NWASNEWS

Volume30 Issue 2

October 2023

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

What DO You Want?

If you look at our speaker meetings on page 2 you will see this is still very empty. And deliberately so. If the members get together and make a new speaker secretary, and a new chairperson they may want to change or redirect the speaker meetings. Until then we will arrange ad hoc meetings, with possibly 4 0r 5 Zoom meetings. At least we get over twice the attendance at Zoom meetings as we do for hall meetings.

But it is not a matter of cost, the hall cost is not shooting up in price, and can be hired as and when we want it.

Are the meetings too late? On he wrong day? All factors we can address.

The last observing session was extremely well attended and a lot of instruction given to people attending.

Outreach is happening with a session at a Melksham school is working towards a possible date and also the Chippenham Scout group are after a session that they can do away from their site at Westmead (the new Arc climbing wall etc makes viewing difficult from their meeting hut but they would come to Lacock. We are looking for volunteers to man telescopes around the middle of November. Weather will change the date.

Clear skies

Andy Burns

Note we have a very full observing year from Lacock planned. See the web page and back page of the newsletter.

Aurora from September 25th Looking North to north west at 3:00am in the morning, the aurora forecast alert woke me, there were earlier high Aurora but it was cloudy, so I was delighted to the the red in the sky with the naked eye, but the photograph enhanced the colours. 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 we will try to hold these at the hall

Meet 7.30 for 8.00pm start

SEASON 2022/23

2023 October 3rd: Hall Meeting Andy Burns The Dark Nebulae, History and Imaging
November 7th:
December 5th
2024
January 2nd
February 6th
March 5th
April 2nd
May 7th
June 4th

AWAITING A SPEAKER SECRETARY FOR 23/24 SEASON

Speaker tonight…

Andy Burns

After being bought the book 'Astronomy' by Patrick Moore in 1961, when I was around 8, astronomy was something that always fascinating. When I was 13, a neighbour brought home a small and basic (by modern standards) refractor and showed us the rings of Saturn, my first look through a telescope. What a turn on to astronomy this was.

Education, work and family commitments put paid to any more than armchair astronomy until I bought my first telescope 6" TAL2 in 1992. Things then galloped along. Mirror grinding (I'm glad telescopes are now cheap enough to buy!), eclipse chasing – 7 for 7 seen so far lead to a regular slot on local BBC radio, and 15 years of weekly broadcasts followed. Both recent transits of Venus covered, the last from Venus point in Tahiti 2012.

I joined the fledgling Wiltshire AS in 1992, became Vice Chair and now Chair since 2006. Edit 24pp newsletter each month. (Now in the 30th year).

Distance learning university courses (a Central Lancashire and University of Glamorgan) to strengthen my background knowledge lead to annual imaging trips for University of Glamorgan students to Portugal. This led to an opportunity to transfer to Spain and set up, equip and Co-direct of the Griffon Educational Observatory in Andalucía.

And many other topics, particularly related to managing expectations for budding astronomers of all levels. Was privileged to be given the Sky at Night Achievement in Amateur Astronomy Award

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

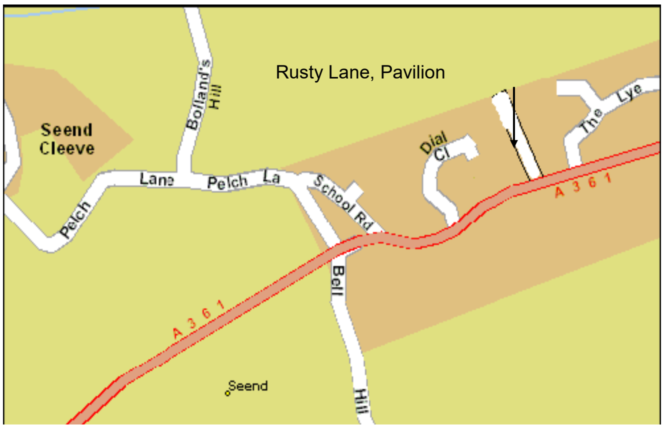
Speaker secretary

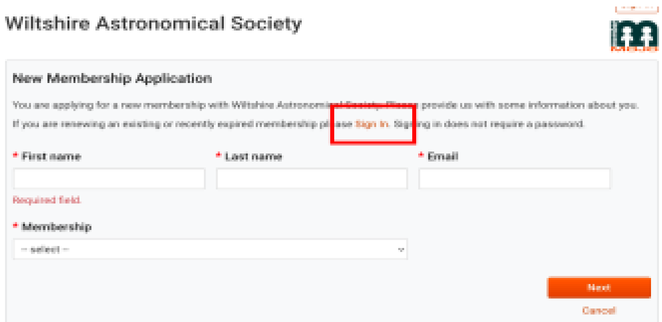
Zoom session coordinator

Observing Sessions coordinators: Chris Brooks, Jon Gale,

Web coordinator: Sam Franklin

Contact via the web site details.





Observing Sessions see back page

in 2010 for 'outstanding contributions to advancement and promotion of astronomy'. Worked with the STFC in promoting astronomy in schools, and established background enrichment programmes within schools prior to them taking on GCSE astronomy, and outreach to primary schools and many other groups.

Working with Dark Sky Wales in their outreach, astrophotography, giving talks, practical astronomy, working at the Griffon Observatory, building up a large collection of meteorites and working with archaeologists with astronomy and drone work has been keeping me pretty busy.

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, 20 October

– Talk on Telescope Tweaks!

Our in-person speaker at our October meet is our own club member Damian OHara.

He will be introducing some ideas to get more from your telescope.

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 here:

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, 20 October @ 19.30

Damian OHara: Telescope Tweaks!

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

Website:
http://www.swindonstargazers.co

Chairman: Damian OHara
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 bunch of stargazers and enthusiastic astronomers who share experiences and know-how as well as offer an extensive outreach programme of public and young people's observing and activities. As a partner to Bath Preservation Trust, they are the resident astronomers at the Herschel Museum of Astronomy, 19 New King Street, Bath, BA1 2BL. 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 are thick in the sky.

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

Next Meetings:

Wednesday, 25th October

A talk by Steve Warbis "Quick Astrophotography under a light polluted sky". Steve joins us from Macclesfield Astronomical Society and gives us his introduction to astrophotography talk which has launched many of the best astro imagers in the UK today. A simple inspiration.

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 0.5m subscribers. This meeting will be held at BRLSI on Queen Square. Get your seat reserved via https://bathastronomers.org.uk/drbecky

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 Jade, Jonathan, Meyrick, Mike, Prim and Simon will be happy to help you.

SPACE NEWS

Supernovae Struck the Earth 3 Million and 7 Million Years Ago

A recent study examines how the Earth was hit by blasts from supernovae (plural form of supernova (SN)) that occurred 3 million years ago (Mya) and 7 Mya with the goal of ascertaining the distances of where these blasts originated. Using the live (not decaying) radioactive isotope 60-Fe, which is produced from supernovae, a team of researchers at the University of Illinois was able to determine the approximate astronomical distances to the blasts, which they refer to as Pliocene Supernova (SN Plio, 3 Mya) and the Miocene Supernova (SN Mio, 7 Mya).

“Supernovae are dramatic examples of the fact that stars have life cycles,” Dr. Brian Fields, who is a Professor of Astronomy at the University of Illinois and a co-author on the study, tells *Universe Today*. “Supernova explosions mark the spectacular deaths of the most massive stars, those at least eight times the mass of the Sun. They play a central role in astrophysics and cosmology for many reasons.”

For the study, the researchers conducted laboratory analyses of the live (non-decayed) radioactive iron isotope species of 60-Fe based on several previous studies where 60-Fe samples were obtained from the Earth’s crust, deep-sea sediments, and lunar regolith. While the ages of these samples were obtained using the 60-Fe half-life of 2.62 million years and determined to have originated from two supernovae blasts, the goal of this recent study was to determine the distances to the two blasts.

The study’s findings indicate that SN Plio originated between 20 to 140 parsecs (pc), or 65 to 457 light-years (ly), from Earth, but the most likely range is between 50 to 65 pc, or 163 to 212 ly. For SN Mio, the team determined the approximate distance is 110 pc, or 359 ly. For context, 1 pc is equivalent to 3.26 ly. While these might be considered relatively “safe” distances from Earth, how can such blasts potentially influence the evolution of our solar system?

“If a supernova blows up too close to the Earth or another Earth-like planet, the consequences can be devastating for life,” Dr. Fields tells *Universe Today*. “The supernova outburst creates high-energy radiation–gamma rays–that will irradiate Earth’s atmosphere for months after the explosion. Our atmosphere will shield us from direct exposure by these gamma rays, but at great cost: the ozone layer in the upper atmosphere will be significantly reduced. This will leave Earth vulnerable to harsh ultraviolet (UV) rays from the Sun, which can be harmful for much of life on Earth. The Earth will take several years to re-generate ozone.”

Supernovae are some of the most awe-inspiring spectacles observed in the cosmos, with the oldest recorded supernova, now named RCW 86 or SN 185, occurring on December 7, 185 A.D., and documented by Chinese astronomers. They referred to this event as a “guest star” and noted its light stayed in the sky until June 186 A.D before it disappeared. Present-day astronomers refer to this event as a transient astronomical event and suggest that RCW 86, which resides approximately 2,800 parsecs (pc) (9,100 light-years (ly)) from Earth with an estimated diameter of 85 ly, was likely a Type Ia supernova.

Dr. Fields tells *Universe Today,* “Supernova explosions are rare—each century, there is about one to three such events in our entire Milky Way galaxy. So, most of them explode far away, and are harmless for Earthlings. But over timescales of many millions of years, it is very likely that one would explode near the Earth, even too close for comfort.”

Dr. Fields notes while the mass extinction that occurred at the end of the Devonian Period approximately 360 million years ago have been the result of one or more supernovae, he tells *Universe Today* there are currently “no threatening supernova candidates”, as in “none so near that we are in their kill zones.” .

One of the most well-known (future) supernovae is the star Betelgeuse, which is a red supergiant located approximately 550 ly from Earth and is the second brightest star in the Orion constellation. Betelgeuse made headlines in late 2019 when astronomers observed the star dimming, with some suggesting it was about to go supernova. However, follow-up observations suggested in August 2020 that the dimming was due to a dust cloud that formed from superhot material ejected by the massive star, which was later confirmed in an August 2022 study. While Betelgeuse is known for its brightness variances due changes in its temperature and size, some might still ask when it’s going to explode?

Dr. Fields tells Universe Today, “It is unknown when [Betelgeuse] will explode, because as far as we know, the late phases of a massive star’s life do not cause noticeable changes in the surface region of the star. Thus, Betelgeuse could be the next supernova in our Galaxy, but it could also explode 100,000 years from now. But its eventual death is certain, so enjoy it in Orion now while you still can!”

What new discoveries will astronomers make about supernovae in the coming years and decades? Only time will tell, and this is why we science!

The Milky Way's Mass is Much Lower Than We Thought

How massive is the Milky Way? It’s an easy question to ask, but a difficult one to answer. Imagine a single cell in your body trying to determine your total mass, and you get an idea of how difficult it can be. Despite the challenges, a new study has calculated an accurate mass of our galaxy, and it’s smaller than we thought.

One way to determine a galaxy’s mass is by looking at what’s known as its rotation curve. Measure the speed of stars in a galaxy versus their distance from the galactic center. The speed at which a star orbits is proportional to the amount of mass within its orbit, so from a galaxy’s rotation curve you can map the function of mass per radius and get a good idea of its total mass. We’ve measured the rotation curves for several nearby galaxies such as Andromeda, so we know the masses of many galaxies quite accurately.

But since we are in the Milky Way itself, we don’t have a great view of stars throughout the galaxy. Toward the center of the galaxy, there is so much gas and dust we can’t even see stars on the far side. So instead we measure the rotation curve using neutral hydrogen, which emits faint light with a wavelength of about 21 centimeters. This isn’t as accurate as stellar measurements, but it has given us a rough idea of our galaxy’s mass. We’ve also looked at the motions of the globular clusters that orbit in the halo of the Milky Way. From these observations, our best estimate of the mass of the Milky Way is about a trillion solar masses, give or take.

The distribution of stars seen by the Gaia surveys. Credit: Data: ESA/Gaia/DPAC, A. Khalatyan(AIP) & StarHorse team; Galaxy map: NASA/JPL-Caltech/R. Hurt

This new study is based on the third data release of the Gaia spacecraft. It contains the positions of more than 1.8 billion stars and the motions of more than 1.5 billion stars. While this is only a fraction of the estimated 100-400 billion stars in our galaxy, it is a large enough number to calculate an accurate rotation curve. Which is exactly what the team did. Their resulting rotation curve is so precise, that the team could identify what’s known as the Keplerian decline. This is the outer region of the Milky Way where stellar speeds start to drop off roughly in accordance with Kepler's laws since almost all of the galaxy's mass is closer to the galactic center.

The Keplerian decline allows the team to place a clear upper limit on the mass of the Milky Way. What they found was surprising. The best fit to their data placed the mass at about 200 billion solar masses, which is a fifth of previous estimates. The absolute upper mass limit for the Milky Way is 540 billion, meaning that the Milky Way is at least half as massive as we thought. Given the amount of known regular matter in the galaxy, this means the Milky Way has significantly less dark matter than we thought.

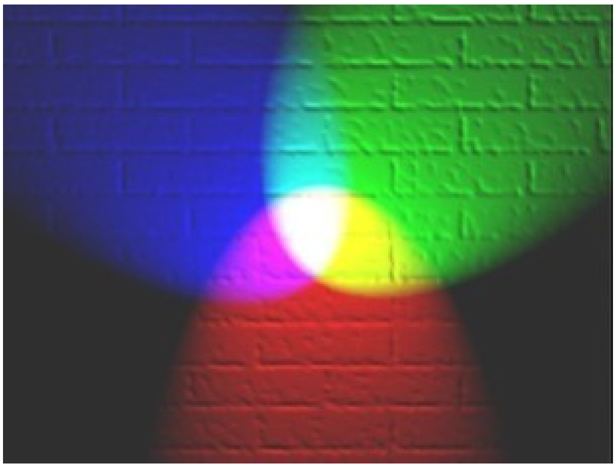
Reference: Jiao, Yongjun, et al. "Detection of the Keplerian decline in the Milky Way rotation curve." *arXiv preprint* arXiv:2309.00048 (2023).

It's Official, Antimatter Falls Down in Gravity, Not Up

It's a basic fact we've all learned in school. Drop any object, be it a baseball, feather, or cat, and it will fall toward the Earth at exactly the same rate. The cat will fortunately land on its feet thanks to a bit of feline grace, but the point is that everything falls at the same rate under gravity. It doesn't matter what an object is made of, or how heavy it is. While we've all been taught this fact, calling it a fact was, until recently, a bit of a lie.

In physics, this fact is known as the equivalence principle, and it is the fundamental tenet of gravitational models. Galileo is rumored to have demonstrated it by dropping things off the Tower of Pisa, and astronauts demonstrated it by dropping hammers and feathers on the Moon. Every experiment we've done confirms the effect. So calling it a fact seems pretty reasonable. Except all of our experiments have only been done with objects made of matter. If we had baseball, feather, or cat made of antimatter, would they *also* fall down at the same rate? You might think the answer is obviously yes, but there are some real physical arguments that the answer could be no. In fact, one could argue that antimatter should fall *up*.

Antimatter was first discovered in 1932 when physicist Carl D. Anderson discovered anti-electrons, now known as positrons. According to quantum physics, antimatter particles are the symmetrical twins of regular matter particles, but with opposite "charge." For electrons, this simply means that positrons have a positive electrical charge instead of a negative one. The antimatter twins of the quarks that make up protons and neutrons have an opposite electrical charge, but also opposite strong force charge. So instead of the strong force red, green, or blue charge, anti-quarks have anti-red, anti-green, or anti-blue charge. This charge symmetry between matter and anti-matter has long been confirmed in particle physics.



Strong force charges follow the naming scheme of color. Credit: Wikipedia

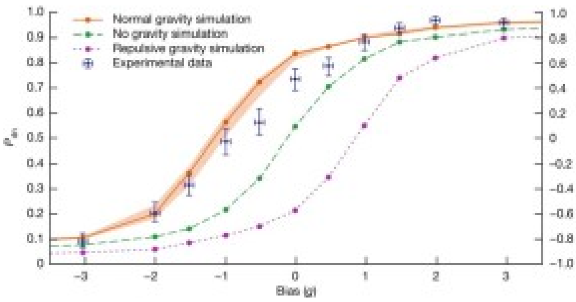
But it does raise an interesting question: is gravitational mass a charge?

By one argument it should be. If gravity is a fundamental force, just like strong, weak, and electromagnetic forces, then mass should be a charge. And if that's the case, then since regular matter has a positive gravitational mass, antimatter should have a negative gravitational mass. So, an antimatter baseball placed in the gravitational field of regular matter Earth should be repelled, not attracted. Anti-baseballs should fall up.

By another argument, gravity isn't a charge. Einstein's theory of general relativity asserts that gravity is an effect of warped space and time. All objects, regardless of their inertial mass, follow a geodesic path through spacetime. So matter and antimatter should fall at exactly the same rate. If they don't, then general relativity is fundamentally wrong, and so far every experiment confirms general relativity.

Of course, the resolution to this paradox is to simply do the experiment. Make some antimatter and drop it. Easier said than done. Although we've been able to create antimatter for decades, most of it has been created at high energy. And the antimatter we make has an electric charge, making it nearly impossible to study its gravitational effects. So for years, the challenge has been to make sufficient quantities of anti-hydrogen. That is an anti-proton bound to a positron. This requires creating both positrons and anti-protons and then cooling them to the point where they can bond. About 10 years ago we finally started to get pretty good at this, making and trapping a few atoms of anti-hydrogen. In the past few years, we've finally been able to create the kind of ultracool anti-hydrogen that could be used in gravity experiments.

This latest study is the culmination of all this work. The team looked at anti-hydrogen atoms confined at a temperature equivalent to 0.5 Kelvin using the ALPHA-g experiment at CERN. To measure their fall under gravity, the team gradually weakened the magnetic bottle which confined them, to see if they escaped the confinement region. By varying the strength of magnetic confinement, they were able to test whether anti-hydrogen falls downward like regular matter, upwards in opposition to regular matter, and even if Earth's gravity has no effect on anti-hydrogen.



This experiment agrees with general relativity. All matter falls down. Credit: Anderson, et al

What they found was that antimatter most definitely does not fall up. It falls downward like regular matter. To the limits of their experiment, anti-hydrogen falls downward at the same rate as regular matter. Granted, those limits are fairly weak. Regular matter falls near the Earth downward at 1 g = 9.8 m/s. This experiment confirmed that anti-hydrogen falls downward at somewhere between 0.46 g and 1.04 g. So perhaps there is some complex quantum gravity effect that causes antimatter to fall *slightly* slower than regular matter, but there's no reason to presume that is true. Future experiments will be more precise, so if there is such a quantum gravity effect it will be discovered.

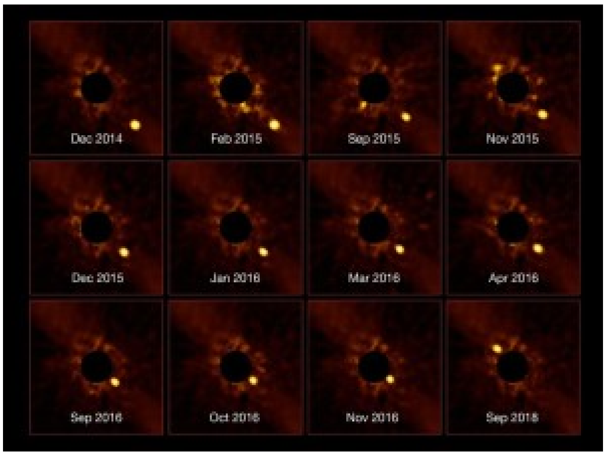
While this experiment proved what most physicists expected, it is a big experimental leap forward. It disproves the negative mass idea, meaning that it rules out all the alternative cosmological models that use negative mass to explain things such as cosmic expansion. This not only supports the standard cosmological model, but also reinforces that Einstein's general relativity is correct and that gravity is fundamentally different from the strong, weak, and electromagnetic forces.

