Lewes Astronomical Society

Newsletter - September 2023

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Astronomy News

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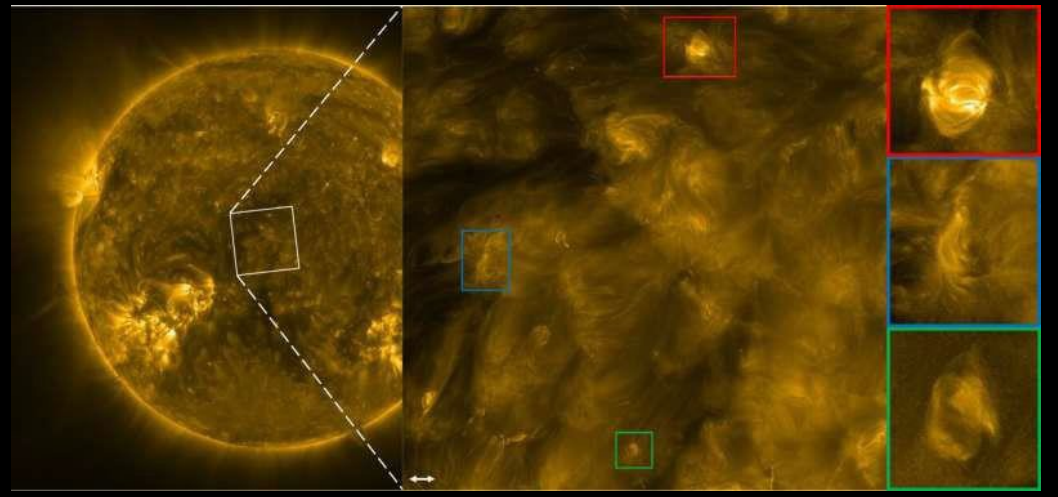
Magnetic waves heat Sun's Corona

- The Extreme Ultraviolet Imager (EUI) telescope, onboard the ESA's Solar Orbiter, has been used to produce these stunning images of the Sun's corona
- The temperature at the Sun's core is estimated to be about 16 million degrees Kelvin; at the surface, 5,772 degrees Kelvin
- But the corona is about 200 times hotter than the surface – and no one has known why
- High frequency magnetic waves, which are produced by fast oscillations in the smallest magnetic structures in the corona, are now thought to be responsible for the heating



Full sun observation taken on October 23rd 2022 by EUI's Full Sun Imager (FSI) and a zoom on the centre of the sun taken by its High-Resolution Imager (HRI). The white arrow corresponds to a distance of about 10,000km. Three smaller structures highlighted with red, blue and green boxes, show magnetic waves that appear as a transverse motion
Credit: Solar Orbiter/EUI Team

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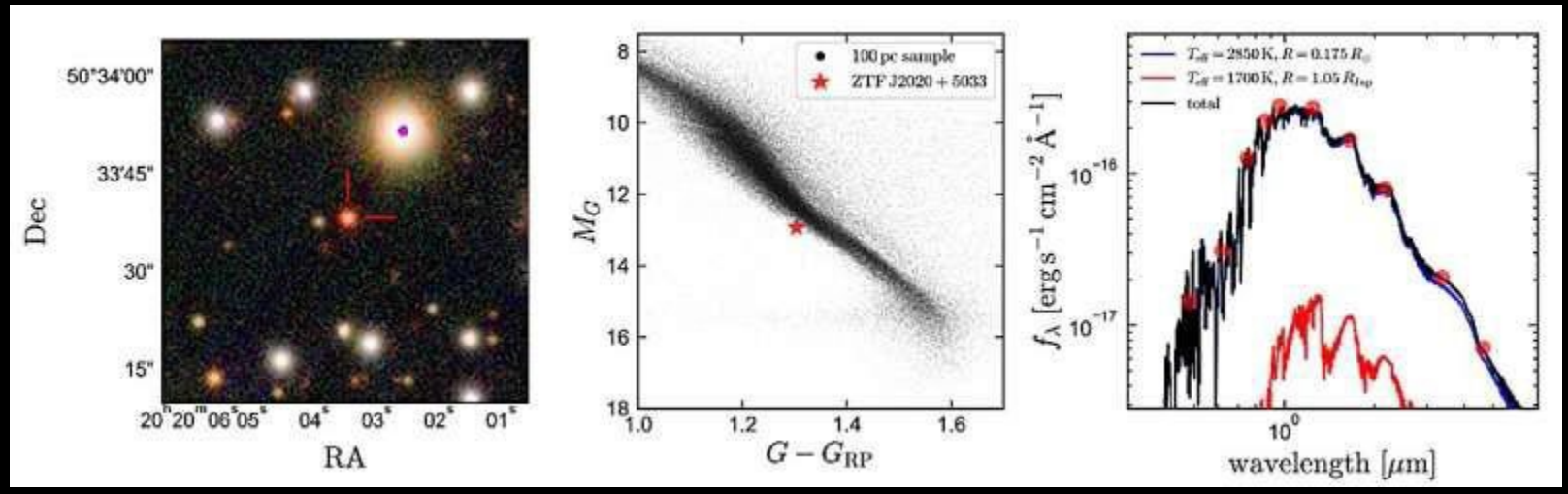
Brown and Red Dwarf binary system

- A new brown dwarf-red dwarf binary system has been discovered 457 light years from Earth
- With an orbit of only 1.9 hours, the entire system could fit inside the Sun
- The system is thought to be quite old. Over time, the brown dwarf is stripping material away from the red dwarf



Left: Pan-STARRS image centred on the binary system
Middle: Gaia colour-magnitude diagram with the binary slightly to the blue of the main sequence
Right: optical and infrared spectral energy distribution

Credit: arXiv (2023). DOI: 10.48550/arxiv.2307.15729

- Brown dwarfs are notoriously difficult to find and, so far, the only ones known are part of a binary system. Could there be many more yet to be discovered?

