

Lewes Astronomical Society

Newsletter - April 2023

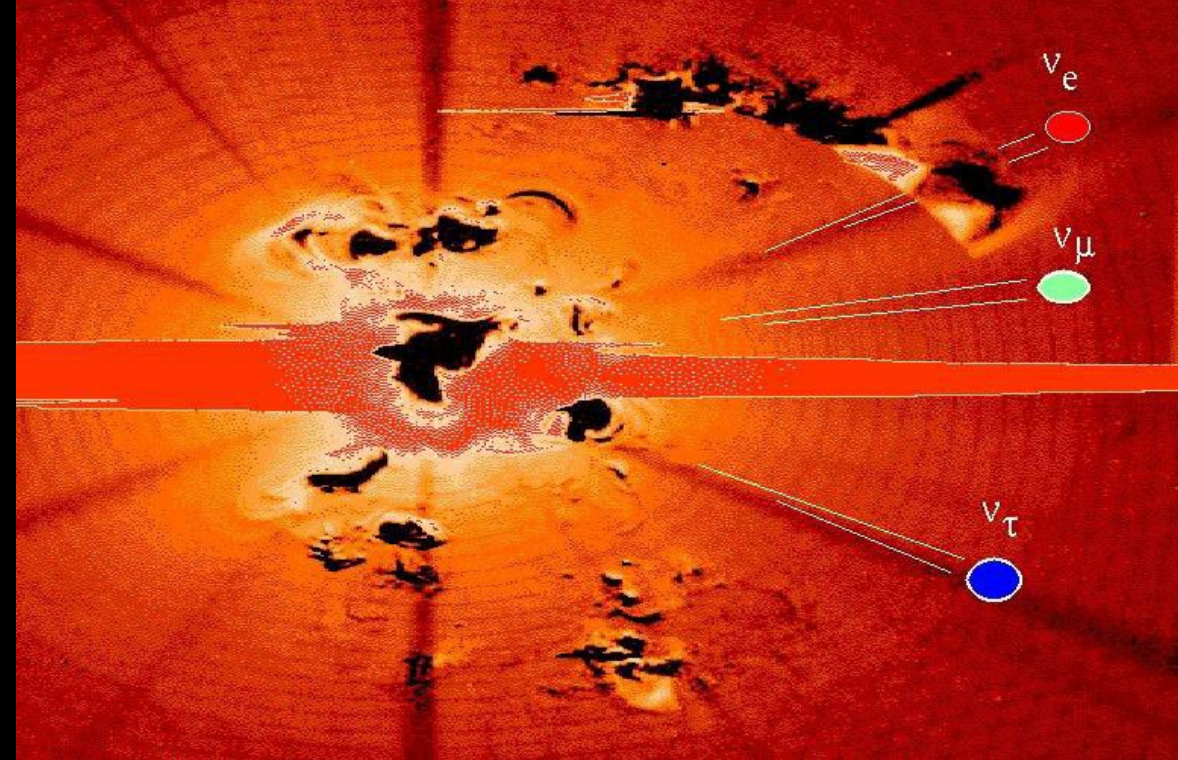
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Astronomy & Space News

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A “Dark” Big Bang?

- Most cosmologists believe the Universe began with inflation driving hyper expansion. The hot Big Bang then produced exotic quantum fields which decayed into the particles we see today
- But this doesn't explain how dark matter came into existence
- New research suggests that a dark quantum field was also produced but it didn't immediately decay. Some short time later, when the universe had cooled enough for atoms to be formed, the dark quantum field decayed sparking the “Dark” Big Bang that created dark matter

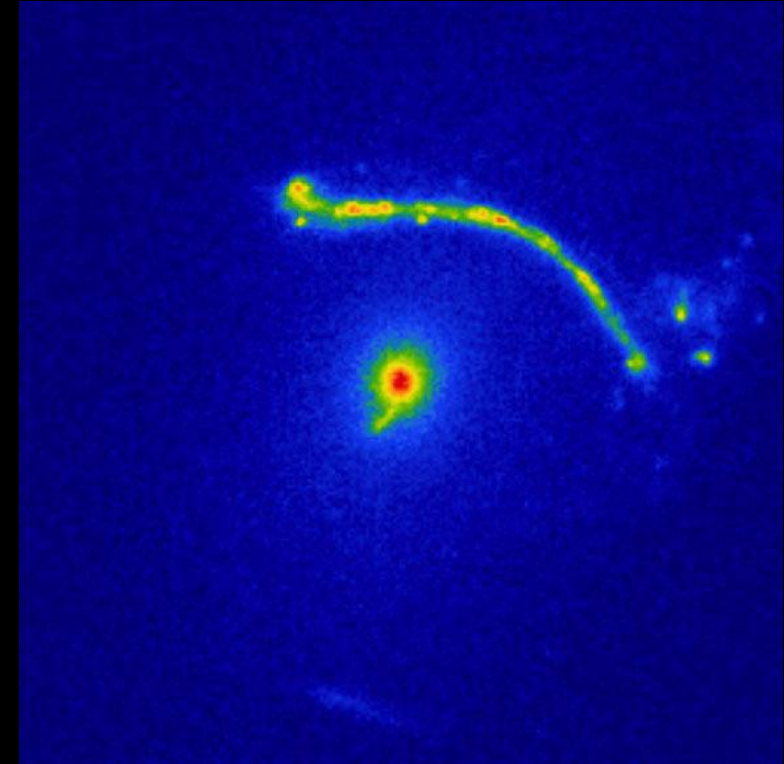


The three particles emerging from the Big Bang are the electron neutrino (red), the muon neutrino (green) and the tau neutrino (blue)

Credit: arXiv (2023). DOI: 10.48550/arxiv.2302.11579

Gravitational Lensing reveals an SMBH

- The Abell 1201 Galaxy Cluster is approximately 2.7 billion light years from Earth
- In 2003 Hubble imaged the cluster and the main galaxy (Abell 1201 BCG) in particular
- In 2004 researchers at Durham University noted that the cluster was gravitationally lensing more distant galaxies. However, something wasn't quite like other similar galaxy clusters
- Dark Matter, which massively increases the mass of a cluster, should be spread through & around the cluster
- But the image suggested that the mass was concentrated near the centre – a 32.7 billion solar mass Supermassive Black Hole (SMBH)
- See the video: <https://youtu.be/thxU8PQUY7w>

