NWASNEWS

Volume30 Issue 6

February 2024

Newsletter for the Wiltshire, Swindon, Bath Astronomical Societies

Getting Ready For Messier Marathon

A Hall meeting tonight.

Our speaker needs more time to compile his talk so will be giving a talk in hall in May.

Instead we will be having a discussion about the Messier Marathon. I have a PDF I can put on line that is a finder guide in the order of observation.

The next two, March and April will be Zoom meetings.

Clear skies.

Andy Burns.

Always a favourite to pick up in the last of the winter skies is the Pleiades cluster. Or Messier 45.
The nebulae surrounding the young blue stars are lit up by the star light and so are reflection nebulae.
But the best of this cluster is to seen through humble binoculars or small refractor telescopes.
A full description is in last month's constellation of the month page of the newsletter.
Photo: Andy Burns
Nikon D810A, 5x30second exposures through 125mm Esprit Skywatcher.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Facebook members page: https://www.facebook.com/groups/wiltshire.astro.society/

Meetings 2023

HALL VENUE the Pavilion, Rusty Lane, Seend

Some Speakers have requested Zoom Meetings will be stay at home sessions.

Meet 7.45 for 8.00pm start

SEASON 2023/24

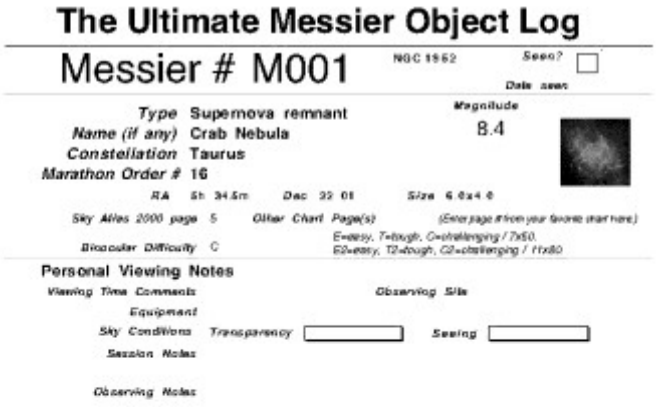
2024
January 2nd Zoom Meeting Paul Money
February 6th Hall Meeting: Andy Burns: The Messier Marathon Discussion.
March 5th Zoom: Tony Vale: Variable Stars
April 2nd Zoom: Andy Burns: The Spring Skies. Galaxy season!
May 7th Hall Meeting, Possibly Rob Lucas Building a Garden observatory
June 4th:

Zoom meeting details for log on will be sent out and published the Sunday before the meeting.
AWAITING A SPEAKER SECRETARY FOR 23/24 SEASON

The Messier Marathon

This weekend is early new Moon to catch some of the harder to see objects in the western sky before sunset. March the 10th will be the better weekend to attempt the ‘Messier Marathon’.

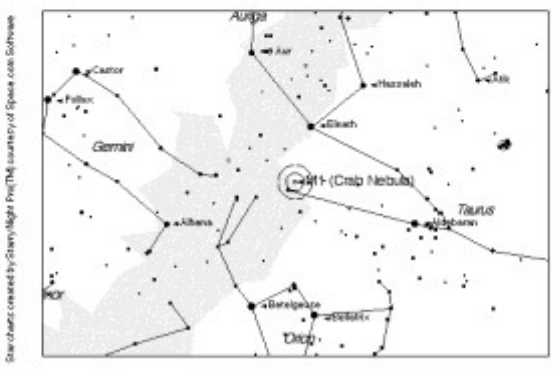
We have a PDF booklet we can hand out.


The Ultimate Messier Object Log

Messier # M001 NGC 1952 Seen? Date seen

Type Supernova remnant
Name (if any) Crab Nebula
Constellation Taurus
Marathon Order # 16
Magnitude 8.4
RA 5h 34.5m Dec 22 01 Size 6.0x4.0
Sky Atlas 2000 page 5 Other Chart Page(s) (Enter page # from your favorite chart here)
Binocular Difficulty C E=easy, T=tough, C=challenging / 7x50, E2=easy, T2=tough, C2=challenging / 11x80

Personal Viewing Notes
Viewing Time Comments Observing Site
Equipment
Sky Conditions Transparency Seeing
Session Notes
Observing Notes

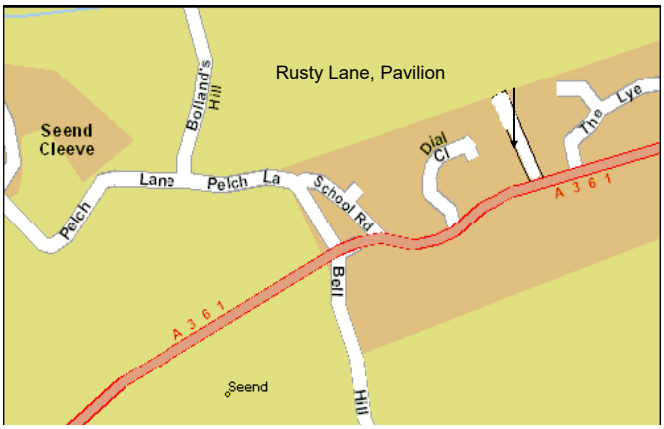


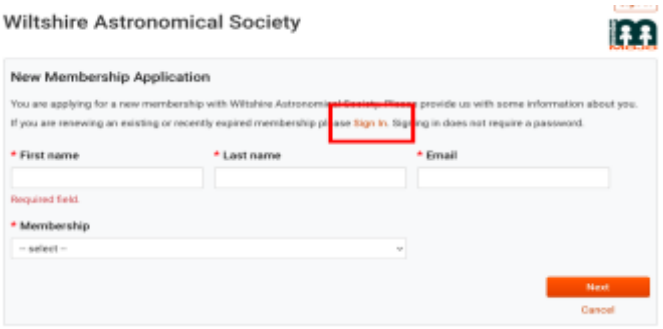
Membership Meeting nights £1.00 for members £3 for visitors

Members can renew or new members sign up online via https://wasnet.org.uk/membership/ and also remind them they can pay in cash too on the door.

Wiltshire AS Contacts

Chairperson:
Outreach coordinator:
Newsletter/Publicity
Treasurer and Membership: Sam Franklin
Hall coordinator:
Live Meeting Supplies
Speaker secretary
Zoom session coordinator
Observing Sessions coordinators: Chris Brooks, Jon Gale,
Web coordinator: Sam Franklin
Contact via the web site details.





Observing Sessions see back page

Swindon's Own Astronomy Group

Physical meetings
The club meets in person once per month.

Online Meetings
Once per month to discuss equipment and techniques.

Friday, 16th February 2024:
The Lunar 100 by Jonathan Gale

The Lunar 100 (L100) is a list of one hundred of the most interesting features to observe on the Moon. The list was first described by Charles A. Wood in the article The Lunar 100 in Sky & Telescope magazine, April 2004.

With this selection, Wood tried to give astronomy fans a list similar to the Messier catalogue of deep-sky objects, but of a more familiar object, the Moon. The objects listed include craters, seas, mountains and other features, and are arranged in ascending order of observational difficulty.

Jonathan has been interested in astronomy from childhood but has been a practical observer since 2006. I have known him since I started in astronomy, especially in connection with the Salisbury Plain Observing Group and we spent a few good cold nights observing on Salisbury Plain,

He is a member of the Webb Deep Space Society and his talk is on the Lunar 100.

Ad-hoc viewing sessions

Regular stargazing evenings are organised near Swindon. The club runs a WhatsApp group to notify members in advance of viewing sessions, usually at short notice. Anyone can call a viewing. To join these events please visit our website.

Information about our evenings and viewing spots can be found below:
http://www.swindonstargazers.com/noticeboard/noticeboard06.htm

Meetings at Liddington Village Hall
Church Road, Liddington, SN4 0HB
7.30pm onwards

The hall has easy access from Junction 15 of the M4, a map and directions can be found at:
http://www.swindonstargazers.com/clubdiary/directions01.htm

Following Meeting Dates

Friday, 15 March 2024 @ 19:30
Club AGM

Friday, 19 April 2024 @ 19:30
Michael Perriman: Gaia and Advances in our Understanding of the Galaxy

Friday, 17 May 2024 @ 19:30
Kate Earl: Magnetars – The Beauty behind the Beast

Friday, 21 June 2024 @ 19:30
Mary McIntyre FRAS: Shadows in Space and the Stories they tell.

Website:
http://www.swindonstargazers.com

Chairman: Damian OHara
Email: swindonstargazers@duck.com

Secretary: Hilary Wilkey
Email: hilary@wilkey.org.uk
Address: 61 Northern Road
Swindon, SN2 1PD

BECKINGTON ASTRONOMICAL SOCIETY

Sadly the Beckington Astronomical Society is closing its regular society.

STAR QUEST ASTRONOMY CLUB

This young astronomy club meets at the
Sutton Veny Village Hall.
Second Thursday of the Month.
Meet at Sutton Veny near Warminster.

BATH ASTRONOMERS

A friendly community of stargazers and enthusiastic astronomers who share experiences and know-how. They offer an extensive outreach programme of public and young people's observing and activities. As a partner with Bath Preservation Trust, they are the resident astronomers at the Herschel Museum of Astronomy, Bath. They also partner with Bath Abbey to showcase the skies above the city both day and night. Bath Astronomers operate a 5m mobile planetarium which they take to schools and community events to present the night sky even when the clouds mask the starry sky.

Gatherings and talks are held on the last Wednesday of each month at 7:30pm at the Herschel Museum of Astronomy (excluding December, July, and August) and are of 90 minutes duration or so.

Next Meetings:

Wednesday, 28th February 2024

Members' Night. A series of short talks by members about their interests and astronomy hobby. This meeting will be held at the Herschel Museum of Astronomy, 19 New King Street, Bath.

More information and news are available via:

https://bathastronomers.org.uk

https://www.youtube.com/@bathastronomers

On Social Media (Facebook, Twitter, Instagram, Threads, Mastodon, Bluesky)
as **@BathAstronomers**

https://stem.bathastronomers.org.uk/ for shared outreach materials

Public stargazing is scheduled twice a month on Saturday evenings as well as during school holidays to promote astronomy in Bath and Somerset area. Locations vary to bring telescopes to local communities.

Members' observing is conducted from the Monkton Combe Community Observatory using the Victorian refractor and more modern telescopes. We try to avoid school nights but will run member's sessions when the clouds look like they'll recede long enough to align a Goto telescope.

Get in touch by
email hello@bathastronomers.org.uk whether you'd like to find out more, pop in for a visit, share the stars , or have Bath Astronomers visit your school, young persons' group (rainbows, beavers, brownies, cubs, guides, scouts, rangers etc) or your community. The Coordination Team of Julia, Martin, Meyrick, Prim and Simon will be happy to help you.

SPACE NEWS

Half the Entire Sky, Seen in X-Rays

There's an old trope in science fiction about someone suddenly getting X-ray vision and looking through solid objects. It turns out to be a physical impossibility with our Mark I eyeballs. However, astronomers have found a way around that challenge that lets us study the Universe with X-ray vision. It's called x-ray astronomy and it's been around for 60 years. It reveals some of the most energetic and violent events and objects in the cosmos. Those include things like bright quasars, supernova explosions, streams of hot gas between galaxies, and hot, young stars.

Recently, astronomers in the eROSITA consortium at the Max Planck Institute for Extraterrestrial Physics announced the latest trove of X-ray data from the eROSITA survey. It covers half the X-ray sky and reveals information about 900,000 distinct X-ray sources. That's more than all the ones ever detected in X-ray astronomy's decades of history, including discoveries made with Chandra and other orbiting observatories.

About eROSITA

eROSITA is a soft x-ray imaging telescope aboard the Spectrum-RG satellite. Its first all-sky survey, called eRASS1, took place over 7 months beginning on December 12, 2019. At its most sensitive setting, the telescope detected 170 million X-ray photons. That allowed the cameras to measure their energies and arrival times.

The astronomy team, led by principal investigator Andrea Merloni, put together a first-release catalog of data. They also published more than 50 new science papers based on their findings. After finishing this first survey, the instrument carried out three more scans of the entire sky between June 2020 and February 2022. That huge treasuring of x-ray data will be released shortly. The video below explains more about the mission.

eROSITA's Treasury of X-ray Sources

X-ray astronomy focuses on hot and energetic objects and events in the Universe. Those would be the cores of galaxies (where supermassive black holes lurk), supernova explosions, newborn stars, and other places where matter gets heated to high temperatures.

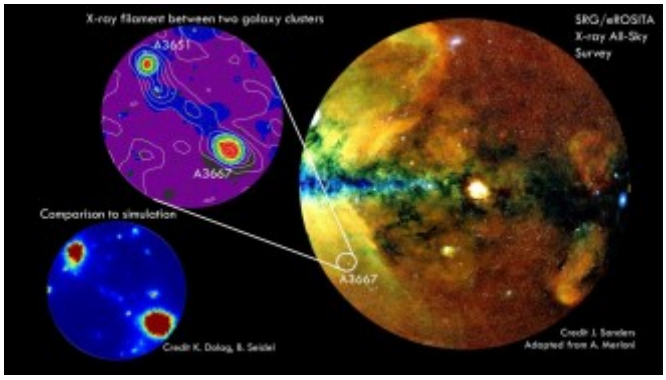
This preliminary data eRASS1 data set pinpoints about 710,000 supermassive black holes, 180,000 x-ray emitting stars in the Milky Way, and 12,000 clusters of galaxies. It also covers a small number of other exotic sources like X-ray -emitting binary stars, supernova remnants, pulsars, and other objects.

"These are mind-blowing numbers for X-ray astronomy," says Andrea Merloni, eROSITA principal investigator and first author of the eROSITA catalog paper. "We've detected more sources in 6 months than the big flagship missions XMM-Newton and Chandra have done in nearly 25 years of operation."

The eROSITA first data release is a rich, "multi-layered" look at the sky at several X-ray energies. Each energy level tells astronomers something about the objects and events emitting the X-rays. And, for each set of images and data, the consortium provides more information. There are lists of source classes, sky positions, energies, and precise arrival times of the photons to the instrument. "We've made a huge effort to release high-quality data and software," added Miriam Ramos-Ceja, who leads the eROSITA Operations team. "We hope this will broaden the base of scientists worldwide working with high-energy data and help push the frontiers of X-ray astronomy."

Zeroing in on Specific X-ray Objects

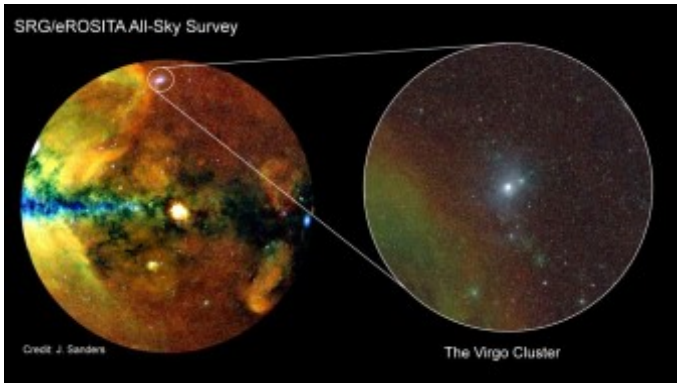
eROSITA's science objectives are to use X-rays as a way to detect the hot intergalactic medium of 50 to 100,000 galaxy clusters and groups. It also looks at hot gas in filaments between them. Those filaments glow in X-rays. The instrument is also tasked with detecting accreting black holes hidden in galaxies. Finally, it studied the physics of galactic X-ray sources (which include pre-main-sequence stars, supernova remnants, and X-ray binaries).



eROSITA X-ray image with the newly discovered filament between two galaxy clusters. The distribution of galaxies (white contours, upper left), as seen from the *Two Micron All Sky Survey,* follows the structure of the filament. In the *SLOW* simulation, which is tailored to reproduce the main features of the Local Universe, this individual system with both clusters and the filament spine is reproduced as well.

Credit: Dietl et al. (2024)

At least one of the papers released with the new survey data uses x-ray data to constrain cosmological models using clusters of galaxies. In one release image, we see a newly discovered filament of material. It stretches between one portion of the galaxy cluster Abell 3667 and the nearby cluster Abell 3651. This may help astronomers determine how much matter exists in the so-called "warm-hot intergalactic medium". It gives insight into the formation of large-scale structures (like galaxy clusters) in the Universe.



This X-ray image shows the full extent of the Virgo Cluster in X-rays as seen by eROSITA. The bright white spot at the center is the central galaxy M87. The hazy white glow around M87 is the very hot gas between galaxies. It extends out more in some directions than others, and isn't circular. This is evidence that the Virgo Cluster is still in the process of forming. Credit: McCall al. (2024)

The nearby Virgo Cluster of galaxies also shows up in the eRASS1 survey and provides a way to study large-scale filamentary structures. In particular, astronomers want to understand the physical effects operating in the outskirts of these massive galaxy clusters. Using the new survey data, plus other all-sky images, a science team explored the structure of the cluster's outskirts. That included high-energy emissions around galaxies and groups within the cluster. They also studied a so-called 320-kiloparsec-long "x-ray extension" near the galaxy M49.

eROSITA's Past Work and Future

eROSITA has enabled a huge leap forward in X-ray astronomy since its launch in June 2019. It began operations in October of that year, providing high-resolution X-ray vision of the cosmos. As it scanned the sky, it glimpsed changes in a distant quasar called SMSS J114447.77-430859.3. Those changes give some clues to the growth of the black hole at the heart of the quasar. It observed changes in the brightness variations at the heart of the quasar, indicating that the black hole swallows some of the material that strays into its

event horizon. Other material escapes in the form of powerful winds.

The instrument has also detected a newly forming black hole in the early Universe and traced the existence of hot gas all around our own Milky Way Galaxy. The instrument had its first light on October 22, 2019. Currently, it's in safe mode and technicians are assessing its health and status.

For More Information

eROSITA

eROSITA Science Papers

The X-ray Sky Opens to the World

Discovery of a >13 Mpc long X-ray filament between two galaxy clusters beyond three times their virial radii

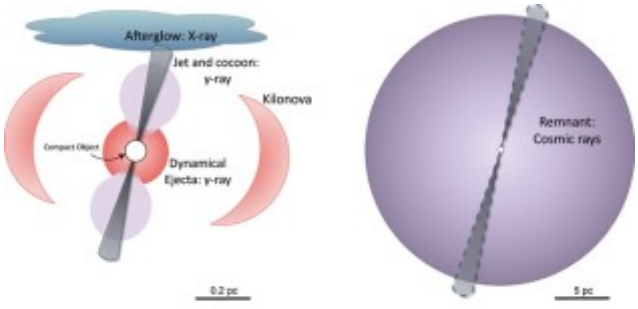
The SRG/eROSITA All-Sky Survey: View of the Virgo Cluster

How Dangerous are Kilonovae?

When we look up at the sky on a particularly dark night, there is a sense of timelessness. We might see the flash of a meteor, and occasionally a comet is visible to the naked eye, but the cold and distant stars are unchanging. Or so it seems. There can also be a sense of calm, that despite all the uncertainty of the world, the stars will always watch over us. So it's hard to imagine that light years away there could be a lurking event that poses an existential threat to humanity. That threat is extremely tiny, but not zero, and it is the focus of a recent paper published in *The Astrophysical Journal*.

The study focuses on kilonovae, which can occur when either two neutron stars collide, or a neutron star collides with a stellar-mass black hole. Kilonovae are similar to supernovae, but much more intense. In the paper, the authors look at a particular kilonova known as GW170817. It was detected by the LIGO and Virgo gravitational wave observatories in 2017, and seen as a gamma-ray burst by the Fermi and INTEGRAL space telescopes. Since we have both optical and gravitational observations, the energy of the kilonova can be calculated quite well.

The team took this data and combined it with computer simulations on kilonovae. They wanted to estimate the minimum safe distance of a kilonova. In other words, how close to us could one go off and still be a harmless light show? What they found was that there are several safe distances, depending on which aspect of the supernova poses a threat.