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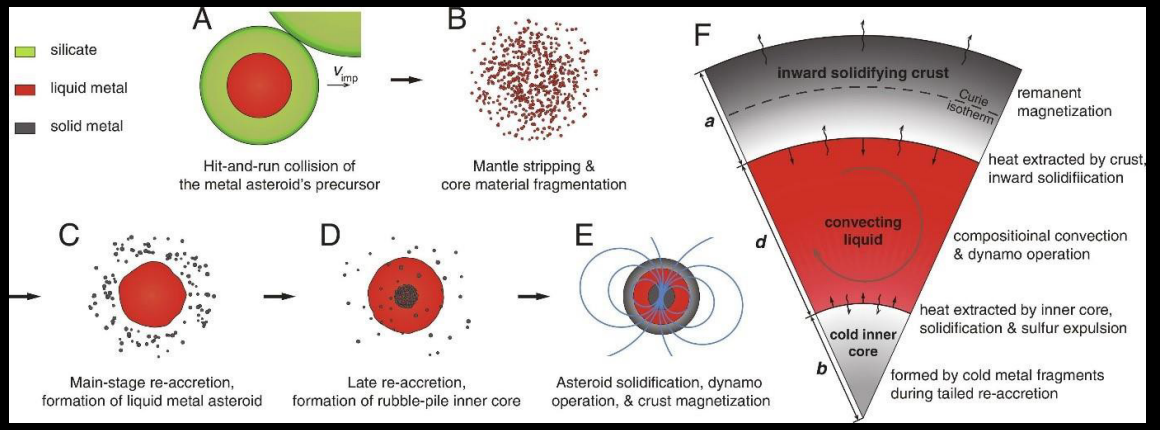
How planetary magnetic fields were formed

- Magnetism found in iron meteorites bear the imprint of an internally-generated magnetic field (once thought impossible)
- But the metallic cores of asteroids are not thought to be able to both generate magnetism and record it
- Now researchers are proposing a new way magnetism happened – collision



Rubble-pile core generating and recording magnetic field after collision
Credit: Zhongtian Zhang and David Bercovic, Yale University, USA

- As a result of collision, iron-rich asteroids may form with a cold, rubble-pile inner core surrounded by a warmer, liquid outer layer. Over time, heat is drawn into the core and lighter elements migrate outwards, creating a magnetic field
- An optimum-sized rubble-pile core may imitate a planetary inner core by being just small enough to cool in space, but by also sinking fast enough into the melted metal to pile up

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The Sun continues to surprise us

- Scientists working at the High-Altitude Water Cherenkov Gamma-Ray Observatory in Mexico, have observed the highest energy light coming from the Sun
- The amount of high energy gamma rays being detected is far above what any of the current models for the Sun predict. The energy is of the order of 1 trillion electron volts (1 TeV) or higher, the same as produced by the Large Hadron Collider

The High-Altitude Water Cherenkov Gamma-Ray Observatory (HWAC) near Puebla, Mexico
Credit: J Goodman

- It is thought that cosmic rays from black holes or supernovae smash into protons from the Sun and produce these gamma rays. As the Sun's magnetic field is thought to repel high energy cosmic rays, the discovery is unprecedented. Could the capture of dark matter by the Sun be behind this?

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Asteroids and the Winchcombe Meteorite

- In the evening of February 28th 2021, a large meteor from outer space hit the Earth's atmosphere. A lump of the rock survived the fiery descent and ended up on a driveway – the Winchcombe Meteorite
- It was recovered within twelve hours, meaning it was not exposed to contamination
- As a CM carbonaceous chondrite meteorite, it is potentially among the oldest objects in the solar system and may offer insights into the origins of the planets
- Analysis shows it was exposed to water as it is rich in clays and other water-bearing minerals. A sample was heated to 1,000 degrees, allowing researchers to tell which minerals were holding the water. Using infrared spectroscopy on asteroids allows scientists to compare them with the meteorite

The Winchcombe Meteorite
Credit: The Trustees of the Natural History Museum, London, 2021

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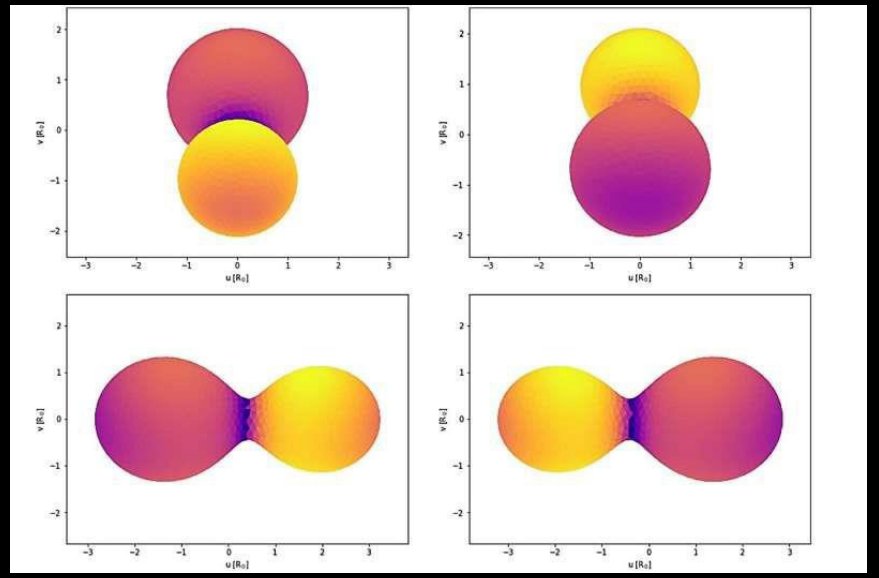
When binary stars get a bit too close

- Binary star systems are very common. In fact, the majority of stars may be in binary systems
- Although often quite widely separated (and easily resolved by telescope), some orbit at close proximity
- One such binary system, CSS J003106.8+313347, located 4,900 light years away in Ursa Major, with an orbital period of 0.344 days, appeared to be an eclipsing binary, where one star passes in front of the other (as in top row of illustration)
- However, it is not all as it seems
- Observations have revealed that the two G type stars are of similar temperature and luminosity and are sharing a common envelope, transferring and sharing material



3D representations of the CSS J003106.8+313347 system based on the light curve solution
Credit: Ehsan Paki, North and South Binaries Project, Toulon, France, et al, 2023

