NWASNEWS

Volume30 Issue 3

November 2023

Newsletter for the Wiltshire, Swindon, Beckington, Bath Astronomical Societies

Practical Session

Hopefully tonight is going to be a practical session as the last hall meeting before next year.

How much will be imaging processing (ucing as many free software tools as possible) and different methods. Hopefully we can also answer some practical setting up questions and equipment advice as YOU require.

The December and January meetings will be on Zoom, with Martin Griffiths and Paul Money agreeing to give talks. With hard weather being expected this winter with low turn outs for hall meetings in December and January it is probably better to make this on line meetings, with possible extension to Zoom for February and one or two on line meetings later in the year. This does NOT mean we are going entirely on line, it is optimising numbers and hall use with available speakers.

Clear skies

Andy Burns (as caretaker chair)

I would like to drum up some volunteers for the 1st Chippenham Scout session on the 14th or 21st November.
Might be good if they bring some binoculars they can share.
I think I have you both down as volunteers but a couple more wouldn't help from a more technical side.

I will print out the handouts for everybody and talk through the observing session.

Cheers
Chris Brooks

Late in the Aurora season (they are expected September and Octobe then February and March/ April close to equinox) a surprise intense Aurora was visible of Wiltshire on November 5th.
Very high spike at 5:45pm become a STEVE in some areas.
Photo Andy Burns,

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

2023 October 3rd: Hall Meeting Andy Burns The Dark Nebulae, History and Imaging
November 7th: Practical Session &A
December 5th Zoom meeting Martin Griffiths
2024
January 2nd Zoom Meeting Paul Money
February 6th
March 5th
April 2nd
May 7th
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

Tonight is a practical session and if you have any

equipment queries,

practical help needed setting up (please bring your equipment for this),

Software use issues (please bring files on a memory stick if you want direct help)

Software advice, practical demonstrations etc.

If you have interesting hardware you want to show and tell, please bring along.

Back up will be image processing techniques.

All welcome.

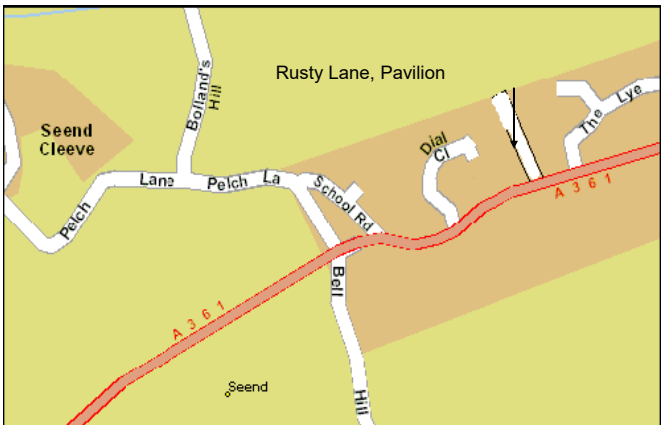
It is a session members have requested, please use it.

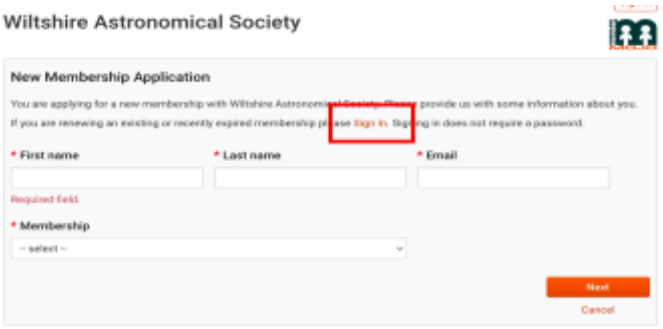
Membership Meeting nights £1.00 for members £3 for visitors

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, 17 November

Talk on Eisa Esinga

– The Planetarium in the Bedroom

Our in-person speaker at our October meet is Dr Lillian Hobbs who will be presenting the Eise Eisinga Planetarium.

The Royal Eise Eisinga Planetarium (Dutch: Koninklijk(e) Eise Eisinga Planetarium) is an 18th-century orrery in Franeker, Friesland, Netherlands. It is currently a museum and open to the public. The orrery has been on the top 100 Dutch heritage sites list since 1990 and in December. It is the oldest working orrery in the world.

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 on the link below.

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 on our website at:
http://www.swindonstargazers.com/clubdiary/directions01.htm

Next Meeting Dates

Friday, 17 November @ 19.30

Dr Lillian Hobbs: Eisa Esinga - The Planetarium in the Bedroom

Friday, 8 December @ 19.30

Christmas Social

Friday 19 January 2024 @ 19:30

Bernard Henin: Imaging our Solar System

Friday 16 February 2024 @ 19:30

John Gale: The Lunar 100

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 O'Hara
Email: damian@cog2.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:

Tuesday, 28th November
A talk by Dr Becky Smethurst. Becky is a Royal Astronomical Society Research Fellow at the University of Oxford (Christ Church). Her research is focussed on nearby galaxy evolution studies; particularly the growth of supermassive black holes (SMBHs) and the processes responsible for the shutdown of star formation in a galaxy. Becky is a panellist on the RAS Supermassive podcast and has a YouTube channel Dr Becky with over 0.6m subscribers. This meeting will be held at BRLSI on Queen Square. Get your seat reserved via https://bathastronomers.org.uk/drbecky

Wednesday, 13th December

A talk by Richard Hook. His talk is entitled "ESO and the development of monster telescopes". This meeting will be held at the Herschel Museum of Astronomy, 19 New King Street, Bath.

More information and news is 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 Celestron 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 Martin, Meyrick, Prim and Simon will be happy to help you.

Simon Holbeche

SPACE NEWS

Dimorphos is Probably a Piece of Didymos

Last September, NASA purposefully smashed a spacecraft into Dimorphos, a 160m-wide space rock orbiting a larger asteroid named Didymos. The goal of the mission, called DART (the Double Asteroid Redirection Test), was to demonstrate humanity's ability to redirect hazardous asteroids away from Earth. That part of the mission was a success above and beyond all expectations. But now scientists are also learning more about the origins of the two asteroids. A study conducted in the wake of the DART impact found that Dimorphos is made from the same material as Didymos, and that the pair of asteroids likely originated from a single body.
The DART impact blasted a significant cloud of debris away from Dimorphos. The initial cloud, made of fine-grained dust and gaseous material containing traces of sodium and potassium, quickly spread out and moved away from the system. It dispersed within a matter of minutes. A second cloud of heavier debris, however, persisted for months. Using NASA's 3m IRTF telescope in Hawaii, a research team observed this secondary debris cloud for a week following the impact, watching as it evolved and spread out. What they found was that the spectroscopic signature of the Dimorphos debris matched that of pre-impact Didymos.
Both asteroids, in other words, were made from the same material: silicate (a compound of silicon and oxygen).

Aftermath of the DART Collision with Dimorphos Captured by SOAR Telescope. Image credit: CTIO/NOIRLab/SOAR/NSF/AURA/T. Kareta (Lowell Observatory), M. Knight (US Naval Academy); Image processing: T.A. Rector (University of Alaska Anchorage/NSF's NOIRLab), M. Zamani & D. de Martin (NSF's NOIRLab).

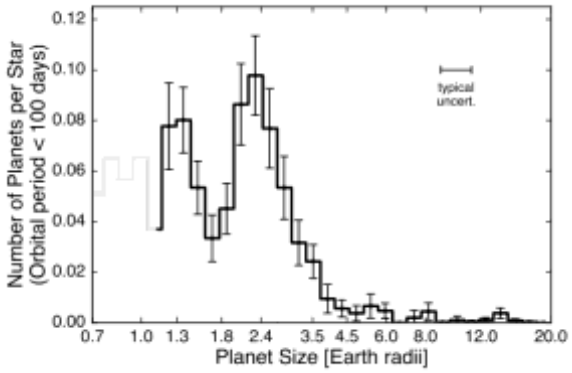
Before the DART impact, only ~5 percent of the light from the system originated at Dimorphos. It was drastically outshined by its larger partner Didymos, making it incredibly difficult to get distinct spectral observations of the tiny asteroid. However, after the impact, the whole system brightened considerably, and the debris, at its maximum, contributed more than 64% of the light reaching Earth-based telescopes from the system. This bright glow made it possible to study the composition of Dimorphos' debris cloud.
The research team noticed that the debris was made largely of heavier material and larger rocks, because the solar wind quickly pushed away the smaller grains. This appears to contrast with material on the surface of Didymos, which the researchers predict is made up of mostly small grains – a prediction that the upcoming European Space Agency's HERA mission will be able to confirm.
So if Didymos and Dimorphos are made of the same material, how did they end up as separate asteroids?
The leading theory is called the 'rotational-disruption' model: "Asteroids with diameters smaller than a few tens of km can disrupt as their fast rotation applies tension on their weak internal strength, resulting in ejected material that goes into orbit and eventually accumulates into a satellite," the researchers explain.
As a small, fast-spinning asteroid, Didymos is a good candidate for this model. It has almost certainly ejected particulates into orbit around it. It also shares a geometry common among binary asteroids: spherical with a bulge around the equator. This geometry only strengthens the case for the rotational-disruption model.
With the new data collected after the DART impact, the case is pretty well closed. The fact that the spectral signature is identical between Didymos and Dimorphos strongly suggests that they originated as one body. Over time, the fast-spinning asteroid spun material out into orbit, which then collected together to form the tiny moon called Dimorphos. There it stayed for eons, until DART interrupted its path, and gave it a new orbit (and gave us a unique opportunity to study it).

TESS Finds Eight More Super-Earths

NASA's Kepler spacecraft has discovered most of the confirmed exoplanets that we know of. But its successor, TESS (Transiting Exoplanet Survey Satellite), is catching up. New research announces the validation of eight more TESS candidates, and they're all Super-Earths.
TESS's planet-hunting mission has a more refined goal than its predecessor, Kepler. TESS was specifically built to detect exoplanets transiting in front of bright stars in Earth's neighbourhood. It's found about 400 confirmed exoplanets, but there's a list of exoplanets awaiting confirmation that contains almost 6,000 candidates. There are only two ways to confirm all these exoplanets-in-waiting: further observations and statistical methods.
What all those unconfirmed candidates amount to is data. They're hiding in TESS's data, waiting for clever scientists to validate them. Further observations can help uncover them, but not alone.
The Validation of Transiting Exoplanets using Statistical Tools (VaTEST) project uses statistical tools and machine learning to comb through all of TESS's data, looking for elusive exoplanets. In the VaTEST project, scientists are not only able to confirm planets while working around false positives; they're also able to characterize exoplanet atmospheres suitable for further study.
A team of scientists presented their results in a paper titled "VaTEST III: Validation of 8 Potential Super-Earths from TESS Data." Their paper is under review at the Publications of the Astronomical Society of Australia and is currently under pre-print. The lead author is Priyashkumar Mistry, a Ph.D. student at the University of New South Wales, Australia.
False positives are a persistent problem in exoplanet science. When you think about it, it's easy to see why. TESS is looking for tiny dips in starlight around distant stars caused by an exoplanet passing in front of the stars. One blip isn't enough; we need several, and there has to be a rhythm to them. But other things can give false impressions of a transiting planet, for example, eclipsing binary stars. Even a star's natural variability can cloud the signals.
So TESS has gathered an enormous amount of data that has to be worked through, sorting out false positives from real signals, and that's what VaTEST does. In this paper, the team has validated eight more Super-Earths.
"We have validated eight potential super-Earths using a combination of ground-based telescope data, high-resolution imaging, and the statistical validation tool known as TRICERATOPS," the authors write.

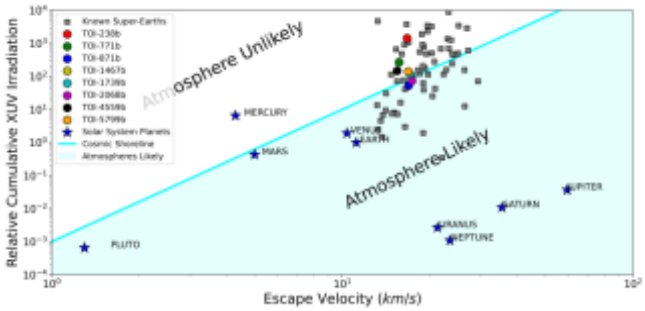
Planet	Earth Masses	Earth Radii
TOI-238b	3.6	1.6
TOI-771b	2.8	1.4
TOI-871b	3.8	1.6
TOI-1467b	4.4	1.8
TOI-1739b	4	1.7
TOI-2068b	4.4	1.8
TOI-4559b	2.7	1.4
TOI5799b	3.7	1.6

Not only did they find eight more super-Earths, but they've identified six of them that are excellent candidates for additional study. "Among all these validated planets, six of them fall within the region known as' keystone planets,' which makes them particularly interesting for study," they explain.
A keystone planet is an idea that has its roots in biology. In biology, a keystone species is one that defines an entire ecosystem. A great example is coral in coral reefs. Coral reefs are a distinct ecosystem anchored by coral.
In exoplanet science, a keystone planet is a planet that helps explain the overall population of exoplanets. In particular, it helps explain the radius gap we see in exoplanet populations. There's a scarcity of planets between 1.5 and 2 Earth radii. It's probably caused by photoevaporation mass loss. A star's powerful radiation, especially in X-ray and UV emissions (XUV), can strip away a planet's atmosphere over time, possibly creating a dearth of 1.5 to 2 Earth radii planets.
"It is noteworthy that planets within the size range investigated herein are absent from our own solar system, making their study crucial for gaining insights into the evolutionary stages between Earth and Neptune," the authors explain. "These keystone planets play a pivotal role in advancing our understanding of the radius-valley phenomenon around low-mass stars."



A histogram of planets with given radii from a sample of 900 Kepler systems. The decreased occurrence rate between 1.5 and 2.0 Earth radii is apparent. It's called the radius gap, Neptune desert, and the Fulton gap. Six of the new planets sit in this gap. Image Credit: Fulton et al. 2017

There's another concept that relates to super-Earths and the radius gap, and it focuses on why some planets lose their atmospheres and fall below the gap and why others don't. It's called the 'cosmic shoreline,' and it's a statistical trend that links exoplanets together.
The cosmic shoreline is a dividing line between planets that have retained their atmospheres and planets that have lost them due to XUV radiation from their stars.



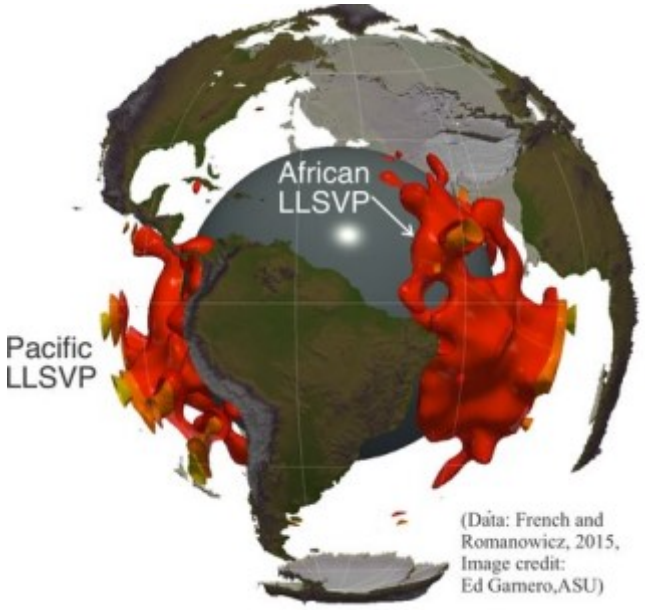
This figure from the study shows how the cosmic shoreline divides exoplanets that retain their atmospheres from exoplanets that lose their atmospheres via XUV radiation from their stars. Several of the planets in this study are clustered right near the shoreline, making them 'keystone planets' and a juicy target for further study. Image Credit: Mistry et al. 2023.
"In this study, we validate eight exoplanets using TESS, ground-based transit photometry, high-resolution imaging, and a statistical validation tool," the authors explain. The researchers say that more precise mass measurements are needed to understand them better and that for three of the planets, these more precise measurements may be attainable.
Not only are some of these planets in the radius gap, but two of them are suitable for further atmospheric study with the JWST and its powerful instruments. "We also found that two of our validated planets, TOI-771b and TOI-4559b, are amenable for transmission spectroscopy using JWST," the authors write. When the JWST was being designed and built, scientists hoped that it would be able to scrutinize the atmospheres of Super-Earths. There are none of these worlds in our own Solar System, so deciphering their atmospheres can help us understand where super-Earths fit into the exoplanet population, how they evolve, and how they relate to the radius gap and the cosmic shoreline.
The team simulated the atmospheres of the eight super-Earths and also what the JWST will likely see when it examines the atmospheres. The results are intriguing, showing signs of carbon dioxide, water, and, most intriguingly, methane. Methane can be a biosignature, though there's a lot of uncertainty. Finding it in any exoplanet atmosphere will help scientists understand its presence more fully, whether it's an actual biosignature or not.
"However, real observations of the validated planets using the JWST are required to confirm our transmission spectra analysis," the paper concludes.

