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Newsletter - June 2023

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Astronomy & Space News

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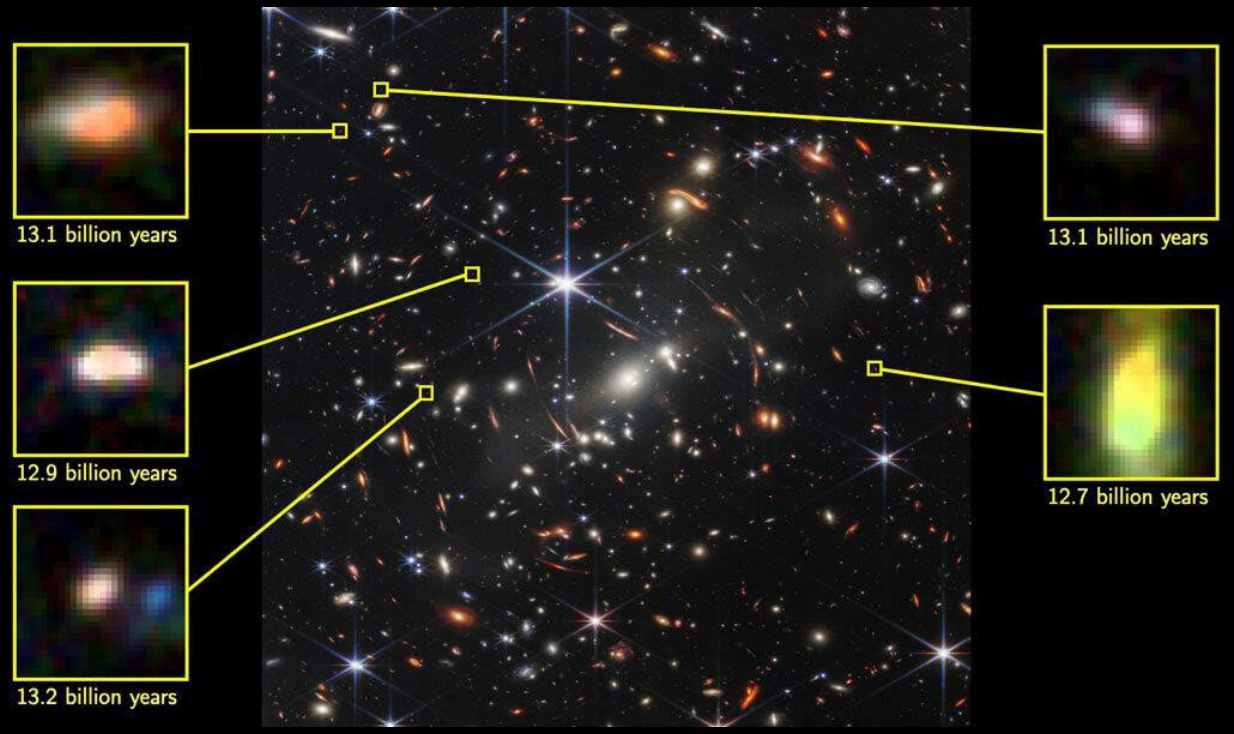
Are early galaxies even more massive?

- JWST has been very successful at imaging some of the earliest known galaxies in the Universe. Quite a few are now thought to have been in existence within 400 to 600 million years after the Big Bang
- Their masses have been calculated from the total amount of visible light in each galaxy and, from that, how many stars would be needed to produce that much light and, from that, their mass
- However, most of the mass in a galaxy resides in smaller, fainter stars which are completely outshone, thus understating the actual galaxy size



One of the first images taken by JWST shows the SMACS 0723 galaxy cluster. Each of the five zoom-ins is approximately 19,000 light years in diameter

Credit: NASA, ESA, CSA, STScI / Giménez-Arteaga et al. (2023), Peter Laursen (Cosmic Dawn Center, Copenhagen, Denmark)

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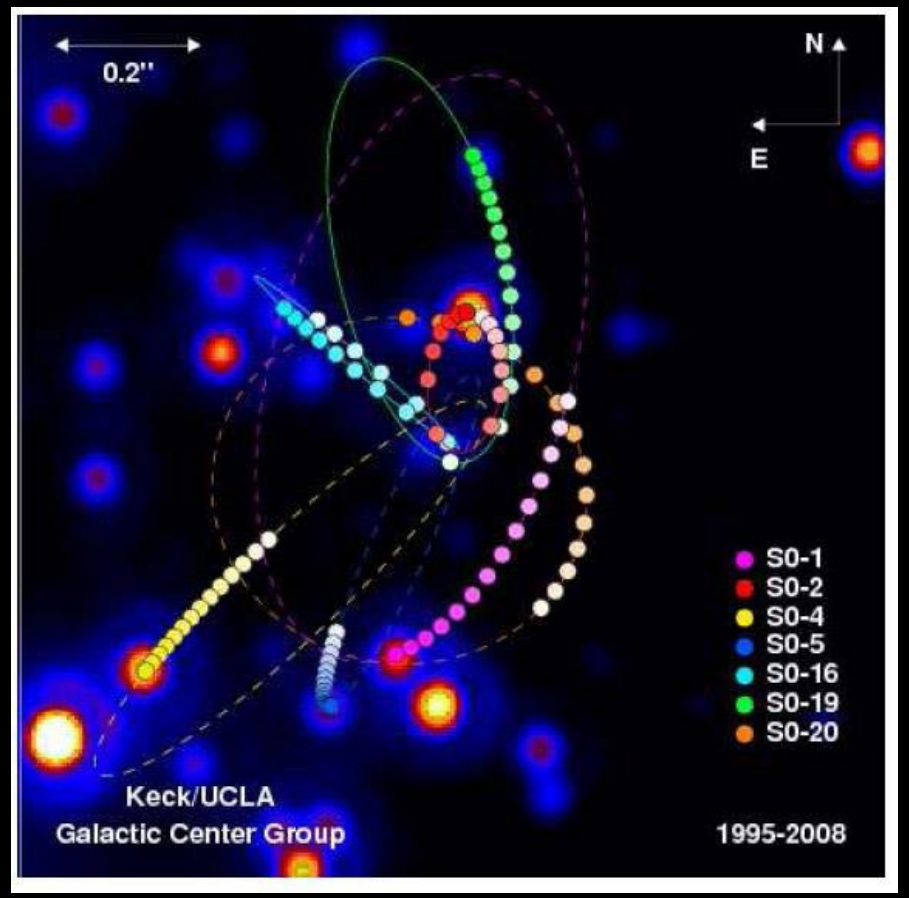
Just how big are Black Holes? (1)

- The size of a black hole depends on 2 things: the mass (the biggest factor) and its rotation
- The black hole (Sagittarius A*) at the centre of the Milky Way is only 1 of 2 directly observed
- Its mass can be determined by the motion of the nearby stars (see the image on the right showing annual positions of 7 close-by stars)
- Based on these observations, the mass of the Sag A* black hole is about 4 million solar masses
- For other galaxies another method must be used, Reverberation Mapping. This is where the gas surrounding an active black hole emits large quantities of energy. Spectral analysis can reveal the orbital speed of the gas (rotation)