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A heartbeat star with gigantic tidal surges

- We experience the effects of the Moon on the Earth every day, with the rise and fall of the tides. Most noticeable by the edge of the sea, even the land moves by a few centimetres due to the Moon’s gravitational pull
- In elongated binary systems, where the orbits of the two stars are elliptical, the larger star will experience a tidal surge and this causes it to brighten, usually by less than one percent. Such stars are known as “heartbeat” stars

Credit: Melissa Weiss, CfA (Harvard & Smithsonian Center for Astrophysics)

- But a new system has been observed where the brightness of the primary star in the MACHO 80.7443.1718 system, in the Large Magellanic Cloud, is swinging up and down by 20%, whenever the smaller star passes close by
- The larger star, 35 times the mass of the Sun, experiences a massive tidal surge with the waves rising to about a fifth of the star's radius. This is equivalent to stacking three Suns one on top of another, or roughly 2.7 million miles high

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Microquasars distorting Spacetime

- A microquasar is a smaller versions of a quasar and is the compact area surrounding a stellar black hole. Matter is pulled off a companion star by the black hole and forms an accretion disk. This is heated by friction to enormous temperatures and emits radiation as x-rays
- The disk also projects jets of highly energised plasma at near light speed, generating strong radio wave emission
- Researchers studying the microquasar, GRS 1915+105, have found a quasi-periodic oscillation (QPO) signal that is sporadic in nature, as if the jet is wandering around, pointing in different directions and returning to its original direction roughly every 0.2 seconds
- It is thought that the dragging of spacetime near the rapidly spinning black hole is causing a misalignment of the spin axis and its accretion disk

Artist's depiction of microquasar event captured by FAST Telescope
Credit: Professor Wei Wang, Wuhan University, China

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The hum of the Universe

- As described in the past two issues of the Newsletter, researchers from around the world have been listening to the sound of thousands of black holes, specifically when they are close together, orbiting each other and about to merge
- Observations of pulsars shows they are being affected by long-wavelength gravitational waves, which is warping spacetime and all matter within it
- As the pairs of supermassive black holes orbit one another they vibrate spacetime, like the sensation felt in a dancefloor from the feet of thousands of dancers
- These vibrations through spacetime overlap in a rippling effect, causing the original hum detected via the millisecond pulsars

Artist's interpretation of an array of pulsars being affected by gravitational ripples
Credit: Aurore Simonnet for the NANOGrav Collaboration

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Super Magnetic Stars and Magnetars

- Magnetars are the strongest magnets in the universe. They are super-dense dead stars found throughout the Milky Way. But why they form, no one knows why
- However, a living star, HD 45166, located 3,000 light years away in the constellation, Monoceros, is suspected to be in the process of becoming a magnetar
- It already has a strong magnetic field of 43,000 gauss, making it the most magnetic star so far discovered
- Eventually it will collapse under its own gravity, increasing its magnetic field to 100 trillion gauss – a truly awesome super magnet!

Artist's impression of HD 45166
Credit: P. Marenfeld, M. Zamani (NOIRLab)

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Astronomy News in Brief (1)

- Eclipsing Binary (1) – astronomers have discovered an eclipsing binary, (a two-star system where the stars orbit around each other in a plane along our line of sight), in an open cluster (NGC 2232), some 10,600 light years from Earth. Spectroscopic observations have been used to identify the types of stars (late F-type dwarf primary star and a late K-type pre-main sequence (PMS) secondary star) involved. The primary star is 16 times the mass of the Sun and 12% larger, while the secondary star is 0.76 solar masses and 0.88 solar radii. Their surface temperatures are 6,070 K and 4,130 K, respectively, and they orbit each other every 3.72 days
- Eclipsing Binary (2) – using NASA's Transiting Exoplanet Survey Satellite (TESS), a group of astronomers have discovered an eclipsing Double White Dwarf (DWD) binary with an orbital period of just 47.19 minutes, around 1,312 light years from Earth. The white dwarfs are predicted to undergo a hot subdwarf phase and to merge into a single, more massive white dwarf within 41 million years. The merged white dwarf will be too small to go supernova

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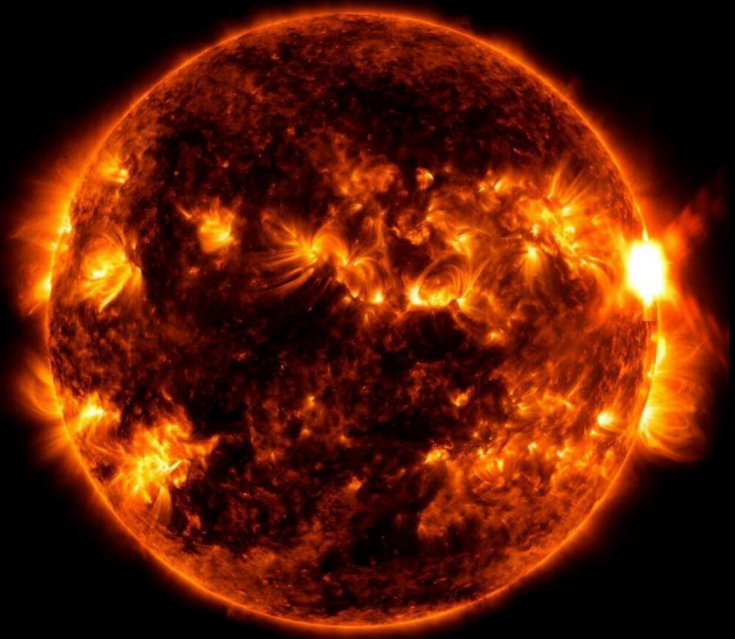
Astronomy News in Brief (2)

- Solar Flare – NASA's Solar Dynamics Observatory (SDO) has captured an image of an X1.6 flare – X representing the most intense class of solar flare - which peaked at 6:21pm EDT (11:21 BST) on the August 5th 2023. The solar flare is seen on the right as the bright flash. The image shows a subset of extreme ultraviolet light that highlights the extremely hot material in flares and which is colourized in red and orange
- Giant Solar Storm – a coronal mass ejection erupted from the Sun on October 28th 2021, spreading solar energetic particles (SEPs) across a volume of space measuring more than 250 million km wide. The event was felt on Earth, Mars, and the Moon, and was picked up by robotic probes