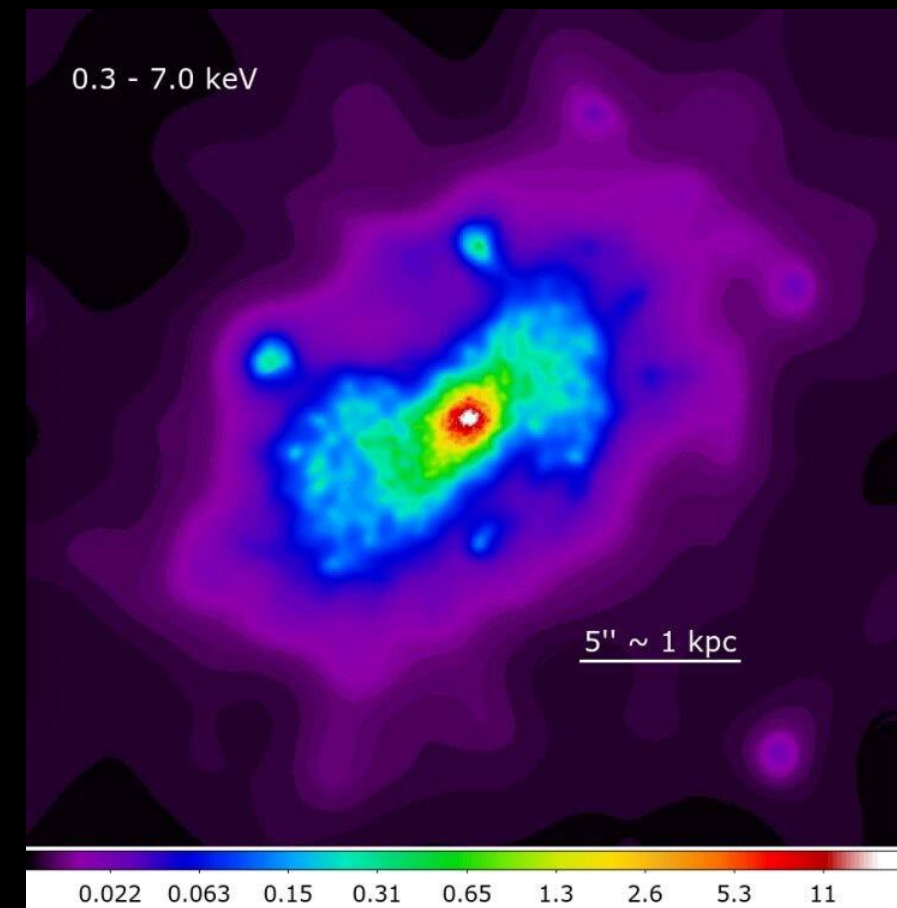


Credit: NASA/ESA/Hubble/Nightingale et al.,
doi: 10.1093/mnras/stad587

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X-Ray view of an AGN

- NGC 5728 is an active barred spiral galaxy situated some 146 million light years away in the constellation Libra
- It is about 100,000 light years in diameter and about 72 billion solar masses – so the size of the Milky Way
- Unlike the Milky Way it is a Seyfert Galaxy (type 1.9) with an Active Galactic Nucleus (AGN) powered by a supermassive black hole which shines in X-ray light
- The Chandra Space Telescope has captured this image of the AGN at the heart of the galaxy



NGC 5728, emission in the full-band (0.3–7.0 keV)

Credit: Anna Trindade Falcao (Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts) et al (2023)

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Last remnants of a Supernova

- In 185 CE the Chinese witnessed the sudden appearance of a new star which shone brightly for about 8 months before fading away; the first recorded sighting of a supernova
- The 4m Victor M. Blanco telescope at the Cerro Tololo Inter-American Observatory in Chile has imaged the remains of the white dwarf type 1a supernova explosion (SN185). The wispy tendrils are all that remain (known as RCW 86)
- The white dwarf, when consuming gas from the companion star, produces high velocity winds driving off the surrounding gas and dust creating a cavity for the debris to expand into
- For more see the video at: <https://youtu.be/UE-4StYA57A>

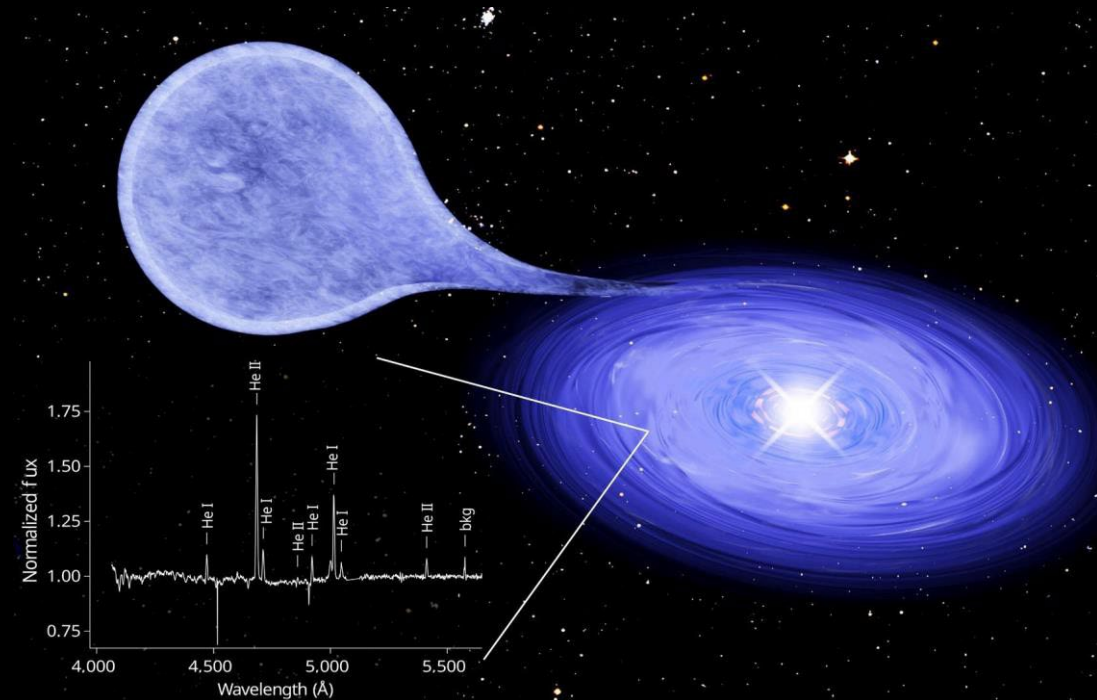


Credit: National Science Foundation

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Whites Dwarfs, Supernovae and Helium

- A white dwarf, by its very nature, is too small and faint to be seen directly
- A type 1a supernova caused by a white dwarf growing beyond the Chandrasekhar Limit (by drawing off material from a companion star) is a theoretical prediction but the process is impossible to observe
- This material would be mainly hydrogen
- But type 1a supernovae show no trace of hydrogen in the remnants
- Double star systems where the white dwarf burns helium instead have been surmised but never seen. Super-soft X-Ray source [HP99] 159 in the LMC could be one



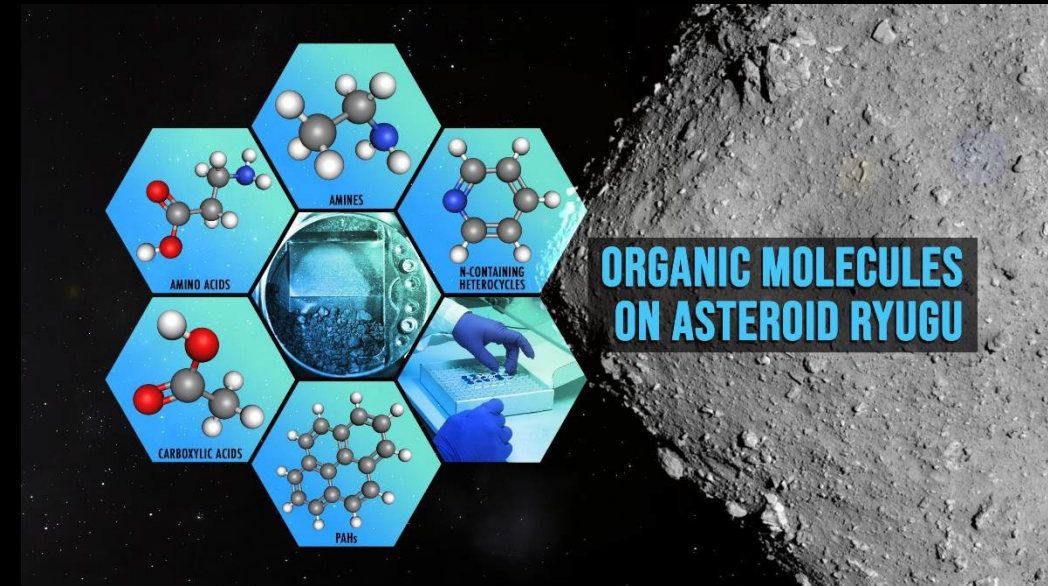
Artist's impression of a super-soft X-ray source: the accretion disk around a white dwarf star is made mainly of helium. [HP99] 159 may be an example but the observed amount of helium given off is less than predicted. It could be a SN Iax, a lower luminosity class of supernova with a weaker explosion