Credit: Andrea Ghez, University of California, Los Angeles, USA

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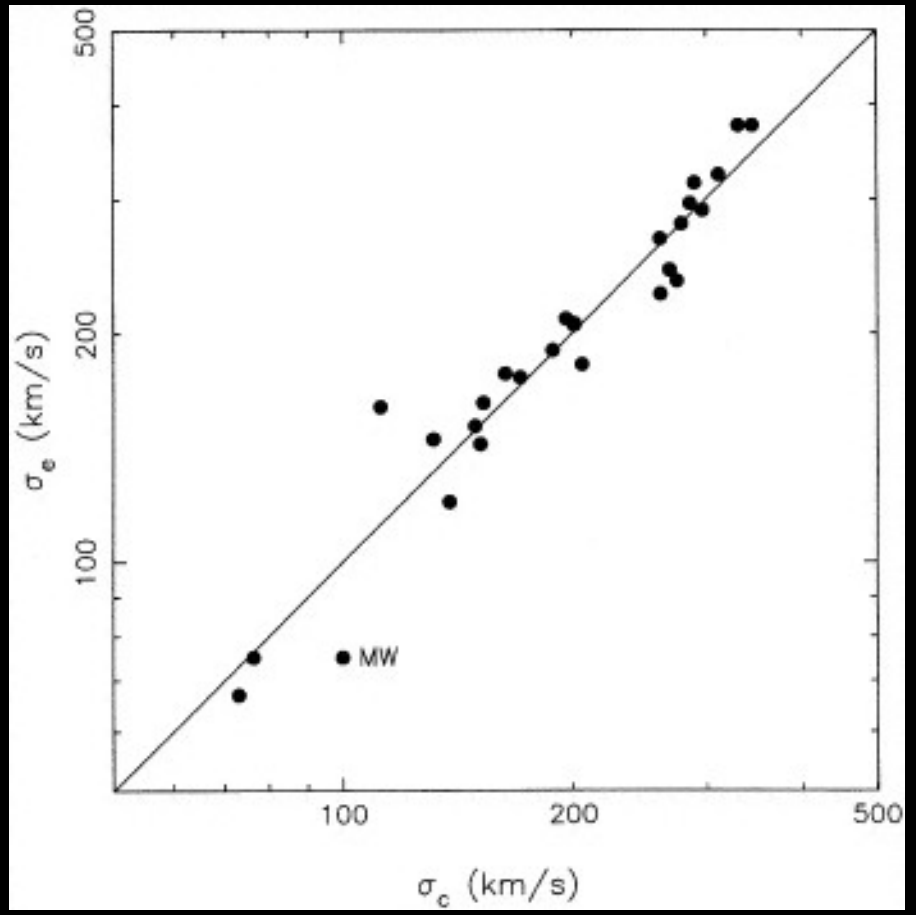
Just how big are Black Holes? (2)

- For non-active black holes, astronomers use the M-sigma Galaxy Relation. Black holes have an effect on both close and more distant objects. The supermassive black holes (SMBH) at the centre of a galaxy can affect the speed at which the central bulge of stars rotates. The average speed of the bulge stars is proportional to the mass of the black hole, as can be seen in the accompanying image
- The largest known black hole is TON 618, which is more than 40 billion solar masses. It is so large it is referred to as an Ultra-Massive Black Hole
- NASA has produced a short animation which shows the relative sizes of black holes. Go to: https://youtu.be/8GnSFAZD8YY



Credit: David Merritt and Laura Ferrarese, Rutgers University, New Brunswick, New Jersey, USA

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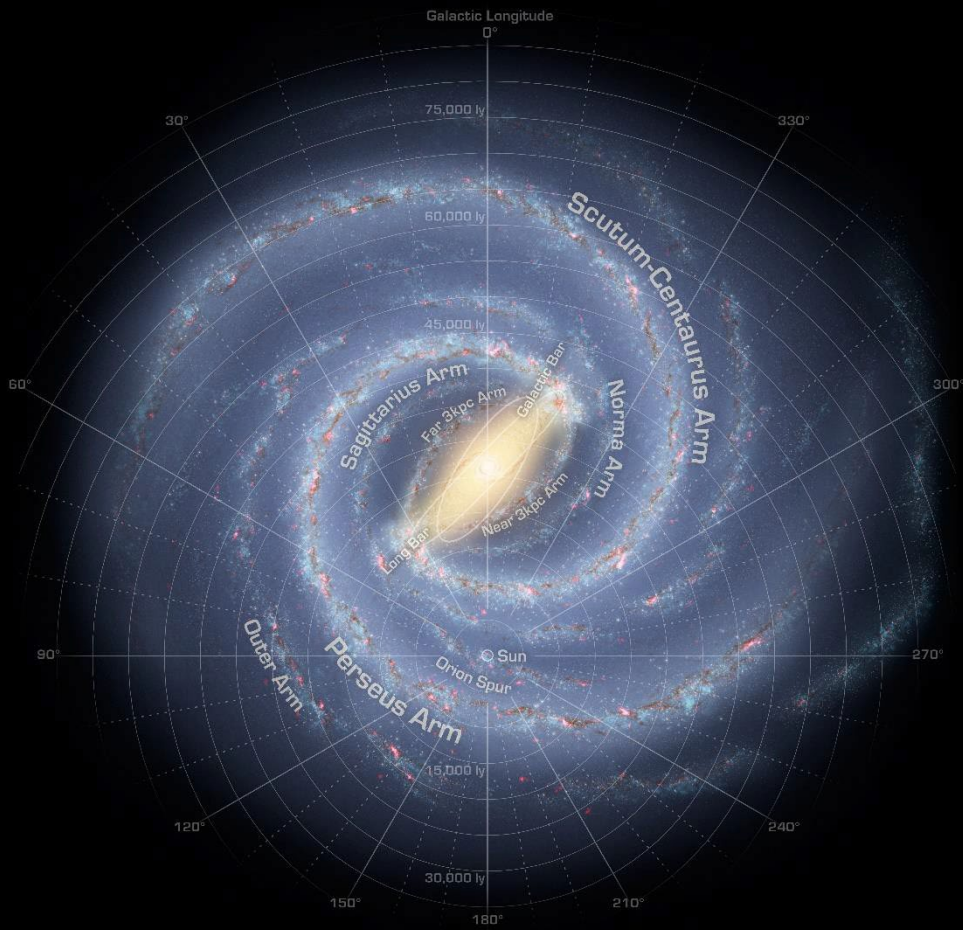
Is the Milky Way so unique? (1)

- From our position in the Solar System, we have learnt far more about the Milky Way galaxy than any other
- However, being inside has a major disadvantage - we cannot see the overall structure
- Previous illustrations have always shown the Milky Way as a barred spiral galaxy with 4 arms. This is not what we see with other barred spiral galaxies, which only have 2 arms
- In 2017, NASA announced that data from the Spitzer Space Observatory suggested that there are only 2 arms. If there were 4 arms it would make the Milky Way very unusual



Credit: NASA/JPL-Caltech/R. Hurt (SSC/Caltech)