Credit: NASA/SDO

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Astronomy News in Brief (3)

- Mars is spinning faster – the now retired InSight probe found that the planet's rotation is accelerating by about 4 milliarcseconds per year, corresponding to a shortening of the length of the Martian day by a fraction of a millisecond per year. It's a subtle acceleration, and scientists aren't entirely sure of the cause. But they have a few ideas, including ice accumulating on the polar caps or post-glacial rebound, where landmasses rise after being buried by ice. The shift in a planet's mass can cause it to accelerate a bit like an ice skater spinning with their arms stretched out, then pulling their arms in
- Hydrogen Peroxide on Ganymede – radiation from Jupiter's magnetosphere bombards the surface of Ganymede, the largest moon in the solar system. This has the effect of converting water ice into other compounds, including oxygen, ozone, and hydrogen peroxide. Ganymede has an intrinsic magnetic field, unlike all other satellites in the solar system. The field funnels charged particles to its polar regions. This is in contrast with the equatorial distribution of hydrogen peroxide found on Europa

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Astronomy News in Brief (4)

- Early Earth heated by another star? – the Gaia satellite has spotted a “retired” asymptotic giant branch (AGB) star passing through a young star-forming region, something which was previously thought not to happen. Researchers identified this interaction occurred in one of the places where they think stars like our Sun must form. Previous research has shown that these retired AGB stars produce large quantities of the radioactively unstable chemical elements: Aluminum-26 and Iron-60. Both occurred in our young solar system at the epoch of planet formation, and are thought to dominate the early internal heating of Earth, and may have contributed to plate tectonics
- Saturn-sized Exoplanet – a new giant exoplanet has been discovered transiting a nearby dwarf star known as TOI-4860. It orbits the star every 1.5 days at a distance of 2.7 million kms. Its close proximity to the host star suggests that strong tidal interactions may be taking place, causing planet distortion and orbital decay. Another Jupiter-sized planet is also known to exist

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Spaceflight News

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PLATO – the next TESS

- In 2026, ESA plan to launch the next-generation exoplanet-hunting space observatory. PLATO (the PLAnetary Transits and Oscillations of stars) will consist of 26 separate 20cm telescopes, the equivalent of a 1m mirror
- It is designed to scan a sky-field ten thousand times larger than the full Moon; surveying 245,000 main-sequence F, G, and K-type (yellow-white, yellow, and orange) stars, and using the Transit Method to look for possible Earth-like planets over a 4-year period

Artist's impression of PLATO Credit: ESA/ATG medialab

- It is likely to find tens of thousands of exoplanets, of which a minimum of 500 should be Earth-sized (although far fewer will be around G-type (Sun-like) stars)

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The Mars Sample Return Program (1)

- Over the past few months, the Perseverance rover has been collecting Martian soil and rock samples from the floor of the Jezero Crater. Some of these have been stored onboard the rover, but others have been deposited on the planet's surface, as a back-up insurance
- In order to return the Perseverance-stored samples, the Sample Retrieval Lander (SRL) will touch down close by (top-right) and a robotic arm will transfer the samples to the Mars Ascent Vehicle (MAV), which is on the Sample Retrieval Lander (SRL)
- Should this prove impossible, Ingenuity-like helicopters will transfer the surface-cached samples to the Mars Ascent Vehicle (MAV)
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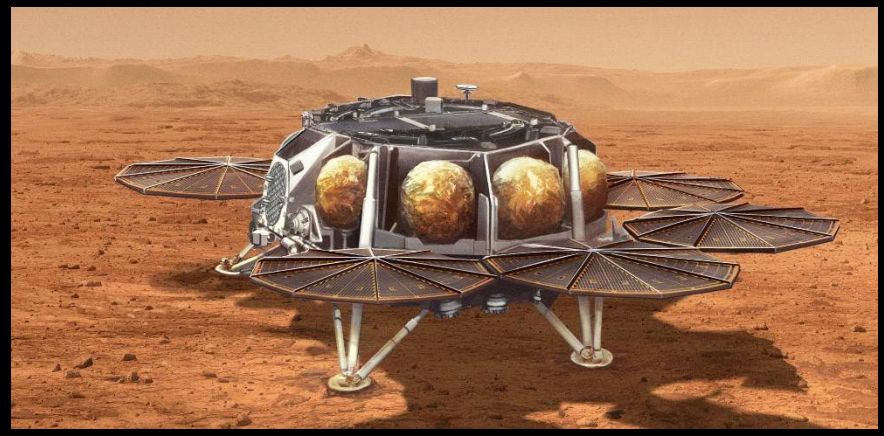

