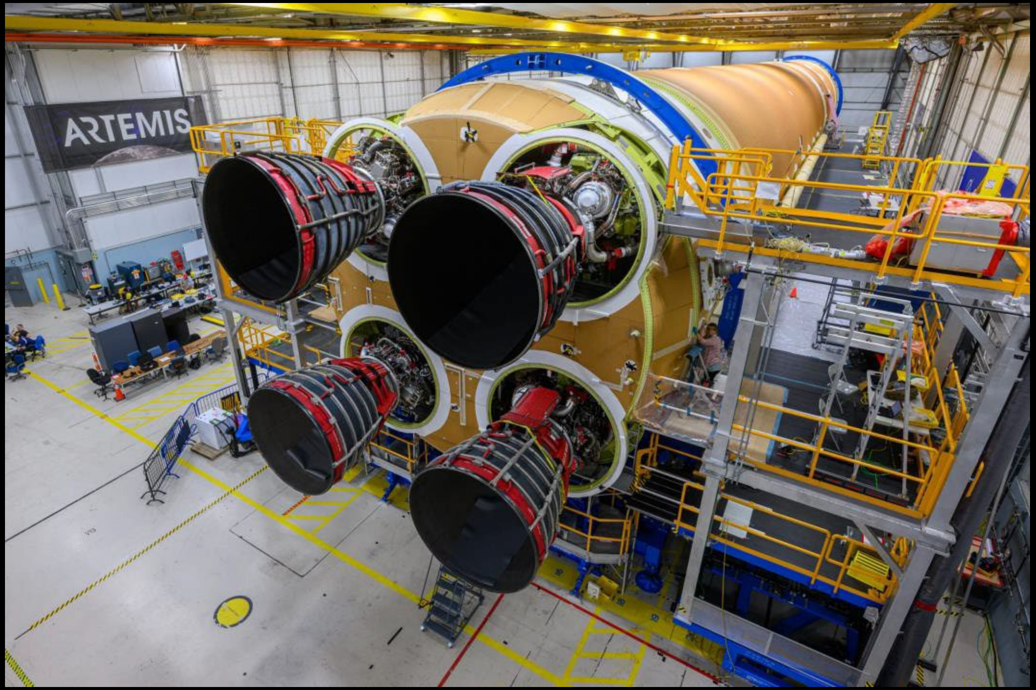
Atlas V Project Kuiper Proto-flight liftoff
Credit: United Launch Alliance (ULA) via flickr

Watch the launch at:

https://youtu.be/HhxpuiOUZIc

Artemis 2 receives its engines

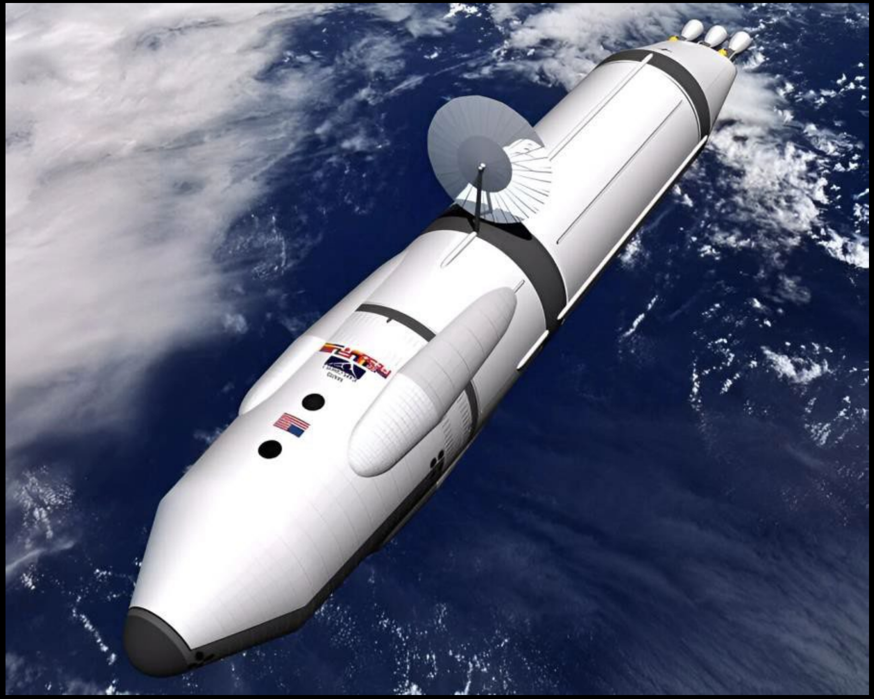
- The Core section of the SLS (Space Launch System) rocket, stage one, which will launch the first manned Moon mission in over 50 years, has had its four RS-25 engines installed at NASA’s Michoud Assembly Facility in New Orleans
- Two of the engines have been recycled from the Space Shuttle program (including one used on a mission to Hubble). The other two are new but do contain a lot of recycled hardware
- The next stage is to integrate the whole propulsion system with the electronics. Once complete, the core stage will be shipped to the Kennedy Space Center at Cape Canaveral via barge before testing next year



