

# Lewes Astronomical Society

Newsletter - March 2023

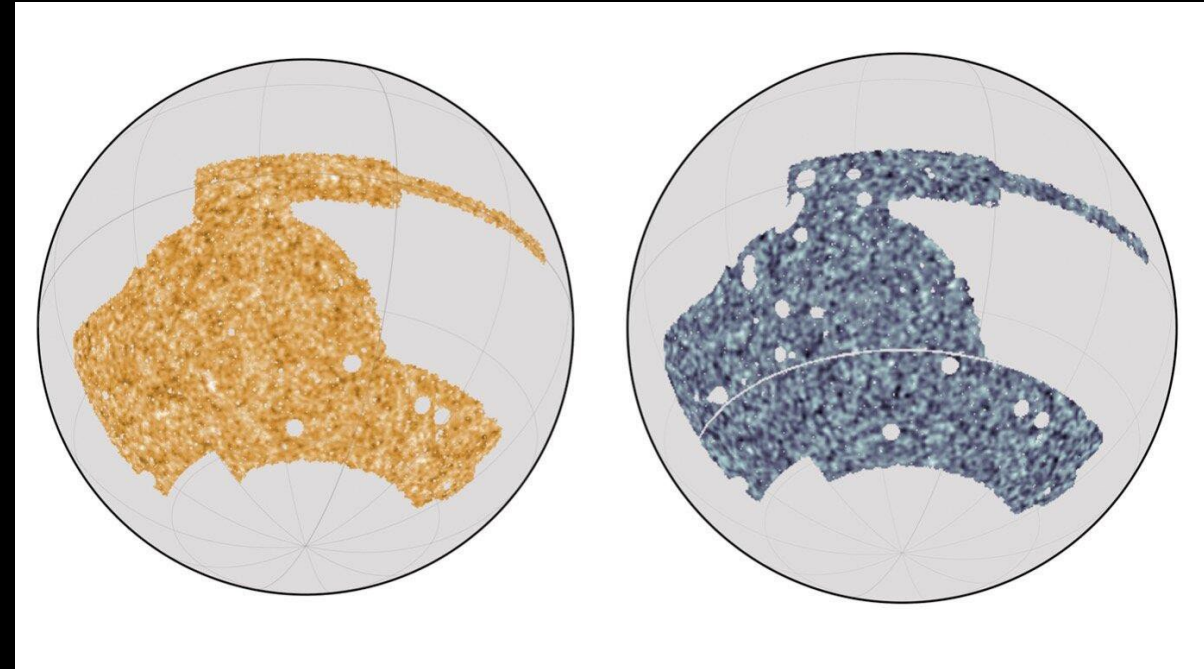
**Lewes Astronomical Society**

**Astronomy & Space News**

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## Map of the Universe

- The most detailed map of the observable universe to date
- Using data from the South Pole Telescope and the Dark Energy Survey in Chile, it provides unprecedented insights into the structure and distribution of galaxies and cosmic structures
- Gravitational lensing was used to reflect the effects of both ordinary and dark matter in the universe
- These results suggest that the universe is less lumpy than current modelling had previously predicted



Data from Dark Energy Survey (left) and South Pole Telescope (right)

Credit: Yuuki Omori, University of Chicago, USA

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## Key Moments in Astrophysics since 1900

- 1905 – Albert Einstein – Special Theory of Relativity, time dilation and  $E = mc^2$
- 1916 – Albert Einstein – General Theory of Relativity (concept of SpaceTime and the prediction of Black Holes and Gravitational Waves)
- 1924 – Edwin Hubble – most nebulae are galaxies far beyond the Milky Way
- 1925 – Cecilia Payne – stars are mainly made out of hydrogen and helium
- 1929 – Edwin Hubble – relationship between galaxy distances and velocities
- 1931 – Georges Lemaître – Big Bang Theory and expansion of the universe
- 1933 – Fritz Zwicky – mass of galaxies – “Dunkle Materie” (Dark Matter)
- 1946/1954 – Fred Hoyle – Stellar Nucleosynthesis & the creation of the elements
- 1980 – Alan Guth & Alexei Starobinsky – “Cosmic Inflation”
- 1998 – Adam Reiss/Saul Perlmutter – expansion of the universe – Dark Energy
- 2016 – Gravitational Waves detected by LIGO (merger of two black holes)
- 2019 – First direct image of a black hole (first black hole identified in 1971)
- 2023 – The mystery of Dark Energy finally revealed?

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## Black Holes & Dark Energy

- Could the supermassive black holes at the centres of galaxies be the source of dark energy?
- Researchers have uncovered the first evidence of “cosmological coupling” which proposes that objects far apart are not independent of each other
- There is a prediction, derived from the General Theory of Relativity, that black holes should exist within an evolving universe
- Black holes at the centres of galaxies gain more mass over time which can't be explained by standard gravity rules and black hole processes
- The increase in their mass ties in with predictions for black holes that not only “cosmologically couple” but also enclose vacuum energy, and the total vacuum energy of black holes matches the amount of dark energy in the universe
- See the YouTube video at: <https://youtu.be/gjwxnoPoEHQ> (credit: STFC RAL Space)



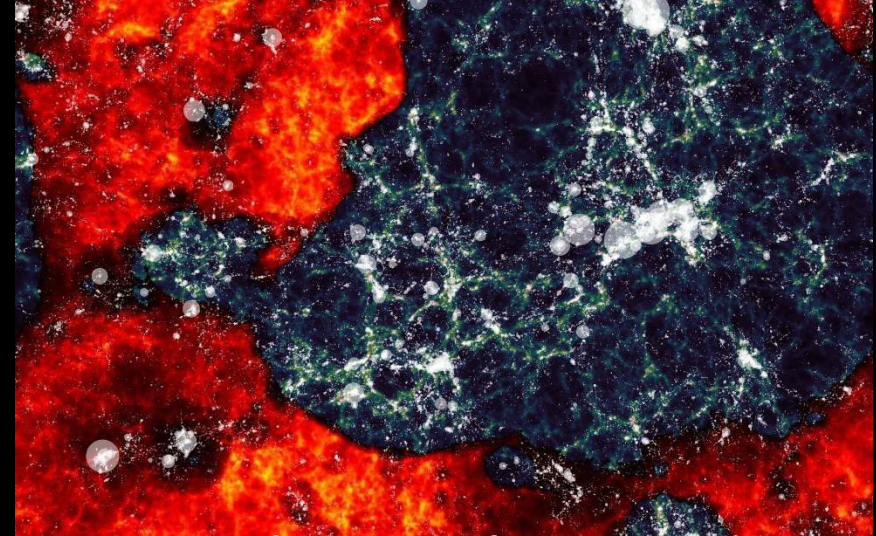
NGC 524, one of the galaxies studied

Credit: ESA/Hubble

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## Supermassive First Stars

- Hydrogen and helium filled the early universe
- Established theories suggest that the first stars would have been able to grow to a hundred times the mass of the Sun without heavier elements
- These would have burnt through their fuel in only a few million years, exploding as huge supernovae and seeding heavier elements into the universe
- Pulling in massive amounts of material into a small space quickly causes it to heat up, inhibiting further condensation and gravitational collapse
- Modelling now suggests that large pockets of dense, super-cold gas may have existed. If one of these met a star-forming accretion disk shockwaves would have caused it to collapse immediately. Any resulting star would be tens or even hundreds of thousands of times more massive than the Sun



Visualisation of the Epoch of Reionisation

Credit: Paul Geil & Simon Mutch/The University of Melbourne, Australia



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## Complex chemistry in cold outer space 1

- The Big Bang formed hydrogen and helium
- Stars form carbon, oxygen, iron, et al
- Where do organic hydrocarbons from?
- The Taurus Molecular Cloud (TMC-1) is a potential new star nursery; it is very cold. TMC-1 has started to collapse and stars will soon start to be born
- Astronomers have detected complex chemical compounds in the Cloud – such as fulvenallene and 2-Ethynyl-1,3-cyclopentadiene. The progenitor for these compounds is suspected to be the molecule ortho-benzene,  $C_6H_4(OH)_2$

