NWASNEWS

Volume28 Issue 9

May 2023

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

MEGA CONSTELLATIONS OF SATELLITES

While out at the last society viewing session in Lacock we had many newcomers to astronomy coming along to share views of the skies through a variety of instruments. But with the odd meteor seen their surprise was how many man made satellites they were able to see. And, of course, the longer they looked the more satellites they began to see.

Many of the society members now take images as through teir telescopes, and since 2018 it has been very difficult to take deep sky images that have not been spoiled be stray satellites crossing the faint galaxy or nebula. It is bad enough being under a flight path to London and Europe with aircraft lights blinking across the sky. But the multitude of satellites can be crazy some nights.

And the number of these tumbling and controlled are also growing. And this is fr profit. Not just the Starlink series but more companies are beginning to launch more satellites for profit.

The law was made it easier for profit from space by Obama, and this further strengthened by Trump. How come American law makers are being allowed to dictate the skies for all of us?

They do have their reasons. And not very worldly. And since the Ukraine war it has been added to be strategic demands. But with this 'information' or 'spying' use come the prospect of deliberate destruction of these satellites, and all the big problems of debris in space increasing exponentially.

Last month it was noted that as Hubble Space Telescope declined in orbit the scientific instruments were beginning to be affected by the mass of satellites in conflicting orbits.

Our speaker for tonight has been monitoring the situation, Dr Paul A Daniels is also the president of the Federation of Astronomical Societies, and has an understanding of the position.

ZOOM MEETING ONLINE

Topic: Wiltshire AS Zoom Meeting May 2nd

Time: May 2, 2023 07:30 PM London

Dr Paul A Daniels The Mega-constellation threat

Join Zoom Meeting

https://us02web.zoom.us/j/89296312967?pwd=NGFZRnBjV2xsY3dhU00vZG5YMHBpZz09

Meeting ID: 892 9631 2967

Passcode: 428426

Clear Skies

Andy

Note June is a Hall meeting and an important AGM for the society.

TOTAL ECLIPSE

Everything was going okay until about 20 minutes before second contact and totality starts, one of the tripod mounts had become loose and the camera and lens would bounce around too much for pictures to be taken, so I decided to carry on with the one camera and take a video with my phone instead.

Peter Chappell

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

2 May Dr Paul A Daniels The Mega-constellation threat
6 Jun Andrew Lound Venus, Paradise Lost

AWAITING A SPEAKER SECRETARY FOR 23/24 SEASON

Dr Paul A Daniels FRAS

President of Federation of Astronomical Societies.

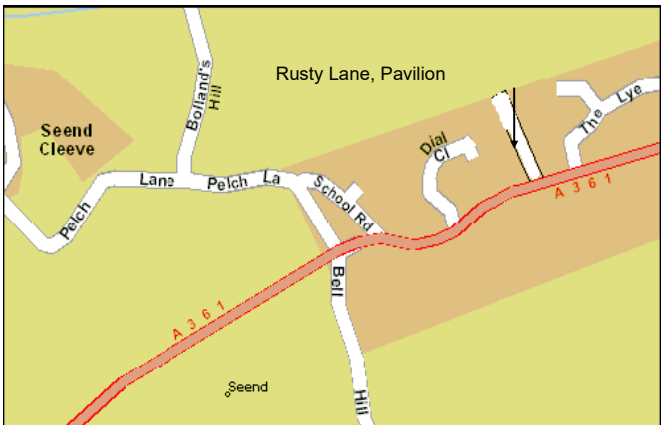
I'm now semi-retired with most of my effort devoted towards Astronomy.

Membership Meeting nights £1.00 for members £3 for visitors

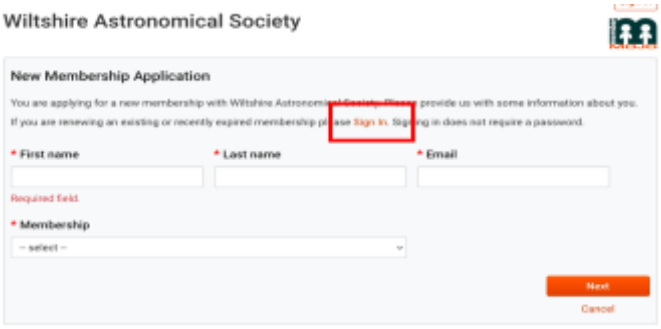
Members can renew or new members sign up online via https://wasnet.org.uk/membership/ and also remind them they can pay in cash too on the door.

Wiltshire AS Contacts

Andy Burns Chair, anglesburns@hotmail.com
Andy Burns Outreach and newsletter editor.
Sam Franklin (Treasurer)
Rebecca Rowan (Hall coordinator)
??? (Teas and Projector)
Peter Chappell (Speaker secretary) Retiring
Nick Howes (Technical Guru)
Observing Sessions coordinators: Chris Brooks, Jon Gale,
Web coordinator: Sam Franklin
Contact via the web site details.



Observing Sessions see back page



Swindon Stargazers

Swindon's own astronomy group

Physical meetings continuing!

Following the relaxation of the Covid rules we are continuing physical meetings.

Friday, 19 May – Talk by Prof Nick Evans

Our speaker this month is **Prof Nick Evans**, Head of Theoretical Physics at Southampton University.

The Southampton High Energy Physics Theory Group is one of the most diverse in the UK with expertise in collider physics, the strong and weak nuclear forces, formal field theory and quantum gravity string theory.

About half his time is spent on my research into the strong nuclear force beyond the standard model physics and quantum gravity.

He also teaches a first-year course on Electricity and Magnetism and maintains a range of outreach activities including an annual particle physics masterclass and the SETI Challenge competition for GCSE and A level students.

Nick's talk is on Dark Energy - a cosmological overview of empty space and links to particle physics.

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

Meeting Dates For 2023

Friday, 16 June 19.30 onwards

Programme: Owen Brazell – Globular Clusters

------Summer Break-----

Friday, 15 September 19.30 onwards -

Programme: First Light Optics: Product trends / changes / news and upcoming products

Friday, 20 October 19.30 onwards Programme: Prof Martin Hendry MBE - The Science of Star Wars

Friday, 17 November 19.30 onwards Programme: Dr Lillian Hobbs: Eisa Esinga - The Planetarium in the Bedroom

Friday, 8 December 19.30 onwards Programme: Christmas Social

Website:
http://www.swindonstargazers.com

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

Society Details & Speakers programme can be found on our Website www.beckingtonas.org

General enquiries about the Society can be emailed to chairman@beckingtonas.org.

Our Committee for 2016/2017 is

Chairman: Steve Hill (email chairman@beckingtonas.org)
Treasurer: John Ball
Secretary: Sandy Whitton
Ordinary Member: Mike Witt

People can find out more about us at www.beckingtonas.org

Meetings take place in Beckington Baptist Church Hall in Beckington Village near Frome.

See the location page for details of how to find us on our website……

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm No hall meetings.

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 actvities. 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 and partner with Bath Abbey to showcase the skies above the city.

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, 3rd May
When we Walked on the Moon – Ian Ridpath takes us back over 50 years in a prelude to the resumption of lunar strolls in 2025. This talk has been postponed from 26th April.

Wednesday, 31st May
Diving through exoplanet atmospheres – Dr Hannah Wakeford drops us into this fascinating new field of discovery. You will dive into the atmospheres of alien planets to discover the truly wild nature of planets in the Universe from chains of rocky worlds around ultra-cool stars to exotic clouds of molten rock in the atmosphere of ultra-hot gas giants.

Wednesday, 28th June
A History of Women in Astronomy Part 2 – Following on from Mary McIntyre's part one, this talk looks at the trailblazing women working in astronomy after Caroline Herschel, through the Victorian era and into the modern day. It covers some of the challenges women faced during this time period, particularly around education.

More information and news is available via:
https://bathastronomers.org.uk
https://www.youtube.com/@bathastronomers
On Social Media (Facebook, Twitter, Instagram)
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.

Member's observing is conducted from the Monkton Combe Community Observatory using the 1860s 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 Scope.

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

SpaceX Starlink mega-constellation: 'Limited time' to fix brightness issue

A time-lapse of the Starlink satellites taken from the Peak District

By Jonathan Amos

BBC Science Correspondent

California's SpaceX company says it will work constructively with the scientific community to fix the brightness of its satellites.

The firm has come under fire for the brilliance of its Starlink spacecraft, which are being launched to deliver broadband to every corner of the globe.

One hundred and eighty of the platforms have already been sent to orbit with thousands more to follow.

Astronomers fear they will interfere with telescope observations.

Pictures of the night sky showing long streaks as the Starlinks cross the field of view have now become a heightened complaint.

But a SpaceX executive told **the American Astronomical Society conference in Hawaii** on Wednesday that the company was seeking ways to make the platforms much less intrusive.

Patricia Cooper, the firm's vice president of satellite government affairs, told a specially convened session that delegates' science was valued and there was no desire to impede it.

Astronomers say view of night sky is under threat

SpaceX puts up 60 Starlink internet satellites

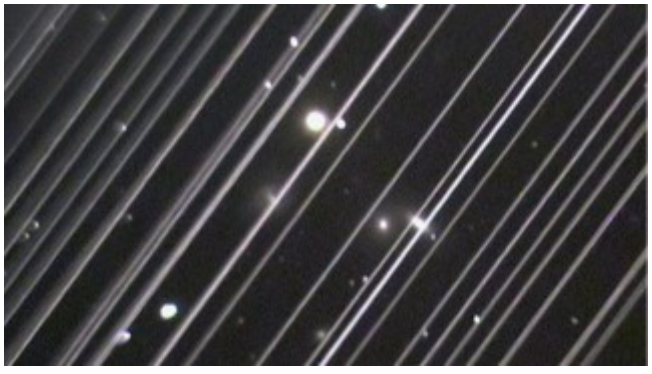
How satellites could revolutionise the internet

The company is experimenting with a new coating that will hopefully reduce the reflectivity of the Starlinks. **Of the 60 new satellites sent up on Monday**, one in the batch had this corrective paint job.

Detailed coordinates of the spacecraft are also being shared so observations of the sky can be planned to avoid the objects' passing.

"We don't know yet if these mitigations are useful and effective. We tend to work very quickly. We tend to test, learn and iterate," she was reported as saying **by the Space News reporter Jeff Foust**.

Astronomers at the meeting said it would not be before the end of February - when the "dark satellite" had reached its operational orbit - that a proper assessment could be made of the coating experiment.



On launch, the Starlinks are released in a train that produces streaks in long exposure images

The AAS has put together a committee to investigate the impact of so-called mega-constellations.

It is not just SpaceX which is rolling out a giant network of satellites. Other companies plan to do the same - some to deliver telecommunications services, others to acquire rapid and repeat imagery of the Earth's surface.

Prof Patrick Seitzer, from the University of Michigan, Ann Arbor, said everybody had been surprised at the brightness of the Starlinks - including SpaceX.

He listed the difficulties posed to astronomy by their current reflectivity. The Michigan astronomer described how they produced multiple streaks and 'ghosts' in telescope pictures, how their brightness could saturate detectors, and generate cross-talk in electronics.

SpaceX may have more than 1,500 Starlinks in orbit by the year's end, but is proposing an eventual constellation that could grow from 12,000 to more than 40,000.

"Mega-constellations in Low Earth Orbit are coming and they are coming fast," said Prof Seitzer. "The new satellites are brighter than 99% of objects in orbit. If the (initial) 1,584 Starlinks was the only constellation to be launched, with six to nine visible above you at any one time, astronomers could handle it. But there are press releases sent out for 10 or 20 times that (number of satellites). It's just the start."

The first threshold he said SpaceX had to meet was making sure the Starlinks could not be seen with the naked eye when they were in their operational orbit some 550km above the Earth. The second threshold was to eliminate the saturation effect in the detectors of large professional telescopes.

Prof Seitzer said the facility that stood to be worst affected was the forthcoming NSF Vera C Rubin Observatory (formerly called the Large Synoptic Survey Telescope). This will be making a map of the entire sky every three days. Its wide field of view and remarkable sensitivity to anything that's moving in sight of its detectors will make Vera Rubin especially vulnerable to Starlink interference.

There is a dedicated team now of telescope and SpaceX engineers looking specifically at measures to help this one observatory.

The forthcoming NSF Vera C Rubin Observatory could be badly affected

While much of the focus has been on the optical visibility of satellites, there is growing concern also about radio interference.

Dr Harvey Liszt, from the National Radio Astronomy Observatory (NRAO), Charlottesville, said his science had been fighting since the 1970s and 80s to get satellite operators to adhere to frequency regulations. "Welcome to my world," he said of the present fuss of the Starlinks' brightness.

Dr Liszt raised the issue of radar imaging satellites. Once rare, these spacecraft, which can map the Earth's surface day or night and in all weathers, are about to see their numbers shoot up as well.

"Synthetic Aperture Radar (SAR) if pointed at a radio telescope when the telescope is pointed in its direction will burn out the radio astronomy receiver," the Charlottesville research told reporters.

Artwork: The first GPS satellites were notorious for causing radio interference for astronomy

One of the radar constellation companies named by Dr Liszt as posing a potential problem is Finland's Iceye.

The firm's CEO, Rafal Modrzewski, said his team took its responsibilities seriously, and that it continued to investigate any potential risks Iceye's technology might pose to the global space community, both in orbit and on the ground.

"Most importantly in this topic, Iceye complies with international regulation regarding our allocated bands," he told BBC News.

"Mitigating any potential or perceived risks to sensors on ground can additionally be done proactively by tracking applicable SAR satellite orbits to avoid clashes with instrumentation, and in the case of Iceye, by also working with us if there are any remaining concerns."