Earth is Hiding Another Planet Deep Inside

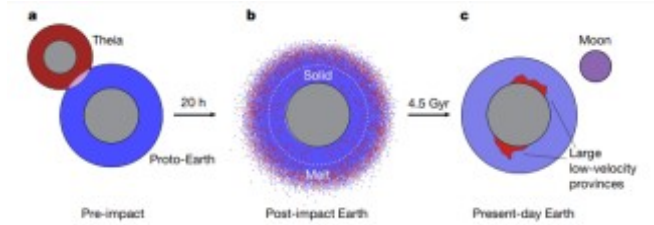
Earth's early history is marked by massive collisions with other objects, including planetesimals. One of the defining events in our planet's history, the formation of the Moon, likely resulted from one of these catastrophic collisions when a Mars-sized protoplanet crashed into Earth. That's the Giant Impact Hypothesis, and it explains how the collision produced a torus of debris rotating around the Earth that eventually coalesced into our only natural satellite.
New research strengthens the idea that Theia left some of its remains inside Earth.
The Giant Impact that created the Moon occurred in the Hadean eon. The Hadean is the first of Earth's four eons and spans from the Earth's formation about 4.5 billion years ago up to about 4.03 billion years ago when it was succeed-

ed by the Archaean eon.
Earth was a magma ocean for about the first 50 million years. It began cooling during the Hadean, but the mantle was still much more viscous than it is today. Residual heat from its formation and the higher level of radiogenic heating kept the mantle in a more fluid state. There was more water in the mantle at that time, too, adding to the mantle's fluidity.

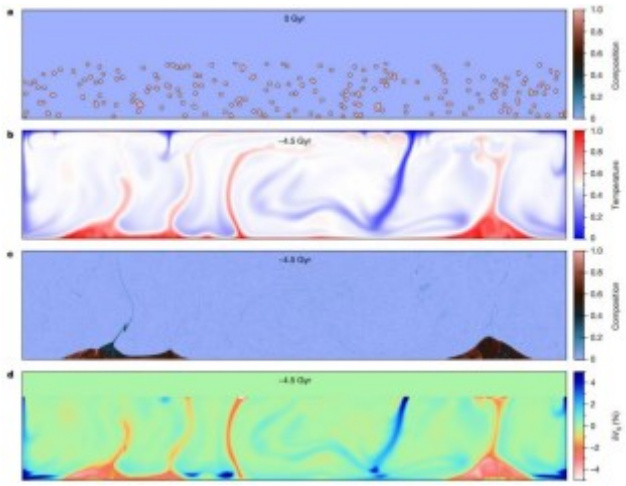
Artist's impression of magma ocean planet. Scientists think all terrestrial planets go through a magma ocean phase early in their history, and Earth is no exception. Credit: Mark Garlick
That's important because when objects slammed into Earth, they were able to sink deeper into the mantle.
Back in the 1980s, scientists made a remarkable discovery. Two gigantic, continent-sized blobs were embedded deep in the Earth. One is under Africa, and one is under the Pacific Ocean. They're called LLSVPs, or Large Low-Shear-Velocity Provinces, and they have unusually high iron levels. The iron concentration changes the speed of seismic waves that travel through them, leading to their discovery.



Scientists discovered two large low-shear-velocity provinces deep inside Earth in the 1980s. They contain high levels of iron that generate tell-tale seismic wave patterns. Image Credit: Edward Garnero.
Both the LLSVPs extend for thousands of kilometres horizontally and extend up to 1000 km upwards from the boundary between the Earth's core and its mantle. They contain about 8% of the Earth's mantle volume and about 6% of the Earth's total volume.
For decades, their origins were a mystery. Scientists wondered if they could be the remains of Theia, the protoplanet that slammed into Earth, resulting in the Moon. But convincing evidence was elusive.
Now, new research points convincingly at the Giant Impact as the LLSVP's source. The new paper is "Moon-forming impactor as a source of Earth's basal mantle anomalies." It's in the journal Nature, and the lead author is Qian Yuan, a Postdoctoral Scholar Research Associate at Caltech's Seismological Laboratory.
Yuan is a geophysicist, but when he attended a seminar on planet formation by Mikhail Zolotov, a professor at Arizona State University, in 2019, a light went on. Zolotov was explaining the Giant Impact Hypothesis. Two things happened simultaneously: Qian noted that the Moon is relatively iron-rich, and Zolotov explained that no trace of Theia has ever been found.
"Right after Mikhail had said that no one knows where the impactor is now, I had a 'eureka moment' and realized that the iron-rich impactor could have transformed into mantle blobs," says Yuan.



This schematic from the research shows how the LLSVPs formed. Image Credit: Yuan et al. 2023.
Yuan isn't the first scientist to consider this possibility. But, scientific methods and tools improve over time. Yuan worked with other researchers from multiple disciplines to perform multiple simulations of the Giant Impact with different chemical compositions for Theia and its impact on the Hadean Earth.
According to their work, this is what happened.
When Theia slammed into Earth, it released an enormous amount of energy. It sprayed molten material from both planets into orbit around Earth. Some escaped, much of it coalesced into the Moon, and some of it remained inside Earth's molten form.
But much of the energy delivered by the collision remained in Earth's upper regions, never penetrating to the core. This is where Yuan's simulations differ from previous efforts. They're more detailed and higher resolution. Previous efforts failed to show that the energy never penetrated the core, leading to uncertain conclusions.
But if Earth's core was effectively blocked off from the impact energy, it remained much cooler. That also means that the Earth's lower mantle wasn't heated to the degree previous research showed. So, the material from Theia, called Theia Mantle Material (TMM) that remained inside the Earth didn't dissolve completely into the mantle. Instead, it formed the two recognizable clumps that form both of Earth's LLSVPs.
If the mantle had been warmer, meaning it had received more energy from the impact, the Earth's mantle material and the TMM would've mixed together more thoroughly. But they didn't mix, and the higher iron content in the TMM makes the LLSVPs visible in seismic probing because all that iron slows down the seismic waves.
The result is what geophysicists call thermochemical piles.



This figure from the study's simulations shows how the Giant Impact formed LLSVP-like thermochemical piles from Theia Mantle Material. ***a*** shows how TMM is introduced to a depth of 1400 km to the core-mantle boundary (CMB.) When introduced, the material is in the form of randomly distributed spheres. ***b*** shows the temperature at 4.5 billion years. ***c*** shows the TMM accumulating into two distinct LLVPS-like thermochemical piles. ***d*** shows the perturbations measured in the seismic shear velocity. Image Credit: Yuan et al. 2023.

"Our mantle convection models show that dense TMM blobs with a size of tens of kilometres after the impact can later sink and accumulate into LLVP-like thermochemical piles atop Earth's core and survive to the present day," the authors write in their paper. "The LLVPs may, thus, be a natural consequence of the Moon-forming giant impact."

This all leads to another fascinating line of inquiry. How did this material influence the rest of Earth's history? Its plate tectonics, climate, even the course of evolution?

"A logical consequence of the idea that the LLVPs are remnants of Theia is that they are very ancient," said study co-author Paul Asimow. "It makes sense, therefore, to investigate next what consequences they had for Earth's earliest evolution, such as the onset of subduction before conditions were suitable for modern-style plate tectonics, the formation of the first continents, and the origin of the very oldest surviving terrestrial minerals."

Lucy Completes its First Flyby… and Discovers a Bonus Asteroid

NASA's Lucy mission hits the jackpot on its very first asteroid flyby earlier this week.

Welcome to Dinkinesh. NASA's Lucy mission flew past its first target of Wednesday, November 1st, and turned up a surprise: 152830 Dinkinesh (meaning 'marvelous' in the Amharic language) is not one asteroid, but two (!)

The Dinkinesh Flyby

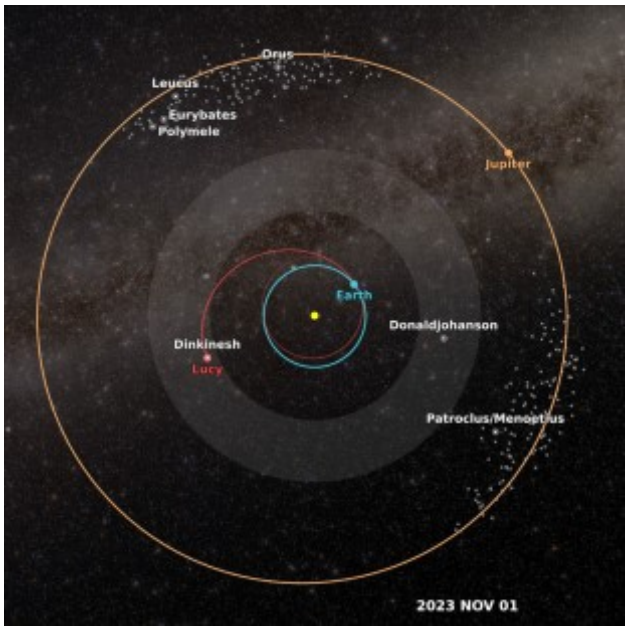
The the 16,000 kilometers per hour (10,000 mph) flyby occurred at a range of 430 kilometers (270 miles), and served as a test for Lucy's instruments on its way to the Trojan asteroids. Closest approach was on November 1st and occurred at 16:54 Universal Time (UT)/12:54 PM U.S. Eastern Time (EDT). The image really caught lots of us off guard, revealing a boulder-strewn surface on both small worlds. At most, we were expecting a few small pixels, so the dramatic resolution was a huge bonus.

The L'LORRI Long Range Reconnaissance Imager and T2Cam tracking cameras really demonstrated their resolution and pinpoint tracking capability on this first flyby. If the names sound familiar, its because the instruments are similar to those carried aboard NASA's New Horizons mission, with completed a flyby past Pluto and Charon in 2015.

The flyby is reminiscent of New Horizons' dramatic 2019 rendezvous with the Kuiper Belt Object 486958 Arrokoth. That passage also surprised scientists, with the object's strange twin-lobed structure.

A Tiny Moonlet

The Dinkinesh moonlet is an estimated 220 meters (720 feet) across, about the size of an Iowa-class battleship. Variations in brightness seen in Dinkinesh on approach hinted at the presence of the unseen moon. As of yet, no orbital period for the moon has been published.



Dinkinesh is a small main belt asteroid, discovered in 1999. Up close, 790 meter-wide Dinkinesh actually looks lots like 101955 Bennu, visited by OSIRIS-REx. The next target for Lucy is asteroid 52246 Donaldjohanson in 2025. Lucy will perform another Earth flyby for a gravitational assist later next year in December 2025. Lucy delivered a great portrait of the Earth and Moon pair during the October 2022 flyby:

The Earth and Moon (faint, to the left) as seen by Lucy during the first Earth flyby. Credit: NASA/SwRI

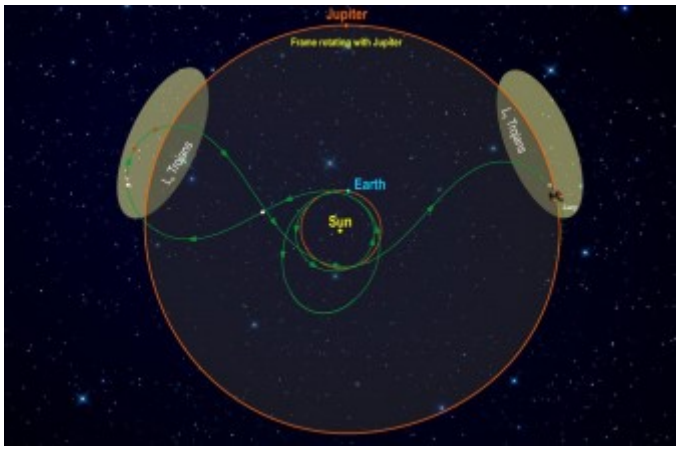
"Dinkinesh really did live up to its name; this is "marvelous'" says principal investigator Hal Levison (Boulder-SwRI) in a recent press release. "When Lucy was originally selected for flight, we planned to fly by seven asteroids…now with this satellite, we've turned it up to 11."

What's Next for Lucy

Lucy takes its name from the 3.2-million year old Lucy hominid fossil, which in turn was named from the Beatles song 'Lucy in the Sky With Diamonds.' The naming alludes to the fossils of planetary formation sought out by planetary researchers in the Jupiter Trojan asteroids. Not only does the spacecraft's L'TES instrument carry a disc made of lab-grown diamonds, but it also has a plaque with poems, speeches and quotes from Earth.

The Lucy plaque affixed to the spacecraft. Credit: NASA

Launched in 2021 atop an Atlas V rocket from Cape Canaveral Space Force Station, the main goal of Lucy is the exploration of the Trojan asteroids, located at stable L4 and L5 points ahead and behind massive Jupiter in its orbit. Plans at launch called for Lucy to visit seven Trojans from 2027 through 2033, though the number has now grown to 11. This now includes two main belt asteroids, plus two moonlets discovered since launch.



Asteroid 15094 Polymele targeted for a Lucy flyby in 2027 was found to possess a moonlet in March 2022. This moonlet is informally named 'Shaun' and was discovered during a stellar occultation. There's an intriguing campaign underway worldwide to observe stellar occultations by target asteroids for the mission. This effort will help map asteroid profiles, refine orbits, and tease out undiscovered moonlets. This is a professional and amateur collaboration, with several events coming right up in 2024.

Lucy will be an amazing mission to follow in the coming decade. Now, what will we name Dinkinesh's new companion moon?

Comet H2 Lemmon Brightens in Early November Ahead of Expectations

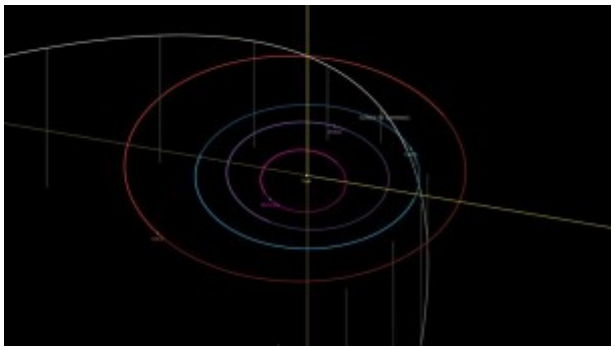
Discovered early this year, Comet C/2023 H2 Lemmon may approach naked eye brightness this month.

A comet discovered earlier this year is performing above expectations, and is currently well-placed in the dusk sky. We're talking about Comet C/2023 H2 Lemmon, moving up the charts now at magnitude +8 and brightening.

Comet H2 Lemmon was discovered on the night of April 23rd 2023, courtesy of the Mount Lemmon Survey (Part of the Catalina Sky Survey) based outside of Tucson, Arizona. To date, the prolific Mount Lemmon Survey has discovered over 50,000 minor planets, to include comets and asteroids.

The Orbit of Comet H2 Lemmon

Comet H2 Lemmon reached perihelion 0.9 Astronomical Units (AU) from the Sun just inside the Earth's orbit on October 29th. The MOID (Minimum Orbit Intersection Distance) from Earth for the comet is just 0.036 AU (5.4 million kilometers), and the comet is on a long 3,870 year, retrograde orbit, inclined 114 degrees relative to the ecliptic plane.

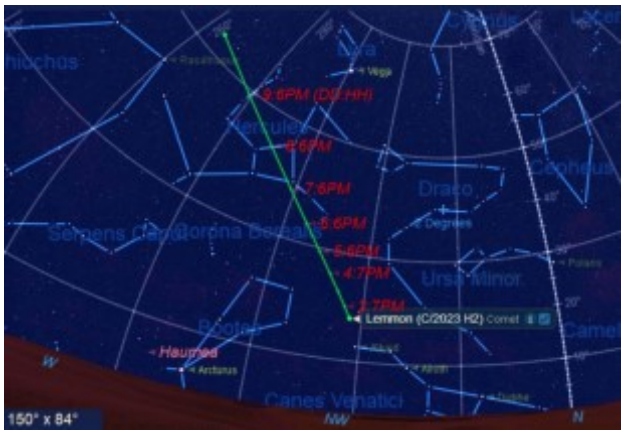


The orbit of Comet H2 Lemmon. Credit: NASA/JPL

The orbit was edge on as seen from the Earth earlier this week on October 31st. Often, this is the time when you'll see a spiky 'anti-tail' that seems to extend from the comet nucleus towards the Sun. Comet E3 ZTF exhibited this sort of dramatic phenomenon earlier this year.

Comet H2 Lemmon during orbital plane crossing on Halloween. Credit: Eliot Herman.

The first half of November is the best time to catch comet H2 Lemmon. The comet will really be truckin,' moving at nine degrees a day at closest approach around November 10th. That's about half an angular degree or the diameter of a Full Moon every 90 *minutes*, a motion versus the stellar background that should be easily discernible after following the comet for about 10 minutes. The comet starts off low to the northwest at dusk for northern hemisphere observers, before vaulting up high through the constellation Hercules into Aquila by mid-month.

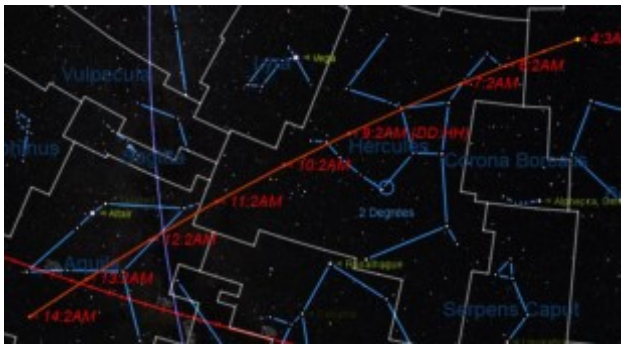


The local path of Comet C/2023 H2 Lemmon through November 10th, 1 hour after sunset as seen from latitude 30 degrees north. Credit: Starry Night

Here are the celestial dates with destiny for Comet H2 Lemmon through November. Unless otherwise noted, 'passes near' denotes a passage closer than one degree:

Comet H2 Lemmon in November

6-Crosses into the constellation Hercules.
7-Passes near the +4.2 magnitude star Phi Herculis.
8-Photo Op: Passes near the +4.2 magnitude star Sigma Herculis, and 4 degrees from the globular cluster Messier 13 and 3 degrees from the globular cluster Messier 92.
9-Passes just 10' from the +3rd magnitude star Pi Herculis.
10-Passes near the +3.7 magnitude star Xi Herculis and passes 0.19 AU from the Earth, perhaps reaching a peak brightness of +5 magnitude.
11-Passes near +4 magnitude star Zeta Aquilae and the +3rd magnitude star Epsilon Aquilae, and moves in to the constellation Aquila.
12-Crosses the galactic plane southward.
13-Crosses the celestial equator southward.
15-Crosses into the constellation Capricornus.
17-Crosses the plane ecliptic southward.
19-The 45% illuminated, waxing crescent Moon passes less than 4 degrees from the comet.
20-Nicks the corner of the constellation Microscopium.
21-Crosses into the constellation Piscis Austrinus.
29-Crosses into the constellation Grus.