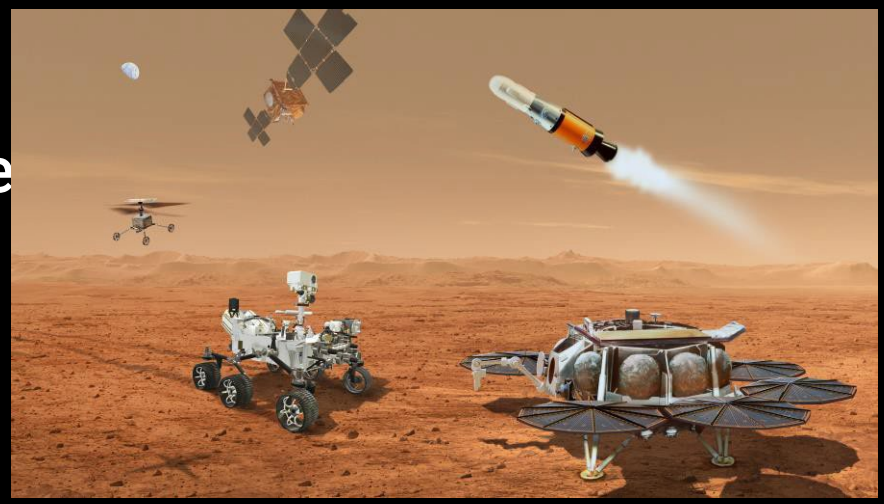

Credit: NASA/JPL-Caltech

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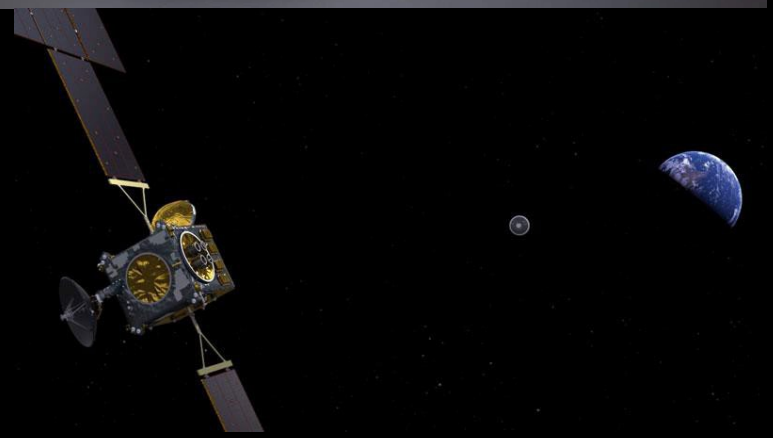
The Mars Sample Return Program (2)

- The Mars Ascent Vehicle (MAV) is a lightweight two-stage rocket which will take to samples in to orbit and a close rendezvous with the Earth Return Orbiter. Before firing the first stage engine, the MAV will be tossed into the thin Martian atmosphere by the SRL
- The first stage burn, to last about 75 seconds, provides the thrust needed to gain the right altitude. The second stage, lasting about 20 seconds, is spin-stabilized, and puts the MAV into orbit
- Once in orbit, it will release the Orbiting Sample Container (top-right) which the Earth Return Orbiter (bottom-right) will then capture. This latter spacecraft will then bring the samples back to Earth



Credit: NASA/JPL-Caltech

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The Mars Sample Return Program (3)

- The orbiter is due to launch in 2027 and the lander in 2028. The samples should be returned to Earth in 2033
- Testing of the stage two development engine (SRM2) for the MAV recently took place in March 2023 in a vacuum-chamber cooled to -20°C. This allowed engineers to test the supersonic splitline nozzle, which is part of the thrust vector control system. This is a novel solution to the problem of the ultracold affecting how gimballing solid rocket motor nozzles work
- You can watch the engine test at: https://youtu.be/rb2CLp2Hlkc
- The stage one development engine (SRM1) test took place a month later

Credit: NASA

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China’s Lunar Ambitions (1)

- Both the United States and China are looking at landing humans on the Moon, and then establishing lunar bases within the next decade
- Carrying resources from Earth to the Moon is extremely expensive so investigations are ongoing into making building blocks from lunar dust (regolith), and extracting water from permanently-shadowed regions (PSRs), especially the deep craters near the South Pole

Artist’s rendition of Chinese lunar facilities Credit: CFP

- The Chinese Lunar Exploration Program (CLEP), or Chang’e Program, is a series of robotic missions to study the Moon. Chang’e 1 and 2 (in 2007 and 2010) were orbiter missions. Chang’e 3 and 4 (in 2013 and 2018 respectively) included a lander and rover. Chang’e 5 in 2020 returned 1.7 kg of lunar samples

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China’s Lunar Ambitions (2)

- Chang’e 6, due to launch either in later 2024 or 2025, will land on the far side of the Moon and return samples from there
- Chang’e 7, due in 2026, will place a lander south east of the Shackleton Crater, near the South Pole. It will use a flying mini probe, equipped with a drill, mechanical arm, and a water molecular analyser and mini furnace to conduct spectral analysis, to explore the dark bottom of PSRs
- Chang’e 8, due in 2028, will look at conducting experiments on in-situ resource utilization, or ISRU, with the goal of constructing an International Lunar Research Station
- Watch a video about Chang’e 7 mission at: https://youtu.be/TecH94d1TTw
- Watch a video about the later Chang’es at: https://youtu.be/4cEMZZb2b9Y
- Why is the Moon’s South Pole so important: https://youtu.be/q2c7nZB-040
- A video simulation of the Shackleton Crater: https://youtu.be/izl9HVo8bjc

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India’s Successful Lunar Mission (1)

- The Indian Space Research Organisation (ISRO) successfully landed its Chandrayaan-3 Lander (Vikram) Module on the surface of the Moon on August 23rd
- With this, India becomes the fourth country to have successfully landed a probe on the Moon, and the first to land at one of the lunar poles
- The entire mission seems to have gone off flawlessly, from the moment the Launch Vehicle Mark-3 (LVM3-M4) rocket lifted off from the Satish Dhawan Space Centre on July 14th, through insertion into orbit on August 5th, and to the landing itself
- Vikram has now deployed the Pragyan rover. These will study the lunar surface composition, the presence of water ice, and the evolution of the atmosphere