While the AAS committee says it is encouraged by the open dialogue it is having with constellation companies, there are those within the astronomy community who feel the response from its leadership is too weak and too slow.

They worry the battle may already have been lost.

Prof Mark McCaughrean, a senior scientific adviser with the European Space Agency (Esa) and an infrared astronomer, tweeted: "It's a matter of asymmetric timescales: on (the) one hand, scientists are used to conducting thorough studies over years, while on the other, industry is simply going ahead and launching 60 new satellites every fortnight."

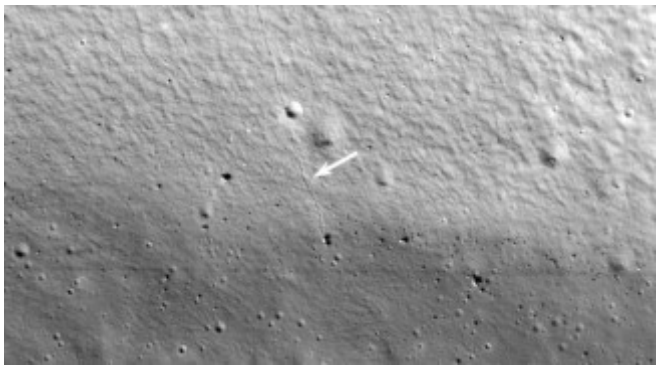
Prof Seitzer remarked: "I think all we can do at this point is move rapidly; we just can't wait for the regulatory environment (to catch up). We need to convince SpaceX that it's in their best interest to move rapidly and solve this problem quickly and set the standard for everybody else."

SPACE NEWS TO MAY 23

We Can Now See Into the Permanently Shadowed Craters on the Moon

An instrument called ShadowCam is giving NASA's planned Artemis missions to the Moon some advanced views of a landing site. It's mounted to the Danuri Korea Pathfinder Lunar orbiter sent to the Moon last year. Lately, this amazing camera has been sending back some highly detailed images of the lunar north and south pole regions.

One view peers into the deeply shadowed Shackleton crater. It shows the track of a boulder that slid down from the rim. This impact crater lies smack on top of the south rotational pole of the Moon. It dates back to an ancient impact some 3.6 billion years ago. Shackleton's 12-kilometer-deep interior is in perpetual shadow. That is, the Sun never shines inside it. However, the mountains on its rim are always in sunlight.



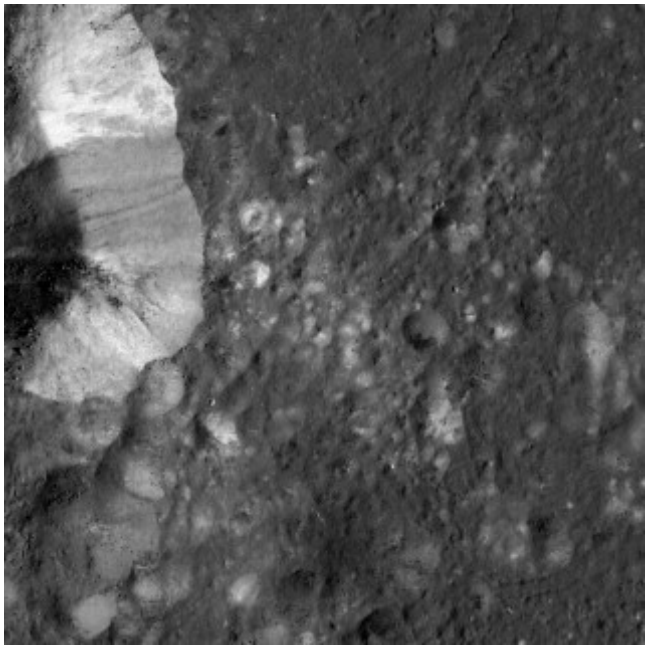
This is a portion of one of ShadowCam's first images from lunar orbit on the permanently shadowed wall and floor of Shackleton crater, which is found near the South Pole. The arrow marks the track of a boulder that rolled down the crater wall. The observation of these trails helps scientists characterize the boulder shape and velocity and regolith features, furthering our understanding of the geotechnical properties of the Moon. The trail is several hundred meters long. Courtesy: NASA/KARI/ASU

The ShadowCam is 200 times more light-sensitive than most other cameras used to study and map the Moon from orbit. Its high-resolution images will provide a great deal of information for Artemis mission planners.

ShadowCam is able to see inside Shackleton and other craters fairly well thanks to Earthshine. It also uses light reflected from nearby mountains and crater walls that do receive direct sunlight. Some of ShadowCam's images were captured during New Moon when sunlight shining off of Earth's surface reaches the Moon. These "reflected light" sources aren't bright, but ShadowCam was able to detect them.

Shackleton: One of the Intriguing Lunar Craters

NASA and other agencies landing astronauts on the Moon want to explore the Shackleton crater polar region because there's a good chance that it contains water ice deposits. Over the years, lunar orbiters have studied and mapped this region. They've investigated the radiation regime and physical properties of the rocks and craters there. There appears to be an abundance of hydrogen, oxygen, silicon, iron, magnesium, calcium, aluminum, manganese, and titanium in the area.



Aristarchus Crater as seen in Earthshine during New Moon. It's very possible that astronauts on the surface would be able to make their way around just by the light of Earthshine. Credit: NASA/KARI/ASU

Future explorers could locate resource processing facilities in the region to mine materials needed for construction and other activities. In addition, thanks to its perpetual shadowed condition, this region offers a great place for astronomical observations in the future. All of that activity lies farther down the line, after Artemis III lands its astronauts on the surface. Their first mission will be only a few days, long enough to start an in-depth study of this fascinating area of the Moon.

The Artemis mission plans cover a variety of bases, from the chances for scientific discovery, and economic benefits, but also because new generations of explorers will be returning to the Moon, more than half a century after the last ones left. The Artemis missions are part of an international cooperative effort that includes NASA, Canada, ESA, and others. Not to be outdone, the China National Space Administration also has set its sights on the Moon. They recently announced missions that could take their first explorers to the lunar surface later on in this decade.

SpaceX Starship Effectively Grounded by FAA After in-Flight Explosion

It was an exciting time when, two weeks ago, SpaceX got the clearance it needed to conduct its first orbital flight test with the *Starship* and *Super Heavy* launch system. After years of waiting, SN flight tests, static fire tests, and stacking and unstacking, the long-awaited test of the SN24 *Starship* and BN7 *Booster* prototype was on! For this flight, SpaceX hoped to achieve an altitude of at least 150 km (90 mi) above sea level, crossing the 100 km (62 mi) threshold that officially marks the boundary of "space" (aka. the Karman Line) and making a partial transit around the world before splashing down off the coast of Hawaii.
Unfortunately, things began to go awry a few minutes into the flight as the *Starship* prototype failed to separate from the booster, sending the rocket into a spin that ended in an explosion. While Musk and SpaceX issued statements that the test was largely successful and lots of valuable data was obtained, residents and environmental researchers claim the explosion caused damage to houses in the area and the local environment. In response, the FAA has launched a "mishap investigation," temporarily grounding the *Starship* until the explosion's impact can be assessed.

The timing of the flight test was certainly fortuitous, falling on April 20th (4/20) exactly as Musk had previously predicted. Everything appeared to be in the green as all 33 engines of the BN7 booster fired, and the fully-stacked and fueled prototype lifted off without incident. About three and a half minutes into the flight, when stage separation was supposed to occur, the Starship began an uncontrolled tumble and was destroyed by onboard charges. The SN24 and BN7 managed to reach an altitude of 40 km (25 miles) before the anomaly occurred.

Musk commended the ground teams, tweeting, "Congrats @SpaceX team on an exciting test launch of Starship! Learned a lot for next test launch in a few months." At the same time, it was clear that some sizeable changes needed to be made. In addition to the mid-air explosion, the launch also destroyed the launchpad, which sent debris flying in all directions. This raised the issue of a deluge system that the Boca Chica launch site does not have (unlike other launch facilities). These systems rely on a "flame trench" to channel rocket exhaust and water or foam to suppress shockwaves and flames.

Musk was sure to temper expectations before the flight, saying in a Twitter discussion on April 16th that when you have a spacecraft that's got "33 engines on the booster, got six engines on the upper stage of the ship. It's a lot of engines! It's like having a box of grenades, really big grenades." He was also sure to cite SpaceX's track record with rapid prototyping, which has always involved "testing to failure" and a lot of trial and error:

"This is really kind of the sort of first step in a very long journey that will require many, many flights. For those that have followed the history of Falcon 9, and Falcon 1 actually, and our attempts at reusability, I think it might have been close to 20 attempts before we actually recovered a stage. And then it took many more flights before we had reusability that was meaningful, where we didn't have to rebuild the whole rocket."

To residents and environmentalists, the test was not an occasion for celebration. Ever since SpaceX broke ground in Boca Chica and began testing, Musk has had a strained relationship with the locals, who have frequently complained about noise and the impact these tests have on their communities and the natural environment. According to Pablo De La Rosa, a reporter with Texas Public Radio (TPR) and NPR, there were multiple reports of "particulates" raining down on South Padre Island up the coast and on the nearby town of Port Isabel.

The IOP/SS system deploys almost a half-million gallons of water in one minute to protect the SLS during launch. Credit: NASA

Residents in the town also reported broken windows "and ash-like particles covering their homes and schools." The Sierra Club cited similar reports, with Dan Cortez (Lone Star

chapter director) stating in an interview with CNBC that the destruction of the launchpad caused collateral damage that could have been much worse. “Concrete shot out into the ocean, and risked hitting the fuel storage tanks which are these silos adjacent to the launch pad,” he said. With mid-air explosions, there are also concerns that residual propellant (which are often toxic) could rain down on the surface, causing environmental damage.

A post-launch assessment by the Federal Aviation Administration (FAA) is standard practice in cases like this. As the Administration explained in a statement regarding Recent Aviation Accidents and Incidents (issued on April 20th):

“The FAA will oversee the mishap investigation of the Starship / Super Heavy test mission. A return to flight of the Starship / Super Heavy vehicle is based on the FAA determining that any system, process, or procedure related to the mishap does not affect public safety. This is standard practice for all mishap investigations. The FAA is responsible for protecting the public during commercial space transportation launch and reentry operations.”

In other words, the FAA has effectively grounded SpaceX’s testing efforts at Boca Chica until they can determine if future flight tests will threaten public health, safety, and the local environment. This will likely result in a list of mandatory actions that SpaceX must complete to keep its license and resume testing. At this juncture, Musk is already prepared to address the issue of a deluge system, which he has admitted his crews looked at in the past but decided was unnecessary. Nevertheless, he also hinted before the launch that “melting the launch pad” was a real possibility.

In any case, Musk appeared to be admitting on April 21st that the decision to proceed without first installing a cooling system beneath the launchpad was a mistake, tweeting: “3 months ago, we started building a massive water-cooled, steel plate to go under the launch mount. Wasn’t ready in time & we wrongly thought, based on static fire data, that Fondag would make it through 1 launch. Looks like we can be ready to launch again in 1 to 2 months.”

At this juncture, a month or two seems optimistic, considering that the full impact could take weeks and corrective actions could take much longer to implement. It could turn out that the FAA will demand that a full deluge system is necessary, that additional protections are needed to prevent debris from striking fuel tanks, and that SpaceX install a launch abort system that will force the Starship and Super Heavy to separate in the event of an anomaly. This last item would ensure that at least the booster (the most explosive element) can remove itself and return safely to a landing site.

It’s even also remotely possible the FAA will revoke SpaceX’s license, and Musk will decide to relocate all testing to Cape Canaveral, where SpaceX is still working on a second launch facility. Then again, this may all be resolved shortly, and SpaceX could be testing prototypes again by mid-summer. As the company’s adage famously goes, “Launch. Recover. Repeat.” In this case, “recover” may mean repairing the damage caused by a test gone wrong and ensuring it never happens again. But the next step remains the same – Repeat!

SpaceX’s Starship Has a Glorious Liftoff — but Then Spins and Explodes

SpaceX’s Starship launch system lifted off on its first full-scale test flight today, rising majestically from its Texas launch pad but falling short of stage separation.

The uncrewed mission represented the most ambitious test yet for the world’s most powerful rocket — which eventually could send people to the moon and Mars, and even between spaceports on our own planet.

Liftoff from SpaceX’s Starbase complex at Boca Chica on the South Texas coast came at 8:33 a.m. CDT (9:33 a.m. EDT). The Starship system’s Super Heavy booster, powered by 33 methane-fueled Raptor rocket engines, rose into clear skies with a deafening roar and a blazing pillar of flame.

Hundreds of SpaceX employees cheered at the company’s California headquarters, but the crowd turned quiet three minutes into the flight when the Starship upper stage failed to separate from the booster as planned. The entire rocket spun in the air as a ground-based camera watched.

A minute later, SpaceX’s flight termination system destroyed both stages of the rocket as a safety measure. “Obviously, we wanted to make it all the way through, but to get this far, honestly, is amazing,” launch commentator Kate Tice said.

Super Heavy is capable of 16.7 million pounds of thrust at liftoff — which represents roughly twice the power of NASA’s Space Launch System or the Apollo-era Saturn V rocket.

In advance of the launch, SpaceX CEO Elon Musk said he would count this test as a success as long as the launch pad wasn’t destroyed. But he and his team were hoping for more. The flight plan called for the 226-foot-tall (69-meter) Super Heavy booster to send the 164-foot-tall (50-meter) Starship second stage on a trip that would have ranged as high as 150 miles (250 kilometers) in altitude and as far as a spot in the Pacific Ocean near Hawaii. The Starship second stage has six Raptor engines, half of which are optimized for use in the vacuum of space.