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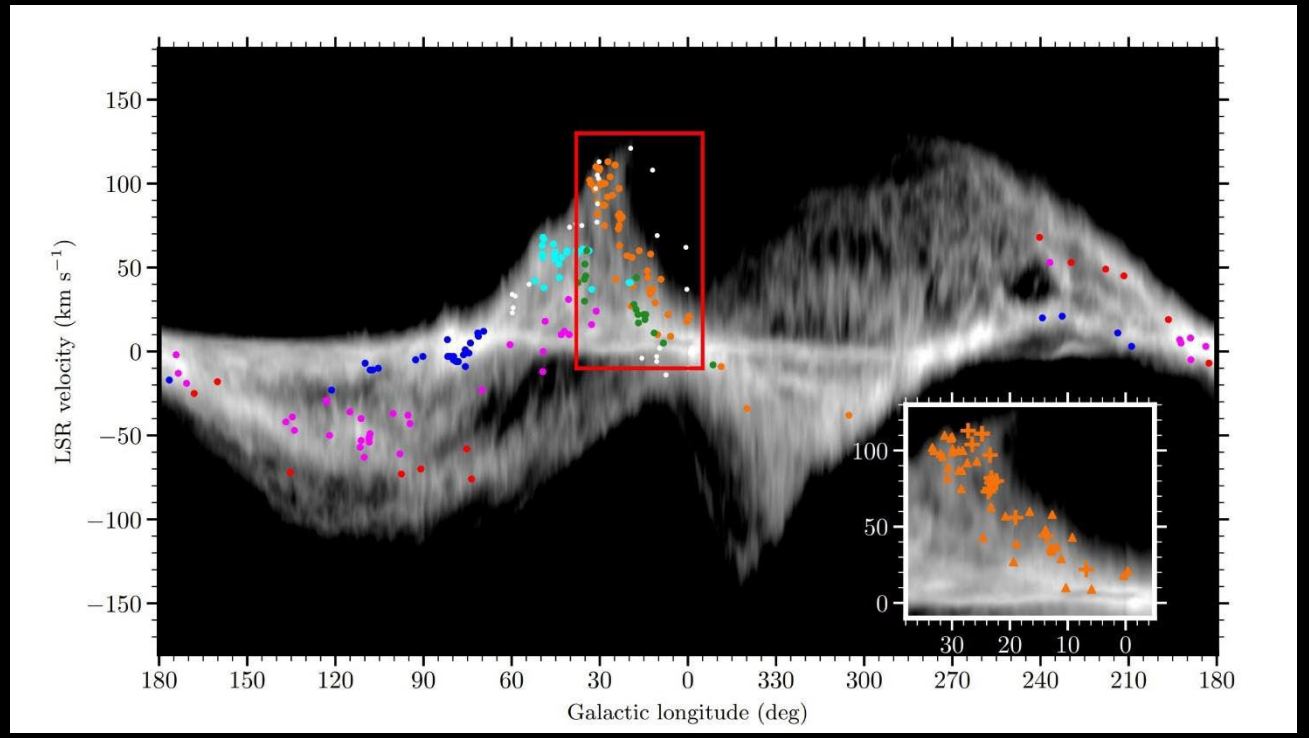
Is the Milky Way so unique? (2)

- Now a team from the Chinese Academy of Science at the Purple Mountain Observatory and the National Astronomical Observatory, using data from the Gaia Space Observatory, have confirmed the earlier NASA theory
- It is now believed that only the Scutum-Centaurus and Perseus Arms are the true major ones and attached to the central bar. The Norma and Sagittarius Arms have been demoted to minor status, like the Outer and Carina Arms



Map of the Milky Way produced from data from the Gaia Space Observatory and observations of 24,000 O-B stars plus 200 stars that emit microwaves and 1,000 open clusters. Masers from the various arms are coloured as: Norma Arm (orange), Sagittarius Arm (cyan), Carina Arm (green), Local Arm (blue), Perseus Arm (magenta), and Outer Arm (red). The team fitted the stars onto a spiral and found the 2-armed version was the best fit.
Credit: The Astrophysical Journal (2023)

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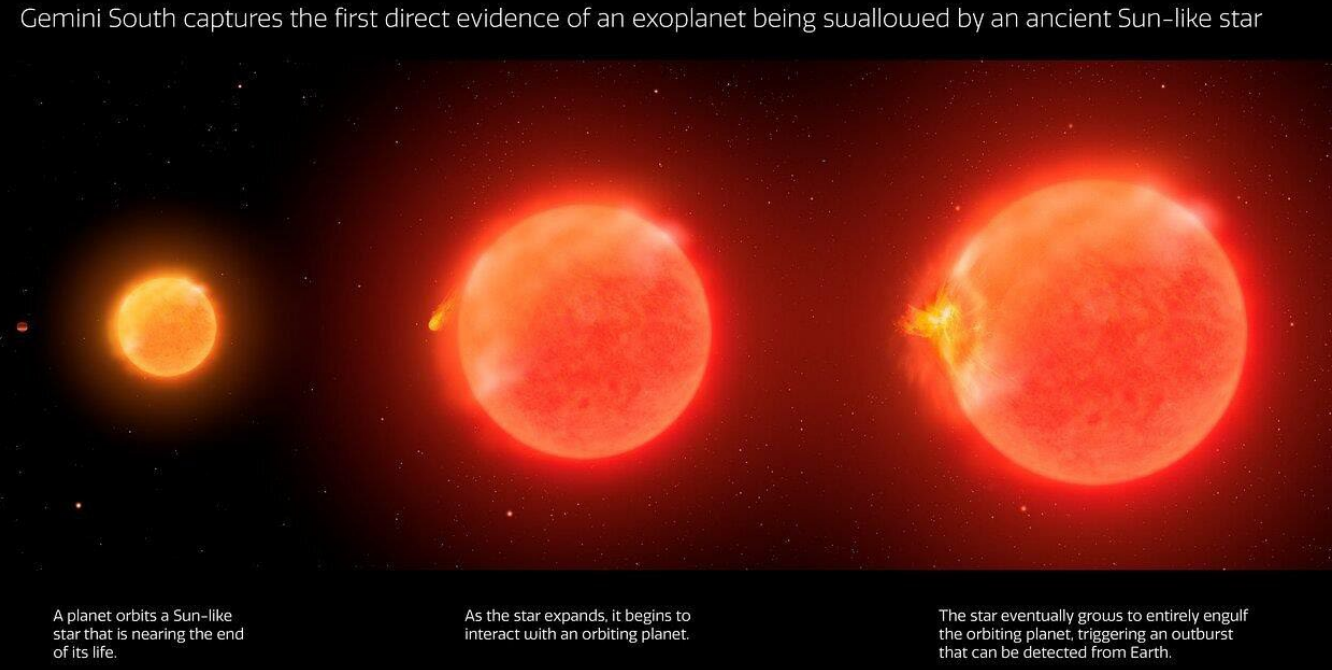
The ultimate fate of the Earth

- Towards the end of the Sun's life, in about 5 billion years, when all the hydrogen in the core is exhausted, helium fusion will start. This will massively heat up the Sun causing it to expand, whilst hydrogen fusion will start nearer the outer shell
- The inner planets will be swallowed and, it is likely, that this will also happen to the Earth
- Now astronomers have observed the process in action. The Gemini South Telescope observed the engulfment event over a period of 100 days in a distant star 13,000 light years away



Engulfment event, ZTF SLRN-2020, witnessed by the Gemini South Telescope. The observed lightcurve and amount of ejected material allowed astronomers to calculate that the planet was between 1 and 10 times the size of Jupiter and that the star is 0.8-1.5 times the mass of the Sun