Diagrams of emissions from a binary neutron star merger. Credit: Perkins, et al

One threat would be the X-ray afterglow. When neutron stars collide, a jet of high-energy gamma rays can stream from their common polar region. These jets collide with interstellar gas and create an afterglow of intense X-rays. The intensity of this glow could ionize Earth's atmosphere, leaving us exposed to things like solar flares and ultraviolet radiation. But only if the kilonova occurred within about 16 light-years of Earth. The gamma rays themselves could pose a similar threat, but only to within about 13 light-years.

But as the team found, the greater threat wouldn't reach us at the speed of light. After the explosion, a shockwave from the collision would expand away from the kilonova over the span of about a thousand years. When the shockwave collides with interstellar gas and dust, it creates intense cosmic rays. If such a stream of cosmic rays reached us it could vaporize our atmosphere, killing almost all life on Earth. But this would only pose a threat to a distance of about 40 light-years.

GW170817 occurred about 130 million light-years away, so it poses absolutely no threat to us. Even if one were to occur in our stellar neighborhood, it would likely be too distant to pose any harm. As far as we know, there are no binary neutron stars within 40 light-years that will merge any time soon. So there is nothing for us to worry about. Mostly what this study shows is that throughout the cosmos kilonovae can pose a threat to life from time to time, but that threat is not large enough to wipe out a large fraction of worlds. We can face cosmic dangers, but thankfully a kilonova isn't one of them.

Reference: Perkins, Haille ML, et al. "Could a Kilonova Kill: A Threat Assessment." *The Astrophysical Journal* 961.2 (2024): 170.

Japan Moon Lander Sleeps After Sending Science — Will It Wake Up Again?

After a few days of wakefulness, Japan's SLIM moon lander has gone dormant once more at the start of a 14-day-long lunar night. The upended robot sent back a stream of data and imagery while its solar cells were in position to soak up sunlight, and its handlers hope they can get SLIM to wake up again and resume its work after lunar sunrise in mid-February.

The car-sized robot accomplished its primary mission on Jan. 20 (Japan time) when it landed within 100 meters of its target point near Shioli Crater. SLIM — which is an acronym standing for "Smart Lander for Investigating Moon" — was designed to demonstrate a precision landing technique that Japan hopes to use for future missions to the moon and Mars.

Unfortunately, the lander ended up in an upside-down position, with its solar cells pointing off to the side. Mission managers were able to get some data and pictures back — including a photo captured by a mini-robot that documented the lander's predicament. But within hours, the lander's batteries ran down to the point that SLIM had to go into hibernation. The mission team could only hope that as the sun moved westward in the lunar sky, enough light would eventually hit the panels to allow for a reawakening.

That's exactly what happened on Jan. 28: The Japan Aerospace Exploration Agency, a.k.a. JAXA, re-established contact with the charged-up SLIM and commanded the lander to transmit a set of multispectral images showing the area around the landing site — including a variety of rocks named after canine breeds, such as Bulldog, Toy Poodle and Aki Inu.

This Japanese-language posting shows a variety of rocks around the lander, plus a closeup focusing on a rock that was named Aki Inu.

SLIM's recent science-gathering session was limited to just a few days due to the moon's day-night cycle. By the time the lander's solar cells soaked up enough sunlight, it was the equivalent of late afternoon on the moon. Sunset came on Feb. 1, and once again, SLIM went into hibernation.

"We sent a command to switch on SLIM's communicator again just in case, but with no response, we confirmed SLIM had entered a dormant state," the mission team at the Japan Aerospace Exploration Agency said in a posting on X / Twitter.

The final image sent back by the lander shows a dark stretch in the foreground, with the sun's dying rays reflecting off rocks and off the heights of a ridge rising in the background.

Temperatures were expected to fall to somewhere around 200 degrees below zero Fahrenheit (-130 degrees Celsius) during the lunar night. JAXA initially had planned to let the lander go dead when the sun went down — but in light of the unlucky lander's recent resilience, those plans could change.

"Although SLIM was not designed for the harsh lunar nights, we plan to try to operate again from mid-February, when the sun will shine again on SLIM's solar cells," mission managers said.

Space Junk is Going to be a Problem for Vera Rubin

The Vera Rubin Observatory (VRO) is different than other large telescopes, and that difference makes it more vulnerable to space junk. Other telescopes, like the Giant Magellan Telescope and the European Extremely Large Telescope, focus on distant objects. But the VRO's job is to repeatedly image the entire available night sky for ten years, spotting transients and variable objects.

All that space junk can look like transient events, impairing the VRO's vision and polluting its results.

In a new research note awaiting publication, Harvard physicist/astronomer Avi Loeb points out how space junk will affect the VRO's work. The paper is "Flares from Space Debris in LSST Images." LSST is the Legacy Survey of Space and Time, the VRO's primary observing effort.

The problem stems from space junk and also the VRO's extreme sensitivity, a critical part of its success. "Owing to the exceptional sensitivity of the Vera C. Rubin Observatory, we predict that its upcoming LSST images will be contaminated by numerous flares from centimetre-scale space debris in Low Earth Orbits (LEO)," Loeb writes. "Millisecond-duration flares from these LEO objects are expected to produce detectable image streaks of a few arcseconds with AB magnitudes brighter than 14."

This NASA video is a representation of space junk orbiting Earth. The debris is obviously not scaled to Earth, but it shows where the greatest orbital debris populations are. Credit: NASA.

Our space junk problem is getting worse, as everyone knows. The ESA says that as of December 6th, 2023, there are 130 million objects in the size range of 0.1-1 cm orbiting Earth. There are also one million objects between 1-10 cm and 36,500 objects larger than 10 cm. With so many launches, the problem is getting worse. Space is a burgeoning economy, and a certain amount of junk goes with it.

Not all of those objects are in the critical Low-Earth Orbit region, but a large subset of them are. According to Loeb, this population of debris has implications for the VRO. "In this Note, we examine the implications of this LEO debris for the upcoming Legacy Survey of Space & Time (LSST) of the Vera C. Rubin Observatory in Chile," Loeb writes.

When it comes to the VRO's images, it's not really the size of the debris that matters. An object's albedo is the real problem. Albedo can scale with size, but not always.

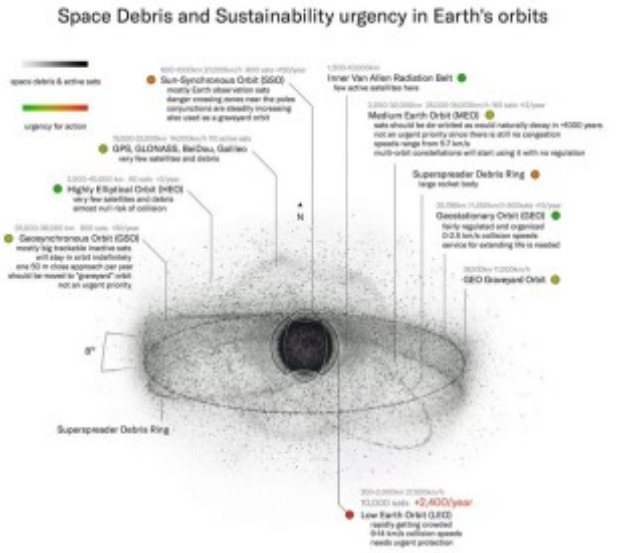
There's no way to measure the individual albedos of pieces of space junk, but in this work, Loeb calculates albedo by combining an object's radius and distance with one of its sides illuminated by the Sun. That yields the fraction of light that it will reflect.

We already know how space junk can reflect light because we can see it with the Zwicky Transient Facility. It's similar to the VRO in that it detects transient light sources. "Data from the Zwicky Transient Facility (ZTF) shows that the sunlight glints from known LEO satellites generate flashes of duration $10^{?3\pm0.5}$ s." That's an extremely brief flash.

But the VRO and its LSST will visit each patch of the sky for 30 seconds and take back-to-back 15-second exposures. The problem is that debris is moving, and rather than just a flash, it creates a streak. "The light from the flares is therefore expected to spread across no more than a few arcseconds, independently of the LSST exposure time which is 4 orders of magnitude longer," Loeb writes.

What does that mean for the VRO?

It's not good. According to Loeb, the number of objects that can create problematic streaks "exceeds by an order of magnitude" the number of large satellites orbiting Earth. USA's Space Surveillance Network regularly tracks satellites and has built a catalogue of orbiting objects that could help the VRO manage the problem. But as Loeb points out, "Out of the entire debris population, only 3.515×10^4 (351,500) objects are regularly tracked and catalogued by Space Surveillance Networks."



This infographic shows the populations of satellites in different orbits and how urgent it is to clean these orbits. Note the LEO "needs urgent protection," according to the maker. While it's primarily about satellites, it drives the space debris problem point home. Image Credit: By Pablo Carlos Budassi – Own work, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=140585562

Streaks of light in images are only part of the problem. There's the more generalized problem of the combined light from all satellites and debris. Other researchers have examined the problem and its effects on ground-based astronomy. A March 2023 paper in Nature Astronomy showed that by 2030, reflected light from space junk and functioning satellites will increase the diffuse background brightness for the VRO by 7.5%. That means the VRO's LSST will be 7.5% less efficient. That'll add over $20 million US to the cost of the 10-year-long LSST.

Satellites and their predictable orbits mean they should be easier to deal with. In fact, the LSST team has a plan to deal with satellites. They propose an updated scheduler that can mitigate the problem. "Overall, sacrificing 10% of LSST observing time to avoid satellites reduces the fraction of LSST visits with streaks by a factor of 2," the authors of a paper in The Astrophysical Journal Letters write.

But junk is far more abundant. Without a solution, will LSST images be littered with noisy streaks?

It seems irrational to download the responsibility for space debris to the people trying to see the sky through it. Any long-term solution has to include two things: the cleaning up of Low Earth Orbit and an international agreement to stop polluting it even further.

The ESA is coming to terms with the space debris problem. "130 million pieces of space debris larger than a millimetre orbit Earth, threatening satellites now and in the future," the ESA wrote when announcing their Zero Debris Charter. "Once a week, a satellite or rocket body reenters uncontrolled through our atmosphere. Behaviours in space have to change." While the Charter is primarily aimed at reducing the risk of collisions, it will benefit ground-based astronomy.

NASA is seeking solutions, too. Their Detect, Track, and Remediate: The Challenge of Small Space Debris competition is reaching out to people around the globe for innovative solutions to the problem.

Those are great initiatives, but the VRO is scheduled to see its first light in early January 2025. A solution to the problem of satellites and satellite constellations in space is likely within reach. But debris is a much thornier problem.

"However, the above numbers suggest that image contamination by untracked space debris might pose a bigger challenge," Loeb concludes.

Torbjorn Larsson
"That means the VRO's LSST will be 7.5% less efficient. That'll add over $20 million US to the cost of the 10-year-long LSST."
Active satellites aren't junk, of course. And if it is now a signal out problem rather than a signal-to-noise problem which it was initially believed to be – algorithms can now identify streaks – the global satellite services can easily pay for their share. It will take a 1/10,000 bit out of their revenue.
"This year's report shows that the global space economy continues to thrive. In 2022, it generated $384 billion in revenues, with the commercial satellite industry contributing $281 billion of that total?a whopping 73% of the space business." [2023 SIA Report]

Betelgeuse. Before, During and After the Great Dimming

When a prominent star in the night sky suddenly dims, it generates a lot of interest. That's what happened with the red supergiant star Betelgeuse between November 2019 and May 2020. Betelgeuse will eventually explode as a supernova. Was the dimming a signal that the explosion was imminent?
No, and new research helps explain why.
Headline writers couldn't resist the supernova angle, even though that explanation was never very likely. Eventually, it became clear that ejected dust from the star caused the dimming. New research based on observations before, during, and after the Great Dimming Event (GDE) supports the idea that dust from the star itself caused Betelgeuse's drop in brightness.
A research letter titled "Images of Betelgeuse with VLTI/MATISSE across the Great Dimming" presents the infrared observations of Betelgeuse. The observations capture the star before, during, and after the GDE. The lead author is Julien Drevon, from the Université Côte d'Azur, France, and the European Southern Observatory.
"To better understand the dimming event, we used mid-infrared long-baseline spectro-interferometric measurements of Betelgeuse taken with the VLTI/MATISSE instrument before (Dec. 2018), during (Feb. 2020) and after (Dec. 2020) the GDE," the research letter states. In particular, their observations focus on silicon monoxide (SiO.)
The authors of the new research outline three steps in the process that created the GDE.

Step One

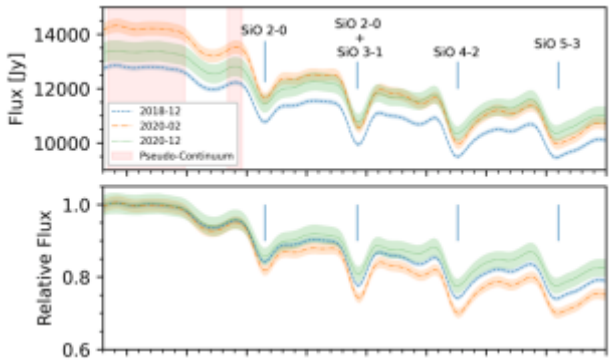
The GDE started with shocks deep inside Betelgeuse. They generated a convective outflow of plasma that brought material to the star's surface. Researchers detected a strong shock in February 2018 and a weaker one in January 2019. The second, weaker shock boosted the effect of the stronger shock that preceded it, generating a progressive plasma flow at the surface of Betelgeuse's photosphere.

Step Two

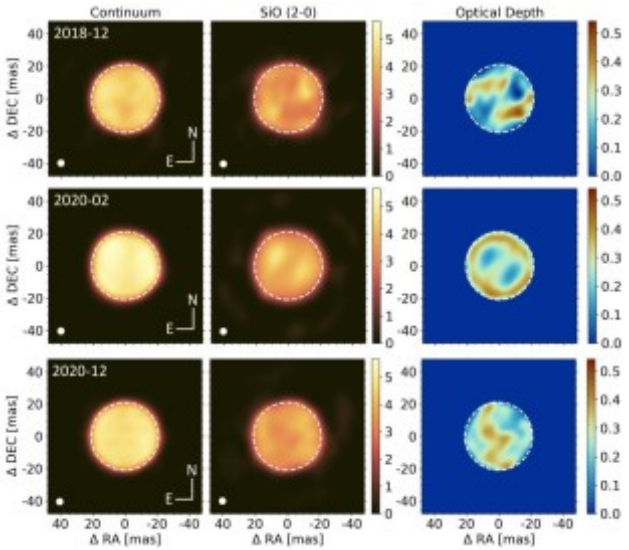
The plasma flowing to the photosphere's surface created a hot spot. Hubble UV observations of Betelgeuse revealed the presence of a luminous, hot, dense structure in the star's southern hemisphere, between the photosphere and the chromosphere.

Step Three

Stellar material detaches from the photosphere and forms a gas cloud above Betelgeuse's surface. A colder region forms under this cloud as a dark spot. Since it's cooler, dust is allowed to condense above this region and in the part of the cloud above it. That dust is what blocked some of Betelgeuse's luminosity, causing the GDE.
Previous research revealed this three-step process behind the GDE. The authors of the new research article set out to observe Betelgeuse's close circumstellar environment to probe and monitor its geometry. In the wavelength range they worked in, SiO spectral features are prominent, and they're used to understand what happened with the red supergiant. In astronomy, SiO is used as a tracer for shocked gas in stellar outflows since it persists at high temperatures.



This figure from the research letter shows some of the data the researchers worked with. The top panel shows the absolute spectra during each observed epoch. The bottom panel shows the relative flux for the SiO bands. The bands are deeper during the GDE than either before or after. Image Credit: J. Drevon et al. 2024.
In their article, the authors focus on the SiO (2-0) band and what it signifies. They note how the band's intensity contrast increases by 14% during the GDE. "Therefore, it seems that during the GDE, we observe brighter structures in the line of sight," they explain.
Next, they note a 50% decrease in intensity contrast in December 2020. What does it mean?
"The SiO (2–0) opacity depth map shows, therefore, strong temporal variations within 2 years, indicative of vigorous changes in the star's environment in this time span," they write.
Their observations also suggest "the presence of an infrared excess in the pseudo continuum during the GDE, which has been interpreted as new hot dust formed," Drevon and his colleagues write.



This figure from the research article explains some of what the researchers found. The middle column is particularly interesting because it's a reconstruction of the SiO (2-0) absorption band onto Betelgeuse's surface for each of the three observed epochs. The third column is similar but shows the SiO (2-0) optical depth. Overall, they constrain the geometry of the dust feature that caused the GDE. Image Credit: J. Drevon et al. 2024.
It seems like the Great Dimming is no longer the mystery it once was. It also shows that Occam's Razor is alive and well: *"The explanation that requires the fewest assumptions is usually correct."*
The supernova proposal was fun for a while, and one day, Betelgeuse will explode as a supernova. But before it ever does, there are likely going to be several more episodes of dimming

For now, the authors say that the star is returning to normal. "The Dec. 2020 observations suggest that Betelgeuse seems to be returning to a gas and surface environment similar to the one observed in Dec. 2018," they write, "but with smoother structures, maybe
due to the unusual amount of dust recently formed during the GDE in the line of sight."
Case closed?

Astrobiology: Why study it? How to study it? What are the challenges?

Universe Today has proudly examined the importance of studying impact craters, planetary surfaces, and exoplanets, and what they can teach scientists and the public about finding life beyond Earth. Impact craters both shape these planetary surfaces and hold the power to create or destroy life, and we learned how exoplanets are changing our views of planetary formation and evolution, including how and where we might find life in the cosmos. Here, we will discuss how these disciplines contribute to the field responsible for finding life beyond Earth, known as astrobiology. We will discuss why scientists study astrobiology, also known as astrobiologists, challenges of studying astrobiology, and how students can pursue studying astrobiology, as well. So, why is it so important to study astrobiology?

Dr. Manasvi Lingam, who is an astrobiologist and assistant professor in the Department of Aerospace, Physics and Space Sciences at the Florida Institute of Technology, tells *Universe Today*, "Astrobiology deals with some of the deepest questions that have fascinated humankind for millennia: Where did we come from? Are we alone? Where are we going?"

The unofficial definition of astrobiology is "the study of life in the universe". While this is often interpreted as
life *beyond* Earth, it actually *includes* Earth. Previously, we learned how planetary geologists use Earth as an analog for studying planetary surfaces on other worlds, and astrobiologists also use Earth—which is the only planet known to have life—as an analog for trying to find life on other worlds, as well. They examine the myriad of processes that take place for life to both exist, survive, and thrive on our small, blue world, and ask whether these same processes could be responsible for life existing on other worlds, not just in our solar system, but throughout the universe. Therefore, what are some of the challenges of studying astrobiology?

"Astrobiology is an inherently multidisciplinary and transdisciplinary subject," Dr. Lingam tells *Universe Today*. "Hence, it requires acquiring a considerable base of knowledge, and then synthesizing that knowledge in a meaningful fashion."

What makes the field of astrobiology unique is that it involves a myriad of scientific disciplines and backgrounds. These disciplines include astronomy, astrophysics, biology, chemistry, computer science, geology, physics, and planetary science, who use fieldwork, laboratory studies, and computer models and come together with the common goal of both better understanding life on Earth and how we can find it beyond Earth, as well. A specific aspect of astrobiology that has taken root in the last few years is the study of extremophiles, which is life that can both survive and thrive in environments too extreme for both humans and most of life on the Earth. These extremophiles have been found to live in extreme heat, cold, salinity (salt), and pressure environments. But what has been the most exciting aspect of astrobiology that Dr. Lingam has studied throughout his career?

"I have enjoyed all areas of astrobiology that I have worked on," Dr. Lingam tells *Universe Today*. "Some recent highlights include: (1) understanding how information sensing and transmission in varied environments may have shaped the origin and evolution of life; (2) formulating novel detectable signatures of extraterrestrial technology and intelligence (i.e., technosignatures); (3) investigating how high-energy astrophysical processes (e.g., supernovae) can sterilize large portions of galaxies; (4) modeling the lifetimes of technospheres on habitable worlds."

2017 video showing Dr. Manasvi Lingam discussing how we can detect biosignatures on exoplanets.