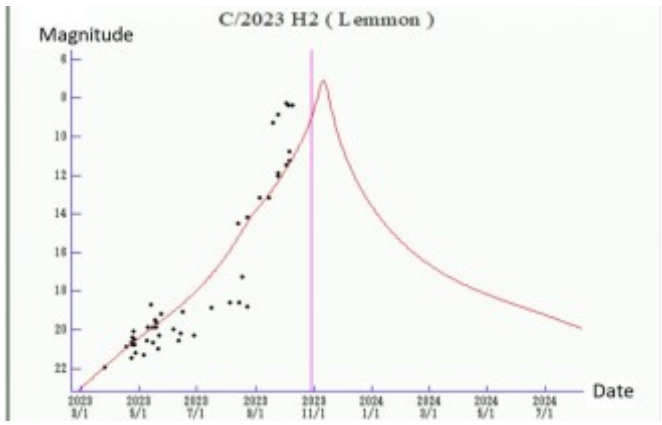


The celestial path of Comet H2 Lemmon through the sky, a week before and after closest approach to the Earth. Credit: Starry Night

Catching the Comet

Through binoculars, the comet will appear similar to a fuzzy globular cluster that stubbornly refuses to snap into focus. Typically, comets that break +10 magnitude grab our attention as potential photographic and binocular targets worth showing off at star parties. Around +5th or +6th magnitude, comets begin to become more appealing, as they're approaching naked eye visibility as seen from a good dark sky site.

At about +2nd or +3rd magnitude, comets start to become truly photogenic targets, bright enough to capture along with foreground objects. Keep in mind that like deep sky objects, all that precious magnitude quoted for comets is smeared out over an extended area. This makes them appear visually fainter than a star of the same brightness. On average, 1 out of 10 comets discovered becomes a good binocular comet, and maybe 1 out of 10 of those goes on to attain naked eye visibility.



The light curve (observed and projected) for Comet C/2023 H2 Lemmon. Credit: adapted from Seiichi Yoshida's *Weekly Information About Bright Comets*.

What Makes a 'Great Comet?'

Orbits also play a key role as to whether a new comet discovery is destined for greatness or not. A good sign includes a perihelion either near the Earth in the inner solar system. Also, an intrinsic brightness while the comet is still far our in the solar system (suggesting a large bright nucleus) is an-

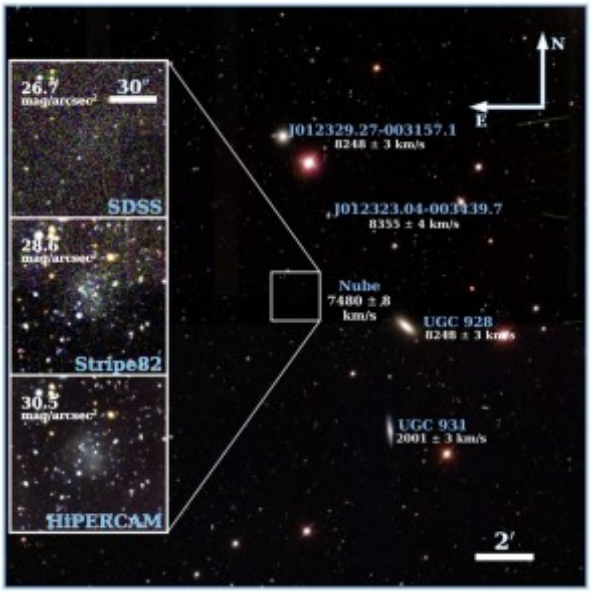
other hopeful sign. We had two great lessons on this in the late '90s. First was Comet C/1995 O1 Hale-Bopp, a large bright comet that was spotted while it was still far out in the solar system. Then, Comet C/1996 B2 Hyakutake, a smaller comet, crept up on us and passed close to the Earth.
Sometimes even prosaic discoveries can have significance. One example is the recently discovered comet from the same sky survey 2023 S3 Lemmon, which shares some similarities with famous Comet 1P Halley. Comet S2 Lemmon has an orbital period exactly twice as long as Halley's Comet at 152 years.
And speaking of the most famous of all comets, 1P/Halley reaches aphelion next month on December 9th at 35 AU from the Sun, out beyond the orbit of Uranus. We're now midway between the last 1986 apparition for the comet, and the next perihelion in (mark your calendars) early 2061.
Comet roll call for 2023 thus far includes Comet 1P/Encke, Comet 103P Hartley, 2023 P1 Nishimura, 2021 T4 Lemmon, 2023 E1 ATLAS, 2022 E3 ZTF. Most of these fell in binocular range, though P1 Nishimura reached magnitude +2 near perihelion in September 2023.

Comet Prospects in 2024

We're certainly due for the next great comet of the century. Looking ahead to next year, comets expected reach perihelion with a magnitude brighter than +10 include:
-12P Pons-Brooks on April 21st at magnitude +3.9;
-13P Olbers on July 1st at magnitude +7.5;
-144P Kushida on January 26th at magnitude +7.9;
-2021 S3 PanSTARRS on February 15th at magnitude +7.4; and:
-2023 A3 Tsuchinshan-ATLAS on September 28th at magnitude +2.5.
12P Pons-Brooks is especially intriguing, as the comet has undergone several outbursts this year, including one this week topping out at magnitude +11. This has given the comet a horseshoe, 'Millennium Falcon' -esque appearance, that has made its rounds on ye 'ole web. Clearly, something interesting is going on on this very active and energetic comet. Along with A3 Tsuchinshan-ATLAS at the end of the year, 12P/Pons-Brooks is worth keeping and eye on. It also reaches perihelion very near the April 8th 2024 total solar eclipse spanning North America.
Will we see a naked eye comet near the Sun during totality? It's an intruding possibility for sure… in the meantime, we can enjoy the brief sight of Comet H2 Lemmon, currently gracing November skies.

A Dwarf Galaxy That's Almost All Dark Matter

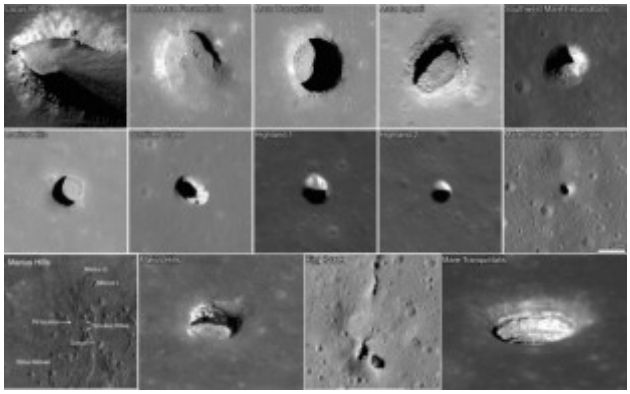
Dark matter is a powerful cosmological model, but it isn't without its problems. In addition to our inability to detect dark matter particles, one issue deals with the number of dwarf galaxies surrounding the Milky Way. According to the most popular models of dark matter, galaxies should be surrounded by clumps of dark matter within their dark matter halo. Since regular matter tends to gather around dark matter, that means the Milky Way should be surrounded by dwarf galaxies. While there are several known dwarf galaxies near the Milky Way, there are fewer than predicted by dark matter simulations. But perhaps there are many more dwarf galaxies we just haven't noticed because they are made mostly of dark matter.
We have detected a few of them. They are known as Almost Dark Galaxies (ADGs), and they are particularly dim. We haven't found enough of them to match the cold dark matter model, but we do keep finding them, as a recent study shows. It describes a newly found dwarf galaxy known as Nube. It was found just by chance in images gathered by the IAC Stripe82 Legacy Project. It is so dim that it doesn't appear in the Sloan Deep Sky Survey (SDSS), which is a bit surprising. But the team noticed what looked like a dark galaxy in an image, and decided to use the Green Bank Telescope to study it further.



The dark matter dwarf galaxy known as Nube. Credit: Montes, et al
Based on the Green Bank data, the galaxy is about 350 million light-years away and has a surface brightness of about 28 mag per square arc second. The galaxy is extremely diffuse, with half of its mass extended over more than 22,000 light years, nearly a quarter of the diameter of the Milky Way. It has a mass of about 26 billion solar masses, but the mass of the stars in the galaxy is only 390 million solar masses. The galaxy is mostly comprised of dark matter, and it is the largest ultra-diffuse galaxy known.
It was only through a bit of luck that we found this dark matter galaxy. Given its size, it's quite likely that other dwarf galaxies are lurking in our celestial neighborhood, if we can only find them. But surprisingly, while galaxies such as these support the dark matter cosmological model, this particular galaxy doesn't match the profile of the most popular variant known as cold dark matter. Instead, it best fits a version known as fuzzy dark matter. So while we're getting closer to the predictions of dark matter simulations, it's clear that there are a few surprises waiting to be accounted for.
So we must keep looking for more of these galaxies. The answers to our dark matter questions are surely there, gathered in the dark.
Reference: Montes, Mireia, et al. "An almost dark galaxy with the mass of the Small Magellanic Cloud." *arXiv preprint* arXiv:2310.12231 (2023).

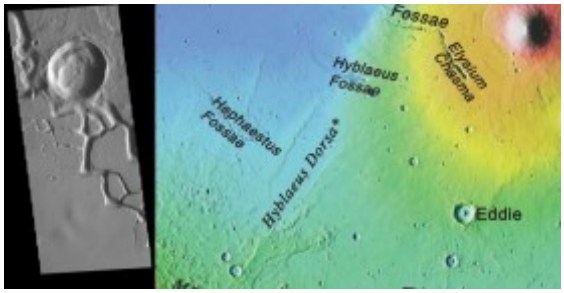
A Collapsed Martian Lava Chamber, Seen From Space

Lava tubes and chambers attract a lot of attention as potential sites for bases on the Moon and Mars. They provide protection from radiation, from temperature swings, and even from meteorites. They beg to be explored.
Volcanoes are just the most obvious and the largest manifestations of a planet's volcanic activity. In reality, most of what creates a volcano happens deep underground. That's true of Earth and Mars.
A volcano occurs when magma, ash, and gases erupt from a magma chamber beneath the surface of a planet. (Or moon, in Io's case.) You can't miss the volcano itself, which rise well above the surface and spew ash high into the atmosphere. But what's hidden is what goes on underground.
Volcanic activity can move an enormous amount of liquid rock, pushing it around and forming an interconnected network of lava tubes and chambers. The lava can drain away, leaving an empty cave or tube. Sometimes the roof collapses, forming what's known as a skylight. There are many of them on the Moon, where they've attracted everyone's attention. The skylight can provide easy access to what could be underground refuges in some cases.



Lava tubes are natural shelters and could serve as Moon bases. These images from the Lunar Reconaissance Orbiter show pits on the lunar surface. The images are each 222 meters (728 feet) wide. Credit: NASA/GSFC/Arizona State University

Mars has them too, and NASA Mars Reconnaissance Orbiter (MRO) captured an image of one with its HiRISE camera. It's in the Hephaestus Fossae Region in Utopia Planitia on Mars. Hephaestus Fossae is a system of channels and troughs. It's connected to the nearby Elysium volcanic center, and melt water from a nearby impact may have helped create it, too. There's some uncertainty.



This image on the left is from the MRO's THEMIS camera and shows more of the Hephaestus Fossae's system of troughs and channels, as well as the nearby impact crater. The image on the right shows the region in relation to its surroundings, including the Elysium Mons volcano on the upper right of the image. Image Credit: NASA/JPL- Caltech/ASU

Lava tubes could provide a solution to one of the obstacles confronting human exploration of Mars. The average surface radiation on Mars is 40 to 50 times stronger than on Earth, but thick overhead rock could provide protection. Mars also experiences wild temperature swings from 20 Celsius down to -152 Celsius. A temperature-controlled habitat buffered by all the overhead rock could protect astronauts and equipment from those swings.

There are all kinds of ideas how to explore these types of features. China is developing plans to explore lunar lava tubes, and even build a base in one. So by the time we make it to Mars, we'll already have our feet wet and will be better equipped to use lava tubes to our advantage.

Did Betelgeuse Consume a Smaller Star?

What's going on with Betelgeuse? In recent years it's generated a lot of headlines as its luminosity has shifted dramatically several times. The red supergiant brightened by almost 50% earlier this year, triggering speculation that it may go supernova.

But new research suggests there's something completely different happening with Betelgeuse that has nothing to do with its recent fluctuations. It may have consumed a smaller companion star.

Listen, when a star like Betelguese brightens and dims to such great extents, humans are bound to sit up and take notice. That's because it's a red supergiant and will certainly blow up as a supernovae. But there's no need to run out and get more tinfoil for our protective head gear. It's too far away to hurt us, but would be one heckuva light show.

Unfortunately for the spectacle-seeker inside all of us, none of the star's recent luminosity fluctuations mean its explosion and destruction are imminent. Instead, the changes have been attributed to dust clouds and the star's regular pulsations.

Some new research can't explain Betelgeuse's recent fluctuations, but it suggests something else happened with our supergiant neighbour in its past. The new study is "Betelgeuse as a Merger of a Massive Star with a Companion." The lead author is Sagiv Shiber from the Department of Physics and Astronomy at Louisiana State University.

But did Betelgeuse have a companion?

You can't miss Betelgeuse. It's the red star on Orion the Hunter's shoulder in this stunning image from astrophotographer Rogelio Bernal Andreo. Humanity's been gazing at it since antiquity. Image Credit: By Rogelio Bernal Andreo – http://deepskycolors.com/astro/JPEG/RBA_Orion_HeadToToes.jpg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=20793252

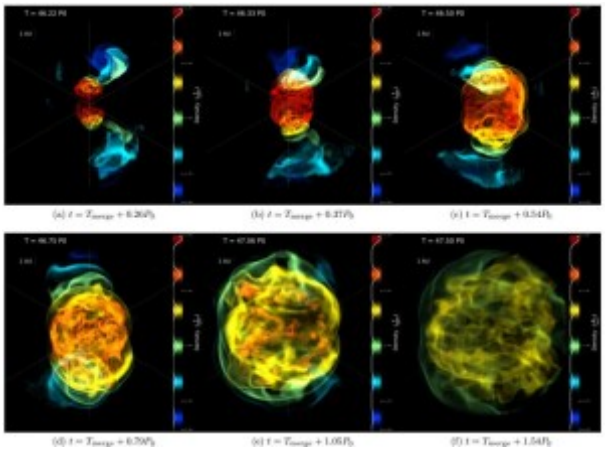
"It has been firmly established that the majority of massive stars exist within binary systems," the authors write. Many of them will experience binary interactions at some point during their evolution. Sometimes, though rarely, the stars can merge. Is that why Betelgeuse is alone?

When a merger happens, a lot depends on the respective masses of the stars. There can be transient "merge-bursts," mass loss, as well as other phenomena.

This is all determined by simulations in the new research. The researchers simulated a merger between a 16 solar mass star and a smaller 4 solar mass star. (Betelgeuse is between 16 and 19 solar masses.) The simulations show that as the stars move closer together and share a common envelope, eventually the minor star merges with the primary star's helium core. "The companion eventually plunges into the envelope of the primary, leading to its spin-up and subsequent merger with the helium core," the authors explain. That causes an exchange of both orbital and thermal energy. Eventually, it triggers a powerful pulse that travels from the core through the primary star's envelope.

But it doesn't stop there. Sometimes, it can also trigger mass

loss. That happens because of the release of gravitational energy caused by the merger. That energy has to express itself somehow, and it's converted into kinetic energy that drives high-speed mass flow away from the primary. In the team's simulations, the mass loss reached as high as 0.6 Earth masses.



This figure from the study is a rendering of the mass loss coming from the simulated merger. From left to right, top to bottom, they show the gas at 7, 10, 14, 21, 27, and 40 days after the merger. Red is the most dense gas and blue is the least dense. Image Credit: Shiber et al. 2023.

But when it comes to Betelgeuse, the evidence for a merger sometime in the past may be in the star's rotation. It rotates at about 5.5 km/second. For reference, our Sun rotates at about 2 km/second. "For instance, studies on Betelgeuse have demonstrated that a previous merger between a pre-main sequence massive star with a mass of approximately 15~17M Earth masses and a low-mass mainsequence companion with a mass of around 1 ~ 4M Earth masses could account for its implied high rotation rate," the paper states.

The merger doesn't interrupt the primary star's evolution into its Red Super Giant (RSG) phase. But it does eject material, often through polar outflows. The gas can travel as fast as 200-300 km/s, which is characteristic of mergeburst events.