Credit: International Gemini Observatory/NOIRLab/NSF/AURA/P. Marenfeld

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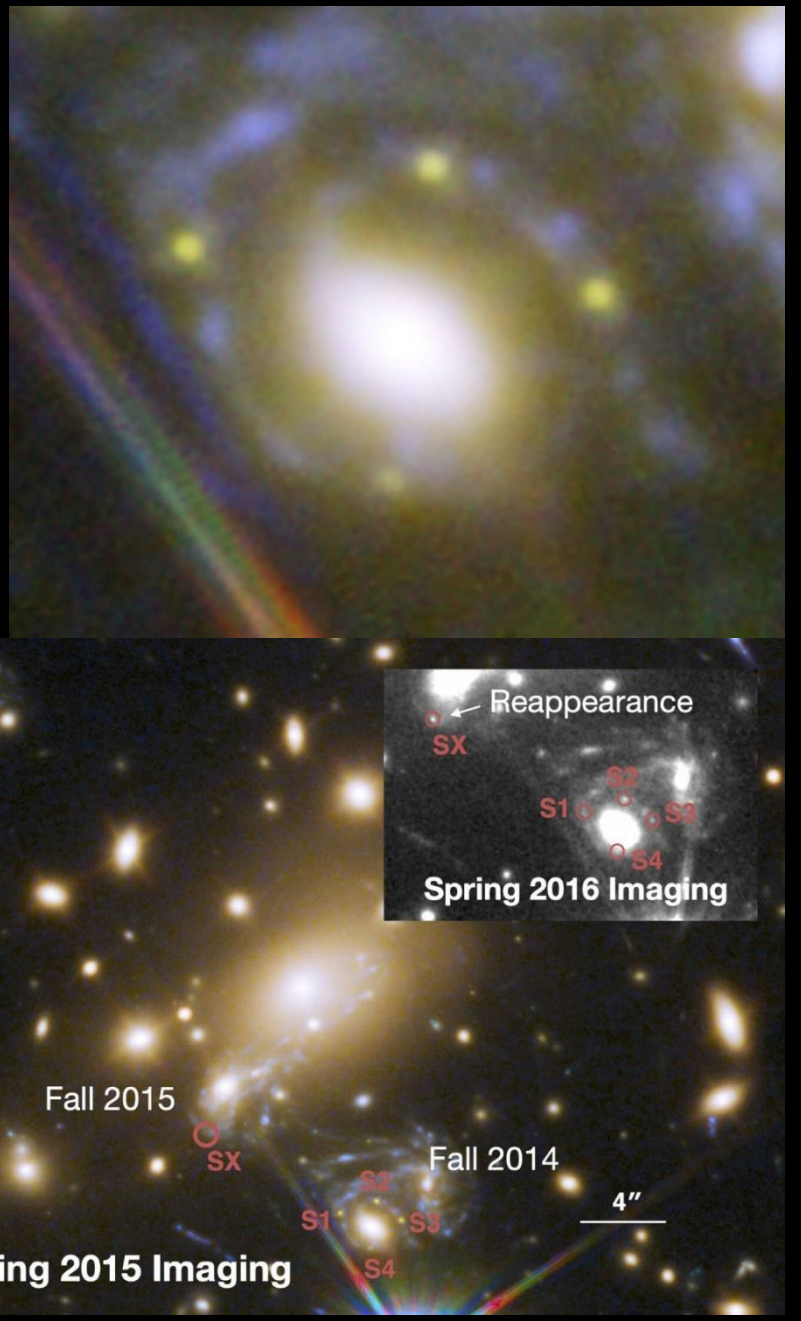
Update from last month:

How fast is the Universe expanding?

- The difference in the value for the expansion of the Universe, as measured either by supernovae and other standard candles, and from the CMB, is known as the Hubble Tension
- Supernova Refsdal exploded in the late 1990s. Light from it has been gravitationally lensed by a nearer galaxy cluster. The path taken by the light varies in distance so that the images appeared at various times. The time delays allowed the Hubble Constant to be measured and it appears to be closer to the CMB value than the supernovae/standard candles value



Credit: Top - NASA/ESA/P Kelly (University of Minnesota, USA)
Bottom – images of SN Refsdal appearing at different times. The Astrophysical Journal (2023)

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Astronomy News in Brief (1)

- Cosmic Explosion – an explosion, AT2021lwx, which happened 8 billion light years away and was probably caused by a black hole ripping apart a gas cloud, is the largest and most ever powerful known. It has lasted over 3 years (so far)
- LIGO – the gravitational wave detector is back online after a 3 year upgrade
- Black Holes – Hubble may have found the missing link between stellar mass and supermassive black holes. Images suggest an 800 sun-sized intermediate black hole may be lurking in a globular cluster only 6,000 light years away
- Small Galaxy – GS-9209, an ancient galaxy formed 600-800 million years after the Big Bang and which is now 25 billion light years away, has a supermassive black hole 5 times the size expected for the number of stars in the galaxy
- Uranus – 4 of the largest moons (Ariel, Umbriel, Titania, and Oberon) are likely to have a watery ocean layer between their cores and icy crusts
- Uranus – scientists make the first observation of a polar cyclone swirling around the northern pole of the planet

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Astronomy News in Brief (2)

- Saturn – analysis of dust collected from Saturn's rings by the Cassini space probe, indicates that the Rings are no more than 400 million years old
- Saturn – has now regained the satellite crown with a further 62 small irregular moons discovered. The total is now 145 (24 regular and 121 irregular)
- Jupiter – changes in the bands and stripes around the planet are probably caused by wavelike motions in the planet's magnetic field
- Mars – small pockets of water may have existed as little as 1 million years ago
- Moon – NASA has been able to image craters in permanent shadow using ShadowCam, a new type of low-light camera, on the Danuri lunar orbiter
- Moon – the core is solid, contains iron and is very similar to Earth's
- Aliens – if there are any nearby aliens, they will soon be able to detect mobile radio leakage from Earth
- Arecibo – studies are underway to see if a replacement facility is feasible

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Space Station with Artificial Gravity

- Airbus have entered the space station race with a proposal called LOOP which could accommodate up to 4 astronauts
- The Multi-Purpose Orbital Module (MPOM) would have 3 decks; a habitation level, a science level with the bottom level containing a centrifuge which 2 astronauts could use at the same time
- Spinning at 6 revolutions a minute it would simulate the Moon's gravity, and 9 revs/min for the gravity on Mars. It is hoped this will help maintain astronauts long-term health
- See the animated tour at: https://youtu.be/0vk9jle8m2Y

Credit: Airbus 2023

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New View on Earth's Weather

- The first image of Earth taken by Europe's new weather satellite, Meteosat Third Generation – Imager 1 (MTG- I1), has just been released
- Launched on an Ariane 5 rocket in December, it is the first of a new generation of weather satellites. There will be 6 MTG-I (Imager) satellites working in pairs with a MTG-S (Sounder) satellite. They will sit in geostationary orbit at 36,000km above Earth
- The Imager Satellites will have a Lightning Imager and the Sounder satellites will carry an Infrared Sounder and an Ultraviolet Visible Near-Infrared spectrometer
- Together these will help give early warnings of extreme weather events, such as major storms and be able to monitor the ozone, carbon monoxide, and volcanic ash in the atmosphere

Credit: EUMETSAT/ESA

Once commissioned a whole Earth image will be taken every 10 minutes

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July Launch for Euclid Satellite

- The European Space Agency's (ESA) Euclid Space Telescope is scheduled for a July launch from Cape Canaveral on top of a SpaceX Falcon 9
- After a journey of a month, it will be positioned at the second Earth-Sun Lagrangian point (L2), which is in the same region as JWST, 1.5 million km from Earth
- Euclid's mission is designed to explore the composition and evolution of the dark Universe. In the process it will build a 3D map of the large-scale structure of the Universe by observing billions of galaxies out to a distance of 10 billion light years across over a third of the sky. Visit: https://www.esa.int/Science_Exploration/Space_Science/Euclid for more information - and lots of videos