SpaceX says both stages are meant to be reusable, and the company has gone so far as to equip the Starbase launch pads in Texas and Florida with “chopsticks” to assist in catching returning rockets. Neither stage was meant to be recovered during this test, however. SpaceX planned to have Super Heavy fall into the Gulf of Mexico after stage separation, and Starship was supposed to sink into the Pacific at the mission’s end.

No commercial payload was carried this time around. Instead, the flight’s primary objective was to provide data for fine-tuning Starship’s systems going forward. “The payload for this mission is information — information that allows us to improve the design of future Starship builds,” Musk said during a pre-launch chat session on Twitter, which he owns.

The launch webcast showed that several of the Raptor engines on the Super Heavy booster were not firing during the ascent — a failure that SpaceX confirmed after the launch.

“The vehicle experienced multiple engines out during the flight test, lost altitude, and began to tumble,” the company said in a status update. “The flight termination system was commanded on both the booster and ship.”

SpaceX said the rocket reached a maximum altitude of about 24 miles (39 kilometers) above the Gulf of Mexico.

Post-launch imagery showed extensive damage to the launch pad, including cratering beneath the launch mounting structure. Witnesses also posted photos and videos that documented damage from debris flying upward and outward from the liftoff’s blast. Some residents who lived miles away from the launch site reported that specks of debris rained down on them.

Such issues are likely to be addressed in SpaceX’s post-launch assessments and remediation efforts.

SpaceX has been using short-hop flights to test Starship prototypes since 2019, and some of those tests have ended with the prototype going up in flames. But this mission posed special challenges.

This was the first flight test of a full-scale Super Heavy booster and the integrated Super Heavy / Starship system, with more than 10 million pounds of propellant on board. Before launch, Musk acknowledged the risk of catastrophic failure along the lines of the Soviet N-1 rocket explosion in 1969, which signaled

the end of the U.S.-Soviet race to the moon.

“Starship is, in some ways, more risky,” Musk said.

Because of the scale of the launch, the Federal Aviation Administration took more than 500 days to analyze the Starship program’s safety measures and potential environmental impacts. “We carefully analyzed the public safety risks during every stage of the mission and required SpaceX to mitigate those risks,” the FAA said in a statement.

A launch license valid for five years of tests was finally issued on April 14, allowing SpaceX to wrap up its preparations. Crowds gathered along the coastline at Boca Chica to witness an initial countdown on April 17, but the launch attempt was transformed into a dress rehearsal when SpaceX’s launch team couldn’t unfreeze a pressurization valve on the Super Heavy’s propulsion system in time for liftoff. The crowds returned for today’s launch.

After the launch, the FAA said there would be an investigation of the problems that arose during the test mission.

“An anomaly occurred during the ascent and prior to stage separation resulting in a loss of the vehicle. No injuries or public property damage have been reported,” the FAA said in an emailed statement. “The FAA will oversee the mishap investigation of the Starship / Super Heavy test mission. A return to flight of the Starship / Super Heavy vehicle is based on the FAA determining that any system, process or procedure related to the mishap does not affect public safety. This is standard practice for all mishap investigations.”

Several notable customers have already signed up for Starship trips, and SpaceX is facing a challenging timeline to meet their expectations.

Jared Isaacman, the billionaire founder of the Shift4 secure payment platform, is due to command the first crewed Starship mission as part of the privately funded Polaris Program.

Japanese billionaire Yusaku Maezawa is paying an undisclosed (but no doubt substantial) amount to have himself and a crew of eight flown on a trip around the moon as early as this year. Dennis Tito, the California investment tycoon who became the first paying passenger to visit the International Space Station in 2001, has signed up to take Starship’s second round-the-moon trip with his wife.

Meanwhile, NASA is counting on SpaceX to provide a modified version of Starship as the lander for a crewed mission to the lunar surface, scheduled for as early as 2025. In a statement distributed via Twitter, NASA Administrator Bill Nelson congratulated SpaceX.

“Every great achievement throughout history has demanded some level of calculated risk, because with great risk comes great reward,” Nelson wrote. “Looking forward to all that SpaceX learns, to the next flight test — and beyond.”

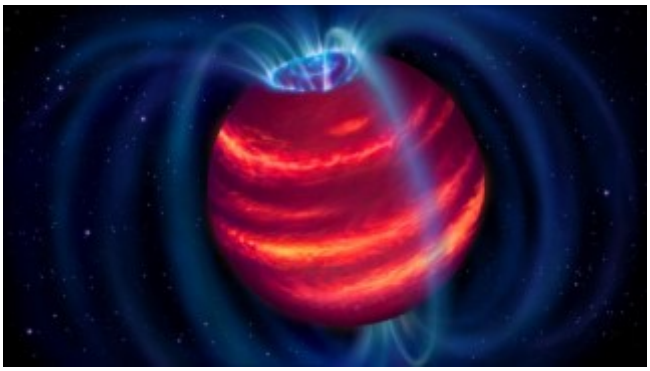
Starship figures prominently in SpaceX’s plans to deploy future generations of its Starlink broadband internet satellites. Musk also has talked about employing Starship to send passengers between any two points on Earth in less than an hour, to carry a million people to Mars, and to help transform humanity into a multiplanetary species.

The Next Generation of Telescopes Will Tell Us About the Weather on Other Worlds

The field of astronomy is about to be revolutionized, thanks to the introduction of Extremely Large Telescopes that rely on primary mirrors measuring 30 meters (or more) in diameter, adaptive optics (AO), coronographs, and advanced spectrometers. This will include the eponymously-named Extremely Large Telescope (ELT), the Giant Magellan Telescope (GMT), and the Thirty Meter Telescope (TMT). These telescopes will enable astronomers to study exoplanets using the Direct Imaging (DI) method, which will yield valuable data on the composition of their atmospheres.

According to a new study by a team of researchers from Ohio State University (OSU), these telescopes will also allow astronomers to study “ultracool objects,” like very low-mass stars (VLMs), brown dwarfs, and exoplanets. In addition to being able to visualize magnetic starspots and determine the chemical compositions of these objects, ELTs will be able to reveal details about atmospheric dynamics and cloud systems. These types of studies could reveal a wealth of information about some of the least-studied objects in our Universe and significantly aid in the search for life beyond our Solar System.

The study was performed by Michael K. Plummer and Ji Wang, a Ph.D. student and professor of astronomy at OSU (respectively), as part of Plummer’s doctoral thesis. Plummer is also an officer and pilot who previously studied at the United States Air Force Academy, while Wang specializes in the creation of sensitive instruments that allow for more-detailed exoplanet studies. The paper that describes their findings, titled “Mapping the Skies of Ultracool Worlds: Detecting Storms and Spots with Extremely Large Telescopes,” was recently accepted for publication in *The Astrophysics Journal.*



Artist’s view of a cool brown dwarf and its magnetic field. Credit: ASTRON/Danielle Futselaar

The study of ultracool objects is a burgeoning field in astronomy, something that has been very difficult using optical telescopes. Thanks to advances in infrared and radio astronomy, astronomers have learned much about these objects in recent years, allowing them to better understand the range and nature of objects in our Universe. As Plummer told Universe Today via email:

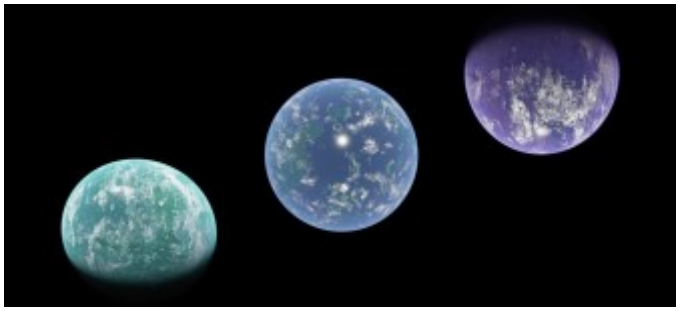
“Ultracool dwarfs, including the lowest-mass stars and brown dwarfs, have effective temperatures that allow condensates to form in their atmospheres. These condensates can include metal and silicate clouds. It is thought that at the spectral L/T transition around 1300 K, the clouds begin to rain out, creating patchy atmospheric features. For rapid rotators, this may lead to high variability in the spectral and photometric signals we observe for these objects.”

Looking at the capabilities of next-generation telescopes, Plummer and Wang considered how their highly-sensitive spectrometers, infrared imaging capabilities, and improved signal-to-noise ratio would allow for more detailed studies of VLMs, brown dwarfs, and exoplanets. These include Transit Spectroscopy (a variation on Transit Photometry), where planets periodically transit in front of their stars (relative to the observer), causing light to pass through their atmosphere. There’s also Direct Spectroscopy, a variation on the Direct Imaging method.

In this case, astronomers rely on coronagraphs to block out the light of a star, making light reflected by exoplanet atmospheres and surfaces visible to their instruments. In both cases, Plummer and his colleagues considered what types of atmospheric features these observatories and their advanced instruments would be able to visualize. As Plummer

added:

"It has also been proposed that banded features (like we see on Jupiter) may be responsible for the observed variability. Doppler imaging can map large scale weather features on these ultracool targets, shedding light on the thermal, chemical, and dynamical structure of substellar objects. This can help us to understand if these objects' atmospheres are predominantly banded, patchy, or a combination of both regimes."



An arrangement of 3 exoplanets to explore how the atmospheres can look different based on the chemistry present and incoming flux. Credit: Jack H. Madden

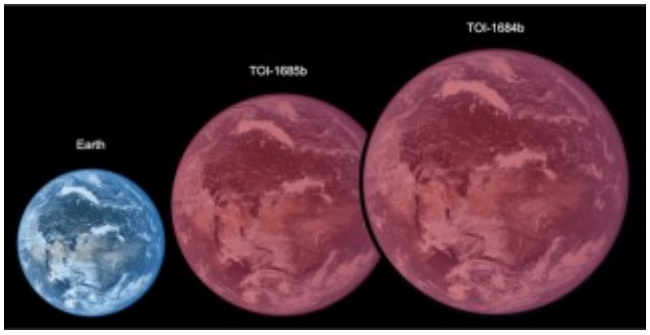
For their study, Plummer and Wang addressed the spectrographs 30-meter-class telescopes will use to conduct stellar and exoplanet studies. This includes the GMT's Consortium Large Earth Finder (G-CLEF), a visible light echelle spectrograph with adaptive optics that will conduct Radial Velocity (RV) measurements that are accurate to at least 50 cm/s. These capabilities will allow astronomers with the GMT to characterize the most metal-poor stars, measure the masses of exoplanets (as small as Mars-sized) around M-type (red dwarf) stars, and detect oxygen gas in exoplanet atmosphere's using transmission spectra.

Second, there's the TMT's Multi-Objective Diffraction-limited High-Resolution Infrared Spectrograph (MODHIS), a diffraction-limited high-resolution infrared facility. As part of the Narrow Field Infrared Adaptive Optics System (NFIRAOS), MODHIS will conduct precision RV measurements (30 cm/s or more) and obtain spectra from exoplanet atmospheres using the Tranist Method and Direct Imaging (thanks to the TMT's coronagraph instrument). It will further measure exoplanet rotations, radial velocities, cloud dynamics, and weather.

Third, there's the ELT's Mid-Infrared ELT Imager and Spectrograph (METIS), which covers the entire infrared wavelength range and will be used to study everything from Solar System bodies to stars, protoplanetary disks, exoplanets, and distant galaxies. Based on their assessment of these instruments and their capabilities, Plummer and Wang illustrated the kind of research they would enable (and its immense implications). As Plummer explained:

"Upcoming ELTs and their planned spectroscopic instruments will provide the requisite signal-to-noise ratio and spectral resolution to create Doppler imaging maps for faint brown dwarfs and, likely, the brightest exoplanets, which also are at large orbital distances from their host stars. Doppler imaging extrasolar giant planets will help us to understand how gas giant atmospheres differ from those observed within our own solar system.

"Brown dwarfs also serve as excellent analogs for extrasolar gas giant planets due to their similar temperature, size, and spectral classes. Young, low surface gravity brown dwarfs are particularly interesting in this regard as they appear to have similarly red spectra (likely from optically thick clouds) as many of the gas giants we have directly imaged (e.g. the HR 8799 planets)."



Artist's conceptual image showing the sizes of the planets observed in this study. The radius of TOI-1634 is 1.5 times larger than Earth's radius, and TOI-1685 is 1.8 times larger. Credit: Astrobiology Center/NINS

Some incredible breakthroughs are expected in the coming years, thanks to next-generation telescopes and instruments revealing more and more about the Universe. Astronomers today also benefit from increased participation from the general public and collaboration between observatories and citizen scientists – who help sort through the heaps of scientific data. Machine learning and more advanced algorithms are also being used more frequently, greatly increasing the rate at which new objects and exoplanets are discovered.

In addition to the volumes of information this will provide, there is also the way that more sophisticated tools and methods are causing the transition from discovery to characterization. Not only is there likely to be an exponential increase in the number of confirmed exoplanets and other bodies, but there's also the fact that scientists will be able to get a much closer look at them. With the ability to determine chemical compositions and even see weather patterns, scientists can determine if distant exoplanets are "habitable."

Who knows? With any luck, the data could reveal the first evidence of life beyond Earth and maybe even an advanced civilization or two!