There's precedent for this type of merger in V838 Monocerotis. It was a possible luminous red nova, a stellar explosion caused by the merger of two stars. It was unremarkable until 2002 when it suddenly brightened, and was one of the largest known stars for a period of time after the purported merger. A 2007 paper concluded that the mergeburst was the only explanation for V838 Monocerotis' brightening and expansion.

This Hubble Space Telescope image shows the light echo of dust illuminated by nearby star V838 Monocerotis as it became 600,000 times more luminous than our Sun in January 2002. That may have been a mergeburst created when the star merged with and consumed a smaller star. Credit: NASA/ESA

So, is this what happened with Betelgeuse? Did it merge with and consume a smaller companion, leaving no trace? It's implied rotation rate supports that conclusion, as does the star's chemical composition.

This study can't reach that conclusion, but it's a distinct possibility. There's a lot astrophysicists don't yet know about these mergers and their effects. The size of the stars' envelopes and eventual common envelope affects the eventual spin-up rate of the surviving primary. And the amount of mass loss can dispel different amounts of kinetic energy, so there's a lot going on.

The authors made some progress in understanding these events, but they need improved methods and tools to understand them more completely.

"By delving deeper into the physics of stellar mergers, we aim to advance our understanding of massive star evolution, the properties of supernova progenitors, and the role of mergers in shaping the astrophysical transient landscape," they write.

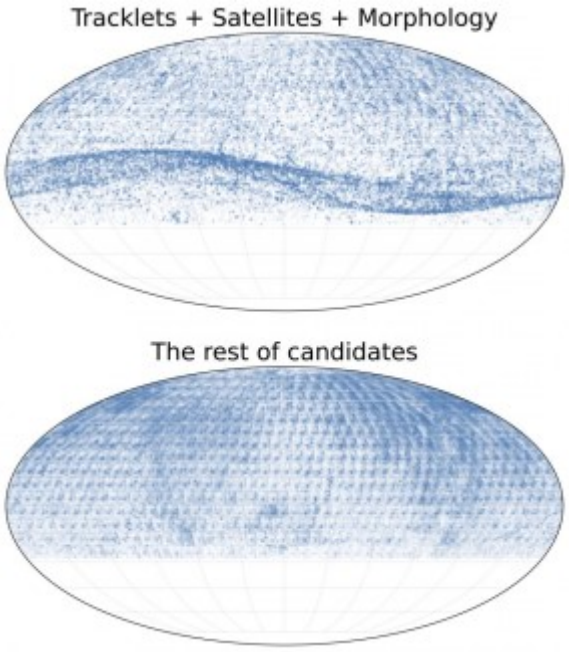
There's no indication that this merger, if it occurred, is directly connected to Betelgeuse's recent fluctuations, or to its eventual explosion as a supernova. But one day, Betelgeuse will explode. If humanity lasts long enough, then many future generations of scientists will be fortunate enough to watch the whole process play out. Then we may finally have answers. But for now, the red supergiant keeps generating headlines.

Satellites Make up to 80,000 Flashing Glints Per Hour. It's a Big Problem for Astronomers

Large-scale sky surveys are set to revolutionize astronomy. Observatories such as Vera Rubin and others will allow astronomers to observe how the sky changes on the scale of days, not weeks or months. They will be able to capture transient events such as supernovae in their earliest stages and will discover near-Earth asteroids we have missed in the past. At the same time, the rise of satellite constellations such as Starlink threatens to overwhelm these surveys with light pollution and could threaten their ability to succeed.

To quantify what the impact of satellite constellations could be, a team recently looked at observations from the Zwicky Transient Facility (ZTF). This survey focuses on short-duration transients, such as stellar flares of red dwarfs and microlensing events. They looked at events that only occurred in a single frame of a particular patch of sky as gathered by ZFT over three years, and sorted them into satellite events and

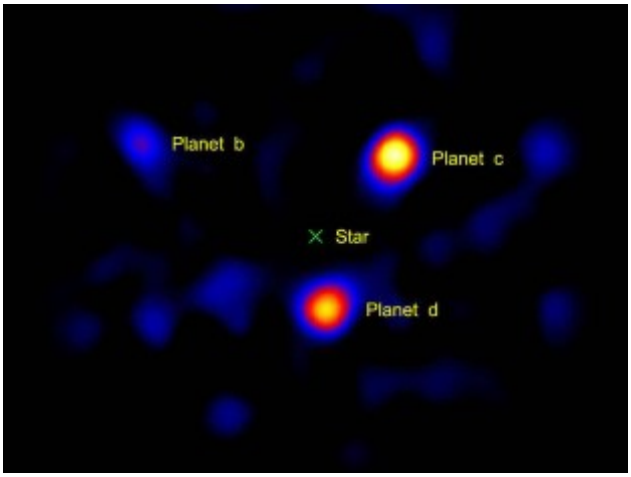
candidate astrophysical events.
Earlier studies have looked at the impact of satellite constellations, but they primarily focused on their overall brightness. When debates over the astronomical impact of these constellations arise, a common argument is that they can be filtered out. Since the satellites drift across the sky, their trails can be identified as artificial and easily removed. But this study focused instead on glints from satellites. Since satellites change orientation as they orbit, flat surfaces on the satellites can reflect sunlight to Earth, creating a short flash or glint. Given the timescale of these glints, they don't leave trails. Instead, they look like short-lived transients, making them more difficult to filter out of the data. The team wanted to see just how bad the situation could be as new sky surveys come online.



Satellite glints (top) vs candidate transients (bottom). Credit: Karpov, et al
They found that the impact is already pretty significant. Based on the ZTF data, they estimated that most glints only last on the order of tens to hundreds of milliseconds, and across the sky, there are currently about 80,000 satellite glints per hour. It's a tremendous amount of light pollution and will impact the transient studies of the Vera Rubin Observatory and others. With Starlink's plans to launch even more satellites and the plans of other large-scale constellations, glints could make certain sky survey projects unfeasible.
Satellite constellations such as Starlink do have many benefits. The goal of bringing internet and data communication to the most remote areas of the world is a noble one. But it comes at a cost, both financially and in what it robs of our view of the heavens. There are choices to be made between connecting everyone instantly and the heritage of our dark skies.
Reference: Karpov, Sergey, and Julien Peloton. "The rate of satellite glints in ZTF and LSST sky surveys." *arXiv preprint* arXiv:2310.17322 (2023).

JWST Sees Four Exoplanets in a Single System

When the JWST activated its penetrating infrared eyes in July 2022, it faced a massive wish-list of targets compiled by an eager international astronomy community. Distant, early galaxies, nascent planets forming in dusty disks, and the end of the Universe's dark ages and its first light were on the list. But exoplanets were also on the list, and there were thousands of them beckoning to be studied.
But one distant solar system stood out: HR 8799, a system about 133 light-years away.
Why this system over others? 15 years ago astronomers discovered three exoplanets orbiting the star. Not long after they announced a fourth, all detected with direct imaging. They're all massive planets on wide orbits, which are rare. The HR 8799 system is also young, another important point.
The fact that they were discovered 15 years ago is also important; it means we have observations of these planets that span a lengthy time. This type of data is critical to understanding other solar systems because the duration of the data paints a more complete picture.
However, it also poses more questions and whets our appetite for more answers.
That's why the JWST observed the system recently. Its MIRI instrument and its coronagraph can perform the kind of high-contrast imaging needed to understand the system better.
A new paper presents the results of these observations. It's title is "Imaging detection of the inner dust belt and the four exoplanets in the HR 8799 system with JWST's MIRI coronagraph." It'll appear in the journal Astronomy and Astrophysics, and the lead author is Anthony Boccaletti from the LESIA, Observatoire de Paris, France.
HR 8799 is 1.5 times more massive than the Sun and is almost five times more luminous. It's also surrounded by a debris disk and is only about 30 million years old. Young solar systems are important because they can reveal the intricate details behind planet formation, one of the things the JWST was built to focus on.
The four planets are HR 8799 b, c, d, and e. They're all massive planets, between 5.7 and 9.1 Jupiter masses, barely below the point where deuterium fusion takes place, making them brown dwarfs. They range from 16 to 71 astronomical units away from the star, and have orbits from about 45 to about 460 years. All four of them have radii of about 1.2 Jupiter radii.

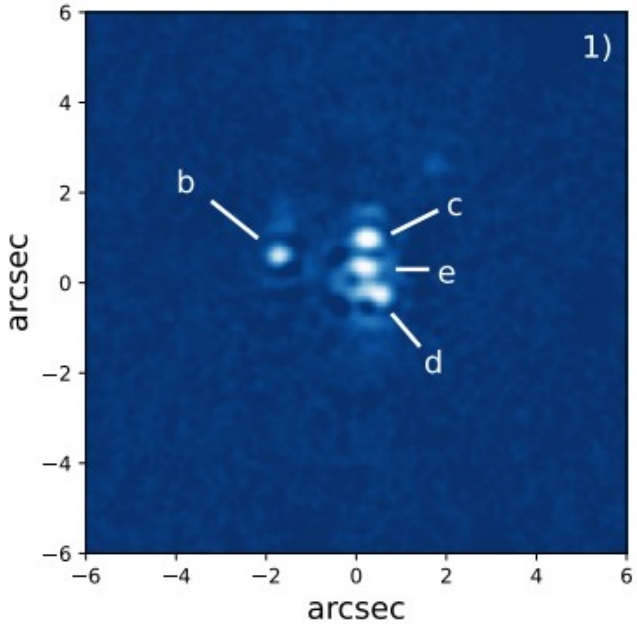


A portrait of the HR8799 planetary system as imaged by the Hale Telescope. A fourth planet was eventually discovered. Credit: NASA/JPL-Caltech/Palomar Observatory.
Massive giant planets that follow large orbits greater than 5 AU are rare. So every instance of these types of planets is important. MIRI's high contrast imaging can open up a new window on these types of systems and allowing scientists to characterize them more fully. Mid-infrared observations of the system have been difficult up until now. Not only that, but the JWST's angular resolution makes the observations even more powerful.
What did the JWST find?
"Overall, the MIRI images of the HR 8799 system yield a very different vision than in the near IR, with the clear detection of the four planets, together with a localized but extended central emission," the authors write.
The JWST was able to refine what we already know about some aspects of this system. The main objective of this work was to characterize the planetary atmospheres better.
While there has been some uncertainty around the nature of the planets, and if they are brown dwarfs, the JWST observations put that idea to rest. "Their colors indicate that these four giant planets differ from field brown dwarfs," the authors write.

An artist's depiction of the relative sizes of the Sun, a low-mass star, a brown dwarf, Jupiter, and the Earth. While there was some initial uncertainty over the nature of the planets around HR 8799, the JWST images confirmed them as planets rather than brown dwarfs. Image Credit: Jupiter: NASA,ESA,and A. Simon (NASA,GSFC); Sun and Low-Mass Star: NASA,SDO; Brown Dwarf: NASA,ESA,and JPL-Caltech; Earth: NASA; Infographic: NASA and E. Wheatley (STScI)

Their temperatures range from 900 K to 1300 K, with HR 8799 b being fainter and cooler. The JWST measurement's shows that planet b's temperature is lower than previous observations showed, an indication of the telescope's greater power. MIRI also identified two atmospheric chemicals unequivocally: H2O and CO. The authors say there's a debatable detection of methane, and that's additional evidence that they're planets not brown dwarfs. Brown dwarfs always show the signature for methane at these temperatures.

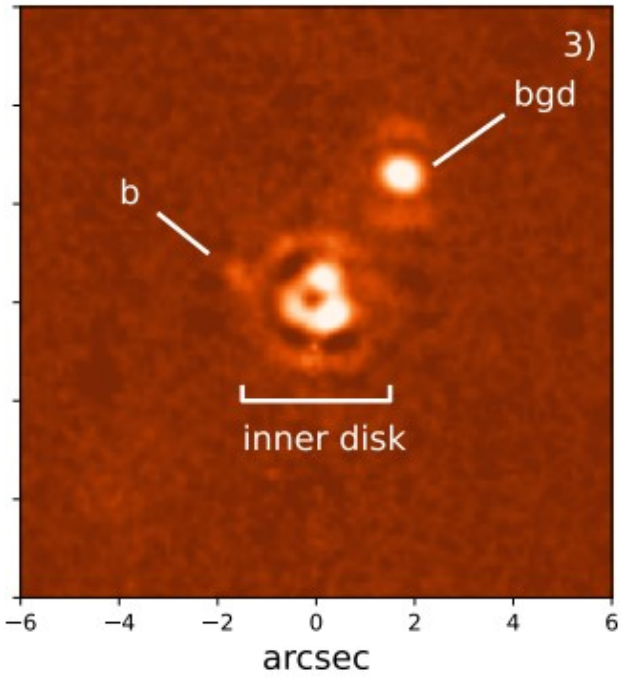
The JWST's MIRI instrument was built with different filters. They were partly designed to investigate the presence of ammonia, which is a solid biosignature on terrestrial planets. Unfortunately, these four planets are a little too hot for ammonia to stand out. "As a result, the current data cannot conclude on the detectability of the ammonia feature in the HR 8799 planets," the paper states. If it had detected ammonia, it would be headline news.



This is one of the JWST's MIRI images of HR 8799 and its four planets. It won't grace the cover of a magazine; it's a scientific image. Image Credit: Boccaletti et al. 2023.

The HR 8799 system is also noteworthy for its debris disk. It's unusual in that it has two belts. Researchers have wondered if the inner edge of the outer belt was caused by a fifth planet with a mass between Jupiter's and Saturn's. Others thought it might be a dust clump.

But the JWST shows that it's a background object, and seems to have ended the debate. "With a new data point, 4.44 years apart from the former detection, we can now safely conclude that this is a background object," the authors write.



The powerful filters on the JWST's MIRI instrument ended the debate about a potential fifth planet at HR 8799. This MIRI image helped determine that the object is in fact a background object. Image Credit: Boccaletti et al. 2023.

This was the JWST's first look at a young exoplanetary system with its MIRI instrument, including its filters and its coronagraph. "The MIRI instrument onboard JWST is now offering high-contrast imaging capacity at mid-IR wavelengths, thereby opening a completely new field of investigation to characterize young exoplanetary systems," the authors explain.

As such, the main thrust of the work was to test the observations and different algorithms to determine how to best use it in future work, and how to interpret the results. For example, measuring a planet's flux successfully means accounting for how the coronagraph attenuates the images, depending on a planet's position.

These observations contribute to using the instrument more effectively. Ironically, MIRI's coronagraph can be so sensitive that understanding its images of young stellar systems can be challenging. The use of the instrument is only in its infancy, and the coronagraphs extreme sensitivity "can make the detection and the interpretation of young system observations very challenging, not mentioning the confusion related to background galaxies," the authors write.

The authors point out that there's still room for improvement, and these results will only lead to improved future results.

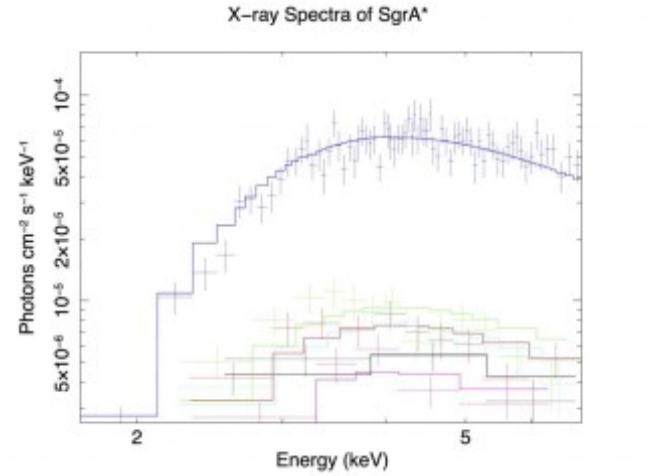
The Milky Way's Black Hole is Spinning as Fast as it Can

Pick any object in the Universe, and it is probably spinning. Asteroids tumble end over end, planets and moons rotate on their axes, and even black holes spin. And for everything that spins, there is a maximum rate at which it can rotate. The black hole in our galaxy is spinning at nearly that maximum rate.

For objects such as the Earth, the maximum rate of rotation is defined by its surface gravity. The weight we feel while standing on the Earth isn't just due to the gravitational pull of the Earth. Gravity pulls us toward the center of our world, but the Earth's rotation also tends to fling us outward away from the Earth. This "centrifugal" force is tiny, but it does mean that your weight at the equator is just slightly less than it is at the north or south pole.

With our 24-hour day, the weight difference between the equator and pole is just 0.3%. But Saturn's 10-hour day means that the difference is 19%. So much that Saturn bows outward a bit at its equator. Now imagine a planet spinning so fast that the difference was 100%. At that point, the gravitational pull of the planet and its centrifugal force at the equator would cancel out. If the world were to spin any faster. it would fly apart. It would likely fly apart at an even slower spin rate, but this is clearly the maximum rate of rotation.

For black holes, things are a bit different. Black holes aren't objects with a physical surface. They aren't made of material that could fly apart. But they still have a maximum rate of rotation. Black holes are defined by their tremendous gravity, which distorts space and time around them. The event horizon of the black hole marks the point of no return for nearby objects, but it isn't a physical surface.



X-ray spectra for Sag A* Credit: Daly, et al

The rotation of a black hole also isn't defined by the spin of physical mass, but rather by the twisting of spacetime around the black hole. When objects such as the Earth spin, they twist space around themselves very slightly. It's an effect known as frame dragging. The spin of a black hole is defined by this frame-dragging effect. Black holes spin without the physical rotation of matter, just a twisted spacetime structure. This means there is an upper limit to this spin due to the inherent properties of space and time. In Einstein's equations of general relativity, the spin of a black hole is measured by a quantity known as *a*, where *a* has to be between zero and one. If a black hole has no spin, then a = 0, and if it is at its maximal rotation, then a = 1.