Credit: F. Bodensteiner/background image ESO

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Asteroid is organically rich

- A sample of the Ryugu asteroid returned by the Japanese Hayabusa2 spacecraft has revealed a wide range of organic compounds
- Only small sample has been studied so far, but it contains several amino acids, aliphatic amines, carboxylic acids, polycyclic aromatic hydrocarbons, and nitrogen-containing heterocyclic compounds, which survived space, solar heating, UV, cosmic rays, etc.
- Uracil, one of the informational units that make up RNA (the molecules that contain the instructions for building and operating living organisms), has also been found, together with Nicotinic acid, also known as Vitamin B3 or niacin
- New material from the NASA OSIRIS-REx mission to the asteroid Bennu, should be returned later this year. See the video at: <https://youtu.be/P6eNCo72FUQ>



Credit: NASA/JAXA/Dan Gallagher

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Update on the Dimorphos Asteroid

- Last September, NASA's DART spacecraft (Double Asteroid Redirection Test) was deliberately smashed into the asteroid Dimorphos in an attempt to prove that potentially hazardous asteroids could be deflected away from the Earth
- Dimorphos orbits the larger asteroid Didymos and the test was hoped to alter the orbital period by about 7 minutes. However, following the impact the orbit was actually shortened by 33 minutes
- Analysis now shows that most of the change was due to the ejection of large amounts of debris giving Dimorphos an extra kick



Credit: ESO/Cyrielle Opitom (University of Edinburgh) et al

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Ride into space on a cheap rocket?

- Following the Virgin Orbit attempt to launch a rocket in January many new companies are coming to market with cheaper alternatives
- Terran-1, the world's first 3D-printed rocket, was launched on Wednesday 22nd March
- Unfortunately, the low-Earth orbit test failed due to an “anomaly” during second stage separation
- 85% of its mass is 3D-printed metal alloys, the engines are also 3D-printed
- Terran-1 is 33.5m high and 2.2m wide. The first stage uses nine Aeon 1 engines and the second stage, one Aeon Vacuum engine. The propellant is a liquid natural gas and oxygen mix. It uses 100 times fewer parts in construction than a conventional rocket and can be built from raw materials in under two months

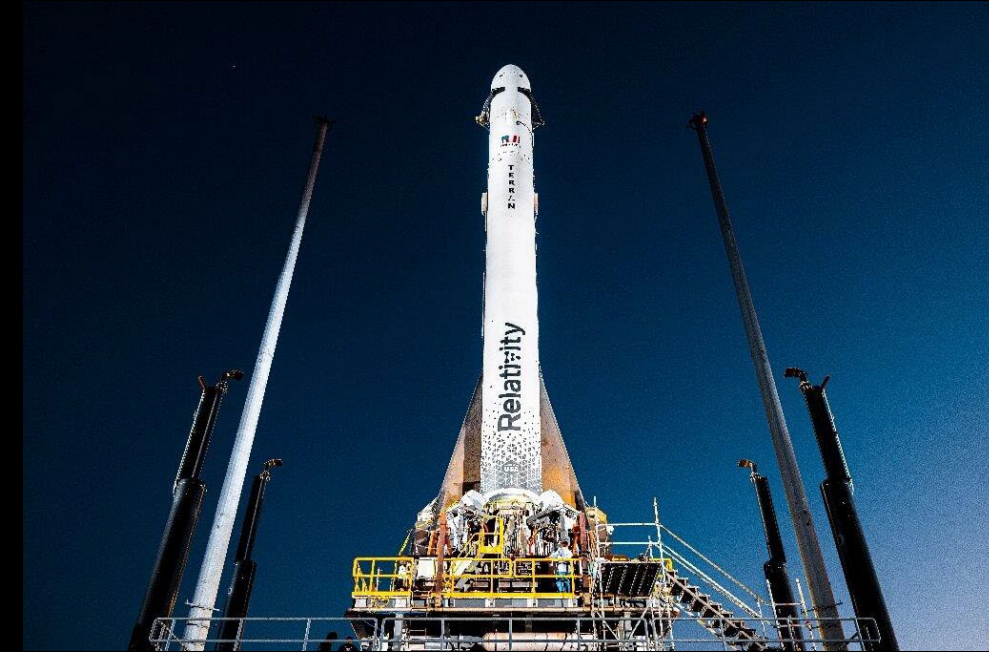
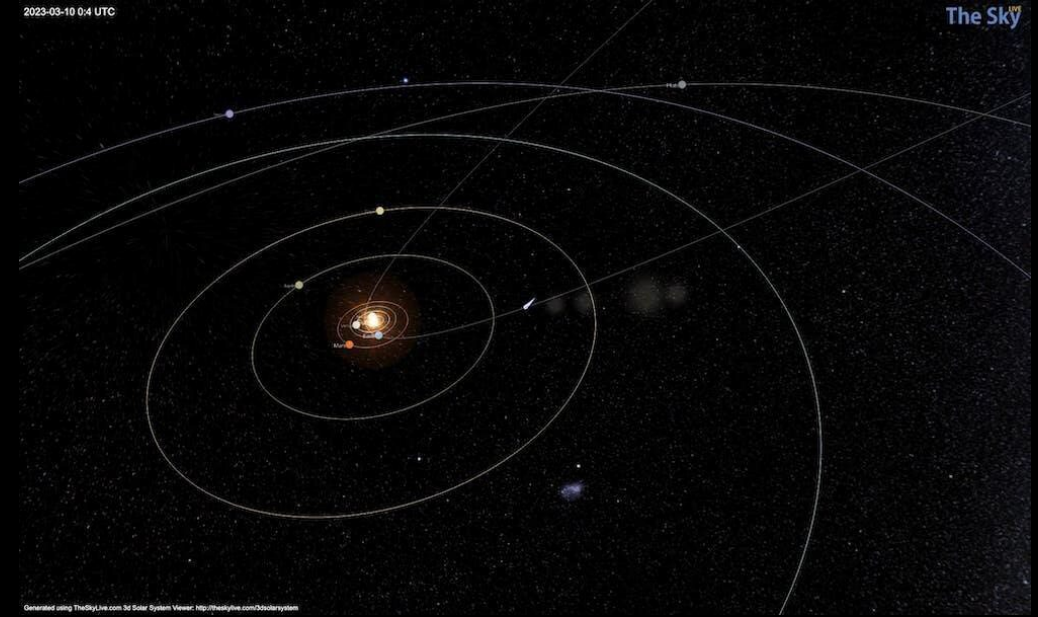


Image: Terran-1 Credit: Relativity Space

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Forget the green comet – all eyes are on 2024

- The green comet C/2022 E3 (ZTF) failed to live up to its billing (see February 2023 News). But could the Autumn of 2024 provide a much better comet display?
- C/2023 A3 (Tsuchinshan-ATLAS) has recently been discovered out between Jupiter and Saturn. It is destined to move to within 59 million km of the Sun (perihelion) in October 2024, then to within 70 million km of the Earth about 2 weeks later
- Although currently faint it is very bright for an object that far from the Sun
- It could turn out to outshine most stars but, as we know, comets can be very fickle. It could brighten too soon, or too late, or just break up!