Artemis 2 in the Michoud Assembly Facility, New Orleans
Credit: NASA/Eric Bordelon

Magnetic Fusion Plasma Drives (1)

- There are many new forms of rocket propulsion that are being talked about. These may crack the problem of getting to another planet, or even a star, far more quickly with far more fuel efficiency than by the present generation of rockets
- Research is being carried out into ion thrusters or electric propulsion, solar sails, nuclear thermal propulsion, antimatter propulsion, or Alcubierre Warp Drive; the latter two are still on the drawing board. All have advantages, all have drawbacks
- Now, a new proposal combines elements of ion, fusion and other concepts: Magnetic Fusion Plasma Drive. The advantages of this form of propulsion would be:



A spacecraft powered by a positron reactor would resemble this artist's concept of the Mars Reference Mission spacecraft
Credit: NASA

Magnetic Fusion Plasma Drives (2)

1. High specific impulse: the MFPD can provide a high-specific impulse, delivering substantial velocity change (delta-v) to the spacecraft, and facilitating missions to distant celestial bodies
2. Energy-dense fuel: fusion fuel, like isotopes of hydrogen, is incredibly energy-dense, potentially enabling extended missions without needing vast amounts of propellant
3. Lower mass fractions: the spacecraft might be designed with lower mass fractions dedicated to fuel storage, affording more mass allocation for scientific instruments or additional technologies
4. Dual utility: the MFPD is not just a propulsion system; it is also envisioned to provide electrical power for the spacecraft's systems and instruments, which is crucial for long-duration missions
5. Adaptability: the potential to adjust the thrust and specific impulse, offering versatility for different mission phases, such as acceleration, cruising, and deceleration

Magnetic Fusion Plasma Drives (3)

6. Reduced travel time: the potential for higher continuous thrust may significantly reduce transit times to distant destinations, mitigating risks related to cosmic radiation exposure and onboard resource management
7. Radiation shielding: although challenging, the inherent magnetic and physical structures might be engineered to provide some level of radiation shielding for the spacecraft and crew, utilising the plasma and magnetic fields
8. Independence from solar proximity: unlike solar sails or solar electric propulsion, the MFPD does not depend on proximity to the sun; thus, it is viable for missions into the outer Solar System and beyond
9. Minimised risk of nuclear contamination: compared to nuclear-thermal or fission-electric concepts, the MFPD could be designed to minimise the risk of radioactive contamination, given that fusion, in general, requires less radioactive material and potentially allows for safer reactor shutdown

Magnetic Fusion Plasma Drives (4)

- All this would increase the ability to traverse vast cosmic distances in reduced timeframes, expanding mission profiles (fast transits to other planets in the solar system and interstellar missions), mitigating the risks of long-duration space missions (exposure to radiation and microgravity), revolutionising spacecraft design by providing propulsion and electrical power simultaneously, and enhancing human exploration capabilities
- And the spin-offs include materials science, plasma physics, and energy production that could have applications here on Earth. The development of this system could also foster international collaborations, bringing experts and resources from multiple fields together to realise common exploratory objectives
- The main challenge lies in achieving and maintaining stable fusion power in space

Spaceflight News and Updates (1)

- New Horizons – NASA has announced that funding has been found to continue the New Horizons mission up to and beyond 2028. There had been concerns expressed that NASA would change the focus to be purely on the Sun, gathering heliophysics data and abandoning its scientific work out beyond Trans Neptunian Objects (such as Pluto) and the Kuiper Belt. Now, whilst still exploring the effects of the Sun at that great distance it will still be ready to intercept another Kuiper Belt object, if one is identified close to its projected path; it has already flown by Arrokoth, a double-lobed relic of the formation of our solar system
- Parker Solar Probe – on 27th September, the small probe made its 17th and nearest approach to the Sun getting to within 7.26 million km of the photosphere. It was also its fastest flyby, travelling at 635,266 km/hour