This brings us to a new study on the rotation of the supermassive black hole in our galaxy. The team looked at radio and X-ray observations of the black hole to estimate its spin. Due to the frame-dragging of spacetime near the black hole, the spectra of light from material near it is distorted. By observing the intensity of light at various wavelengths, the team was able to estimate the amount of spin. What they found was that the *a* value for our black hole is between 0.84 and 0.96, which means it's rotating incredibly fast. At the upper range of the estimated rotation, it would be rotating at nearly the maximal rate. This is even higher than the spin parameter of the black hole in M87, where *a* is estimated to be between 0.89 and 0.91.

Reference: Daly, Ruth A., et al. "New Black Hole Spin Values for Sagittarius A* Obtained with the Outflow Method." *Monthly Notices of the Royal Astronomical Society* (2023): stad3228.

Mars Still Has Liquid Rock Near its Core

Why doesn't Mars have a magnetic field? If it did, the planet would be protected from cosmic radiation and charged particles emitted by our Sun. With a magnetic field, perhaps the Red Planet wouldn't be the dry, barren world it is today.

It has long been believed that Mars once had a global magnetic field like Earth does, but somehow the iron-core dynamo that generated it must have shut down billions of years ago.

But new seismic data from NASA's InSight lander might change our understanding of Mar's interior, as well as alter the view of how Mars evolved and changed over time. InSight's data revealed the presence of a molten silicate layer overlying Mars' metallic core. Scientists say this insulating layer is like a blanket that might prevent the core from producing a global magnetic field.

"The blanket not only insulates the heat coming from the core and prevents the core from cooling, but also concentrates radioactive elements whose decay generates heat," said Vedran Lekic, a professor at the University of Maryland and co-author of a new paper published in Nature. "And when that happens, the core is likely to be unable to produce the convective motions that would create a magnetic field—which can explain why Mars currently doesn't have an active magnetic field around it."

Earth's magnetic field comes from its core, where molten, electrically conducting iron flows beneath the crust. This magnetic field is global, meaning it surrounds the entire planet. Even though Mars is a rocky, terrestrial planet like Earth, Mars does not generate a magnetic field on its own, outside of relatively small patches of magnetized crust.

Without the protection a magnetic field provided, Mars' atmosphere was stripped, and eventually, any water on the surface – even oceans – would have evaporated as water vapor in the atmosphere was lost to space, making it incapable of sustaining life.

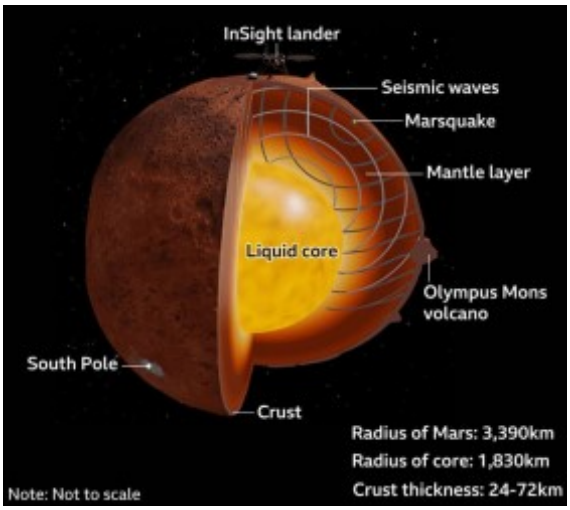
InSight's seismometer, SEIS, the Seismic Experiment for Interior Structure. Credit: NASA/JPL

NASA's InSight mission deployed the first seismometer on the surface of Mars. It recorded "Marsquakes," and it has also helped determine the layering and thickness of the planet's crust, the structure of the mantle, and the size of Mars' core and its composition. Data from InSight is helping planetary scientists to work out the internal structure of Mars. Lekic and his colleagues say that InSIght has now revealed, surprisingly, the molten silicate layer overlying the planet's metallic core.

Silicates are rock-forming minerals that make up the crust and mantle of both Mars and Earth. The molten layer on Mars lies between the mantle and core. Earlier research with data from InSight revealed that the Martian core is molten, but this new research means that the core likely smaller than previously thought. With the discovery of this molten layer, the researchers say this explains "other geophysical data and analysis of Martian meteorites," according to a press release from the University of Maryland.

They also theorize that Mars was at one time a molten ocean of magma that later crystallized to produce a layer of silicate melt enriched in iron and radioactive elements at the base of the Martian mantle. The heat emanating from the radioactive elements would then have dramatically altered the thermal evolution and cooling history of

the red planet.



Mars' interior as revealed by the NASA/DLR InSight lander. Image Credit: Cottar, Koelemeijer, Winterbourne, NASA

"These layers, if widespread, can have pretty big consequences for the rest of the planet," Lekic said. "Their existence can help tell us whether magnetic fields can be generated and maintained, how planets cool over time, and also how the dynamics of their interiors change over time."

The InSight lander mission officially ended in December 2022 after more than four years of collecting data on Mars. InSight was part of the overall effort to understand Mars and if it was habitable in the past. By probing the planet's interior, it has revealed some of the planet's geological history. Another finding by InSight's magnetometer showed that the planet's magnetic field may have been much stronger on the surface than orbital measurements showed, which strengthens the case for its potential ancient habitability.

As this new research indicates, analysis of the spacecraft's observations continues.

"This new discovery of a molten layer is just one example of how we continue to learn new things from the completed InSight mission," Lekic said. "We hope that the information we've gathered on planetary evolution using seismic data is paving the way for future missions to celestial bodies like the Moon and other planets like Venus."

'Her Space, Her Time' Reveals the Hidden Figures of Physics

Quick: Name a woman scientist.

Chances are the name you came up with is Marie Curie, the physicist and chemist who won two Nobel Prizes more than a century ago for the discoveries she and her husband Pierre made about radioactivity.

But who else? In a new book titled "Her Space, Her Time," quantum physicist Shohini Ghose explains why women astronomers and physicists have been mostly invisible in the past — and profiles 20 researchers who lost out on what should have been Nobel-level fame.

"This issue around having low representation of women in physics is something that's common all around the world," Ghose says in the latest episode of the Fiction Science podcast. "And I've certainly faced it in my own experiences as a physicist growing up. I really didn't know of any woman physicist apart from Marie Curie."

The road to "Her Space, Her Time" began with a TED talk that Ghose gave in India in 2019. That talk highlighted the case of Bibha Chowdhuri, an Indian physicist who played a key role in unraveling the mysteries of subatomic particles and cosmic rays in the 1940s.

She wasn't able to follow up on her findings, in part due to shortages brought on by World War II. Instead, it was a British physicist named Cecil Powell who won the Nobel Prize in 1950 for discovering particles known as pions. Chowdhuri's work went largely unrecognized.

Shohini Ghose is a professor of physics and computer science at Wilfrid Laurier University. (Photo via Perimeter Institute)

That's the way it typically went with the other women researchers profiled in Ghose's book. The litany includes Annie Jump Cannon, who in the early 1900s came up with a stellar classification system that's still in use today. (The Star Trek saga gives a nod to Cannon's letter-based system every time it references an "M-class star.")

Another woman on Ghose's list is Henrietta Leavitt, who figured out how to use variable stars as a cosmic measuring stick, calibrated by their periodicity and apparent brightness. Leavitt's research opened the way for Edwin Hubble to discover that there was more than one galaxy in the observable universe, and that the universe was expanding.

NASA celebrated Hubble's legacy by naming a space telescope after him. Leavitt's work was recognized — but not widely celebrated.

"None of the major space telescopes have a woman's name attached to it," Ghose says. "So when the James Webb [Space Telescope] was being planned, before it was called James Webb, I was very excited. I was hoping they would name it after Leavitt or any of the other women who have contributed. But you know, that didn't happen."

NASA's decision to go with Webb, who was the space agency's first administrator, drew criticism because of his reported connection to government discrimination against employees in the 1950s and '60s based on sexual orien-

tation — the so-called "Lavender Scare." After a review of the historical record, NASA decided to stick with the JWST name. But Ghose still wants to see a Leavitt Space Telescope. "There are many reasons why we can do better with our naming," she says. "Hopefully NASA will learn and do better next time."

You could argue that NASA executives and other leaders of the scientific community already have learned their lesson, at least when it comes to naming telescopes.
The Vera C. Rubin Observatory, a wide-angle survey telescope that's expected to revolutionize ground-based astronomy starting in the mid-2020s, pays tribute to one of the women astronomers profiled in "Her Space, Her Time." And NASA's Nancy Grace Roman Space Telescope, due for launch in 2027, honors an astronomer who led the charge for the Hubble Space Telescope — so much so that she became known as the "Mother of Hubble."

Ghose approves of the trend, but says efforts to elevate the status of women in science shouldn't be limited to naming telescopes.
"That's just part of a much bigger issue that women have been facing for a long time," she says. "I'd say there's basically some very specific practical barriers that we still see. For example, there's still a gender wage gap. There are issues around fair hiring practices."

"Her Space, Her Time," by Shohini Ghose. (The MIT Press)
Studies have shown that women in physics and astronomy continue to face discrimination and harassment, and tend to be given fewer resources than their male counterparts. "They have slower paths on their career journeys, so they don't get promoted as much," Ghose says. "They don't get invited as much to give talks at major conferences, which are really important if you want to get those promotions. Grant funding levels are lower for women. So there is this whole series of issues, and these are structural problems." Ghose argues that scientific institutions have to increase their efforts to address those structural problems.
"Unfortunately, what often happens is that instead we focus on things like mentoring women or having science camps for girls … or we have work-life balance kids of approaches to, you know, help women balance their family time vs. work better," Ghose says.
"If you think about it, the common pattern in all of this is that we're aiming at the women, as in 'fix them, make them somehow better,'" she says. "We have to fix all these structural issues, and not just focus on 'fix the women.' Let's fix the system instead."
In addition to Cannon, Chowdhuri, Curie, Leavitt and Rubin, the women physicists and astronomers highlighted in "Her Space, Her Time" include Anna Draper, Williamina Fleming, Antonia Maury, Cecilia Payne-Gaposchkin, Margaret Burbidge, Mary Golda Ross, Joyce Neighbors, Dilhan Eryurt, Claudia Alexander, Harriet Brooks, Lise Meitner, Marietta Blau, Hertha Wambacher, Elisa Frota Pessoa, Maria Mitchell and Chien-Shiung Wu.
My co-host for the Fiction Science podcast is Dominica Phetteplace, an award-winning writer who is a graduate of the Clarion West Writers Workshop and currently lives in San Francisco. To learn more about Phetteplace, visit her website, DominicaPhetteplace.com.

In 250 Million Years, a Single Supercontinent will Form, Wiping Out Nearly all Mammals

A recent study published in *Nature Geoscience* uses supercomputer climate models to examine how a supercontinent, dubbed Pangea Ultima (also called Pangea Proxima), that will form 250 million years from now will result in extreme temperatures, making this new supercontinent uninhabitable for life, specifically mammals. This study was conducted by an international team of researchers led by the University of Bristol and holds the potential to help scientists better understand how Earth's climate could change in the distant future from natural processes, as opposed to climate change.

The Earth's temperatures are estimated to rise drastically 250 million years from now due to two reasons: increased volcanism from the tectonic activity merging all the continents together, and our Sun giving off more energy and heat as it ages. While volcanoes act as temperature moderators by releasing carbon dioxide and naturally warming the planet, too much volcanism results in too much carbon dioxide, which results in drastic temperature increases. Additionally, like mammals, our Sun also grows with age, and as it grows it gives off more heat and energy.
"The newly emerged supercontinent would effectively create a triple whammy, comprising the continentality effect, hotter sun and more CO_2 in the atmosphere, of increasing heat for much of the planet," said Dr. Alexander Farnsworth, who is a Senior Research Associate at the University of Bristol and lead author of the study. "The result is a mostly hostile environment devoid of food and water sources for mammals. Widespread temperatures of between 40 to 50 degrees Celsius, and even greater daily extremes, compounded by high levels of humidity would ultimately seal our fate. Humans – along with many other species – would expire due to their inability to shed this heat through sweat, cooling their bodies."
For the study, the researchers used computer climate models to simulate the environmental conditions of Pangea Ultima, including humidity, rain, wind, and temperature. They also determined the starting and ending CO_2 levels based on biology, ocean chemistry, and tectonic processes. In the end, they found that only somewhere between 8 percent to 16 percent of Pangea Ultima's total land mass will maintain its habitability for mammals, and while human-caused climate change is estimated to increase the Earth's temperature over time, the Earth is hypothesized to remain habitable until the creation of Pangea Ultima.

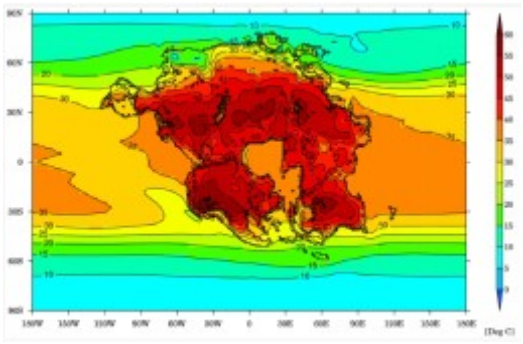


Figure 1 from the study displaying the warmest month average temperature (degrees Celsius) for Earth and the hypothesized supercontinent, Pangea Ultima, 250 million years from now, which the researchers hypothesize would make life for most mammals extremely difficult. (Credit: University of Bristol)

The reason mammals, including humans, have survived for so long on the Earth is due to their uncanny ability to adapt to extreme weather conditions. However, while evolution has resulted in mammals being able to lower their survivable limit in cold temperatures, they aren't able to increase their survivable limit in hot temperatures. This means that as the Earth's temperatures continue to rise, it will make the likelihood of mammals surviving in these new conditions unlikely.

"The outlook in the distant future appears very bleak," said Dr. Farnsworth. "Carbon dioxide levels could be double current levels. With the Sun also anticipated to emit about 2.5% more radiation and the supercontinent being located primarily in the hot, humid tropics, much of the planet could be facing temperatures of between 40 to 70 °C. This work also highlights that a world within the so-called 'habitable zone' of a solar system may not be the most hospitable for humans depending on whether the continents are dispersed, as we have today, or in one large supercontinent."

While Pangea Ultima might be dominating the Earth 250 million years from now, it won't be the first supercontinent to grace the Earth's surface in the planet's history. Scientists hypothesize there have been 10 supercontinents that have existed throughout Earth's history, with the most well-known being Pangea, the most recent supercontinent to exist. The reason all these supercontinents have existed throughout the Earth's approximately 4.5 billion-year history is due to plate tectonics since the Earth's surface is divided into 7 major and 8 minor plates that collide and subduct beneath each other over vast geologic periods of time.

How will Pangea Ultima change the habitability of the Earth and what new discoveries about supercontinents will scientists make in the coming years and decades? Only time will tell, and this is why we science!

As always, keep doing science & keep looking up!

OSIRIS-REx Returned Carbon and Water from Asteroid Bennu

Carbon and water are so common on Earth that they're barely worth mentioning. But not if you're a scientist. They know that carbon and water are life-enabling chemicals and are also links to the larger cosmos.

Initial results from OSIRIS-REx's Bennu samples show the presence of both in the asteroid's regolith. Now, eager scientists will begin to piece together how Bennu's carbon, water, and other molecules fit into the puzzle of the Earth, the Sun, and even the entire Solar System and beyond.

These results aren't unexpected. Asteroid 101955 Bennu is a C-type asteroid, and the C stands for carbonaceous. And asteroids are one of the sources of Earth's water, scientists are pretty certain. In fact, we already have evidence that the water in carbonaceous asteroids like Bennu has isotopic levels most similar to Earth's ocean water.

This isn't our first sample from a carbon-rich asteroid. Japan's Hayabusa 2 mission returned a sample of the asteroid 162173 Ryugu three years ago in December 2020. But OSIRIS-REx's (Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer) sample is much larger than Hayabusa 2's. The Japanese mission returned 5.4 grams of material from Ryugu and was a huge success. The Bennu sample will be much larger than that, but NASA isn't certain how large yet. But no matter its size, it holds secrets yet to be revealed.

"As we peer into the ancient secrets preserved within the dust and rocks of asteroid Bennu, we are unlocking a time capsule that offers us profound insights into the origins of our solar system."

Dante Lauretta, OSIRIS-REx principal investigator, University of Arizona.

They don't know the sample's size because they haven't opened the main part of the sample return canister yet. After the spacecraft captured its samples with its sampling head, the entire head was placed in the capsule, not just the sample.

This image shows OSIRIS-REx placing its sampling head inside the Sample Return Capsule. The initial science results are from extra material on the outside of the sampling head. The primary sample hasn't been examined yet. Image Credit: NASA/Goddard/University of Arizona/ Lockheed Martin.

When they opened the canister's exterior lid, they found asteroidal material covering the outside of the collector head, canister lid, and base. This extra material had to be processed before they could open the rest of the canister and process the main sample. NASA isn't certain yet, but they think they have about 250 grams (9oz) of material from Bennu in total.