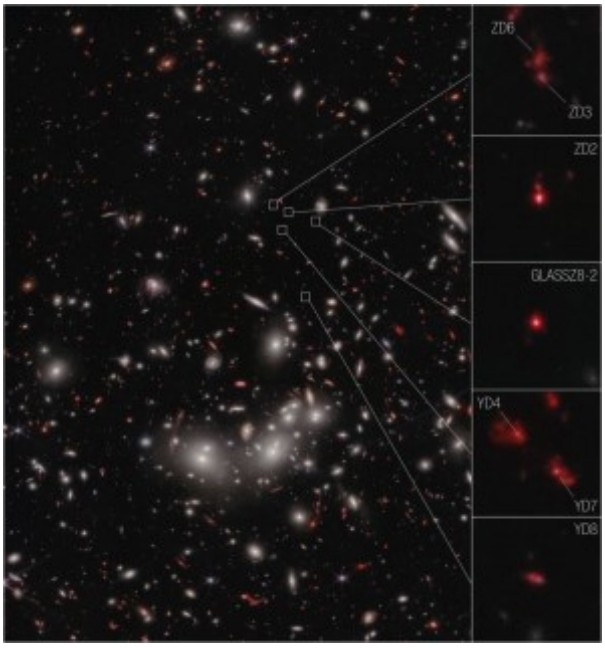
JWST Sees a Galaxy Cluster Coming Together in the Early Universe

One of the James Webb Space Telescope's science goals is to help cosmologists understand how the first galaxies and galaxy clusters formed in the early Universe. New images from the telescope show just that. Astronomers say the seven galaxies shown in this new JWST images are the earliest yet to be spectroscopically confirmed as part of a developing galaxy cluster. These galaxies are about 13 billion light-years away, meaning JWST is seeing them at about 95% of the age of the observable Universe.

Because these seven galaxies have been shown to be gravitationally bound together, astronomers say they are destined to form a much larger galaxy cluster in the future. The seven galaxies were seen just 650 million years after the Big Bang and were first identified by Hubble as promising candidates for further study by JWST.

Astronomers use redshift to measure approximate distances to very distant galaxies. The more distant an object, the more it will be redshifted. As the universe expands, wavelengths of light are stretched and "shifted" to redder wavelengths, which are longer. Very distant objects may emit energy in the ultraviolet or even higher energy wavelengths, while shorter wavelengths like ultraviolet and X-ray, are toward the bluer end of the electromagnetic spectrum.

So, extreme distances in the early universe are referenced by how much the light emitted from an object has been shifted as it travelled through space. These galaxies were measured to have a redshift 7.9, which correlates to 650 million years after the Universe began.



The seven galaxies highlighted in this image from the James Webb Space Telescope are helping astronomers precisely measure the distances of these galaxies, helping them determine these galaxies are part of a developing cluster. Credit: ESA/NASA/ STScI.

So far, one of the earliest galaxies JWST has seen, one named JADES-GS-z13-0, is estimated to be imaged at 325 million years after the Big Bang.

JWST's Near-Infrared Spectrograph (NIRSpec) instrument allowed astronomers to precisely measure the distances of these galaxies and therefore determine their ages, as well as helping them determine that the galaxies are part of a developing cluster.

One galaxy, named YD4, was previously estimated to be at a further distance based on imaging data alone and was not thought to be part of this group of galaxies. But now JWST data more accurately placed this galaxy at the same redshift as the other galaxies. ESA says that before JWST, astronomers did not have high resolution imaging or spectral infrared data available to do this type of science.

As JWST's predecessor has done many times already, the Hubble Space Telescope established these galaxies as candidates for observations by JWST for further study. HST's Frontier Fields program was used to makes observations using gravitational lensing, to observe very distant galaxies in detail. However, because Hubble cannot detect light beyond near-infrared, there is only so much detail it can see. JWST then came online, allowing scientists to see further and deeper, gathering detailed spectroscopic data in addition to imagery.

Here's How NASA is Planning to Protect Earth From Asteroids and Comets

The large impact craters dotting our planet are powerful reminders that asteroids and comets strike the Earth from time to time. As often said, it's not a question of "if"; it's a matter of "when" our planet will face an impending strike from space. But an impact is one existential threat humanity is finally starting to take seriously and wrap its head around.

Seemingly spurred by the success of the Double Asteroid Redirection Test (DART), NASA just released a new planetary defense strategy and action plan, describing its efforts to find and identify potentially hazardous objects to provide an advanced warning, and then even push them off an impact trajectory.

This 10-year strategy looks to advance efforts to protect the Earth from a devastating encounter with a Near Earth asteroid or comet.

"An asteroid impact with Earth has potential for catastrophic devastation, and it is also the only natural disaster humanity now has sufficient technology to completely prevent," said Lindley Johnson, NASA's planetary defense officer, in a NASA press release. "The release of this NASA strategy steps up NASA's intentions for the next 10 years to ensure the agency works both nationally and internationally to protect our planet for the benefit of all."

The 46-page "NASA Planetary Defense Strategy and Action Plan" (pdf document) was released on April 18, 2023 and follows another document that was put out on April 3 by the White House Office of Science and Technology Policy, "National Preparedness Strategy and Action Plan for Near-Earth Object Hazards and Planetary Defense" (pdf document.)

Each of the reports focuses on enhancing the detection, characterization and responses to impact threats as well as improving international cooperation for coordinating strategies among government agencies.

NASA wants to focus on six key areas for planetary defense over the next decade:

Improving NEO survey, detection, and characterization efforts to work toward a completed catalogue of all NEOs that might pose an impact hazard to Earth

Developing and demonstrating NEO mitigation technologies similar to the agency's Double Asteroid Redirection Test (DART) mission, the world's first planetary defense test mission, which successfully demonstrated one method of asteroid deflection using a kinetic impactor spacecraft

Fostering international collaboration related to NEO surveying and mitigation to leverage international capabilities

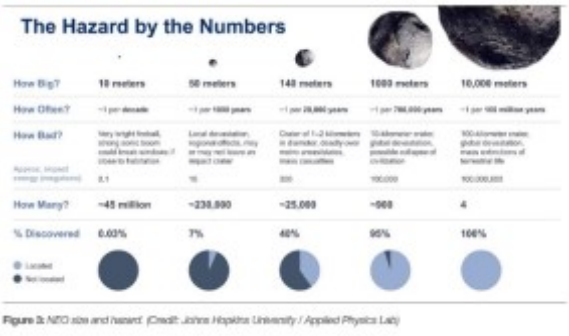
Strengthening interagency coordination between NASA and other U.S. government agencies to enhance and streamline U.S. government NEO preparedness and response planning

Review the agency's internal planning to maximize the benefits obtained from limited resources

Better integrate messaging regarding planetary defense work with the agency's strategic communications

Each of the strategy objectives are defined into short-term, medium-term, long-term, and ongoing timelines with the goal of meeting all objectives within the next 10 years.

The Near Earth Objects (NEOs) that NASA feels are of most concen range in diameter from 10 m (33 ft.) to more than 10,000 meters (33,000 ft), and that come within 42 million km (30 million miles of the Earth's orbital path.



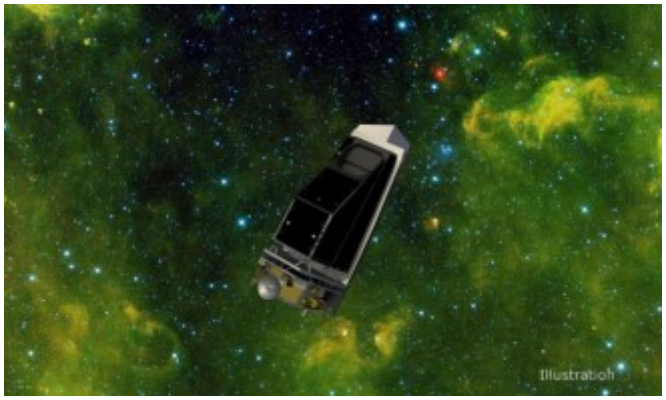
NEO size and hazard. (Credit: Johns Hopkins University / Applied Physics Lab)

For decades, scientists and other proponents have been championing the need for humanity to prepare for an what will certainly happen at some point. Apollo astronaut Rusty Schweickart, who helped found the planetary defense nonprofit advocate B612 Foundation has talked with Universe Today numerous times about planetary defense. Even back

in 2010, he emphasized that the technology needed to divert an asteroid already existed.

“That is, we do not have to go into a big technology development program in order to deflect most asteroids that would pose a threat of impact,” he said. He also added that coordination and cooperation between countries around the world was essential, and would perhaps be even more difficult to organize than the technology.

“Bureaucracy is the most likely reason we will be hit with an asteroid in the future, not the technology,” said Schweickart. “That is an audacious statement to make, but if we can get past that and do our jobs right we should never be hit in the future by an asteroid that could threaten life on Earth. And it’s going to be a heck of a challenge.”



This illustration shows NASA’s NEO Surveyor against an infrared observation of a starfield made by the agency’s WISE mission. NEO Surveyor is the first purpose-built space telescope that will advance NASA’s planetary defense efforts by finding and tracking hazardous near-Earth objects. Credit: NASA/JPL-Caltech/University of Arizona

Of course, finding the NEOs that are potentially on course for our planet is key. One such mission is now officially on track. The Near Earth Object (NEO) Surveyor mission is a space telescope to detect near Earth asteroids as part of NASA’s planetary defense efforts. The fiscal year 2023 omnibus spending bill enacted in December directed NASA to spend no less than $90 million on this mission and it is tentatively set to launch no earlier than 2028.

The DART mission was a key milestone for addressing the need for testing ways to deflect an asteroid. On Sept. 26, 2022 DART slammed into Dimorphos, a 530-ft. asteroid moonlet almost 7 million mi. from Earth and successfully demonstrated a kinetic-impact strategy for diverting an NEO on a course to strike the Earth. Dimorphos does not pose an actual threat, but was chosen for the test because it and its larger parent asteroid, Didymos, could be observed from Earth before and after the encounter to measure the effectiveness of a kinetic impact.

NASA says that the release of this plan of action is an important step forward in ensuring the momentum of DART and the upcoming NEO Surveyor mission continues to move forward for safeguarding Earth from potentially hazardous NEOs for generations to come.

Solar Orbiter Continues to Get Closer to the Sun, Revealing More and More With Each Pass

On April 10th, ESA’s Solar Orbiter made its closest flyby of the Sun, coming to within just 29% of the distance from the Earth to the Sun. From this vantage point, the spacecraft is performing close-up studies of our Sun and inner heliosphere. This is basically uncharted territory, as we’ve never had a spacecraft this close to the Sun.

One of the goals of the mission is to figure out why the Sun’s corona — its outer atmosphere — is so hot. The corona can reach temperatures of 2 million degrees C, vastly hotter than its 5,500 C surface. A new paper based on Solar Orbiter data, may offer some clues.

Last year, the spacecraft returned data showing that a known phenomenon called magnetic reconnection is taking place on the Sun’s surface. But in this case, it is taking place on extremely small scales, which previously were not able to be seen.

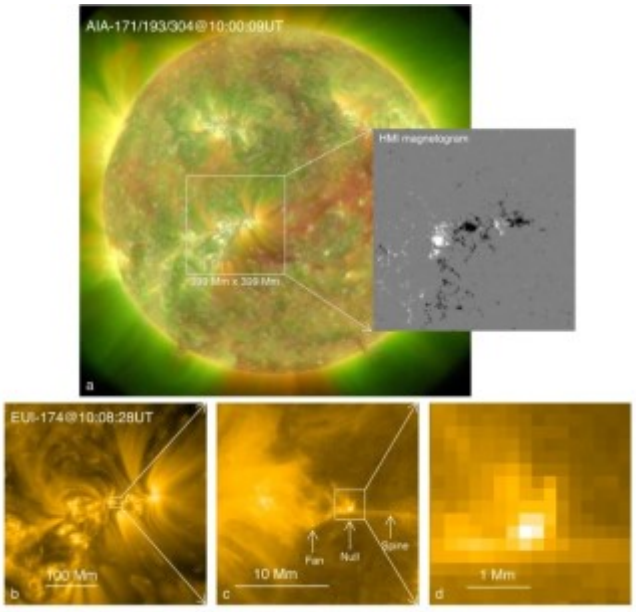
In the team’s paper, published in the journal Nature, they explain that magnetic reconnection occurs when a magnetic field changes itself into a more stable configuration. It is a fundamental energy release mechanism in superheated gasses known as plasmas. These reconnections have been seen previously occurring over large areas of the Sun’s surface and are known to be a key mechanism involved in causing solar flares and eruptions.

The new research, which combined data from Solar Orbiter along with NASA’s Solar Dynamics Observatory (SDO) and the Interface Region Imaging Spectrograph (IRIS) missions, shows that the magnetic reconnection occurring at smaller scales is a prime candidate for the mysterious heating of the Sun’s corona.

“Taking advantage of extreme-ultraviolet (EUV) imaging data from the High-resolution Coronal Imager (Hi-C), which ideally is able to resolve scales on the order of 150?km, provided evidence for reconnection between braided magnetic threads and corresponding heating,” the team wrote in their paper. They said the observations, which took place on March 2, 2022 took place over the period of one hour.

In an ESA press release, the team said Solar Orbiter’s ultra-high-resolution observations shows persistent small-scale (around 390 km across) reconnections take place in the corona. These are revealed to be a long-lived ‘gentle’ sequence compared to sudden explosive releases of energy that reconnection is usually associated with for events like coronal mass ejections.

The researchers said the temperatures around the point of the magnetic field where the magnetic field intensity drops to zero, known as the null-point, sustained itself at around 10 million °C, and generated an outflow of material that came in the form of discrete ‘blobs’ travelling away from the null point with a speed of around 80 km/s.