So now we know, both matter and anti-matter cats fall downward when released near the Earth. Future experiments will need to determine whether anti-matter cats, like our common feline friends, also land on their feet.
Reference: Anderson, E. K. et al. "Observation of the effect of gravity on the motion of antimatter." *Nature* 621 (2023): 716–722

A New Planet-Hunting Instrument Has Been Installed on the Very Large Telescope

Exoplanet studies have come a long way in a short time! To date, 5,523 exoplanets have been confirmed in 4,117 systems, with another 9,867 candidates awaiting confirmation. With all these planets available for study, exoplanet researchers have been shifting their focus from detection to characterization – i.e., looking for potential signs of life and biological activity (biosignatures). Some major breakthroughs are expected in the coming years, thanks in part to next-generation observatories like NASA's *James Webb* and *Nancy Grace Roman Space Telescope* and the ESA's PLAnetary Transits and Oscillations of stars (PLATO) mission.

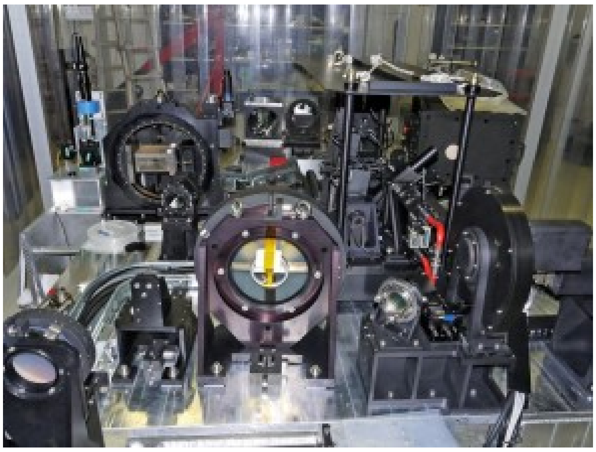
Several ground-based facilities will also be vital to the characterization of exoplanets, like the Extremely Large Telescope (ELT), the Giant Magellan Telescope (GMT), and the Thirty Meter Telescope (TMT). But there are also existing observatories that could be upgraded to perform vital exoplanet research. This idea was explored in a recent paper by an international team of astronomers, who presented the first light results of the High-Resolution Imaging and Spectroscopy of Exoplanets (HiRISE) recently installed on the ESO's Very Large Telescope (VLT) – not to be confused with the High-Resolution Imaging Science Experiment camera on NASA's *Mars Reconnaissance Orbiter* (MRO).
The study was led by Dr. Arthur Vigan, a permanent researcher with the Centre Nationale Reserches Scientifique based at the Laboratoire d'Astrophysique de Marseille. He was joined by researchers from the European Southern Observatory (ESO), the National Institute for Astrophysics (INAF), the Academia Sinica, the Ecole Normale Supérieure, the UH Institue for Astronomy, the Space Telescope Science Institute (STScI), and multiple universities and laboratories. A preprint of their paper recently appeared online and is being reviewed for publication by the journal *Astronomy & Astrophysics*.



ESO's Very Large Telescope (VLT) has captured an unprecedented series of images showing the passage of the exoplanet Beta Pictoris b around its parent star. Credit: ESO
As mentioned above, exoplanet research has been moving into characterization thanks to improvements in instrumentation and machine learning. With such a large sample of planets, scientists are now characterizing individual planet atmospheres and can draw statistical conclusions on large samples. These improvements are also leading to a transition in terms of methods, where exoplanets are being studied using Direct Imaging more than ever before. This method consists of detecting exoplanets by imaging the light reflected from their atmospheres and surfaces.

This stands in contrast to indirect methods like Transit Photometry or Doppler Spectroscopy (aka. the Transit Method and Radial Velocity Method), which have been responsible for the majority of exoplanet detections and confirmations so far. A major benefit of Direct Imaging is that astronomers can examine the reflected light using spectrometers to determine the chemical composition of an exoplanet's atmosphere. Said Dr. Vigan via email:

"Detection of these objects and measuring accurate spectra is still quite challenging because they are typically at extremely small angular separation from their host star and with a huge difference in brightness. A classical analogy is that of trying to image a candle located 1 m apart from a lighthouse when you observe from 700 km away! In the field of direct imaging, the combination of high-contrast imaging, which enables the detection of these planets, with high-resolution spectroscopy is a really hot topic right now. This is exactly what HiRISE enables on the VLT."
The HiRISE instrument is designed to characterize extrasolar giant planets (EGPs) in the infrared H band, an atmospheric transmission window astronomers use to measure the absorption by water vapor, volcanic activity, and other atmospheric phenomena. It combines the Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE) imager with the recently upgraded high-resolution CRyogenic high-resolution InfraRed Echelle Spectrograph (CRIRES) using single-mode optic fibers. The addition of this instrument will greatly enhance the VLT's imaging capabilities, which are currently limited in terms of spectral resolution relative to other observatories.



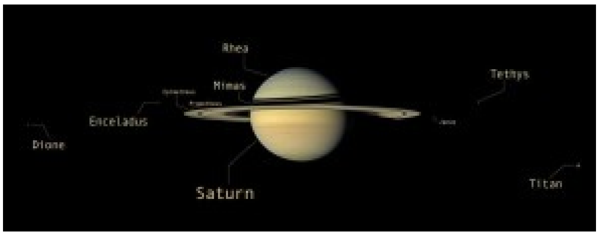
The SPHERE (Spectro-Polarimetric High-contrast Exoplanet REsearch) instrument is installed on the ESO Very Large Telescope and will assist researchers by directly imaging exoplanets larger than Jupiter. Credit: ESO
This is particularly the case for SPHERE, said Dr. Vigan, which is dedicated to finding exoplanets via Direct Imaging but has a maximum resolution of just ~70. "Other instruments like SINFONI (retired) or now ERIS provide higher resolutions, but they are not really optimized for exoplanet imaging, and GRAVITY provided some great results with interferometry, but except in a few cases, it is limited to a resolution of a few hundred," he said. "By contrast, HiRISE enables a resolution of 100,000! This opens the door to much more detailed spectral characterization and to measuring dynamical parameters such as the speed at which these planets orbit around their star and how fast they spin."
In addition to atmospheric characterization, these measurements will help astronomers investigate EGP formation, composition, and evolution, addressing some significant

mysteries and helping astronomers refine their models for solar system formation. Based on the first light collected using the new HiRISE instrument, the team demonstrated how its incorporation into the VLT has led to improved astrometry, temporal stability, optical aberrations, and transmission. Moreover, their paper demonstrates how existing instruments and observatories can be upgraded to provide high-contrast imaging or high-dispersion spectroscopy by coupling them using optical fibers.
This offers a cost-effective alternative to creating entirely new facilities from the ground up, which is the case with the ELT, GMT, and TMT. As these examples have demonstrated, the creation of new facilities is expensive, subject to delays, and can generate controversy when it comes to where facilities are being built (sensitive ecosystems, protected environments, Indigenous land, etc.). As Dr. Vigan explained:
“Designing, manufacturing, testing, and installing a brand new instrument on a large ground-based telescope is both long and costly: 10 years and ~20 million euros (including 10 million in hardware) for the SPHERE instrument on the VLT. This is even without taking into account that you need an available focus on the telescope for the new instrument. The advantage of coupling existing instruments is that you can go much faster and much cheaper while still making a great instrument that benefits from existing ones.”

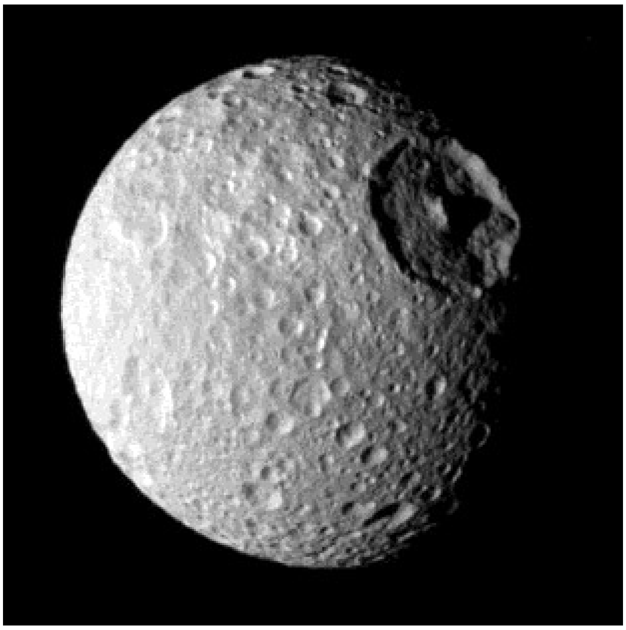
This image, taken in late June 2023, shows a night view of the construction site of ESO’s Extremely Large Telescope at Cerro Armazones, in Chile’s Atacama Desert. Credit: ESO.
In the case of HiRISE, he added, it took about five years of development and cost around €1 million ($1.16 million), including €200,000 to pay for the hardware and labor costs. In contrast, the European Southern Observatory placed the cost of building the ELT at $1.5 billion in 2020 (€1.42 billion). This was after the ESO approved a budget increase of 10%, and the facility will not be completed for several more years. Meanwhile, Dr. Vigan and the ESO hope to commence observations with the upgraded VLT by November, which will serve as a pathfinder for other observatories:
“Hopefully, HiRISE will pave the way for future instruments, for exemple on the extremely large telescopes (ELTs). We have learned a lot while designing the instrument and we will now investigate its limits. The European ELT built by ESO will at some point have an exoplanet imaging instrument aiming at the detection of Earth analogs around nearby stars. It’s already foreseen that the instrument will include a high-resolution spectroscopy mode to help boost the detection. Everything we have done and learned with HiRISE will be a great starting point.”

Colliding Moons Might Have Created Saturn’s Rings

If we could wind the clock back billions of years, we’d see our Solar System the way it used to be. Planetesimals and other rocky bodies were constantly colliding with each other, and new objects would coalesce out of the debris. Asteroids rained down on the planets and their moons. The gas giants were migrating and contributing to the chaos by destroying gravitational relationships and creating new ones. Even moons and moonlets would’ve been part of the cascade of collisions and impacts.
When nature crams enough objects into a small enough space, it breeds collisions. A new study says that’s what happened at Saturn and created the planet’s dramatic rings.
The research is “A Recent Impact Origin of Saturn’s Rings and Mid-sized Moons,” and it’s published in The Astrophysical Journal.” The lead author is Luis Todorow, a Research Fellow at the School of Physics and Astronomy at the University of Glasgow.
Saturn’s rings are so iconic that even schoolchildren can identify them. Astronomers have puzzled over them for a long time, trying to figure out how they formed and when. We know they’re mostly made of ice, but a consensus for their formation has been hard to reach.
This study, conducted by NASA and its partners, says a collision between two icy moons is responsible, and the debris is still circling the planet.
We don’t have to wind the clock back too far to find the impact the research identifies. It occurred only a few hundred million years ago, maybe even more recently than that. The research team says that it was triggered by “resonant instabilities in a previous satellite system.”
The research is based on detailed simulations of Saturn and its system of moons (it has 146 confirmed satellites) and rings.
NASA’s Cassini mission laid the groundwork for this research. The spacecraft spent more than ten years in the Saturn system. One of its main discoveries was that the gas giant’s rings and moons are not very old in astronomical terms. The larger ones are probably old, and their cratered surfaces are a clue to their ages. But some of the planet’s smaller moons are likely much younger.



An annotated picture of Saturn’s many moons captured by the Cassini spacecraft. Image Credit: By Kevin Gill from Los Angeles, CA, United States – Saturn – September 9, 2007 – Annotated, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=131463918
A moon’s distance from its planet plays a role in this. The gravitational struggle between a planet and its moon tends to drive moons away. Earth’s Moon is receding a tiny yet measurable amount each year. Some research shows that if the moons nearest to Saturn’s rings were old, they would’ve been pushed away by now. Since they’re still there, they must be young.
But it’s not that cut and dry because the smaller inner moons also have cratered surfaces.



Saturn's moon Mimas is covered in craters, including the dramatic Herschel crater that gives the moon its "Death Star" nickname. But it's close to Saturn. What's going on? Image credit: NASA/JPL/SSI

So Saturn is still mysterious.

Adding to the intrigue is our fascination with icy moons. Saturn's moon Enceladus, as well as other moons like Jupiter's Europa, contain vast oceans underneath icy shells. They're prime targets in the search for life, so their histories have elevated importance. If two of them collided to form Saturn's rings, what does it all mean?

"There's so much we still don't know about the Saturn system, including its moons that host environments that might be suitable for life," said Jacob Kegerreis, a research scientist at NASA's Ames Research Center and one of the paper's co-authors. "So, it's exciting to use big simulations like these to explore in detail how they could have evolved."

There's abundant research into Saturn's rings. One study in 2022 proposed that there used to be an additional moon between Iapetus and Titan. The moon's presence helped the Saturn system form a resonance with Neptune, and that drove Saturn's obliquity. As the system became more destabilized, the moon grazed Saturn, the planet's powerful gravity tore it to pieces, and the debris formed the icy rings while also kicking Saturn out of the resonance. This evidence supports a young age for Saturn's rings, perhaps only 100 million years old.

This new research is in the same vein, but instead of a single moon getting torn apart by Saturn, two moons experience a high-speed impact that destroys them both.

An artist's conception of two bodies smacking into each other.

A collision like this could've formed Saturn's rings. Credit: NASA/JPL-Caltech

The researchers performed simulations with the powerful Distributed Research using the Advanced Computing (DiRAC) supercomputing facility at Durham University's Institute of Computational Cosmology in the UK. It's dedicated to particle physics, astronomy, and cosmology. The team used the powerful computer to model collisions between precursor moons in the Saturn system.

The Roche Limit governs a critical part of the relationship between a planet and its moons. It's the minimum distance a moon can approach its planet without being torn apart by the planet's gravity. Saturn's rings are inside the Roche Limit, and beyond that limit, planets can form from debris. So debris beyond the Roche Limit wouldn't last long because the material would likely coalesce into new moons.

That's basically what happened, according to this research. An ancient collision between two moons created a shower of debris inside Saturn's Roche Limit. The massive planet's powerful gravity prevented the debris from forming a new moon, so the debris formed into rings. The team performed almost 200 simulated collisions, each one with different masses, velocities, and angles of impact. In a wide range of scenarios, material settled into rings around Saturn, inside its Roche Limit.

"This scenario naturally leads to ice-rich rings," said Vincent Eke, Associate Professor in the Department of Physics/ Institute for Computational Cosmology at Durham University and a co-author on the paper. "When the icy progenitor moons smash into one another, the rock in the cores of the colliding bodies is dispersed less widely than the overlying ice."

This is a strong point of the study. Icy moons still have rocky cores, and other scenarios can't explain why there would be almost no rock in Saturn's rings. The simulations show that only a negligible amount of rock from the collisions finds its way inside the Roche Limit, which matches the icy nature of Saturn's rings.

This would've been a messy process that played out over time. The study shows there would've been a lot of debris from the collision and that it would've impacted other moons, which may have led to collisional cascades.

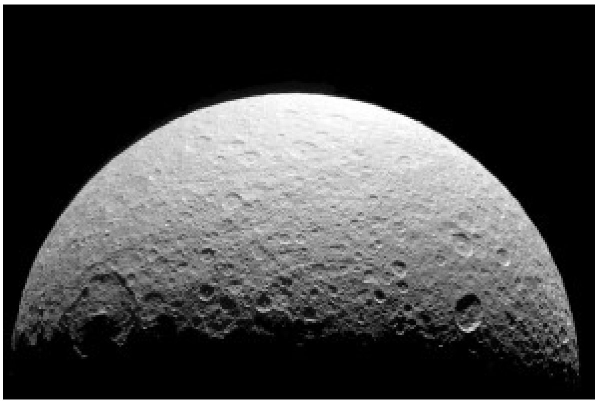
"Furthermore, more than a Mimas mass of material—and even more than an Enceladus mass in some cases—is placed onto crossing orbits with present-day Mimas, Enceladus, and Tethys (and Titan), facilitating the possibility of a collisional cascade to further distribute material across the system," the paper states.

It would've taken a long time for things to settle down. But what caused it?

Everything in the Universe is in motion, and every object exerts a gravitational force on other objects. In our Solar System, the Sun's mass dominates. So even though Saturn is almost 1.5 billion km (932 million mi) away from the Sun, the star's gravity still affects things.

The Sun's gravitational input at that distance is small, but it can build up in orbital resonances. Eventually, things can become destabilized, and Moons are driven from their circular orbits into elongated and tilted orbits. Saturn is rich in moons, so it's only a matter of time until their orbits cross, and that causes a high-speed impact and the resulting cloud of mostly icy debris.

Saturn's moon Rhea has something to tell us about this collision scenario. It's Saturn's second-largest moon, and its orbit is significant. It's just beyond the point where these orbital resonances would affect it. Since moons tend to drift away from their planets, Rhea should've crossed this threshold of resonance eviction recently. That would've messed with its orbit, but its orbit is circular and flat. This supports the moon's recent formation.



Saturn's moon Rhea, as imaged by the Cassini-Huygens space probe. Credit: NASA/JPL-Caltech

But if Rhea formed recently, it clouds some of our thinking about Saturn's icy moon Enceladus and its potential for life. How old is Enceladus? Did it form only a few hundred million years ago, maybe even more recently? If so, that's not enough time for life to appear, as far as we understand it.

Saturn and its rings and moons are a fascinating system. There are so many factors at work that scientists struggle to come up with definitive explanations. The Cassini mission showed us that the rings are likely much younger than thought, somewhere between 10 million and 100 million years old. These simulations support that idea, though they're not conclusive.

"We conclude that the impact of two destabilized icy moons is a promising scenario for the recent formation or rejuvenation of Saturn's rings and reaccretion of mid-sized moons," the researchers say in their conclusion.

But more research is needed before we can rule out other scenarios.

"Future work on the long-term evolution of the orbit-crossing debris, combined with further and more detailed modelling of collisions between both icy moons and smaller fragments, will help to constrain the implications of this scenario for Saturn's rings, its moons, their craters, and other surface environments," they write.

NASA Opens the Lid on OSIRIS-REx's Sample Capsule

September 23rd, the Sample Retrieval Capsule (SRC) from NASA's OSIRIS-REx mission landed in the Utah desert. Shortly thereafter, recovery teams arrived in helicopters, inspected and secured the samples, and flew them to the Utah Test and Training Range (UTTR). On Monday, the sample canister was transferred to the Astromaterials Research and Exploration Science Directorate (ARES) in Houston, Texas. Yesterday, on Tuesday, September 26th, NASA announced that the process of unsealing and removing the samples from the canister had begun with the removal of the initial lid.

Housed at NASA's Johnson Space Center, ARES holds the world's largest collection of samples returned from space – aka. "astromaterials." In anticipation of OSIRIS-REx's sample return, this facility was augmented with a special clean room built exclusively for the Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission. This clean room includes custom "glove boxes" built to assist with the disassembly process (shown above). For months, curation experts have been rehearsing the intricate process of removing the samples from their container.