While present technological constraints currently limit our direct search for life beyond Earth to our solar system, there are several planetary bodies that are targets for astrobiologists, including the planets Venus and Mars, along with Jupiter's icy moon, Europa, and Saturn's largest moon, Titan. Beyond the solar system, the study of exoplanets continues to shape our understanding of the formation and evolution of planets and their atmospheres, some of which exhibit characteristics that vary greatly from what we see in our solar system.

Regarding what advice Dr. Lingam can offer upcoming students who wish to pursue studying astrobiology, he tells *Universe Today*, "I would advise students to specialize in one particular area (physics in my case) — as it will be the core field through which they interface with astrobiology — while also acquiring a broad knowledge base in fields like chemistry, astronomy, biology, geology, and planetary science."

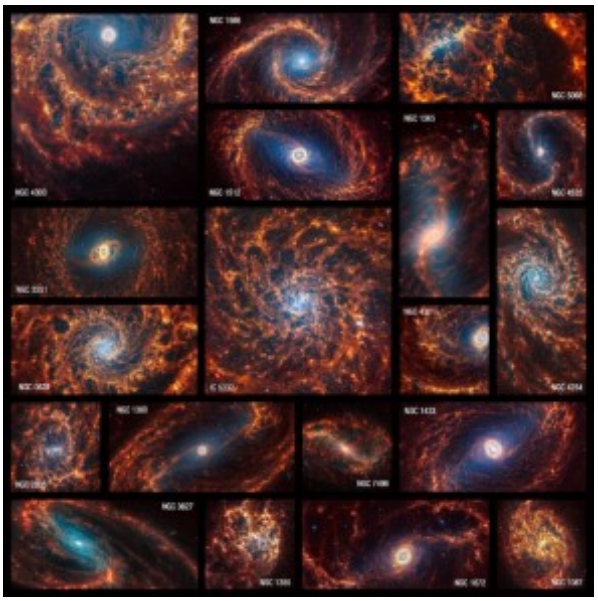
Several academic institutions in the United States offer both undergraduate and graduate programs for astrobiology, including Arizona State University, Florida Institute of Technology, Penn State University, and University of Washington. However, it might be safe to assume that any scientific degree of choice could lead to a career in astrobiology, which includes research, academia, and science communication.

Dr. Lingam concludes by telling *Universe Today*, "Carl Sagan wrote of astronomy: '*It has been said that astronomy is a humbling and character-building experience.*' This beautiful statement is even more applicable to astrobiology, which grapples with the grand theme of understanding and making sense of our place in the grand cosmic scheme of things."

How will astrobiology help us better understand our place in the universe in the coming years and decades? Only time will tell, and this is why we science!

As always, keep doing science & keep looking up!

Feast Your Eyes on 19 Face-On Spiral Galaxies Seen by Webb



These Webb images are part of a large, long-standing project, the Physics at High Angular resolution in Nearby GalaxieS (PHANGS) program, which is supported by more than 150 astronomers worldwide. Before Webb took these images, PHANGS was already brimming with data from NASA's Hubble Space Telescope, the Very Large Telescope's Multi-Unit Spectroscopic Explorer, and the Atacama Large Millimeter/submillimeter Array, including observations in ultraviolet, visible, and radio light. Webb's near- and mid-infrared contributions have provided several new puzzle pieces. Image Credit: NASA/ESA/CSA

If you're fascinated by Nature, these images of spiral galaxies won't help you escape your fascination.

These images show incredible detail in 19 spirals, imaged

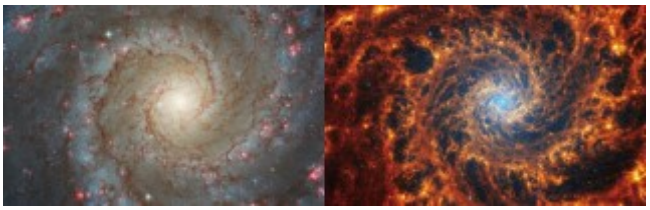
face-on by the JWST. The galactic arms with their multitudes of stars are lit up in infrared light, as are the dense galactic cores, where supermassive black holes reside.
The JWST captured these images as part of the Physics at High Angular resolution in Nearby GalaxieS (PHANGS) programme. PHANGS is a long-running program aimed at understanding how gas and star formation interact with galactic structure and evolution. One of Webb's four primary science goals is to study how galaxies form and evolve, and the PHANGS program feeds that effort. The VLT, ALMA, the Hubble, and now the JWST have all contributed to it.
But Webb's images are the juiciest.
"Webb's new images are extraordinary. They're mind-blowing even for researchers who have studied these same galaxies for decades."
Janice Lee, Project Scientists, Space Telescope Science Institute.
The JWST can see in both near-infrared (NIR) and mid-infrared (MIR) light. That means it reveals different details, and more details, than even the powerful Hubble Space Telescope, which operates in visible light, UV light, and a small portion of infrared light.

This is NGC 4254 (Messier 99), a spiral galaxy about 50 million light-years away. It has a peculiarity to it, as one spiral arm is normal looking, and one is extended and less tightly wound. Though not a starburst galaxy, it forms stars three times as fast as other similar galaxies. This rapid star formation rate may have been triggered by interaction with another galaxy about 280 million years ago. With the JWST's help, the PHANGS program will help astronomers understand NGC 4254's history. Image Credit: NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), PHANGS Team
In these JWST high-resolution images, the red colour is gas and dust emitting infrared light, which the JWST excels at seeing. Some of the images have bright diffraction spikes in the galactic center, which are caused by an enormous amount of light. That can indicate that a supermassive black hole is active, or it could be from an extremely high concentration of stars.
"That's a clear sign that there may be an active supermassive black hole," said Eva Schinnerer, a staff scientist at the Max Planck Institute for Astronomy in Heidelberg, Germany. "Or, the star clusters toward the center are so bright that they have saturated that area of the image."

The diffraction spike in the center of NGC 1365 is a telescope artifact caused by an enormous amount of light in a compact region. It's caused by either the active supermassive black hole or tightly grouped stars in the galactic centre. NGC 1365 is a double-barred spiral galaxy about 74 million light-years away. Image Credit: NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), PHANGS Team
Stars near a galaxy's center are typically much older than stars in the arms. The further a star is from the galactic center, the younger it typically is. The younger stars appear blue and have blown away the cocoon of gas and dust that they spawned in.

This is NGC 2835, a spiral galaxy about 35 million light-years away that has four or five spiral arms. Blue dots are very young stars that have blown away nearby gas and dust with their powerful UV light. Orange/red clumps are where even younger stars reside. They're still surrounded by gas and dust. Several background galaxies are visible in the image. Image Credit: NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), PHANGS Team
Orange clumps indicate even younger stars. They're still wrapped in their blanket of gas and dust and are still actively accreting material and forming. "These are where we can find the newest, most massive stars in the galaxies," said Erik Rosolowsky, a professor of physics at the University of Alberta in Edmonton, Canada.
The new images were released alongside some of the Hubble's views of the same galaxies. These highlight how ob-

serving different wavelengths of light reveals or obscures different details in the galaxies. In the PHANGS observing program, different telescopes have observed galaxies in visible light, infrared light, UV light, and radio.



A Hubble Space Telescope image of NGC 628 (left) and the same galaxy as imaged by the JWST (right.) Both images are grand and inspiring and full of information, but the JWST image provides more detail. Large bubble-shaped gaps between concentrations of gas and dust are visible. In some of the images, those could be caused by supernovae. Image Credit: NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), PHANGS Team
Since the human eye can't see infrared, different visible colours are assigned to different wavelengths of light in order to make the images meaningful. In the JWST image of NGC 628 above, the galaxy's center is filled with old stars that emit some of the shortest wavelengths of light the telescope can detect. They've been given a blue colour to make them visible. In the Hubble image, the same region is more yellow and washed out. The region emits the longest wavelengths of light that the Hubble can sense, so it has different colour assignments than the JWST.
Janice Lee is a project scientist at the Space Telescope Science Institute in Baltimore. She spoke for all of us when she said, "Webb's new images are extraordinary. They're mind-blowing even for researchers who have studied these same galaxies for decades. Bubbles and filaments are resolved down to the smallest scales ever observed and tell a story about the star formation cycle."

This is NGC 1672, a spiral galaxy about 60 million light-years away. It may be a type II Seyfert galaxy, though astronomers aren't totally certain. It has both a bright nucleus and a surrounding starburst region. Image Credit: NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), PHANGS Team
These galaxies are all spiral galaxies like the Milky Way, meaning their massive arms define them. The spiral arms are more like waves that travel through space rather than individual stars moving collectively. Astronomers study the arms because they can provide key insights into how galaxies build, maintain, and shut off star formation. "These structures tend to follow the same pattern in certain parts of the galaxies," Rosolowsky added. "We think of these like waves, and their spacing tells us a lot about how a galaxy distributes its gas and dust."

The spiral galaxy NGC 1566 is about 60 million light-years away in the constellation Dorado. NGC is interacting with smaller member galaxies in its neighbourhood. It's an active galaxy, meaning its nucleus emits a lot of light that doesn't come from stars. Instead, it probably comes from the supermassive black hole at the center. NGC 1566 is extensively studied due to its proximity, orientation, its strong spiral arms and its active galactic nucleus. Image Credit: NASA, ESA, CSA, STScI, Janice Lee (STScI), Thomas Williams (Oxford), and the PHANGS team
Ever since it began science operations, the JWST has given astronomers an overwhelming flow of data that will fuel research for years and decades to come. These beautiful images are just a part of a larger data release that includes a catalogue of about 100,000 star clusters. "The amount of analysis that can be done with these images is vastly larger than anything our team could possibly handle," said the University of Alberta's Erik Rosolowsky. "We're excited to support the community so all researchers can contribute."

Perseverance is Definitely Inside an Ancient Lake on Mars

The search for life on alien worlds has captivated us for hundreds of years. In some respect, the search for life has expanded to the search for water since it is not unreasonable to assume if there is water then there is a good chance there is life too. When NASA selected the landing site for Perseverance, they were looking for such a body of water and settled upon the Jezero Crater. Images from orbiters reveal a crater that looks like it has been filled with water in the past but further investigations were needed to confirm. Now it seems, Perseverance has risen to the challenge.
Perseverance is a car sized rover that arrived on Mars on 18 February 2021 and carried with it the innovative Ingenuity helicopter, the first powered aircraft on another world. The main objective of the mission was to identify ancient Martian

environments capable of supporting life and if possible, finding evidence of ancient microbial life through collecting rock and soil samples. Since its arrival in 2021, the rover has been travelling around the 50km wide crater studying the geology and atmosphere as it goes.

Mars Perseverence rover sent back this image of its parking spot during Mars Solar Conjunction. Courtesy NASA/JPL-Caltech

A paper recently published in Science Advances journal declares that the crater was indeed filled at some point in its geological past, with water! More that it has deposited layers of sediments on the floor of the crater which have gone through periods of erosion as the lake shrank but are now visible in space images of the region.

Although there have been nearly 3 years of operation on Mars, the really interesting stuff occurred between May and December 2022 when Perseverance drove from the crater floor onto the ancient river delta, a region believed to be 3 billion years old. During its journey, Perseverance used RIMFAX (the Radar Imager for Mars' Subsurface Experiment) to shoot radar signals into the ground every 10cm. The pulses reflected from depths of about 20metres from below the surface showing that the base of the sediment was here and they had located the top of the buried crater.

The Jezero Crater and delta. Credit NASA

The data from RIMFAX showed sediment from two distinct periods bordered by periods of erosion as the environmental factors affected the sediments. The team reported that the original crater floor was not completely flat and that erosion must have taken place prior to the deposition of the sediments in the lake.

Despite the discovery of sediments, the team have yet to identify any fossilised remains or primitive life. The journey however has just begun. Over the last few decades we have found mounting evidence that water is common across the universe. It seems to that the processes we see on Earth are also common. Perhaps then we may be permitted to assume that other processes are replicated across the Cosmos, perhaps those that lead to the evolution of life! Time will tell if this latter assumption plays out.

Source : Confirmation of ancient lake on Mars builds excitement for Perseverance rover's samples

Japan's SLIM Lander Finds Power Even Though It's Face Down

The Moon is a bit of a hot bed for exploration of late. The Japanese agency JAXA have been getting in on the act but their SLIM lander fell on its side with its solar panels pointing toward the ground. Until today, JAXA thought that was it but today it seems that they have managed to re-established contact again.

JAXA's first lunar lander known as SLIM (Smart Lander for Investigating Moon) was designed to demonstrate the ability to land on the Moon. The mission was particularly wanting to show how precision can be applied to lunar landings. During the descent, craters were identified using technology developed for facial recognition and location pinpointed by the lunar orbiter SELENE. They hoped to land with an accuracy of 100m which, in comparison to the historic Apollo 11 mission accepted a 20km range.

JAXA's H-IIA Launch Vehicle taking off from the Tanegashima Space Center. Credit: Wikipedia Commons/NARITA Masahiro

On its arrival on January 20th one of the two engines lost power so with reduced power, the landing was compromised. On touchdown it somehow slid and tumbled down the side of a crater leaving its solar panels unable to generate electricity. Reacting swiftly the team immediately commanded the lander to transmit landing data before the power ran out. As the lander sat there quietly out of power, the team waited, hoping that the batteries may recharge once other aspects of the Moon started to receive sunlight.

Fortunately during the final stages of the descent the two probes on board were successfully deployed. One of them a tiny hoping robot and the other designed to roll about the surface. Thankfully they both seemed to be working well with one image having been beamed back to show the orientation of the spacecraft on its side. Not only did the probes function well but the on board navigation camera captured images during the descent showing the rocky terrain just before touch down.

Even though the mission ended in a slightly unplanned way it still managed to land within its 100 metre target, hitting 55 metres from its identified spot. A couple of hours after touchdown the team decided to switch off the power to conserve power for a possible power up when solar energy allowed.

In a post on the company 'X' profile the team confirmed that sufficient sunlight had managed to trickle in to give the batteries enough power to boot up and operations resumed.

Atmosphere Pressure Changes Could Explain Mars Methane

One ongoing mystery on Mars is the sporadic detection of atmospheric methane. Since 1999 detections have been made by Earth-based observatories, orbital missions, and on the surface by the Curiosity Rover. However, other missions and observatories have not detected methane at all, and even when detected, the abundances appear to fluctuate seasonally or even daily.

So, where does this intermittent methane come from? A group of scientists have proposed an interesting theory: the methane is being sucked out of the ground by changes in pressure in the Martian atmosphere. The researchers simulated how methane moves underground on Mars through networks of underground fractures and found that seasonal changes can force the methane onto the surface for a short time.

In their paper, published in the Journal of Geophysical Research: Planets, the scientists say their simulations predict short-lived methane pulses prior to sunrise for Mars' upcoming northern summer period, which is a candidate time frame for Curiosity's next atmospheric sampling campaign.

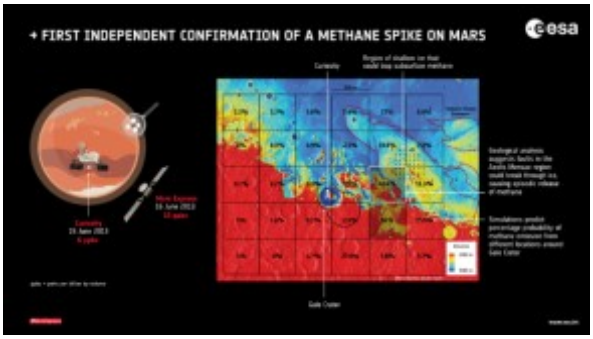
"Our work suggests several key time windows for Curiosity to collect data," said John Ortiz, a graduate student at Los Alamos National Laboratory who led the research team. "We think these offer the best chance of constraining the timing of methane fluctuations, and (hopefully) down the line bringing us closer to understanding where it comes from on Mars."

The presence of methane (CH_4) in the Martian atmosphere is of great interest to planetary scientists and exobiologists because it could indicate present or past microbial life. Or, it could also be related to nonbiological processes, such as volcanism or hydrothermal activity.

The problem with detecting methane is that it doesn't last long. Once released into the atmosphere, it can be quickly destroyed by natural atmospheric processes. Therefore, any methane detected in Mars' atmosphere means it must have been released recently, which only adds to the intrigue.

On Earth, most methane is produced by living creatures such as microorganisms in sedimentary strata, or in the guts of ruminants (cows, sheep, deer, etc.). For methane produced through abiotic or non-living processes, there is a high likelihood it could have been produced millions or even billions of years ago, lying trapped in underground rock formations.

But still, finding methane on Mars is a big deal because of the potential for biological sources, such as methanogenic microbes.



This graphic is the result of an analysis that gives a percentage chance of the methane originating in each grid square centered on Gale Crater. Image Credit: Giuranna et al. (2019)

In 2004, the Mars Express Orbiter (MEO) detected methane in the Martian atmosphere. In 2013 and 2014 Curiosity detected spikes in methane in the atmosphere at Gale Crater. Interestingly, MEO detected a methane spike again, at the same location that Curiosity did, only one day later.

Ortiz and his team wanted to better understand Mars' methane levels, and used high-performance computing clusters to simulate how methane travels through networks of underground fractures, and then released into the atmosphere when driven by atmospheric pressure fluctuations. They also modeled how methane is adsorbed onto the pores of rocks, which is a temperature-dependent process that may contribute to the methane level fluctuations.

The team said their simulations predicted methane pulses from the ground surface into the atmosphere just before the Martian sunrise in the planet's northern summer season, which just recently ended. This corroborates previous rover data suggesting that methane levels fluctuated not only seasonally, but also daily. With these insights, the Curiosity rover team can figure out when and where to look for methane, which could aid in the rover's main goal, searching for signs of life.

"Understanding Mars' methane variations has been highlighted by NASA's Curiosity team as the next key step towards figuring out where it comes from," Ortiz said. "There are several challenges associated with meeting that goal, and a big one is knowing what time of a given sol (Martian day) is best for Curiosity to perform an atmospheric sampling experiment."

Paper: "Sub-diurnal methane variations on Mars driven by barometric pumping and planetary boundary layer evolution." Journal of Geophysical Research: Planets. DOI: 10.1029/2023JE008043

LANL press release

NASA Gives us an Update on its Long-term Plans for the Moon and Mars

Going to Mars is a major step in space exploration. It's not a quick jaunt nor will it be easy to accomplish. The trip is already in the planning stages, and there's a good chance it'll happen in the next decade or so. That's why NASA and other agencies have detailed mission scenarios in place, starting with trips to the Moon. Recently, NASA updated its "Moon to Mars Architecture" documents, including a closer look at some key decisions about Mars exploration.

Those decisions cover a wide gamut of challenges to living and working on the Red Planet. NASA planners narrowed them down to these key areas: science priorities, number of crew members on the first trip, how many on each follow-up trip, number of crew members per Mars location, Mars surface power generation technologies, what kinds of missions will be sent (the "target state"), and establishing what they call a "loss of crew risk" posture. That last one involves making the right decisions about missions based on risk to the crew's health and performance.

NASA Plans for the Moon and Mars

Why create a mission architecture for the Moon and Mars? Essentially, anybody going to these other worlds needs a mutually agreed-upon "roadmap" that plans the explorations and technologies needed. That's why NASA created its first Moon to Mars objectives in 2022 and has been refining them ever since. The agency's roadmap includes feedback from a wide swath of society. Members of academia, U.S. industry, international partners, and the NASA workforce all contributed to the project.

"Our new documents reflect the progress we've made to define a clear approach to exploration and lay out how we'll incorporate new elements as technologies and capabilities in the U.S. and abroad mature," said Catherine Koerner, associate administrator, Exploration Systems Development Mission Directorate at NASA Headquarters in Washington. "This process is ensuring that everything we are doing as an agency and together with our partners is focused on achieving our overarching exploration goals for the benefit of all."

The Key Decisions Regarding Mars Exploration

In a white paper published along with the Moon to Mars Architecture document, NASA explains key areas of concern when it comes specifically to Mars exploration. The first is science. It's the main reason for going the both the Moon and Mars, and its needs will drive almost all other considerations. It will determine the resources needed, including crew numbers,

payloads, technology deliveries, and power and communications infrastructure, and contingencies for possible accidents or other challenges.