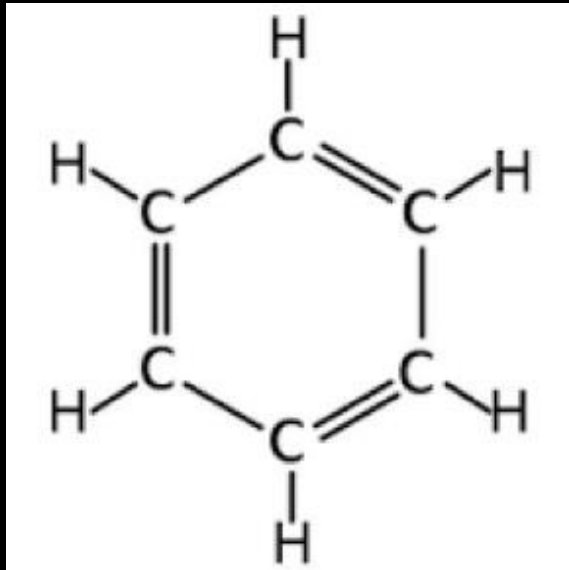


Taurus Molecular Cloud (TMC-1)

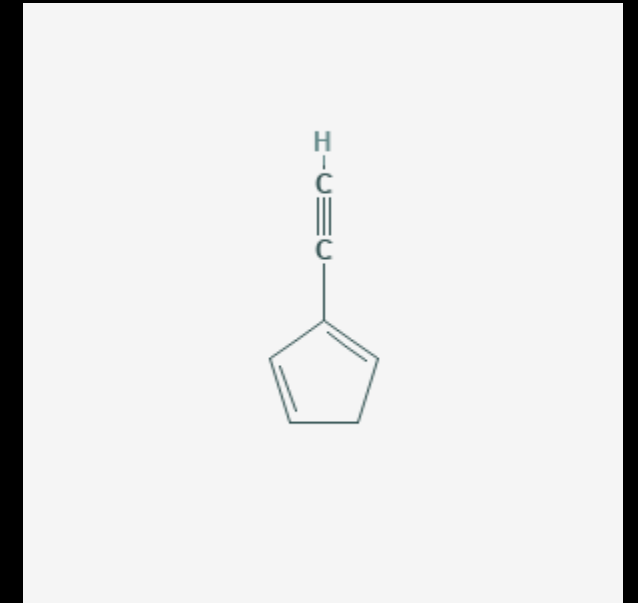
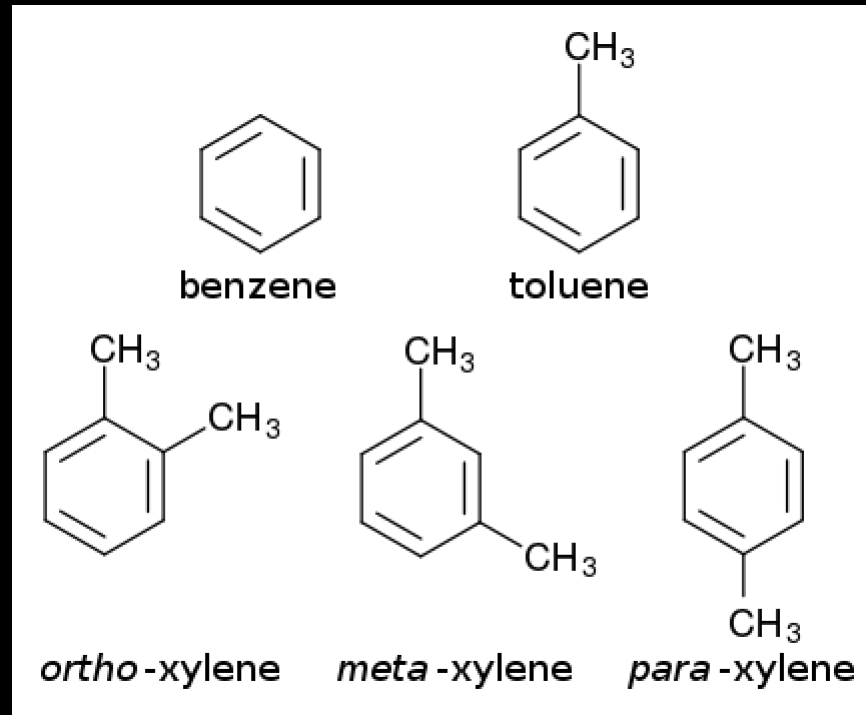
Credit: ESA/Herschel/NASA/JPL-Caltech, USA;  
acknowledgement: R. Hurt (JPL-Caltech), CC BY-SA 3.0 IGO

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## Complex chemistry in cold outer space 2



Benzene



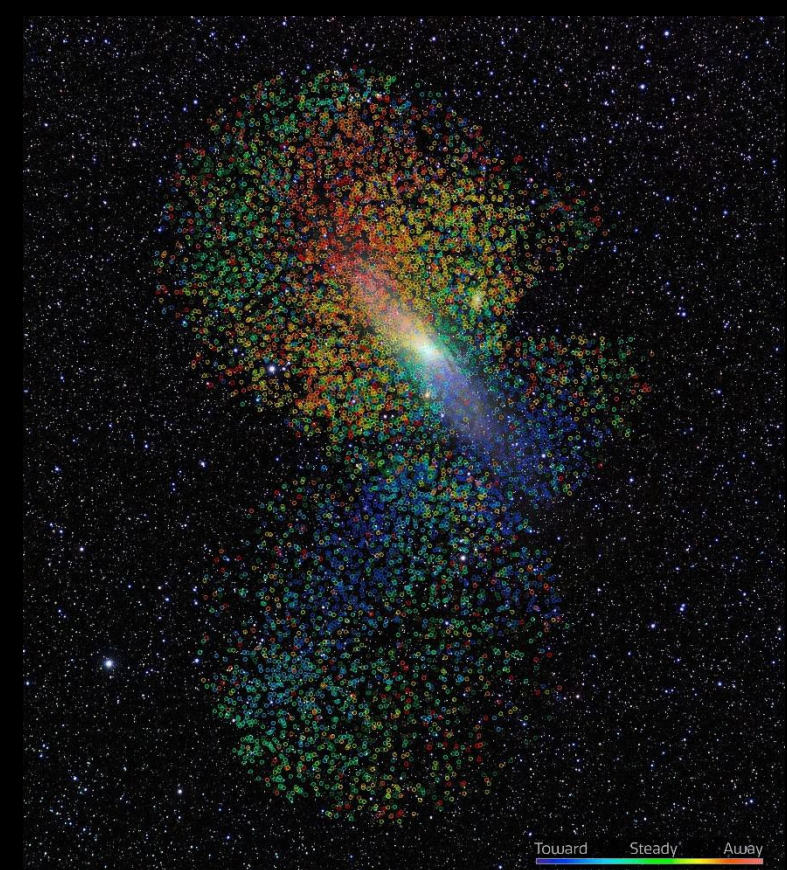
2-Ethynyl-1,3-cyclopentadiene



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## Galactic Cannibalism

- Galaxies grow by merging and absorbing other galaxies – a process known as “galactic cannibalism”
- The inner halo surrounding the Milky Way came about this way when another galaxy was cannibalised about 8 - 10 billion years ago
- That this process occurs in other galaxies has been inferred from what has happened in the Milky Way
- Now observers have found the same to be true in the Andromeda Galaxy
- Researchers using DESI on the 4m Mayall Telescope at the Kitt Peak Observatory have observed 7,500 stars in the halo of the Andromeda Galaxy
- By studying the patterns in the positions and the motions of these stars reveals that they started life in another galaxy that merged about 2 billion years ago



Individual stars in the halo of Andromeda. Red indicates movement away, blue towards us

Credit: KPNO/NOIRLab/AURA/NSF/E. Slawik/D. de Martin/M. Zamani

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## Jupiter – undisputed ‘King of the Planets’