The first step, performed yesterday, involved the removal of the aluminum lid that protects the Touch and Go Sample Acquisition Mechanism (TAGSAM) head. This component was part of the robotic arm used by OSIRIS-REx to collect rocks and dust from the surface of asteroid Bennu in October 2020. The next step will consist of separating the TAGSAM from the canister and inserting it into a sealed transfer container that will preserve it in a nitrogen environment for about two hours. This container will allow the curation team enough time to insert the TAGSAM into another unique glovebox.

These steps speed up the disassembly process while ensuring that the samples are not contaminated by contact with lab hardware or Earth's environment. According to NASA Shaneequa Vereen, a Public Affairs Officer and Live Mission Commentator at NASA, NASA scientists reportedly found "black dust and debris on the avionics decks of the canister" once the lid was removed. While no indication has been provided, this dust and debris is likely part of the Bennu sample that escaped from the TAGSAM head during retrieval or its transport back to Earth.

The final step, the removal of the sample, will be part of a special live broadcast event on October 11th at 11 AM EDT (08:00 AM PDT), which will be streamed on NASA Live and the agency's website. Stay tuned for more, or check out the OSIRIS-REx mission page at NASA Blods for regular updates.

Day Has Returned, but India's Lander and Rover have Failed to Wake Up

It looks like India's Chandrayaan-3 succumbed to the cold, and its mission is over. The frigid lunar night lasted about two weeks, and a new day has dawned. With that day came hopes of a sunlit revival for the lander and the rover, but the India Space Research Organization (ISRO) says the chances of the spacecraft awakening in the Sun are diminishing by the hour.

The lunar night that wrapped its cold arms around the lander and rover lasted 14 days, and so will the current lunar day. When the day dawned last Friday, ISRO began trying to communicate with the lander. There's been no response so far, as both explorers may be forever entombed about 600km (373 mi) from the Moon's south pole.

Even though things don't look good for the mission, it's still a success. It's the first spacecraft to land in the Moon's south pole region. The area is critical because it contains vast quantities of frozen water in its permanently shadowed crater. That water is a valuable resource for astronauts who'll visit the Moon in the future and set up bases. It's also the first time ISRO successfully landed a rover and lander on the Moon after its predecessor, Chandrayaan-2, crashed into the surface.

But it's encouraging that Vikram and Pragyaan are still intact. ISRO hoped that the Sun would bring both back to life after the agency put them into sleep mode as night fell. There's a chance that the sunlight would recharge the batteries.

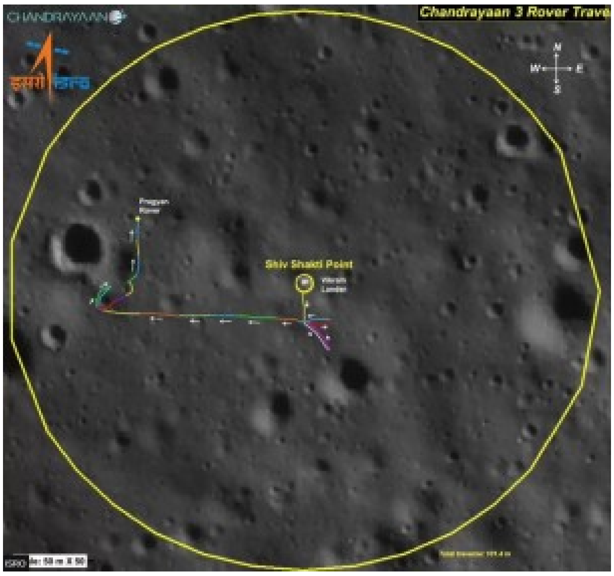
"Once there is sufficient solar generation, they are expected to come back to life provided that they have survived the night."

M Srikanth, Chandrayaan-3 Mission Operations Director.

ISRO released an update on Friday, the beginning of the new lunar day. Unfortunately, there was no response from either the lander or the rover.

When night falls on the Moon's south pole, temperatures plummet as low as -200C to -250C (-328F to -418F.) The lander and rover were never designed to handle these temperatures. The rover has only a small battery—10 amp-hours—that provides the necessary power to deploy its solar array. It was also included to help the rover survive a periodic eclipse. The small battery was fully charged when night came, and the solar panels were positioned to receive incoming starlight when morning came. The Vikram lander was also ready for the morning, and its 62.5 amp hour was fully charged.

Both vehicles are pre-programmed to come back to life as the Sun reappears. "When sunlight comes back, there's an autonomous logic pre-loaded on both the lander and rover," said M Srikanth, Chandrayaan-3 Mission Operations Director, in an interview with the Times of India. "Once there is sufficient solar generation, they are expected to come back to life provided that they have survived the night."



If ISRO's Chandrayaan-3 mission is truly over, it was still a success. It was the first spacecraft to land at the Moon's south pole region. Image Credit: ISRO

But according to Isro chief AS Kiran Kumar, the "chances of reawakening are dimming with each passing hour." In an interview with the BBC, Kumar added, "The lander and rover have so many components which may not have survived the frigid temperatures on the Moon." In fairness, they were never designed to.

It's all up to the lander's transmitter now. It's ISRO's link with the mission, and if it won't function, it won't matter if some of the spacecraft's other systems are somehow still working. "It has to tell us that it's alive. Even if all other sub-systems work, we have no way of knowing that," Kumar added.

Some of ISRO's hopefulness is based on China's successful Chang'e 4 mission. It landed on the lunar far side and was plunged into darkness and freezing temperatures, too. It woke up with the sunrise more than once.

There's still a tiny shred of hope, but it looks like Chandrayaan 3 is done.

It's Official. No More Astronomy at Arecibo

Damage to the 305-meter telescope at Arecibo Observatory, after its collapse on Dec. 1, 2020. The remains of the instrument platform are visible on the telescope's dish. Credit: NSF.

Even though the National Science Foundation announced last year that it would not rebuild or replace the iconic Arecibo radio dish in Puerto Rico — which collapsed in 2020 – a glimmer of hope remained among supporters that the remaining astronomy infrastructure would be utilized in some way.

Instead, the NSF announced this week they have chosen four institutions to transition the site from its historic hub of astronomical research to a STEM educational outreach center, with a seeming focus on biology. A biomedical laboratory, Cold Spring Harbor Laboratory in New York along with the University of Maryland, Baltimore County, and the University of Puerto Rico (UPR) and the University of the Sacred Heart, both in San Juan will oversee the new education center.

Chinese Astronauts May Build a Base Inside a Lunar Lava Tube

Caves were some of humanity's first shelters. Who knows what our distant ancestors were thinking as they sought refuge there, huddling and cooking meat over a fire, maybe drawing animals on the walls. Caves protected our ancient ancestors from the elements, and from predators and rivals, back when sticks, stones, furs and fire were our only technologies.

So there's a poetic parallel between early humans and us. We're visiting the Moon again, and lunar caves could shelter us the way caves sheltered our ancestors on Earth.

On the Moon, astronauts will need protection from a different set of hazards. They'll have to contend with cosmic and solar radiation, meteorites, wild temperature swings, and even impact ejecta. The Lunar Reconnaissance Orbiter (LRO) has found hundreds of lunar 'skylights,' locations where a lava tube's ceiling has collapsed, making a natural opening into the tube. It's hard to tell without exploring, but lava tubes several hundred meters in diameter could exist on the Moon. That's a lot of room to work with, and they could provide the shelter astronauts will need. The idea is to build a base inside a lunar lava tube, where astronauts gain additional protection from the thick rock ceiling overhead

China is considering the idea now, just like others before them. Lunar lava caves might be a resource too valuable to ignore.

Lava tubes are also called pyroducts. They formed when lava flowing across the surface of the Moon began to cool. The top of the flowing lava formed a hardened crust, but the molten lava kept flowing underneath it and eventually drained, leaving an empty tube. They're here on Earth as well.

This is the entrance to a lava tube on Hawaii's Big Island. Image Credit: By dronepicr – Lava tube Big island Hawaii, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=75616740

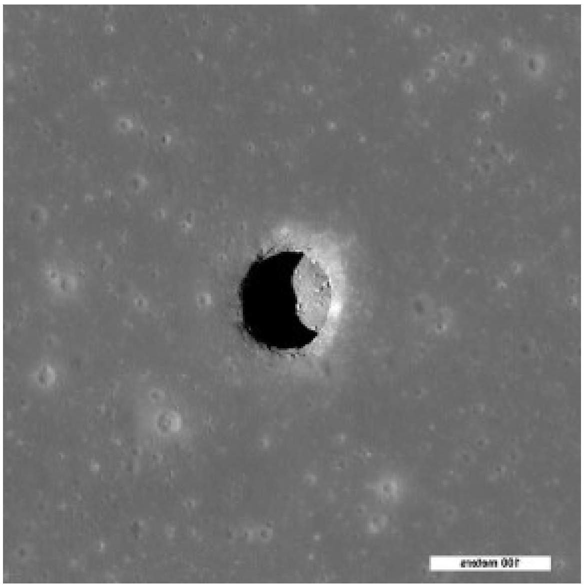
Scientists aren't sure when lunar volcanism ended. It may have been as far back as one billion years ago, though some evidence shows there was small-scale volcanism in the last 50 million years. In either case, these lava tubes are ancient and untouched.

On the Moon, astronauts will have to contend with the temperature swings. Earth's natural satellite is a world of temperature extremes. One side of the Moon is in direct sunlight for half of the time, and surface temperatures reach as high as 127 Celsius (260 F.) The side that's shrouded in darkness sinks as low as -173 C (-280 F.) That wild temperature swing makes it challenging to work on the lunar surface, and to engineer and build equipment that can be effective in such a large range. Lava tubes provide a natural steady-temperature environment that can't be found elsewhere on the Moon.

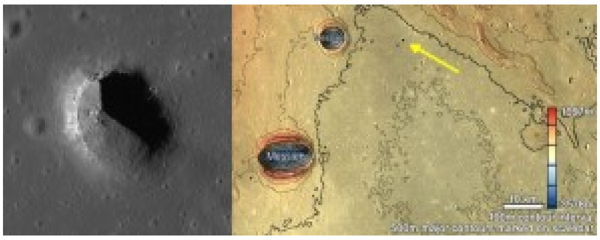
Radiation is also hazardous on the lunar surface. It can be as much as 150 times more powerful than on Earth's surface. That's deadly, but in lunar caves astronauts would be sheltered by several metres of overhead rock. That's a thick enough barrier to provide effective protection.

The risk of impacts and impact debris is much smaller, but it has to be accounted for. Obviously, lava tubes provide shel-

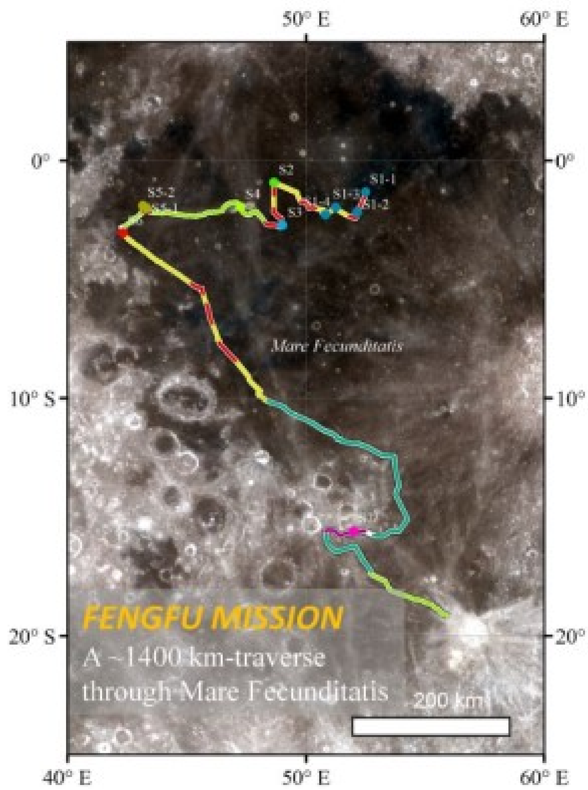
ter from small impacts.
Different teams of scientists from different countries and agencies have studied the idea of using lava tubes as shelter. At a recent conference in China, Zhang Chongfeng from the Shanghai Academy of Spaceflight Technology presented a study into the underground world of lava tubes. Chinese researchers did fieldwork in Chinese lava tubes to understand how to use them on the Moon.
According to Zhang, there's enough similarity between lunar and Earthly lava tubes for one to be an analogue of the other. It starts with their two types of entrances, vertical and sloped. Both worlds have both types.
Most of what we've found on the Moon are vertical-opening tubes, but that may be because of our overhead view. The openings are called skylights, where the ceiling has collapsed and left a debris accumulation on the floor of the tube directly below it. Entering through these requires either flight or some type of vertical lift equipment.
Sloped entrances make entry and exit much easier. It's possible that rovers could simply drive into them, though some debris would probably need to be cleared. According to Zhang, this is the preferred entrance that makes exploration easier. China is prioritizing lunar lava tubes at Mare Tranquillitatis (Sea of Tranquility) and Mare Fecunditatis (Sea of Fecundity) for exploration.



Spectacular high Sun view of the Mare Tranquillitatis pit crater revealing boulders on an otherwise smooth floor. The 100-meter pit may provide access to a lunar lava tube. Image Credit: By NASA/GSFC/Arizona State University – http://photojournal.jpl.nasa.gov/catalog/PIA13518, Public Domain, https://commons.wikimedia.org/w/index.php?curid=54853313
China is planning a robotic system that can explore caves like the one in Mare Tranquillitatis. The primary probe will have either wheels or feet and will be built to adapt to challenging terrain and to overcome obstacles. It'll also have a scientific payload.
Auxiliary vehicles can separate from the main probe to perform more reconnaissance and help with communications and "energy support." They could be diversified so the mission can meet different challenges. They might include multi-legged crawling probes, rolling probes, and even bouncing probes. These auxiliary vehicles would also have science instruments to study the lunar dust, radiation, and the presence of water ice in the tubes.
China is also planning a flight-capable robot that could find its way through lava tubes autonomously using microwave and laser radars.
China's future plan, after successful exploration, is a crewed base. It would be a long-term underground research base in one of the lunar lava tubes, with a support center for energy and communication at the tube's entrance. The terrain would be landscaped, and the base would include both residential and research facilities inside the tube.
China doesn't have the same enthusiasm for information-sharing that an organization like NASA has, so details are more difficult to uncover. But there's no question that China's space activities are ascendant right now, with multiple successful missions completed, some still in progress, and future ones planned. In the Spring of 2023, China announced plans to start building a Moon base by 2028, though it's not clear if that announcement referred to a lunar lava tube base. That seems to contradict the most recent statement saying that China plans to "realize manned lunar landing by 2030."
But regardless of when they start, China seems committed to the idea. Ding Lieyun, a top scientist at Huazhong University of Science and Technology, told the China Science Daily that "Eventually, building habitation beyond the Earth is essential not only for all humanity's quest for space exploration but also for China's strategic needs as a space power." This language almost exactly mirrors the language used by NASA when talking about its Artemis program.
In preparation for more lunar missions and an eventual base, Chinese researchers have studied both Mare Tranquillitatis and Mare Fecunditatis. In 2022 a team of scientists published a study on Mare Fecunditatis' volcanic features in the journal Remote Sensing.



On the left is an LRO image of a pit in the center of Mare Fecunditatis, and on the right is a context map showing the pit with a yellow arrow. This is just one of the pits begging to be explored. Image Credit: NASA/LRO
Mare Fecunditatis is rich in volcanic features, including lava tubes. The 2022 paper pointed out that no mission to the Moon's surface has travelled more than 40 km (25 mi.) But that will change in the future. The researchers behind this work propose a five-year long mission similar to NASA's Mars rover missions. In five years, a Chinese rover could explore Mare Fecunditatis during a 1400 km (870 mi) traverse. By studying volcanic features like lava tubes, domes, and rilles, they would develop a more comprehensive understanding of the Moon's regional geology. They may also select a site for a lunar base.



This image shows a proposed 1400 km traverse across the Moon's Mare Fecunditatis, a region rich in volcanic features, including lava tubes and the pit craters that could provide access. Image Credit: Zhao et al. 2022.

China is not the first to wonder about lava tubes as bases. The idea has been around for a long time. But before long, China and other spacefaring nations will be in a position to explore them, and to begin to get serious about building one.

Space exploration and politics are intertwined, and in China, they're even more intertwined than other countries. The inner machinations of both are sometimes hidden behind an opaque wall, and details aren't always readily available. It's as if people are afraid of saying the wrong thing. But China's intentions are clear, and if past is prologue, they'll get to the Moon and build a base.

Maybe some of the Chinese taikonauts who eventually shelter in these lunar caves will spend a moment or two thinking about our ancient ancestors and how caves sheltered them. Maybe one of them will be the first human to make marks on the wall of a lunar lava tube.

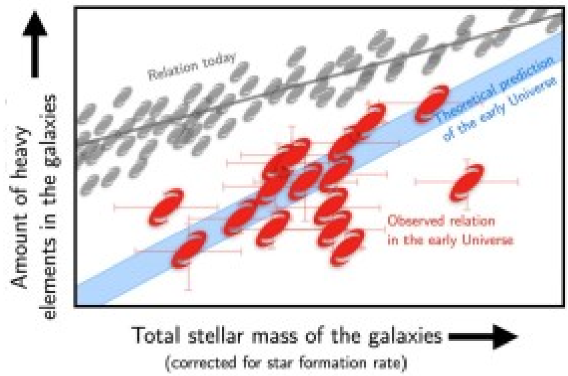
Finally! Astronomers are Starting to See the First Galaxies Coming Together With JWST

One of the James Webb Space Telescope's principal science goals is to observe the epoch where we think that the first galaxies were created, to understand the details of their formation, evolution, and composition. With each deep look back in time, the telescope seems to break its own record for the most distant galaxy ever seen. Science papers are now are starting to trickle in, as astronomers are finally starting to collect enough data from JWST to build a deeper understanding of the early Universe.

In a new study published in Nature Astronomy, a team of researchers in Denmark believe they have observed some of the very first, earliest galaxies with JWST. These galaxies are so old, they are likely still in the process of being formed.

Galaxy Ratios

One known standard is that the ratio between galaxies and their heavy elements has held constant in the local Universe through the last 12 billion years of history, or about 5/6 of the age of the Universe. But with JWST, astronomers are now seeing that the youngest galaxies look different. They don't have that same ratio of stars to heavier elements because they haven't gone through the cycles of star formation and star death yet, enriching gas clouds with metals, i.e., elements heavier than hydrogen and helium.



This plot shows the observed galaxies in an "element-stellar mass diagram": The farther to the right a galaxy is, the more massive it is, and the farther up, the more heavy elements it contains. The gray icons represent galaxies in the present-day Universe, while the red show the new observations of early galaxies. These ones clearly have much less heavy elements than later galaxies, but agree roughly with theoretical predictions, indicated by the blue band. Credit: Kasper Elm Heintz, Peter Laursen.

For this study, the astronomers looked at 16 galaxies, some of the earliest galaxies ever observed. Their observations revealed that the chemical abundances in these galaxies are one-fourth of that seen in galaxies that were formed later. In their paper, the astronomers wrote that "these findings suggest that galaxies at this time are still intimately connected with the intergalactic medium and subject to continuous infall of pristine gas, which effectively dilutes their metal abundances."

As gravity gathered together the first clumps of gas,the first stars and galaxies were formed.

"When we analyzed the light from 16 of these first galaxies, we saw that they had significantly less heavy elements, compared to what you'd expect from their stellar masses and the amount of new stars they produced," said Kasper Elm Heintz, leader of the study and assistant professor at the Cosmic Dawn Center at the Niels Bohr Institute and DTU Space in Copenhagen, Denmark, in a press release.