Credit: ESA-Manuel Pedoussaut

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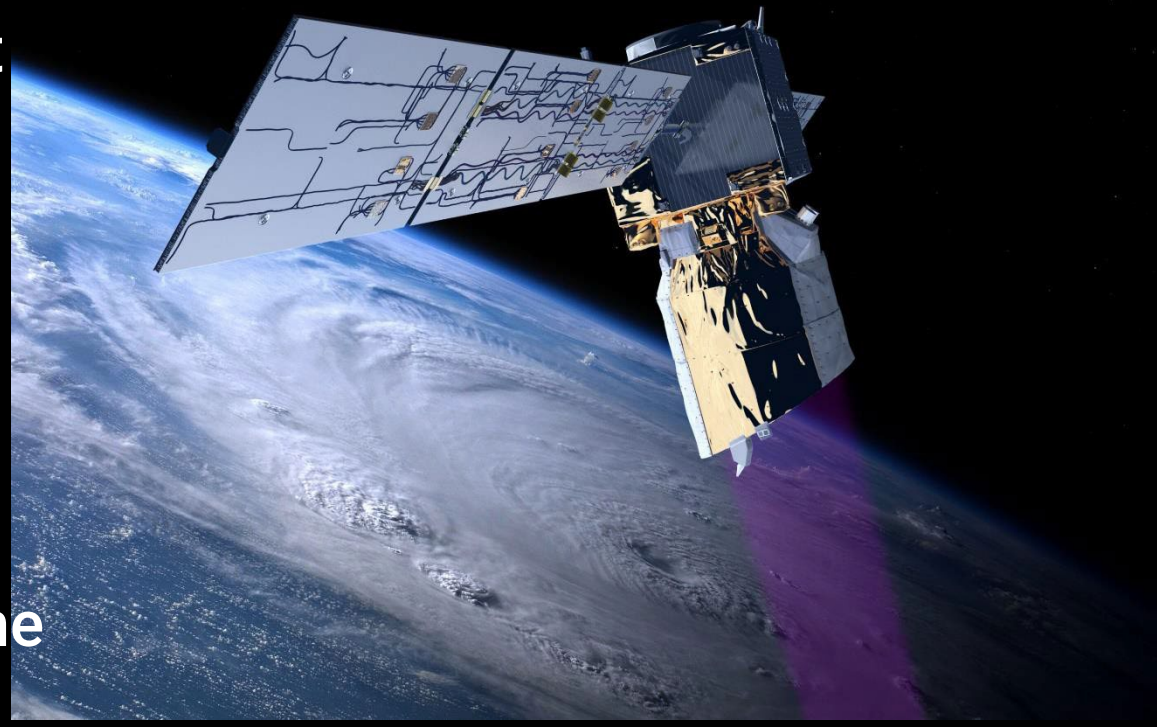
Fiery end for European weather satellite (1)

- ESA's hugely successful wind mission, Aeolus, will soon descend to a lower orbit prior to its re-entry and burn-up through Earth's atmosphere
- The satellite has already exceeded its 3 year mission plan by 18 months having been launched in 2018. The instruments were turned off on April 30th 2023
- With fuel running out it will start to drop from an altitude of 320km to 150km by the end of June. As it does the atmospheric drag on the satellite will increase accelerating the descent. It will then burn up, probably in late August



Credit: ESA/ATG medialab

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Fiery end for European weather satellite (2)

Re-entry Protocols

- ESA follows very strict protocols for bringing satellites back to Earth at the end of their missions. This ensures that they burn up safely and any remaining parts that do survive re-entry fall into the deep oceans
- Future satellites will be designed to break up on re-entry so that they completely burn up in the upper atmosphere

Credit: ESA / UNOOSA

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Not so fiery end for future spacecraft

- Current heat shields are ablative – that is the surface burns off taking the heat away from the space craft
- Now a Cardiff-based company, Space Forge, has designed a reusable heat shield called Pridwen. Folded up on launch it is deployed, origami fashion, on re-entry
- Instead of ablation, the shield relies on radiation. Its high temperature alloy fabric has a sufficiently large surface area that the heat flux can spread evenly across it to gradually radiate the heat away
- The shuttlecock-styled shield slows satellites down sufficiently that it is hoped to capture them using a water-based hover net, called Fielder

The heat shield is called Pridwen, after King Arthur's legendary shield

Credit: Space Forge

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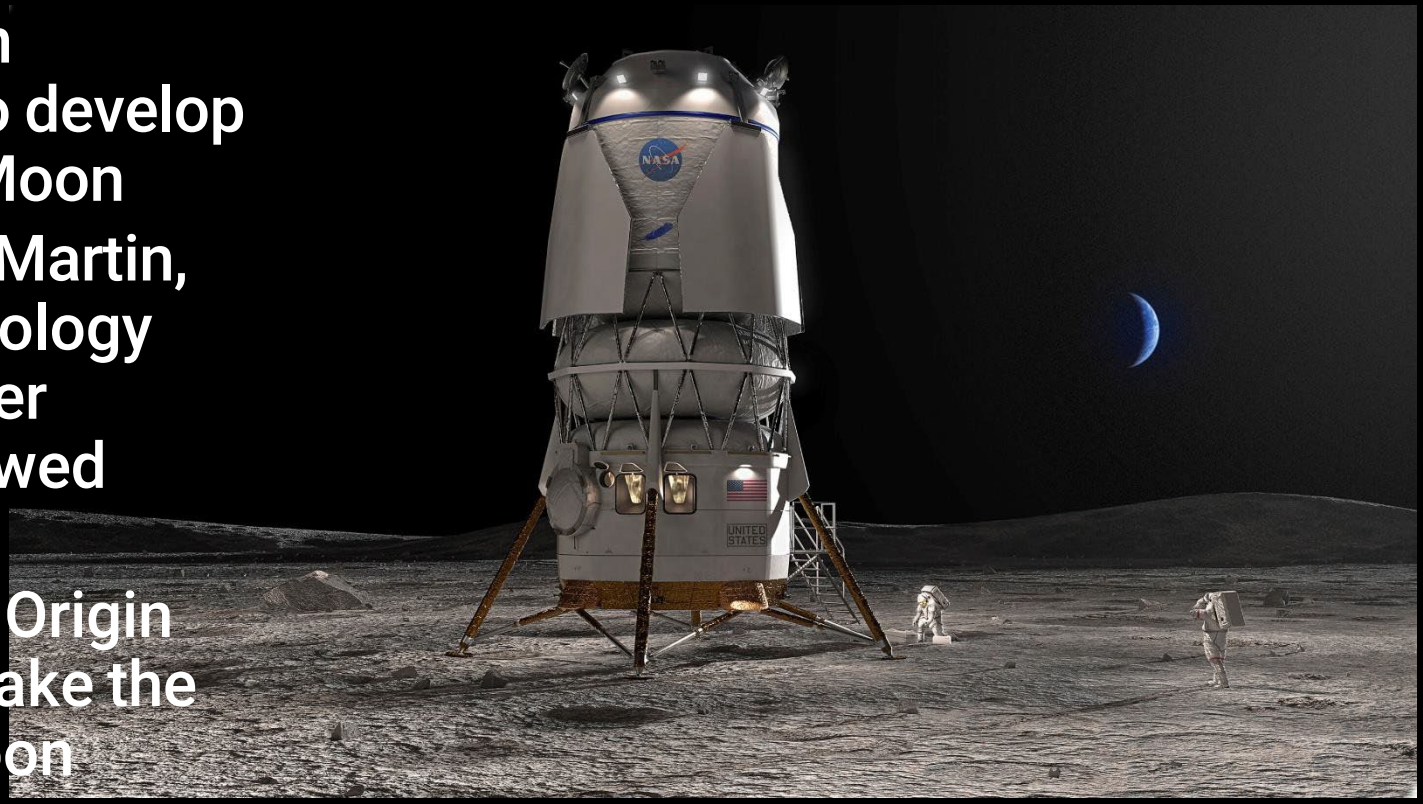
Once in a Blue Moon