- Jupiter is the ‘King of the Planets’ in our solar system (twice as massive as all the other planets put together) but has long been regarded as second to Saturn when comparing the total number of moons
- Astronomers have now confirmed an additional 12 (albeit very small) new moons orbiting Jupiter giving it the largest number
- The outer planets now have:
  - Jupiter            92 moons
  - Saturn             83 moons
  - Uranus            27 moons
  - Neptune          14 moons

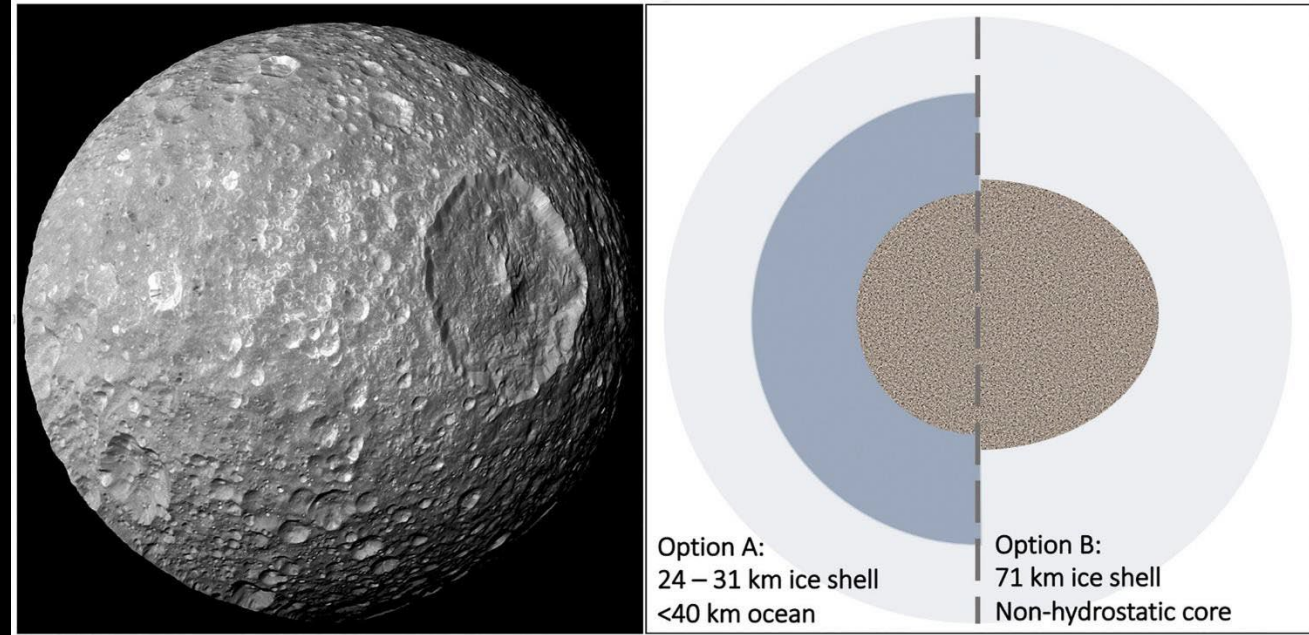


Credit: NASA, ESA, A. Simon/Goddard Space Flight Center, M.H. Wong/University of California, Berkeley, USA (via AP)

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## The 'Death Star' with a warm heart

- Saturn's innermost moon, Mimas, may have a liquid ocean under its icy crust
- Cassini first spotted an oscillation (wobbles called librations) in Mimas's orbit due to a possible internal liquid ocean
- Models suggest that the ice crust has thinned from 55 km to 30 km since the Herschel impact crater was formed 4.1 billion years ago
- An internal ocean helps explain the shape of the crater



Mimas's heavily cratered surface suggests a cold history but the librations rule out a homogeneous interior. Mimas must therefore have either an icy crust with a liquid ocean surrounding a rocky core (Option A) or be fully frozen with an irregular-shaped core. The librations point to option A but the known geology fits option B better

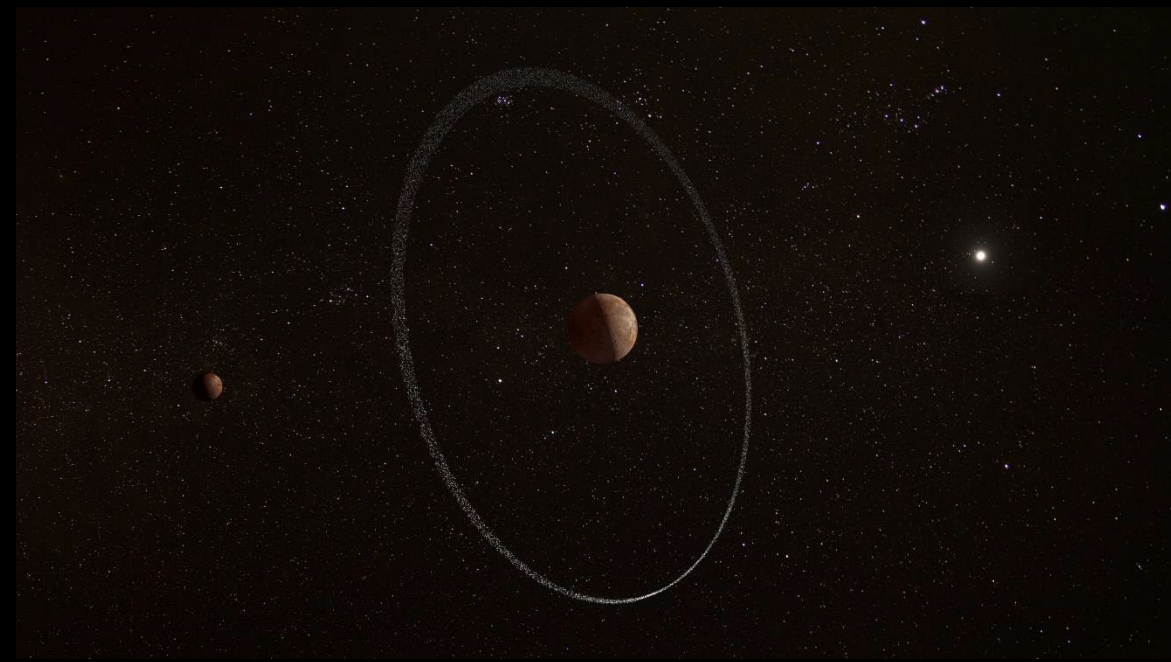
Credit: NASA/JPL/SSI/SwRI



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## Saturn may not be so unique

- First Saturn, then Jupiter, Uranus, Neptune and the minor planets, Chariklo and Haumea - they all have ring systems
- Now add another, the minor planet Quaoar
- The ring system was discovered by the transit method when Quaoar blocked the light of a distant star and two dips in the starlight were noted
- Unlike other systems, Quaoar's ring sits 7 planetary radii away, beyond the Roche limit which normally determines satellite stability



Credit: ESA, CC BY-SA 3.0 IGO

- Quaoar's ring system's position beyond the Roche limit challenges our understanding of ring system formation and stability.