These results, the astronomers say, are in stark contrast to the current model where galaxies evolve in a form of equilibrium throughout most of the history of the Universe, where there is a relationship between how many stars have formed and how many heavy elements have formed.

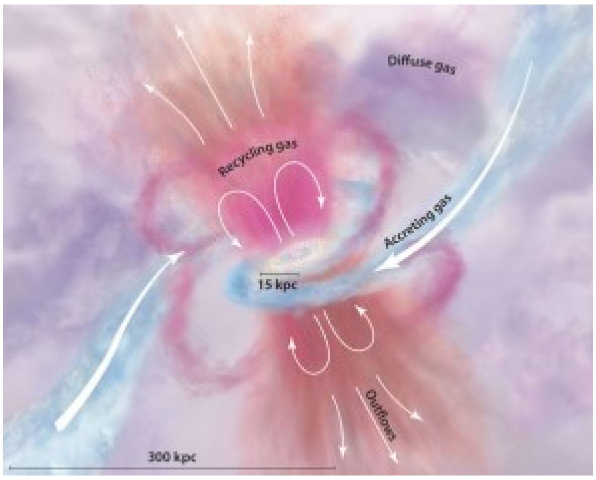


Illustration of galaxy formation: Diffuse gas from intergalactic space plummets toward the center, sparking star formation and becoming part of the galaxy's rotating disk. When stars die, they return their gas to the galaxy (and the intergalactic space), now enriched with heavy elements. Credit: Tumlinson et al. (2017).

Not Entirely Surprising

The researchers say, however, this result is not entirely surprising. Theoretical models of galaxy formation have predicted this very thing. And now it has been observed.

"The result gives us the first insight into the earliest stages of galaxy formation which appear to be more intimately connected with the gas in between the galaxies than we thought," said Elm Heintz. "This is one of the first James Webb observations on this topic, so we're still waiting to see what the larger, more comprehensive observations that are currently being carried out can tell us."

The researchers said there is no doubt that JWST will provide more data and soon they should have a much clearer understanding of how galaxies and the first structures began their formation during the first billion years after the Big Bang.

Gaia is Now Finding Planets. Could it Find Another Earth?

The ESA launched Gaia in 2013 with one overarching goal: to map more than one billion stars in the Milky Way. Its vast collection of data is frequently used in published research. Gaia is an ambitious mission, though it seldom makes headlines on its own. But that could change.

Gaia relies on astrometry for much of its work, and astrometry is the measurement of the position, distance, and motions of stars. It's so sensitive that it can sometimes detect the slight wobble a planet imparts to its much more massive star. Gaia detected its first two transiting exoplanets in 2021, and it's expected to find thousands of Jupiter-size exoplanets beyond our Solar System. But new research takes it even further. It shows that Gaia should be able to detect Earth-like planets up to 30 light-years away.

The new paper is "The Possibility of Detecting our Solar System Through Astrometry," and is available on the pre-press site arxiv.org. It has a single author: Dong-Hong Wu from the Department of Physics, Anhui Normal University, Wuhu, Anhui, China.

Astronomers find most exoplanets with the transit method. A spacecraft like TESS monitors a section of the sky and looks at many stars at once. When a planet passes between us and one of the stars, it's called a transit. It creates a dip in starlight that TESS's sensitive instruments can detect. When TESS detects multiple, predictable dips, it signifies a planet.

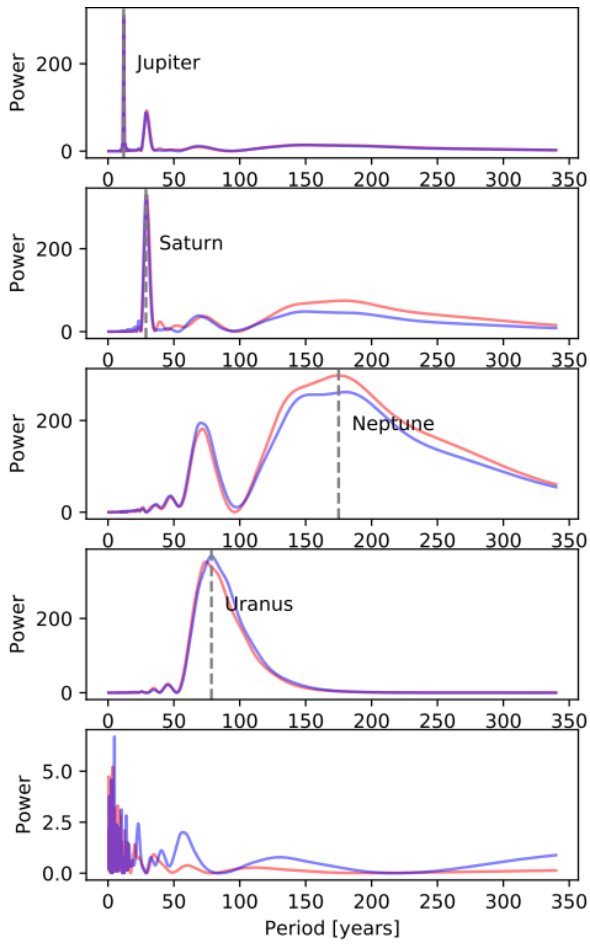
But that's not the only way to detect them. Astrometry can do it too, and that's Gaia's way.

Astrometry has an advantage over other methods. Gaia can more accurately determine an exoplanet's orbital parameters. This doesn't mean the other methods aren't valuable. They obviously are. But as the paper's author explains, "Neither the transit nor radial velocity method provides complete physical parameters of one planet, and both methods prefer to detect planets close to the central star. On the contrary, the astrometry method can provide a three-dimensional characterization of the orbit of one planet and has the advantage of detecting planets far away from the host star." Astrometry's advantages are clear.

If other technological planetary civs exist—and that's a big if—then it's not outrageous to think they have technology similar to Gaia's. While Gaia is impressive, there are improvements on the horizon that will make astrometry even more precise. The author asks a question in his paper: If ETIs (ExtraTerrestrial Intelligences) are using advanced astrometry equal to or even surpassing Gaia's, "…which of them could discover the planets in the solar system, even the Earth?"

Astrometrical precision is calculated in microarcseconds, and precision decreases with distance. The ESA says that Gaia can measure a star's position within 24 microarcseconds for objects 4000 times fainter than the naked eye. That's like measuring the thickness of a human hair from 1000 km away. But that's not precise enough for Wu's scenario. His work is based on even more advanced astrometry, the type we'll likely have in the near future. "If the astrometry precision is equal to or better than ten microarcseconds, all 8,707 stars located within 30 pcs of our solar system possess the potential to detect the four giant planets within 100 years."

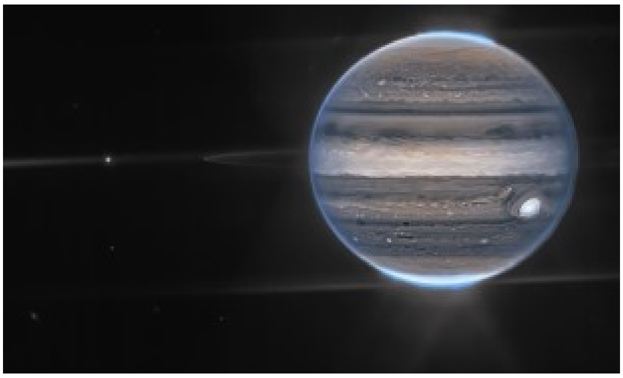
This is the heart of Wu's paper. The 30-parsec (approx. 100 light-years) region contains almost 9,000 stars, and if an ETI from one of those stars has powerful enough astrometry, then it could detect Jupiter, Saturn, Uranus, and Neptune. The only drawback is they'd have to observe our Solar System for nearly a century to make sure the signal was clear.



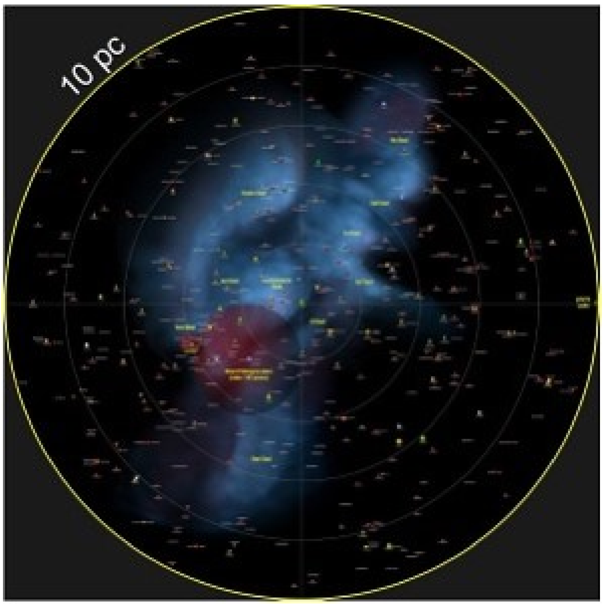
This figure from the research shows how long it would take for an ETI with advanced astrometry to detect our Solar System's four giant planets. "We find that all the four giants in our solar system could be detected and well-characterized as long as they are observed for at least 90 years with SNR > 1," the author writes. Image Credit: Wu 2023.

There are 8707 stars within 100 light-years of the Sun according to the Gaia Catalog of Nearby Stars. An ETI on any one of them could detect the four giants, as long as their precision is within ten microarcseconds. The precision expressed in microarcseconds is key here, and if the observa-

tional error is too large, it has a huge effect and drastically shrinks the number of stars close enough. “If the observational error is as large as 100 microarcseconds, only 183 neighbouring stars could detect all four giants, but all of them could detect Jupiter within ten years,” Wu explains.
Detecting Jupiter from a distance could be a critical threshold. When Gaia released its first data set in 2016, an ESA paper discussing the mission touched on exoplanet science and the importance of detecting Jupiter-mass planets. It’s based on the idea that Jupiter may have played a protective role by deflecting asteroids and comets away from the planets in the inner Solar System. “These are logical prime targets for future searches of terrestrial-mass exoplanets in the habitable zone in an orbit protected by a giant planet further out,” the paper states.
ETIs might know things about solar systems that we don’t know. To them, finding gas giants in the outer regions beyond a solar system’s asteroid belt might be a strong signal that rocky planets are closer to the star. Maybe they’d be curious and want a closer look.



This JWST image of Jupiter practically jumps off the screen. Jupiter should be the most easily-detected planet in our Solar System, from an ETI’s perspective. And finding it could signal the presence of smaller, rocky planets. Credit: NASA/CSA/ESA/STScI
Where it really gets interesting is when it comes to our own planet. Could ETIs detect Earth using astrometry?
That, again, depends on microarcsecond accuracy.
“Additionally, our prediction suggests that over 300 stars positioned within ten parsecs from our solar system could detect our Earth if they achieve an astrometry precision of 0.3 microarcseconds,” Wu writes.
Technological barriers stop us from achieving this for now, but who knows what an ETI’s technological level might be?



This image shows a 10-parsec sphere centred on the Sun. Click on it for a larger, explorable version. Image Credit: Reylé et al. 2021.

Now turn this idea around with our own technological advances in mind.
The ESA is already discussing a successor to Gaia. They call it GaiaNIR, and it would expand Gaia’s search into objects only visible in the infrared. If built and launched, it would not only measure IR targets, it would revisit Gaia targets again to further increase the accuracy of Gaia’s existing data.
GaiaNIR’s improvements would open up “new science cases, such as long-period exoplanets,” according to one paper. Long-period planets are difficult to detect with the transit method because you have to watch a star for a long time. For example Neptune with its 165-year orbit. With GaiaNIR’s improved technology, and even more improvements in the future, we could be the ones detecting Earth-size planets in a 10-parsec radius.
Astrometry is an improvement over the transit method because the transit method only works when things line up just right. An exoplanet must pass between us and its star before we can detect the dip in light. But Gaia’s astrometry doesn’t have the same limitation. It can watch a star from any angle to detect planet-induced wobbles.
How technologically advanced would an ETI have to be to detect Earth with astrometry? Are there any ETIs within 10 parsecs? 30 parsecs? 100 parsecs? Are there any ETIs at all?
Who knows.
But we’re hungry for Earth-sized exoplanets, and this research shows how Gaia may be able to satisfy our appetite. If it does, it might generate more of its own headlines and get some of the attention other missions regularly attract.

The OSIRIS-REx Capsule Has Landed! Asteroid Samples Returned!

The OSIRIS-REx mission has just completed NASA’s first sample-return mission from a near-Earth asteroid (NEA). The samples arrived at the Utah Test and Training Range (UTTR) near Salt Lake City, where a team of engineers arrived by helicopter to retrieve the sample capsule. The samples will be curated by NASA’s Astromaterials Research and Exploration Science Directorate (ARES) and Japan’s Extraterrestrial Sample Curation Center (ESCuC). Analysis of the rocks and dust obtained from Bennu is expected to provide new insight into the formation and evolution of the Solar System.

Radar data from the UTTR confirmed that the Sample Retrieval Capsule (SRC) entered Earth’s atmosphere as planned at 10:42 AM EDT (8:42 AM MDT) off the coast of California. The capsule deployed its parachutes and touched down on the surface ten minutes later, where it was met by four helicopters and two backup ground vehicles carrying NASA and the U.S. Air Force personnel. The recovery operation (which included inspection of the SRC and surrounding environment) was the subject of a live broadcast on NASA TV and the agency’s website (recap posted below).

The coverage took place from the U.S. Air Force’s Dugway Proving Grounds in northern Utah. Dr. James B. Garvin, the Chief Scientist at NASA’s Goddard Spaceflight Center, expressed excitement during the broadcast about the successful return of the samples and the mission in general. “I’m over the asteroid!” he said. “It’s a masterpiece of engineering we have here. Just think about this. In fifty years, we’ve gone from bringing things on the Moon back with crews to all-robotic sample return for science that’s… literally beyond words. It’s sublime. So we cannot wait to see what we’re going to learn.”
This represents the culmination of the Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) mission, which rendezvoused with the carbonaceous asteroid Bennu in 2018. After two years of studying the asteroid from orbit, OSIRIS-REx began descending toward its surface on October 20th, 2020. After collecting between 400 grams and 1 kg (0.88 to 2.2 lbs), the spacecraft departed on May 10th, 2021, and began returning to Earth.

During the broadest, NASA Director Bill Nelson delivered his congratulations to the OSIRIS-REx team for their efforts:

"You did it. You designed it, you built it, and you carried out a first mission to collect a sample from an asteroid. And after a two-year journey, it has touched down at the Utah Desert. It brought something extraordinary: the largest asteroid sample ever received on Earth. It's going to help scientists investigate planet formation. It's going to improve our understanding of asteroids that could possibly impact the Earth, and it will deepen our understanding of the origin of our Solar System and its formation. This mission proves that NASA does big things. Things that inspire us, things that unite us, things that show that nothing is beyond reach."

By 12:37 AM EDT (9:37 AM PDT), the sample return capsule was attached to the end of a 100-foot cable and transported to a hangar at the UTTR. The SRC was then loaded onto a cart by another team, who unwrapped and cleaned it before wheeling it into a temporary clean room to remove the unopened sample canister. All the parts will packaged for transport by aircraft and flown to NASA's Johnson Space Center tomorrow.

A team from Lockheed Martin prepare the sample return capsule from NASA's OSIRIS-REx mission for transport on Sunday, Sept. 24th, 2023. Credit: NASA

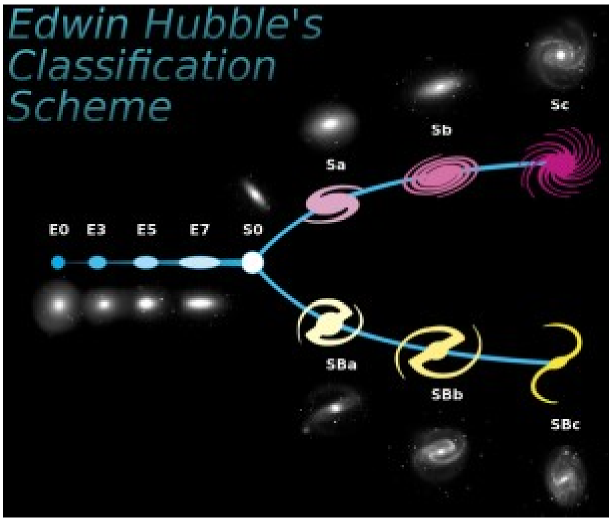
The OSIRIS-REx mission has since continued onto the next leg of its mission, which will be to study Apophis. This NEA was previously thought to pose a potential risk to Earth – aka. a Potentially-Hazardous Asteroid (PHA) – though scientists have since indicated there's a slight risk it might impact Earth in 2068. This mission extension was announced on April 25th, 2022, and NASA indicated it would henceforth be known as the *OSIRIS-APEX* ('APophis EXplorer') mission. The mission will rendezvous with Apophis in April 2029, when the asteroid makes an extremely close pass to Earth, then orbit the asteroid for about 18 months before retrieving a sample.

The JWST is Forcing Astronomers to Rethink Early Galaxies

The JWST has surprised astronomers again. Contrary to our existing understanding, the JWST showed us that the early Universe was full of fully-formed galaxies similar to the ones we see today. The widely-held belief is that the early Universe was too chaotic in its early years, and frequent mergers would've disrupted galaxies' graceful shapes.

Galaxy morphologies are important clues to their history. Understanding how their structure and morphology change over time is critical to understanding them. Astronomers only figured out that there were spiral galaxies in the 1840s when the Earl of Rosse built his gigantic telescope called the Leviathan of Parsonstown. He discovered the spiral nature of some galaxies, which he thought were nebulae at the time. Using his massive telescope, he was the first to discover the Whirlpool Galaxy's (M51) spiral shape.

As astronomers learned more about galaxies, they classified them into shapes. In 1926, Edwin Hubble published the Hubble Sequence, a way of classifying galaxies. It divides galaxies into three classes: ellipticals, lenticulars, and spirals.



Galaxies are the Universe's building blocks, and their morphologies range from simple to complex. The Hubble Sequence is sometimes called the Tuning Fork because it looks like one. By Cosmogoblin – Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=121743256

We're all aware of the different shapes galaxies can take now.

Since the Hubble Space Telescope was launched, it's looked at faint distant galaxies and shown that they have peculiar and irregular shapes. Few of these distant, ancient galaxies looked like anything on the Hubble Sequence. Over time, astronomers understood that galaxies grew through mergers, and these mergers disrupted galaxies as they evolved, preventing many of them from forming into the majestic spirals we see today.

"For over 30 years it was thought that these disk galaxies were rare in the early Universe due to the common violent encounters that galaxies undergo."