Spaceflight News and Updates (2)

- Euclid – thanks to a software patch, the problems with setting up the navigation system and avoiding stray sunlight have been overcome and the commissioning phase is now complete
- MIURA1 launch – a Spanish company, PLD Space, launched its first rocket successfully on October 7th from a military base in the southern region of Andalusia. The small 12m single-stage MIURA1 rocket rose to an altitude of 46km before landing in the Atlantic Ocean. The company hopes to recover it. The next step forward is to launch the 35m, two-stage MIURA5 rocket into orbit from the Kourou Space Centre in French Guiana, probably in 2025
- Another Russian coolant leak – Russia has suffered its third coolant leak on the ISS within the past 12 months, this time in a pipe to the backup radiator in the relatively new (July 2021) science lab module. The leak poses no risk to the astronauts on board the ISS. The reason for the leak has not been established so far, but much of the Russian equipment on the ISS is thought to be beyond its warranty date

Spaceflight News and Updates (3)

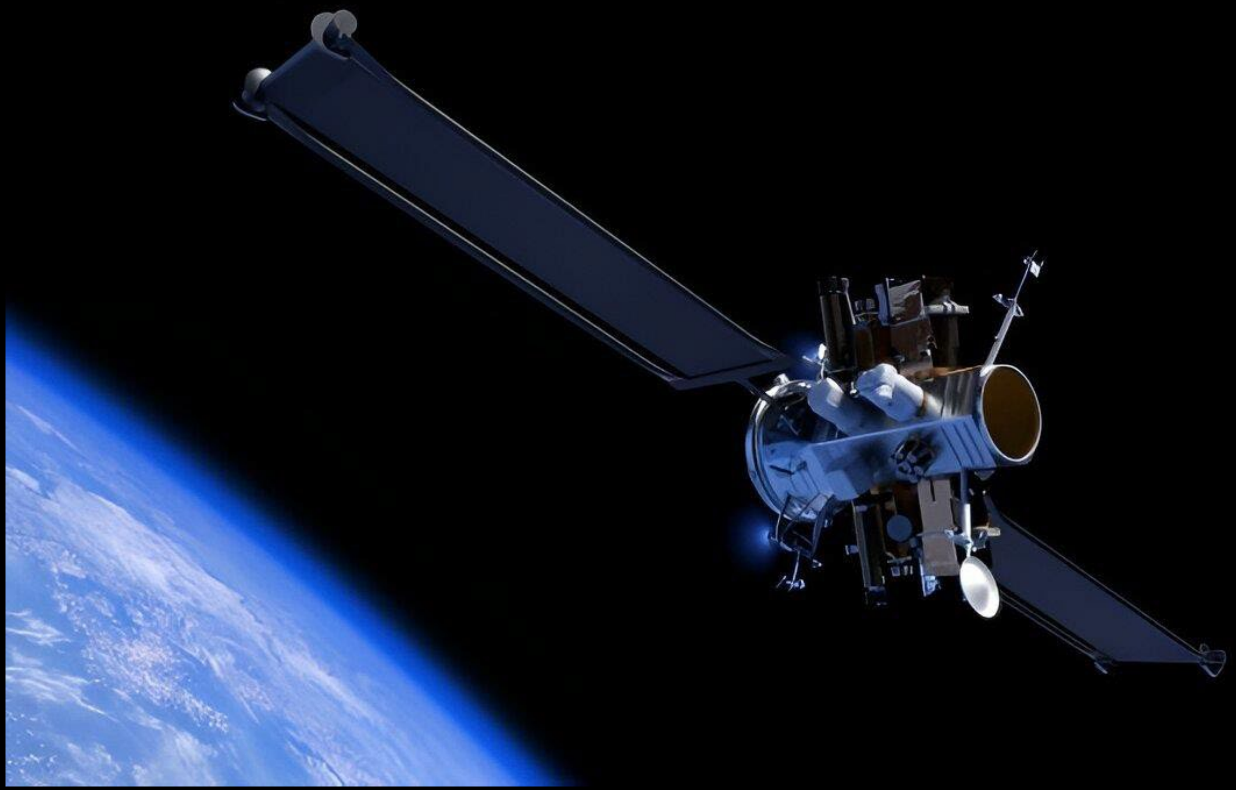
- China to double the size of its space station – China has announced that the newly completed space station, Tiangong ("Heavenly Palace"), will be doubled in size and remain operational until at least 2027. Tiangong consists of three modules, Tianhe ("Harmony of the Heavens") the core cabin, and two laboratory modules – Wenhian ("Quest for the Heavens"), and Mengtian ("Dreaming of the Heavens"). Three more modules will be added. Once upgraded, Tiangong will be able to take 6 taikonauts at any one time and China is inviting other nations to send their astronauts to the space station
- Space junk – it's not only Low Earth Orbit that is becoming increasingly crammed with redundant satellites and other debris. A study from Purdue University has found that the Geostationary Orbit and even space around the Moon will soon have a similar problem
- SpaceX ramping up launches – with hopes of reaching 100 launches before the end of this year, SpaceX has announced they plan for 144 in 2024 (12/month)