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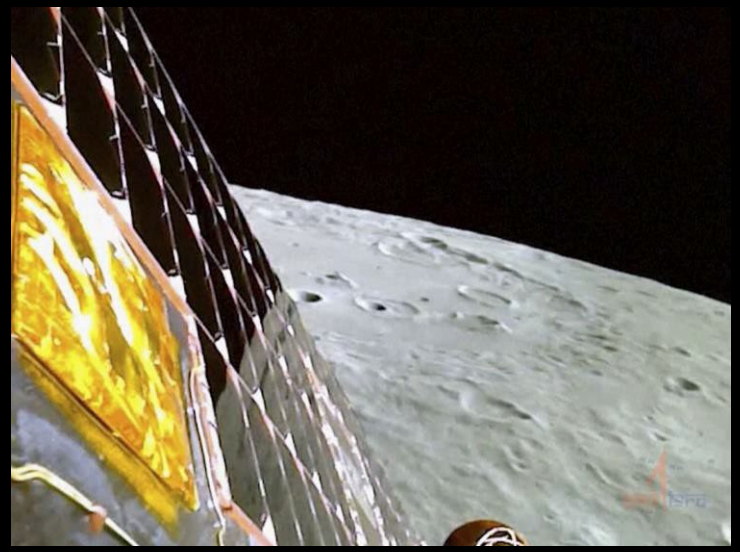
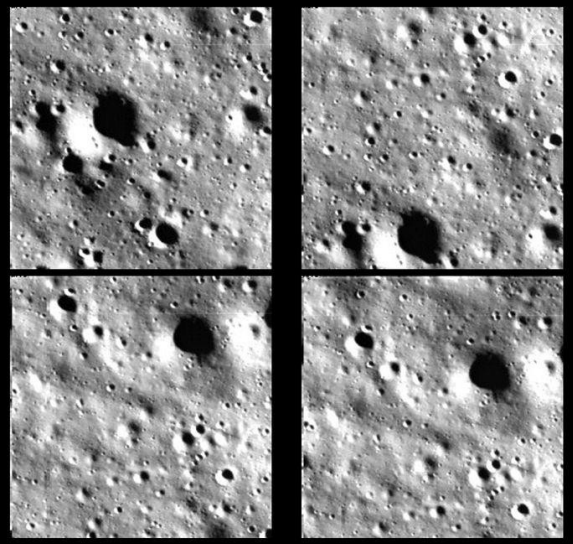
India’s Successful Lunar Mission (2)





- The ISRO have released a number of pictures of the landing (above)
- There are a number of videos available, including one which describes the missions in some detail: https://youtu.be/hP0GbRNGMLk
- The launch: https://youtu.be/_1MbC2ASk3g
- Entering orbit: https://cdn.jwplayer.com/previews/NNpttIgy
- And the landing: https://cdn.jwplayer.com/previews/4zbD5ONh

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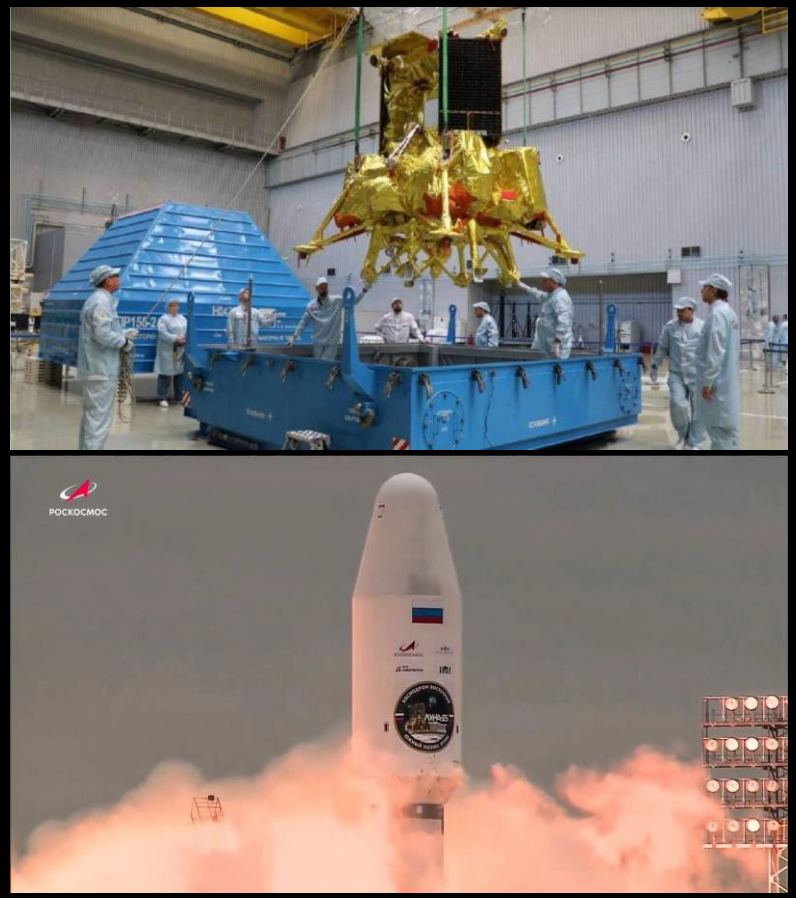
The Space Race is (sort of) warming up

- For the last few years, the challenge of landing the next humans on the Moon has been between the United States and China; now Russia has tried to enter the race
- Following a two-year delay, and after a gap of 47 years, Luna 25, on top of a Soyuz 2.1b rocket, was launched on August 10th from the Vostochny Cosmodrome. This was to herald the start of a new era in Russian lunar missions, and a possible joint lunar base with China
- However, following a five-day flight to the Moon and a successful insertion into lunar orbit, disaster struck when the lander crashed into the Moon's surface on August 19th. Back to the drawing board!
- See an animated video of the mission at: https://cdn.jwplayer.com/previews/5g6l7XhZ



Credit: Roscosmos State Space Corporation via AP

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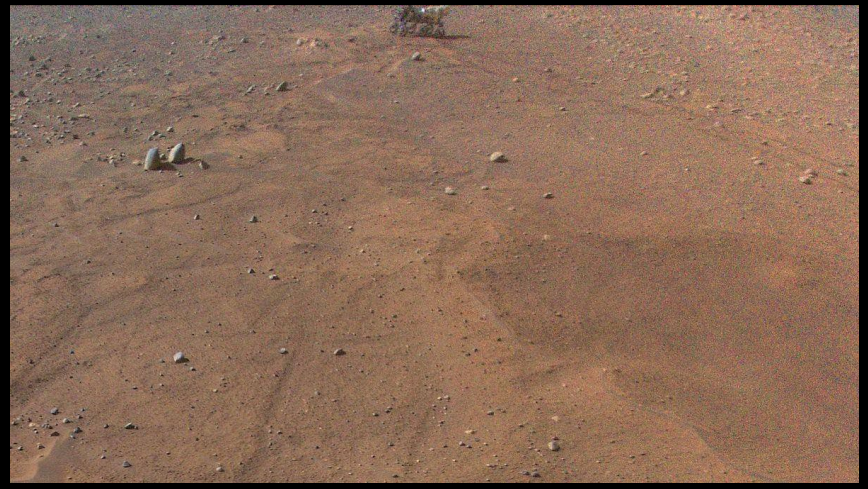
Spaceflight News and Updates (1)