An artist's concept of Mars explorers and their habitat on the Red Planet. Courtesy NASA.

Once the science is determined, planners can decide on crew needs for the first and subsequent missions. As the white paper states, "…a series of focused science exploration missions to different landing sites would favor one architecture. Establishing a permanent, fixed base from which astronauts could conduct many surface missions supporting diverse and evolving exploration activities would favor a very different architecture."

From there, planners will figure out the "cadence" of the missions and crew deployments. How often do we send missions and how many people will go? Just as an example, let's say that the first mission will land in Jezero Crater, near the Perseverance rover. NASA could use its data to determine further science exploration at the site. That will drive the best placement for habitats and other infrastructure, and the type of mission will dictate the number of crew members needed.

Those decisions will then drive the infrastructure and technology needed for each step. Science stations need power to do the science, but also to sustain the habitats for the science teams. If those teams travel across the surface, their rovers will need power, fuel, and possibly replacement parts. Crew members themselves will need to be able to grow food, use local resources to extract fuel and water, and otherwise maintain safe living conditions. And, these are just the first steps in the long-term exploration of Mars, enabled by what people learn about living and working on the Moon.

Why Does NASA Want a Moon to Mars Plan?

While it may seem sexy to send people directly to Mars without any intervening stops at the Moon, NASA and other agencies want a measured approach. The idea to use the Moon as a stepping stone to Mars is not new. The Moon makes a good "training base" of sorts where we can "practice" with the technologies and techniques of living on another world. In addition, it offers a unique environment for astronomy and planetary science exploration. Astronauts learn in an environment close to Earth and if something dire happens to them, rescue is not far away.

Artist's impression of astronauts on the lunar surface, as part of the Artemis Program. Credit: NASA

These ideas underlie the planning for the upcoming Artemis missions to the lunar surface. There's supposed to be a gateway orbiting the Moon, to which astronauts and equipment will fly. Then, from there, materials and people head to the Moon to explore various sites, and begin the complex tasks of exploration and habitat construction. That set of missions will establish the foundation for scientific exploration, and land a diverse set of people on the lunar surface, all in cooperation with international partners. Ultimately, everything they learn on the Moon will prepare people for the leap to Mars.

The Moon to Mars mission architectural plans unite both lunar and Mars exploration in one timeline, identifying technologies and capabilities needed to accomplish each step. They are living documents, updated every year to reflect changes in any aspect of mission planning and technology.

For More Information

NASA Shares Newest Results of Moon to Mars Architecture Concept Review

Moon to Mars Architecture

Key Mars Architecture Decisions

There's Less Dark Matter at the Core of the Milky Way

Science really does keep you on your toes. First there was matter and then there were galaxies. Then those galaxies had more stuff in the middle so stars further out were expected to move slowly, then there was dark matter as they actually seemed to move faster but now they seem to be moving slower in our Galaxy so perhaps there is less dark matter than we thought after all!

Let's start with dark matter. It is a strange and mysterious form of matter that doesn't really seem to behave in any way like normal matter. It doesn't emit light, absorb or reflect it so is to all intents invisible, hence its name. It's thought that about 27% of the Universe is made up of dark matter but the only way we can detect it is its gravitational effect on passing light and other matter. Despite mounting evidence for its existence, we have still yet to actually detect particles that make up dark matter, whatever they are.

Physicists at MIT (the Massachusetts Institute of Technology) have measured the speed of stars in the Milky Way galaxy and found that those further out to the edge are moving slower than expected. This suggests, rather surprisingly that the core of the milky way may be lighter in mass than first thought and thus contain less dark matter.

The team used data from Gaia and APOGEE (Apache Point Observatory Galactic Evolution Experiment) to plot the velocity of stars against their distance. This enabled them to generate a rotation curve that shows how fast matter rotates at a given distance from the centre of a galaxy. Interpreting graphs like these allow astronomers to estimate how much dark matter there is.

Artist impression of ESA's Gaia satellite observing the Milky Way (Credit : ESA/ATG medialab; Milky Way: ESA/Gaia/DPAC)

This was quite in contrast to earlier observations since the 1970's that revealed a hint of dark matter distribution. Measurements of previous galaxies showed that stars were moving around the centre at a fairly constant velocity with distance from centre. The only way this can be explained is dark matter. This work was pioneered by Vera Rubin from the Carnegie Institution in Washington and was supported by multiple observations from other astronomers in the following years.

The efforts to measure galactic rotation have focussed on other galaxies rather than our own. It's actually quite difficult to achieve the same in a galaxy that you live in but undaunt-

ed; Xiaowei Ou, Anna-Christina Eilers, and Anna Frebel set about the task. Their initial observations came from Gaia data but used APOGEE data to refine their results. They were able to measure distances of more than 33,000 stars out to a distance of 30 kiloparsecs (97,846 light years). The data was then incorporated into a model of circular velocity to estimate the velocity of stars given the location of all other stars in the galaxy. This gave them an updated and refined rotation curve.

The curve their work revealed showed a more rapid decline over distance rather than the shallow decline they expected. Stars further out are moving slower than expected and so there is less matter in the centre of our galaxy. We can observe the 'normal' or baryonic matter but it requires less dark matter to account for the observations. Further research is now required to explore other galaxies like the Milky Way and perhaps, change our view of the amount of dark matter in the Universe.

New Webb Image of a Massive Star Forming Complex

The *James Webb Space Telescope*, a collaborative effort between NASA, the ESA, and the Canadian Space Agency (CSA), has revealed some stunning new images of the Universe. These images have not only been the clearest and most details views of the cosmos; they've also led to new insight into cosmological phenomena. The latest image, acquired by *Webb*'s Mid-InfraRed Instrument (MIRI), is of the star-forming nebula N79, located about 160,000 light-years away in the Large Magellanic Cloud (LMC). The image features a bright young star and the nebula's glowing clouds of dust and gas from which new stars form.

The image above is centered on one of the three giant molecular cloud complexes – dubbed N79 South (S1) – a region dominated by interstellar atomic hydrogen that is ionized. The star is identifiable as the brightest spot in the image, surrounded by six large spokes of light that cross the image. The processed image uses many different colors to indicate different infrared wavelengths, with near-infrared light (7.7-10 microns) shown in blue, while mid-infrared wavelengths (10, 15, and 21 microns) are shown in cyan, yellow, and red (respectively).

The Tarantula Nebula as seen by the James Webb Space Telescope. Credit: NASA/ESA/CSA/STScI/Webb ERO Production Team.

This N79 nebula spans over 500 parsecs (1,630 light-years) in the largely unexplored southwest region of the LMC and is often regarded as the younger sibling to the Tarantula Nebula (aka. 30 Doradus). This nebula was imaged recently by Webb (see above), where combined light from varying wavelengths created a detailed image revealing many interesting features (like star-forming regions astronomers were not expecting to find). However, research suggests that for the past 500,000 years, N79 has had star formation efficiency more than twice that of the Tarantula Nebula.

Several other bright objects can be seen in the cloud, which are stars in the early stages of formation (aka. protostars) shown in great detail as layers of colorful wisps. Thanks to *Webb*'s ability to capture longer and shorter wavelengths of infrared light, these latest image provides insight into the nebula's star forming regions. Since shorter wavelengths are absorbed or scattered by dust grains, mid-infrared light reveals what is happening deeper inside the clouds (which include some young protostars). The image shows a distinct "starburst" pattern surrounding a bright object.

This is known as a "diffraction spike," an artifact only visible around very bright and compact objects that arises from the design of a telescope's mirrors. In this case, the six diffraction spikes extending from the center are due to the hexagonal symmetry of Webb's eighteen primary mirror segments. Astronomers are particularly interested in star-forming regions because their chemical composition resembles that of nebulas observed when the Universe was only a few billion years old.

Unlike nebulae in the Milky Way today, star formation was at its peak during this time, producing particularly massive stars with low concentrations of metal and short-lived by current standards. By taking details images from N79 and similar nebulae, astronomers can compare and contrast star-formation rates to deep observations of distant galaxies in the early Universe.

Webb images of early galaxies shaped like surfboards and pool noodles. Credit: NASA/ESA/CSA

These latest observations by *Webb* are part of a program to study the evolution of circumstellar discs and envelopes around stars in formation over a wide range of mass and evolutionary stages. *Webb*'s sensitivity will allow astronomers for the first time, to detect these planet-forming disks around stars of similar mass to that of our Sun and at distances comparable to that of the LMC (around 160,000 light-years). This will shed light on how planetary systems like our own formed and evolved, potentially providing clues as to where life may have also emerged in our galaxy.

The Galactic Habitable Zone

Our planet sits in the Habitable Zone of our Sun, the special place where water can be liquid on the surface of a world. But that's not the only thing special about us: we also sit in the Galactic Habitable Zone, the region within the Milky Way where the rate of star formation is just right.

The Earth was born with all the ingredients necessary for life – something that most other planets lack. Water as a solvent. Carbon, with its ability to form long chains and bind to many other atoms, a scaffold. Oxygen, easily radicalized and transformable from element to element, to provide the chain reactions necessary to store and harvest energy. And more: hydrogen, phosphorous, nitrogen. Some elements fused in the hearts of stars, other only created in more violent processes like the deaths of the most massive stars or the collisions of exotic white dwarfs.

And with that, a steady, long-lived Sun, free of the overwhelming solar flares that could drown the system in deadly radiation, providing over 10 billion years of life-giving warmth. Larger stars burn too bright and too fast, their enormous gravitational weight accelerating the fusion reactions in their cores to a frenetic pace, forcing the stars to burn themselves out in only a few million years. And on the other end of the spectrum sit the smaller red dwarf stars, some capable of living for 10 trillion years or more. But that longevity does not come without a cost. With their smaller sizes, their fusion cores are not very far from their surfaces, and any changes or fluctuations in energy result in massive flares that consume half their faces – and irradiate their systems.

And on top of it all, our neighborhood in the galaxy, on a

small branch of a great spiral arm situated about 25,000 light-years from the center, seems tuned for life: a Galactic Habitable Zone.

Too close to the center and any emerging life must contend with an onslaught of deadly radiation from countless stellar deaths and explosions, a byproduct of the cramped conditions of the core. Yes, stars come and go, quickly building up a lot of the heavy elements needed for life, but stars can be hundreds of times closer together in the core. The Earth has already suffered some extinction events likely triggered by nearby supernovae, and in that environment we simply wouldn't stand a chance. Explosions would rip away our protective ozone layer, exposing surface life to deadly solar UV radiation, or just rip away our atmosphere altogether.

And beyond our position, at greater galactic radii, we find a deserted wasteland. Yes, stars appear and live their lives in those outskirts, but they are too far and too lonely to effectively spread their elemental ash to create a life-supporting mixture. There simply isn't enough density of stars to support sufficient levels of mixing and recycling of elements, meaning that it's difficult to even build a planet out there in the first place.

And so it seems that life would almost inevitably arise here, on this world, around this Sun, in this region of the Milky Way galaxy. There's little else that we could conceivably call home.

The Moon is Still Shrinking, Explaining Why it Still Has Landslides

Although our Moon formed 4.5 billion years ago, it's still evolving. The interior continues to cool and its orbit is slowly changing. As a result, the Moon has lost 150 feet of its circumference. That shrinkage contributes to near-constant moonquakes, and those trigger landslides and other surface changes. The Moon is currently uninhabited, but all that activity threatens future Artemis landing sites and missions at the South Pole.

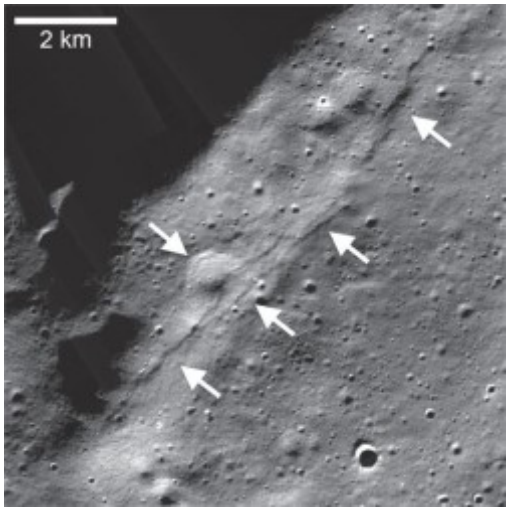
In a recent paper, planetary scientists point out that the potential of strong seismic events from active thrust faults should be a top consideration when NASA and other agencies are planning permanent outposts on the Moon. This is particularly true as the Artemis mission planners plot exploration of the South Pole. "Our modeling suggests that shallow moonquakes capable of producing strong ground shaking in the south polar region are possible from slip events on existing faults or the formation of new thrust faults," said the study's lead author Thomas R. Watters, a senior scientist emeritus in the National Air and Space Museum's Center for Earth and Planetary Studies. "The global distribution of young thrust faults, their potential to be active, and the potential to form new thrust faults from ongoing global contraction should be considered when planning the location and stability of permanent outposts on the Moon."

The Moon is particularly vulnerable to the large-scale effects of moonquakes. That's because its surface is very brittle and easily broken up during a quake. One of the strongest quakes in lunar history occurred in the 1970s and lasted for hours. Such a lengthy event does quite a bit of damage to the lunar surface. So, even a light moonquake could cause significant damage via landslides.

Our Shaky, Shrinking Moon

Moonquakes generally happen within a hundred miles or so of the lunar surface. On Earth, that might result in a fairly mild quake. But, since the Moon's surface is so brittle, the effects of those "shakes" are much more noticeable. According to Nicholas Schmerr, a co-author of the paper and an associate professor of geology at the University of Maryland, this means that shallow moonquakes can devastate hypothetical human settlements on the Moon.

"You can think of the Moon's surface as being dry, grounded gravel and dust," he said. "Over billions of years, the surface has been hit by asteroids and comets, with the resulting angular fragments constantly getting ejected from the impacts," Schmerr explained. "As a result, the reworked surface material can be micron-sized to boulder-sized, but all very loosely consolidated. Loose sediments make it very possible for shaking and landslides to occur."

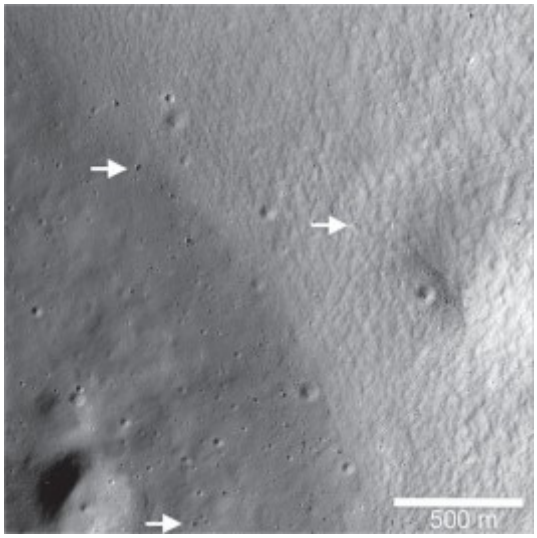


An LROC NAC mosaic of the Wiechert cluster of lobate scarps in Moon's south pole region, left pointing arrows). A scarp crosscuts a small (?1 km) degraded crater (right-pointing arrow).

Quakes affect every part of the lunar surface. Global compressional stresses deform the surface, forcing splits and cracks to occur. These scarps—steep slopes and cliffs—exist everywhere there. In their paper, the team suggests that many are close to the epicenters of geologically recent quakes. And the regions where they occurred could still be active today. That includes the lunar South Pole.

Risks to Artemis

The team led by Watters examined data and images of the lunar South Pole and linked faults there to a major moonquake in the 1970s. The region is filled with scarps, which are prime evidence for moonquakes. Although they conclude that some regions in the area are probably safe enough for the Artemis missions, others are not. The team's computer models show that the most dangerous areas are vulnerable to landslides triggered by seismic shaking. They continue to map the Moon and track its quakes to identify the riskiest areas for Artemis astronauts to land.



A mosaic of Shackleton Crater at the Moon's south pole region. It shows a portion of an interior wall and floor, with arrows pointing to boulder falls likely created during seismic shaking during a moonquake. Image courtesy: NASA/KARI/ASU

That mission could take place by the end of the decade, when NASA hopes to establish long-term habitations for research and exploration. Schmerr points out that the risks to safety from even the slightest quakes can't be

overestimated. “As we get closer to the crewed Artemis mission’s launch date, it’s important to keep our astronauts, our equipment, and infrastructure as safe as possible,” Schmerr said. “This work is helping us prepare for what awaits us on the moon—whether that’s engineering structures that can better withstand lunar seismic activity or protecting people from really dangerous zones.”

The Artemis missions essentially mark NASA’s return to human exploration of the Moon. The idea is to collaborate with both commercial partners and international agencies to make this happen. Teams of lunar astronauts will establish an Artemis Base camp, and depend on a lunar gateway to connect the mission to Earth. Eventually, what they learn there will inform the first human missions to Mars.

For More Information

The Moon is Shrinking, Causing Landslides and Instability in Lunar South Pole

Tectonics and Seismicity of the Lunar South Polar Region

Artemis

How Rare Are Total Solar Eclipses… Really?

As April’s ‘Great North American Eclipse’ nears, here’s a look at eclipses in time and space.

It comes around every total solar eclipse, and I fully expect to hear it trotted out once again this year, leading up to the Great North American eclipse on April 8th, 2024.

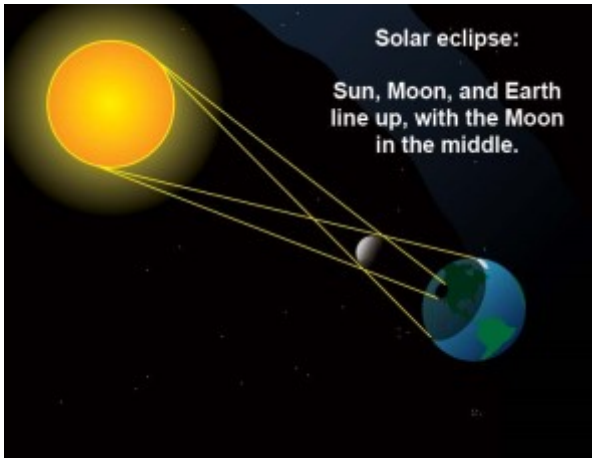
It’s often repeated (usually around the time leading up to a total solar eclipse) that the syzygy of the Earth, Moon and Sun is special, allowing totality to occur. To be sure, eclipses *are* extraordinary and spectacular events, and standing in the shadow of the Moon during totality is a spectacle that shouldn’t be missed.

But just how rare are the circumstances we witness on Earth during totality across time and space?

The path of totality across North America on April 8th, 2024. Credit: Michael Zeiler/The Great American Eclipse

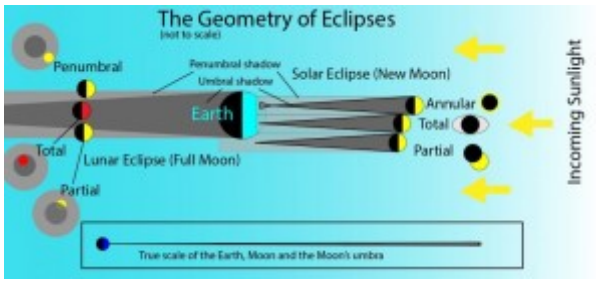
How Rare are Eclipses?

The Moon’s orbit intersects the ecliptic at two points, known as its ascending and descending nodes. We see lunar and solar eclipses on Earth when these nodes line up with the Sun (during a solar eclipse) or the Earth’s shadow (during a lunar eclipse). The Moon’s path is tilted just over 5 degrees versus the ecliptic plane. This means that most of the time, the Moon misses the Sun, and the Earth’s shadow. If it wasn’t tilted, an even more unique situation would occur. In this case, we’d see two eclipses (one lunar and one solar) occurring every synodic period or roughly just under once a month. As it is, eclipses worldwide happen in seasons or about twice a year as the nodes line up, with a solar and lunar eclipse about two weeks apart.