Spaceflight News and Updates (4)

- Blue Origin crash investigation – the FAA has closed its investigation into the failure of the Blue Origin New Shepherd sub-orbital vehicle which happened on 12th September 2022. The rocket lifted off successfully but the first stage suffered a serious malfunction after a minute's flight and crashed. The vehicle's capsule and payload were safely recovered. The FAA findings found that the failure was due to problems with the nozzle of the BE-3PM engine. 21 corrective measures need to be taken before a modified licence can be issued. These have not been made public and there is no news as to when all the fixes will be in place. The September 2022 launch was the 23rd overall mission of New Shepherd, six of which were manned.
- Blue Origin's orbital vehicle - Blue Origin has announced its new spacecraft platform, Blue Ring. It will be multi-purpose, covering logistics, refuelling and transportation. It will be able to carry payloads in excess of 3,000kg and be placed in either Earth or lunar orbit, or even beyond. Whilst the exact size is unknown Blue Origin suggest it could be carried by existing rockets. It is expected to fly in 2025

Spaceflight News and Updates (5)

- Blue Ring is being designated as a “space tug”, which is a spacecraft designed to move cargo and other spacecraft from one orbit to another. This seems appropriate given its multi-orbit and delta-V capabilities (ability to change velocity)



A Blue Ring rendering in space (image not to scale)
Credit: Blue Origin

- Watch a video about Blue Ring at: https://youtu.be/m8LzZncYZqI
- Watch a video about the New Glenn rocket at: https://youtu.be/LSftIaLhQzE

November 2023

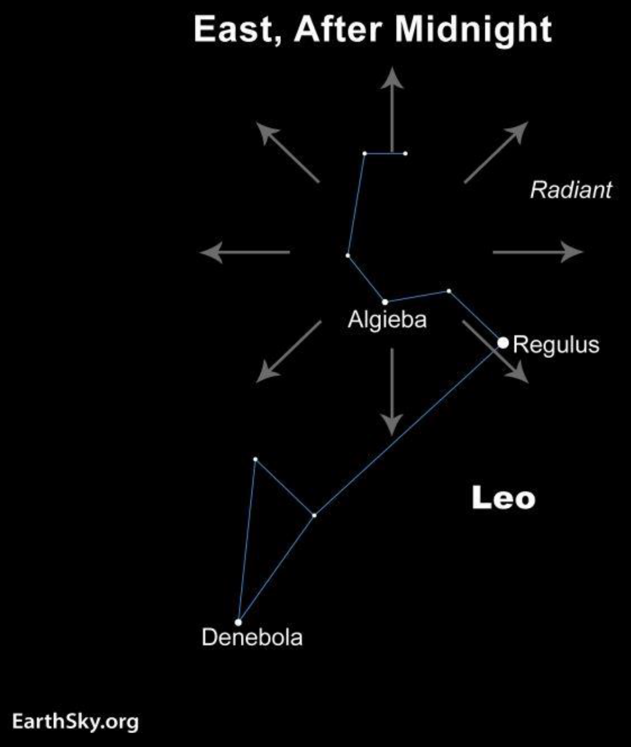
Observational Highlights

November 2023 dates

- 1st November – Jupiter at perigee (closest point to Earth – 3.98 AU), and maximum brightness at -2.9 (21:00 GMT)
- 3rd November – Jupiter at opposition in Aries (04:55 GMT)
- 10th November – Comet C/2023 H2 (Lemmon) passes perigee (0.19 AU) and reaches its brightest. Highest at 17:43, 46° above western horizon
- 12th/13th November – Northern Taurid meteor shower (minor). Slow, maximum 5 per hour. Best display around midnight
- 13th November – Uranus at opposition in Aries (17:12 GMT)
- 17th/18th November – Leonid meteor shower. Fast, maximum, 10-15 per hour. The radiant point is at its highest just after dawn so the best displays are just before dawn. It is the remnant of comet 55P/Tempel-Tuttle
- 18th November – Mars at solar conjunction (05:14 GMT)