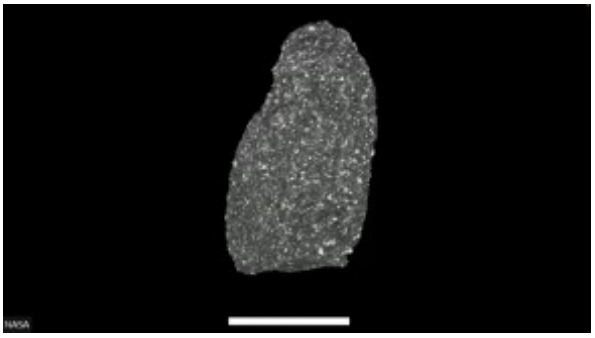
When NASA opened the sample canister, they found that black powder coated the surfaces. The initial results are from this powder. Image Credit: NASA

These initial results are from the extra material, which scientists subjected to two weeks of analysis. Collecting excess material like this wasn't part of the plan, but the investigating scientists took it in stride.

"Our labs were ready for whatever Bennu had in store for us," said Vanessa Wyche, director of NASA's Johnson Space Center, where the samples are currently located. "We've had scientists and engineers working side-by-side for years to develop specialized gloveboxes and tools to keep the asteroid material pristine and to curate the samples so researchers now and decades from now can study this precious gift from the cosmos."

Processing Bennu's sample is a meticulous process that took years of preparation. In this image, astromaterials processors Mari Montoya, left, and Curtis Calva, right, use tools to collect asteroid particles from the base of the OSIRIS-REx science canister. Image Credit: NASA

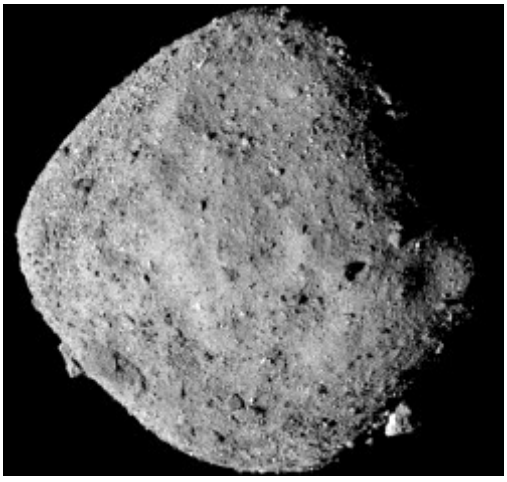
The scientists examined the initial sample with several technologies and techniques. They created a 3D computer model of a single particle using tomography. The model highlighted its interior, revealing the presence of carbon-rich material and water. The water isn't liquid, obviously, or ice. It's contained in water-bearing clays.



This is a computer 3D model of a single particle from asteroid Bennu. The scale bar is one mm. The dust from Bennu contains almost 5% carbon by weight. There's also water locked inside its crystal structure. Image Credit: NASA.

"As we peer into the ancient secrets preserved within the dust and rocks of asteroid Bennu, we are unlocking a time capsule that offers us profound insights into the origins of our solar system," said Dante Lauretta, OSIRIS-REx principal investigator, University of Arizona, Tucson. "The bounty of carbon-rich material and the abundant presence of water-bearing clay minerals are just the tip of the cosmic iceberg."

That's the type of inspiring language we expect from NASA, and it's all true. But what's the science behind it?



Science teams have identified water-bearing clay-type minerals on asteroid Bennu. Water from such objects gets carried into larger worlds during the process of accretion. Image Credit: NASA/OSIRIS-REx mission.

The OSIRIS-REx missions had several goals. The primary goal, obviously, was to collect a sample and return it to Earth. But what was NASA hoping to learn?

Bennu is a primitive carbonaceous asteroid made up of pristine, primordial material. It's a link to the past that holds clues to how Earth formed. Studying Bennu means studying how things are linked.

"We're trying to find out who we are, what we are, where we came from. What is our place in this vastness called the Universe?"

Bill Nelson, NASA Administrator

Specifically, the mission was designed to map the asteroid's properties, chemistry, and mineralogical composition. The mission also needed to document and analyze the sampling site to add context to the sample itself. The sampling site was documented down to a scale of mere millimetres, including the texture, morphology, and geochemistry. The mission will also allow scientists to compare the spacecraft's detailed measurements of an asteroid with ground-based observations of the Solar System's asteroid population. This will make ground-based observations more reliable.

OSIRIS-REx also measured the Yarkovsky Effect, a heating/cooling effect on rotating asteroids that changes their path through space. The Yarkovsky Effect can make it difficult to calculate an asteroid's future trajectory and what kind of threat it might pose to Earth.

All laudable goals. Even if it accomplishes nothing more than helping us protect our civilization from a catastrophic asteroid strike, it will be a success.

But the meat of the mission is in what it can tell us about ourselves, the planet we live on, life, and how it all arose. Much of that depends on water.

Scientists think that carbon-rich, water-rich asteroids like Bennu helped build planet Earth. They delivered key components to young Earth that helped it become the water-bearing, life-supporting planet we see today. The water contained in clays like the ones in Bennu gave rise to Earth's oceans, lakes, and rivers. The samples from Bennu will test this idea, either buttressing it or tearing it down.

"We're trying to find out who we are, what we are, where we came from. What is our place in this vastness called the Universe?" said NASA Administrator Bill Nelson during a briefing at the Johnson Space Center, where the dedicated lab is housed.

"These discoveries, made possible through years of dedicated collaboration and cutting-edge science, propel us on a journey to understand not only our celestial neighbourhood but also the potential for life's beginnings," said principal investigator Lauretta. "With each revelation from Bennu, we draw closer to unravelling the mysteries of our cosmic heritage."

OSIRIS-REx's journey of discovery isn't over yet. It's been renamed OSIRIS-APEX as it heads to its next destination, the asteroid Apophis. Apophis was once considered a threat to Earth, but not anymore. It'll still come close, though. The asteroid will make its closest approach to Earth in 2029, so close that people in Africa will have a chance to see it with the naked eye.

M87's Jet is Triggering Novae

Everyone loves a good mystery, and astronomers have just uncovered a new one in a nearby supermassive galaxy called M87. Like most galaxies, M87 regularly plays host to a smattering of stellar explosions called novae, each the result of a star stealing material from a neighbour. M87 also features a massive jet of plasma blasting out into deep space from the galactic core. These phenomena: the jet and the novae, are unrelated astronomical occurrences, or so scientists believed. But astrono-

mers recently discovered that the novae in M87 seem to be uncharacteristically aligned along the jet, instead of scattered randomly throughout the galaxy. Is the jet somehow triggering nova explosions?

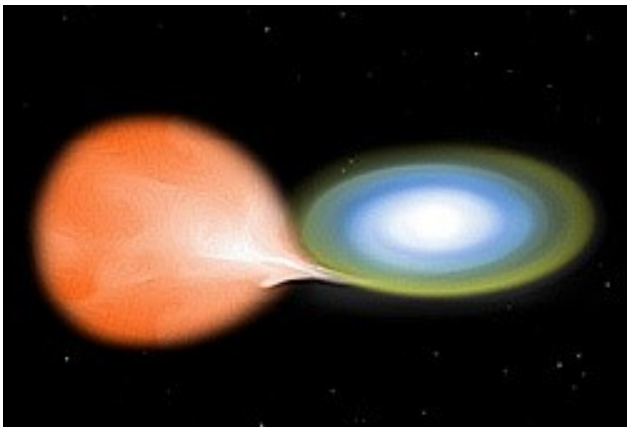
It might be, but the mystery is: how?

Using data from two separate surveys by the Hubble Space Telescope, a team of astronomers confirmed the presence of 135 novae within M87, and they appear to occur with unexpected frequency in the path of the jet.

“The likelihood that this distribution occurred by chance is of order 0.3%,” the team wrote in a preprint release of their paper last week.

For the moment, it is unclear if this situation is unique to M87, or if this is a common effect of galactic jets.

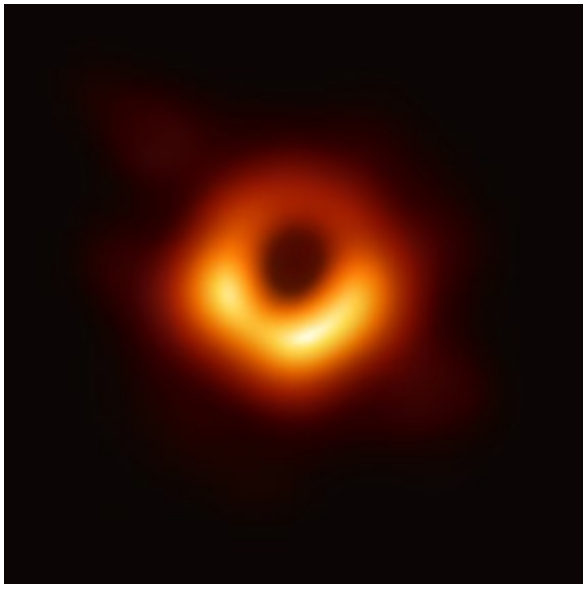
“No other galaxy with jets has been observed with sufficient sensitivity or frequency to yield samples of novae large enough to check if M87’s putative nova-jet connection is ubiquitous, rare or spurious,” the scientists said.



Artist’s conception of a white dwarf, right, accreting hydrogen from its companion star. NASA/CXC/M.Weiss.

Here’s what we know so far. Novae are caused by explosions from the surface of white-dwarf stars. For a nova to occur, the white dwarf must be in a binary pair, and be close enough to its partner star to accrete material from it. Unlike a supernova, a nova doesn’t completely destroy the white dwarf, and the same star can have multiple novae occur over time as more and more material is stolen from its partner.

Meanwhile, M87’s galactic jet is driven by the black hole at the centre of the galaxy – which, incidentally, was the first black hole ever imaged by astronomers in 2019. As material spirals in towards the back hole, an accretion disk forms around it, and powerful magnetic fields funnel intense radiation outward, causing it to be expelled at relativistic speeds, travelling almost 5000 lightyears out into deep space.



The black hole at the centre of M87. Event Horizon Telescope.

There are a couple of theories as to how the jet might set off novae.

One simple explanation is that radiation from the jet is heating donor stars in its path, increasing mass transfer to their white dwarf partners and triggering a thermonuclear runaway. Such heating would make novae more frequent.

Unfortunately, the math on this theory doesn’t check out. As powerful as the radiation from the jet is, the stars are too small and the distances too great for it to have much influence. We can probably rule this answer out: the effect is “orders of magnitude” too weak.

Another suggestion is that the jet is triggering star formation: more stars means more binaries, which means more novae. But there’s a problem with this explanation too. In this scenario, you would also expect to see a similar increase in star formation along the galaxy’s ‘counterjet’, and that isn’t borne out by the evidence.

So astronomers are going back to the drawing board. There are a couple of other ideas they are considering but have not yet properly tested. Perhaps, for example, the jet’s shock waves are shepherding gas and dust together as it moves through the galaxy, forming clouds of interstellar medium. As one of these clouds arrives at a binary star system, it would increase the rate of material accretion, setting off a nova. Similarly, a shock wave might also heat a star up (more effectively than radiation could on its own), increasing the mass transfer rate.

These last two possibilities are as-of-yet just guesses: they haven’t yet been fully explored.

So for now, it remains a mystery.

In the words of the authors, “the enhanced rate of novae along M87’s jet is now firmly established, and unexplained.”

E MAILS and MEMBERS VIEWING LOGS.

Hi Andy,

This is Saturn, the most beautiful sight in the night sky. There is something so wonderful about this enigmatic planet with its complex ring system and entourage of moons. What I like about this image is that it is my best view ever of Saturn. The challenge with high resolution planetary imaging (and lunar) is turbulence in the Earth's atmosphere degrading the fine details. Not only do we need clear skies, we need steady skies. Of course, being in southern England the planets (and Saturn in particular) are fairly low in the sky so we look through more atmosphere and therefore suffer more from poor seeing.
While on half term holiday in southern Spain, we were lucky to visit the Griffon Educational Observatory run by Andy Burns, Chairman of Wiltshire Astronomical Society. Here his wonderful 11-inch Maksutov on an EQ8 provided wonderful views and by chance on an evening of near-perfect seeing. Seeing Saturn standing so still in the eyepiece (and camera screen) with the cicadas singing under the warm tropical air was simply wonderful.
Thanks to Andy Burns for his hospitality and Shane Bennett for his company.
#saturn #griffoneducationalobservatory,

Saturn and Moons (Composite)
27 October 2023 1920UT
5 images derotated 1912 - 1928UT
Moons Captured 1931UT
11-inch Intes Mak EQ8 ASI224MC IR-filter
Griffon Educational Observatory, Andalucia, Spain

Viewing Log for 13th of October Peter Chappell

(Wiltshire AS viewing session)

Chris Brookes arranged the second viewing session of the season and which I was able to attend. I arrived at the playing fields at Lacock and was met with Chris and Andy Burns sitting on a small wall. Looking at the sky it was still cloudy but should break fairly soon. During the day we had a lot of rain with full cloud cover but the forecast did say the skies would break in the early evening? This turned out to be true and by 20:49, I had my Meade eight inch or 203 mm telescope set up and ready using my trusty Pentax 14 mm eye piece, with a temperature of 12 °C and some wind, the conditions should be okay for the evening? While I was setting up I thought I heard a fox making a noise close by, unfortunately it was Andy being sick (he later thought he had food poisoning) and could not stay for the rest of the evening in case he needed to go to the toilet quickly! *(Editors note: I was very sick, and didn't make from the car to my house a mere 15 steps!)*

My guide stars for the evening were Altair and Vega, the first target would be the planet Saturn shining fairly brightly in the southern sky. I could make out the moon Titan to the west of the planet and thought I could make out another a bit closer to Saturn? Looking at the programme 'Stellarium' on my computer later on, I think I might have seen the moon Rhea? On to Neptune and as usual, I could not find this planet which I find strange using GOTO equipment but that is how it goes! With Jupiter low down and behind a large tree it was time to go on to my planned viewing for the evening. I would be looking at September's and October's edition of Astronomy Now and their 'Deep Sky' section. September's edition would go around the constellation of Pegasus, first object was NGC 7479, a barred spiral galaxy which also goes by the name of Caldwell (C) 44. This object was a faint fuzzy blob to look at, pretty standard for me and galaxies! While viewing this object another member of WAS turned up, another Peter which I do not think I had met before? From the start there was a family in the same field as us but did not make contact with us, so I do not know if they had anything to do with WAS or not? Next object was

NGC 1 & 2, both spiral galaxies (SG) which I could not locate, seems like you need at least a 10 inch scope to see these objects with a mag of 12.9, I think they were too faint for my telescope to see? On to Messier (M) 15, a great globular cluster to look at in the head of Pegasus. While viewing this object another two visitors turned up, the boy seemed to have a good knowledge of astronomy and had some good questions to ask Chris and myself and stayed for most of the session, unfortunately I did not get their names. A few of the objects in the September edition I could not find as they were not in my hand controller memory, the final object was NGC 7814, another SG which also goes by the name of C 43 or the 'Little Sombrero' galaxy, this was also another FFB to look at!

On to October's edition and planetary nebula was the subject this time. First object was M 57, the Ring Nebula in Lyra, this object looked very good to view, and the same could be said for M 27, the Dumbbell nebula (the first planetary nebula to be discovered). On to NGC 6905, the Blue Flash nebula which I do not think I could see? Next was NGC 7009, the Saturn nebula or C 55, I could make out a lobe either side of the object, hence the name 'Saturn' nebula. Still with the Caldwell list and number 22 or NGC 7662 and the Blue Snow Ball nebula, to me it looked like an out of focus star? Back to the Messier list and number 76, the Little Dumbbell nebula, a small grey blob to look at and no detail to be seen. This object is one of the hardest objects to see with the naked eye on Messier's list. The Skull nebula was next, NGC 246 or C 56, a fuzzy blob to look at. That was the end of the October's edition list, so it was back to a few objects before Jupiter would finally clear the large tree for me. M 29 in Cygnus, a good open cluster (OC) to look at and final object was NGC 457, the ET or Owl cluster, another good OC to look at. On to Jupiter, I been looking at this planet with Chris's refractor as he told me a moon had just come out of a transit and was sitting pretty close to the edge of Jupiter. Jupiter was shining very brightly, I could make out all four of the large moons with Europa being the closet followed by Io, Ganymede and finally Calisto, all out to the east of Jupiter. Could not see the Great Red Spot this time.

The time was now 22:50 and time to pack up, there was very little dew on the telescope. Temperature had dropped to 8 °C and the wind had stopped completely. Not too many objects had been viewed this evening as there was a lot of chat between the five of us that had stayed on. Peter had brought his telescope which was taking pictures of various galaxies and must say they looked pretty good on his mobile phone which was controlling the scope.

Clear skies.

Peter Chappell

<u>Viewing Log for14tyh of October</u>

As I had a free Saturday evening and the sky was pretty clear, I thought I would go out viewing again, two nights on the trot!

This time I went back to Nebo Farm and hope to see some deep sky objects in the south west. I had my Meade LX90 set up and ready by 20:00, again I would be using my Pentax WX 14 mm eye piece with a temperature of 8 °C, some wind and little cloud, the viewing should be okay? As usual, my alignment stars were Vega and Altair, while doing my alignments, I thought I could see some dark nebulas? This dark nebula was in the same place each time I centred the star, strange? So, I took the eye piece out to have a look at it, turns out there was some water on the eye end lens! Not sure how that got there but cleaning the lens dry I could carry on with my viewing.

First object for the evening was Saturn in the southern skies, could make out Titan to the west of Saturn and again I could see Rhea to the east. First constellation I was going to attack was Sagittarius before it got too low to view.