- Jeff Bezoz's Blue Origin has been awarded a $3.4 billion contract to develop a lunar lander, to be called Blue Moon
- Working with partners Lockheed Martin, Boeing, Draper, Astrobotic Technology and Honeybee Robotics, the lander should be ready in 2029 for a crewed landing
- The original contract, which Blue Origin lost, sees the SpaceX Starship make the first two landings before Blue Moon
- NASA will transport crews to lunar orbit in its own rockets before they transfer to either a Starship or Blue Moon lander



Both Starship and Blue Moon are intended to be reusable. An uncrewed practice flight will take place prior to crewed landings

Credit: Blue Origin via AP

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Building the infrastructure – up in space

- Getting equipment up into space is an expensive and hazardous issue. Handicapped by rocket size, the presence of gravity, and the rigours of the launch, it would be much better to build in space
- NASA has now announced a new consortium to take this forward, focusing on making in-space servicing (repair and refuelling), assembly, and manufacturing (ISAM) capabilities a routine part of space architectures and mission lifecycles

Credit: NASA/Michael Guinto

- Watch the video on how space manufacture will affect the economy at: https://youtu.be/fUj1-cPaFgo
- For an example of ISAM go to: https://youtu.be/mDIDlEJUdlo (the spacecraft mentioned in the video, Archinaut 1, has now been renamed, OSAM-2 and will launch next year). See an animation of OSAM-2: https://youtu.be/7Nm5phrTplM

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Spaceflight News and Updates (1)

- Astronauts – Europe's latest cohort have started training in a pool to simulate weightlessness. Only 1 of the 4 will eventually travel into space
- Female crews – a study shows that the female form is the most efficient body type for the rigours of long-distance travel and space exploration
- ISS astronauts – 2 Saudi astronauts, 1 male and 1 female, spent 8 days on the International Space Station. They used a SpaceX Dragon spacecraft to get to and from the ISS. The Axiom Mission 2 is the second all-private Axiom mission
- JWST – the MIRI instrument is having problems collecting light of the longest wavelengths. Scientists hope to find a work-around solution
- JUICE – the stuck antenna was freed after a mechanical device (non-explosive actuator) in the jammed bracket was fired, dislodging the restraining pin
- Lucy – a small course correction manoeuvre has set the spacecraft on a close fly-by trajectory to the small main belt asteroid Dinkinesh

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Spaceflight News and Updates (2)

- Spitzer – the long-serving IR space observatory was taken out of commission in 2019 but kept in warm storage. NASA is looking to at ways to get the Spitzer IR Space Telescope back online with a servicing and restoration mission
- Hakuto-R – NASA's Lunar Reconnaissance Orbiter may have pinpointed the Japanese lunar lander which was lost on April 25th 2023 as it approached the surface and is thought to have crash-landed
- Snakebot – NASA and JPL are testing a snake-like robotic crawler (Exobiology Extant Life Surveyor – EELS) that will potentially supersede rovers for exploring other planets and moons. See: https://youtu.be/ifCIDT4X9AM
- Chinese Secret Space Plane – an unmanned spacecraft has completed its second flight lasting 276 days. It is a direct competitor to US Boeing X-37B Orbital Test Vehicle (OTV) which has completed 6 flights since 2010; the last flight stayed up for 908 days. See the X-37B video at: https://www.youtube.com/watch?v=5AxEQ_w6sJc

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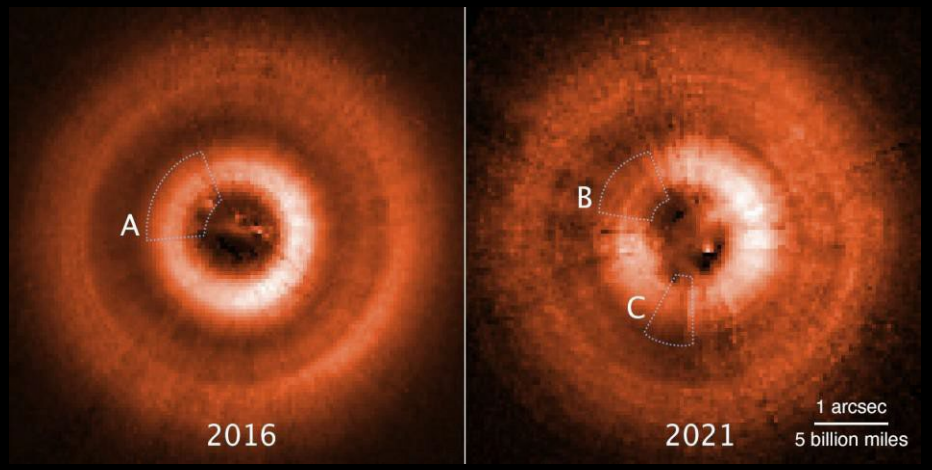
JWST and Hubble latest photos (1)

- Two Hubble images, taken in 2016 and 2021, of the red dwarf TW Hydrae and its protoplanetary disk. The system is about 10 million years old and is about 200 light years away
- The shadow (A) in the left-hand image is caused by the inclined dust and gas inner disk casting a shadow onto the larger outer disk. By 2021 the shadow has moved slightly clockwise (B) and has been joined by another shadow (C) which was hidden in the first image
- The likely explanation is that the gravitational pull of 2 unseen planets in slightly different orbital planes is causing disk misalignment



Credit: NASA, ESA, STScI, John Debes (AURA/STScI for ESA)IMAGE PROCESSING: Joseph DePasquale (STScI)

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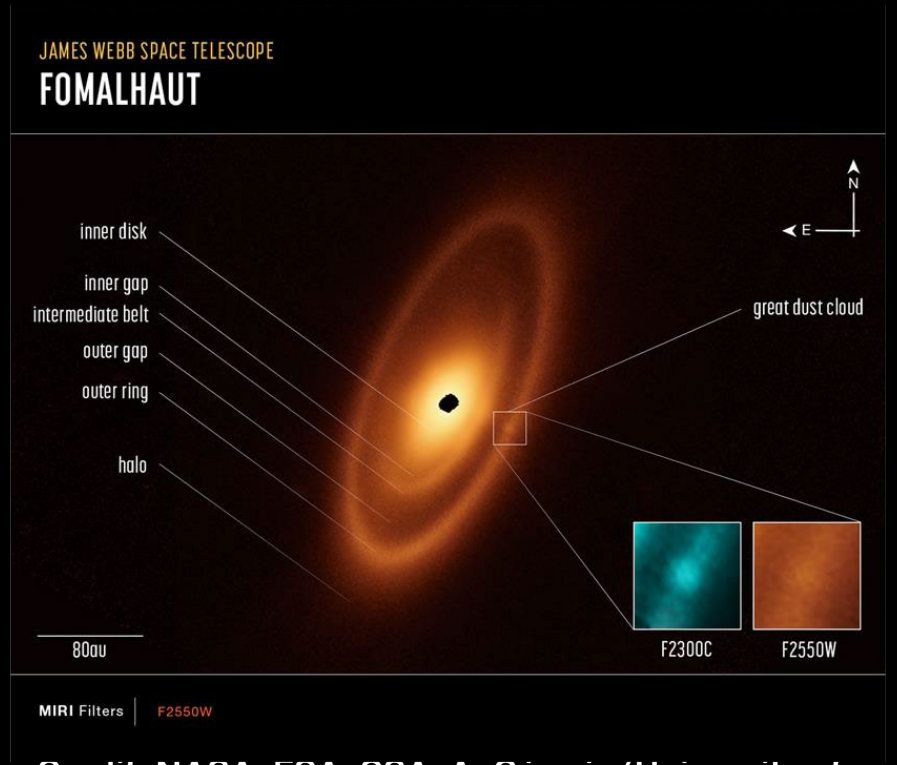
JWST and Hubble latest photos (2)