Views from various spacecraft showing the observations of the solar magnetic reconnection event. The top shows the Solar Dynamics Observatory's Atmospheric Imaging Assembly (AIA) full image of the Sun, overlaid with the grey-scale image from SDO's Helioseismic and Magnetic Imager (HMI) for the area observed by Solar Observatory's Extreme Ultraviolet Imager (EUI.) B displays the fine structure of the observed event, NOAA 12957. C is a zoom-in) showing a fan-like bright structure. D is a zoom-in of the point-like brightening (white box in c) indicating the spatial scale of heated plasma associated with the null reconnection. Credit: X. Cheng et al.

In addition to this continuous outflow, an explosive episode also took place around this null point, and lasted for four minutes.

The team said that Solar Orbiter's results suggest that magnetic reconnection, at scales that were previously too small to be resolved, proceeds continually in both gentle and explosive ways. This is importantly because it means that reconnection can therefore persistently transfer mass and energy to the overlying corona, contributing to heating it.

As the Solar Orbiter mission continues, the researchers said they now hope perform observations at even higher spatio-temporal resolution in future close approaches by the spacecraft to estimate what fraction of the corona's heat may be transferred in this way.

The spacecraft is in a 180 day-long orbit around the Sun, where it reaches closest approach to the Sun every six months, at around 42 million km (26 million miles) from the Sun.

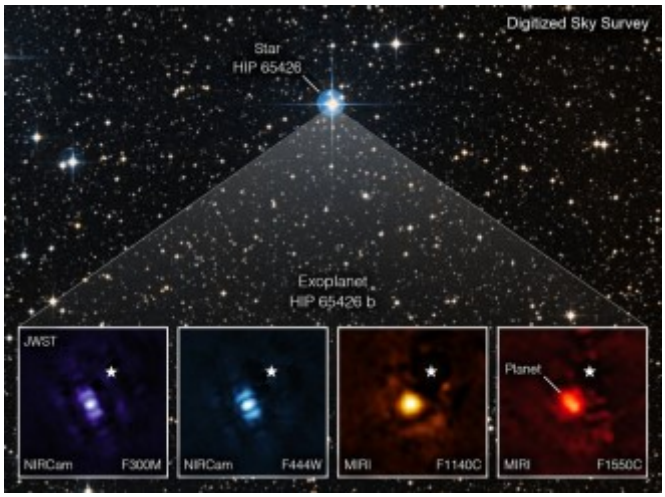
Astronomers Find a Planet Using Gaia Data

The ESA's Gaia mission is our most accurate star-measuring spacecraft. It's busy mapping the positions and radial velocities of one billion stars in the Milky Way. The mission's goal is to create a representative map of the galaxy's stellar population with unprecedented accuracy. The mission has released 3 sets of data since its inception, leading to many discoveries.

Now a team of astronomers has found an exoplanet with help from Gaia, an unintended result of the ambitious mission.

Most exoplanets are found using the transit method, where an exoplanet passes in front of its star and causes a dip in the light. But that method has its limitations, as every method does. The transit method is an indirect observation of an exoplanet. All observers see is the dip in starlight, not the planet itself, and while the dip provides important information, that information is limited.

Direct observations provide more information but are much more difficult. We're only now getting telescopes powerful enough to observe exoplanets directly. The powerful James Webb Space Telescope directly imaged the exoplanet HIP 65426 b in 2022. Thanks to the JWST and the powerful ground-based telescopes that are nearing completion, astronomers are getting to a point where they can use both direct and indirect observations of exoplanets to learn more about them, at least in some instances.



This image shows the exoplanet HIP 65426 b in different bands of infrared light, as seen from the James Webb Space Telescope. This was the first exoplanet imaged by JWST. Credit: NASA/ESA/CSA, A Carter (UCSC), the ERS 1386 team, and A. Pagan (STScI).

In this new research, Gaia data played a central role, helped by data from the ESA's now-defunct Hipparcos mission, Gaia's predecessor. That data told astronomers where to point the Subaru Telescope on Mauna Kea, which provided direct observations and confirmation of the distant exoplanet.

Illustrations of the Gaia spacecraft (l), the Hipparcos spacecraft (m), and a photo of the Subaru Telescope (r). All three facilities contributed to the exoplanet discovery. Image Credits: ESA, ESA, NAOJ.

The team of astronomers that found the planet presented their results in a research article in the journal Science. The article is "Direct imaging and astrometric detection of a gas giant planet orbiting an accelerating star." The lead author is Thayne Currie from the National Astronomical Observatory of Japan and the NASA Ames Research Center.

"This is sort of a test run for the kind of strategy we need to be able to image an Earth."

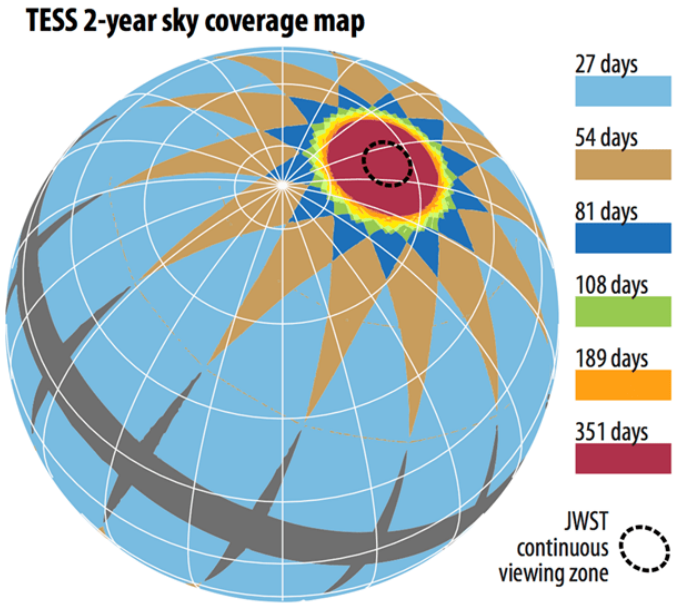
Thayne Currie, NASA, NAOJ

Astronomers have only been able to observe about 20 exoplanets directly, and that's out of over 5000 confirmed exoplanets. And the 20 all have two things in common: they orbit at a great distance from their stars, and they're much more massive than Jupiter. With our current level of technology, those are the only exoplanets we can really see directly.

Scientists would like to find and study more of these planets because they're rare. There's nothing like them in our Solar System. But they need to know where to look, and that's where this new method comes in. The Gaia and Hipparcos data revealed the tell-tale wobble of a star as a massive planet tugged on it gravitationally. This brings us to an important distinction between indirect and direct observations of exoplanets.

Indirect observations like the well-known transit method cast a wide net. They survey a large number of stars in one segment of the sky simultaneously, looking for repeated dips in light from stars as planets transit in front of them. This only works

when our viewpoint is right. We have to be looking at the system through the orbital plane of the planets; otherwise, the planet doesn't pass in front of its star from our viewpoint, and there's no detectable dip in starlight. Other indirect methods target a specific type of star, low-mass red dwarfs, for instance, and hope to detect some transits.



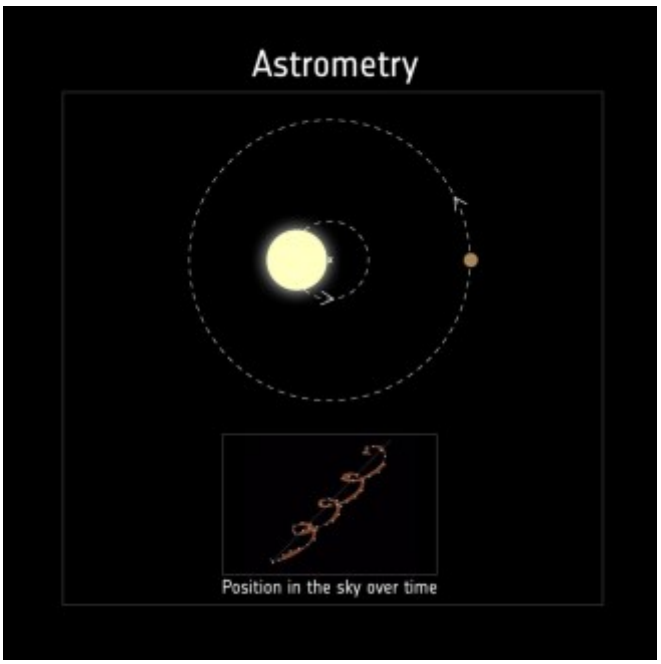
This image shows how NASA's Transiting Exoplanet Survey Satellite (TESS) surveys large swathes of the sky at once, hoping to detect transits. It's effective at finding exoplanets, but not the specific types the researchers are interested in. Image Credit: NASA

But to find the rarer planets that are more massive than Jupiter and orbit their stars at a great distance—so great that it could take hundreds of years for a transit to occur—astronomers need a more targeted way to find them. Casting a wide net isn't effective, and that's where Currie and his co-authors sought a different solution.

"We wanted a different strategy," said lead author Thayne Currie.

Their effort to develop a different strategy led them to the Hipparcos-Gaia Catalogue of Accelerations (HGCA). The HGCA is a cross-collaboration of Gaia and Hipparcos data that highlights astrometrically accelerating stars. The catalogue's measure of proper motions "… provide a powerful tool to measure the masses and orbits of faint, massive companions to nearby stars," according to the catalogue's introduction.

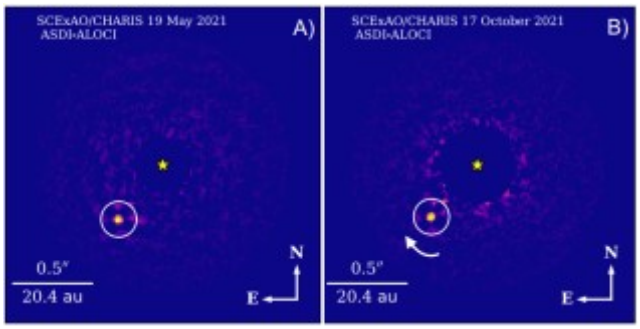
Even though the planet type in question orbits its star at a great distance, its mass is large enough to tug on the star, creating a wobble. Measuring the wobble a planet induces in its star is part of astrometry.



Astrometry detects a star's motion through the sky by taking precise measurements of its position over time. It can also measure the tiny, almost imperceptible wobble caused by orbiting exoplanets, even when we can't directly detect the planet. As exemplified by this new research, Gaia is creating a massive astrometric catalogue of stars, including their exoplanet-induced wobbles. Image Credit: ESA, CC BY-SA 3.0 IGO

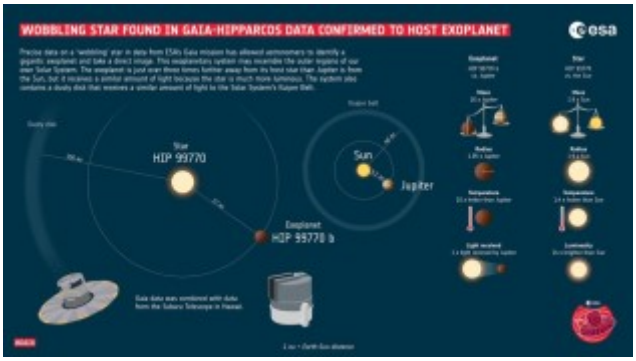
Of course, those planets weren't sitting there in the data plain for anyone to see. Currie and his colleagues still had to find them. After working with the HGCA, they found what they were looking for. The team identified a number of candidates that could be massive planets tugging on their stars from a distance.

Next, they turned to the NAOJ's Subaru Telescope. The telescope has a large, 8-meter mirror. But perhaps more importantly, it has two powerful instruments: the Subaru Coronagraphic Extreme Adaptive Optics (SCExAO) instrument and the Coronagraphic High-Resolution Imager and Spectrograph (CHARIS) instrument. The team used the telescope and instruments in July and September 2020 and May and October 2021. With those observations, the team found what they were looking for; a giant exoplanet on a wide orbit.



These images from the research letter are the two best direct images of HIP 99770 b. HIP 99770 b is shown by the white circle, and the white arrow in the right-hand image shows the direction of the planet's orbit. Image Credit: Currie et al. 2023.

The new planet is called HIP 99770 b, with HIP referring to the catalogue of data from Hipparchos. HIP 99770 b is about 14 – 16 times more massive than Jupiter and orbits a star about twice as massive as the Sun. Its orbit is three times larger than Jupiter's orbit around the Sun.



This graphic from the ESA helps explain the new research. Not only did the researchers find the giant exoplanet, but they also identified a dusty disk in the distant solar system. Image Credit: ESA.

The researchers are excited about finding the first exoplanet with their method and hopeful that this is just the beginning.

“It provides a new path forward to discovering more exoplanets and characterizing them in a far more holistic way than we could do before,” says Currie.

Combining direct measurements and indirect measurements is a holistic approach to exoplanet science that will only grow in the future. The combination is effective and makes sense. Each type of measurement contributes something different to our understanding of an exoplanet.

Direct measurements are effective at constraining a planet’s temperature and composition, and indirect measurements are effective at measuring a planet’s mass and orbit. When astronomers combine direct measurements of a planet’s position with indirect measurements of its mass and orbit, a more complete picture of the planet emerges.

For the exoplanet HIP 99770 b, this is just the beginning. Now that astronomers know it’s there, there will be follow-up observations to deepen our understanding of it. “The discovery of this planet will spawn dozens of follow-on studies,” says Currie.

This method has proven successful once, and it’ll no doubt be refined and employed to find other giant planets. The team identified a number of candidate stars in the Hipparchos-Gaia catalogue that could host giant planets on wide orbits, and the star HIP 99770 was one of the first ones they looked at. That bodes well for the rest of the candidates they extracted from the catalogue.