How a totality occurs. Credit: NASA

The precision-looking fit of the Moon over the Sun seen during totality is due to geometry. The Sun is about 400 times farther away from the Earth than the Moon, and 400 times as large in terms of physical diameter. But this is only approximate, and only true for our current epoch.



Geometry for lunar and solar eclipses, with the true scale of the Moon’s umbra during totality (bottom). From *The Universe Today’s Ultimate Guide to Viewing the Cosmos*.

A Receding Moon

In fact, we know from the retro-reflectors placed on the Moon by Apollo astronauts that the Moon is moving away from us at 3.8 centimeters per year. About 600 million years from now, the last total solar eclipse will occur as seen from the Earth. Likewise, about a billion years in the past, the first brief annular solar eclipse must have occurred.

The apparent size of the Sun and Moon also vary slightly from one eclipse the the next. This ranges around half a degree (30 arcminutes) by few arcminutes (‘). This occurs as the Earth travels from perihelion to aphelion, and the Moon travels from perigee to apogee. When the Moon is too small to cover the Sun, a ‘ring of fire’ annular solar eclipse occurs.

The value difference for the apparent size of the Sun ranges from 31.6′ to 32.6′, and the Moon is 29.3′ to 34.1′. During the April 8th total solar eclipse, the Sun will be an apparent 31′ 57″ across. The Moon will be slightly larger, at 33′ 37″ across. This will yield a generous maximum totality of 4 minutes and 28 seconds in duration, as seen from near Nazas, Mexico .

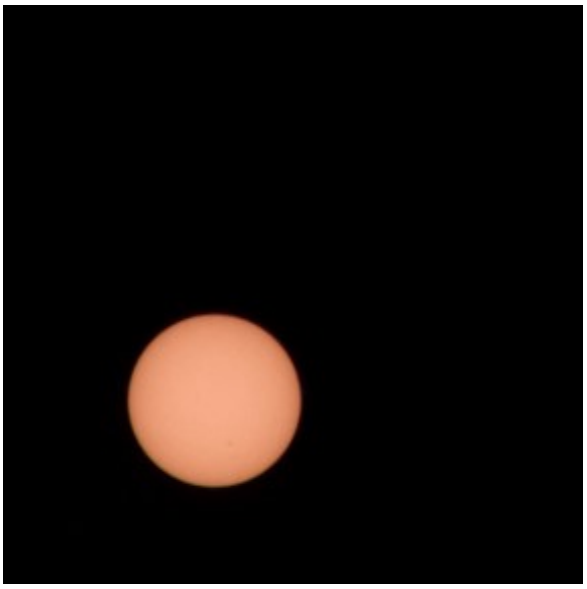
A Fortunate Epoch

Even now in our current 5,000-year epoch, annulars are already *more* common, at 33.2% to 26.7% versus totals. The remainder are partials and rare hybrid annular-total eclipses.

“I found that whenever I use the phrase ‘cosmic coincidence’ to describe our current good fortune in the distance/diameter ratios favorable for a tight occultation of the Moon and Sun, almost predictably some of the responses will be ‘there are no coincidences,’ or ‘divine provenance,’” Eclipse chaser and cartographer Michael Zeiler told *Universe Today*. “I respond that often coincidences are true! We are simply lucky to live within the evolution of our solar system to witness total solar eclipses.”

Looking Out Across the Solar System

To be sure, solar eclipses *do* occur throughout the solar system. It's all a matter of perspective, and literally knowing where and when to stand. New Horizons saw the Sun pass behind Pluto in 2015 (a sight no human eye has ever witnessed). Rovers on Mars have caught strange potato-shaped annular eclipses (or more properly, transits) courtesy of Deimos and Phobos.



Deimos transits the Sun, as seen by NASA's Perseverance Rover of Sol 1037 (January 20th, 2024). Credit: NASA/ JPL Image processing: Simeon Schmaub

These robotic observations of the Martian moons aren't just pretty pictures. They also also researchers to refine and pin down the exact orbits of both Phobos and Deimos. This is handy, as Japans Martian Moons Explorer is headed to the pair in 2026.

What's more, Phobos is doomed to crash into Mars millions of years from now… at some far off date, it will briefly be close enough to totally eclipse the Sun as seen from the Martian surface. If humans are on Mars on November 10th, 2084, they can witness an uber-rare, transit featuring Phobos, the Earth and the Moon.

Eclipses and the Curious Case of the Jovian Moons

Of course, none of these are are precise fits in terms of the eclipsing body versus the Sun. There is, however, another place in the solar system you *could* stand on a solid surface and witness totality similar to what's seen on Earth. (Be sure to pack your space suit). Jupiter's major moons produce eclipses very analogous to those seen on Earth as they pass one in front of the other. This happens in cycles that occur during what's known as mutual eclipse-transit season. This happens when the major Galilean moons of Io, Europa, Ganymede and Callisto mingle as seen from our perspective.

Europa as seen from the surface of Callisto is a particularly good baseline 'fit'. Europa is about 1/450th the size of the Sun, which is also 450 times farther away at certain points along its orbital path… not all that different than eclipse circumstances here on Earth. These events are faster, lasting only a few dozen seconds at most. Mutual transit-eclipse season occurs twice every Jovian orbit, or every six years. The next cycle resumes in 2026.

A Twice a Decade Transit Season

We noticed this similarities of Jovian versus terrestrial eclipses while writing an article on mutual eclipse season in 2015. To be sure, eclipse seasons on the Earth tend to be biannual, while seasons in the Jovian system occur less frequently, about twice a decade. More distant moons may see similar celestial sights, but for now, my future plans for building an eclipse viewing hotel and resort are pegged for the surface of Callisto.

Bill Kramer also did a fascinating look at eclipses throughout the solar system from a few years back, posted on his Eclipse-Chasers website.

The Hunt for 'Exo-Eclipses'

So, what does this all say for eclipses beyond our solar system? Well, as of writing this, there are 5,506 exoplanets known… but claims of any 'exomoons' orbiting them remain controversial. Even the best known cases—such as the contentious recent Kepler-1513 b exomoon claim—still have very wide distance and diameter perimeters to say if good-fit eclipses are possible. Still, as the menagerie of extra-solar worlds grow and good exomoon candidates are found, we might yet be able to say with some authority just how common 'exo-eclipses' are very soon.

Perhaps, human astronauts will one day witness these far-flung eclipses. Imagine standing on the Earthward face of the Moon during a total lunar eclipse, and witnessing 'a thousand sunsets' as the Earth eclipses the Sun. For now, I'd wager that ideal tight-fit eclipses aren't all that uncommon when you take into account the vast expanse of time and space… but totality over an expanse where life has evolved to enjoy it might be rare indeed.

Ingenuity Suffers Rotor Damage, Ending the Mission

There have been numerous robotic space missions reach the end of their operating life over the years and for a multitude of reasons. Be they catastrophic failure or a scheduled end but I must say one that has recently made me a little sad is the demise of the Ingenuity helicopter on Mars. It sustained damage after its recent flight and can now no longer fly. In a mission that was supposed to complete five flights in 30 days, the plucky little helicopter completed 72 flights over three years!

The Ingenuity helicopter's historic journey began on 18 February 2021 when it arrived on Mars. It was transported as part of the Mars 2020 mission which included the Perseverance rover too. Ingenuity had been built by NASA Jet Propulsion Laboratory with involvement from AeroVironment Inc., Qualcomm, SolAero and Lockheed Space. The task for Ingenuity was a simple one, to demonstrate the technology to perform flights on another world.

Perseverance Rover (Credit : NASA)

Once setup for flight, it stood 0.49 metres tall and its rotors had a span of 1.2 metres. This may seem a large wingspan in comparison to drones here on Earth but they needed to be this long to achieve flight on Mars. The lower atmospheric density meant that larger rotors were needed to produce the required amount of lift. The blades were to spin at a rate of 2,400 revolutions per minute but there were two drives that would spin one set of blades clockwise and the other counterclockwise. At the very top, above the rotors was a solar panel to charge its batteries there was a wireless communication system and of course navigation sensors and cameras.

The first flight took place on 19th April in the same year proving for the first time that powered flight was possible on another world. In the flights that followed, the operations team tested its systems and used it to scout out locations for the Perseverance rover to explore in detail.

The plan was for Ingenuity to only last 3 days during the spring of 2021 and so the team had to overcome a number of obstacles during its extended mission. The teams had to develop winter operating procedures so that Ingenuity could survive the long cold nights. They upgraded the systems giving it the ability to choose its own landing sites and even had to clean itself after dust storms.
On the 18th January this year, the team had to identify the location of Ingenuity since it had to make an emergency landing on a previous flight. As planned, the helicopter lifted off to an altitude of 12 metres to survey the surrounding terrain and hovered for 4.5 seconds before descending again at a velocity of 1 metre per second. Unfortunately and for unknown reasons, there was a communication failure at an altitude of about 1 metre. Investigations the following day revealed there was damage to one of the rotor blades rendering the helicopter incapable of further flight. The team are now trying to identify the cause of the failure while they perform tests on the systems one last time and download the last images stored onboard. Too often we hear of missions that go wrong but Ingenuity was a fabulous example of a mission that went way beyond its expectations giving us so much more than was ever hoped for.
Source : After Three Years on Mars, NASA's Ingenuity Helicopter Mission Ends

Why Venus Died

Venus is only slightly smaller than the Earth, and so has enjoyed billions of years of a warm heart. But for this planet, sometimes called Earth's sister, that heat has betrayed it. That planet is now wrapped in suffocating layers of a poisonous atmosphere made of carbon dioxide and sulfuric acid. The pressures on the surface reach almost 100 times the air pressure at Earth's sea level. The average temperatures are over 700 degrees Fahrenheit, more than hot enough to melt lead, while the deepest valleys see records of over 900 degrees.
If Venus is indeed Earth's sister, she's a twisted one. Like Mars, we suspect that Venus also once hosted a thinner, balmier atmosphere and a surface replete with liquid water oceans. The reasoning here is a little more tenuous than for Mars – where we can literally see the evidence for water before our very eyes – but the thinking is that both Venus and Earth formed in a roughly similar fashion, in roughly the same orbits with roughly the same material. Thus we should have been born with roughly the same amount of water.
Like Earth, most of that water would have been chemically bound up in rock, buried deep in the mantle. But some of it may have leeched to the surface or been delivered by hosts of water-rich comets shortly after formation, building up a supply on the surface, once again stabilized by a thick atmosphere.
What doomed Venus was not any fault of its own, but our own treacherous Sun. As stars age they gradually brighten. Day by day it's imperceptible, but over the course of millions of years it completely changes the character of a star. Billions of years ago our Sun's habitable zone was shifted inwards compared to where it rests now, but with increased brightness comes increased heat, and that habitable zone steadily creeps outwards over time.
Did Venus ever host life? I doubt we'll ever know, given the excruciating temperatures on the surface that make exploration nearly impossible. But it's likely that it had water and a rich atmosphere – the basic ingredients were there. But if life did gain a foothold it did not last long. As our Sun aged, Venus got warmer and warmer. On a warmer planet, more water exists as vapor in the atmosphere than as liquid on the surface.
At first the changes were small, with nothing more than a higher dew point to mark the inexorable path to destruction. But at some point in the past – we are not sure exactly when – Venus reached a tipping point. With too much water vapor, the atmosphere of Venus became too good at trapping the heat radiating from the surface. That radiation could not penetrate the haze and make into space, but instead was ensnared within the atmosphere itself, heating it up.
What came next was, at least, mercifully quick. Venus entered a feedback loop, dumping more heat into the atmosphere, which boiled the oceans into more vapor, which increased the temperatures, and so on. First the shallow lakes and streams were gone, then came the deeper oceans, until every scrap of water was blowing in the winds of the atmosphere.
With its proximity to the ever-brightening Sun, the water vapor did not last long. Solar radiation pummeled it, disassociating its chemical bonds and sending the oxygen and hydrogen flying away, joining a grim procession beyond our solar system.
If Venus had plate tectonics like the Earth, then this is where that process came to end. With no water to act a lubricant, the great slow grinding of the plates seized up, locking the crust in place. This constant churning acts as a natural sink for carbon: the carbon dioxide binds to rocks which get pulled deep into the mantle, preventing too much carbon from building up in the atmosphere.
But without the cleansing effect of plate tectonics, carbon dioxide levels rose to dangerous heights, its own ability to absorb radiation from the surface choking off any remaining hope for rescuing the planet. Eventually the atmosphere would pile upon itself until it reached its present swollen size.
As our Sun aged, Venus strangled itself.
Venus is not alone in sharing that fate, for the Sun has not yet reached its final days. It continues to brighten, bringing more warmth to the solar system day by day, its habitable zone steadily inching outwards with every passing year.
At some point, approximately 500 million years from now, Venus will not be alone, The Earth's oceans will boil, our continents will halt their ancient motion, and we will finally be twins with our sister: dead, lifeless, and strangling on our own bloated atmosphere.

Why Mars Died

We know of Mars as the Red Planet, for its surface and atmosphere is caked in endless swirling dust of rusted iron, the rusting action provided by the always-eager oxygen. But this was not always so.
As attested by our robotic emissaries that we have sent to that planet for over half a century, Mars was once a vibrant (if not verdant) world. We see the evidence for water everywhere we look: ancient flood plains, seabeds, alluvial fans, all of it. If I were to give you two pictures, one from the surface of Mars and one from one of Earth's deserts, you could not tell the difference.
While Mars may not have had as rich an abundance of liquid water as the Earth, we do know with confidence that the world once hosted vast oceans, long, meandering rivers, and a weekly forecast featuring rainy, overcast, dreary days,
We do not yet know if the right chemicals found the right combinations at the right times to begin climbing the ladder to life on that planet, but we do know that if you could transport yourself back billions of years, to the early days of our solar system, you would find two Earth-like planets orbiting within the habitable zone of our star.
But Mars was born with a flaw, a crippling birth defect that fated it to snuff out any hope for life on its surface. The planet Mars, though it gleams with red anger in our nighttime skies, is small. By mass it's roughly only 11% that of the Earth. And that small mass means that its core cooled off much faster than it should have.
All worlds are warm. Some of the heat comes from the decay of radioactive elements, elements mixed within the primordial gas cloud that condensed long ago to form our solar system. But they also retain heat from the process of formation itself. Every planet that we see today is the end result of collapsing a large, diffuse cloud of gas and dust into a relatively compact volume. That collapse caus-

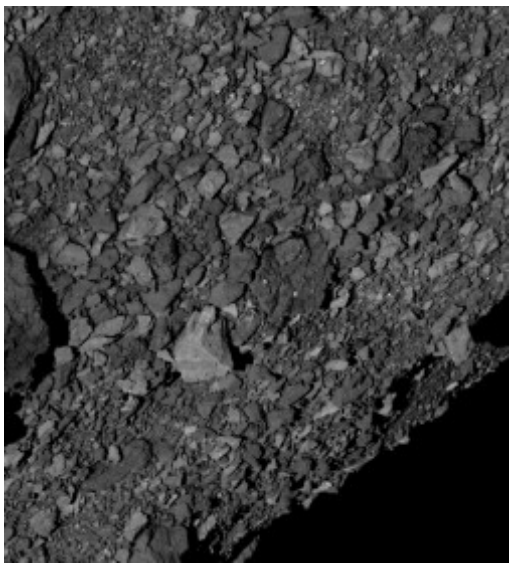
es friction, and that friction generates heat.
That heat is trapped inside the body of a planet as it forms. The only way for that heat to escape is through the planet emitting radiation into the vacuum of space. As methods of heat transport go, radiation is by far the most inefficient (for a gruesome but tangible example, if we were to toss your body into the vacuum of space far away from the Sun, it would take several hours for you to freeze). As the planets emit infrared radiation, they slowly release the heat from within and cool off.
The Earth still has plenty of heat to spare, for two reasons. One, our planet is larger than Mars, and so it acquired more heat during its formation. Second, the heat of our planet is contained within the volume of its body, but the heat can only radiate from its surface. If you double the size of a planet, its surface area quadruples, but its volume becomes eight times larger. Larger planets release heat more slowly than smaller ones. In other words, we are much more inefficient than Mars when it comes to removing our heat.
Our heat keeps the core of our planet molten, and it's there, buried thousands of miles beneath the surface, where the complex twisting of charged elements like iron, worming against each other in a great churning fire, generate our planet's magnetic field. That magnetic field deflects the onslaught of the solar wind, the ever-present rain of charged subatomic particles streaming from our Sun, keeping our atmosphere safe. Without that protective magnetic field, we would lose our air like dandelion seeds in the breeze.
And this was Mars' flaw. Born too small, within a billion years its core cooled and solidified, its magnetic field becoming feeble. Without that protection, Mars lost its atmosphere. Without that atmospheric pressure, the water on its surface boiled and evaporated into gas, where it too got caught up in the solar wind and blown out of the solar system. That water has now joined its brethren in the interstellar wastes, never to be seen again.
And with that, Mars died, along with any hope of life on that world.

Finally, Let's Look at the Asteroid Treasure Returned to Earth by OSIRIS-REx

NASA's OSIRIS-REx delivered its precious cargo to Earth on September 24th, 2023. The sample from asteroid Bennu is contained inside the spacecraft's sampling head, and it's in safe hands at NASA's Johnson Space Center in Houston. Two stubborn fasteners delayed the opening of the sampling head, but they've been removed, and now we can see inside.
What looks like unremarkable dirt is primordial asteroidal material that's billions of years old, a natural treasure trove that eager scientists can't wait to begin studying.
The head and its sample are in the hands of the astromaterials curation team at Johnson Space Center. On January 10th, they opened the Touch-and-Go-Sample-Acquisition-Mechanism (TAGSAM.) The leading image shows what greeted them.

The sample material includes dust and rocks up to about .4 in (one cm) in size. Credit: NASA/Erika Blumenfeld & Joseph Aebersold
The next step is to remove the round metal collar and place the sample into trays. Each tray will be photographed, weighed, packaged, and stored. The final mass will be determined in the weeks ahead, including the 70.3 grams (2.48 oz) removed previously. That material was on the sampling machinery but outside of the capsule. OSIRIS-REx's goal was to return 60 grams of material, so it's already exceeded that amount.
The curation team will catalogue all of the samples later this year. After that, scientists from around the world can request access.

This map shows the 38 institutions that will be the first to receive Bennu samples. Image Credit: NASA/Goddard/University of Arizona.
Bennu is a carbonaceous asteroid, a primitive chunk of rock that forms a link to the past when the rocky planets were forming. Scientists have already found carbon and water in the previously removed material. In fact, according to initial analysis, its carbon concentration is close to 5%. That's among the highest non-terrestrial carbon percentages ever measured. "The OSIRIS-REx sample is the biggest carbon-rich asteroid sample ever delivered to Earth and will help scientists investigate the origins of life on our own planet for generations to come," said NASA Administrator Bill Nelson at the time.
Once scientists get their hands on more of the material, they'll doubtlessly find other interesting components. Maybe even some of life's building blocks, like amino acids. Bennu's water and carbon content could indicate that life's building blocks originated in asteroids like Bennu. The sample also gives researchers an opportunity to test their findings against previous observations of Bennu. Astronomers studied the asteroid's composition with OSIRIS-REx's instruments as it approached Bennu, and the samples will tell them how accurate their efforts were. It's an opportunity to verify and improve spacecraft instruments and remote sensing methods.



Bennu's boulder-strewn surface. The asteroid is a rubble pile rather than a monolithic body. Image Credit: NASA/University of Arizona.
Scientists suspect that Bennu could actually be older than our Solar System. If that's true, then it's a window into the

distant past when only the solar nebula and the proto-Sun existed. It may contain insights into how everything formed, including the Sun.
Bennu may also be one of the remaining pieces of a much larger body. Scientists think that the parent body broke apart between 700 million and two billion years ago. Scientists hope to learn more from the Bennu sample about its parent body and how Bennu migrated to the inner Solar System.
In a notable act of foresight, 75% of the sample will be stored for the future. Instruments and analysis techniques will only improve over time, and these pristine samples will be available when they do. NASA has done the same with other materials like lunar samples, and it's paid off.
The Bennu samples can only enhance our understanding of our Solar System and how everything came to be. From its ancient early beginnings in the solar nebula to its present-day location in the inner Solar System, Bennu is a well-travelled message-bearer. Now that we have some of that message in our labs, scientists can reveal what Bennu has to say.