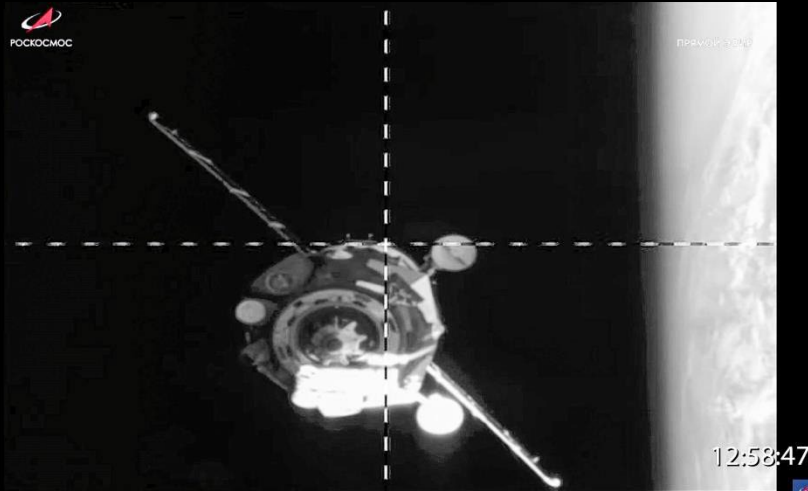
Comet's position on 10th March 2023

Credit: TheSkyLive.com

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Update from February – Damaged Soyuz Spacecraft

- The damaged Soyuz MS-22 spacecraft, which was leaking coolant into space, has been successfully returned to Earth landing near Zhezkazgan, Kazakhstan, on Tuesday 28th March



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Update from February – Light Pollution/Dark Skies

- The North Yorkshire village of Hawnby has decided to replace all the street lamps and 100 external lights on over 30 properties with dark-sky-friendly lighting in an attempt to cut light pollution
- The North York Moors village is in an international dark skies reserve
- Mike Hawtin, dark skies officer for the North York Moors National Park, said: *“We’re aiming to show how relatively easy it can be for communities to take a similar approach to the one at Hawnby and help us protect the pristine qualities of our dark skies”*



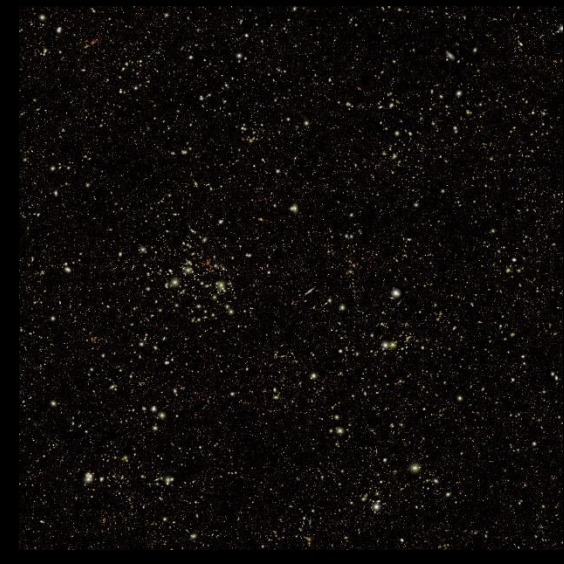
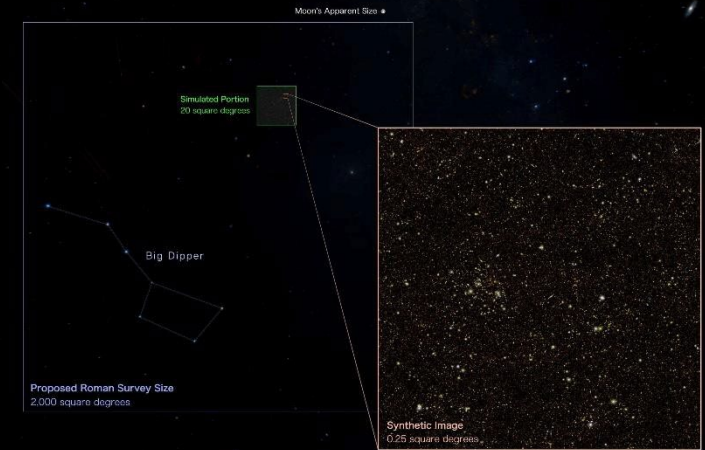
Image: The Station Inn, Hawnby (before and after) Credit: BBC News

- To be recognised, places must have low light meter readings, support from more than 80% of the local population, and dark-sky-friendly lighting

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Update from January – Roman Space Telescope

- Prior to the launch of the new Nancy Grace Roman Space Telescope (sometime between October 2026 and May 2027) scientists have been creating a simulated deep field image as part of the design work
- Unlike JWST or Hubble which focus on individual objects, Roman is a survey telescope with a wide field of view, 100 times bigger than that of Hubble
- The top simulation shows how much area the survey will cover (blue – the complete future survey, green – the size of the area simulated and in orange, enlarged)
- The future survey will take 7 months for Roman to complete (JWST or Hubble would need 1,000 years). Image contains 33 million galaxies + 200,000 stars



Credit: (top image) NASA's Goddard Space Flight Center and M. Troxel
(bottom image): M. Troxel and Caltech-IPAC/R. Hurt

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Update from October – Blue Origin Rocket failure

- On 12th September 2022, the launch of a New Shepherd rocket went wrong when, 1 minute into the flight, the booster malfunctioned. The uncrewed capsule catapulted off and parachuted to safety but the booster crash landed.
- The rockets were grounded whilst an investigation was conducted
- The investigation concluded that the rocket nozzle broke apart due to excessive temperatures; a redesign should solve the issue
- The FAA is reviewing the investigation before giving the go-ahead to resume



Blue Origin's capsule is seen firing emergency thrusters to separate from its booster during an emergency manoeuvre