“HIP 99770 b is a proof of concept of this new strategy for finding imageable planets that will get far better in the next five years,” Currie says.

Gaia’s next data release will be its fourth. It’ll be its most complete data set because it has a longer baseline, nearly 5.5 years. All that data will make it even easier to spot other giant planets on wide orbits.

Giant planets on wide orbits are interesting anomalies that can eventually tell astronomers a lot about solar system evolution and architecture. But the ultimate goal behind exoplanet research is to find another planet similar to ours. The holistic approach the team developed can eventually be used in the search for a so-called Earth 2.0. An Earth-like planet will be much closer to its star, which means it’ll spend a lot of time behind or in front of the star. That makes it very difficult to image directly, though transits could be detected if the planet orbits on the right plane from our vantage point. But this combined approach holds a lot of promise.

“This is sort of a test run for the kind of strategy we need to be able to image an Earth. It demonstrates that an indirect method sensitive to a planet’s gravitational pull can tell you where to look and exactly when to look for direct imaging. So I think that’s really exciting,” says Thayne.

ESA's Juice is On Its Way to Visit Jupiter's Moons

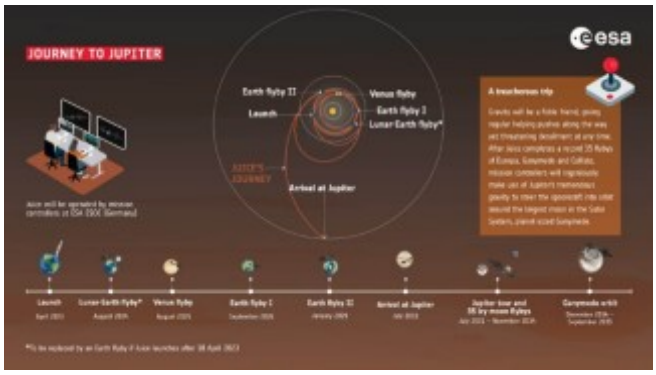
A new era of exploration at Jupiter’s moons began last week with the launch of the European Space Agency’s Juice, the Jupiter Icy Moons Explorer. This mission will visit three of Jupiter’s largest moons — Europa, Callisto and Ganymede — to investigate whether they could be potentially habitable, a question that’s been highly debated since the first evidence of subsurface oceans on these moons was seen by the Galileo mission in the 1990s.

The spacecraft launched onboard an Ariane 5 rocket from the European Spaceport in French Guiana on April 14th, 2023. After about 2 hours into the flight, ESA operations confirmed that it unfurled its gigantic 27-meter-(88 ft.) long solar arrays, meaning the launch was successful. Now comes the long flight to Jupiter. Juice will arrive at the planet in 2031, where after the flybys of Europa, and Callisto, the spacecraft will eventually settle into a final orbit around Ganymede.

“ESA, with its international partners, is on its way to Jupiter,” says ESA Director General Josef Aschbacher, in a press release. “Juice’s spectacular launch carries with it the vision and ambition of those who conceived the mission decades ago, the skill and passion of everyone who has built this incredible machine, the drive of our flight operations team, and the curiosity of the global science community. Together, we will keep pushing the boundaries of science and exploration in order to answer humankind’s biggest questions.”

The volume of subsurface water held by Europa, Ganymede and Callisto is far greater than in Earth’s oceans. Juice’s suite of science instruments will provide unprecedented, close-up details to help uncover the mysteries of these enticing moons.

The timing for Juice’s launch was very precise. The launch window was about one second so that the orbital mechanics could allow for the spacecraft’s complex trajectory. The eight-year cruise includes four gravity-assist flybys of Earth and Venus, which will slingshot the spacecraft towards the outer Solar System. The first flyby of Earth comes in August 2024 and will be the first time a spacecraft will perform a maneuver called a Lunar-Earth gravity assist (LEGA), which involves flying first past the Moon and then past Earth just a day and a half later.



Juice’s journey to Jupiter. Credit: ESA

Everything about Juice is big. At 4,800 kilograms (10,600 pounds), Juice is one of the heaviest spacecraft ever launched. The complex trajectories also means Juice needed to carry extra fuel, almost 3,000 kilograms (roughly 6,600 pounds) of propellant in total. Over the next two-and-half weeks Juice will deploy its various antennas and instrument booms, including the 16 meter (55 ft)- long radar antenna,

10.6 meter (35 ft)- long magnetometer boom.

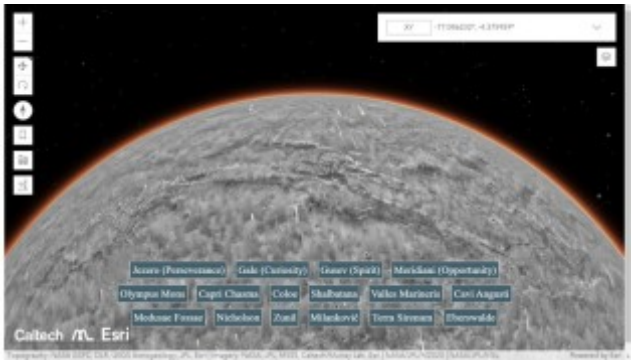
Ten state-of-the-art instruments will study the environment of Jupiter and the subsurface of the icy moons. The instruments include radar that can penetrate the surfaces of the icy moons as deep as nine kilometers (six miles), showing us their internal structures for the first time. A visible-and-infrared spectrometer will be able to detect what the surfaces of the icy moons are made of. Two radio instruments will allow scientists to infer the gravity fields of the moons, providing insights into their interiors. And a magnetometer will in particular be focused on Ganymede, as it is the only moon in our Solar System with its own magnetic field.

And if you're wondering if the name of the spacecraft is Juice or JUICE, ESA decided to simplify the original complicated acronym for JUpiter ICy moons Explorer to just Juice, the Jupiter Icy Moons Explorer.

Navigate a Global Image of Mars (If Your Computer Can Handle It)

Using data from the Mars Reconnaissance Orbiter (MRO), planetary scientists have created one of the most unique and detailed maps of Mars ever. But fair warning, the biggest version of this is a could overload your computer.

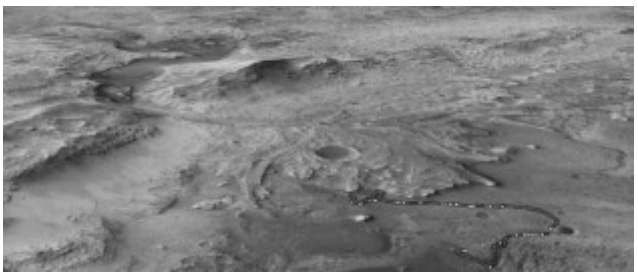
Global CTX Mosaic of Mars is the highest-resolution global image of the Red Planet ever created and it even allows you see Mars in 3D.



A screenshot of the entry page for the new interactive Global CTX Mosaic of Mars.

The map is made of 110,000 images from MRO's Context Camera (CTX). Stitched together, the map covers almost 270 square feet (25 square meters) of surface *per pixel,* meaning they have developed a mosaic with 5.7 trillion pixels. If you printed it out, it would cover 25 square meters – which is about the size of the Rose Bowl Stadium in Pasadena, California, just down the street from the Jet Propulsion Laboratory and Caltech, where the new map was generated.

The interactive version lets you zoom in and out from the surface of Mars, revealing ancient river channels, volcanic shield mountains, giant impact craters, and endless dusty dune-covered rocky landscapes. You'll be lost in it for hours, and you can even trace the journey of rovers across the Red Planet's surface.



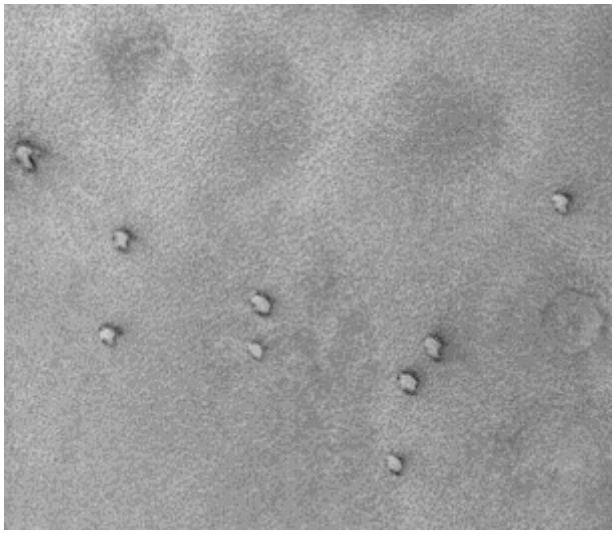
A screenshot from the Global CTX Mosaic of Mars showing the a portion of Jezero Crater on Mars and the path traveled so far by the Perseverance rover.

The mosaic took six years and tens of thousands of hours to develop. It is so detailed that more than 120 peer-reviewed science papers have already cited a beta version. It was created at Caltech's Bruce Murray Laboratory for Planetary Visualization, and the developers say the mosaic is also easy enough for anyone to use.

"I wanted something that would be accessible to everyone," said Jay Dickson, the image processing scientist who led the project and manages the Murray Lab. "Schoolchildren can use this now. My mother, who just turned 78, can use this now. The goal is to lower the barriers for people who are interested in exploring Mars."

While we've written many articles about another camera on MRO, HiRISE (the High-Resolution Imaging Science Experiment) the CTX, or context imager has had a lower profile for the MRO mission. However, it provides a 6 meter per pixel resolution, better than any other previous camera (except for HiRISE) and over the 17 years of MRO's time in Mars' orbit, CTX has imaged nearly all of Mars' surface, allowing science teams to create detailed maps of Mars.

"For 17 years, MRO has been revealing Mars to us as no one had seen it before," said the mission's project scientist, Rich Zurek of JPL. "This mosaic is a wonderful new way to explore some of the imagery that we've collected."



MRO's Context Camera (CXT) image showing the northern polar sand dunes. Credit: MSSS

While HiRISE imagery provides detailed closeups of Mars, CTX captures wide-area images to provide context for the high resolution images. CTX's image are in black and white, but with its wide area of coverage, that allows this map to be the highest-resolution global image of the Mars as yet ever created.

JPL said that to create the new mosaic, Dickson developed an algorithm to match images based on the features they captured. He manually stitched together the remaining 13,000 images that the algorithm couldn't match. The remaining gaps in the mosaic represent parts of Mars that hadn't been imaged by CTX by the time Dickson started working on this project, or areas obscured by clouds or dust.

Laura Kerber, a Mars scientist at JPL, provided feedback on the new mosaic as it took shape. "I've wanted something like this for a long time," Kerber said. "It's both a beautiful product of art and also useful for science."

MRO launched in 2005. Back in 2016 when I interviewed Zurek for my book "Incredible Stories From Space: A Behind-the-Scenes Look at the Missions Changing Our View of the Cosmos," he told me the science and data teams from MRO were reaping the benefits of a such a long-duration mission. Now, 17 years in, its even more true.

"There is value in long-term records," he said, "and MRO has been a good friend to us for a long time."

Check out the *Global CTX Mosaic of Mars* here.

Astronomers Find 1,179 Previously Unknown Star Clusters in Our Corner of the Milky Way

Some of the most exciting things that happen in a telescope's lifetime are its data releases. Gaia, which has been operating since 2013, recently released its third major dataset, and astronomers that weren't intimately involved in the operation and planning for the project have had some time to pull over. Their studies are starting to pop up in journals everywhere. For example, a new one from a research team, mainly from Guangzhou University, catalogs over 1100 new star clusters, significantly increasing the overall total of these critical components in the structure of the Milky Way.

There has long been a disconnect between the estimated number of star clusters (or open clusters) in the Milky Way and their observed total. Around 15 years ago, researchers thought there would be as many as 100,000 open clusters in the Milky Way based on observed structures in the formation of the galaxy.

Actual observational evidence for that many clusters was lacking, though. Gaia, which focuses on cataloging an astronomical 1.7 billion stars in our galaxy, has already been a source of a large percentage of the 7000 or so that have already been found. Before the first Gaia release, only 1200 open clusters were known. Data release two found an additional 4,000, while previous work with the third data release found an additional 1600.

Most of those previous findings had a weakness, though – they looked primarily at the central galactic plane, with a "galactic latitude," as the paper calls it, of less than 20 degrees. Only open clusters on the main galactic plane would be visible in that dataset.
So the researchers from Guangzhou took a different approach – they analyzed Gaia data that went well above the 20 degrees previously studied. In addition, they looked out about as far as they could go in the Gaia data – about 5 kiloparsecs or a little more than 16000 light years.

They then had to find a way to sort through all that data. For that, they turned to a series of algorithms akin to simplistic AI learning models. Those include an unsupervised clustering algorithm – basically a way to lump similar data sets together. They also used a Random Forest binary classification system, which tries to construct a valid way to categorize previously unstructured data by using a training input (in this case, the output of the clustering algorithm).

Since the number of potential findings was still semi-manageable (at least for hard-working graduated students), the team also visually confirmed each of the 1,179 clusters they found in the data. Once confirmed, the team worked to classify some of their more important characteristics, such as the metallicity and age of their stars.

Results from their work move astronomers closer to confirming the theory about the total number of open clusters in the galaxy. And while 16,000 light-years might seem far (given that it would take light more than twice the time of all of history to travel it), it's a relative drop in the bucket compared to the overall size of the Milky Way. There are surely plenty of other open clusters left to find, and hopefully, there will be plenty more data releases from both Gaia and its successors to help find them.