- Fomalhaut is one of the brightest stars visible in the southern hemisphere at magnitude 1.16. It is only 24.73 light years distant in the Pisces Austrinus constellation. It is 440 million years old (about half way through its life) and it emits excess infrared radiation due to it being surrounded by a warm, dusty circumstellar disk
- It is the first asteroid belt outside the Solar System to be studied in infrared by JWST. It appears to be far more complex than ours, with 3 nested belts extending out to 23 billion kilometres (or 150 times the distance from the Earth to the Sun). The inner belts have never been seen before



Credit: NASA, ESA, CSA, A. Gáspár (University of Arizona). Image processing: A. Pagan (STScI)

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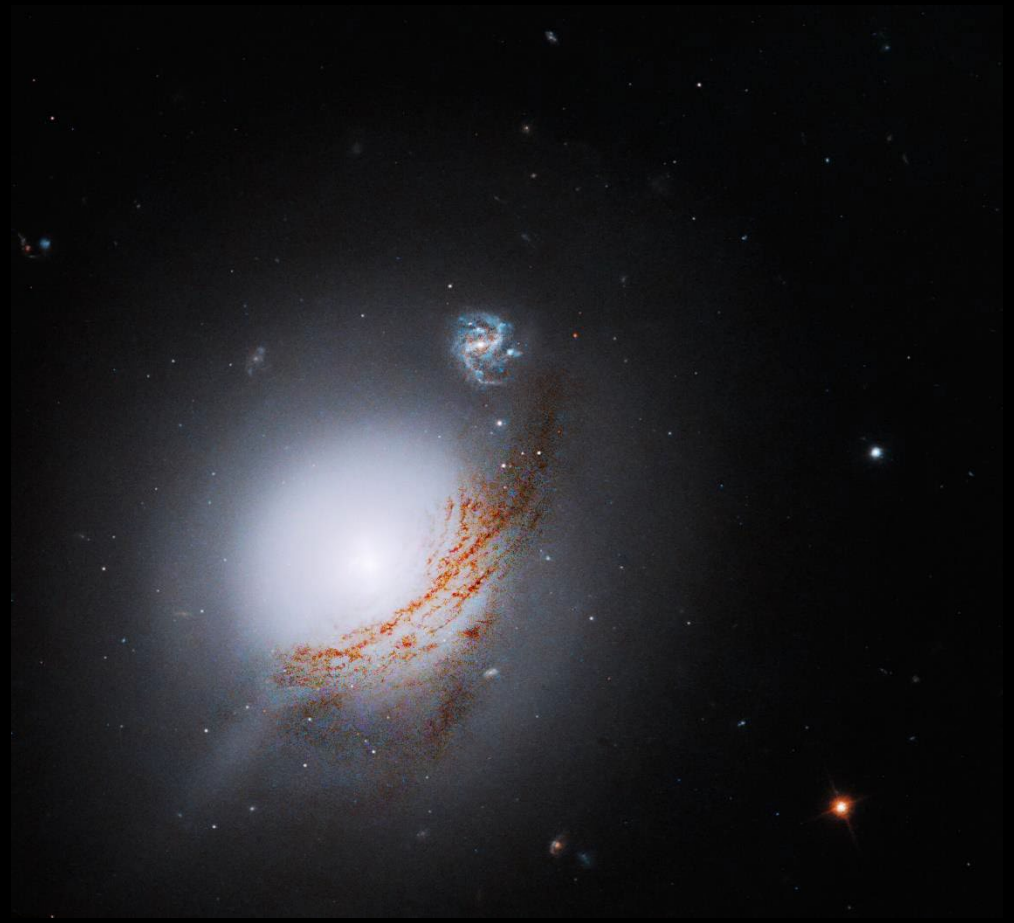
JWST and Hubble latest photos (3)

- Hubble has imaged the lenticular galaxy NGC 5283, a Seyfert galaxy with an Active Galactic Nucleus. Seyfert galaxies differ from other galaxies that contain AGNs because the galaxy itself is clearly visible. Other AGNs emit so much radiation that they outshine or make it impossible to observe the structure of their host galaxy.
- About 10% of all galaxies are of the Seyfert type



Credit: NASA, ESA, A. Barth (University of California–Irvine), and M. Revalski (STScI); Processing: Gladys Kober (NASA/Catholic University of America)

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Observational Highlights

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June 2023 dates

- 21st June – Summer Solstice (15:54 BST)
- 21st June – Venus (-4.4) and Mars (+1.7) lie close to the young crescent Moon. Venus is 4.5° west of the Moon, and Mars a further 4.5° west of Venus
- 22nd June – conjunction of the Moon and Venus at 11:10 BST (same right ascension – separated by 3° 47'). Closest approach at 13:54 BST (3° 34')
- 27th June – Bootid meteor shower reaches its peak just before midnight. It is a weak shower with only a couple an hour, slow – 18 km/sec. Comet Pons-Winnecke
- Venus continues to dazzle us into June. Unfortunately, although it is continuing to brighten it is starting to slip lower in the sky. Starting at a magnitude of -4.3 and 24° on the first (visible from 21:30), it will be -4.4 by mid-month but only reach 19° (visible from 21:42 on the 15th), and -4.5 at the end of the month but now only 13° above the western horizon (from 21:43)

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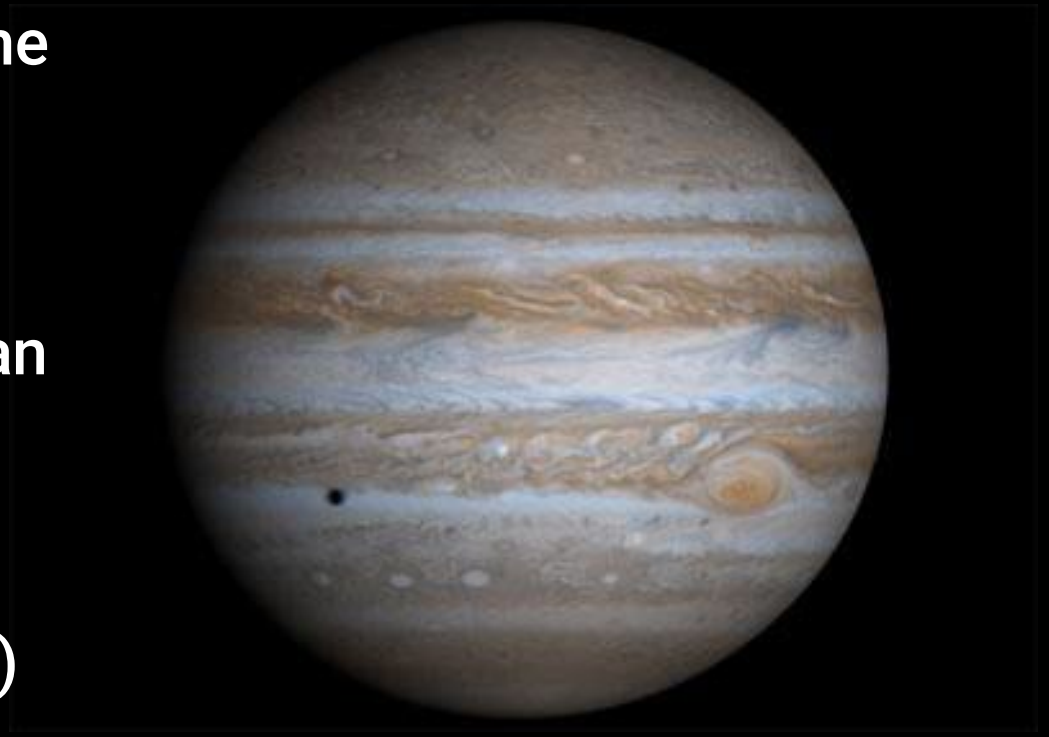
Jupiter is back