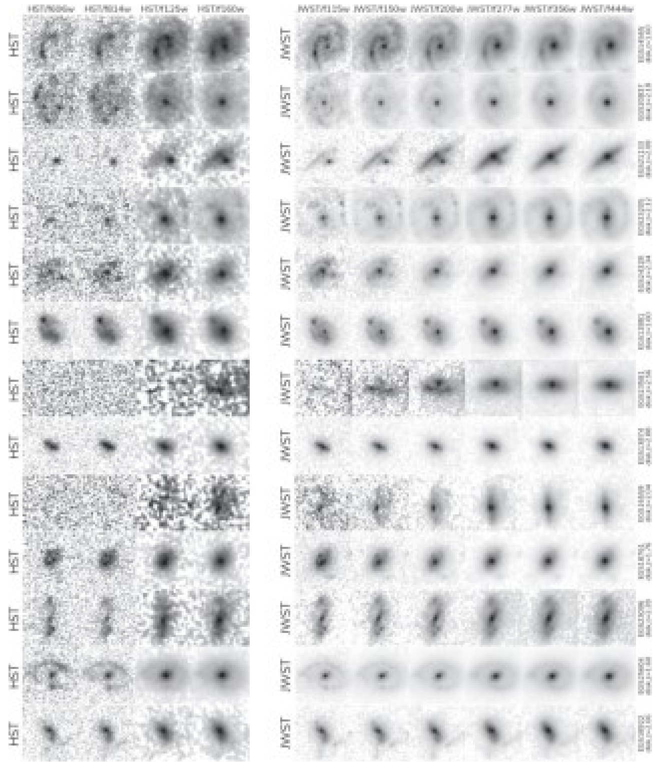
Leonardo Ferreira, lead author, Department of Physics & Astronomy, University of Victoria

The JWST was launched with a variety of science objectives in mind, and one of them was studying the early Universe, including the first galaxies. It has the infrared horsepower to look back further and more clearly than the Hubble can. When it did, it upended our existing understanding.

The new observations are presented in a paper in The Astrophysical Journal titled "The JWST Hubble Sequence: The Rest-frame Optical Evolution of Galaxy Structure at 1.5 < z < 6.5." The lead author is Leonardo Ferreira from the Department of Physics & Astronomy at the University of Victoria, also affiliated with the Centre for Astronomy and Particle Theory at the University of Nottingham.

"For over 30 years it was thought that these disk galaxies were rare in the early Universe due to the common violent encounters that galaxies undergo," Ferreira said. "The fact that JWST finds so many is another sign of the power of this instrument and that the structures of galaxies form earlier in the Universe, much earlier in fact than anyone had anticipated."

There's a clear and pronounced difference between HST and JWST observations. While the HST was able to observe some distant ancient galaxies, the JWST revealed the morphologies of more high-redshift galaxies for the first time.



This figure from the research compares HST observations with the new JWST observations. It shows 13 galaxies from the sample that have observations in the four filters from the CANDELS survey with the HST in the left panel. The right panel shows JWST images of the same galaxies with the telescope's different filters. Faint features in CANDELS are generally very clear in JWST. In some cases, only the central core of the galaxy is visible with the HST imaging. The classification label shown comes from the JWST classifications. Image Credit: Ferreira et al. 2023.

It's difficult to overstate the significance of these results. They overturn our entire understanding of how galaxies formed and evolved. Prior to these observations, astronomers thought evolved disk galaxies didn't appear until around 6 billion years after the Big Bang.

"Using the Hubble Space Telescope we thought that disk galaxies were almost non-existent until the Universe was about six billion years old, these new JWST results push the time these Milky Way-like galaxies form to almost the beginning of the Universe," said study co-author Christopher Conselice, Professor of Extragalactic Astronomy at The University of Manchester.

This work is the largest sample yet of visually classified galaxies observed with the JWST. It's about 20 times larger than previous studies, and a larger sample means that astronomers can examine in detail how galaxy structure has changed over this critical epoch. One of the main reasons for examining galaxy morphology is to figure out how and when the Hubble Sequence emerges. It shows that the Hubble Sequence was already in effect as early as one billion years after the Big Bang.

Before the JWST began its observations, simulations and observations with less powerful telescopes showed that galaxies grow and evolve through hierarchical mergers in the Universe's early times. High redshift observations were more challenging prior to the JWST, but research showed an increase in the number of peculiar galaxies the further back astronomers looked.

But that might all be discarded now and added to astronomy's history of getting things wrong before getting things right.

"Based on our results astronomers must rethink our understanding of the formation of the first galaxies and how galaxy evolution occurred over the past 10 billion years," Conselice added.

Solar Sails Could Reach Mars in Just 26 Days

A recent study submitted to *Acta Astronautica* explores the potential for using aerographite solar sails for traveling to Mars and interstellar space, which could dramatically reduce both the time and fuel required for such missions. This study comes while ongoing research into the use of solar sails is being conducted by a plethora of organizations along with the successful LightSail2 mission by The Planetary Society, and holds the potential to develop faster and more efficient propulsion systems for long-term space missions.

"Solar sail propulsion has the potential for rapid delivery of small payloads (sub-kilogram) throughout the solar system," Dr. René Heller, who is an astrophysicist at the Max Planck Institute for Solar System Research and a co-author on the study, tells *Universe Today*. "Compared to conventional chemical propulsion, which can bring hundreds of tons of payload to low-Earth orbit and deliver a large fraction of that to the Moon, Mars, and beyond, this sounds ridiculously small. But the key value of solar sail technology is speed."

Unlike conventional rockets, which rely on fuel in the form of a combustion of chemicals to exert an external force out the back of the spacecraft, solar sails don't require fuel. Instead, they use sunlight for their propulsion mechanism, as the giant sails catch solar photons much like wind sails catching the wind when traveling across water. The longer the solar sails are deployed, the more solar photons are captured, which gradually increases the speed of the spacecraft.

For the study, the researchers conducted simulations on how fast a solar sail made of aerographite with a mass up to 1 kilogram (2.2 pounds), including 720 grams of aerographite with a cross-sectional area of 10^4 square meters, could reach Mars and the interstellar medium, also called the heliopause, using two trajectories from Earth known as direct outward transfer and inward transfer methods, respectively.

The direct outward transfer method for both the trip to Mars and the heliopause involved the solar sail both deploying and departing directly from a polar orbit around the Earth. The researchers determined that Mars being in opposition (directly opposite Earth from the Sun) at the time of solar sail deployment and departure from Earth would yield the best results for both velocity and travel time. This same polar orbit deployment and departure was also used for the heliopause trajectory, as well. For the inward transfer method, the solar sail would be delivered to approximately 0.6 astronomical units (AU) from the Sun via traditional chemical rockets, where the solar sail would deploy and begin its journey to either Mars or the heliopause. But how does an aerographite solar sail make this journey more feasible?

Image taken by The Planetary Society's LightSail 2 on 25 November 2019 during its mission orbiting the Earth. The curved appearance of the sails is from the spacecraft's 185-degree fisheye camera lens, and the image was pro-

cessed with color-correction along with removal of parts of the distortion. (Credit: The Planetary Society)
"With its low density of 0.18 kilograms per cubic meter, aerographite undercuts all conventional solar sail materials," Julius Karlapp, who is a Research Assistant at the Dresden University of Technology and lead author of the study, tells *Universe Today*. "Compared to Mylar (a metallized polyester foil), for example, the density is four orders of magnitude smaller. Assuming that the thrust developed by a solar sail is directly dependent on the mass of the sail, the resulting thrust force is much higher. In addition to the acceleration advantage, the mechanical properties of aerographite are amazing."
Through these simulations, the researchers found the direct outward transfer method and inward transfer method resulted in the solar sail reaching Mars in 26 days and 126 days, respectively, with the first 103 days being the travel time from Earth to the deployment point at 0.6 AU. For the journey to the heliopause, both methods resulted in 5.3 years and 4.2 years, respectively, with the first 103 days of the inward transfer method also being devoted to the travel time from the Earth to the deployment point at 0.6 AU, as well. The reason the heliopause is reached in a faster time with the inward transfer method is due to the solar sail achieving maximum speed at 300 days, as opposed to achieving maximum speed with the outward transfer method at approximately 2 years.
Current travel times to Mars range between 7-9 months, which only happens during specified launch windows every two years while relying on the positions of both planets to be aligned at both launch and arrival of any spacecraft going to, or coming from, Mars. Estimating current travel times to the heliopause can be done using NASA's Voyager 1 and Voyager 2 probes, which reached the heliopause at approximately 35 years and 41 years, respectively.
The researchers note that one major question of using solar sails is deceleration, or slowing down, upon arriving at the destination, specifically Mars, and while they mention aerocapture as one solution, they admit this still requires further study.
"Aerocapture maneuvers for hyperbolic trajectories (like flying from Earth to Mars) use the atmosphere to gradually reduce velocity due to drag," Dr. Martin Tajmar, who is a physicist and Professor of Space System at the Dresden University of Technology and a co-author on the study, tells *Universe Today*. "Therefore, less fuel is required to enter the Martian orbit. We use this braking maneuver to eliminate the need for additional braking thrusters, which in turn reduces the mass of the spacecraft. We're currently researching what alternative strategies might work for us. Yet the braking method is only one of many different challenges we are currently facing."

While solar sail technology has been proposed by NASA as far back as the 1970s, a recent example of solar sail technology is the NASA Solar Cruiser, which is currently scheduled to launch in February 2025.

What new discoveries will researchers make about solar sail technology in the coming years and decades? Only time will tell, and this is why we science!

The Moon's Southern Ice is Relatively Young

Around the Moon's southern polar region lies the South Pole-Aitken Basin, the single-largest impact basin on the lunar surface. Within this basin, there are numerous permanently shadowed regions (PSRs) that are thought to have trapped water ice over time. These deposits are crucial to future missions like the Artemis Program that will lead to the creation of permanent infrastructure. This water ice will supply crews with a steady source of water for drinking and irrigation and the means for chemically producing oxygen gas and rocket fuel.

For scientists, these PSRs are believed to have emerged when the Moon began migrating away from Earth roughly 2.5 billion years ago. Over time, these regions acted as "cold sinks" and trapped water ice that existed on the lunar surface at the time. However, according to a recent study led by the Planetary Science Institute (PSI), the Moon's permanently shadowed areas arose less than 2.2 billion years ago and trapped ice even more recently than that. These findings could significantly impact future crewed missions as they indicate that the water ice found in lunar craters could be of more recent origin.
The research was conducted by Senior Scientist Norbert Schorghofer of the Planetary Science Institute and Raluca Rufu of the Planetary Science Directorate at the Southwest Research Institute (SwRI). Their paper, titled "Past Extent of Lunar Permanently Shadowed Areas," recently appeared in *Science Advances*. The research was supported by NASA by a grant issued through the Lunar Data Analysis Program (LDAP) and through the Geophysical Exploration of the Dynamics and Evolution of the Solar System (GEODES) node at the Solar System Exploration Research Virtual Institute (SSERVI).

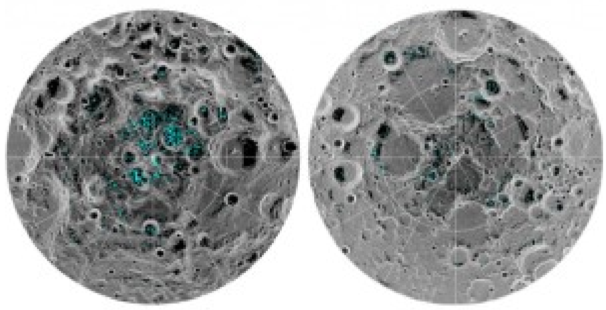


Image showing the distribution of surface ice at the Moon's south pole (left) and north pole (right), detected by NASA's Moon Mineralogy Mapper instrument. Credits: NASA
As the Moon began steadily migrating away from Earth, it felt the tidal forces caused by the Earth's and the Sun's gravitational pull. For decades, scientists have known that the Moon experienced a major spin axis reorientation at some point, which led to the formation of PSRs around the lunar south pole. Until recently, there was insufficient data to determine precisely when this reorientation occurred. Only a year ago, a French research team developed a coherent history for the evolution of the Earth-Moon distance. As Schorghofer explained in a PSI press release:
"When I heard about their result, I immediately realized it has profound implications for the search of water ice on the Moon. I dropped everything I was doing and began to work out the specifics, with the help of my co-author Raluca Rufu. We calculated the lunar spin axis orientation and the extent of PSRs based on recent advances for the time evolution of the Earth-Moon distance. We have been able to quantify how young the lunar PSRs really are. The average age of PSRs is 1.8 billion years, at most. There are no ancient reservoirs of water ice on the Moon."
To be clear, the Moon has a long history of hosting water ice on its surface. This water was distributed by comets and meteors roughly 4.1 to 3.8 billion years during the Late Heavy Bombardment or resulted from volcanic outgassing. However, these processes started dying down when permanently shaded areas started appearing 3.4 billion years ago. This means most of the water delivered by impactors or outgassed from the interior could not have been trapped in the polar regions. In short, the water ice we observe today must be more recent.
"These findings change the prediction for where we would expect to find water ice on the Moon, and it dramatically changes estimates for how much water ice there is on the

Moon. Ancient water ice reservoirs are no longer expected," Schorghofer concluded.

Artist impression of LCROSS approaching the Moon. Credit: NASA

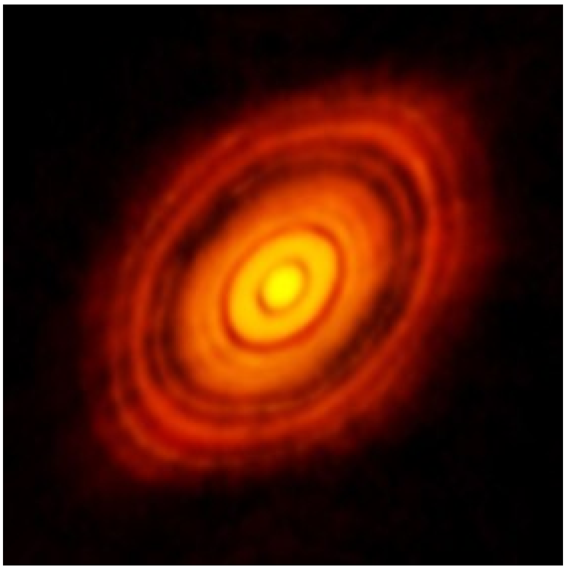
This is consistent with what NASA's Lunar Crater Observation and Sensing Satellite (LCROSS) observed in 2009 while investigating the hydrogen signatures previously observed around the polar regions. After LCROSS deployed an impactor to the Cabeus crater, it detected water in the debris that was kicked up. Since the PSR within the Cabeus crater was less than 1 billion years old, all the water, carbon dioxide, and other volatiles must have collected there more recently. This is rather encouraging since young PSRs could accumulate lots of ice relatively quickly, meaning older ones should have even more.

These findings might also help address the mystery of why Mercury has considerably more ice in its polar regions than the Moon. Previous data has indicated that PSRs on Mercury are much older and may have been capturing water far earlier.

Do The Gaps in Protoplanetary Disks Really Indicate Newly Forming Planets?

Roughly 5 billion years ago Earth was in the process of forming. Gas and dust gathered with the young Sun's protoplanetary disk, likely nudged a bit by the resonant gravitational pull of Jupiter and other large worlds. One can imagine that as Earth formed it swept its orbit clear of debris, leaving a gap in the disk visible from light years away. While we know this tale is reasonably accurate, the idea that planets such as Earth always clear gaps in a protoplanetary disk likely isn't.

For decades, the idea of planets forming from the debris of young stars was supported by low-resolution images of disks around stars such as Fomault. The gas and dust surrounding young stars are often cold and faint, making it difficult to study. But advanced radio telescopes such as ALMA have now captured detailed images of these disks. Many of them possess ringed gaps largely clear of debris, and some of these gaps contain visible protoplanets. So a general consensus is that gaps in a disk indicate the presence of planets, even if we can't observe them directly. But a new study finds things are much more complicated.



A protoplanetary disc surrounding the young star HL Tauri, as shown by ALMA. ALMA reveals some of the substructure in the disk, like gaps where planets may be forming, but it's difficult to measure the amount of dust in the disk accurately. Image Credit: ESO/ALMA

The team looked at N-body simulations of early disks, in which 3 – 7 protoplanets interact with gas, dust, and pebbles within the disk. Their model is sophisticated enough to look not only at how these planets accrete matter and grow, but also how the orbits planets can migrate through gravitational interactions, and how interactions with the disk can change the shape of an orbit or its orientation relative to the disk. They simulated these systems over a span of 100 million years, which is long enough to study how the planets might settle into stable orbits.

One of the things they found was that within a young disk, 5 – 7 protoplanets quickly develop unstable orbits. In their simulations, stability dissolved within 40,000 years, which is the blink of a cosmic eye. It would take much longer than that for the planets to clear a gap in the disk. This means that where we see 5 or more gaps in a protoplanetary disk, they cannot all be cleared by planets. It's possible that the rings are caused by the orbital resonances of a particularly large planet, similar to the way Jupiter worked to prevent planet formation within the asteroid belt.

Another discovery was that the planetary orbits can migrate and shift dramatically, which again wouldn't allow them to clear their orbital path. Smaller worlds in particular likely spend their early days moving through the disk in chaotic ways. Our young Earth likely migrated significantly as it formed, spending most of its time hidden among gas and dust rather than visible in a gap. This means we often won't see Earth-like worlds forming in a protoplanetary disk, since we can't pick them out from the overall glow of the disk.

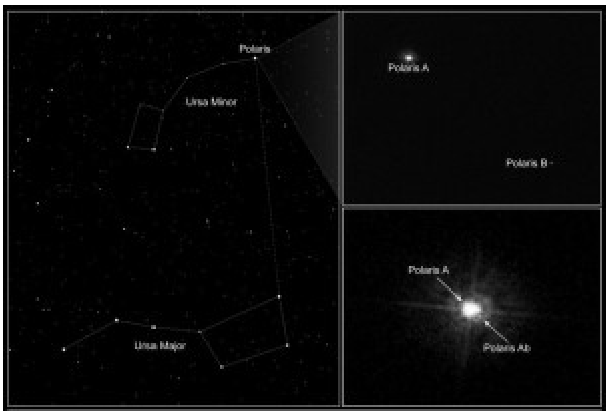
All of this means that we can't make a simple connection between the number and size of gaps seen in early planetary disks and the number and distribution of exoplanets we see in evolved star systems. Planetary formation is a complex dance, and while we know some of the steps, there are still plenty for us to learn.

Polaris is the Closest, Brightest Cepheid Variable. Very Recently, Something Changed.

When you look up in the night sky and find your way to the North Star, you are looking at Polaris. Not only is it the brightest star in the Ursa Minor constellation (the Little Dipper), but its position relative to the north celestial pole (less than 1° away) makes it useful for orienteering and navigation. Since the age of modern astronomy, scientists have understood that the star is a binary system consist-

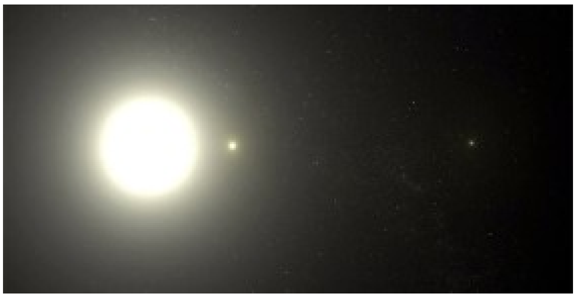
ing of an F-type yellow supergiant (Polaris Aa) and a smaller main-sequence yellow dwarf (Polaris B). Further observations revealed that Polaris Aa is a classic Cepheid variable, a stellar class that pulses regularly.
For most of the 20th century, records indicate that the pulsation period has been increasing while the pulsation amplitude has been declining. But recently, this changed as the pulsation period started getting shorter while the amplitude of the velocity variations stopped increasing. According to a new study by Guillermo Torres, an astronomer with the Harvard & Smithsonian Center for Astrophysics (CfA), these behaviors could be attributed to long-term changes related to the binary nature of the system, where the two stars get closer to each other, and the secondary perturbs the atmosphere of the primary.

Cepheid variables are stars that pulsate radially, causing them to vary in diameter and temperature. These pulsations are directly related to changes in their brightness, which makes them a useful tool for measuring galactic and extragalactic distances. The variable nature of Polaris was confirmed in 1911 by Danish astronomer Ejnar HertzsDaprung, for whom the Hertzsprung–Russell diagram is partly named. Observations conducted throughout the 20th century have shown that Polaris has a consistent pulse period of about four days, which has been steadily increasing every year.