An Amazing New Map of the Moon, In LEGO

OK, LEGO fans, it's time to vote this awesome new LEGO Idea into existence! A stunning new 2,360-piece Lego Art space poster called "The Moon: Earth's Companion" is currently gathering supporters on the LEGO Ideas website. If it gets enough votes, LEGO will review it and possibly create it.

This highly detailed, retro-style brick-built Moon map is not only beautiful, but educational. When put together, it shows the Moon's craters and terrain features, displaying lunar geology and maria. It also includes geometrical phases of the Moon and a brick-built panorama depicting the Earth rising over the lunar landscape.

Not surprisingly, the idea was chosen as one of the LEGO Ideas Staff Picks, which celebrates "fantastic projects that show off something out of the ordinary." In just a matter of weeks, the submission has already notched up over 8,800 supporters, and is well on its way to the 10,000-supporter milestone needed for it to be considered for production by Lego. Let's do this, vote here!

Another view of "The Moon: Earth's Companion" on the LEGO Ideas site. Image courtesy Marc Sloan.

It measures roughly 15.5 inches (40 cm) wide and 20.2 inches (51 cm) in height and can be hung on a wall.

The idea was submitted by Marc Sloan, aka @Sharky_Bricks who said it took him over a year to design this piece.

"I wanted to find the right balance between artistic license and accuracy, especially on something as familiar as the Moon," he said via email. "I'm glad that my hard work has paid off, and I'm excited to share my creation with the world."

Sloan said his inspiration for this design came from a lifelong passion for space travel and astronomy.

"As a child, I was fascinated by all things related to the cosmos, and I vividly remember visiting Cape Canaveral, and feeling in awe of the Apollo rockets and spacecraft on display. In addition to the Apollo missions, I was also inspired by the upcoming Artemis missions, which aim to take humans back to the Moon."

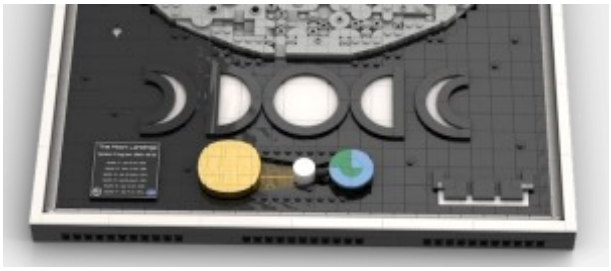
A detailed look at the design of "The Moon: Earth's Companion." Image courtesy Marc Sloan.

Sloan said he has submitted several other 3D map designs to Lego Ideas, so he has a lot of experience using Lego bricks to bring 2D images to life. However, this one is the most popular to date. Sloan said he's also revised his design after feedback from the LEGO Ideas folks.

"My original design was based around the Moon landings and featured a mini lunar lander that could be placed on all the Apollo landing sites," he said, "but after some feedback from Lego Ideas, I made it more general to instead highlight the Moon's geology and topography and its relationship to Earth."

An alternate idea for the design is to depict a solar eclipse instead of the "Earthrise" panorama.

"I decided to use the Earthrise panorama in my final design after I shared a poll on my Lego Maps community on Facebook and they voted for it," Sloan told me. "But it's entirely possible that Lego might include alternative builds in the final product if it makes it through their selection process. It's usually the case that Lego will modify the original design to improve on it in the final product."



A possible alternative to the depiction of 'Earthrise' is a solar eclipse explainer. Image courtesy Marc Sloan.

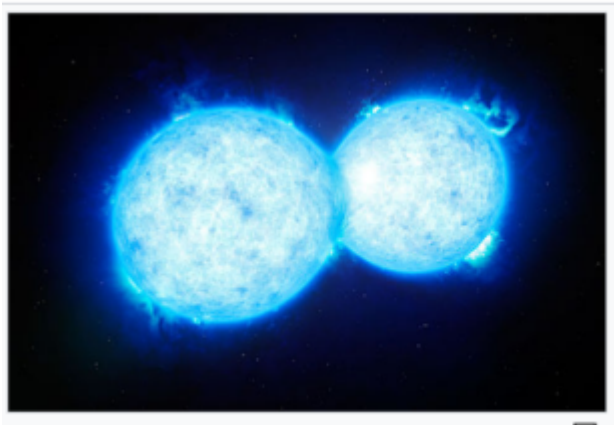
The description on the LEGO Ideas site says this piece "celebrates the beauty and mystery of the Moon," and is "designed in a cool, retro style that will look great on any wall."

If you agree this beautiful and detailed map of the Moon should become a reality, check out the LEGO Ideas site for The Moon: Earth's Companion and vote!

E MAILS and MEMBERS VIEWING LOGS.

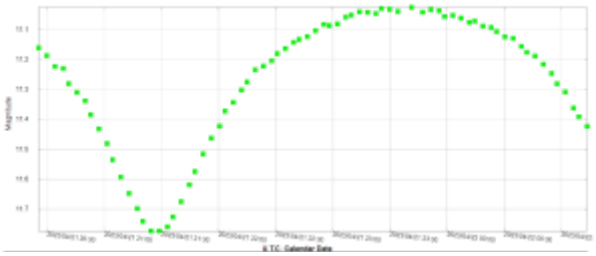
Tony Vale 21st APRIL

The society observing session which took place on the evening of 21st April coincided with an opportunity to observe a double eclipse of the eclipsing binary AW Virginis. This is a type of star sometimes referred to as an over contact binary consisting of two stars so close to each other that they share their outer atmospheres and complete an orbit in less than a day. (See artists impression below)

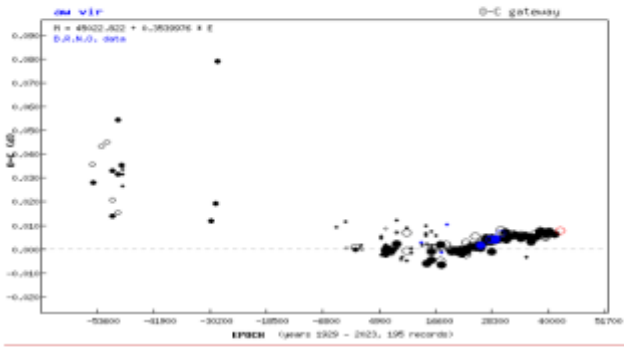


Credit: ESO/L. Calçada

AW Virginis completes an orbit in just under 8.5 hours with a secondary eclipse scheduled for 22:38 and the primary for 02:53 BST on the night of 21st to 22nd April. I was able to start the observation run from 09:25 and had to stop at 02:15 when the sky clouded over so unfortunately I missed the primary eclipse. The light curve obtained is shown here :



You can see that I was able to capture the earlier secondary eclipse. Note also that the light curve is changing continuously through the cycle which is characteristic of this type of system. To understand why, imagine the dumbbell shaped object in the artist's impression spinning. As it does so, it presents a continuously changing surface area to us. Other systems with greater separations and longer periods can show a steady, flat light curve between eclipses. With this light curve I was able to determine the time of the secondary minimum and then plot it on the O-C diagram of the Czech astronomical society as shown here :



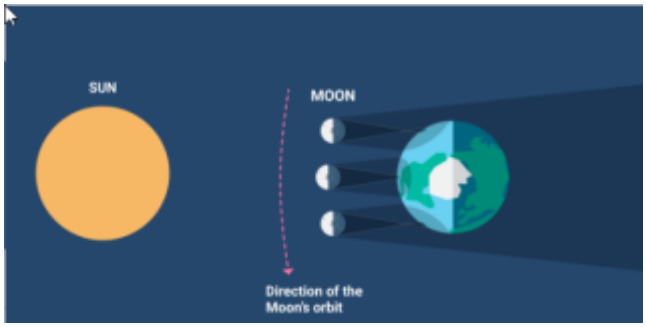
My observation is the red circle on the right. This diagram contains observations as far back as 1929 and shows how the period has been changing over that time. Note the huge improvement in scatter since the beginning of the use of CCD and DSLR cameras to make these measurements. (Mine was made with a ZWO CMOS camera and a 4" F5 refractor). O-C means observed less calculated, so it shows how early or late the eclipse took place compared to a prediction of the eclipse time. An upward trend indicates a lengthening period and later eclipses and a downward trend indicates the opposite. A change in gradient suggests a mass transfer is taking place or has taken place between the components or perhaps mass loss from the system. A sinusoidal curve suggests the presence of a third body. From this diagram it is difficult to tell how the system is changing. Only more observations and time will tell.

Peter Chappell: Eclipse from Western Australia

Viewing Log for Hybrid Total Solar Eclipse

This eclipse was going to be a first for me, I have never seen a hybrid total solar eclipse before, they are quite rare, they will only be seven occurring in the 21st century out of 224 solar eclipses, next being in 2031, and previous one was in 2013.

The Ningaloo eclipse as it was known as comes from an Aboriginal word, would fall across the remote North West



cape area of Australia near the town of Exmouth during the morning. I was part of the Astro Trails group that was based in Perth, some 1,300 kms away. As the eclipse was due to start around 10:04 (local time), this would mean an early rise of around 03:15 to catch a plane from Perth airport to Learmonth airport near Exmouth. What surprised me with the charter flight at Perth airport we did not go thru a metal detector, only show our passports to confirm who we were! The same happened on the way back to Perth later in the afternoon. When we took off just after sunrise the skies were clear but as we headed north we came to a large bank of cloud which hopefully would not be around for our eclipse date? By the time we arrived at the North West cape area, the cloud had gone, so we should have a clear sky for the event? Once off of the plane, it was about a 5 km trip to our viewing spot right beside the Indian Ocean. It is a lot warmer up here than Perth, probably another 15 ° warmer coming in at 88 ° F? I started setting up my equipment about 35 minutes before first contact which was due at 10:04, as I had limited weight allowance for the plane trip, I had to re plan what equipment I would bring with me. So the 80 mm refractor telescope I normally use for eclipse trips got binned and used two cameras with an 18 – 400 mm zoom lens and a 70 – 300 mm zoom lens attached to them instead, at the front end of the lens I would be using a Seymour glass solar filter and a homemade Baader filter. All this equipment was attached to two full size tripods. I had trouble getting the

sun into focus as it was that bright, I had sun glasses on but had to change to normal glasses to get the focus about right? Everything was going okay until about 20 minutes before second contact and totality starts, one of the tripod mounts had become loose and the camera and lens would bounce around too much for pictures to be taken, so I decided to carry on with the one camera and take a video with my phone instead.

I had planned to run one camera in video mode and the other to take pictures and look at totality with my eyes, a lot to do in only 63 seconds! When second contact happens it is totally safe to look at the Sun with no filters at all and you will see the Corona, the outer most layer of the Sun's atmosphere which consists of plasma. With third contact (when the Moon starts to move off of the Sun) it is time to put filters back on any equipment used. While in

totality I noticed Venus to the lower right with Jupiter above and to the left, did not see any stars unfortunately. As I was down under, everything in the sky is upside down to

what I can view in the northern hemisphere! About another 90 minutes later at 13:02 and the eclipse was over. My next planned eclipse is to the USA next April, the last one was in Argentina back in July 2019, Had planned another

in Oman in June 2020 but Covid 19 put a stop to that planned trip.

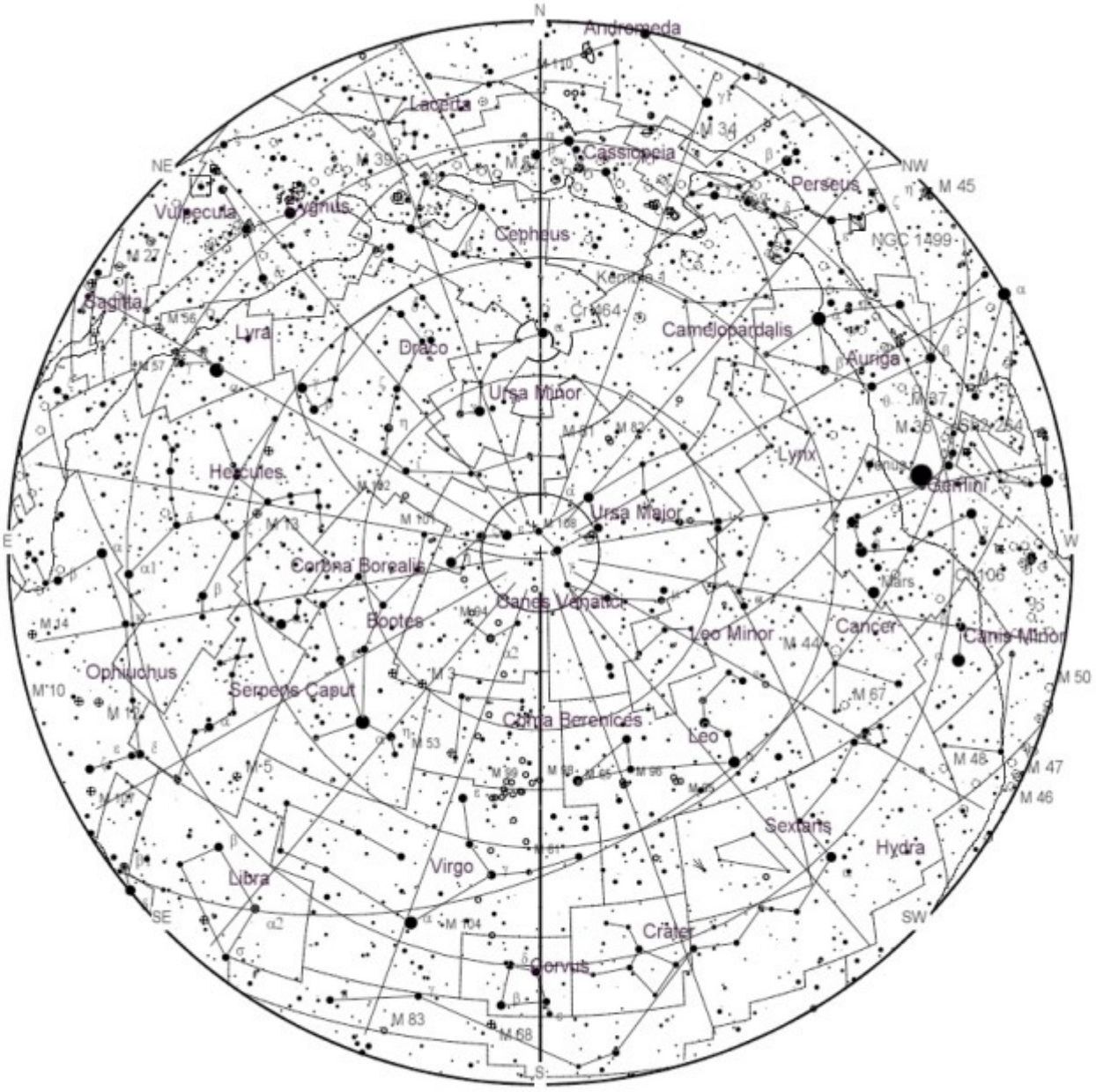
While waiting for the bus to take us back to the plane for the trip back to Perth I started to fall asleep. Heat, very early start and only being in the country for three days was starting to take its toll on me. We got back to the hotel around 20:00 that evening, best part of a 17 hour day for the eclipse, very tired from the trip but happy to have seen it.