The Leonid meteor shower

- One of the major meteor showers of the year peaks around November 17th/18th November
- Best to view just before dawn when it is highest in the sky. The Moon will have set in the early evening so will not be a problem
- The radiant rises after 22:15 in the south-east, climbing to about 50° above the south-western horizon by dawn
- The meteor shower is caused by the debris left behind by comet Tempel-Tuttle. It has a period of 33 years when meteor storms can occur. The next is due in 2032
- Fast meteor shower (70 km/sec) with 10 – 15 meteors per hour



The Messier open clusters of Auriga (1)

- Auriga – the charioteer – is less well-known than its close neighbours, Gemini, Perseus and Taurus, but it is only second to Sagittarius for the number of Messier open clusters. All three open clusters feature in the top 100 deep sky objects this month
- M37, the “Salt-and-Pepper Cluster”, with a magnitude of +5.6 is an easy object for a good pair of binoculars, and a small telescope will reveal about 30 of the more than 2,000 stars in the cluster. It is an old cluster (400+ million years) and has numerous white dwarfs and giant stars

Credit: Starry Night Software

- M36, the “Pinwheel Cluster” (+6.0) and M38, the “Starfish Cluster” (+6.4) will reveal about 20 to 30 stars in each with a 100mm telescope under clear skies. There are a number of other clusters and nebulae to look out for in Auriga

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The Messier open clusters of Auriga (2)

M36 – The Pinwheel Cluster
Credit: Anthony Ayiomamitis/Astronomy Magazine

M37 – The Salt and Pepper Cluster

M38 – The Starfish Cluster

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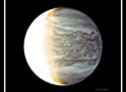
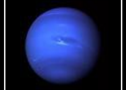
Data reproduced from In-The-Sky.org

Planets (information for 1st November)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	07:33	16:45	12:09			-0.81	NO
	VENUS	02:27	15:12	08:49	South-East	34° ▫	-4.33	YES
	MARS	07:18	16:44	12:01			+1.33	NO
	JUPITER	16:37	07:03	23:50	South	52°	-2.90	YES
	SATURN	14:31	00:26	19:28	South	26°	+0.72	YES
	URANUS	16:59	08:12	00:36	South	56°	+5.64	YES
	NEPTUNE	15:12	02:48	21:00	South	35°	+7.84	YES

* = Highest point at Dawn (05:28 - last visible sighting)

** = Highest point at Dusk (17:55 - first visible sighting)

◊ = Highest point when first visible

◊◊ = Highest point when first visible

▫ = Highest point when last visible (06:27)

▫▫ = Highest point when last visible

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

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
Cr50	The Hyades (Taurus)	Open Cluster	19:44	06:01	01:47	South	55°	+1.0
M45	The Pleiades (Taurus)	Cluster with Nebulosity	18:28	05:57	01:07	South	63°	+1.3
NGC1980	Open Cluster (Orion)	Cluster with Nebulosity	23:05	05:41	02:55	South	33°	+2.5
M44	Beehive Cluster (Cancer)	Open Cluster	22:11	05:34	05:34 ▫	South	58°	+3.1
M31	Andromeda Galaxy (Andromeda)	Galaxy	17:55	05:28	17:55 **	East	47°	+3.4
IC1396	The Elephant Trunk (Cepheus)	Cluster with Nebulosity	17:55	05:28	20:23	North	83°	+3.5
M42	Orion Nebula (Orion)	Cluster with Nebulosity	23:24	05:28	02:55	South	33°	+4.0
NGC2264	The Christmas Tree Cluster (Monoceros)	Cluster with Nebulosity	23:07	05:28	04:00	South	49°	+4.1
IC4665	Open Cluster (Ophiuchus)	Open Cluster	17:55	21:35	17:55 **	South-West	32°	+4.2
NGC1977	Running Man Nebula (Orion)	Open Cluster	23:05	05:28	02:55	South	33°	+4.2
NGC1981	Open Cluster (Orion)	Open Cluster	23:21	05:28	02:55	North	34°	+4.2
NGC2232	Open Cluster (Monoceros)	Open Cluster	00:16	05:28	03:47	South	34°	+4.2
C14	Double Cluster (Perseus)	Open Cluster	17:55	05:28	23:36	North	83°	+4.3
M47	Open Cluster (Puppis)	Open Cluster	02:46	05:28	04:56	South	24°	+4.4
IC4756	Graff's Cluster (Serpens Cauda)	Open Cluster	17:55	22:27	17:55 **	South-West	38°	+4.6