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## SpaceX successfully tests rocket engines

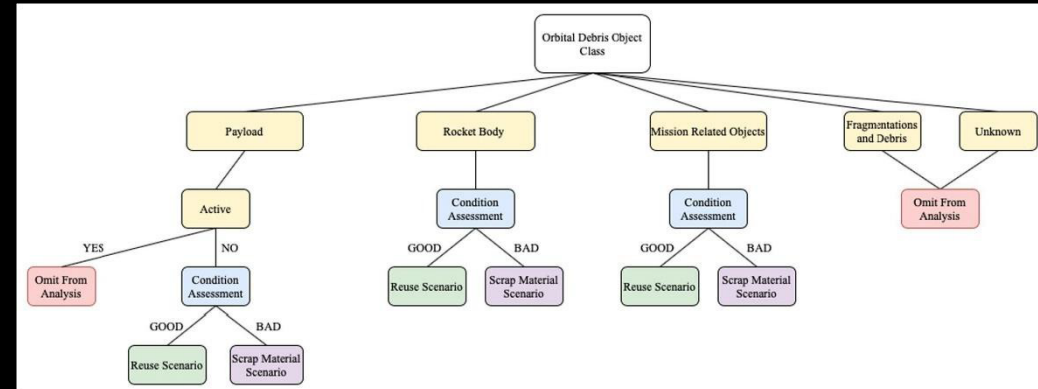
- The super heavy boosters that will be used to launch SpaceX's new giant Starship spacecraft were successfully fired at the Boca Chica test site in Texas on 9<sup>th</sup> February
- 33 boosters were used in the test and although one was not started and another shut down during the firing, the other 31 performed faultlessly. They would have provided enough power to put the Starship into orbit
- Only stage 1 was used in the test (it is a mere 69m high – the whole rocket stands at 120m)



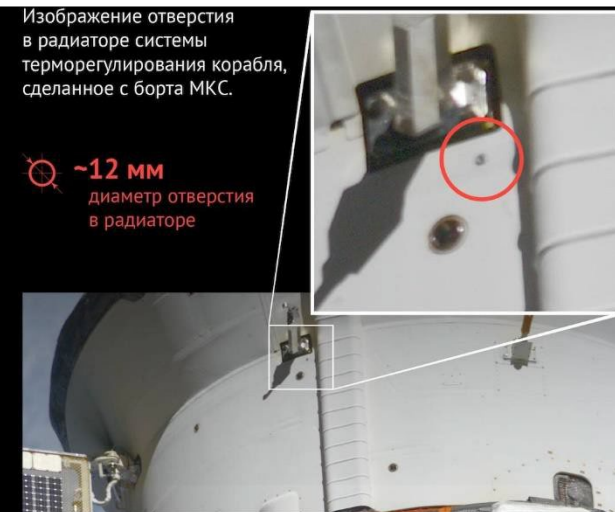
Credit: SpaceX via AP

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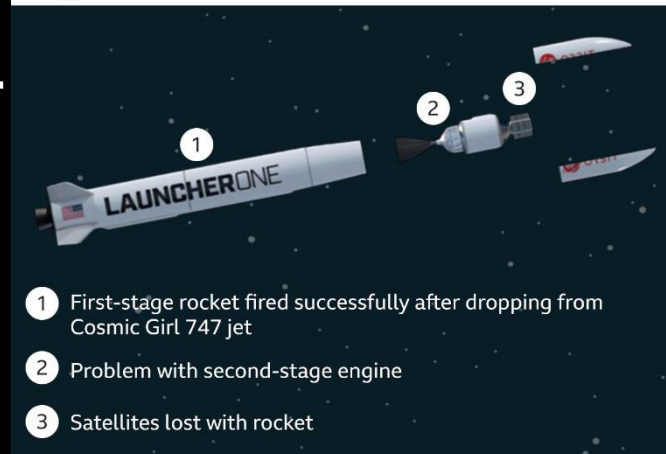
## Updates from last month



- Space debris has a value. The University of Southampton has estimated space junk is worth between \$570 billion and \$1.2 trillion (based on 5,312 – 19,124 tons of metal)
- Roscosmos delayed the launch of rescue Soyuz spacecraft (MS-23) until 24<sup>th</sup> February (docked 26<sup>th</sup>) as the already docked cargo spacecraft (Progress MS-21) had started leaking coolant. Another Progress spacecraft (MS-22) successfully docked and unloaded its cargo unscathed
- The failure of the Virgin Orbit rocket was due to a fuel filter becoming dislodged thus starving the Newton 4 engine of fuel. The engine overheated causing it to shutdown



Virgin Orbit's LauncherOne rocket



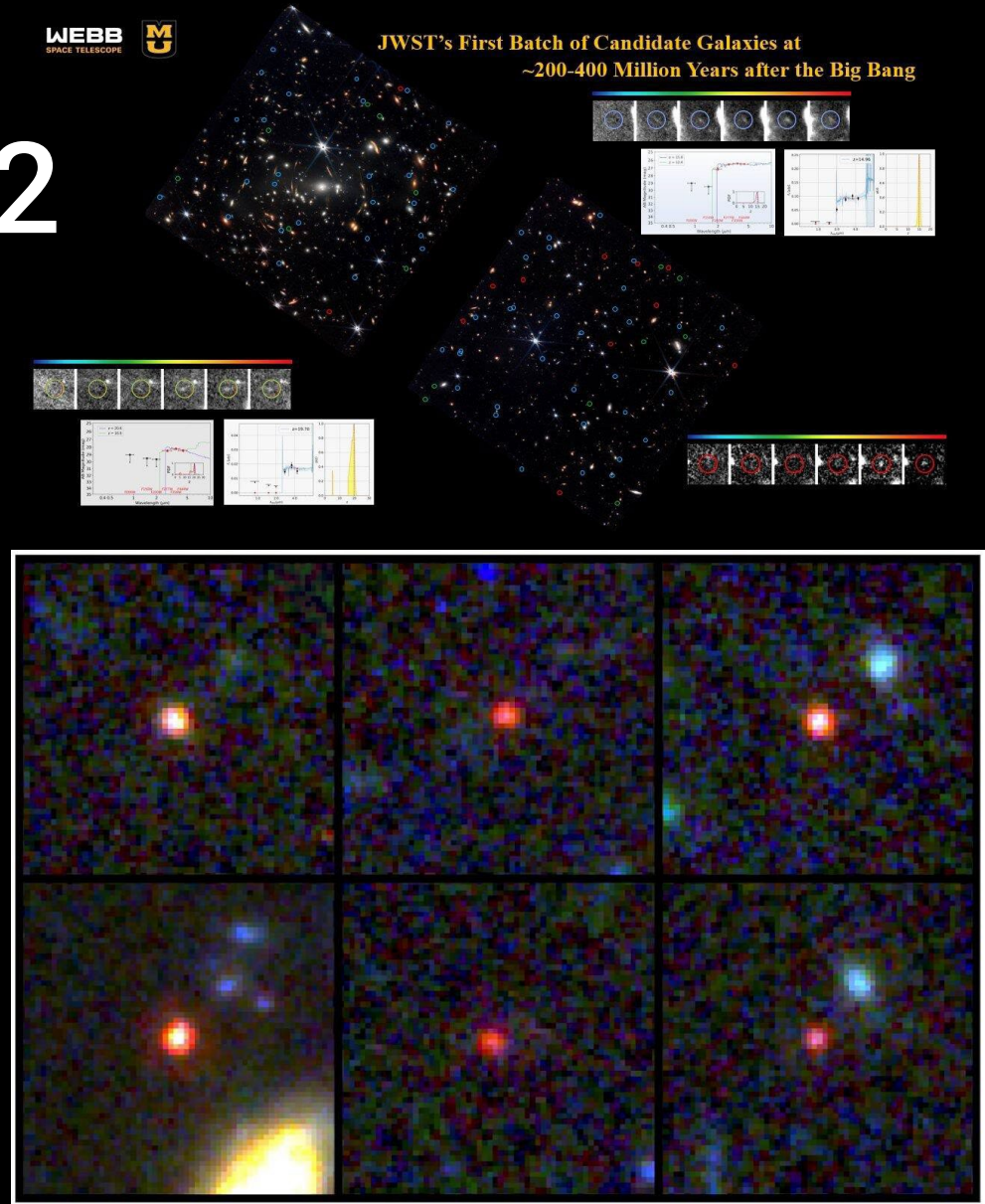
Credit: 1) Waste Management (2022). DOI: 10.1016/j.wasman.2022.10.024  
 2) Roscosmos State Space Corporation  
 3) Virgin Orbit



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## Updates from last month 2

- JWST is challenging some long-held beliefs
- Last month we reported on the discovery of large numbers of very young galaxies formed under 300 million after the Big Bang
- More diverse and complex than expected.
- 6 massive candidate galaxies are only 500 million years after the Big Bang have confounded the picture of early galaxy formation even further
- They are as large as today's galaxies
- Another, 1.4 billion years old is “super-chemically abundant”