Credit: Blue Origin



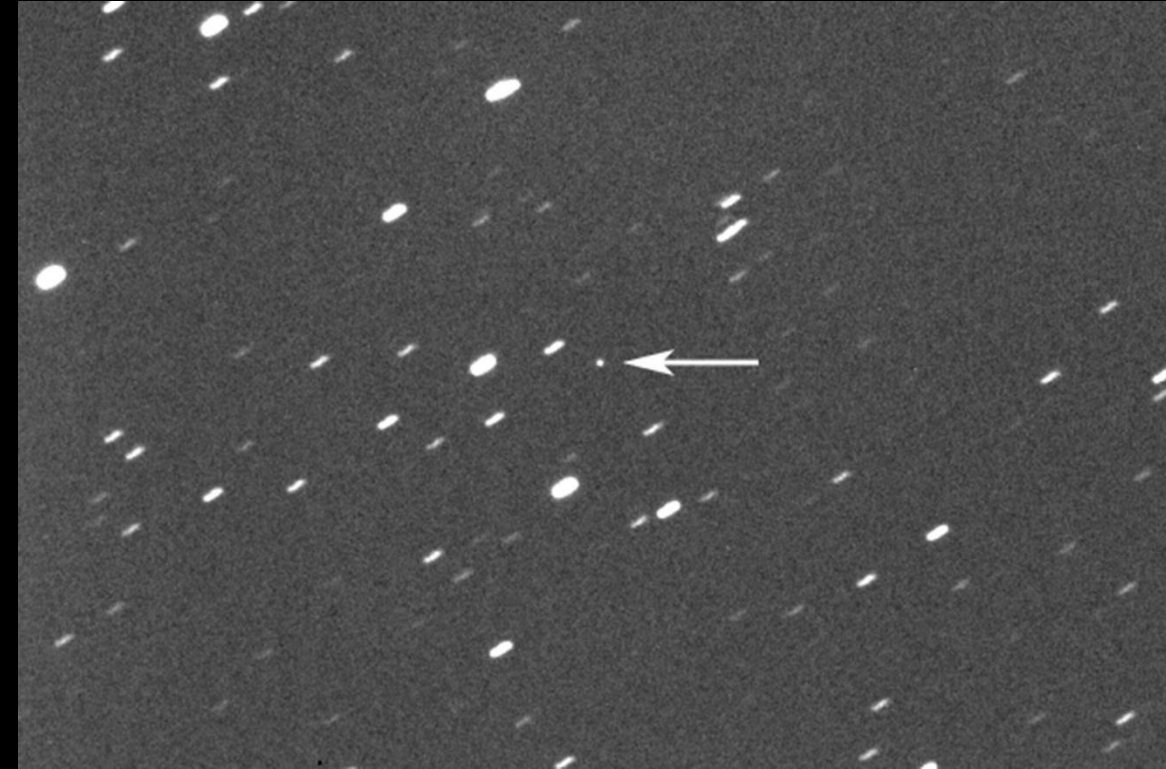
Finally (1): The Powers of Ten

- In 1977 Charles and Ray Eames, successful designers from the USA, came up with a way of visualising how big the cosmos is. It is a wonderful piece of science communication
- In a short film, “**The Powers of Ten**” they looked at a 1 metre square from the distance of 1 metre from directly above (10^0m)
- Over the next ten seconds the camera would zoom out to 10 metres and look at a 10 metre square ($10\text{m} \times 10\text{m}$) (10^1m)
- Then during the next ten seconds the camera would zoom out to 100 metres and look at a 100 metre square (10^2m) and so on out to 100 million light years (10^{24}m)
- In a tribute to the vision of the Eames and a homage to the original film, the BBC and Professor Brian Cox have updated the work. You can see it on BBC iPlayer (go to the ‘Science & Nature’ category and search for “**Life’s Big Questions**”, then “**Series 1.3 How Big is Our Universe**”)
- Or follow this link: <https://www.bbc.co.uk/iplayer/episode/p0d7lny2/lifes-big-questions-series-1-3-how-big-is-our-universe>
- For the original “**Powers of Ten**” film visit: <https://www.youtube.com/watch?v=0fKBhvDjuy0>

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Finally (2): Killer Asteroids - not this week anyway

- Another close brush with death, though not that close in reality. A second large asteroid has passed within a whisper of Earth in just a matter of a few months. It hurtled past at a distance of a mere 100,000 miles (168,000 km) on 25th March 2023
- Discovered a month ago, the asteroid known as 2023 DZ2 passed within 320,000 miles (515,000 km) of the Moon then, several hours later, buzzed the Indian Ocean at about 17,500 mph (28,000 kph). 2023 DZ2 is between 42 and 94 metres across



Credit: Gianluca Masi/Virtual Telescope Project via AP
Imaged when 1.8 million kms (1.1 million miles) from Earth of 22nd March 2023

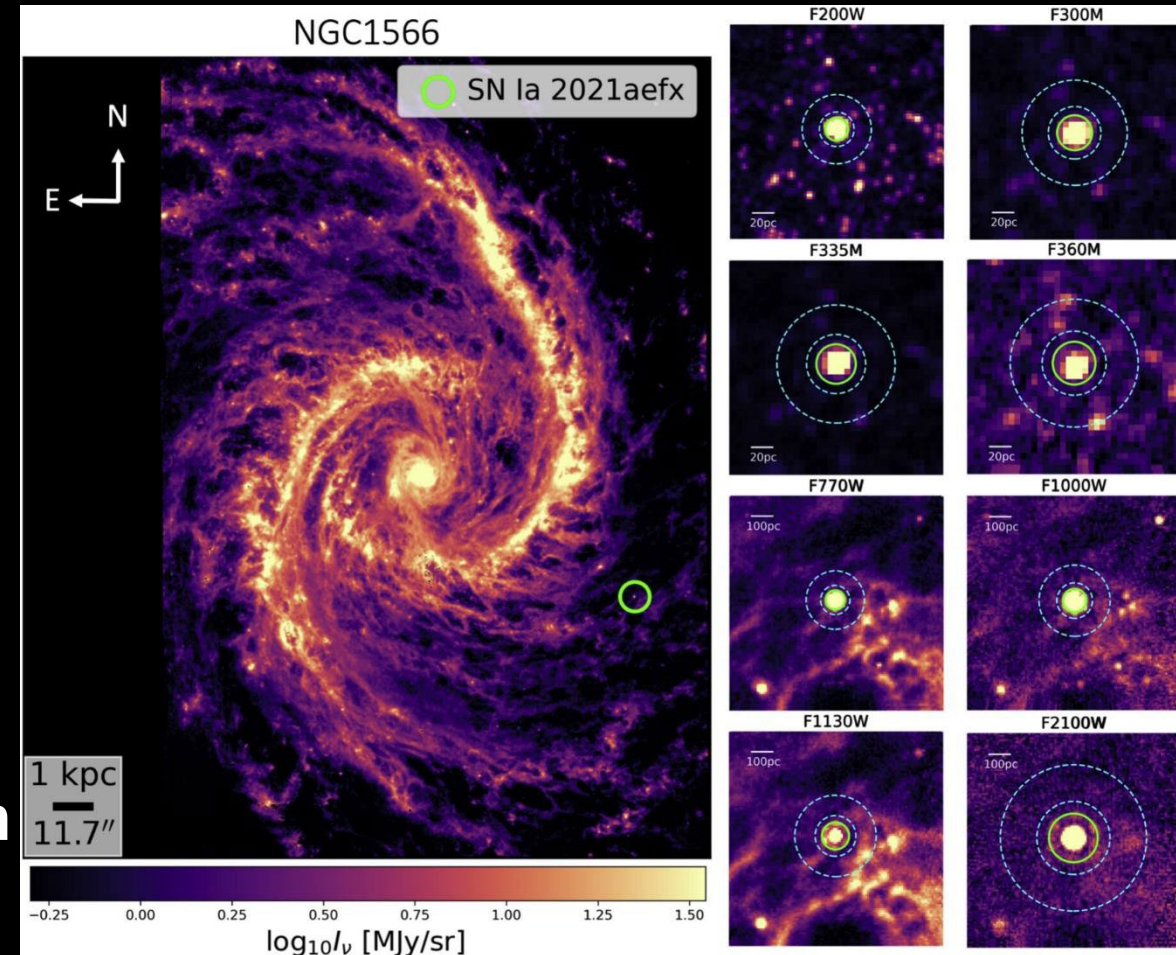
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JWST and Hubble latest photos 1

- JWST has imaged a type 1a supernova explosion in a nearby galaxy, NGC 1566, known as the “Spanish Dancer”, about 40 million light years from Earth
- White dwarf explosions produce huge amounts of iron, nickel and cobalt
- Much of the material is highly radioactive and elements such as Cobalt-56 decay to stable Iron-56, emitting high-powered photons which fail to escape the region of the explosion

Credit: The Astrophysical Journal Letters (2023).