Now We Know Why Starship's Second Flight Test Failed

SpaceX is often in the headlines, unfortunlatey its not always good news. On 18th November we saw the second of the Starship and SuperHeavy booster get off the launchpad successfully, it failed before reaching orbit. In a recent event, Elon Musk explained how a fuel venting near the end of the burn was responbie but entirely avoidable next time!
The Starship and SuperHeavy booster are an impressive combination. Standing at over 120 metres tall together they are one of the most powerful and versatile rocket systems ever built. It can produce 16,700,000 pound force of thrust making it twice as powerful as Saturn V that took the Apollo astrnauts to the Moon.

The Apollo 10 Saturn V during rollout. Credit: NASA
The first launch attempt failed when the rocket spun out of control, exploding about four minutes from liftoff. Following the disaster, the team identified that the flight termination system which was supposed to destroy the vehicle if it went out of control, failed to do its job.
Musk reported on the second launch test from an event at Boca China in Texas where he explained that the lack of a payload meant that it needed to vent some of the liquid oxygen propellant. It almost made it to orbit and would have succeeded if it had a payload. The liquid oxygen would have been consumed by the mighty Raptor engines instead of being vented which was as per design. Musk however did not elaborate on how this all led to a fire.
The third test flight is slated for February and Musk is confident it will reach orbit this time. On the assumption of a succesful launch they plan to test the de-orbit process, the payload door operations and transferring propellant from header tank to main tank. This latter test is part of the NASA Tipping Point program to test fuel transfer from one vehicle to another.
Whether its the third or even the fourth test launch that brings success for SpaceX their long term goals remain unchanged. They still hope to be able to carry up to 100 people on interplanetary missions and become a pivotal part of the return to the Moon.

Early Galaxies Looked Nothing Like What We See Today

Though an estimated 100 million black holes roam among the stars in our Milky Way galaxy, astronomers have never identified an isolated black hole – until now. Following six years of meticulous observations, NASA's Hubble Space Telescope has provided, for the first time ever, strong evidence for a lone black hole plying interstellar space. The black hole that was detected lies about 5,000 light-years away, in the Carina-Sagittarius spiral arm of our galaxy. However, its discovery allows astronomers to estimate, statistically, that the nearest isolated black hole to Earth might be as close as 80 light-years. Black holes are born from rare, monstrous stars (less than one-thousandth of the galaxy's stellar population) that are at least 20 times more massive than our Sun. These stars explode as supernovae, and the remnant core is crushed by gravity into a black hole. Because the self-detonation is not perfectly symmetrical, the black hole may get a kick, and go careening through our galaxy like a blasted cannonball. Hubble can't photograph the wayward black hole because it doesn't emit any light, but instead swallows all radiation due to its intense gravitational pull. Instead, Hubble measurements capture the ghostly gravitational footprint of how the stealthy black hole warps space, which then deflects starlight from anything that momentarily lines up exactly behind it. Ground-based telescopes, which monitor the brightness of millions of stars in the rich star fields in the direction of the central bulge of our Milky Way, look for the tell-tale sudden brightening of one of them when a massive object passes between us and the star. Then Hubble follows up on the most interesting such events. Kailash Sahu of the Space Telescope Science Institute in Baltimore, Maryland, along with his team, made the discovery in a survey designed to find just such isolated black holes. The warping of space due to the gravity of a foreground object passing in front of a star located far behind it will momentarily bend and amplify the light of the background star as it passes in front of it. The phenomenon, called gravitational microlensing, is used to study stars and exoplanets in the approximately 20,000 events seen so far inside our galaxy. The signature of a foreground black hole stands out as unique among other microlensing events. The very intense gravity of the black hole will stretch out the duration of the lensing event for over 200 days. Also, If the intervening object was instead a foreground star, it would cause a transient color change in the starlight as measured because the light from the foreground and background stars would momentarily be blended together. But no color change was seen in the black hole event. Next, Hubble was used to measure the amount of deflection of the background star's image by the black hole. Hubble is capable of the extraordinary precision needed for such measurements. The star's image was offset from where it normally would be by two milliarcseconds. That's equivalent to measuring the diameter of a 25-cent coin in Los

Angeles as seen from New York City. This astrometric microlensing technique provided information on the mass, distance, and velocity of the black hole. The amount of deflection by the black hole's intense warping of space allowed Sahu's team to estimate it weighs seven solar masses. The isolated black hole is traveling across the galaxy at 90,000 miles per hour (fast enough to travel from Earth to the moon in less than three hours). That's faster than most of the other neighboring stars in that region of our galaxy. "Astrometric microlensing in conceptually simple but observationally very tough," said Sahu. "It is the only technique for identifying isolated black holes." When the black hole passed in front of a background star located 28,000 light-years away in the galactic bulge, the starlight coming toward Earth was amplified for a duration of 265 days as the black hole passed by. However, it took several years of Hubble observations to follow how the background star's position appeared to be deflected by the bending of light by the foreground black hole. The existence of stellar-mass black holes has been known since the early 1970's, but all of them—until now—are found in binary star systems. Gas from the companion star falls into the black hole, and is heated to such high temperatures that it emits X rays. About two dozen black holes have had their masses measured in X-ray binaries through their gravitational effect on their companions. Black hole masses in X-ray binaries inside our galaxy range from 5 to 20 solar masses. Black holes detected in other galaxies by gravitational waves from mergers between black holes and companion objects have been as high as 90 solar masses. "Detections of isolated black holes will provide new insights into the population of these objects in our Milky Way," said Sahu. He expects that his program will uncover more free-roaming black holes inside our galaxy. But it is a needle-in-a-haystack search. The prediction is that only one in 1500 microlensing events are caused by isolated black holes. NASA's upcoming Nancy Grace Roman Space Telescope will discover several thousand microlensing events out of which many are expected to be black holes, and the deflections will be measured with very high accuracy. In a 1916 paper on general relativity, Albert Einstein predicted that his theory could be tested by observing the sun's gravity offsetting the apparent position of a background star. This was tested by astronomer Arthur Eddington during a solar eclipse on May 29, 1919. Eddington measured a background star being offset by 2 arc seconds, validating Einstein's theories. Both scientists could hardly have imagined that over a century later this same technique would be used – with unimaginable precision of a thousandfold better — to look for black holes across the galaxy.

Talk to anyone about galaxies and it often conjurs up images of spiral or elliptical galaxie. Thanks to a survey by the James Webb Space Telescope it seems the early Universe was full of galaxies of different shapes. In the first 6 billion years up to 80% of the galaxies were flat, surfboard like. But that's not it, there were others like pool noodles too, yet why they looked so different back then is a mystery.

Galaxies were first identified back in the 17th Century by French astronomer Charles Messier. He was a comet hunter who identified a number of fuzzy objects which he realised were not comets. He catalogued them in his famous catalogue of deep sky objects but it wasn't until Edwin Hubble measure the distances to some of them in the 1920's that they were recognised as galaxies.

The bluish-white spiral galaxy NGC 1376 hangs delicately in the cold vacuum of space. Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)

Analysing images from the JWST survey known as the Cosmic Evolution Early Release Science Survey, the team studied galaxies from a time when the universe was between 600 million and 6 billion years old. To their surprise they did not see the usual cosmic zoo of galaxies like spiral, elliptical and irregular galaxies. Instead they found that between 50 and 80% of the galaxies seem to be glattened in two dimensions.

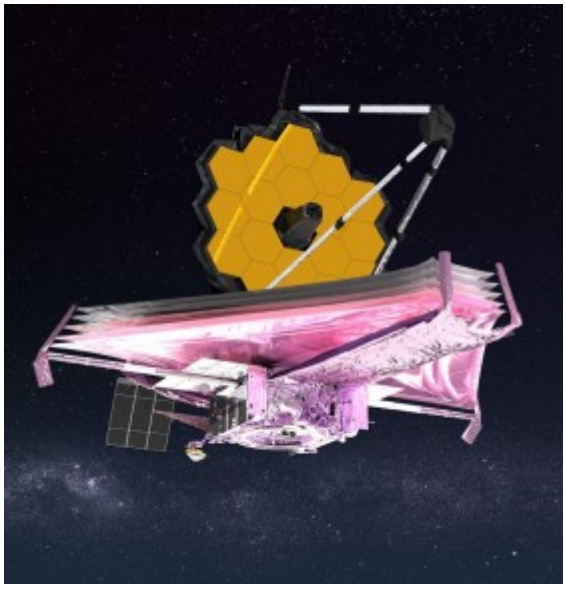


Illustration of James Webb Space Telescope

Instead, the team found galaxies shaped like surfboards, pool noodles, frisbees and volleyballs. Among these new types, the surfboard shape was most common with the least common being the volleyball, sphere shaped galaxies. Interestingly too they foudn that the frisbee and noodle shaped galaxies became more common in the later era around 6 billion years.

The mass of the early galaxies seemed to be far less than the mass of galaxies we see today. It seems they had far less time to grow when compared to today's galaxies which are far more massive. The team would have not been able to complete their work without the incredible sensitivity and resolution of the JWST.

The paper was authored by Viraj Pandya, a NASA Hubble Fellow at Columbia University. They went further to explore what category our own Milky Way galaxy would fall into if we could hop in a time machine and wind back time. They concluded it was likely to have been surfboard shaped galaxy, not too dissimilar to the spiral structure familiar to us today.

We have learned lots about galaxies over the years and images from Hubble has most certainly helped. The latest set of images from JWST have shown us that we still have lots to learn and as we delve deeper and deeper

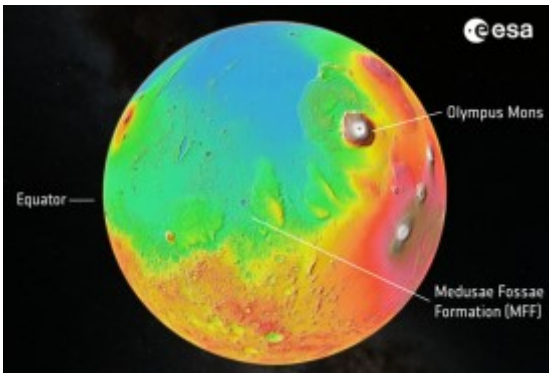
into space and further and further back into time we are only just starting to scratch the surface.

The Ice Sheet on Mars is Even Thicker Than Previously Believed

Maybe Mars isn't as dry as we thought. ESA's Mars Express has revealed new details about a region near Mars' equator that could contain a massive deposit of water ice several kilometers deep. If it is indeed ice, there is enough of it in this one deposit that if melted, water would cover the entire planet up to 2.7 meters (almost 9 feet) deep.

But ice is just one explanation for the unusual features detected by the orbital spacecraft. Another is that this is a giant pile of dust several kilometers deep — although the dust would still need to have some ice mixed in.

Mars Express has been orbiting Mars since December of 2003 and back in 2007, the spacecraft studied the Medusae Fossae Formation (MFF), a large geological formation that includes wind-sculpted ridges and grooves, abrupt mesas, interspersed with smooth and gently undulating areas. The region extends intermittently for more than 5,000 km (3,100 miles) along the equator of Mars, extending from just south of Olympus Mons to Apollinaris Patera, with a smaller additional region closer to Gale Crater, where the Curiosity rover is exploring.

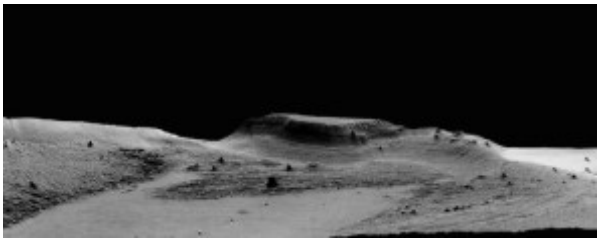


This image shows a height map of the Martian surface, with lowest land in blue and highest in white. Standing at an impressive 22 km, Olympus Mons is the tallest volcano in the entire Solar System. The Medusae Fossae Formation (MFF) is shown near the equator. Credit: ESA

Various spacecraft in addition to Mars Express, such as NASA's Mars Global Surveyor and Mars Odyssey, have also detected subsurface ice, as much as 2.5 km (1.5 miles) deep.

Now, new data from Mars Express suggest layers of water ice stretching even further underground – the most water ever found in this part of the planet.

Watters and his team say that if melted, the ice contained within the MFF would cover the entire planet in a layer of water 1.5 to 2.7 m deep, enough to fill Earth's Red Sea.

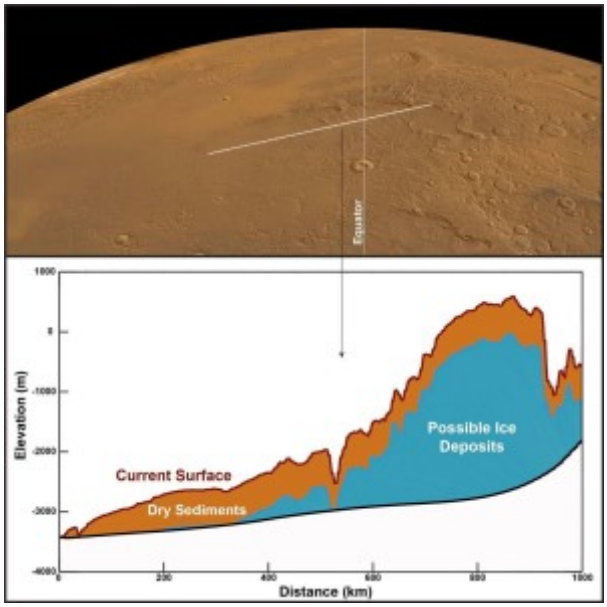


An isolated hill in the Medusae Fossae Formation. The effect of wind erosion on this hill is evident by its streamlined shape. Credit: High Resolution Stereo Camera/ European Space Agency

But MFF's windswept landscapes contains one of the most extensive deposits of dust on Mars, which is possibly the biggest single source of dust on Mars. Some studies determined the strange features in this landscape could have been formed by explosive volcanoes.

In the 2007 observations with Mars Express, the radar data showed the MFF to be relatively transparent to radar and low in density – two characteristics which would reveal icy deposits. However, scientists couldn't rule out a drier possibility: that the features are actually giant accumulations of windblown dust, volcanic ash or sediment.

But the beauty of long-lasting spacecraft is that it provides the opportunity for multiple observations of a single region on Mars over many years, providing additional follow-up data for study.



At the top is an image of Mars's surface. A white line crosses the surface diagonally, with a black arrow coming down from the white line to point at a graph below. The graph shows the shape of the surface and subsurface. It indicates that under the surface is a thin layer of dry sediments then a thick layer of ice deposit. The x axis of the graph shows distance, indicating that the diagonal white line covers a distance of 1000 km. The y axis of the graph shows elevation, indicating that the ice deposit is up to 3000 m thick. Credit: CReSIS/KU/Smithsonian Institution.

"Here's where the new radar data comes in! Given how deep it is, if the MFF was simply a giant pile of dust, we'd expect it to become compacted under its own weight," said co-author Andrea Cicchetti of the National Institute for Astrophysics, Italy. "This would create something far denser than what we actually see with MARSIS. And when we modelled how different ice-free materials would behave, nothing reproduced the properties of the MFF – we need ice."

The new results instead suggest layers of dust and ice, all topped by a protective layer of dry dust or ash several hundred meters thick.

We do know that massive stores of ice near the equator could not have formed in the planet's present climate.

"This latest analysis challenges our understanding of the Medusae Fossae Formation, and raises as many questions as answers," says Colin Wilson, ESA project scientist for Mars Express and the ESA ExoMars Trace Gas Orbiter (TGO). "How long ago did these ice deposits form, and what was Mars like at that time? If confirmed to be water ice, these massive deposits would change our understanding of Mars climate history. Any reservoir of ancient water would be a fascinating target for human or robotic exploration."

If this does turn out to be large stores of water ice, the MFF deposits would be an incredibly valuable resource for any future human exploration of Mars. These types of missions would need to land near the planet's equator, due to landing constraints, and resources like abundant solar power, and more moderate temperatures. The presence of equatorial water ice could provide a steady supply of water for a future base on Mars.

Further reading: ESA

E MAILS and MEMBERS VIEWING LOGS.

A discussion item from Dave Buckle:

Hi Andy,

When we do Public Outreach activities as a society, we don't make a charge. I wondered whether we could consider supporting the 'Starlight' charity for terminally and seriously ill children? When we attend school or other venues, we could take along a collection box or two and ask for voluntary donations.

Perhaps you could ask the committee and members what they think at the next meeting.

Regards,

Dave.

https://www.starlight.org.uk/about-us

https://www.starlight.org.uk/how-you-can-help-old/fundraising

Viewing Log for 9th of January

This was going to be my first viewing session of 2024, hopefully with many more to follow?

I had put out a call out on the Swindon Stargazers ad hoc WhatsApp viewing group, only Hilary Wilkey was able to meet up with me. We arranged to meet at Nebo farm (after I had got permission from the land owner) for around 19:00. I was the first to arrive and was met by a brutal and strong wind which really felt cold, air temperature was 0 °C but felt well below with the wind chill. Hilary arrived within a couple of minutes and after a quick chat we decided to travel to Uffcott to see if there was better shelter there from the strong wind. As it was, the hedge to the north did filter some of the wind out, so we decided to set up camp here. By 19:20, I had my Meade LX90 telescope with a 14 mm Pentax eye piece set up and ready, the strong wind might bounce the scope around a bit but we would find out later on. The guide stars for the set up were Capella and Rigel.

My first target was Saturn, now getting very low in the western sky and well past its best, it turned out to be only 8 ° above the horizon, as usual I could make out the rings of the planet and the moon Titan out to the west. Off to Jupiter and this is where I noticed the telescope bouncing around a bit by the wind, the brighter the object the more bounce I would notice. I could make out the two main weather belts with three moons out to the west (from Jupiter it was Io, Ganymede and Callisto) with Europa out to the east. Managed to find Neptune this time, it was in the finderscope just a case of manually slewing the telescope to the right object (first one I choose, lucky me!), could make no detail out of this planet. This is when the only car came pass us all evening, after the car had gone I went off to Uranus, could make some blue or green colour on this planet? One Messier (M) object I do not see very often is M79 sitting below Orion in Lupus (the Hare), as it had cleared the hedge I went off to find it, this globular cluster was a fuzzy blob to look at, did not help being so low in the sky. Next object was M1, the only Supernova remnant in his list, this object was a large grey blob to look at. Following on from this was M41 sitting about 4 ° below the star Sirius, this open cluster was large and sparse to look at. Final object for the evening was one of my all-time favourites and M42, as usual this object was great to look at. While I was looking at these objects, Hilary was using a three inch refractor on a manual mount and picking up new objects for her. I did help her at times using my laser pen to direct her to the general location for some objects.

The time was now 20:13 and we were both getting cold (temperature had not dropped, it was just the strength of the wind), so we decided to pack up and go home as both of us were getting cold, at least there was no dew on the telescope, so I would not need to dry any used equipment off overnight.

Clear skies.

Peter Chappell

Viewing Log for 17th of January

Wednesday's is normally the evening I play chess at the Merlin in Swindon but this evening the sky was clear, so I decided I would do a viewing session instead as it has been a long time since I have been out viewing. I put a notice out on the Swindon Stargazers Ad Hoc group but no one could come out with me. I contacted the owner at Nebo and he was more than happy for me to use his land for viewing.

When I got close to the viewing position I noticed two fairly bright 'stars' very low in the western sky, these I could not make out from memory, at all? Only when I finally got out of the car I noticed more bright objects in a straight line about the same distances apart in the western sky, yes Starlink satellites I thought! Anyway with the lights gone, I started to set up my Meade LX90 would be using a 10 mm XW Pentax eye piece for the evening and was ready by 19:42. With a temperature of – 2 °C already it would be a cold evening, having some wind would not help me either and on top of that some cloud had arrived which might ruin the evening for me? I did have company with me for the evening, I would be trying out my new SeeStar S50 telescope/camera and see how I get on with it, I knew my night vision would not be great as I would have to look at my phone once in a while and see how it was getting on. Guild stars were Capella and Rigel.