Credit: 1) University of Missouri Graphics: Haojing Yan and Bangzheng Sun, University of Missouri

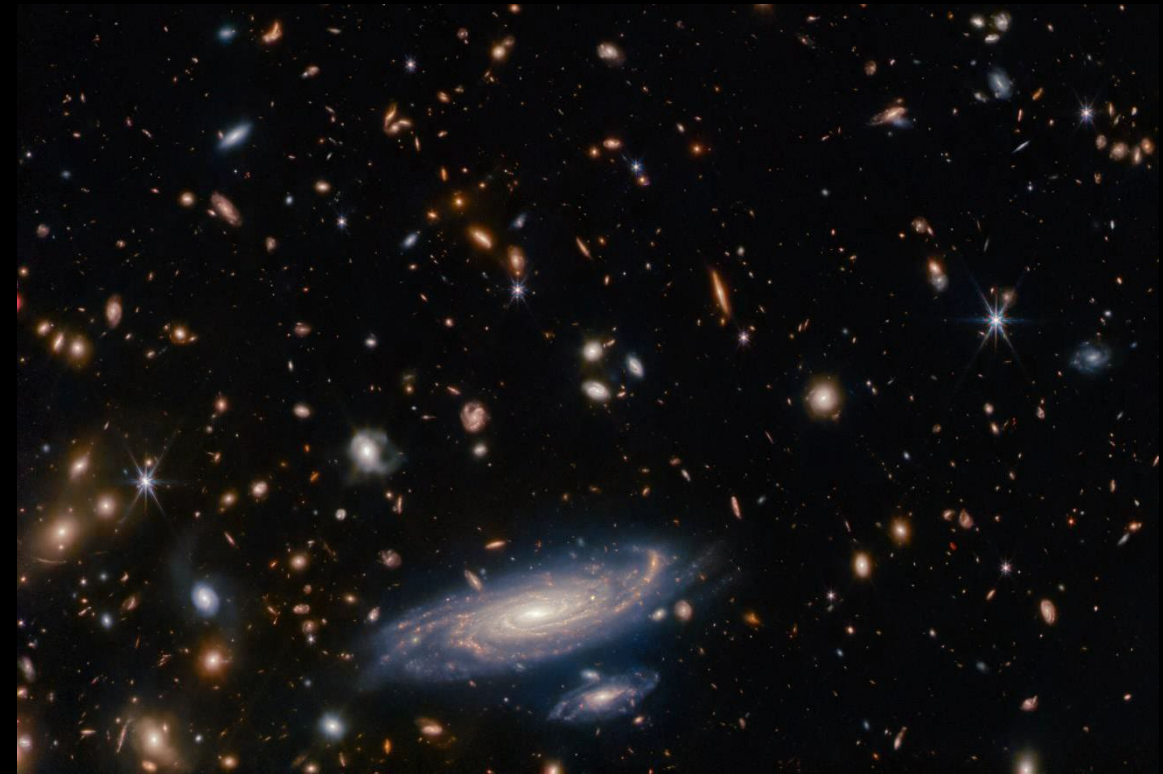
2) NASA, ESA, CSA, I. Labbe (Swinburne University of Technology).

Image processing: G. Brammer (Niels Bohr Institute's Cosmic Dawn Center at the University of Copenhagen)

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## JWST and Hubble latest photos 1

- Part of the huge programme of work JWST is tasked with is the imaging of distant, and therefore very ancient galaxies. This will help in determining the evolution of the universe
- LEDA 2046648 is a galaxy about 1 billion light years away in the constellation of Hercules. In the background are hundreds of more distant and hence even older galaxies



Credit: ESA/Webb, NASA & CSA, A. Martel

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## JWST and Hubble latest photos 2

- JWST has been studying very compact star clusters inside distant galaxies. This helps us understand the link between clump formation and galaxy evolution and growth
- The Sparkler Galaxy is about 4 billion years old and is surrounded by two dozen clusters which it will absorb
- This mirrors what happened in the early Milky Way with the assimilation of nearly 200 such star clusters

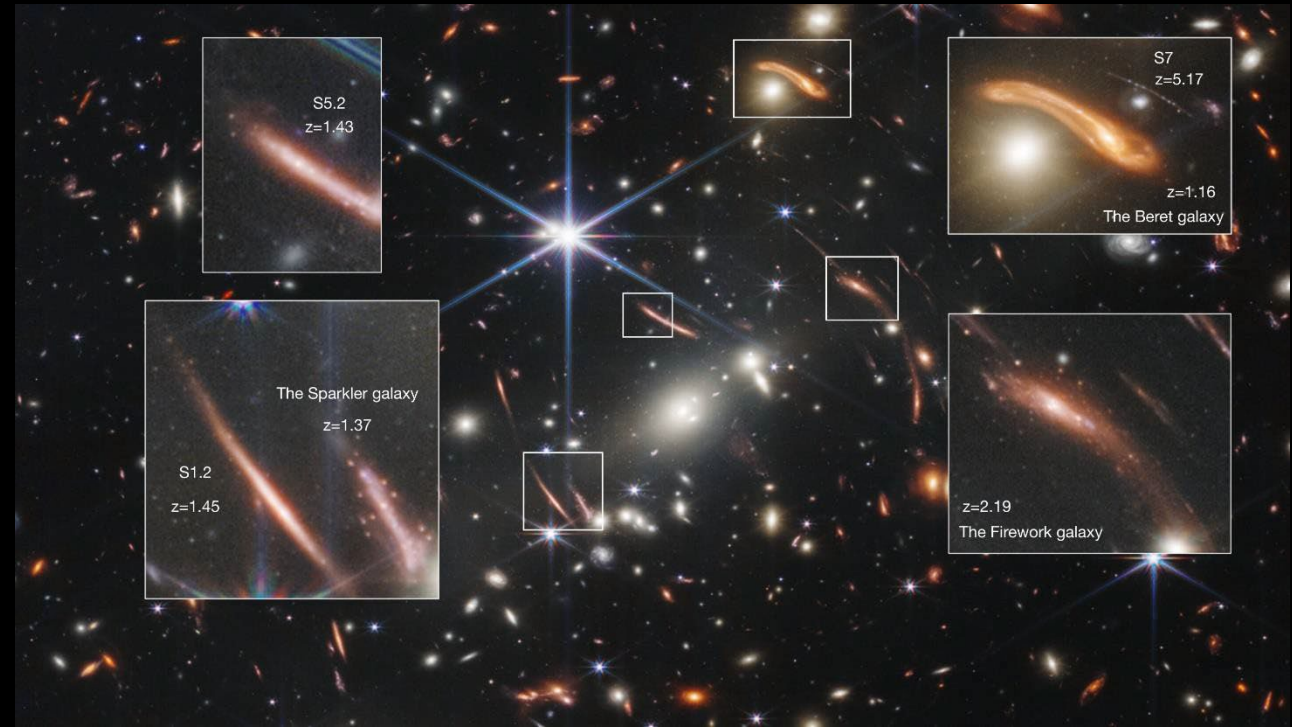


Image of galaxy cluster SMACS0723. The 5 highlighted galaxies are estimated to be between one and five billion years old

Credit: Image adapted from image released by NASA, ESA, CSA, STScI



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## JWST and Hubble latest photos 3

- JWST was just carrying out a routine calibration using the asteroid belt when it accidentally discovered a 100 – 200 m asteroid, one of the smallest yet found!
- “*Webb's incredible sensitivity made it possible to see this roughly 100-metre object at a distance of more than 100 million kilometres*” said Thomas Müller, an astronomer at the Max Planck Institute for Extraterrestrial Physics in Germany



Artist's impression of small grey asteroid

Credit: N. Bartmann (ESA/Webb), ESO/M. Kornmesser and S. Brunier, N. Risinger (skysurvey.org)

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## JWST and Hubble latest photos 4