Polaris (Alpha Ursae Minoris) as seen by the Hubble Space Telescope. Credit: NASA/HST

As Dr. Torres explained to Universe Today via email, this recently began to change, leading many astronomers to question what is driving Polaris' pulsations. "For more than 150 years and up until about 2010, the period had been getting longer by about 4 or 5 seconds each year," he said. "Modern observations have shown that this trend has now reversed, and the pulsation period is getting shorter. This is an unexpected change, showing that there is still much that we do not understand about Polaris and other stars like it."
To learn more about Polaris' pulsation period, Torres consulted radial velocity (RV) measurements going back to 1888. This technique consists of measuring spectra from a distant star and looking for redshift and blueshift, which are indications that the star is moving back and forth (this technique also yields accurate estimates of its velocity). Torres' sample included more than 3,600 RV measurements, including the nearly 1,200 spectroscopic observations carried out by the Lick Observatory over more than 60 years. This allowed Torres to trace the evolution of the pulsation properties of Polaris, which showed how often pulses occur and their amplitude as well. Said Torres:
"In the early 1990's the amplitude had become so small that it was thought that the pulsations were about to stop. However, Polaris decided otherwise, and by the late 1990's the amplitude had started to increase again, which lasted until about 2015. The most recent observations indicate the amplitude is no longer increasing, and may begin to come down again. Additionally, RVs have shown that this behavior may be related to the fact that Polaris is orbited by another star, which comes close to it every 30 years and may be perturbing the Cepheid's outer layers, where the pulsations take place."

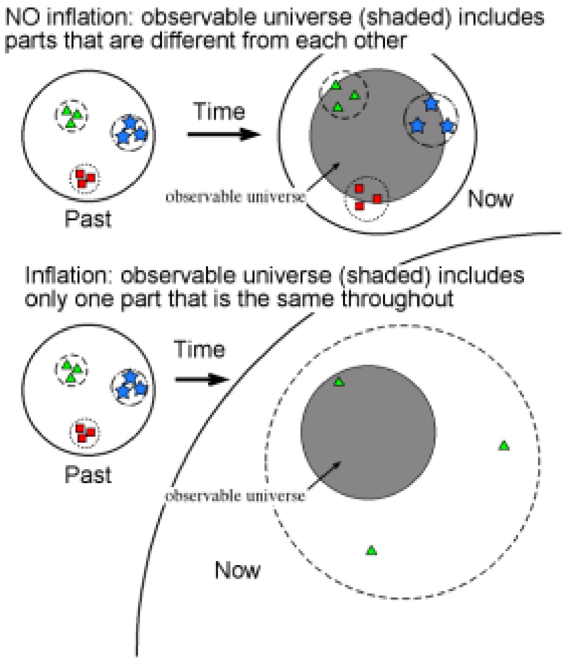


An artist's conception shows Polaris A with a close companion, known as Polaris Ab. Yet another companion star, Polaris B, can be seen as a speck in the background at right. Credit: STScI

In short, the changes in Polaris' pulsation period may result from its companion disturbing it whenever they make their closest pass to each other. Once this is factored in, Torres was able to derive an improved spectroscopic orbit for the binary system, something astronomers have been trying to resolve for generations. This could also lead to more accurate estimates of the dynamical masses of each stellar companion, which were also subject to uncertainty. As Torres summarized:
"We now know that Polaris behaves in an irregular and unpredictable manner. If it is confirmed that this has to do with the presence of its companion, this may shed light on the behavior of other pulsating stars with similar properties and help us understand the nature of the oscillations. It is therefore important to keep an eye on it, as it may still hold surprises for us."

The Case for a Small Universe

The Universe is big, as Douglas Adams would say.
The most distant light we can see is the cosmic microwave background (CMB), which has taken more than 13 billion years to reach us. This marks the edge of the observable universe, and while you might think that means the Universe is 26 billion light-years across, thanks to cosmic expansion it is now closer to 46 billion light-years across. By any measure, this is pretty darn big. But most cosmologists think the Universe is much larger than our observable corner of it. That what we can see is a small part of an unimaginably vast, if not infinite creation. However, a new paper argues that the observable universe is mostly all there is.
In other words, on a cosmic scale, the Universe is quite small.
There are several reasons why cosmologists think the Universe is large. One is the distribution of galaxy clusters. If the Universe didn't extend beyond what we see, the most distant galaxies would feel a gravitational pull toward our region of the cosmos, but not away from us, leading to asymmetrical clustering. Since galaxies cluster at around the same scale throughout the visible universe. In other words, the observable universe is homogenous and isotropic.
A second point is that spacetime is flat. If spacetime weren't flat, our view of distant galaxies would be distorted, making them appear much larger or smaller than they actually are. Distant galaxies do appear slightly larger due to cosmic expansion, but not in a way that implies an overall curvature to spacetime. Based on the limits of our observations, the flatness of the cosmos implies it is at least 400 times larger than the observable universe.

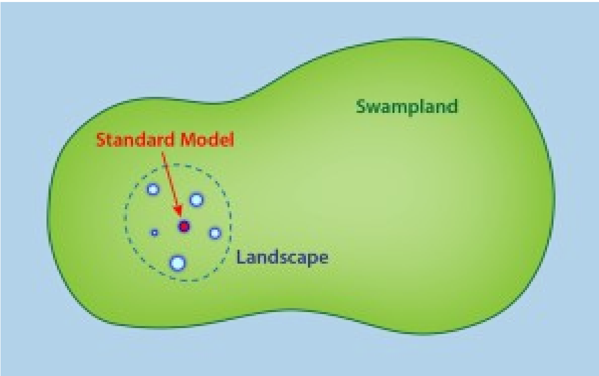


Inflation would make the CMB temperature uniform. Credit: Nick Strobel

Then there is the fact that the cosmic microwave background is almost a perfect blackbody. There are small fluctuations in its temperature, but it is much more uniform than it should be. To account for this, astronomers have proposed a period of tremendous expansion just after the Big Bang, known as early cosmic inflation. We have not observed any direct evidence of it, but the model solves so many cosmological problems that it's widely accepted. If the model is accurate, then the Universe is on the order of 10^{26} times larger than the observable universe.

So given all of this theoretical and observational evidence, how could anyone argue that the Universe is small? It has to do with string theory and the swamplands.

Although string theory is often presented as a physical theory, it's actually a collection of mathematical methods. It can be used in the development of complex physical models, but it can also just be mathematics for its own sake. One of the problems with connecting the mathematics of string theory to physical models is that the effects would only be seen in the most extreme situations, and we don't have enough observational data to rule out various models. However, some string theory models appear much more promising than others. For example, some models are compatible with quantum gravity, and others are not. So often theorists will define a "swampland" of theories that aren't promising.



Most of string theory is in the swampland. Credit: APS/Alan Stonebraker

When you separate the promising theoretical lands from the swamp, what you are left with are theories where early cosmic inflation isn't an option. Most of the inflationary string theory models are in the swampland. This leads one to ask whether you could construct a model cosmology that matches observation without early inflation. Which brings us to this new study.

One way to get around early cosmic inflation is to look at higher-dimensional structures. Classic general relativity relies upon four physical dimensions, three of space and one of time, or 3+1. Mathematically you could imagine a 3+2 universe or 4+1, where the global structure can be embedded into an effective 3+1 structure. This is a common approach in string theory since it isn't limited to the standard structure of general relativity. The authors demonstrate that under just the right conditions, you could construct a higher-dimensional structure within string theory that matches observation and avoids the swampland. Based on their toy models, the Universe may only be a hundred or a thousand times larger than the observed universe. Still big, but downright tiny when compared to the early inflation models.

All of this is pretty speculative, but in a way so is early cosmic inflation. If early cosmic inflation is true, we should be able to observe its effect through gravitational waves in the somewhat near future. If that fails, it might be worth looking more closely at string theory models that keep us out of the theoretical swamp.

DART Had a Surprising Impact on its Target

After NASA's DART mission slammed into asteroid Dimorphous in September 2022, scientists determined the impact caused tons of rock to be ejected from the small asteroid's surface. But more importantly, DART's impact altered Dimorphos' orbital period, decreasing it by about 33 minutes.

However, a group of researchers measured the orbital period about a month later and discovered that it had increased to 34 minutes — 1 minute longer than the first measurements. Even though it was a single impact from DART, some force continued to slow the asteroid's orbit, and astronomers don't yet know what that mechanism might be.

"We find that no mechanism previously presented for this system can account for this large of a period change, and drag from impact ejecta is an unlikely explanation," the researchers wrote in their paper, published as a preprint on arXiv. "Further observations of the (65803) Didymos system are needed to both confirm our result and to further understand this system post impact."

DART's purpose was a test of how asteroids respond to impacts. When the first data following the impact was released, the change in orbital period was great news, since this type of kinetic impact is a planetary defense technique, where a spacecraft intentionally collides with a Potentially Hazardous Asteroid to alter its course. The data from DART is helping both NASA and ESA prepare for the possibility of having to redirect an asteroid away from an eventual impact with Earth.

"We know the initial experiment worked. Now we can start to apply this knowledge," said Andy Rivkin, DART investigation team co-lead at the Johns Hopkins Applied Physics Lab (APL), back in December 2022 when the first DART data was released.

Image captured by the Italian Space Agency's LICIACube a few minutes after the intentional collision of NASA's Double Asteroid Redirection Test (DART) mission with its target asteroid, Dimorphos, captured on Sept. 26, 2022. Credits: ASI/NASA

DART weighed 610 kg (1,340 lb) and it crashed into Dimorphos at approximately 22,530 km/h (14,000 mph. DART excavated a crater on the Dimorphos' surface that ejected more than 900,000 kg (990 US tons) of debris into space. Data also indicated DART's impact into Dimorphos also changed the trajectory of the moonlet's parent asteroid, Didymos.

Scientists estimated DART's impact displaced over one million kilograms (two million pounds) of the dusty rock into space – or enough to fill six or seven railroad cars. The DART science team is continuing to analyze their data, as well as new information on the composition of the asteroid moonlet and the characteristics of the ejecta to learn just how much DART's initial hit moved the asteroid, and how much came from the recoil.

But now another group of researchers, led by Taylor Gudebski and Elisabeth Heldridge, used the 0.7m telescope at the Thacher Observatory located on the campus of The Thacher School in Ventura County, California to make their observations.

They measured the post-collision period change in observations taken about 20-30 days after the initial data, and their results indicate that the system period may have shortened during this brief time.

One thought was that since the debris cloud was so large and changed over time, it could influence Dimorphos' orbit. In a study released in March 2023, astronomers tracked the evolution of the debris cloud from the collision for a month and found that as the debris expanded outward, structures started forming, such as clumps, spirals and a long tail pushed away by the Sun's radiation. But Gudebski and Heldridge's team doesn't think the debris would account for the change they observed.

An animated view captured by Hubble Space Telescope. NASA, ESA, CSA, and STScI

Interestingly, the researchers said, even before the DART collision, the period of Dimorphos was observed to be slowly changing. But, the researchers wrote, even that amount of change can't account for the difference, "as it was 4 orders of magnitude too small to account for the difference we see."

"Therefore, whatever effect was causing the orbital decay before the collision cannot account for the discrepancy we observe; this includes the binary YORP effect, mutual tides, differential Yarkovsky force, nodal precession, and mass loss," they said.

This group of researchers and the DART team will continue to observe and study DART's impact. It will be interesting to find out if the orbital period continues to decline or not, and how that might affect the use of kinetic impactors.

Additionally, another spacecraft will launch in 2024 to study Dimorphos even closer. ESA's Hera mission should arrive at Didymos and Dimorphos in December 2026. Hera will undertake a detailed study of Dimorphos to understand more deeply how the impact affected it.

Follow the Fall 2023 Return of Comet 103P Hartley

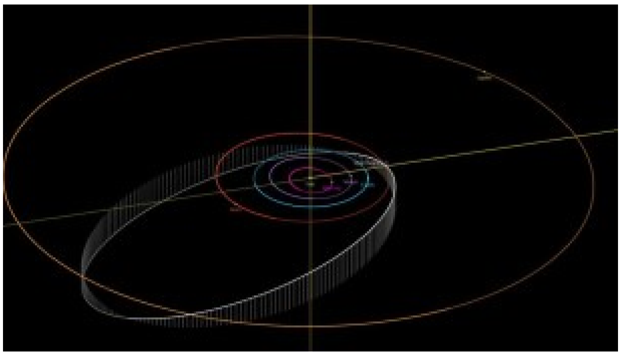
Catch periodic cosmic interloper 103P Hartley while you can.

Periodic comets are like old friends, back for a visit. We have a get together with just such a denizen of the cometary league, as Comet 103P Hartley makes a favorable apparition in late 2023.

Comet 103P Hartley: An Origin Story

The Jupiter-family comet was discovered by astronomer Malcolm Hartley on the night of March 15th, 1986, observing from the Siding Spring Observatory in Australia. Comet 103P Hartley is also sometimes referred to Comet Hartley 2.

The comet reaches perihelion just beyond Earth's orbit, at 1.05 Astronomical Units (AU) from the Sun. The next perihelion passage for the comet occurs next month on October 12th, 2023. The comet reaches an aphelion of 5.9 AU, just out beyond the orbit of Jupiter in its 6.5 year orbit. We get a favorable appearance of the comet on every second perihelion pass, or once every 13 years.

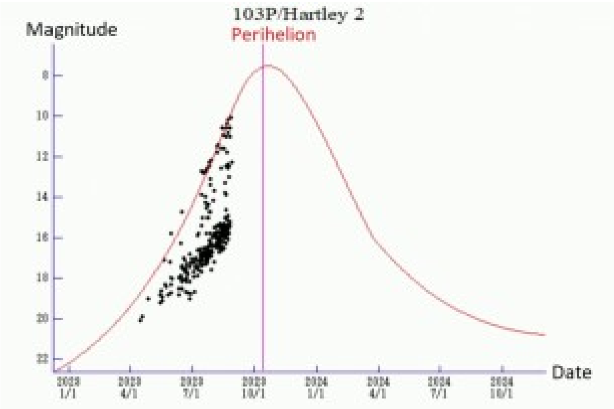


The orbital path of Comet 103P Hartley. Credit: NASA/JPL

The comet made its closest pass to the Earth for the 21st century on October 20th 2010, just 8 days prior to perihelion at 0.12 AU (11 million miles or 18 million kilometers) distant, or about 44 times the distance from the Earth to the Moon.

As is the case with many inner solar system short period comets, the comet's orbit was captured and shaped by massive Jupiter.

On the 2010 passage, the comet flirted with naked eye visibility at +5th magnitude. This apparition isn't quite as good, as the comet passes 35.5 million miles or 57 million kilometers from the Earth on September 26th, just over two weeks prior to reaching perihelion. Still, it should top out as a respectable binocular object at +8th magnitude in 2023.



The projected versus observed light curve for comet 103P Hartley. Credit: Seichii Yoshida's *Weekly Information About Bright Comets*.

See Comet 103P Hartley in September

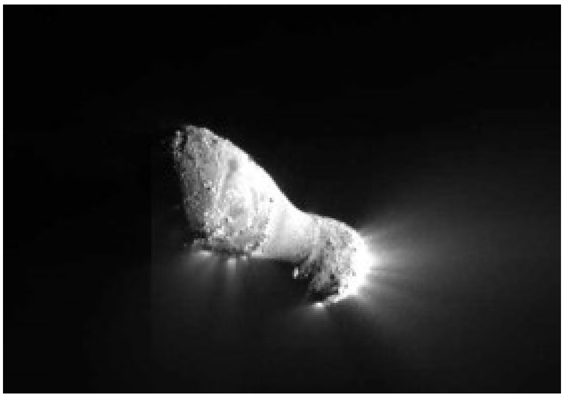
The September apparition sees the comet traveling from the constellation of Perseus the Hero into Auriga the Charioteer. This places the comet well in the late evening sky for northern hemisphere observers. Some photogenic dates with destiny include a 0.5 a degree (the diameter of a Full Moon) pass near the +7th magnitude open star cluster NGC 1857 on September 20th, and close passes near the familiar open star clusters Messier 38 and Messier 37 during the week of September 21st through the 26th.

The path of Comet 103P Hartley through September 2023. Credit: Starry Night/Dave Dickinson

The comet crosses the star rich galactic plane southward on September 12th. The comet should be a fine binocular object around this time, shining at magnitude +10.

The Moon reaches New phase this month on September 15th, representing the span of a week or so, that is ideal for tracking down the comet.

This is the best apparition of the comet since 2010. We won't have another favorable appearance until 13 years from now, in 2036. The passage will, however, see the comet passing Earth at a much farther 0.8 AU distant.



Comet 103P Hartley imaged by NASA's EPOXI mission during its 2011 flyby. Credit: NASA/EPOXI.

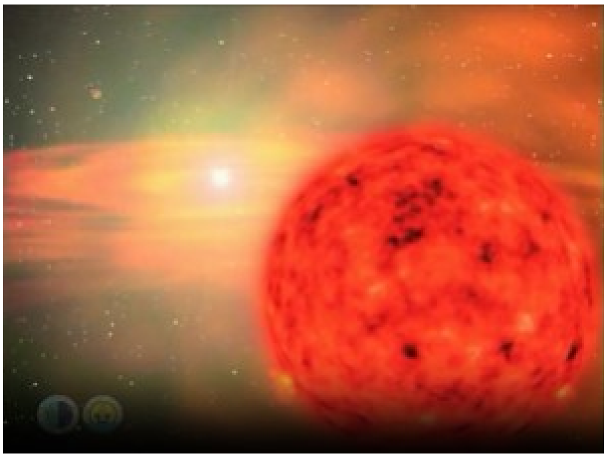
NASA's EPOXI mission flew by Comet 103P Hartley in 2010 and revealed a strange, two axis 18.3 hour rotation and a two-lobed 'dog bone' shape characteristic of many comets seen up close. This rotation seems to be slowing down due to mass loss, and may actually stop and reverse direction mid-21st century. After that, 103P many speed up fast enough to fly apart late next century.

Comet 103P also seems to be active with lots of outbursts, including hyper-activity from the comet witnessed close-up during the EPOXI flyby.

Be sure to catch sight of Comet 103P Hartley as it graces September skies, for its best appearance for this decade.

E MAILS and MEMBERS VIEWING LOGS.

Are we really going to see one of the brightest Novae in living memory during 2024 ?



This is an artist's impression of a red giant star orbiting a white dwarf. An accretion disc surrounds the dwarf and both stars are embedded in a nebula (credit: Gabriel Ángel Pérez Díaz, Instituto de Astrofísica de Canarias)

T Corona Borealis (T CrB for short) is one of a rare class of variable stars called recurrent novae of which only 10 are known. These stars have been observed to undergo a nova eruption more than once. Novae occur in binary stars in which the primary is a white dwarf and the secondary is either a red dwarf or, as in the case of T CrB, a red giant which is donating material to the primary via an accretion disc. A layer of material from the secondary builds up on the surface of the primary. As the depth of the layer increases, the temperature and pressure at the base of the layer also increase until they become sufficient to detonate a thermonuclear explosion and this explosion is what we see in a Nova outburst. The frequencies of these outbursts vary from system to system. Most are believed to occur at intervals of thousands to tens of thousands of years but in recurrent novae the intervals are much shorter due to their higher mass transfer rates.