- Voyager 2 – On July 21st, flight controllers accidentally sent a wrong command to Voyager 2, a mere 19 billion km distant in interstellar space, causing the spacecraft to tilt by 2° and point its antenna away from Earth. Luckily, NASA's Deep Space Network picked up a signal from Voyager 2, indicating it was still functioning. Now, flight controllers have managed to send a counter-command. This took over 18 hours to reach the spacecraft, instructing it to realign itself – but they didn't know if they had been successful for another 18.5 hours!
- Ingenuity – Perseverance's helicopter had to cut short a planned scouting flight on July 22nd. The reasons for why the 53rd flight ended early are not yet known but the helicopter successfully completed another flight (the 54th) on August 3rd. It is hoped this later flight will provide information on why the helicopter landed early



Ingenuity looking back at Perseverance Credit: NASA/JPL-Caltech

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Spaceflight News and Updates (2)

- China to use two rockets for Moon landings – unlike the Apollo/Saturn V era, the Chinese Moon landing will use two separate Long March 10 rockets. One will carry the crew capsule, and the other, the lunar lander. Once in lunar orbit, the taikonauts will dock with and transfer to the lander craft, then descend to the Moon’s surface
- Artemis 3 - the third Artemis mission, planned for December 2025, is due to land a crew on the Moon. However, NASA is seriously considering delaying a crewed landing to a later mission as the SpaceX Starship, the lander for the early missions, is not ready. A series of successful launches and recoveries will be needed before the go-ahead can be given

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Spaceflight News and Updates (3)

- ISS Replacement – Airbus and the US space exploration firm, Voyager Space, have announced a joint venture to build a replacement for the current International Space Station, possibly by the end of 2028. The commercial venture, called Starship, will sell services to NASA, rather than NASA managing them itself. Voyager has already been given $160 million by NASA to develop Starship; this is in addition to $130 million given to Blue Origin and $126 million to Northrop Grumman to develop rival space stations. In addition, a fourth project is being developed by Axiom Space, with help from NASA and the Franco-Italian firm, Thales Alenia Space
- Astronaut controls robots on Earth – NASA's Frank Rubio, on board the ISS, controlled a number of Earth-based robots in order to complete a complex task. The successful test, (the first of the "Surface Avatar" series), is a step on the road to allowing astronauts and Earth-based experts to be able to command and manage teams of robots in space

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Spaceflight News and Updates (4)

- Ariane 6 – ESA's new Ariane 6 successfully completed the first launch preparation and countdown sequence test on July 18th, at Europe's Spaceport in Kourou, French Guiana. The test involved filling the rocket with liquid oxygen and hydrogen, cooling the ground and launcher fluidic systems, and drawback of the mobile gantry, as well as internal systems checks and full software testing. The launch sequence was completed up to the point of ignition. A short ignition of the new Vulcain 2.1 engine will be carried out in later tests
- Boeing Starliner – on-going problems with the parachute system and repairs needed to be made to the wiring (the insulation has been found to be flammable), have pushed the launch of a crewed Starliner spacecraft back to March 2024 at the earliest. For a short video about the Boeing Starliner see: https://cdn.jwplayer.com/previews/KCfo5TgU

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Spaceflight News and Updates (5)

- Final flight of current Antares rocket – after 10 years and 18 launches of various iterations, Northrop Grumman launched the final Antares 230+ rocket on August 2nd. Carrying the Cygnus cargo ship, NG-19, named SS Laurel Clark, headed for the ISS. After using Falcon 9 rockets for the next few Cygnus cargo spacecraft, NG-23 will be launched in Summer 2025 using the upgraded Antares 330. It will feature a new first stage (based on the Firefly Aerospace MLV and using 7 Miranda engines); this will produce almost twice as much thrust as a 200 series first stage. The current upper stage, Castor 30XL, will continue to be used
- Nighttime launch of Falcon 9 – a SpaceX launch of 15 Starlink satellites in the evening of July 20th, from the Vandenburg Space Force Base in California, provided some spectacular shots. See the launch at: https://cdn.jwplayer.com/previews/2mf5QHTe

Credit: SpaceX

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Observational Highlights

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September 2023 dates

- 6th September – Mercury is at inferior solar conjunction (12:04 BST)
- 17th September – Comet 2020 V2 (ZTF) is at its closest to Earth (2.23 AU)
- 18th September – Venus reaches its greatest brightness (mag -4.54) (13:09)
- 19th September – Neptune is at opposition (12:09), in the constellation Pisces
- 22nd September – Mercury at greatest western elongation (18°) from Sun (12:27); it will be 15° above the eastern horizon at sunrise
- 23rd September – Autumnal Equinox (07:46)
- 24th September – Comet 2P/Encke is at its closest to Earth (0.90 AU). Visible as a morning object in early October; expected magnitude +8.0
- 26th September – Comet 103P/Hartley is at its closest to Earth (0.38 AU); expected magnitude +7.0 in Auriga (north-east of Capella)

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Return of the Planets (but not Mars) (1)

- September sees all the planets on show, with the exception of Mars
- Mercury and Venus are now seen in the morning, the others are evening objects

Mercury

- Mercury will provide its best show this year, moving to its furthest away from the Sun on September 22nd. It will be a challenge as it doesn't rise over 15°above the horizon
- During the month the phases (and brightness) change quickly from 13° (at a magnitude of +1.73) on September 14th to 79° on September 30th (magnitude -1.01). Over a cycle (around 4 months) the magnitude varies enormously, on May 3rd it was +6.71 but by July 2nd it had brightened to -2.22. However, this has nothing to do with the distance from Earth (often, quite the opposite). On May 3rd it was 83.9 million km away, but on July 2nd it was 198.6 million km away!