- The Tarantula Nebula (Doradus 30), 161 thousand light years from Earth in the Large Magellanic Cloud, is well-known and often imaged object by both Hubble and JWST
- Data for this Hubble image came from the Scylla and Ulysses projects
- Scylla is looking at the dust grains that exist between the stars
- Ulysses is looking at how the interstellar dust interacts with starlight in a variety of environments



Credit: ESA/Hubble & NASA, C. Murray, E. Sabbi;  
Acknowledgment: Y. -H. Chu

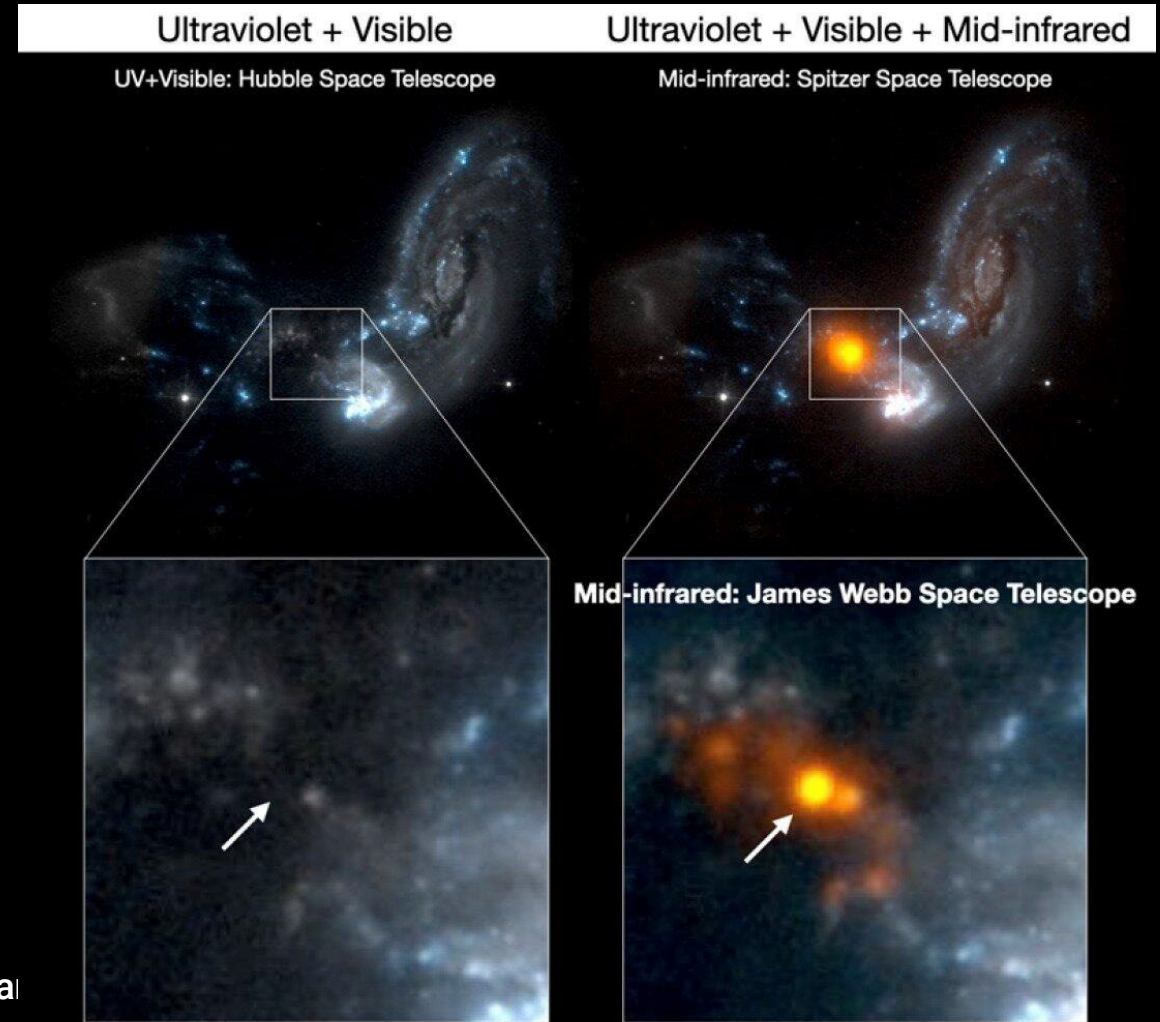


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## JWST and Hubble latest photos 5

- Two galaxies roughly 500 million light years away in the constellation Delphinus are in the process of merging
- The driving force in the combined galaxy (II Zw 096) is hidden by dust clouds through which Hubble can't see
- The infrared Spitzer Space Telescope identified the source but not the exact position
- JWST found the source (570 light years across – the galaxy is 65,000 light years)

Credit: Hanae Inami, Hiroshima University, Japan





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## JWST and Hubble latest photos 6

- NGC 4303 is a weakly-barred spiral galaxy about 55 million light years away in the Virgo constellation
- There is a ring structure in its spirals and the arms sparkle with star formation
- Classified a late-type spiral, it gave birth to stars slowly at first. There is still a lot of gas left
- Now busy with star formation, astronomers are puzzled how there are so many ancient clusters



Top: Hubble image taken in visible and U/V light

Credit: ESA/Hubble/NASA

Bottom: ALMA image taken in millimeter wavelengths and visible light

Credit: ESO/ALMA (ESO/NAOJ/NRAO)/PHANGS

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## JWST and Hubble latest photos 7

- Seasons on Saturn last 7 years!
- At the equinox strange spokes are seen in the rings which disappear near the solstices
- The Autumnal Equinox in the northern hemisphere is on 6<sup>th</sup> May 2025 and the spokes have just started to appear
- The Hubble image shows two smoky smudges – the next spokes forming
- The YouTube video uses Hubble images taken 4 minutes apart:  
<https://youtu.be/1rcroxA6Pp8>  
and a longer feature on the ring phenomenon:  
[https://youtu.be/\\_et1sMxVrpY](https://youtu.be/_et1sMxVrpY)



Credit: NASA, ESA, Amy Simon (NASA-GSFC); Image Processing:  
Alyssa Pagan (STScI)

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## JWST and Hubble latest photos 8

- Abell 2744, otherwise known as Pandora's Cluster has been imaged in never-seen-before-detail by JWST
- 3 clusters are coming together to form a supercluster
- It has already become a powerful gravitational lens
- Watch the tour of Pandora's Cluster at:  
<https://youtu.be/FM0boU-hZZQ>
- And a video zooming in on Pandora's Cluster at:  
[https://youtu.be/M2-z6t6X\\_os](https://youtu.be/M2-z6t6X_os)



Credit : NASA

Credit (1st video): NASA, ESA, CSA, I. Labbe (Swinburne University of Technology), R. Bezanson (University of Pittsburgh), A. Pagan (STScI), N. Bartmann (ESA/Webb); Music: Stellardrone—Twilight

Credit (2nd video): NASA, ESA, CSA, I. Labbe (Swinburne University of Technology), R. Bezanson (University of Pittsburgh), A. Pagan (STScI). Dark Energy Survey/DOE/FNAL/NOIRLab/NSF/AURA, DSS, N. Bartmann, E. Slawik, N. Risinger, D. de Martin, M. Zamani; Music: Tonelabs—The Red North

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# **Observational Highlights**