The Moon was waxing half phase, so I would come back to this object at the end of my session, so first object for the evening was Neptune as Saturn had unfortunately set by now, could not make out any colour with this planet, probably did not help being fairly close to the horizon? So on to Jupiter shining very brightly in the southern sky, I could make out the two main weather belts with Europa to the west and (from Jupiter) Ganymede (which would soon be eclipsed by Jupiter) Io and finally Callisto to the east. Final solar system object was Uranus which like Neptune was in the finderscope but I had to manually slew the telescope to see the objects, I think there was a hint of blue/green coming from the planet? For a change I thought I was try 'Tonight's Best', first object was Sirius, the brightest star in the whole night sky at magnitude (mag) -1.44, this is an 'A' class star. Next was Messier (M) 42, probably the best object to look at in the winter sky? As usual this object was great to look at, another member of Swindon Stargazers suggested looking at the object with an O3 filter, I have never done this before and noticed the dust lanes showed up better but the stars were dimmer, all depends which you wish to look at, I guess? Tried the star Mira but this was hiding in the clouds! On to the Double Cluster or Caldwell 14, these are large open clusters (OC) with some bright stars within the groups. Next object was M45 which is no good with the telescope (too large for it), so I viewed this OC with the finderscope which was still good even with the Moon washing some of the sky out. Back to Betelgeuse, the red giant star at the shoulder of Orion, going more east we came across Regulus in Leo, this has a mag of 1.3 and is a 'B' class star. Going much further west and Aldebaran in the Hyades cluster (this is a foreground star and not part of the cluster), this has a mag of 0.8 and is a 'K' class of star. On to Castor in Gemini, this is a visual double star with a gap of 2.0 arc seconds (actually a six star system but only two can be seen with small tele-

scopes?), this has a mag of 1.9. Now the controller went off to the Hyades which we have already been too! This like M45 is too large for the telescope, better with the finderscope or with the mark one eye ball. Now going east again to M44, the Beehive cluster again better seen with the finderscope. On to M37 in Auriga, a large OC with lots of stars within this cluster, nearby is M38, again a large OC but not as many bright stars as M37. Time to look at the Moon as I was starting to get really cold by now, the terminator (day/night line on the surface of the Moon) was great, even managed to see some Rilles.

The time was now 21:28 and time to pack everything up, by now the skies had cleared with no wind, so conditions had improved a lot a lot. Noticed there was no ice or frost on the kit used or the car even though it was – 4°C, the dew level must be low for this evening? I would still dry everything off over night to be on the safe side.

I have added some pictures I took with the SeeStar S50.

Clear skies.

Peter Chappell

SeeStar S50 review

At one of the Wiltshire AS viewing evening at Lacock before Christmas, a member brought a long new astronomy equipment (to me), turns out it was the SeeStar S50 All-in-one Smart APO telescope. The pictures he got on his mobile phone looked very good. That was about all I thought about the product until around the Christmas period when I thought I could get one as a present for myself. I placed an order with First Light Optics for £539 (standard price in the UK) but had to wait about 10 days as they were out of stock at that time.

The SeeStar arrived about two weeks later, took it out of the box, I was surprised how small and light (around 5 kg with tripod attached) it was. It comes with a 50 mm f5 apochromatic telescope with electric focuser, digital camera and intelligent controller to name a few. First thing I did was too charge up the telescope, it will last up to six hours in the field? While this was happening I down loaded the App to my phone, you need a smart phone to operate the SeeStar. Later on I connected both together via Wi-Fi, so I could operate the telescope. The instructions were fairly simple to get started, I had to view a couple of YouTube videos to help me out. After that it was just a case of waiting for a clear night so I could get out and try the kit out.

First clear night and I was free turned out to be the 16th of January, so I went outside on to my driveway and set up the telescope following the instructions I read. I used an umbrella to shield the telescope from a street light right outside my front garden, anybody going past would be wondering what I was doing! The sky from my front garden was limited by houses, trees and street lights, my first target I tried was M76, the Little Dumbbell in Peruses, while doing it self-checks it was not happy with the levels but I let it carry on and see what would happen it takes a dark frame first and then light frames which are either 10, 20 or 30 seconds long. I went for a session of 10 minutes using 10 second pictures and see what I could get at the end, several times it dumped a picture as it was not happy with the result. In the end I did get a picture of M76 which I had to blow up so I could see the nebula on the screen of my phone, it was not bad at all, I expect with some post processing the picture would be much better (something I am totally useless at before you start asking)? Could not go to M42 as that object was still behind a roof, so I tried for M45, the Pleiades. Unfortunately I only got a few stars in this large open cluster, the subject was too big? The following night I went out for a viewing session with my Meade telescope and took the SeeStar with me. After doing the set ups I let the telescope do its bit on some subjects, as I had problems with cloud being around, I had a go at IC434 better known as the Horsehead nebula an object I have never seen with my own eyes, yet! I left the telescope run for approx. 17 minutes on this object and the result was pretty good, I had a half phase Moon to deal with in the sky. Following this I went on to M42 and the amount of colour it brought out was very surprising, all I see with my eyes is stars and grey dust lanes. I still had the odd error come up around some pictures that the controller dumped. A few days later I was speaking to Damian, the chairperson of Swindon Stargazers and I found out he had one and was willing to help me out one evening. So we arranged

a time and date and went off to his house for some instruction. Seems like I was not setting up correctly to start with, Damian took me through the set up and I made mental notes which I put to paper later on. We had a go at the Rosette nebula (NGC2244 or Caldwell 49) and after a few shots we started to get good detail from this open cluster and associated nebula. That was the only picture I took with Damian as I did not want to take too much time from him as he was take pictures as well that evening. Since the night with Damian I have not been able to get out and try the SeeStar for myself but I think with the notes I have made, I should not have any trouble setting up?

For the price, I think this is a great object, the pictures are very good as the unit as an auto focus which I have not mentioned before, you can store the pictures on either the unit or phone and it is very mobile. It also comes with a solar filter, so you can view the surface of the sun, fitting the filter only takes a few seconds, built in dew heater and good carrying case.

If you have the money spare, it is a worth well object to buy, might even come down in price in the future if newer models come out? I have included some pictures I took with the SeeStar as they come from the unit to my phone with no processing. Only real downside I could up with, no good if you are doing visual viewing at the same time as viewing the phone screen you could lose night vision?

Peter Chappell

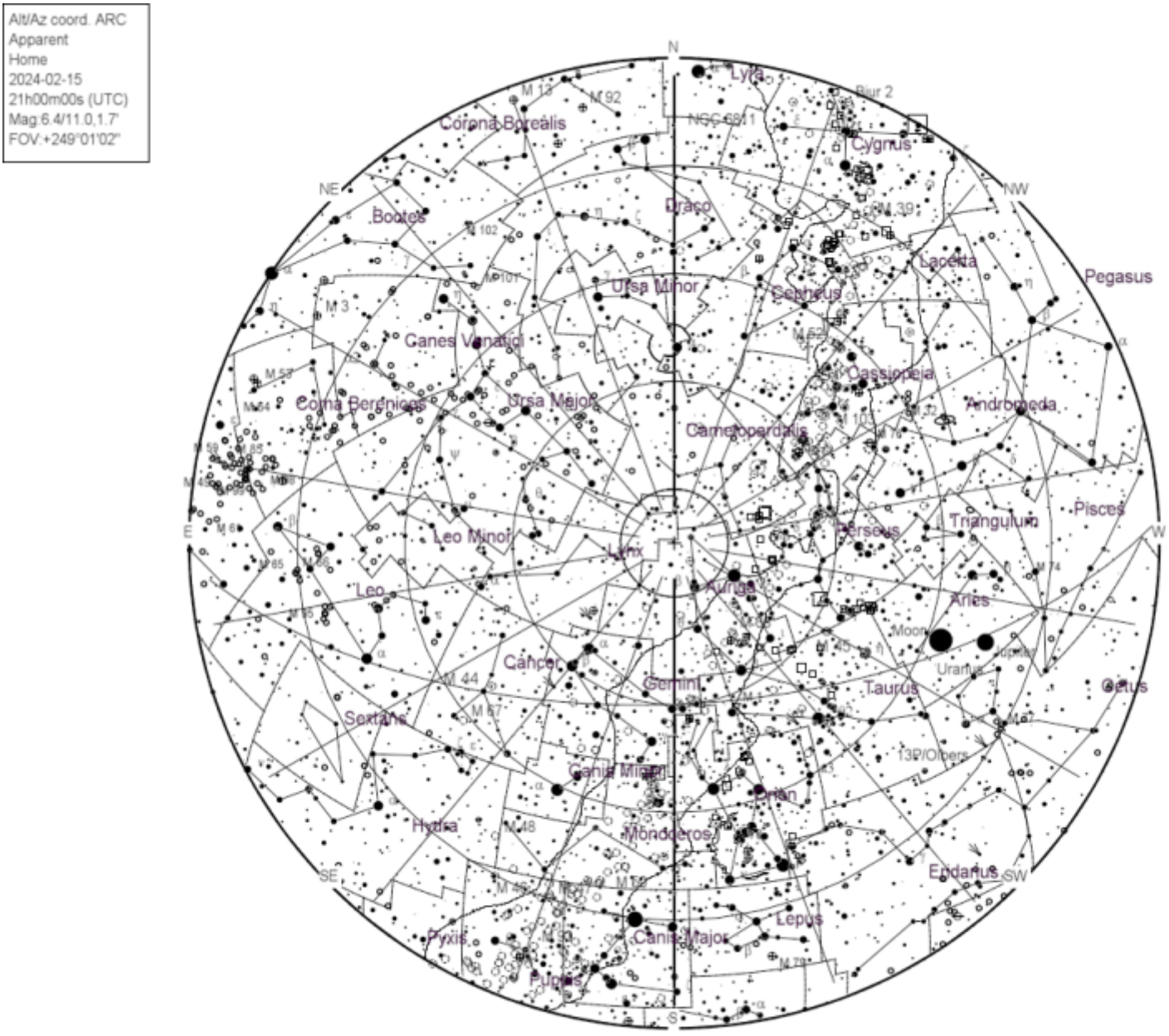
Thank you Peter.

Someluar images from my Nikon P1000

This month.

Camera zoom only.

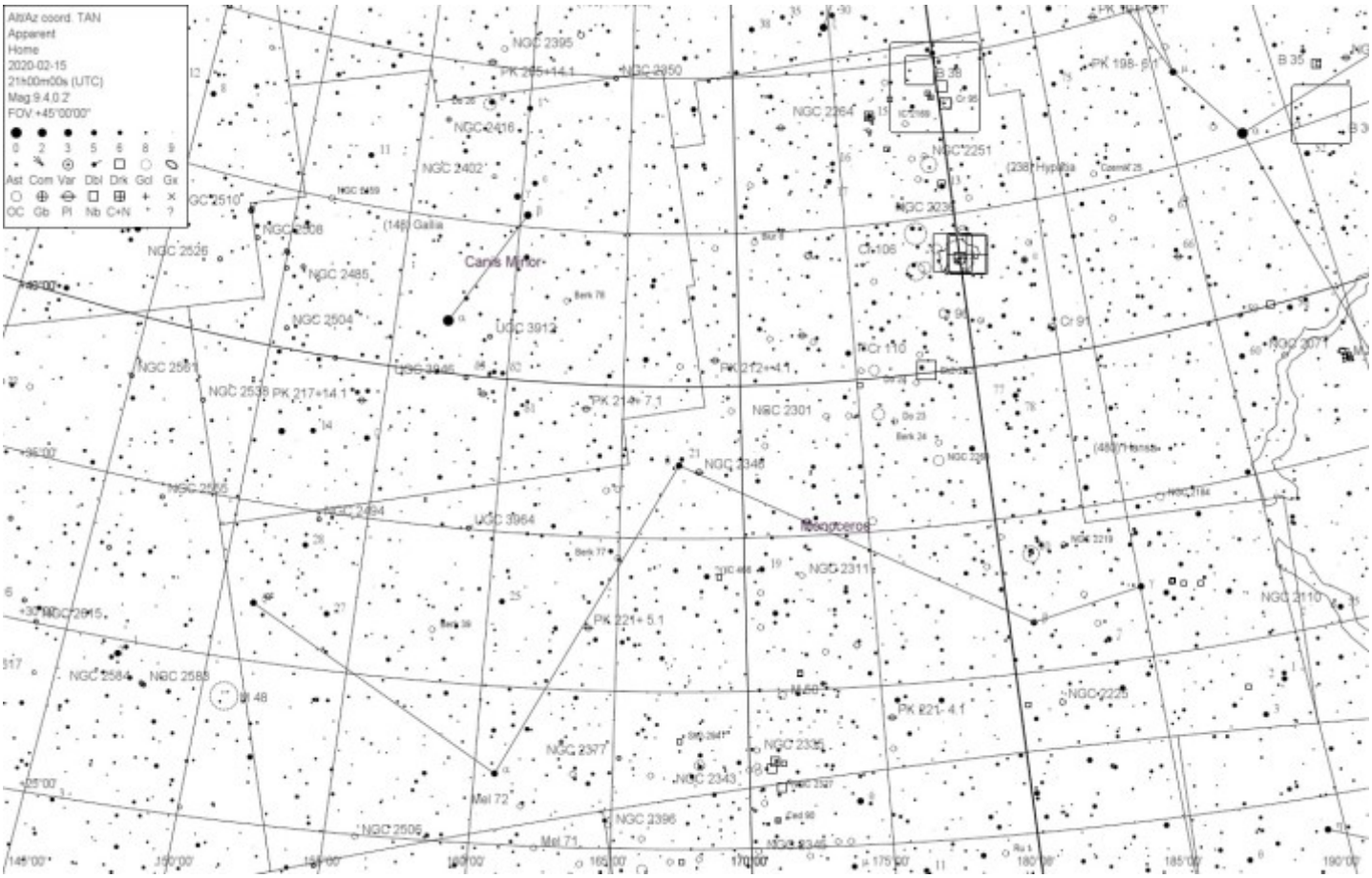
WHATS UP, FEBRUARY 24



February 9 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 23:00 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

February 24 - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 12:32 UTC. This full moon was known by early Native American tribes as the Snow Moon because the heaviest snows usually fell during this time of the year. Since hunting is difficult, this moon has also been known by some tribes as the Hunger Moon, since the harsh weather made hunting difficult.

CONSTELLATION OF THE MONTH: MONOCEROUS and CANIS MINOR



Monoceros

The constellation of Monoceros was originally charted on a work done by Petrus Plancius in the early 1600s for its biblical references, but its first historical reference appears in Jakob Bartsch's star charts created of 1624 where it was listed as Unicornu. There is also a possibility, according to Heinrich Wilhelm Olbers and Ludwig Ideler's work with older astrological charts, that Monoceros could have been referred to as "the Second Horse" – while historian Joseph Justus Scaliger also makes reference to it in his (mid 1500s) work with Persian astrological records. Regards of its origins, Monoceros was adopted as one of the 88 modern constellations by the International Astronomical Union in 1930 and remains on the charts today. It is a relatively dim constellation that consists of 4 main stars in its primary asterism and contains 32 Bayer Flamsteed designated stars within its confines. Monoceros spans approximately 482 square degrees of sky and is bordered by the constellations of Canis Minor, Gemini, Hydra, Lepus, Orion and Puppis. It is visible to all observers located at latitudes between +75° and ?85° and is best seen at culmination during the month of February.

There is one annual meteor shower associated with Monoceros which peaks on or about December 10 of each year – the Monocerids: The radiant for this meteor shower occurs near the border of Gemini and averages about 12 meteors per hour at maximum fall rate. It is best viewed when there is little to no Moon to interfere with the faint streaks and activity is at its most when the constellation reaches the zenith.

Because Monoceros is a relatively "new" constellation, there isn't any mythology associated with it – but the Unicorn itself has a long history of mystery. You'll not find this creature mention anywhere in mythology, but everywhere else! The unicorn is mention in the Bible, in accounts of natural history, in Chinese lore, Ethiopian artwork, medieval stories and religious art. It is depicted as a one-horned horse, thought to have existed somewhere at the edge of the known Earth.. and it still exists roaming the edges of the celestial sphere just between the northern and southern ecliptic plane. Fable or folklore? No matter which, it's filled with many great and starry delights!

Let's begin our binocular tour of Monoceros with its primary star – Alpha Monocerotis – the "a" symbol on our map. Hanging out in space some 144 light years from Earth, it's not the brightest star in the constellation, nor is it particular special. Alpha is just another orange/yellow helium-fusing giant star, not a whole lot different than ours. Averaging about 11 times larger than our Sun and putting out about 60 times more light, Alpha's hydrogen fuel tank went to empty about 250 million years ago. Now it just waits quiety, waiting for its helium shell to fade away… ready to spend the rest of its life as just another dense white dwarf star.

Now, take a look at Beta Monocerotis – the "B" symbol on our map. If you think it's slightly brighter – you're right. That's because Beta has some help from two other stars, too! Put your telescope Beta's way and discover what Sir William Herschel called "one of the most beautiful sights in the heavens". This fantastic triple star star system is located about 690 light years from our solar system. As you watch it slowly drift by the eyepiece, you'll know the names of the stars by which leave sight first… from west to east they are A, B and C. In this circumstance, it is believed the B and C stars orbit each other and the A star orbits this pair. All three are about 34 million years old and all three are dwarf stars. Close to

each other in magnitude, this trio of hot, blue/white B3 stars each run a temperature of about 18,500 Kelvin and shine anywhere from 3200 down t0 1300 times brighter than our own Sun and spinning on their axis up to 150 times faster. A real triple treat!

For binoculars, have a look at visual double star Delta Monocerotis – the “8” symbol on our map. Located 115 light years from our solar system, this cool pair is worth stopping by – just to see if you can resolve it with your eyes alone! Don’t forget to try Epsilon Monocerotis, too. The backwards “3” on our map. Larger, steady binoculars may separate it and it’s easy for a smaller telescope. This is a very pretty gold and yellow combination binary star, seperated by about two magnitudes. You’ll find it on a number of observing lists. While there, take a look just two degrees northwest of Epsilon for T Moncerotis. This is a great Cepheid variable star with a period of 27 days and a magnitude range of 6.4 to 8.0. Those are the kinds of changes you can easily notice!

Our first deep sky binocular and telescope target will be magnificent Messier 50 (RA 07:03.2 Dec -08:20). This splendid open star cluster averages around magnitude 6 and was logged on April 5, 1772 by Charles Messier in his catalog on deep sky objects. Located about about 3,200 light years from Earth, it spans about 20 light years of space and contains about 200 stars. Inside this 78 million year old cloud is at least one red giant star – located just a little bit south of central. Can you spot it? How about the smattering of yellows amid the blue/whites?

Now head for equally bright NGC 2301 (6:51.8 Dec +00:28). This easily resolvable chain of stars can be seen in binoculars, but requires a telescope to resolve its individual members. Smaller telescopes will notice at least 30 members, while larger aperture can detect many more from this 80 member galactic star cluster. Located about 2500 light years away, be sure to see if you notice color in the stars here, too. This intermediate age open cluster has been studied for short-term variable stars and chemically peculiar stars. You’ll find this one on many challenging observing lists, too!

Time to hop to NGC 2244 (RA 6:32.4 Dec +04:52). The “Rosette Nebula” is a fine target for either telescopes or larger binoculars at a combined magnitude of 5. But, remember, combined magnitude isn’t true brightness! You’ll find the nebula here is quite faint and requires a good, dark, Moon-less sky. NGC 2244 is a star cluster embroiled in a reflection nebula spanning 55 light-years and most commonly called “The Rosette.” Located about 2500 light-years away, the cluster heats the gas within the nebula to nearly 18,000 degrees Fahrenheit, causing it to emit light in a process similar to that of a fluorescent tube. A huge percentage of this light is hydrogen-alpha, which is scattered back from its dusty shell and becomes polarized. While you won’t see any red hues in visible light, a large pair of binoculars from a dark sky site can make out a vague nebulosity associated with this open cluster. Even if you can’t, it is still a wonderful cluster of stars crowned by the yellow jewel of 12 Monocerotis. With good seeing, small telescopes can easily spot the broken, patchy wreath of nebulosity around a well-resolved symmetrical concentration of stars. Larger scopes, and those with filters, will make out separate areas of the nebula which also bear their own distinctive NGC labels. No matter how you view it, the entire region is one of the best for winter skies.