T CrB has been observed to undergo two nova eruptions, one in 1866 and a second in 1946 and both reached magnitude 2. A nova of that brightness in 2024 would make it the second brightest Nova in living memory, beaten only marginally by Nova Cygni 1975 which reached magnitude 1.7. The 80 year gap suggests we might expect the next one in 2026 but analysis of the light curves of the two outbursts has led Prof. Bradley E. Schaefer (Department of Physics and Astronomy, Louisiana State University) to predict an outburst between February and August 2024. In the earlier outbursts, a brightening was observed which began several years before the outburst. About 1 year before the outburst a pre-eruption dip was observed. In 2015, T Crb brightened and entered a "super-active phase" which continued until March of this year which Professor Schaefer believes is the start of the pre eruption dip. If correct, this makes an outburst well before 2026 highly likely. Let's hope for good weather though, because although it is very bright, T CrB is a fast nova and it will brighten and fade quickly. It will probably be below naked eye visibility within a week.

If you would like to know more, Professor Schaefer's recent webinar to AASO members is available at https://fb.watch/mZhv9T6ax3/

Professor Schaefer has also written an historical paper concluding that outbursts of T CrB in 1787 and 1217 were witnessed by the Reverend Francis Wollaston and Abbot Burchard of Ursberg Abbey in Germany respectively. He also concludes that John Herschel, who, following the 1866 outburst, claimed to have seen T CrB in outburst in 1842 did not in fact do so. https://arxiv.org/ftp/arxiv/papers/2308/2308.13668.pdf

Most of what we know about T CrB comes from observations made by amateur astronomers extending back into the middle of the 19th century and amateur visual, ccd/cmos and spectroscopic observations are urgently requested from now, throughout the outburst and beyond. If you would like to contribute to this effort more information about how to go about this is available from the website of the British Astronomical Association Variable Star Section (BAAVSS) https://britastro.org/photdb/ or the American Association of Variable Star Observers (AAVSO) https://www.aavso.org/

Tony Vale

Viewing Log for 13th of September

I went to a new viewing site that Damian (the chairman from Swindon Stargazers) managed to get for the club, the site was at an old RAF World War II airfield called Nebo and is not far from the village of Clyffe Pypard, south of Royal Wotton Bassett. We had been there about a month earlier to see how the views were. I had hoped to see the southern constellations around Sagittarius but cloud stopped us that evening, in fact cloud was around for most of the time we were there, hence no viewing log for that evening.

After getting permission (which is needed before you can use the site, most important), I arrived and had my Meade LX90 set up and ready by 20:46, as usual I would be using a Pentax XW 14 mm eye piece, with a temperature of 14 °C, some cloud around and a slight wind the conditions would not be that bad. I had brought along my normal winter jacket as the site is exposed to the winds when blowing but otherwise the rest of my normal viewing clothing was at home. I also had some uninvited company with me, namely two owls hooting in some nearby trees! The set up stars were Arcturus and Altair.

My first target for the evening was Saturn, shining fairly brightly at mag 0.55 in the southern sky, I could make out the rings and the large moon Titan to the east of the planet, and I thought I could make out another moon to the west but I was not sure? As the southern sky seem clear, I thought I would see if I could get anything from the constellation of Sagittarius, lucky for me I could locate Messier (M) 70 at a declination of -32 ° about 6 ° above the horizon. With this begin the lowest Messier object in this constellation, I should be able to get most of the other 14 Messier objects during the evening? M 70, is a very faint globular cluster (GC) which to me was a faint fuzzy blob (FFB), begin that low in the sky it was expected? Not far away is M 69, another GC but not sure if I could pick it up. Both of these objects are at the bottom of the 'Teapot' asterism. Next was M 54, a compact GC with a bright core, a faint blob (FB) to me. M 55, a GC was very hard to find. Now going further north into better skies landed on M 8, the Lagoon nebula, this diffused nebula (DN) showed some cloud like structure. While viewing this object two satellites went thru the eye piece, I noticed an open cluster (OC) nearby (looking at Stellarium later on, I think it was part of the same object?). The road to this site is a dead end, so not many cars should come down this road, one did but did a U turn and went back the way it came, it did not affect my night vision. Not sure if I could make out M 20, the Trifid nebula, cloud might be in the area? On to M 21, the first OC of the night, a small loose object with not many stars in it. M 22 is a large GC which would probably look very good if it was higher in the sky, might give M 13 a run for its money? While viewing M 22, I heard sounds of a low flying aircraft coming to me from the north, turns out it was an A400M quite low with no lights on, probably doing night exercises? Onto another GC and M 28, a small FB with a bright core. Next I noticed two bright satellites above the 'Teapot' which disappeared into Earth's shadow, I would put a mag of about -4 for this object? Back to viewing again and M 23, a large loose OC. M 24 is known as the 'Star Cloud', lots of dim stars. Using a 20 mm eye piece, the view was better. Still going upwards and M 17, the Swan or Omega nebula, this object was a large thin grey cloud, guess it looks like a swan but not to me? M 75 is right on the border with Capricornus, this GC is a small FB with a bright core. Final object for Messier list was M 25, a small loose OC with not many stars in it. I was using my Sky & telescope star atlas to find these objects, I noticed an item called the 'Little Gem' (NGC 6818), so I slewed my telescope to this object which turned to be a planetary nebula, it was that small it was only a point of light for me, bigger telescopes might be needed to make anything out of this object? Tried for Neptune but that was hiding in clouds! Jupiter was now well up, I could make out two moons to either side of this large plant, to the east was Ganymede and Europa with Calisto and Io to the west, the Great Red Spot was on view but unfortunately I did not see it!. Final object was Uranus, no colour with this planet, begin only 11 ° probably did not help?

It was now 22:47 and time to pack up, there was very little dew on the telescope this evening and the temperature had only dropped to 12 °. I could see the glow from both Swindon and Calne but did not affect my viewing at all. My main delight was the lack of cars going pass me which happens when I am at Uffcott, only one for the whole two hours, great!

Clear skies.

Peter Chappell

Viewing Log for 22nd of September (Swindon Stargazers star party)

Damian, the chair of the club arranged for a star party to be held at Rouselands farm campsite. He did the same last year but all see saw was cloud with more cloud coming in, going home that night I got a puncture for my efforts! This year it would be a two night affair, the first night look good but the second was a maybe?

I left home around 16:30 with camp gear (which had not seen daylight in four years) and food in tow plus telescope equipment, the car was pretty full! After driving for around 10 minutes I had remembered I had left a few things at home which might be needed during my stay, so turned around went home and collected said objects. Arriving back at the campsite, I was the first to arrive, so I would be setting up my tent with no help, lucky the wind was slight so my tent would not be blown away while trying to put pegs in the ground. It took a while to set the tent up, forgot how to put it up, after around 90 minutes everything was set up and time for a cup of tea and my sandwiches for the evening. Over the next few hours another two tents were set up plus one caravan, another three people would attend that evening but would not stay. While setting up my tent there was a lot of cloud in the sky but as the evening went by it broke up nicely. I had my Meade LX90 set up and ready by 20:12, at 9 ° it would feel a bit cold but no wind should help later on?

The guild stars were Arcturus and Altair. As the moon would set within the next hour I thought I would look at this object first, if the moon is in the sky I would normal view this object last as my night vision would get destroyed! It was just over half phase (50.2% lit or 7.74 days old), near the terminator is a chain of three craters, namely Arazchel, Alphonsus and Ptolemaeus, looked great to view. With the moon too low now, I started with Saturn, could make out Titan but no other moons in this system, tried for Neptune but no luck, yet again! By now the ISS was due over, I had set up my Canon 60 Da camera with a Samyang lens earlier in the evening ready for the fly over but the lens had dewed over! A quick cleaning of the lens and I could start (pictures in magazine with the moon as well). With the ISS over, I thought I would try 'Tonight's Best' from the hand controller. First object was the Double Cluster or Caldwell (C) 14, both of these open clusters (OC) were good to look at, also go the name of NGC 884 and 869. On to Vega, an A class star at mag 0.0, the fifth brightest star in the night sky, followed by Albireo in Cygnus, probably the best double star in the whole sky, the stars are a yellow and a blue. First globular cluster (GC) was Messier (M) 13, an excellent object to look at, could make out some stars close to the edge of this cluster. Into Pegasus and the star Enif at the head of the winged horse, this is a red star at mag 2.3, already been to Altair while setting up which is another white star and 12th brightest in the sky. M34, this an OC, small and very loose with not many stars in it? M 15 and M 2 are GC's which are fairly similar, small with a bright core. On to Deneb, the head of the swan, a blue white star. Back to Hercules and M 92, the often overlooked GC in this constellation, it is a lot smaller than M 13 but has a bright core to look at. In to Ursa Major and M 82, the Cigar galaxy, this irregular galaxy is long and thin, a faint blob (FB) to look at. In the other direction was M 11, the Wild Duck cluster, a compact and dim OC with some bright stars within its boundary, as for ducks, I could not make out any! M 57, the Ring Nebula is always good to see. The Andromeda galaxy, M 31 is a large grey blob. In to Cassiopeia and M 52 a small OC with not many stars in it. In to Canes Venatici and M 51, the Whirlpool galaxy, this spiral galaxy was a FB to look at, think the sky had high thin cloud or something worst in it? Turns out the eye piece had dewed up, as for the finder scope it was totally dewed up! Cleaned the lens and started again, now back to the area of M 31 but M 32 this time (why not go from one to the next as they are next door to each other, strange!) M 32 is an elliptical galaxy, a FB with a bright core. Moving the scope slightly I could M 32 in the same field as M 31. Next object was the Helix nebula or Caldwell 63, a planetary nebula that was hard to find and look at. Back to the planets and Uranus which was in the finder scope, some slewing and I could view the seventh planet, a hint of colour this time. Off to Neptune which was also in the finder scope when I slewed to the eighth planet from the sun, no detail at all. Final object for the evening was Jupiter, the biggest planet in the solar system, I could see Calisto and Ganymede to the east of the planet and Io to the west, could not find Europa at all. In fact not long before it had started a shadow transit of the planet's surface, the Great Red Spot was on the other side of the planet.

I was the final person to pack up for the night, the other three in Damian, Rob and new person Adrian and finished over an hour beforehand. I hope the noise of the Meade when slewing did not keep them awake? Pack up time was 23:37, there was a heavy dew on the equipment used that night which would need drying the in the morning (lucky for me it was a sunny morning at the camp site), no wind and 7 °. Sleeping in a tent at that temperature would be a bit cold as I found out during the night. I did not have a great sleep that night. I decided not to stay for the second night as I would have work in the afternoon and it might be a bit of a rush getting to work on time with all the gear that would need packing up that I used. At least I could have a relaxing time putting everything away for another day.

Clear skies.

Peter Chappell

CHIPPENHAM 1st Scout Group

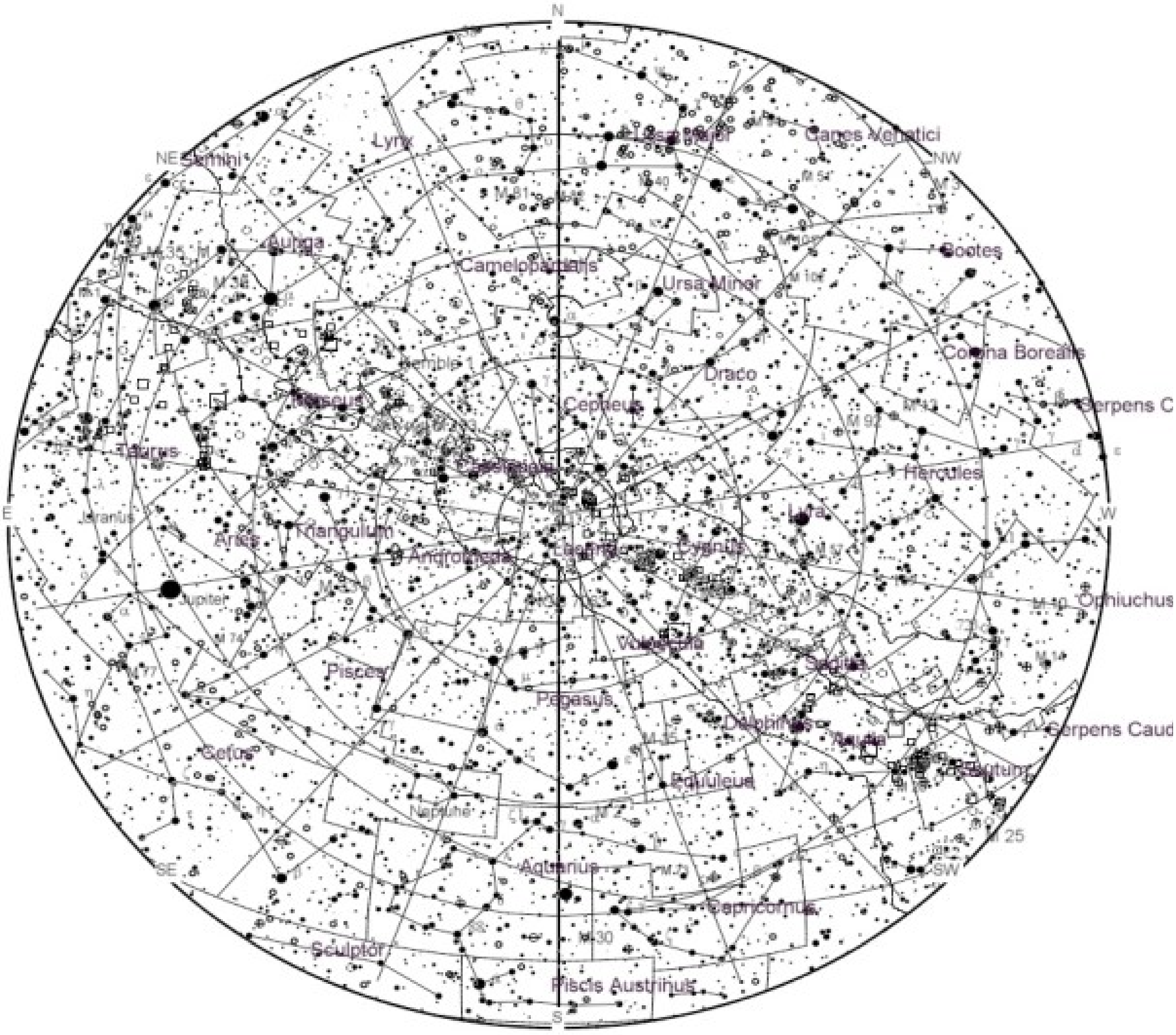
Hi Stefanie,

I have spoken to Andy Burns who has been looking after out-reach and has worked with your scout group in the past, and providing we can get some volunteers to help out we could do something mid-week. Hopefully we can confirm the volunteers after our need society meeting in early October.
Currently the 14th November looks best with darker skies and a crescent moon. with the 21st as a back up but with a much fuller moon which will wash out some of the stars and make observing a little more challenging.
I have looked at the requirements for astronomy badge and we will be happy to help with observations and can provide explanations on the various subject matter and objectives.
Do you have any specific task sheets or work notes you need us to work through with your scouts?
Many thanks
Chris

Can you put something in the newsletter requesting volunteers for the observing session with the 1st Chippenham scouts, on the evening of 14th November with a possible back-up session on 21st if the 14th is clouded out.
We will request again at the beginning of November.
Cheers
Chris

WHATS UP, OCTOBER 23

Alt/Az coord. ARC
Apparent
Home
2023-10-15
22h00m00s (BST)
Mag:6.9/11.5,1.2'
FOV:+249°01'02"



October 8, 9 - **Draconids Meteor Shower.** The Draconids is a minor meteor shower producing only about 10 meteors per hour. It is produced by dust grains left behind by comet 21P Giacobini-Zinner, which was first discovered in 1900. The Draconids is an unusual shower in that the best viewing is in the early evening instead of early morning like most other showers. The shower runs annually from October 6-10 and peaks this year on the the night of the the 8th and morning of the 9th. The second quarter moon will be visible in the early morning but shouldn't interfere too much. Best viewing will be in the early evening from a dark location far away from city lights. Meteors will radiate from the constellation Draco, but can appear anywhere in the sky.

October 14 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 17:56 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.

October 14 - **Annular Solar Eclipse.** An annular solar eclipse occurs when the Moon is too far away from the Earth to completely cover the Sun. This results in a ring of light around the darkened Moon. The Sun's corona is not visible during an annular eclipse. The eclipse path will begin in the Pacific Ocean off the coast of southern Canada and move across the southwestern United States and Central America, Columbia, and Brazil. A partial eclipse will be visible throughout much of North and South America. (**NASA Map and Eclipse Information**) (**NASA Interactive Google Map**)

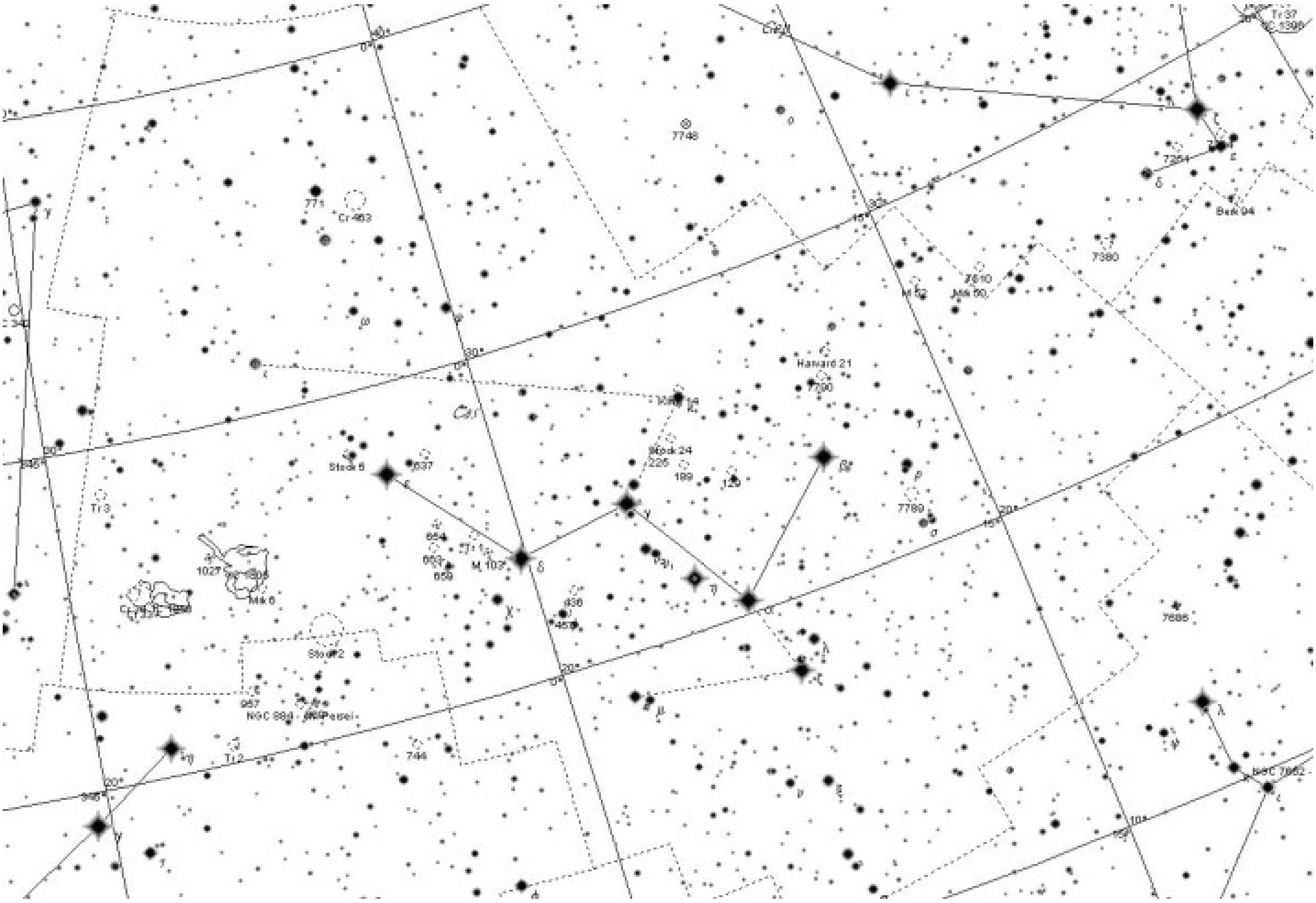
October 20, 21 - **Orionids Meteor Shower.** The Orionids is an average shower producing up to 20 meteors per hour at its peak. It is produced by dust grains left behind by comet Halley, which has been known and observed since ancient times. The shower runs annually from October 2 to November 7. It peaks this year on the night of October 20 and the morning of October 21. The first quarter moon may block some of the dim meteors in the evening, but it will set shortly after midnight. This will leave dark skies for what could be a good morning show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Orion, but can appear anywhere in the sky.