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## March 2023 dates

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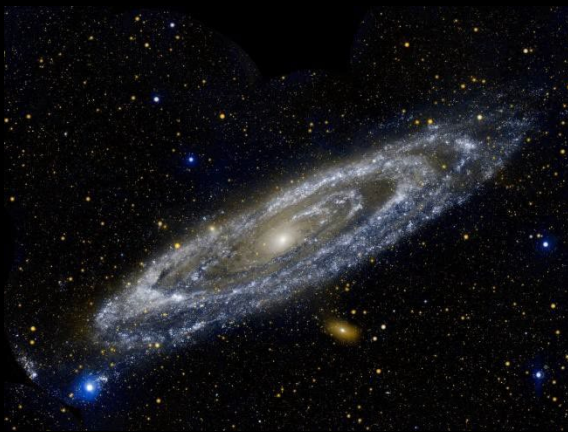
- **2<sup>nd</sup> March – close approach (appulse) of Jupiter and Venus passing within 29.4 arcminutes of each other (05:05 GMT/UTC); conjunction is during day-time (10:41 GMT/UTC)**
- **15<sup>th</sup> March – Neptune at solar conjunction and furthest from Earth at 30.91 AU (23:30 GMT/UTC)**
- **17<sup>th</sup> March – Mercury at superior solar conjunction and furthest from Earth at 1.35 AU (10:53 GMT/UTC)**
- **20<sup>th</sup> March – Vernal Equinox (21:20 GMT/UTC)**
- **29<sup>th</sup> March – Comet C/2019 U5 (PANSTARRS) at perihelion and 3.62 AU from the Sun. Expected magnitude 11.9**
- **31<sup>st</sup> March – Mercury at perihelion being only 0.31 AU from the Sun (19:48 BST/20:48 UTC)**



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## Last chance to see Andromeda Galaxy

- The New Moon (21<sup>st</sup> March) coincides with the Spring Equinox (20<sup>th</sup> March). These dark moonless nights will be your last chance to see our nearest galactic neighbour, the Andromeda Galaxy (M31) until after Summer



Credit: NASA/JPL-Caltech

- In the early evening, M31 lies about 25° above the north-west horizon but sets at about 20:45 – so hurry!
- Unless you are in a really dark sky area you will need a good pair of binoculars to see M31, which appears as a faint hazy patch. The Autumn months are the best time to view M31 in the evenings, when it can be found overhead in the sky.



Credit: Starry Night Software



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## Planets (@ 01-03-2023)

Data reproduced from In-The-Sky.org

Dominic Ford – original author & copyright holder

<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	06:34	16:15	11:21			-0.55	NO
Venus	07:43	20:27	14:03	South-West	21° ***	-3.97	YES
Mars	10:07	03:01	18:33	South	64°	+0.42	YES
Jupiter	07:47	20:29	14:08	South-West	22° ***	-2.10	YES
Saturn	06:32	16:28	11:30			+0.86	NO
Uranus	08:48	23:42	16:15	South-West	42° **	+5.81	YES
Neptune	07:17	18:52	13:05			+7.96	NO

\* = Highest point at Dawn (05:26 - last visible sighting)

\*\* = Highest point at Dusk (18:57 - first visible sighting)

\*\*\* = Highest point when first visible (18:00)

## Deep Sky Objects 1 (@ 01-03-2023)

[\*\*\* = circumpolar]

<u>Object</u>	<u>Name</u>	<u>Type</u>	<u>Rises</u>	<u>Sets</u>	<u>Highest</u>	<u>Direction</u>	<u>Alt</u>	<u>Mag</u>
Cr50	The Hyades (Taurus)	Open Cluster	10:23	01:16	18:57**	South	53°	+0.5
M45	The Pleiades (Taurus)	Open Cluster	08:53	01:29	18:57**	South-West	56°	+1.3
M44	The Beehive Cluster (Cancer)	Open Cluster	14:14	05:51	22:03	South	58°	+3.1
M31	Andromeda Galaxy (Andromeda)	Galaxy	***	***	18:57**	West	40°	+3.4
C14	Double Cluster (Perseus)	Open Cluster	***	***	18:57**	North-West	61°	+3.7
M42	The Orion Nebula (Orion)	Open Cluster	13:21	00:35	18:58	South	33°	+4.0
NGC2232	Open Cluster (Monoceros)	Open Cluster	14:11	01:30	19:51	South	34°	+4.2
IC4665	Open Cluster (Ophiuchus)	Open Cluster	00:40	13:43	05:26*	South-East	39°	+4.2
M47	Open Cluster (Puppis)	Open Cluster	16:09	01:49	20:59	South	24°	+4.4
NGC6633	Open Cluster (Ophiuchus)	Open Cluster	01:16	14:28	05:26*	South-East	36°	+4.6
IC4756	Graff's Cluster (Serpens)	Open Cluster	01:33	14:34	05:26*	South-East	34°	+4.6
M5	Globular Cluster (Serpens)	Globular Cluster	22:30	10:58	04:44	South	41°	+5.7
M33	Triangulum Galaxy (Triangulum)	Galaxy	05:44	00:10	18:57**	West	41°	+5.8
M13	Great Globular Cluster (Hercules)	Globular Cluster	19:35	16:38	05:26*	South-East	73°	+5.8
M12	Globular Cluster (Ophiuchus)	Globular Cluster	00:18	12:06	05:26*	South	36°	+6.1
M3	Globular Cluster (Canes Venatici)	Globular Cluster	21:10	05:26	03:08	South	67°	+6.3

\* = Highest point at Dawn (05:26 - last visible sighting)    \*\* = Highest point at Dusk (18:57 - first visible sighting)

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## Deep Sky Objects 2 (@ 01-03-2023)

[\*\*\* = circumpolar]

<u>Object</u>	<u>Name</u>	<u>Type</u>	<u>Rises</u>	<u>Sets</u>	<u>Highest</u>	<u>Direction</u>	<u>Alt</u>	<u>Mag</u>
M92	Globular Cluster (Hercules)	Globular Cluster	***	***	05:26*	South	74°	+6.5
M10	Globular Cluster (Ophiuchus)	Globular Cluster	00:39	12:05	05:26*	South	33°	+6.6
M81	Bode's Galaxy (Ursa Major)	Galaxy	***	***	23:31	North	72°	+6.9
M101	Pinwheel Galaxy (Ursa Major)	Galaxy	***	***	03:29	North	86°	+7.9
M110	'Satellite' Galaxy - 1 (Andromeda)	Galaxy	***	***	18:57**	West	40°	+8.1
M94	'Spiral' Galaxy (Canes Venatici)	Galaxy	***	***	02:16	South	80°	+8.2
M1	The Crab Nebula (Taurus)	S'nova Remnant	18:57	03:01	18:57**	South	61°	+8.4
M51	Whirlpool Galaxy (Canes Venatici)	Galaxy	***	***	02:55	South	86°	+8.4
M104	Sombrero Galaxy (Virgo)	Galaxy	21:00	07:11	02:06	South	27°	+8.6
M57	The Ring Nebula (Lyra)	Planetary Nebula	***	***	05:26*	East	54°	+8.8
NGC2403	'Spiral' Galaxy (Camelopardalis)	Galaxy	***	***	21:02	North	75°	+8.9