DOI: 10.3847/2041-8213/acb6d8



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JWST and Hubble latest photos 2

- Hubble has imaged SPT-CL J0019-2026, a massive galaxy cluster which is 4.6 billion light years away in the constellation Cetus.
- It was first discovered in 2010 by the South Pole Telescope as part of a survey of the CMB radiation.
- It contains several hundred galaxies with a total mass of around 660 trillion times that of the Sun.
- It is gravitational lensing dozens of more distant galaxies behind the cluster

Credit: ESA/Hubble & NASA, H. Ebeling



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JWST and Hubble latest photos 3

- Hubble has imaged the Jellyfish galaxy J0201 in the constellation Cetus. As the galaxy moves through space, gas is stripped away from it and produces tendrils which hang down from the central core
- The process is called “ram pressure stripping” and happens when a galaxy encounters diffuse gas that envelopes galaxy clusters. This diffuse gas acts like a headwind, dragging the gas and dust from the galaxy, creating streamers



Credit: ESA/Hubble & NASA, M. Gullieuszik

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JWST and Hubble latest photos 4

- Researchers from the COSMOS-Web program have released mosaic images taken in early January by JWST's Near-Infrared Camera (NIRCam) and Mid-Infrared Instrument (MIRI)
- COSMOS-Web will attempt to map the early universe with a deep survey of about 1 million galaxies
- The first view contains an amazing 25,000 galaxies (4% of what the total survey will have) and far larger than the Hubble Ultra Deep Field
- Upper left – barred spiral galaxy
- Upper right – gravitational lensing effects
- Lower left – galaxy after recent merger
- Lower right – barred spiral galaxy with star formation



Credit: COSMOS-Web/Kartaltepe, Casey, Franco, Larson, et al./RIT/UT Austin/CANDIDE

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JWST and Hubble latest photos 5

- JWST has captured the massive Wolf-Rayet star WR 124 in unprecedented detail
- It is 15,000 light years away in the relatively small and faint constellation Sagitta
- It has already shed 10 solar masses over a period of time giving it a wavy, bloated nebula appearance
- WR 124 is still thirty times the Sun's mass
- As the ejected gas cools, cosmic dust forms and glows in infrared. It is estimated that WR 124 will go supernova in a few hundred thousand years
- Watch the videos at:

<https://youtu.be/2oFmouRSM0g> and
<https://youtu.be/CX6PMOTcMK8>

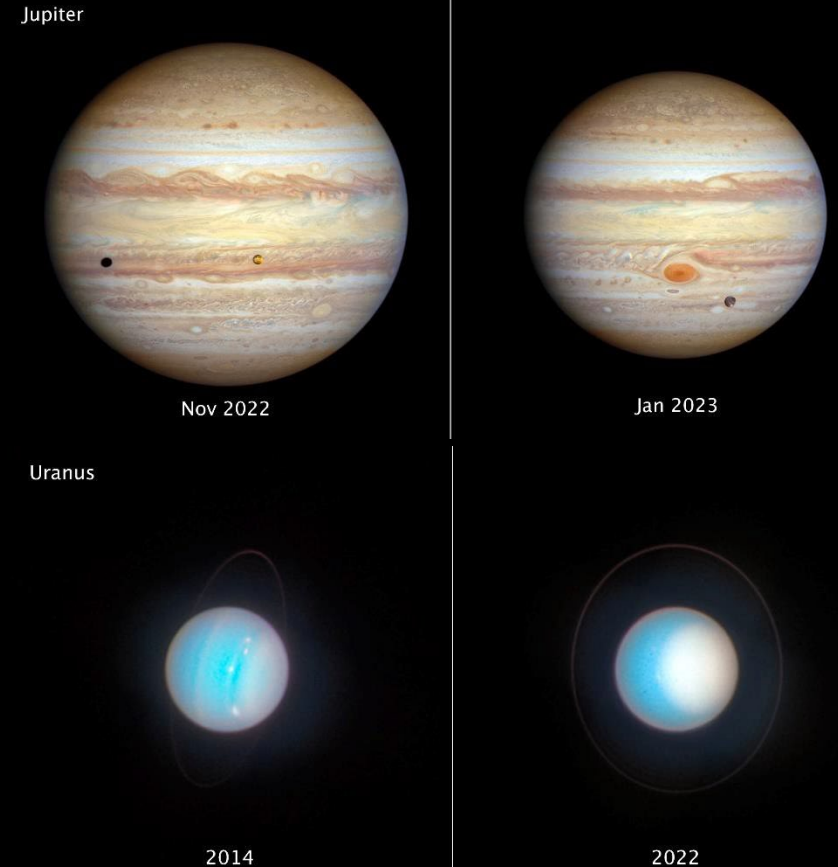


Credit: NASA, ESA, CSA, STScI, Webb ERO Production Team

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JWST and Hubble latest photos 6

- As part of the Outer Planet Atmospheres Legacy (OPAL) Program, Hubble takes regular photographs of the outer planets to keep a tab on their weather
- **Jupiter**
- Left – storms in northern hemisphere, volcanoes on Io cause orange colouration on Jupiter. Transit of Io with its shadow on Jupiter
- Right – Jupiter is further away. Great Red Spot at smallest size ever seen. Transit of Ganymede
- **Uranus**
- Left – multiple storms with methane crystal clouds
- Right – north pole with photochemical smog



Credit: NASA, ESA, STScI, Amy Simon (NASA-GSFC), Michael H. Wong (UC Berkeley);
Image Processing: Joseph DePasquale (STScI)

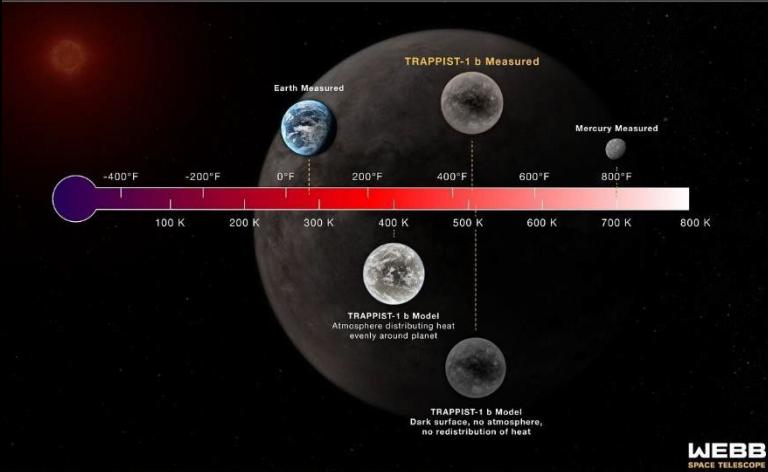
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JWST and Hubble latest photos 7