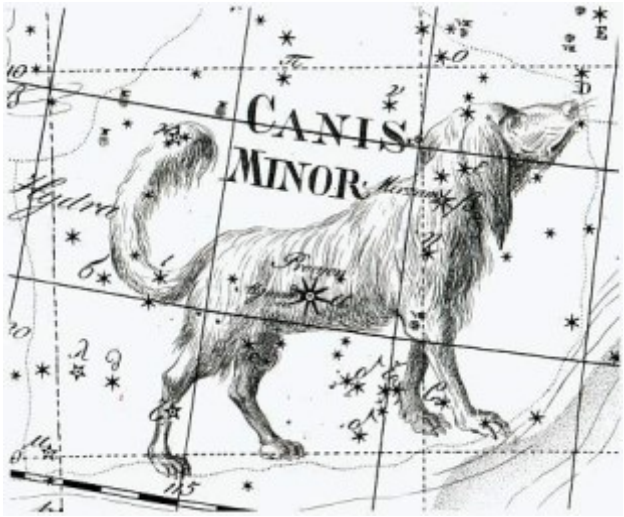
Now for NGC 2264 (RA 6:41.1 Dec +09:53). Larger binoculars and small telescopes will easily pick out a distinct wedge of stars. This is most commonly known as the “Christmas Tree Cluster,” its name given by Lowell Observatory astronomer Carl Lampland. With its peak pointing due south, this triangular group is believed to be around 2600 light-years away and spans about 20 light-years. Look closely at its brightest star – S Monocerotis is not only a variable, but also has an 8th magnitude companion. The group itself is believed to be almost 2 million years old. The nebulosity is beyond the reach of a small telescope, but the brightest portion illuminated by one of its stars is the home of the Cone Nebula. Larger telescopes can see a visible V-like thread of nebulosity in this area which completes the outer edge of the dark cone. To the north is a photographic only region known as the Foxfur Nebula, part of a vast complex of nebulae that extends from Gemini to Orion.

Northwest of the complex are several regions of bright nebulae, such as NGC 2247, NGC 2245, IC 446 and IC 2169. Of these regions, the one most suited to the average scope is NGC 2245 (RA 6:32.7 Dec +10:10), which is fairly large, but faint, and accompanies an 11th magnitude star. NGC 2247 is a circular patch of nebulosity around an 8th magnitude star, and it will appear much like a slight fog. IC 446 is indeed a smile to larger aperture, for it will appear much like a small comet with the nebulosity fanning away to the south-

west. IC 2169 is the most difficult of all. Even with a large scope a “hint” is all!

Now, get out there and capture NGC 2261 (RA 6:39.2 Dec +08:44). You’ll find it about 2 degrees northeast of star 13 in Monoceros. Perhaps you know it better as “Hubble’s Variable Nebula”? Named for Edwin Hubble, this 10th magnitude object is very blue in appearance through larger apertures, and a true enigma. The fueling star, the variable R Monocerotis, does not display a normal stellar spectrum and may be a proto-planetary system. R is usually lost in the high surface brightness of the “comet-like” structure of the nebula, yet the nebula itself varies with no predictable timetable – perhaps due to dark masses shadowing the star. We do not even know how far away it is, because there is no detectable parallax!

There are many other wonderful objects in Monoceros just waiting for you to discover them… So get a good star atlas



and go hunting the Unicorn!

CANIS MINOR

In the 2nd century CE, Greek-Egyptian astronomer Claudius Ptolemaeus (aka. Ptolemy) compiled a list of all the then -known 48 constellations. This treatise, known as the Almagest, would be used by medieval European and Islamic scholars for over a thousand years to come, effectively becoming astrological and astronomical canon until the early Modern Age.

One of these constellations was Canis Minor, a small constellation in the northern hemisphere. As a relatively dim collection of stars, it contains only two particularly bright stars and only faint Deep Sky Objects. Today, it is one of the 88 constellations recognized by the International Astronomical Union, and is bordered by the Monoceros, Gemini, Cancer and Hydra constellation.

Like most asterisms named by the Greeks and Romans, the first recorded mention of this constellation goes back to ancient Mesopotamia. Specifically, Canis Minor’s brightest stars – Procyon and Gomeisa – were mentioned in the Three Stars Each tablets (ca. 1100 BCE), where they were referred to as MASH.TAB.BA (or “twins”).

In the later texts that belong to the MUL.APIN, the constellation was given the name DAR.LUGAL (“the star which stands behind it”) and represented a rooster. According to ancient Greco-Roman mythology, Canis Minor represented the smaller of Orion’s two hunting dogs, though they did not recognize it as its own constellation.

In Greek mythology, Canis Minor is also connected with the Teumessian Fox, a beast turned into stone with its hunter (Laelaps) by Zeus. He then placed them in heaven as Canis Major (Laelaps) and Canis Minor (Teumessian Fox). According to English astronomer and biographer of constellation history Ian Ridpath:

“Canis Minor is usually identified as one of the dogs of Orion. But in a famous legend from Attica (the area around Athens), recounted by the mythographer Hyginus, the constellation represents Maera, dog of Icarius, the man whom the god Dionysus first taught to make wine. When Icarius gave his wine to some shepherds for tasting, they rapidly became drunk. Suspecting that Icarius had poisoned them, they killed him. Maera the dog ran howling to Icarius’s daughter Erigone, caught hold of her dress with his teeth and led her to her father’s body. Both Erigone and the dog took their own lives where Icarius lay.

“Zeus placed their images among the stars as a reminder of the unfortunate affair. To atone for their tragic mistake, the people of Athens instituted a yearly celebration in honour of Icarius and Erigone. In this story, Icarius is identified with the constellation Boötes, Erigone is Virgo and Maera is Canis Minor.”

Canis Minor, as depicted by Johann Bode in his 1801 work Uranographia. Credit: Wikipedia Commons/Alessio Govi

To the ancient Egyptians, this constellation represented Anubis, the jackal god. To the ancient Aztecs, the stars of Canis Minor were incorporated along with stars from Orion and Gemini into as asterism known as “Water”, which was associated with the day. Procyon was also significant in the cultural traditions of the Polynesians, the Maori people of New Zealand, and the Aborigines of Australia.

In Chinese astronomy, the stars corresponding to Canis Minor were part of the The Vermilion Bird of the South. Along with stars from Cancer and Gemini, they formed the asterisms known as the Northern and Southern River, as well as the asterism Shuiwei (“water level”), which represented an official who managed floodwaters or a marker of the water level.

History of Observation:

Canis Minor was one of the original 48 constellations included by Ptolemy in his the Almagest. Though not recognized as its own asterism by the Ancient Greeks, it was added by the Romans as the smaller of Orion’s hunting dogs. Thanks to Ptolemy’s inclusion of it in his 2nd century treatise, it would go on to become part of astrological and astronomical traditions for a thousand years to come.

For medieval Arabic astronomers, Canis Minor continued to be depicted as a dog, and was known as “al-Kalb al-Asghar“. It was included in the Book of Fixed Stars by Abd al-Rahman al-Sufi, who assigned a canine figure to his stellar diagram. Procyon and Gomeisa were also named for their proximity to Sirius; Procyon being named the “Syrian Sirius (“ash-Shi’ra ash-Shamiya“) and Gomeisa the “Sirius with bleary eyes” (“ash-Shira al-Ghamisa“).

The constellation Canis Minor, shown alongside Monoceros and the obsolete constellation Atelier Typographique. Credit: Library of Congress

The constellation was included in Syndey Hall’s Urania’s Mirror (1825) alongside Monoceros and the now obsolete constellation Atelier Typographique. Many alternate names were suggested between the 17th and 19th centuries in an attempt to simplify celestial charts. However, Canis Minor has endured; and in 1922, it became one the 88 modern constellations to be recognized by the IAU.

Notable Features:

Canis Minor contains two primary stars and 14 Bayer/ Flamsteed designated stars. It's brightest star, Procyon (Alpha Canis Minoris), is also the seventh brightest star in the sky. With an apparent visual magnitude of 0.34, Procyon is not extraordinarily bright in itself. But it's proximity to the Sun – 11.41 light years from Earth – ensures that it appears bright in the night sky.

The star's name is derived from the Greek word which means "before the dog", a reference to the fact that it appears to rise before Sirius (the "Dog Star") when observed from northern latitudes. Procyon is a binary star system, composed of a white main sequence star (Procyon A) and Procyon B, a DA-type faint white dwarf as the companion.

Procyon is part of the Winter Triangle asterism, along with Sirius in Canis Major and Betelgeuse in the constellation Orion. It is also part of the Winter Hexagon, along with the stars Capella in Auriga, Aldebaran in Taurus, Castor and Pollux in Gemini, Rigel in Orion and Sirius in Canis Major.

Next up is Gomeisa, the second brightest star in Canis Minor. This hot, B8-type main sequence star is classified as a Gamma Cassiopeiae variable, which means that it rotates rapidly and exhibits irregular variations in luminosity because of the outflow of matter. Gomeisa is approximately 170 light years from Earth and the name is derived from the Arabic "al-ghumaisa" ("the bleary-eyed woman").

Canis Minor also has a number of Deep Sky Objects located within it, but all are very faint and difficult to observe. The brightest is the spiral galaxy NGC 2485 (apparent magnitude of 12.4), which is located 3.5 degrees northeast of Procyon. There is one meteor shower associated with this constellation, which are the Canis-Minorids.

Finding Canis Minor:

Though it is relatively faint, Canis Minor and its stars can be viewed using binoculars. Start with the brightest, Procyon – aka. Alpha Canis Minoris (Alpha CMi). If you're unsure of which bright star is, you'll find it in the center of the diamond shape grouping in the southwest area. Known to the ancients as Procyon – "The Little Dog Star" – it's the seventh brightest star in the night sky and the 13th nearest to our solar system.

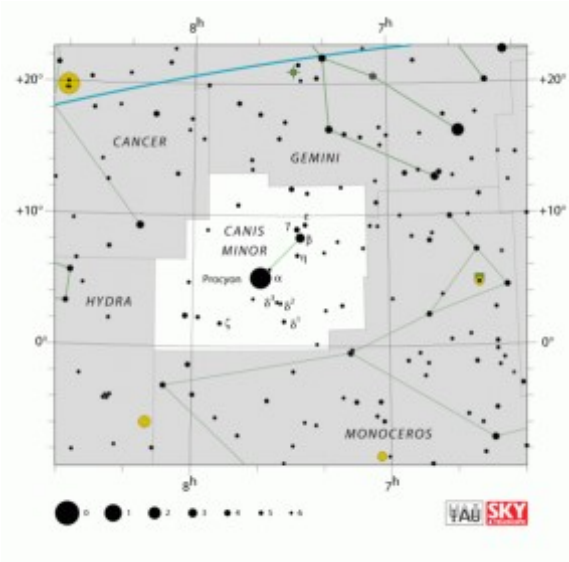
For over 100 years, astronomers have known this brilliant star had a companion. Being 15,000 times fainter than the parent star, Procyon B is an example of a white dwarf whose diameter is only about twice that of Earth. But its density exceeds two tons per cubic inch! (Or, a third of a metric ton per cubic centimeter). While only very large telescopes can resolve this second closest of the white dwarf stars, even the moonlight can't dim its beauty.

Now hop over to Beta CMi. Known by the very strange name of Gomeisa ("bleary-eyed woman"), it refers to the weeping sister left behind when Sirius and Canopus ran to the south to save their lives. Located about 170 light years away from our Solar System, Beta is a blue-white class B main sequence dwarf star with around 3 times the mass of our Sun and a stellar luminosity over 250 times that of Sol.

Gomeisa is a fast rotator, spinning at its equator with a speed of at least 250 kilometers per second (125 times our Sun's rotation speed) giving the star a rotation period of about a day. Sunspots would appear to move very quickly there! According to Jim Kaler, Professor Emeritus of Astronomy at the University of Illinois:

"Since we may be looking more at the star's pole than at its equator, it may be spinning much faster, and indeed is rotating so quickly that it is surrounded by a disk of matter that emits radiation, rendering Gomeisa a "B-emission" star rather like Gamma Cassiopeiae and Alcyone. Like these two, Gomeisa is distinguished by having the size of its disk directly measured, the disk's diameter almost four times larger than the star. Like quite a number of hot stars (including Adhara, Nunki, and many others), Gomeisa is also surrounded by a thin cloud of dusty interstellar gas that it helps to heat."

Now hop over to Gamma Canis Minoris, an orange K-type giant with an apparent magnitude of +4.33. It is a spectroscopic binary, has an unresolved companion which has an orbital period of 389 days, and is approximately 398 light years from Earth. And next is Epsilon Canis Minoris, a yellow G-type bright giant (apparent magnitude of +4.99) which is approximately 990 light years from Earth.



The location of Canis Minor in the northern hemisphere. Credit: IAU/Sky&Telescope magazine

For smaller telescopes, the double star Struve 1149 is a lovely sight, consisting of a yellow primary star and a faintly blue companion. For larger telescopes and GoTo telescopes, try NGC 2485 (RA 07 56.7 Dec +07 29), a magnitude 13 spiral galaxy that has a small, round glow, sharp edges and a very bright, stellar nucleus. If you want one that's even more challenging, try NGC 2508 (RA 08 02 0 Dec +08 34).

Canis Minor lies in the second quadrant of the northern hemisphere (NQ2) and can be seen at latitudes between +90° and -75°. The neighboring constellations are Cancer, Gemini, Hydra, and Monoceros, and it is best visible during the month of March.

ISS PASSES For December 2023

from Heavens Above website maintained by Chris Peat.

Date	Brightn	Start	Highest	End						
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
15 Feb	**-0.8**	**06:42:45**	**10°**	**S**	**06:44:47**	**15°**	**SE**	**06:46:49**	**10°**	**ESE**
16 Feb	-0.4	05:56:31	10°	SE	05:56:50	10°	SE	05:57:10	10°	SE
17 Feb	-1.8	06:41:49	10°	SSW	06:44:48	29°	SSE	06:47:47	10°	E
18 Feb	-1.4	05:54:07	10°	SSW	05:56:43	21°	SE	05:59:20	10°	E
19 Feb	-1.0	05:06:58	11°	S	05:08:40	15°	SE	05:10:37	10°	ESE
19 Feb	-3.0	06:41:35	10°	SW	06:44:52	53°	SSE	06:48:10	10°	E
20 Feb	-2.6	05:53:52	12°	SW	05:56:40	39°	SSE	05:59:50	10°	E
21 Feb	-2.2	05:07:42	25°	S	05:08:28	28°	SSE	05:11:25	10°	E
22 Feb	-1.1	04:21:25	17°	ESE	04:21:25	17°	ESE	04:22:51	10°	E
22 Feb	-3.5	05:54:20	18°	WSW	05:56:39	66°	SSE	06:00:00	10°	E
23 Feb	-3.3	05:07:57	47°	S	05:08:20	51°	SSE	05:11:37	10°	E
24 Feb	-1.5	04:21:29	24°	ESE	04:21:29	24°	ESE	04:23:11	10°	E
24 Feb	-3.8	05:54:23	20°	W	05:56:38	89°	S	06:00:00	10°	E
25 Feb	-3.9	05:07:52	67°	SW	05:08:13	79°	SSE	05:11:36	10°	E
26 Feb	-1.8	04:21:17	30°	E	04:21:17	30°	E	04:23:09	10°	E
26 Feb	-3.8	05:54:11	18°	W	05:56:33	85°	N	05:59:55	10°	E
27 Feb	-3.9	05:07:34	62°	W	05:08:05	86°	N	05:11:26	10°	E
28 Feb	-2.1	04:20:56	34°	E	04:20:56	34°	E	04:22:57	10°	E
28 Feb	-3.8	05:53:49	16°	W	05:56:22	81°	S	05:59:43	10°	ESE
29 Feb	-0.3	03:34:17	11°	E	03:34:17	11°	E	03:34:27	10°	E
29 Feb	-3.9	05:07:10	54°	W	05:07:51	89°	N	05:11:13	10°	E
01 Mar	-2.3	04:20:31	37°	E	04:20:31	37°	E	04:22:41	10°	E
01 Mar	-3.5	05:53:24	15°	W	05:56:00	54°	SSW	05:59:17	10°	ESE
02 Mar	-0.4	03:33:52	12°	E	03:33:52	12°	E	03:34:06	10°	E
02 Mar	-3.8	05:06:45	49°	W	05:07:29	70°	SSW	05:10:50	10°	ESE
03 Mar	-2.4	04:20:08	37°	ESE	04:20:08	37°	ESE	04:22:17	10°	ESE
03 Mar	-2.7	05:53:02	14°	W	05:55:25	30°	SSW	05:58:25	10°	SSE
04 Mar	-0.4	03:33:34	11°	E	03:33:34	11°	E	03:33:40	10°	E
04 Mar	-3.3	05:06:28	39°	SW	05:06:56	42°	SSW	05:10:07	10°	SE
05 Mar	-2.0	04:19:57	27°	SE	04:19:57	27°	SE	04:21:40	10°	ESE
05 Mar	-1.9	05:52:51	12°	WSW	05:54:36	16°	SW	05:56:44	10°	S

END IMAGES, AND OBSERVING

At some stage in January we got enough clear spies to tempt me back into my dome. A lot of faff and cable untwisting and I eventually managed to rig the Nikon D800A onto the 125mm esprit Sly Watcher refactor, and grab some shots before cloud and cold got me. One of my targets was Messier 35 (and much further away open cluster ngc 2158. These are by the 'foot' of Gemin the twins, close to the star Propus. A lot of 'bright' nebulae are in the region, but require filters and long multiple exposures. It was too cold to sort that! Andy Burns

OUTREACH

Friday 9th February Brecon Beacons, Dark Skies Wales. Weather permitting

Tuesday 13th February: Beaufort Townswomens Guild. 10:39am

Wiltshire Astronomical Society Public Observing Dates for the 2023-2024 Season.

The observing site is normally in the Picnic Area beside the Red Lion Pub car park, in Lacock but can change, so sign up for email confirmation at https://wasnet.org.uk/observing/

The WAS Observing team have provided at least two opportunities for observing evenings each month. If the first is cancelled due to weather then we have normally have a second chance the following week. A reminder email is sent out on the Tuesday before the day and a 'Go, No-Go' email sent by 16:00 on the observing day which based on various weather Apps and looking out of the window at work.

Opportunity	Day	Date	Month	set-up	Observe	Moon Phase and Rise/Set Times			Suggested Observing Targets
Second	Friday	9th	February	19:00	19:30	New	Rising	17:30	becomes less favourable.
First	Friday	01st	March	19:00	19:30	Qtr	Rising	1:00	The outer planets are becoming less favourable and Orion is at his heighest at the very beginning of the night. Galaxy season is beginning with as Leo Coma Berenices and Ursa Major rising.
Second	Friday	08th	March	19:30	20:00	Cres	Rising	6:45	
First	Friday	05th	April	20:00	20:30	Cres	Rising	6:00	With Virgo rising the Galaxy observbing season is well underway. We are also graced by the Great Star Clust M13 in Hercules with Venus and Mars only obserable in the morning skies
Second	Friday	12th	April	20:30	21:00	Cres	Setting	1:00	
First	Friday	03rd	May	20:30	21:00	Cres	Rising	4:30	The nights are short and the rise of Vega, Deneb and Altair, mark the rise of the summer triangle and the final few weeks of the Wiltshire Astronomical Societies observing season.
Second	Friday	10th	May	20:30	21:00	Cres	Setting	23:45	

Always feel free to contact the observing team for advice on what to see in the night sky.
Also if members want to see a particular event the observing team can look into setting up ad-hoc sessions where possible.

Wiltshire Astronomical Society Observing Team