* = Highest point at Dawn (05:28 - last visible sighting)   ** = Highest point at Dusk (17:55 - first visible sighting)

▫ = Bright object last visible sighting (05:34)   ▫▫ = Bright object last visible sighting

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

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
M39	Open Cluster (Cygnus)	Open Cluster	17:55	03:16	18:49	South	87°	+4.6
NGC6633	Open Cluster (Ophiuchus)	Open Cluster	17:55	22:20	17:55 **	South-West	37°	+4.6
NGC1499	The California Nebula (Perseus)	Bright Nebula	17:55	05:28	01:23	South	75°	+5.0
M35	Open Cluster (Gemini)	Open Cluster	21:39	05:28	03:28	South	63°	+5.1
M34	The Spiral Cluster (Perseus)	Open Cluster	17:55	05:28	05:28 *	North-West	36°	+5.2
NGC6871	Open Cluster (Cygnus)	Open Cluster	17:55	03:42	17:55 **	South-West	73°	+5.2
NGC869	h Per Cluster (Perseus)	Open Cluster	17:55	05:28	01:07	North	83°	+5.3
NGC2281	Open Cluster (Auriga)	Open Cluster	20:52	05:28	04:08	South	80°	+5.4
M37	The Auriga Salt-and-Pepper	Open Cluster	20:48	05:28	03:12	South	71°	+5.6
NGC7686	Open Cluster (Andromeda)	Open Cluster	17:55	04:58	20:47	South	88°	+5.6
NGC752	Open Cluster (Andromeda)	Open Cluster	17:55	05:28	23:14	South	77°	+5.7
M11	Wild Duck Cluster (Scutum)	Open Cluster	17:55	21:41	17:55 **	South-West	28°	+5.8
M13	Great Globular Cluster (Hercules)	Globular Cluster	17:55	00:31	17:55 **	North-West	46°	+5.8
M33	Triangulum Galaxy (Triangulum)	Galaxy	17:55	05:02	22:50	South	69°	+5.8
M48	Open Cluster (Hydra)	Open Cluster	00:52	05:28	05:28 *	South	33°	+5.8

* = Highest point at Dawn (05:28 - last visible sighting)   ** = Highest point at Dusk (17:55 - first visible sighting)

▫ = Bright object last visible sighting (05:34)   ▫▫ = Bright object last visible sighting

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

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
M50	The Heart-Shaped Cluster (Monoceros)	Open Cluster	01:45	05:28	04:22	South	30°	+5.9
NGC2169	The "37" Cluster (Orion)	Open Cluster	22:38	05:28	03:28	South	53°	+5.9
M36	The Pinwheel Cluster (Auriga)	Open Cluster	20:29	05:28	02:56	South	73°	+6.0
NGC2301	Open Cluster (Monoceros)	Open Cluster	00:34	05:28	04:11	South	39°	+6.0
NGC7000	The North American Nebula (Cygnus)	HII Region	17:55	03:58	18:16	South	83°	+6.0
M46	Open Cluster (Puppis)	Open Cluster	03:40	05:28	05:01	South	24°	+6.1
NGC1746	Open Cluster (Taurus)	Open Cluster	20:48	05:28	02:23	South	62°	+6.1
NGC7160	Open Cluster (Cepheus)	Open Cluster	17:55	05:28	19:10	North	78°	+6.1
NGC884	chi Per Cluster (Perseus)	Open Cluster	17:55	05:28	23:39	North	83°	+6.1
NGC1545	Open Cluster (Perseus)	Open Cluster	17:55	05:28	01:41	South	89°	+6.2
M15	Globular Cluster (Pegasus)	Globular Cluster	17:55	23:27	18:47	South	51°	+6.3
M3	Globular Cluster (Canes Venatici)	Globular Cluster	02:09	05:28	05:28 *	East	25°	+6.3
NGC6940	Open Cluster (Vulpecula)	Open Cluster	17:55	02:42	17:55 **	South	67°	+6.3
M38	The Starfish Cluster (Auriga)	Open Cluster	20:12	05:28	02:48	South	75°	+6.4
NGC1528	Open Cluster (Perseus)	Open Cluster	17:55	05:28	01:35	North	89°	+6.4