- Now a morning sky object, it will start to become visible by the end of the first week of June low above the eastern horizon, magnitude -2.1
- By June 15th it will rise at 02:36 BST, 2 hours before the Sun in the eastern sky. It will reach an altitude of 14° before fading in the early dawn light at 04:16 BST
- At the end of the month, Jupiter (mag -2.2) will be an even earlier riser (visible from 01:43 BST) and climbing to 23° before being lost at 04:20 BST



Credit: NASA/JPL/University of Arizona

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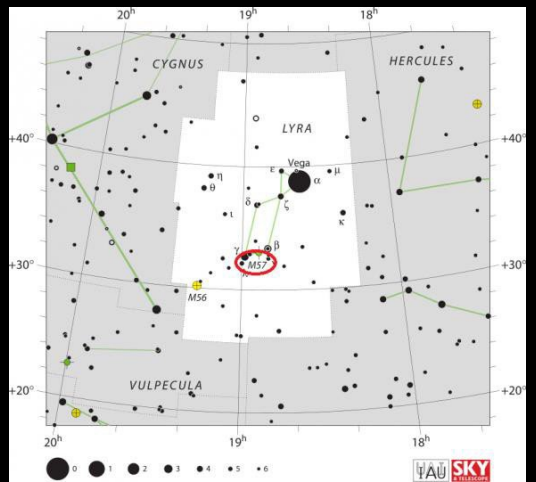
Try a closer look at the Ring Nebula (M57)

- Messier 57, the Ring Nebula, is one of the easiest planetary nebulae to see with a small telescope (3”/75mm or larger). With a larger 100 – 150mm telescope and either an O-III or UHC filter some variation in the brightness can be seen
- In June it is easy to find, (by mid-month it becomes visible at 23:27 BST, 54° above the eastern horizon before reaching its zenith, 72° above the southern horizon at 02:21BST)



- It is located in the constellation of Lyra and only 6.7° south-east of the magnitude 0 star, Vega
- Explore the nebula’s structure at: https://youtu.be/6FSIfUYFeTM

Credit: NASA, ESA and the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration

Sky chart credit: IAU and Sky & Telescope magazine (Roger Sinnott & Rick Fienberg)

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Summer is the season for Noctilucent Clouds

- On a clear evening, when the Sun has set, look up into the north-western sky and you may be lucky to see lines of thin wispy clouds
- These “night shining” clouds are formed when water vapour freezes onto particles of dust, forming ice crystals high up in the mesosphere, at around 50 miles above the Earth’s surface. The Sun illuminates them from below causing them to shine
- The Summer is a particularly good time to see them as the mesosphere is at its coldest
- The same effect can be seen before dawn in the north-eastern skies

Noctilucent clouds over Roker Beach
Credit: Matt Robinson

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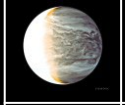
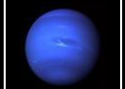
Planets for evening of 1st/morning of 2nd June

	Planet	Rises	Sets	Highest	Direction	Altitude	Magnitude	Visible
	MERCURY	04:06	18:34				+0.18	NO
	VENUS	08:01	00:27	15:50	West	24° ◊	-4.29	YES
	MARS	09:06	00:46	17:43	West	20° ◊◊	+1.59	YES
	JUPITER	03:22	17:26	04:23	East	8° ▫	-2.11	YES
	SATURN	01:43	12:06	03:51	South-East	16° ▫▫	+0.95	YES
	URANUS	03:53	19:03				+5.86	NO
	NEPTUNE	02:07	14:02				+7.91	NO

◊ = Highest point when first visible (20:45)
◊◊ = Highest point when first visible (21:21)
▫ = Highest point when last visible (04:23)
▫▫ = Highest point when last visible (03:46)

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

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
M31	Andromeda Galaxy (Andromeda)	Galaxy	***	***	02:47 *	North-East	29°	+3.4
IC4665	Open Cluster (Ophiuchus)	Open Cluster	23:08	02:47	02:05	South-East	44°	+4.2
C14	Double Cluster (Perseus)	Open Cluster	***	***	02:47 *	North-East	29°	+4.3
NGC6633	Open Cluster (Ophiuchus)	Open Cluster	23:08	02:47	02:47 *	South	45°	+4.6
IC4756	Graff's Cluster (Serpens Cauda)	Open Cluster	23:08	02:47	02:47 *	South	44°	+4.6
M5	Globular Cluster (Serpens Caput)	Globular Cluster	23:08	02:47	23:34	South	41°	+5.7
M13	Great Globular Cluster (Hercules)	Globular Cluster	23:08	02:47	01:01	South	75°	+5.8
M12	Globular Cluster (Ophiuchus)	Globular Cluster	23:08	02:47	01:06	South	37°	+6.1
M3	Globular Cluster (Canes Venatici)	Globular Cluster	23:08	02:47	23:08 **	South	63°	+6.3
M15	Globular Cluster (Pegasus)	Globular Cluster	23:08	02:47	02:47 *	South-East	36°	+6.3
M92	Globular Cluster (Hercules)	Globular Cluster	***	***	02:47 *	South-West	75°	+6.5
M10	Globular Cluster (Ophiuchus)	Globular Cluster	23:08	02:47	01:16	South	35°	+6.6
M2	Globular Cluster (Aquarius)	Globular Cluster	23:52	02:47	02:47 *	South-East	25°	+6.6
M81	Bode's Galaxy (Ursa Major)	Galaxy	***	***	23:08 **	North	51°	+6.9
M101	Pinwheel Galaxy (Ursa Major)	Galaxy	***	***	23:08 **	North-West	81°	+7.9

* = Highest point at Dawn (02:47 - last visible sighting) ** = Highest point at Dusk (23:08 - first visible sighting)
*** = circumpolar

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

Object	Name	Type	Rises	Sets	Highest	Direction	Alt	Mag
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	***	***	23:08 **	West	67°	+8.2
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	***	***	23:08 **	West	76°	+8.4
M57	The Ring Nebula (Lyra)	Planetary Nebula	***	***	02:47 *	South	71°	+8.8
NGC2403	'Spiral' Galaxy (Camelopardalis)	Galaxy	***	***	23:08 **	North	39°	+8.9

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

Twilight	Civil	Naut	Astro
Ends	21:48	22:52	
Starts	04:05	03:01	

	Rises	Sets
Sun	04:49	21:04
Moon	19:27	03:20

* = Highest point at Dawn (02:47 - last visible sighting) ** = Highest point at Dusk (23:08 - first visible sighting)
*** = circumpolar

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Brown Lunation Numbers

numbered from first New Moon in 1923

Phases of the Moon

Phase	Date	Time	Lunation
FULL MOON	4th June	04:41	1242
LAST QUARTER	10th June	20:31	1242
NEW MOON	18th June	05:37	1243
FIRST QUARTER	26th June	08:49	1243

Credit: Sean Smith/NASA