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Return of the Planets (but not Mars) (2)

Venus

- Venus, after spending the first half of the year as the most glorious of evening sights, is now established as the “Morning Star”
- As the month progresses, Venus will rise away from the horizon and continue to brighten. From 14° and -4.41 on the 1st, it will reach 25° and -4.54 on the 15th, and 32° and -4.52 on the 30th. More importantly, you will be able to see it for longer ,as it rises earlier, and the dawn becomes later further into September, (on the 30th it rises at 03:01 whilst fading in the dawn light at 06:35)
- After being only 43.20 million km from Earth on August 13th, it will be 50.04 million km on September 1st, and 77.13 million km on September 30th

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Return of the Planets (but not Mars) (3)

Jupiter

- Jupiter lies in Aries this month. It will be visible from late evening through to early morning
- On the 4th, Jupiter reaches its first stationary point, before beginning its retrograde motion from east to west for the rest of the year
- As the month progresses, Jupiter will begin low down in the East at around 7° above the horizon, before reaching its highest point, at around 53°/54° above the southern horizon. The highest point will move earlier as the month moves on, so that by the 30th it will be at 03:14, giving a further 3 hours 20 minutes before Jupiter is lost to sight, 35° above the south-western horizon
- Over the night of 21st/22nd Io, and its shadow, will coincide with a transit of the Great Red Spot

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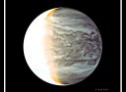
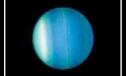
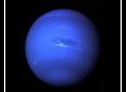
Planets (for evening of 1st/morning of 2nd September)

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	07:22	19:34	13:28			+3.25	NO
	VENUS	04:14	18:03	11:09	East	14° ▫	-4.41	YES
	MARS	08:27	20:30	14:28			+1.75	NO
	JUPITER	21:51	12:34	05:12	South	54°	-2.63	YES
	SATURN	19:40	05:47	00:44	South	27°	+0.42	YES
	URANUS	22:02	13:20	05:41	South-East	55° *	+5.72	YES
	NEPTUNE	20:18	08:00	02:09	South	36°	+7.82	YES

* = Highest point at Dawn (04:46 - last visible sighting)

** = Highest point at Dusk (21:10 - first visible sighting)

◊ = Highest point when first visible

◊◊ = Highest point when first visible

▫ = Highest point when last visible (05:49)

▫▫ = Highest point when last visible

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

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
Cr50	The Hyades (Taurus)	Open Cluster	23:20	14:13	06:46 ▫	South-East	51°	+1.0
M45	The Pleiades (Taurus)	Open Cluster	21:49	14:25	06:07 ▫▫	South-East	61°	+1.3
M31	Andromeda Galaxy (Andromeda)	Galaxy	***	***	03:03 *	North	79°	+3.4
M42	Orion Nebula (Orion)	Open Cluster	02:18	13:32	07:55 *	South-East	20°	+4.0
IC4665	Open Cluster (Ophiuchus)	Open Cluster	13:32	02:35	20:04 **	South	42°	+4.2
C14	Double Cluster (Perseus)	Open Cluster	***	***	04:40	North	83°	+4.3
NGC6633	Open Cluster (Ophiuchus)	Open Cluster	14:09	03:20	20:44 **	South	45°	+4.6
IC4756	Graff's Cluster (Serpens Cauda)	Open Cluster	14:25	03:27	20:56 **	South	44°	+4.6
M5	Globular Cluster (Serpens Caput)	Globular Cluster	11:22	23:50	17:36 **	South-West	23°	+5.7
M33	Triangulum Galaxy (Triangulum)	Galaxy	18:41	13:07	03:54	South	69°	+5.8
M13	Great Globular Cluster (Hercules)	Globular Cluster	08:28	05:31	18:59 **	West	62°	+5.8
M12	Globular Cluster (Ophiuchus)	Globular Cluster	13:11	00:59	19:05 **	South-West	30°	+6.1
M3	Globular Cluster (Canes Venatici)	Globular Cluster	07:09	00:52	16:00 **	West	29°	+6.3
M15	Globular Cluster (Pegasus)	Globular Cluster	16:41	06:52	23:47	South	51°	+6.3
M92	Globular Cluster (Hercules)	Globular Cluster	***	***	19:35 **	West	71°	+6.5

* = Highest point at Dawn (04:46 - last visible sighting) ** = Highest point at Dusk (21:10 - first visible sighting)
▫ = Bright object last visible sighting (05:22) ▫▫ = Bright object last visible sighting (05:17) *** = circumpolar

Lewes Astronomical Society

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

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
M2	Globular Cluster (Aquarius)	Globular Cluster	17:51	05:50	23:50	South	38°	+6.6
M10	Globular Cluster (Ophiuchus)	Globular Cluster	13:31	00:58	19:15 **	South-West	29°	+6.6
M81	Bode's Galaxy (Ursa Major)	Galaxy	***	***	12:14 *	North-East	40°	+6.9
M101	Pinwheel Galaxy (Ursa Major)	Galaxy	***	***	16:21 **	North-West	47°	+7.9
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	***	***	15:09 **	North-West	30°	+8.2
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	***	***	15:48 **	North-West	39°	+8.4
M57	The Ring Nebula (Lyra)	Planetary Nebula	***	***	21:30	South-West	71°	+8.8
NGC2403	'Spiral' Galaxy (Camelopardalis)	Galaxy	***	***	09:56 *	North-East	50°	+8.9

Twilight ends (1st), Twilight starts (2nd)
Sunset (1st), Sunrise (2nd)
Moon rises (1st), Moon sets (2nd)

Twilight	Civil	Naut	Astro
Ends	20:21	21:03	21:49
Starts	05:36	04:53	04:07

	Rises	Sets
Sun	06:10	19:47
Moon	20:20	07:46

* = Highest point at Dawn (04:46 - last visible sighting) ** = Highest point at Dusk (21:10 - first visible sighting)
▫ = Bright object last visible sighting (05:22) ▫▫ = Bright object last visible sighting (05:17) *** = circumpolar

Lewes Astronomical Society

Brown Lunation Numbers

numbered from first New Moon in 1923

Phases of the Moon

Phase	Date	Time	Lunation
FULL MOON	29th September	10:57	1246
LAST QUARTER	6th September	23:21	1245
NEW MOON	15th September	02:39	1246
FIRST QUARTER	22nd September	20:31	1246

Credit: Sean Smith/NASA