October 23 - **Venus at Greatest Western Elongation.** The planet Venus reaches greatest eastern elongation of 46.4 degrees from the Sun. This is the best time to view Venus since it will be at its highest point above the horizon in the morning sky. Look for the bright planet in the eastern sky before sunrise.

October 28 - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 20:25 UTC. This full moon was known by early Native American tribes as the Hunters Moon because at this time of year the leaves are falling and the game is fat and ready to hunt. This moon has also been known as the Travel Moon and the Blood Moon.

October 28 - **Partial Lunar Eclipse.** A partial lunar eclipse occurs when the Moon passes through the Earth's partial shadow, or penumbra, and only a portion of it passes through the darkest shadow, or umbra. During this type of eclipse a part of the Moon will darken as it moves through the Earth's shadow. The eclipse will be visible throughout all of Europe, Asia, and Africa, and western Australia.

CONSTELLATIONS OF THE MONTH: CASSIOPEIA



The Cassiopeia Constellation

Welcome back to Constellation Friday! Today, in honor of the late and great Tammy Plotner, we will be dealing with the "keel of the ship", the Carina constellation!

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

One of the most famous of these constellations is Cassiopeia, which is easily recognized by its W-shape in the sky. As one of the 48 constellation included in the *Almagest*, it is now one of the 88 modern constellations recognized by the IAU. Located in the norther sky opposite of the Big Dipper (Ursa Major), it is bordered by Camelopardalis, Cepheus, Lacerta, Andromeda and Perseus.

Name and Meaning:

In mythology, Cassiopeia the wife of King Cepheus and the queen of the mythological Phoenician realm of Ethiopia. Her name in Greek means "she whose words excel", and she was renowned for her beauty but also her arrogance. This led to her downfall, as she boasted that both she and her daughter Andromeda were more beautiful than all the Nereids – the nymph-daughters of the sea god Nereus.

Cassiopeia in her chair, as depicted in Urania's Mirror. Credit: Sidney Hall/United States Library of Congress

This led the Nerieds to unleash the wrath of Poseidon upon the kingdom of Ethiopia.Accounts differ as to whether Poseidon decided to flood the whole country or direct the sea monster Cetus to destroy it. In either case, trying to save their kingdom, Cepheus and Cassiopeia consulted a wise oracle, who told them that the only way to appease the sea gods was to sacrifice their daughter.

Accordingly, Andromeda was chained to a rock at the sea's edge and left there to helplessly await her fate at the hands of Cetus. But the hero Perseus arrived in time, saved Andromeda, and ultimately became her husband. Since Poseidon thought that Cassiopeia should not escape punishment, he placed her in the heavens in such a position that, as she circles the celestial pole, she is upside-down for half the time.

History of Observation:

Cassiopeia was one of the traditional constellations included by Ptolemy in his 2nd century CE tract, the *Almagest*. It also figures prominently in the astronomical and astrological traditions of the Polynesian, Indian, Chinese and Arab cultures. In Chinese astronomy, the stars forming the constellation Cassiopeia are found among the areas of the Purple Forbidden enclosure, the Black Tortoise of the North, and the White Tiger of the West.
Chinese astronomers also identified various figures in its major stars. While Kappa, Eta, and Mu Cassopeiae formed a constellation called the *Bridge of the Kings*, when combined with Alpha and Beta Cassiopeiae – they formed the great chariot *Wang-Liang*.
In Indian astronomy, Cassiopeia was associated with the mythological figure Sharmishtha – the daughter of the great Devil (Daitya) King Vrishparva and a friend to Devavani (Andromeda).

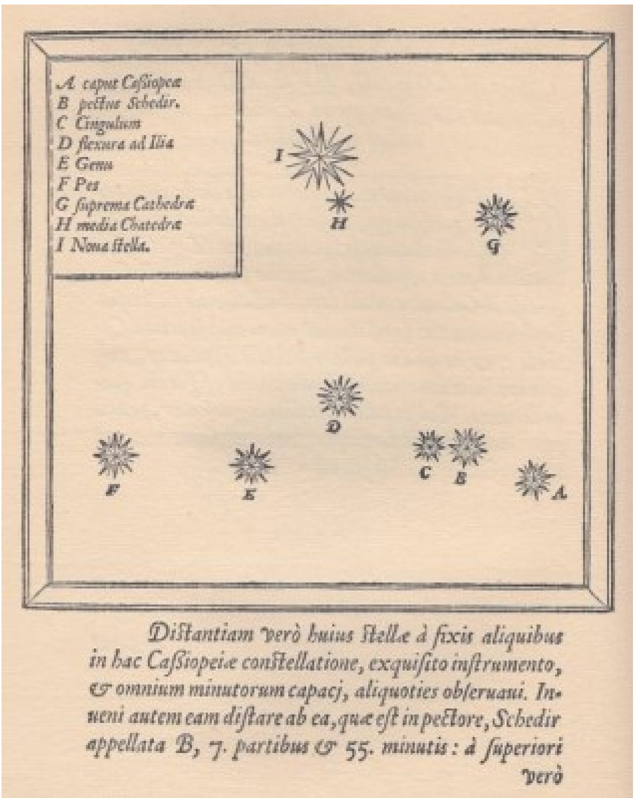
Kappa Cassiopeiae and its bow shock. Spitzer infrared image (NASA/JPL-Caltech)

Arab astronomers also associated Cassiopeia's stars with various figures from their mythology. For instance, the stars of Alpha, Beta, Gamma, Delta, Epsilon and Eta Cassiopeiae were often depicted as the "Tinted Hand" in Arab atlases – a woman's hand dyed red with henna, or the bloodied hand of Muhammad's daughter Fatima. The arm was made up of stars from the neighboring Perseus constellation.

Another Arab constellation that incorporated the stars of Cassiopeia was the Camel. Its head was composed of Lambda, Kappa, Iota, and Phi Andromedae; its hump was Beta Cassiopeiae; its body was the rest of Cassiopeia, and the legs were composed of stars in Perseus and Andromeda.

In November of 1572, astronomers were stunned by the appearance of a new star in the constellation – which was later named Tycho's Supernova (SN 1572), after astronomer Tycho Brahe who recorded its discovery. At the time of its discovery, SN1572 was a Type Ia supernova that actually rivaled Venus in brightness. The supernova remained visible to the naked eye into 1574, gradually fading until it disappeared from view.

The "new star" helped to shatter stale, ancient models of the heavens by demonstrating that the heavens were not "unchanging". It helped speed the the revolution that was already underway in astronomy and also led to the production of better astrometric star catalogues (and thus the need for more precise astronomical observing instruments).



Star map of the constellation Cassiopeia showing the position (labelled I) of the supernova of 1572. Credit: Wikipedia Commons

To be fair, Tycho was not even close to being the first to observe the 1572 supernova, as his contemporaries Wolfgang Schuler, Thomas Digges, John Dee and Francesco Maurolico produced their own accounts of its appearance. But he was apparently the most accurate observer of the object and did extensive work in both observing the new star and in analyzing the observations of many other astronomers.

Notable Features:

This zig-zag shaped circumpolar asterism consists of 5 primary stars (2 of which are the most luminous in the Milky Way Galaxy) and 53 Bayer/Flamsteed designated stars. It's brightest star – Beta Cassiopeiae, otherwise known by its traditional name Caph – is a yellow-white F-type giant with a mean apparent magnitude of +2.28. It is classified as a Delta Scuti type variable star and its brightness varies from magnitude +2.25 to +2.31 with a period of 2.5 hours.

Now move along the line to the next bright star – Alpha. Its name is Schedar and its an orange giant (spectral type K0 IIIa), a type of star cooler but much brighter than our Sun. In visible light only, it is well over 500 times brighter than the Sun. According to the Hipparcos astrometrical satellite, distance to the star is about 230 light years (or 70 parsecs).

Continue up the line for Eta, marked by the N shape and take a look in a telescope. Eta Cassiopeiae's name is Achird and its a multiple is a star system 19.4 light years away from Earth. The primary star in the Eta Cassiopeiae system is a yellow dwarf (main sequence star) of spectral type G0V, putting it in the same spectral class as our Sun, which is of spectral type G2V. It therefore resembles what our Sun might look like if we were to observe it from Eta Cassiopeiae.

Mosaic image of Cassiopeia A, a supernova remnant, taken by the Hubble and Spitzer Space Telescopes. Credit: NASA/JPL-Caltech/STScI/CXC/SAO

The star is of apparent magnitude 3.45. The star has a cooler and dimmer (magnitude 7.51) orange dwarf companion of spectral type K7V. Based on an estimated semi major axis of 12″ and a parallax of 0.168 mas, the two stars are separated by an average distance of 71 AU. However, the large orbital eccentricity of 0.497 means that their periapsis, or closest approach, is as small as 36 AU.

The next star in line towards the pole is Gamma, marked by the Y shape. Gamma Cassiopeiae doesn't have a proper name, but American astronaut Gus Grissom nicknamed it "Navi" since it was an easily identifiable navigational reference point during space missions. The apparent magnitude of this star was +2.2 in 1937, +3.4 in 1940, +2.9 in 1949, +2.7 in 1965 and now it is +2.15. This is a rapidly spinning star that bulges outward along the equator. When combined with the high luminosity, the result is mass loss that forms a disk around the star.

Gamma Cassiopeiae is a spectroscopic binary with an orbital period of about 204 days and an eccentricity alternately reported as 0.26 and "near zero." The mass of the companion is believed to be comparable to our Sun (Harmanec et al. 2000, Miroschnichenko et al. 2002). Gamma Cas is also the prototype of a small group of stellar sources of X-ray radiation that is about 10 times higher that emitted from other B or Be stars, which shows very short term and long-term cycles.

Now move over to Delta Cassiopeiae, the figure 8. It's traditional name is Ruchbah, the "knee". Delta Cassiopeiae is an eclipsing binary with a period of 759 days. Its apparent magnitude varies between +2.68 mag and +2.74 with a period of 759 days. It is of spectral class A3, and is approximately 99 light years from Earth.

Gamma Cassiopeiae. Credit & Copyright: Noel Carboni/ Greg Parker, New Forest Observatory

Last in line on the end is Epsilon, marked with the backward 3. Epsilon Cassiopeiae's tradition name is Segin. It is approximately 441 light years from Earth. It has an apparent magnitude of +3.38 and is a single, blue-white B-type giant with a luminosity 720 times that of the Sun.

Finding Cassiopeia:

Cassiopeia constellation is located in the first quadrant of the northern hemisphere (NQ1) and is visible at latitudes between +90° and -20°. It is the 25th largest constellation in the night sky and is best seen during the month of November. Due to its distinctive shape and proximity to the Big Dipper, it is very easy to find. And the constellation has plenty of stars and Deep Sky Objects that can be spotted using a telescope or binoculars.

First, let's begin by observing Messier 52. This one's easiest found first in binoculars by starting at Beta, hopping to Alpha as one step and continuing the same distance and trajectory as the next step. M52 (NGC 7654) is a fine open cluster located in a rich Milky Way field. The brightest main sequence star of this cluster is of mag 11.0 and spectral type B7.

Two yellow giants are brighter: The brightest is of spectral type F9 and mag 7.77, the other of type G8 and mag 8.22. Amateurs can see M52 as a nebulous patch in good binoculars or finder scopes. In 4-inch telescopes, it appears as a fine, rich compressed cluster of faint stars, often described as of fan or "V" shape; the bright yellow star is to the SW edge. John Mallas noted "a needle-shaped inner region inside a half-circle." M52 is one of the original discoveries of Charles Messier, who cataloged it on September 7, 1774 when the comet of that year came close to it.

For larger telescopes, situated about 35′ southwest of M52 is the Bubble Nebula NGC 7635, a diffuse nebula which appears as a large, faint and diffuse oval, about 3.5×3′ around the 7th-mag star HD 220057 of spectral type B2 IV. It is difficult to see because of its low surface brightness.

Just immediately south of M52 is the little conspicuous open cluster Czernik 43 (Cz 43).

Now let's find Messier 103 by returning to Delta Cassiopeiae. In binoculars, M103 is easy to find and identify, and well visible as a nebulous fan-shaped patch. Mallas states that a 10×40 finder resolves the cluster into stars; however, this is so only under very good viewing conditions. The object is not so easy to identify in telescopes because it is quite loose and poor, and may be confused with star groups or clusters in the vicinity.

But telescopes show many fainter member stars. M103 is one of the more remote open clusters in Messier's catalog, at about 8,000 light years. While you are there, enjoy the other small open clusters that are equally outstanding in a telescope, such as NGC 659, NGC 663 and NGC 654. But, for a real star party treat, take the time to go back south and look up galactic star cluster NGC 457.

It contains nearly one hundred stars and lies over 9,000 light years away from the Sun. The cluster is sometimes referred by amateur astronomers as the Owl Cluster, or

the ET Cluster, due to its resemblance to the movie character. Those looking for a more spectacular treat should check out NGC 7789 – a rich galactic star cluster that was discovered by Caroline Herschel in 1783. Her brother William Herschel included it in his catalog as H VI.30.

This cluster is also known as "The White Rose" Cluster or "Caroline's Rose" Cluster because when seen visually, the loops of stars and dark lanes look like the swirling pattern of rose petals as seen from above. At 1.6 billion

years old, this cluster of stars is beginning to show its age. All the stars in the cluster were likely born at the same time but the brighter and more massive ones have more rapidly exhausted the hydrogen fuel in their cores.

Are you interested in faint nebulae? Then try your luck with IC 59. One of two arc-shaped nebulae (the other is IC 63) that are associated with the extremely luminous star Gamma Cassiopeiae. IC 59 lies about 20′ to the north of Gamma Cas and is primarily a reflection nebula. Other faint emission nebulae include the “Heart and Soul” (LBN 667 and IC 1805) which includes wide open star clusters Collider 34 and IC 1848.

Of course, no trip through Cassiopeia would be complete without mentioning Tycho’s Star! Given the role this “new star” played in the history of astronomy (and as one of only 8 recorded supernovas that was visible with the naked eye), it is something no amateur astronomer or stargazer should pass up!

While there is no actual meteoroid stream associated with the constellation of Cassiopeia, there is a meteor shower which seems to emanate near it. On August 31st the Andromedid meteor shower peaks and its radiant is nearest to Cassiopeia. Occasionally this meteor shower will produce some spectacular activity but usually the fall rate only averages about 20 per hour. There can be some red fireballs with trails. Biela’s Comet is the associated parent with the meteor stream.

Whilst I was imaging the clusters of Cassiopeia here was ngc 3370 and other clusters, but in 3x 60 second images I

was photobombed be a mass of Elon Musk Starlink crap...

ISS PASSES For September/Mid Oct 2023

from Heavens Above website maintained by Chris Peat.

Date	Brightn	Start	Highest	End						
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
20 Oct	-0.9	06:21:12	10°	S	06:23:00	14°	SE	06:24:47	10°	ESE
22 Oct	-1.9	06:21:21	10°	SSW	06:24:15	27°	SSE	06:27:10	10°	E
23 Oct	-1.6	05:35:48	17°	S	05:36:52	20°	SE	05:39:23	10°	E
23 Oct	-3.4	07:09:55	10°	WSW	07:13:15	65°	SSE	07:16:36	10°	E
24 Oct	-0.7	04:50:32	13°	ESE	04:50:32	13°	ESE	04:51:21	10°	ESE
24 Oct	-3.1	06:23:30	18°	SW	06:25:47	50°	SSE	06:29:03	10°	E
25 Oct	-2.7	05:38:10	37°	SSE	05:38:22	38°	SSE	05:41:31	10°	E
25 Oct	-3.7	07:11:38	10°	W	07:15:01	89°	SSE	07:18:23	10°	E
26 Oct	-1.0	04:52:46	18°	ESE	04:52:46	18°	ESE	04:53:56	10°	E
26 Oct	-3.8	06:25:45	25°	WSW	06:27:32	79°	S	06:30:55	10°	E
27 Oct	-3.5	05:40:19	63°	SE	05:40:19	63°	SE	05:43:28	10°	E
27 Oct	-3.7	07:13:33	10°	W	07:16:56	85°	N	07:20:18	10°	E
28 Oct	-1.0	04:54:53	19°	E	04:54:53	19°	E	04:56:02	10°	E
28 Oct	-3.8	06:27:51	28°	W	06:29:29	85°	N	06:32:52	10°	E
29 Oct	-3.6	04:42:25	71°	E	04:42:25	71°	E	04:45:28	10°	E
29 Oct	-3.7	06:15:34	10°	W	06:18:56	79°	SSW	06:22:17	10°	ESE
30 Oct	-1.0	03:57:00	19°	E	03:57:00	19°	E	03:58:06	10°	E
30 Oct	-3.8	05:29:58	29°	W	05:31:34	89°	SW	05:34:56	10°	E
31 Oct	-3.5	04:44:35	69°	E	04:44:35	69°	E	04:47:35	10°	E
31 Oct	-3.3	06:17:42	10°	W	06:20:58	50°	SSW	06:24:14	10°	SE
01 Nov	-0.9	03:59:14	19°	E	03:59:14	19°	E	04:00:16	10°	E
01 Nov	-3.7	05:32:12	29°	W	05:33:42	65°	SSW	05:37:03	10°	ESE
02 Nov	-3.4	04:46:54	62°	SE	04:46:54	62°	SE	04:49:48	10°	ESE
02 Nov	-2.4	06:20:04	10°	W	06:22:59	27°	SSW	06:25:52	10°	SSE
03 Nov	-0.9	04:01:40	17°	E	04:01:40	17°	E	04:02:34	10°	E
03 Nov	-2.9	05:34:39	27°	WSW	05:35:50	37°	SSW	05:38:58	10°	SE
04 Nov	-2.7	04:49:30	39°	SSE	04:49:30	39°	SSE	04:51:57	10°	SE
04 Nov	-1.5	06:23:12	10°	WSW	06:24:55	13°	SW	06:26:39	10°	S
05 Nov	-0.7	04:04:26	13°	ESE	04:04:26	13°	ESE	04:04:51	10°	ESE
05 Nov	-2.1	05:37:25	19°	SW	05:37:55	19°	SW	05:40:23	10°	S
06 Nov	-1.6	04:52:27	19°	S	04:52:27	19°	S	04:53:46	10°	SSE

END IMAGES, AND OBSERVING

On Friday night the full Harvest Moon was due to rise (9hours after technical full). Peter Chappell and I met up at Silbury Hill, but with horizon hugging cloud we missed the first appearance of the Moon, and had to move to get the rising against the silhouette of the hill. 18 images stacked in Startrails.
Andy Burns

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	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	!7:30	
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