- JWST has been looking at the exoplanet HD149026b
- A gas giant, mass similar to Saturn with a surface temperature 3 times hotter than Venus
- Abundant carbon and oxygen in atmosphere
- TRAPPIST-1b is a rocky exoplanet
- Surface temperature 230°C
- Tidally-locked
- No significant atmosphere
- Coronagraphs used to eliminate effects of the parent star

ROCKY EXOPLANET TRAPPIST-1 b
DAYSIDE TEMPERATURE COMPARISON

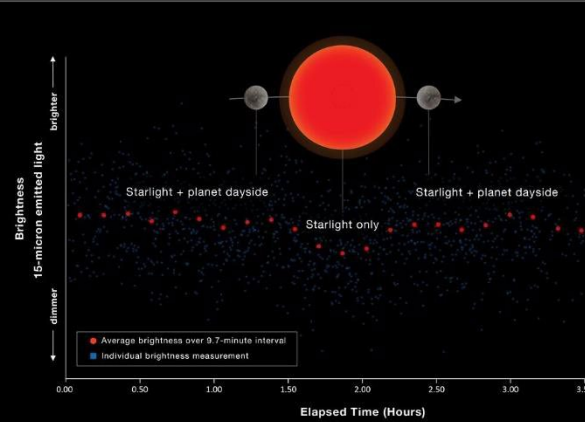
MIRI | F1500W



WEBB
SPACE TELESCOPE

ROCKY EXOPLANET TRAPPIST-1 b
SECONDARY ECLIPSE LIGHT CURVE

MIRI | Time-Series Photometry (F1500W)



WEBB
SPACE TELESCOPE

Top image: HD149026b Credit: NASA/JPL-Caltech

Bottom image: TRAPPIST-1b Credit: European Space Agency

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JWST and Hubble latest photos 8

- NGC 1433 is a Seyfert type 2 spiral barred galaxy located some 46 million light years away in the southern constellation Horologium
- This image was taken by JWST using its Mid-Infrared Instrument (MIRI)
- It shows the extent to which dust and gas is being blown away by the radiation from new star formation
- At the heart of the galaxy there appears to be a double ring structure caused by the spiral arms wrapping themselves around the central bar



Credit: NASA/ESA/CSA/Janice Lee (NOIRLab)
Image Processing: Alyssa Pagan (STScI)

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Observational Highlights

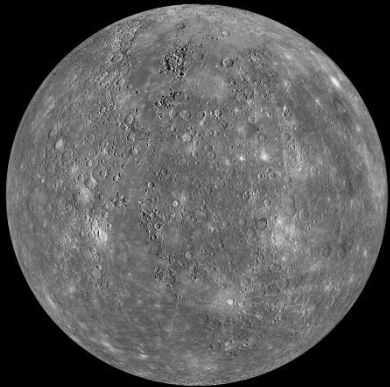
April 2023 dates

- 11th April – Mercury at greatest eastern elongation (19° from Sun); best this year
- 11th April – Venus in close proximity to the Pleiades
- 11th April – Jupiter at conjunction and furthest distance from Earth, 5.95 AU
- 16th April – Moon at perigee (closest to Earth) at 367,000 km with an angular size of $32' 27''$; it rises close to Saturn before dawn separated by 3°
- 17th April – Venus at perihelion (closest to Sun) - 0.72AU (12:15 BST)
- 22nd/23rd April – Lyrid meteor shower, peaking at 2am looking east on morning of 23rd April but radiant at highest just before dawn looking south (so best display)
- 23rd April – Venus 2° below the Moon in the evening sky (closest at 13:31 BST)
- 26th April – Moon and Mars in close proximity passing within 4° of each other
- 28th April – Moon at apogee (furthest from Earth) at 404,000 km with an angular size of $29' 32''$

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Mercury and Venus on display

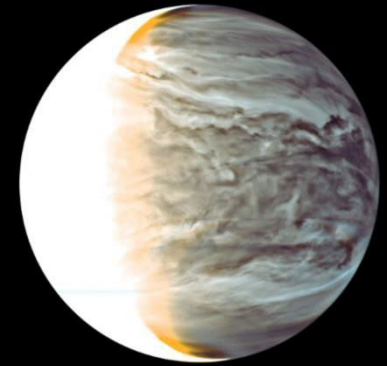
- Mercury will be at its best this month
- As far as it gets from the Sun by 11th April
- Bright at -1.1 magnitude at start of month, fading later
- Look for it shortly after sunset in the west/north-west sky
It reaches an altitude of 16° on 11th April



Mercury

Credit: NASA/HUAPL

- Venus is coming into its own this month
- Will steadily get brighter from -4.03 to -4.11 by July (best seen before June)
- Venus will be high in the sky, up to 30° (highest 28th April)
- Moves through Taurus passing close to the Pleiades on 11th April
- It will be 2° below the new crescent Moon on 23rd April