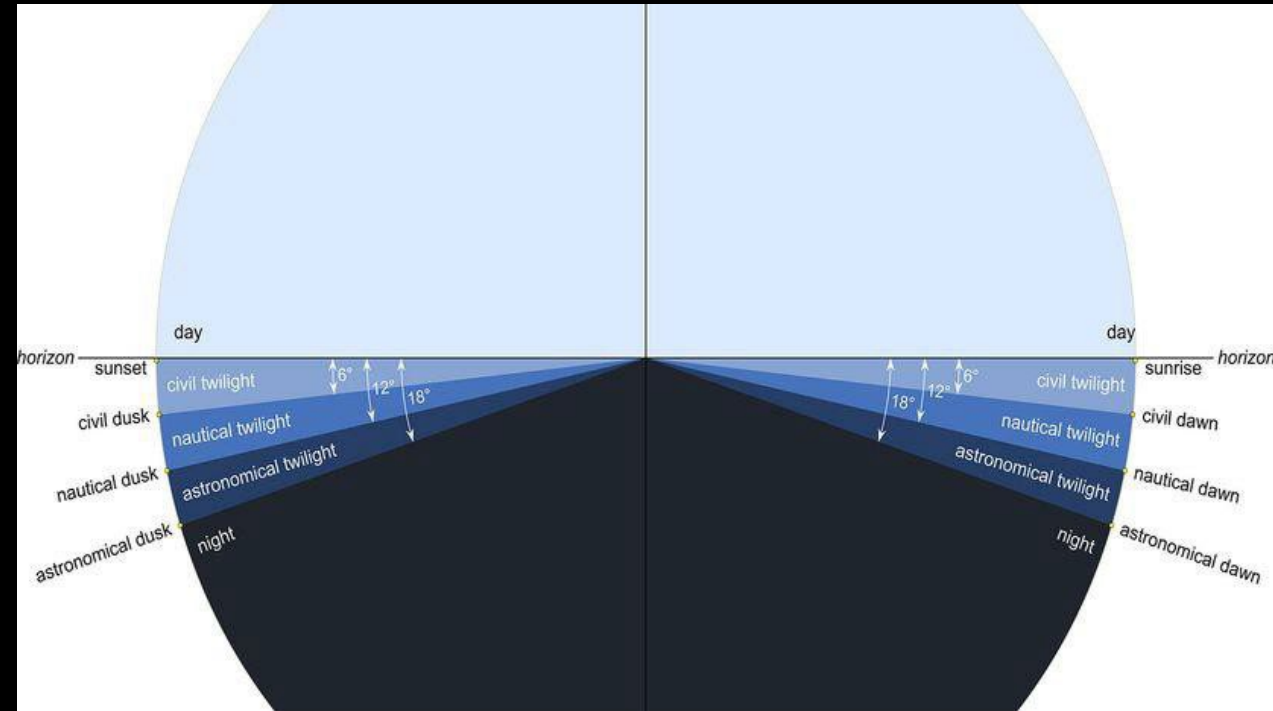
<u>Twilight</u>	<u>Civil</u>	<u>Nautical</u>	<u>Astronomical</u>		<u>Rises</u>	<u>Sets</u>
Morning (begins)	06:10	05:32	04:54	Sun	06:44	17:40
Evening (ends)	18:13	18:51	19:29	Moon	11:00	04:57

\* = Highest point at Dawn (05:26 - last visible sighting)    \*\* = Highest point at Dusk (18:57 - first visible sighting)

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## Twilight – civil, nautical or astronomical?

- There are three recognised types of twilight
- They always occur in the same order but the length of each one depends on the season and latitude
- Only the brightest stars and planets can be seen in civil twilight
- Nautical twilight occurs when the horizon becomes difficult to distinguish at sea
- Dawn and dusk occur when the Sun passes a specific point below the horizon (at  $6^\circ$ ,  $12^\circ$ , and  $18^\circ$ ); twilight is the period between those points



Credit: TWCARLSON/WIKIPEDIA/CC BY-SA 3.0

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## Phases of the Moon

							
New	Waxing Crescent	1st Qtr	Waxing Gibbous	Full	Waning Gibbous	Last Qtr	Waning Crescent

**Brown Lunation Numbers: 1239 & 1240** (numbered from first New Moon in 1923)

**Full Moon**                      **7<sup>th</sup> March**                      **12:40 (1239)**

**Last Quarter**                      **15<sup>th</sup> March**                      **02:08 (1239)**

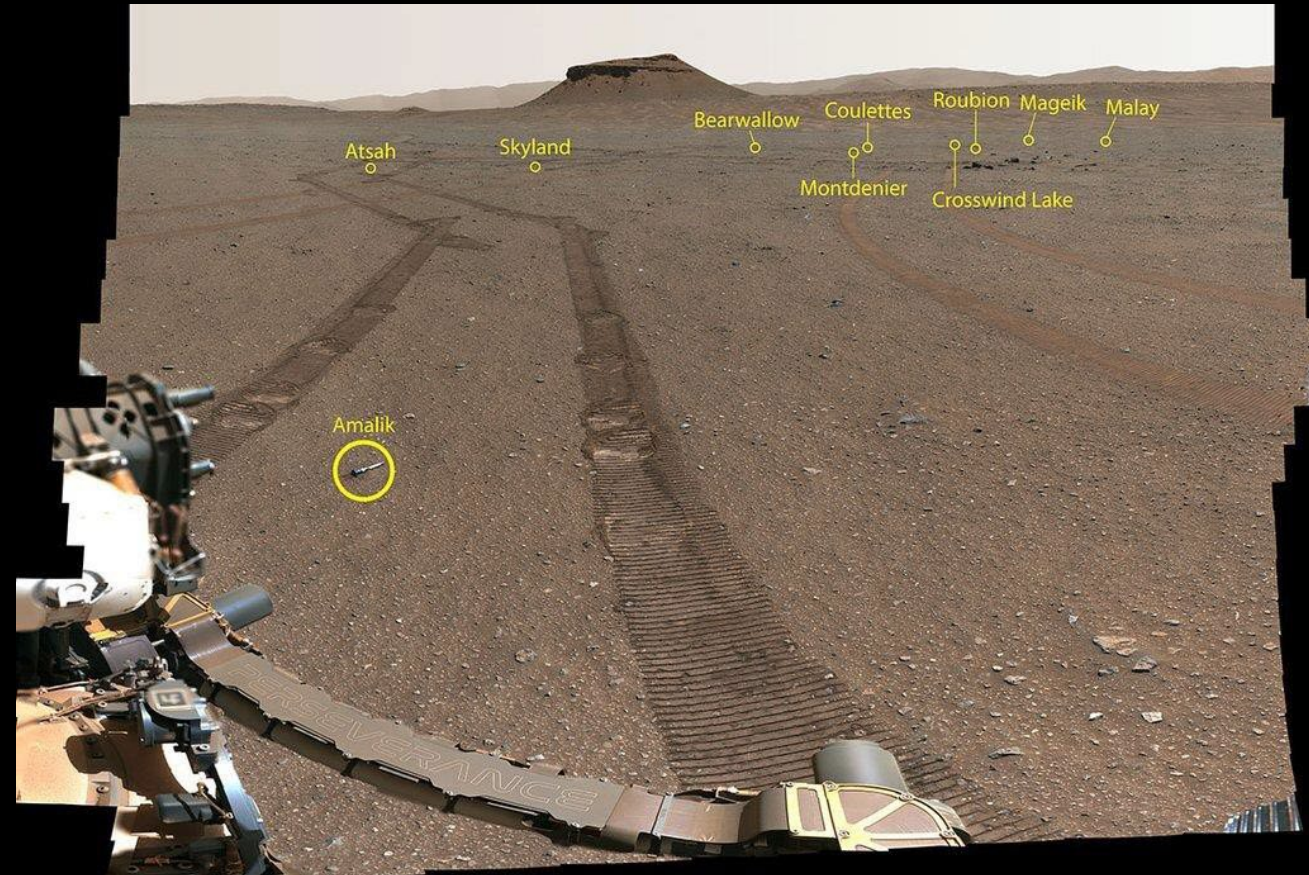
**New Moon**                      **21<sup>st</sup> March**                      **17:23 (1240)**

**First Quarter**                      **29<sup>th</sup> March**                      **03:32 (1240)**

# Lewes Astronomical Society

## Updates from January - Perseverance

- Since January the Perseverance Rover has cached another 9 samples on the surface of Mars at the “Three Forks” location
- These 10 samples act as the back-ups in case the primary collection (17 in total), stored on the rover, cannot be retrieved
- The nearest sample is “Amalik” about 3 metres from the rover whereas the furthest, “Malay”, is about 60 metres away



Credit: NASA/JPL-Caltech/ASU/MSSS



# Lewes Astronomical Society

**Friday 10<sup>th</sup> March 2023**

*“An Introduction to Astrophotography”*

Arlington village hall, @ 8pm - strictly members only (courtesy of EAS)

**Wednesday 5<sup>th</sup> April 2023**

*“Archaeoastronomy: how the people of the past used the sky to navigate their lives and deaths”*

Carina Garland, Lewes town hall, guests welcome

**Wednesday 3<sup>rd</sup> May 2023**

*“A personal journey into astronomy and imaging”*

Doug Edworthy (FRAS), Lewes town hall, guests welcome

[www.lewesas.org.uk](http://www.lewesas.org.uk)