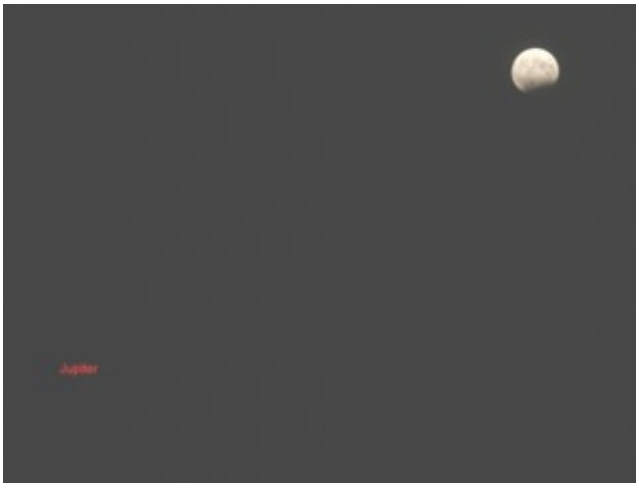
Starting off with Messier (M) 22, a globular cluster (GC), this was a large hazy patch which I could make out some stars on the edge of this cluster. As I was using my Star and Telescope sky atlas tonight I saw another GC nearby, namely NGC 6642, the Tadpole cluster. Coming in at mag 8.8 this was a faint fuzzy blob (FFB) and could make no detail out of the cluster. M 8, the Lagoon nebula was hiding in a tree, so off to the next which was M 20, a diffused nebula (DN), hard to find FFB, does not help only being 7 ° above the horizon. Climbing a bit now I went to M 25, a large sparse open cluster (OC) with some bright stars within the group. Next was another OC, namely M 23, a large dim cluster. M 21 was a small dim OC with some bright stars in it. The Star Cloud, namely M 24 has masses of dim stars, probably better using a wide field telescope and not an F10? M 18 is another small OC which has a few stars in the group but loose. Last object in the constellation I could view was M 17, the Omega or Swan nebula, this object is a large grey blob of dust. Next constellation was Ophiuchus which is above Sagittarius starting off with M 107, unfortunately this GC was hiding in another tree! Going east I came across M 10, a large GC but could not make out any stars. Linked to M 10 (according to my hand controller) is M 12, another GC which was poor to look at, a FFB. Next was M 14 another GC which looked like a fuzzy blob. Now looking at some stars in this constellation starting off with Rasalhague, the alpha star, this is a white star. The beta star, Cebalrai is a yellow star. I was trying to get some other stars in this constellation but they had already set, so I thought I would go to the most southerly mag 1 star from the UK, namely Fomalhaut. This is an A3V white star about 22 light years away. Back to Saturn and I thought I could just make out the Cassini division in the ring system? Tried for Neptune but got the same result, could not find it! Off to Jupiter, could make out Io to the east of this gaint planet and Europa, Ganymede and Calisto to the west. Thought I could see the Great Red Spot but looking later at home turns out it was on the other side of the planet, doh! Uranus was in the finderscope, doing a manual slew to centre Uranus I could not make out any details. Final object for the evening was M 45, the Pleiades which is best viewed with the finderscope.

Time was now 22:01 with a temperature of 5 °C I packed up all my equipment and went home, not one car drove past me this evening, being a dead end I should not get many?

Clear skies.

Peter Chappell

Partial Lunar October 28th: Peter's images

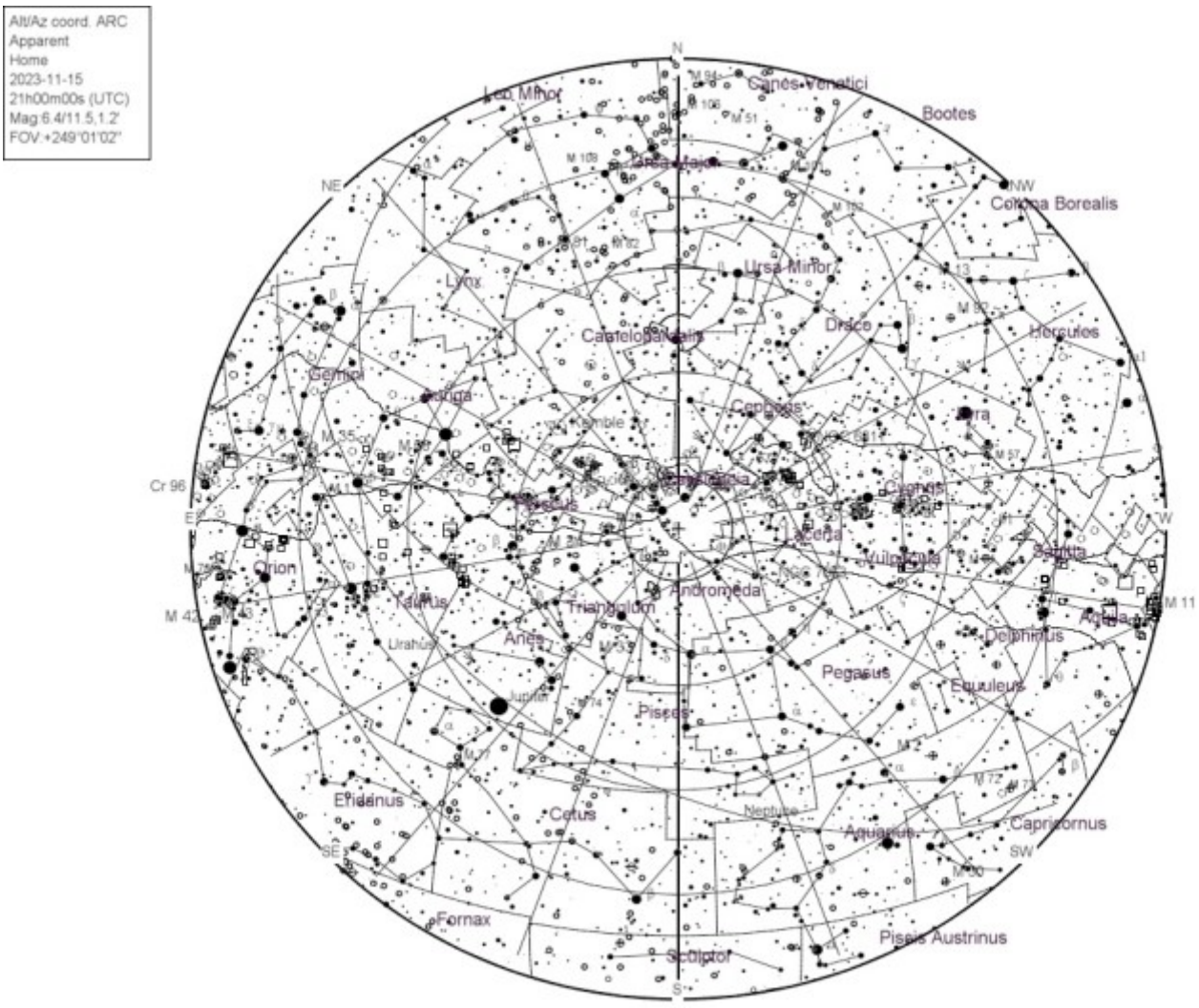


Firstly with Jupiter..

Partial Lunar Eclipse: Peter Chappell

From Spain: Andy Burns

WHATS UP, NOVEMBER 23



November 3 - **New Moon.** The Moon will be directly between the Earth and the Sun and will not be visible from Earth. This phase occurs at 12:50 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.

November 3 - **Hybrid Solar Eclipse.** A hybrid solar eclipse occurs when the Moon is almost too close to the Earth to completely block the Sun. This type of eclipse will appear as a total eclipse to some parts of the world and will appear annular to others. The eclipse path will begin in the Atlantic Ocean off the eastern coast of the United States and move east across the Atlantic and across central Africa

November 4, 5 - **Taurids Meteor Shower.** The Taurids is a long-running minor meteor shower producing only about 5-10 meteors per hour. It is unusual in that it consists of two separate streams. The first is produced by dust grains from Asteroid 2004 TG10. The second stream is produced by debris left behind by Comet 2P Encke. The shower runs annually from September 7 to December 10. It peaks this year on the the night of November 4. This is an excellent year because there will be no moonlight to spoil the show. Best viewing will be just after midnight from a dark location far away from city lights. Meteors will radiate from the constellation Taurus, but can appear anywhere in the sky.

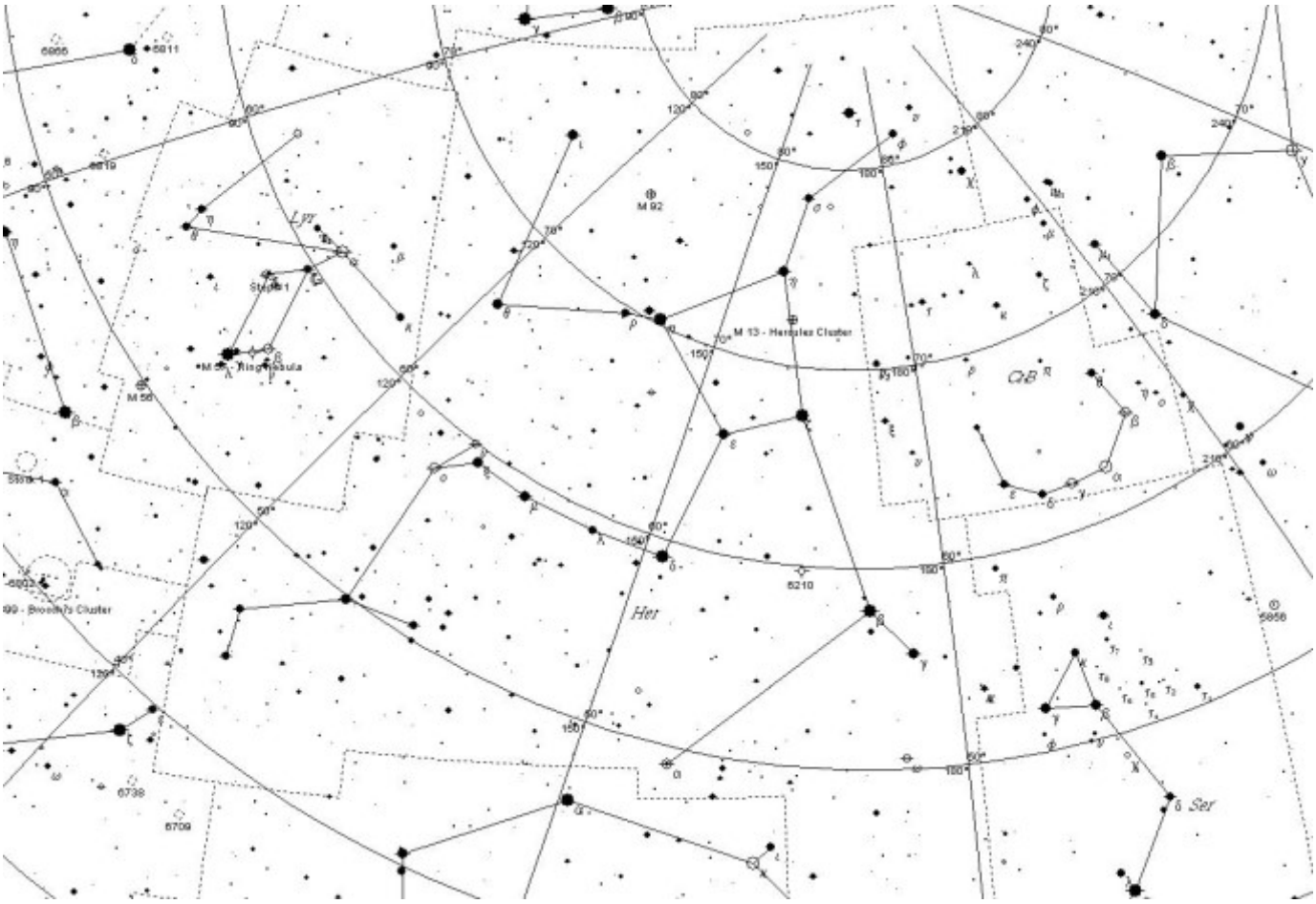
November 9th– Occultation of Venus. In daylight.
At 9:45am the Crescent of the Moon will begin to pass in front of Venus, well away from the Sun (45degrees) it should be easy to see high up to the South.and 40 degrees up. It will emerge again at 10:41am.

November 17 - **Full Moon.** The Moon will be directly opposite the Earth from the Sun and will be fully illuminated as seen from Earth. This phase occurs at 15:16 UTC. This full moon was known by early Native American tribes as the Full Beaver Moon because this was the time of year to set the beaver traps before the swamps and rivers froze. It has also been known as the Frosty Moon and the Hunter's Moon.

November 16, 17 - **Leonids Meteor Shower.** The Leonids is an average shower, producing up to 15 meteors per hour at its peak. This shower is unique in that it has a cyclonic peak about every 33 years where hundreds of meteors per hour can be seen. That last of these occurred in 2001. The Leonids is produced by dust grains left behind by comet Tempel-Tuttle, which was discovered in 1865. The shower runs annually from November 6-30. It peaks this year on the night of the 16th and morning of the 17th. Unfortunately the glare from the full moon will block many of the meteors this year, but if you are patient you should still be able to catch quite a few good ones. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Leo, but can appear anywhere in the sky.

November 28 - **Comet ISON Closest Approach to the Sun.** Newly discovered comet ISON will make its closest approach to the Sun on November 28. If the comet survives its encounter with the Sun, it could be one of the brightest comets in recent memory. Some astronomers estimate that it could even be bright enough to be seen during daylight hours. In August and September, the comet will begin to be visible in the morning sky in dark locations with telescopes. In October it will start to be visible to the naked eye and will continue to get brighter until November 28. If the comet survives, it will be visible in the early morning and early evening sky and could be nearly as bright as the full Moon. Some astronomers are already calling it the comet of the century. **Update:** Comet ISON did not survive its trip around the Sun. It appears to have totally disintegrated as it passed too close to the Sun's atmosphere.

CONSTELLATION OF THE MONTH: HERCULES



The constellation of Hercules belongs to one of the 48 originals plotted by Ptolemy and has survived time to become one of the 88 modern constellations adopted by the International Astronomical Union. Spanning an impressing 1225 square degrees of sky and containing 22 stars in the asterism, it has 106 Bayer/Flamsteed designated stellar designations. Hercules is bordered by the constellations of Draco, Bootes, Corona Borealis, Serpens Caput, Ophiuchus, Aquila, Sagitta, Vulpecula and Lyra. It is visible to all observers at latitudes between +90° and ?50° and is best seen at culmination during the month of July. There is one annual meteor shower associated with Hercules, the Tau Herculids, which peak on or near June 3. The radiant, or point of origin, is near the Hercules/ Corona Borealis border and the meteor shower itself last about a month beginning around two weeks before and lasting about two weeks after the peak date. Most of these meteors are quite faint and at maximum, expect to see no more than 15 per hour average.

The mythology surrounding Hercules is a long and very colorful one. He was considered the greatest of all heroes – both Greek and Roman. The legendary strong man was supposed to be the son of Zeus; immortal, yet forever challenged by Hera by his circumstance of birth. His tasks were many: killing a lion with a hide that could not be punctured, destroying the many headed Hydra, cleaning out nasty stables, fighting birds with knife-like feathers, capturing a bull that breathed fire, taming horses that ate flesh, stealing cattle from monsters, stealing golden apples, fighting dragons, snatching a three-headed dog, loosing the love of his life, accidentally killing his teacher and so much more… It is no wonder that Hercules is so often depicted as kneeling in the sky! Even an immortal would be tired from so much… But at last, Hercules earned his place in the stars and he remains there to this day… The fifth largest constellation in the night sky.

Because the constellation of Hercules has no particularly bright stars, it is sometimes difficult to navigate through with binoculars until you learn a few “key” ingredients. There is a large asterism which is fairly easy to recognize that forms a lopsided box, referred to as the “keystone”. The northeast corner is Pi. The northwest corner is Eta. The southeast corner is Epsilon. The southwest corner is Zeta. Always remember when you look at a star chart that north and south are up and down… But east is to the left and west is to the right! To find the “keystone”, let bright Vega guide you…. just start by looking southwest.

Have you found Pi Herculis, yet? If you’re seeing two stars in your binoculars and you’re not sure which one, Pi is the slightly redder and slightly brighter of the pair. Situated about 370 light years from Earth, Pi Herculis is a cool, red supergiant star that was born about 140 million years ago. Although you can’t see it, Pi also has an orbiting substellar companion about 27 times larger than Jupiter there, too! Now, drop south for Epsilon – another binary star. Chances are good this pair of twin stars are almost identical to each other – about twice the size and mass of our Sun – and orbit each other so closely they nearly touch.

Don’t stop moving south. Our next stop is Gamma Herculis, the “8” shape on our map. Gamma is also a very cool star – one with a dead helium core that’s waiting to become a red giant. In maybe 8 million or so years, it will begin to fuse helium into carbon and become much brighter than it is tonight. If you see a faint companion star, it is only an optical one in binoculars – but Gamma is also a genuine binary star.

Next stop? Further south for Alpha – the “a” shape on our map. Now **here** is a great star! Named Rasalgethi and located about 380 light years away, here we have one of the finest double stars in the night sky. The primary star is a magnificent red class M supergiant that’s over 475 more luminous than our Sun and whose size would fill up our solar system clear out to the orbit of the asteroid belt. But that’s not all… Aim a telescope at Rasalgethi and you’ll see it has a fifth magnitude companion five seconds of arc away. It is also a binary star – an F2 giant with a close orbiting dwarf star companion. Surrounding this whole system is an envelope of gas expelled from the primary star’s incredible solar winds… Enjoy the unusual red and green hues of this colorful double star! And keep watching… Because Rasalgethi is also an irregular variable star – whose brightness changes from magnitude 2.7 to 4.0 within a period of about three months.