© ISAS/JAXA

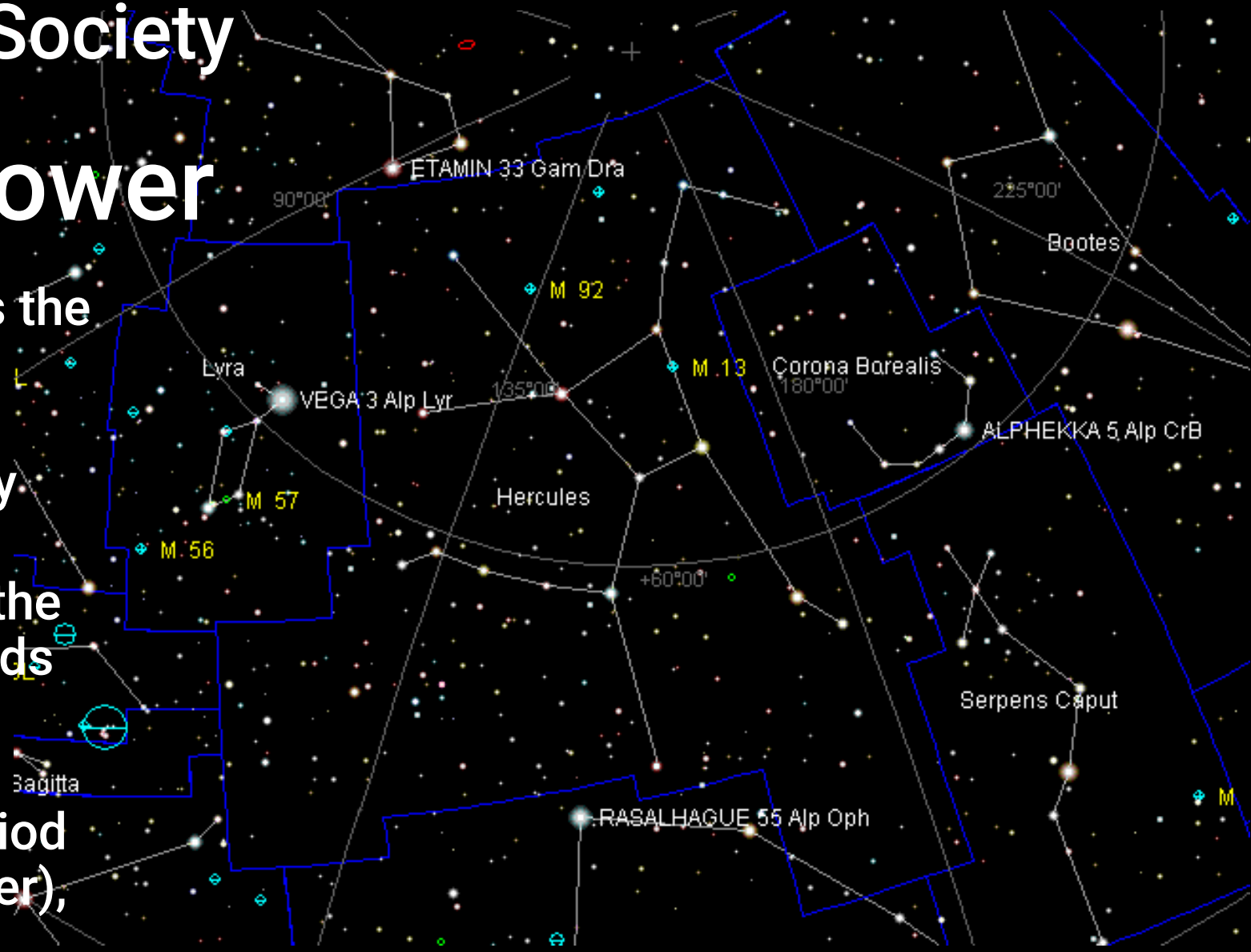
Venus

Credit: ISAS/JAXA

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Lyrid meteor shower

- The Lyrid meteor shower is the first major one of the year
- Visible for 3 days centred around the peak in the early morning of 23rd April
- The radiant point is below the mag 0 star Vega and towards the constellation Hercules, due east at 02:00
- Debris remains of long-period comet C/1861 G1 (Thatcher), next here in 2276
- Medium speed shower (48km/sec), expect between 15 and 20 meteors per hour
- Best observed just after New Moon when there will be minimal light interference



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

	<u>Planet</u>	<u>Rises</u>	<u>Sets</u>	<u>Highest</u>	<u>Direction</u>	<u>Altitude</u>	<u>Magnitude</u>	<u>Visible</u>
	MERCURY	06:55	21:01	19:53	West	8° ◇	-1.13	YES
	VENUS	07:42	23:06	19:53	West	27° ◇	-4.03	YES
	MARS	10:05	03:01	20:20	South-West	57° ◇◇	+0.97	YES
	JUPITER	06:54	20:06				-2.04	NO
	SATURN	05:34	15:43				+0.98	NO
	URANUS	07:45	22:43				+5.85	NO
	NEPTUNE	06:14	17:52				+7.96	NO

* = Highest point at Dawn (05:12 - last visible sighting)

** = Highest point at Dusk (20:54 - first visible sighting)

◇ = Highest point when first visible (19:53)

◇◇ = Highest point when first visible (20:20)

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

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
Cr50	The Hyades (Taurus)	Open Cluster	09:18	00:11	20:18 ◇	West	32°	+0.5
M45	The Pleiades (Taurus)	Open Cluster	07:47	00:23	20:24 ◇	West	34°	+1.3
M44	The Beehive Cluster (Cancer)	Open Cluster	13:08	04:45	20:57	South	58°	+3.1
M31	Andromeda Galaxy (Andromeda)	Galaxy	***	***	05:12 *	North-East	17°	+3.4
C14	Double Cluster (Perseus)	Open Cluster	***	***	20:54 **	North-West	38°	+3.7
M42	The Orion Nebula (Orion)	Open Cluster	12:15	23:29	20:54 **	South-West	21°	+4.0
NGC2232	Open Cluster (Monoceros)	Open Cluster	13:05	00:25	20:54 **	South-West	27°	+4.2
IC4665	Open Cluster (Ophiuchus)	Open Cluster	23:34	12:37	05:12 *	South	43°	+4.2
M47	Open Cluster (Puppis)	Open Cluster	15:03	00:43	20:54 **	South	23°	+4.4
NGC6633	Open Cluster (Ophiuchus)	Open Cluster	00:10	13:22	05:12 *	South-East	41°	+4.6
IC4756	Graff's Cluster (Serpens Cauda)	Open Cluster	00:27	13:28	05:12 *	South-East	39°	+4.6
M5	Globular Cluster (Serpens Caput)	Globular Cluster	21:24	09:52	03:38	South	41°	+5.7
M13	Great Globular Cluster (Hercules)	Globular Cluster	18:29	15:32	05:01	South	75°	+5.8
M12	Globular Cluster (Ophiuchus)	Globular Cluster	23:12	11:00	05:06	South	37°	+6.1
M3	Globular Cluster (Canes Venatici)	Globular Cluster	17:10	10:53	02:02	South	67°	+6.3

* = Highest point at Dawn (05:12 - last visible sighting) ** = Highest point at Dusk (20:54 - first visible sighting)

◇ = For bright objects highest point pre-Dusk - first visible sighting) *** = circumpolar

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

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
M15	Globular Cluster (Pegasus)	Globular Cluster	02:43	16:53	05:12 *	East	22°	+6.3
M92	Globular Cluster (Hercules)	Globular Cluster	***	***	05:12 *	South-West	81°	+6.5
M10	Globular Cluster (Ophiuchus)	Globular Cluster	23:33	11:00	05:12 *	South	35°	+6.6
M81	Bode's Galaxy (Ursa Major)	Galaxy	***	***	22:31	North	72°	+6.9
M101	Pinwheel Galaxy (Ursa Major)	Galaxy	***	***	02:23	North	86°	+7.9
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	***	***	05:12 *	West	48°	+8.2
M1	The Crab Nebula (Taurus)	Supernova Remnant	18:53	02:57	20:54 **	West	44°	+8.4
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	***	***	05:12 *	West	57°	+8.4
M104	Sombrero Galaxy (Virgo)	Galaxy	19:54	06:05	01:00	South	27°	+8.6
M57	The Ring Nebula (Lyra)	Planetary Nebula	***	***	05:12 *	South-East	61°	+8.8
NGC2403	'Spiral' Galaxy (Camelopardalis)	Galaxy	***	***	20:54 **	North	67°	+8.9

Twilight ends (1 st), Twilight starts (2 nd)	Twilight	Civil	Naut	Astro		Rises	Sets
Sunset (1 st), Sunrise (2 nd)	Ends	20:05	20:45	21:28	Sun	06:33	19:31
Moon rises (1 st), Moon sets (2 nd)	Starts	06:00	05:19	04:36	Moon	14:16	06:05

* = Highest point at Dawn (05:12 - last visible sighting) ** = Highest point at Dusk (20:54 - first visible sighting)

◇ = For bright objects highest point pre-Dusk - first visible sighting) *** = circumpolar

Phases of the Moon



<u>Phase</u>	<u>Date</u>	<u>Time</u>	<u>Lunation</u>
FULL MOON	6th April	05:34	1240
LAST QUARTER	13th April	10:11	1240
NEW MOON	20th April	05:12	1241
FIRST QUARTER	27th April	22:19	1241



Credit: Sean Smith/NASA

Lewes Astronomical Society

Wednesday 5th April 2023

*“An introduction to Archaeoastronomy:
How the people of the past used the sky to navigate their lives and deaths”*
Carina Garland, Lewes town hall, guests welcome

Wednesday 3rd May 2023

“A personal journey into astronomy and imaging”
Doug Edworthy (FRAS), Lewes town hall, guests welcome

Wednesday 7th June 2023

*“A beginner’s guide to cosmology and the insights gained
from studying the cosmic microwave background”*
Kate Land, Lewes town hall, guests welcome

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