* = Highest point at Dawn (05:28 - last visible sighting) ** = Highest point at Dusk (17:55 - first visible sighting)
▫ = Bright object last visible sighting (05:34) ▫▫ = Bright object last visible sighting

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

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
NGC1647	Open Cluster (Taurus)	Open Cluster	20:52	05:28	02:06	South	58°	+6.4
NGC1662	Open Cluster (Orion)	Open Cluster	21:34	05:28	02:08	South	50°	+6.4
NGC457	The Dragonfly Cluster (Cassiopeia)	Open Cluster	17:55	05:28	22:36	North	82°	+6.4
NGC7243	Open Cluster (Lacerta)	Open Cluster	17:55	05:28	19:32	South	89°	+6.4
IC1805	The Heart Nebula (Cassiopeia)	Cluster with Nebulosity	17:55	05:28	01:20	North	79°	+6.5
IC1848	The Soul Nebula (Cassiopeia)	Cluster with Nebulosity	17:55	05:28	01:39	North	80°	+6.5
M92	Globular Cluster (Hercules)	Globular Cluster	17:55	21:54	17:55 **	West	55°	+6.5
NGC129	Open Cluster (Cassiopeia)	Open Cluster	17:55	05:28	21:46	North	80°	+6.5
NGC2539	Open Cluster (Puppis)	Open Cluster	00:31	05:28	05:28 *	South	26°	+6.5
NGC654	Open Cluster (Cassiopeia)	Open Cluster	17:55	05:28	23:00	North	78°	+6.5
M2	Globular Cluster (Aquarius)	Globular Cluster	17:55	23:47	18:46	South	40°	+6.6
M29	The Cooling Tower (Cygnus)	Open Cluster	17:55	05:22	17:55 **	South	77°	+6.6
NGC1444	Open Cluster (Perseus)	Open Cluster	17:55	05:28	01:09	North	88°	+6.6
NGC1027	Open Cluster (Cassiopeia)	Open Cluster	17:55	05:28	00:03	North	79°	+6.7
NGC1342	Open Cluster (Perseus)	Open Cluster	17:55	05:28	00:51	South	76°	+6.7

* = Highest point at Dawn (05:28 - last visible sighting)   ** = Highest point at Dusk (17:55 - first visible sighting)

▫ = Bright object last visible sighting (05:34)   ▫▫ = Bright object last visible sighting

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

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
NGC2129	Open Cluster (Gemini)	Open Cluster	21:47	05:28	03:21	South	62°	+6.7
NGC2343	Open Cluster (Monoceros)	Open Cluster	02:13	05:28	04:28	South	28°	+6.7
NGC2423	Open Cluster (Puppis)	Open Cluster	03:20	05:28	04:56	South	25°	+6.7
NGC6709	Open Cluster (Aquila)	Open Cluster	17:55	23:04	17:55 **	South-West	43°	+6.7
NGC7789	The Caroline's Rose (Cassiopeia)	Open Cluster	17:55	05:28	21:14	North	84°	+6.7
NGC2175	Open Cluster (Orion)	Cluster with Nebulosity	22:09	05:28	03:29	South	59°	+6.8
NGC6811	The Hole in a Cluster (Cygnus)	Open Cluster	17:55	00:36	17:55 **	West	78°	+6.8
M52	The Cassiopeia Salt-and-Pepper	Open Cluster	17:55	05:28	20:41	North	79°	+6.9
M67	Open Cluster (Cancer)	Open Cluster	23:07	05:28	05:28 *	South	50°	+6.9
M81	Bode’s Galaxy (Ursa Major)	Galaxy	17:55	05:28	17:55 **	North-East	66°	+6.9
NGC1502	Open Cluster (Camelopardalis)	Open Cluster	17:55	05:28	01:28	North	78°	+6.9
M103	Open Cluster (Cassiopeia)	Open Cluster	17:55	05:28	22:50	North	80°	+7.4
M27	Apple Core Nebula (Vulpecula)	Planetary Nebula	17:55	01:25	17:55 **	South	60°	+7.4
M14	Globular Cluster (Ophiuchus)	Globular Cluster	17:55	20:43	17:55 **	South-West	23°	+7.6
M101	Pinwheel Galaxy (Ursa Major)	Galaxy	17:55	05:28	17:55 **	North-West	39°	+7.9