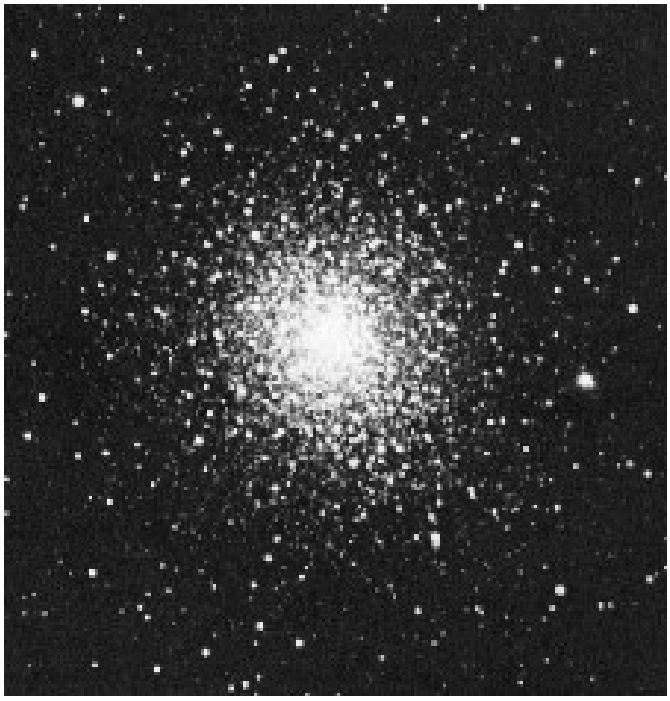
Return to the “keystone” and the northwest corner for Eta – the “n” shape on our map. Shining away about 50 times brighter than our own Sun at a distance of 112 light years, there is nothing particularly impressive about Eta, except where it leads. Begin moving your optics slowly south towards Zeta and you *will* encounter the “Great Hercules Cluster” – M13! Easily seen in binoculars, sometimes visible to the unaided eye in a dark sky location and absolutely magnificent in any telescope, Messier 13 is perhaps the most famous of all northern globular clusters. Located about 25,000 light years away and home to more than half a million stars, this 12 billion year old system spans no more than 100 light years across. Also known as NGC 6205, this impressive ball of stars was first discovered by Edmund Halley in 1714 and catalogued by Charles Messier on June 1, 1764. If you aren’t impressed, then take the words of Kurt Vonnegut to heart: “”Every passing hour brings the Solar System forty-three thousand miles closer to Globular Cluster M13 in Hercules — and still there are some misfits who insist that there is no such thing as progress.”

Almost seventy years ago, radio was exciting. People were still adjusting to its instantaneous connection with events from around the world as soon as they happened. Therefore, many listeners believed the dramatic presentation, presented as news during the radio play, was real. The broadcast has been followed by countless books, television shows and motion pictures which, combined, helped the notion of intelligent alien life to take firm roots in our culture. Science was also invaded by the possibility of extraterrestrial beings. In 1974, a carefully crafted message was transmitted from the world's largest radio telescope and directed towards stars in M13, pictured here, in hopes someone or something would be listening.

M13 is one of the most prominent and best-known globular clusters in the night sky. It is the brightest that can be easily seen with a small telescope or pair of binoculars from most places in the northern hemisphere. Located in the constellation of Hercules, M13 is visible this time of year. It is twenty thousand lights years from Earth and its 100,000 stars form a ball so immense that it takes light 150 years to travel from one side to the other. The age of M13 is estimated at about 14 billion years.

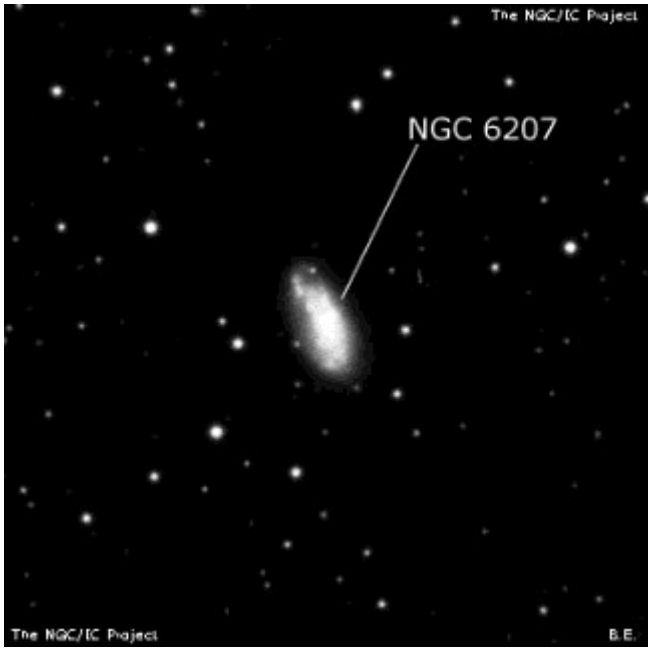
The 1974 three minute message to M13 was beamed into space from the Arecibo Radio Telescope, in Puerto Rico, and was spearheaded by Dr. Frank Drake, a leading SETI proponent and colleague of the late Carl Sagan. A much longer three-hour message to other carefully selected stars was subsequently transmitted in 2001 from a radio telescope in the Ukraine. Of course, if anyone is around when our 1974 message arrives at a hypothetical planet orbiting a star in M13, their response will not return here until fifty thousand years have transpired.

Then take another look at Eta and Pi and form an imaginary triangle on the sky using these two stars as the base. The apex is very near where you will find another amazing globular cluster for binoculars or small telescopes – Messier 92. First discovered by Johann Elert Bode in 1777 and independently rediscovered by Charles Messier on March 18, 1781, M92 is a 16 billion year old beauty – formed back at the Milky Way Galaxy’s beginnings. Hiding in there are 16 variable stars and one rare eclipsing binary. What a treat to have two such bright objects so near to one another!

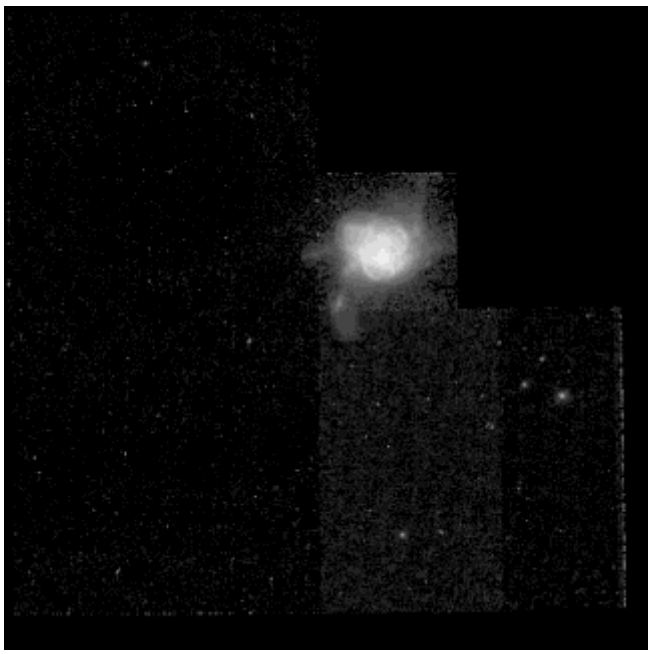


Ready for an alternative binocular tour of Hercules? Then let’s use what you’ve learned. Start by locating magnificent M13 and move 3 degrees northwest – about a binocular field. What you will find is a splendid loose open cluster of stars known as Dolidze/Dzimselejsvili (DoDz) 5 – and it looks much like a miniature of the constellation Hercules. Just slightly more than 4 degrees to its east and just about a degree south of Eta Herculis is DoDz 6, which contains a perfect diamond pattern and an asterism of brighter stars resembling the constellation of Sagitta. Now we’re going to move across the constellation of Hercules towards Lyra. East of the “keystone” is a tight configuration of three stars – Omicron, Nu, and Xi. About the same distance separating these stars northeast you will find DoDz 9. You’ll see a pretty open cluster of around two dozen mixed magnitude stars. Now look again at the “keystone” and identify Lambda and Delta to the south. About midway between them and slightly southeast you will discover the stellar field of DoDz 8. This last is easy – all you need to do is return to Alpha. Move about 1 degree northwest (Rasalgethi will stay in the field) to discover the star-studded open cluster DoDz 7. These great open clusters are very much off the beaten path and will add a new dimension to binocular and fast-telescope observing!

Would you like a challenge? Then go back to M13 with a large telescope and take a look about 40 arc minutes to the northeast for NGC 6207 (RA 16:43.1 Dec +36:50). At near



magnitude 12, this small spiral galaxy isn't for everyone, but it's always a smile a bonus when you're in the area, despite the lack of details. Try NGC 6210 (RA 16:44.5 Dec +23:49), too. This bright planetary nebula is suited for all telescopes and takes magnification very well. Look for a blue/green color in larger telescopes, and adding a nebula filter can sometimes reveal some subtle details of a shell



around this one. But be sure to take the filter out if you want to catch the central star!

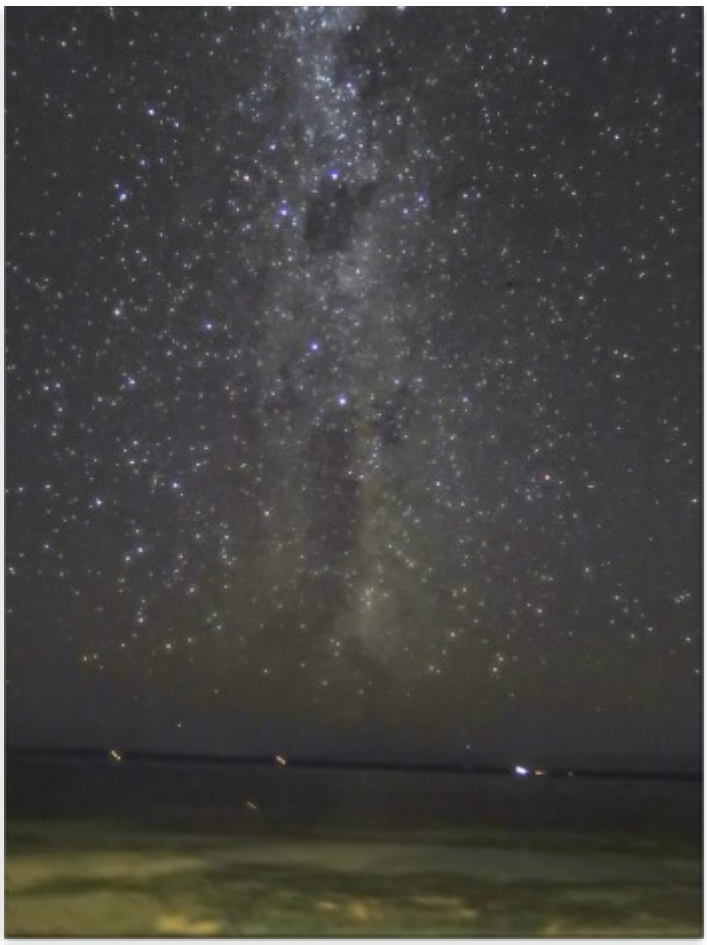
ISS PASSES For November 2023

from Heavens Above website maintained by Chris Peat.

Date	Brightn	Start	Highest	End						
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
17 Nov	-1.4	18:38:47	10°	SSW	18:39:52	16°	S	18:39:52	16°	S
18 Nov	-1.8	17:50:23	10°	S	17:52:33	16°	SE	17:52:53	16°	SE
18 Nov	-0.6	19:25:27	10°	WSW	19:25:45	12°	WSW	19:25:45	12°	WSW
19 Nov	-1.3	17:02:45	10°	SSE	17:03:35	11°	SE	17:04:25	10°	ESE
19 Nov	-2.4	18:36:25	10°	SW	18:38:38	32°	SSW	18:38:38	32°	SSW
20 Nov	-2.6	17:47:28	10°	SSW	17:50:27	30°	SSE	17:51:25	25°	ESE
20 Nov	-0.7	19:23:32	10°	WSW	19:24:16	16°	WSW	19:24:16	16°	WSW
21 Nov	-2.0	16:58:41	10°	SSW	17:01:18	21°	SE	17:03:54	10°	E
21 Nov	-3.1	18:34:16	10°	WSW	18:36:57	52°	SW	18:36:57	52°	SW
22 Nov	-3.4	17:45:01	10°	SW	17:48:16	53°	SSE	17:49:34	31°	E
22 Nov	-0.8	19:21:32	10°	W	19:22:24	17°	W	19:22:24	17°	W
23 Nov	-2.8	16:55:48	10°	SW	16:58:56	38°	SSE	17:02:05	10°	E
23 Nov	-3.3	18:32:07	10°	W	18:34:56	60°	W	18:34:56	60°	W
24 Nov	-3.8	17:42:39	10°	WSW	17:46:00	79°	SSE	17:47:24	32°	E
24 Nov	-0.8	19:19:21	10°	W	19:20:14	17°	W	19:20:14	17°	W
25 Nov	-3.5	16:53:11	10°	WSW	16:56:30	64°	SSE	16:59:49	10°	E
25 Nov	-3.3	18:29:49	10°	W	18:32:39	61°	W	18:32:39	61°	W
26 Nov	-3.8	17:40:14	10°	W	17:43:34	86°	N	17:45:02	31°	E
26 Nov	-0.8	19:16:55	10°	W	19:17:51	17°	W	19:17:51	17°	W
27 Nov	-3.8	16:50:36	10°	W	16:53:57	88°	S	16:57:19	10°	E
27 Nov	-3.4	18:27:18	10°	W	18:30:13	65°	W	18:30:13	65°	W
28 Nov	-3.9	17:37:37	10°	W	17:40:58	88°	N	17:42:34	29°	E
28 Nov	-0.9	19:14:19	10°	W	19:15:23	18°	W	19:15:23	18°	W
29 Nov	-3.8	16:47:54	10°	W	16:51:14	85°	N	16:54:35	10°	E
29 Nov	-3.3	18:24:34	10°	W	18:27:45	56°	SSW	18:27:45	56°	SSW
30 Nov	-3.6	17:34:47	10°	W	17:38:07	73°	SSW	17:40:09	22°	ESE
30 Nov	-0.9	19:11:42	10°	W	19:12:58	17°	WSW	19:12:58	17°	WSW
01 Dec	-3.7	16:44:58	10°	W	16:48:18	86°	S	16:51:39	10°	ESE
01 Dec	-2.4	18:21:42	10°	W	18:24:45	33°	SSW	18:25:26	30°	S
02 Dec	-2.8	17:31:46	10°	W	17:34:59	46°	SSW	17:38:00	11°	SE
02 Dec	-0.7	19:09:35	10°	WSW	19:10:51	12°	SW	19:10:51	12°	SW
03 Dec	-3.3	16:41:49	10°	W	16:45:07	62°	SSW	16:48:25	10°	ESE
03 Dec	-1.1	18:18:56	10°	W	18:21:19	18°	SW	18:23:35	11°	S
04 Dec	-1.6	17:28:40	10°	W	17:31:31	26°	SSW	17:34:22	10°	SSE
05 Dec	-2.2	16:38:31	10°	W	16:41:37	37°	SSW	16:44:44	10°	SE

END IMAGES, AND OBSERVING

Thank you for your Dark Nebulae session yesterday.
Here are my images of the Milky Way Emu taken from Kangaroo Island Australia in March 2019. The first image is a blend of 3 images at 15 sec, ISO 800, F1.8 taken with my Canon G16 and stacked in Sequator. The second is the same image post processed in Affinity Photo.
Regards, John



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
First	Friday	08th	September	20:00	20:30	Cres	Rising	0:10	Jupiter, Saturn and Uranus are very late risers only just getting above the horizon as it gets dark but things improve as the month progresses. The summer triagle is high above a full of faint fuzzies.
Second	Friday	15th	September	20:00	20:30	New	Setting	19:15	
First	Friday	06th	October	19:00	19:30	Qtr	Rising	23:00	Orionid Meteor Shower on the 21st and the Usual planets throughout the month along with the Pleiades open cluster rising around 9pm.
Second	Friday	13th	October	19:00	19:00	New	Rising	7:15	
October Special	Saturday	28th	October	19:30	20:00	Full	Rising	7:15	A Partial Eclipse of the Moon starting around 20:30 if anybody would like to observe - let me know!
First	Friday	10th	November	18:30	19:00	Cres	Rising	5:00	Saturn heads for the horizon but Jupiter burns brightly ,and the normally quiet Leonid meteor shower makes an appearance with the occassional bright display.
Second	Friday	17th	November	18:30	19:00	Cres	Setting	18:30	
First	Friday	08th	December	18:30	19:00	Cres	Rising	13:15	Orion makes an appearance above the horizon much earlier and we catch the end of the Geminid Meter shower on the 16th, bring your binoculars and comfy chair!
Second	Friday	15th	December	18:30	19:00	Cres	Setting	17:45	
Third	Friday	29th	December	18:30	19:00	Gibb	Rising	18:45	New Equipment Practical session with nearly full moon
First	Friday	5th	January	18:30	19:00	Cres	Rising	3:00	Saturn has now gone but the remaining outer planets are still on deplay. Worth observing and photographing the Andromeda Galaxaxy as it is high in the sky now.
Second	Friday	12th	January	18:30	19:00	Cres	Setting	16:45	
First	Friday	2nd	February	18:30	19:00	Cres	Rising	1:45	Jupiter is still observable but is starting to head to the horizon at the start of the month and becomes less favourable.
Second	Friday	9th	February	19:00	19:30	New	Rising	17:30	
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