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▫ = Bright object last visible sighting (05:34)   ▫▫ = Bright object last visible sighting

Lewes Astronomical Society

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

Object	Name	Type	↗ Visible ↘		Highest	Direction	Alt	Mag
M26	Open Cluster (Scutum)	Open Cluster	19:07	22:47	19:07	South-West	26°	+8.0
M78	Reflection Nebula (Orion)	Reflection Nebula	23:31	05:28	03:06	South	39°	+8.0
M110	Galaxy (Andromeda)	Galaxy	17:55	05:06	21:57	South	80°	+8.1
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	03:03	05:28	05:28 *	East	42°	+8.2
M1	The Crab Nebula (Taurus)	Planetary Nebula	21:27	05:28	05:28 *	South	61°	+8.4
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	17:55	05:28	05:28 *	East	39°	+8.4
M56	Globular Cluster (Lyra)	Globular Cluster	17:55	01:42	17:55 **	South-West	64°	+8.4
M71	Globular Cluster (Sagitta)	Globular Cluster	17:55	00:54	17:55 **	South	56°	+8.4
M82	The Cigar Galaxy (Ursa Major)	Galaxy	17:55	05:28	17:55 **	North-East	66°	+8.4
NGC1245	Open Cluster (Perseus)	Open Cluster	17:55	05:28	05:28 *	North-West	43°	+8.4
M63	The Sunflower Galaxy (Canes Venatici)	Galaxy	03:20	05:28	05:28 *	East	38°	+8.6
M57	The Ring Nebula (Lyra)	Planetary Nebula	17:55	01:50	17:55 **	South-West	63°	+8.8
M66	Galaxy (Leo)	Galaxy	01:29	05:28	05:28 *	South-East	36°	+8.9
M73	Nebula (Aquarius)	Nebula	17:55	20:08	18:16	South	26°	+8.9
M77	Galaxy (Cetus)	Galaxy	20:28	03:37	00:39	South	39°	+8.9

* = Highest point at Dawn (05:28 - last visible sighting)   ** = Highest point at Dusk (17:55 - first visible sighting)

▫ = Bright object last visible sighting (05:34)   ▫▫ = Bright object last visible sighting

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

Object	Name	Type	↗ Visible	↘	Highest	Direction	Alt	Mag
NGC2403	‘Spiral’ Galaxy (Camelopardalis)	Galaxy	17:55	05:28	01:25	North	75°	+8.9
M32	Galaxy (Andromeda)	Galaxy	17:55	05:04	21:59	South	80°	+9.0
M43	De Mairan's Nebula (Orion)	HII Region	23:56	05:28	02:55	South	33°	+9.0
M40	Double Star (Ursa Major)	Double Star	17:55	05:28	17:55 **	North-East	53°	+9.1
M85	Galaxy (Coma Berenices)	Galaxy	02:04	05:28	05:28 *	East	30°	+9.1
M72	Globular Cluster (Aquarius)	Globular Cluster	17:55	20:04	18:10	South	26°	+9.2
M96	Galaxy (Leo)	Galaxy	01:02	05:28	05:28 *	South-East	39°	+9.2
M105	Galaxy (Leo)	Galaxy	00:59	05:28	05:28 *	South-East	40°	+9.3
M106	Galaxy (Canes Venatici)	Galaxy	01:49	05:28	05:28 *	South-East	50°	+9.3
M74	Galaxy (Pisces)	Galaxy	17:55	03:50	22:53	South	54°	+9.3
M100	Galaxy (Coma Berenices)	Galaxy	02:16	05:28	05:28 *	East	28°	+9.5

Twilight	Civil	Naut	Astro
Ends	17:10	17:51	18:29
Starts	06:14	05:40	05:02

	Rises	Sets
Sun	06:48	16:35
Moon	18:31	12:33

* = Highest point at Dawn (05:28 - last visible sighting)   ** = Highest point at Dusk (17:55 - first visible sighting)
▫ = Bright object last visible sighting (05:34)   ▫▫ = Bright object last visible sighting

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Brown Lunation Numbers

numbered from first New Moon in 1923

Phases of the Moon

Phase	Date	Time	Lunation
LAST QUARTER	5th November	08:36	1247
NEW MOON	13th November	09:27	1248
FIRST QUARTER	20th November	10:49	1248
FULL MOON	27th November	09:16	1248

Credit: Sean Smith/NASA