A hybrid eclipse is when its appearance changes from an annular to total and back again as the Moon's shadow moves across the Earth's surface in case you were wondering?

Clear skies.

Peter Chappell

WHATS UP, MAY 2023



May 5 - **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 17:36 UTC. This full moon was known by early Native American tribes as the Flower Moon because this was the time of year when spring flowers appeared in abundance. This moon has also been known as the Corn Planting Moon and the Milk Moon.

May 5 - **Penumbral Lunar Eclipse.** A penumbral lunar eclipse occurs when the Moon passes through the Earth's partial shadow, or penumbra. During this type of eclipse the Moon will darken slightly but not completely. The eclipse will be visible throughout all of Asia and Australia and parts of eastern Europe and eastern Africa. (**NASA Map and Eclipse Information**)

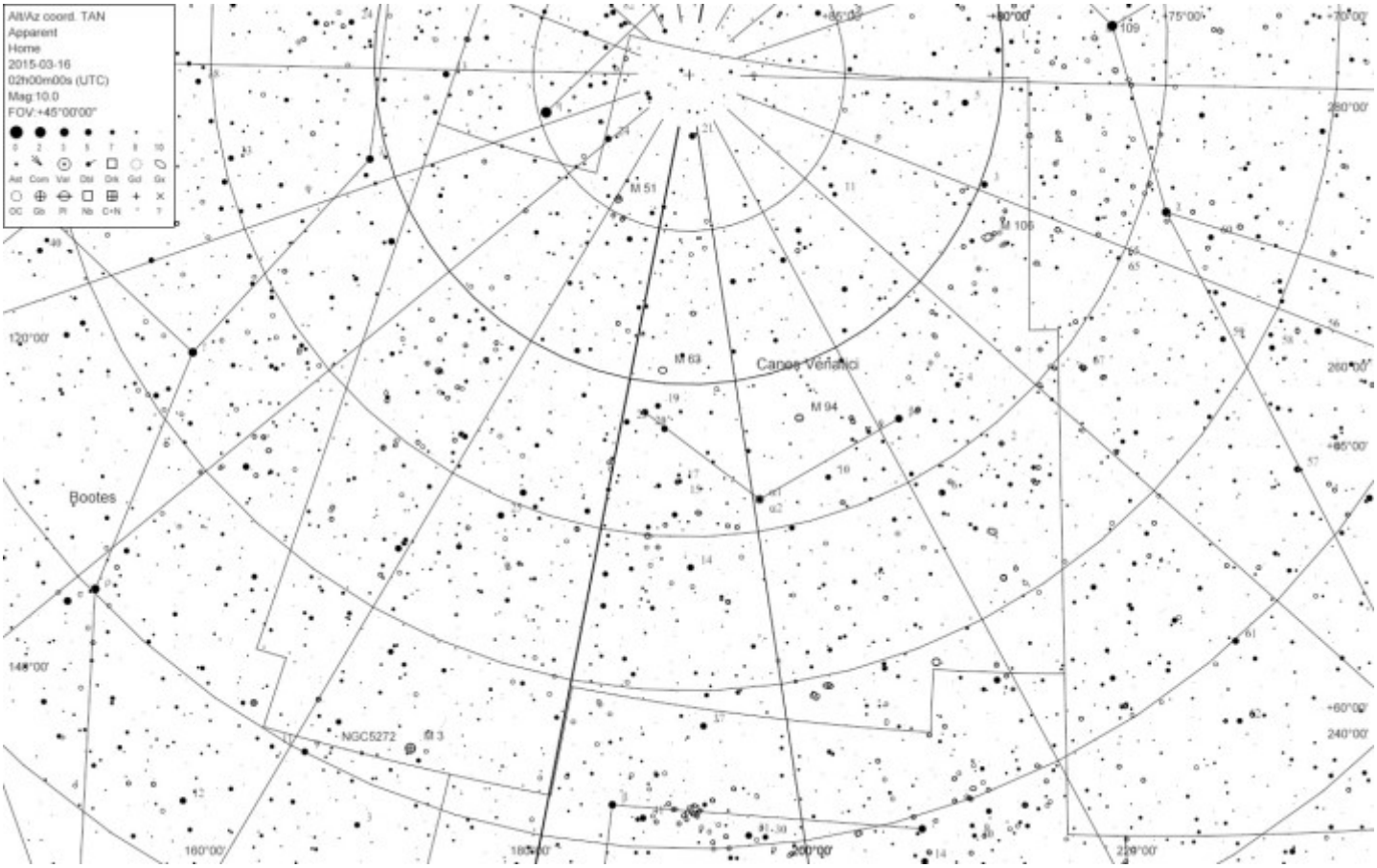
May 5, 6 - **Eta Aquarids Meteor Shower.** The Eta Aquarids is an above average shower, capable of producing up to 60 meteors per hour at its peak. Most of the activity is seen in the Southern Hemisphere. In the Northern Hemisphere, the rate can reach about 30 meteors per hour. It is produced by dust particles left behind by comet Halley, which has been observed since ancient times. The shower runs annually from April 19 to May 28. It peaks this year on the night of May 5 and the morning of the May 6. The nearly full moon will be a problem this year, blocking out all but the brightest meteors. If you are patient, you should still should be able to catch a few good ones. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Aquarius, but can appear anywhere in the sky.

May 19 - **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 15:55 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.

May 29 - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 24.9 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

June 1, 2 - **Mars in the Beehive.** The planet Mars will pass through the beehive cluster, an open cluster of stars located in the constellation Cancer. Mars can be seen in or very near the cluster on the nights of June 1st and 2nd. A good pair of binoculars should be enough to see this rare event all though a telescope will provide a much better view.

CONSTELLATIONS OF THE MONTH: CANES VENETICI



Canes Venatici is one of those obscure constellations introduced by Johannes Hevelius in 1690. It represents the two dogs Asterion and Chara, both held on a leash by Bootes as they apparently chase the Great Bear around the North Pole.

With one exception, the constellation's stars are quite faint, fourth- and fifth-magnitude stars. There are only three Bayer stars, yet several notable binaries can be found, as well as a famous variable and a number of interesting deep sky objects as well.

Alpha Canum Venaticorum is popularly called Cor Caroli (*Heart of Charles*). Most sources give Edmund Halley the credit, naming it after King Charles II after the restoration of the monarchy in Britain in 1660. (Some say, however, that the reference was initially meant to commemorate Charles I, after his execution.)

The star has a visual magnitude of 2.9 (variable), a distance of 110 light years, and roughly the same size as our Sun. It is also a splendid double with, perhaps, a subtle colour contrast (discussed below).

Double stars in Canes Venatici:

Canes Venatici has two attractive binaries: *alpha CVn* and *25 CVn*.

Alpha^2 and *alpha*^{1} *CVn* form a celebrated fixed double star system. Note that the primary is *alpha*^{2}, since it is slightly east of its companion.

While both stars are usually reported to be blue-white, some find them slightly different, perhaps soft blue and yellow, or two shades of white.

25 CVn (Struve 1768) is a visual binary with an elegant orbit of 240 years. Presently, the companion is at near maximum separation, with a PA of 100 degrees and separation 1.8".

Variable stars in Canes Venatici:

The constellation contains one of the more interesting semi-regular stars, Gamma CVn, called *La Superba* by its admirers. One look and you will understand why: the star is an unusually vivid red.

Gamma CVn is classified as an SRb star. Such stars are known to have several periodic cycles, superimposed on each other. Basically, it changes in magnitude from 7.4 to 10.0 every 157 days. (However an update published in Budapest, in the *Information Bulletin of Variable Stars*, #2271, has reassessed the period at 251.8 days.) La Superba is a semi-regular variable star, peaking at about +4.8 mag and diminishing to around +6.3 over a 160 day cycle. Known in short form as γ CVn, it is one of the reddest stars in the sky, and it is among the brightest of the giant red "carbon stars". It is the brightest J-star in the sky, a very rare category of carbon stars that contain large amounts of carbon-13 (carbon atoms with 7 neutrons instead of the usual 6). 19th century astronomer Angelo Secchi, impressed with its beauty, gave the star its common name.[1]

La Superba's temperature is believed to be about 2800 K, making it one of the coolest true stars known. γCVn is almost never visible to the naked eye since most of its output is outside the visible spectrum. Yet, when infrared radiation is considered, γ CVn has a luminosity 4400 times that of the Sun, and its radius is approximately 2 AU. If it were placed at the position of our sun, the star's surface would extend beyond the orbit of Mars.

Appearance

To explain its remarkable coloration, it is necessary to understand that mid-sized stars, once they have finished fusing hydrogen to helium in their core, begin to fuse helium to carbon. During this so called red giant stage, the outer layers expand and cool, causing the star's radiation output to move towards the red end of the electromagnetic spectrum. Near the end of the star's life cycle, fusion products are moved outwards from the core by convection, thus creating a carbon abundance in the outer atmosphere where carbon monoxide and other compounds are formed. These molecules tend to absorb radiation at shorter wavelengths, resulting in a remarkable spectrum with even less blue and violet compared to ordinary red giants, giving the star its distinguished red color.

Outlook

La Superba is most likely in the final stages of fusing its remaining secondary fuel (helium) into carbon and shedding its mass at the rate of about a million times that of the Sun's solar wind. It is also surrounded by a 2.5 light year-wide shell of previously ejected material, implying that at one point it must have been losing mass as much as 50 times faster than it is now. La Superba thus appears almost ready to eject its outer layers to form a planetary nebula, leaving behind its core in the form of a vanishing white dwarf.

Alpha^2 *CVn* is the prototype of a class of variables. Such stars usually have a spectrum from B9 to A5, are unusually abundant in particular heavy metals and deficient in common elements. Alpha^2 has an abundance of silicon, europium, and mercury, and oscillates in magnitude from 2.84 to 2.98 every 5.5 days.

Deep Sky Objects in Canes Venatici:

There are five Messier objects in this constellation, and many more deep sky objects worthy of attention.

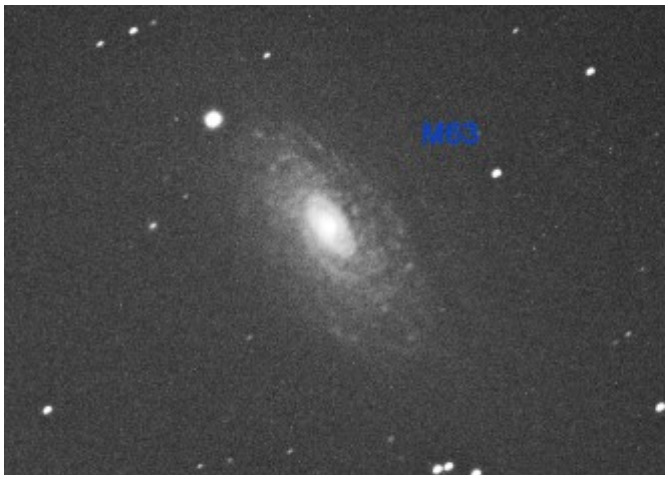
M3 (NGC 5272) is a wonderful globular cluster found roughly halfway between Cor Caroli and Arcturus (in Bootes). Considered one of the finest globular clusters in the entire heavens, you'll need a large scope to resolve its individual stars. The cluster is about 45,000 light years away.

M51 (NGC 5194) or *The Whirlpool Galaxy* is the finest galaxy in Canes Venatici.

This spiral, found just southwest from the tip of the Big Dipper's handle, was the first spiral galaxy to be discovered (in 1845 by Lord Ross at his castle in Ireland).

Some say the galaxy is 14 million light years away, others that it is twice that. In any case, you'll need a large telecope and a fine evening to enjoy its delicate detail, which includes an appendage system (NGC 5195), another galaxy seemingly hanging onto one of its extended arms.

M63 is sometimes called the Sunflower Galaxy, by its numerous arms, which Burnham describes as "reminiscent of showers of sparks thrown out by a rotating fiery pinwheel". Fairly



bright, at 8.1 magnitude, it has a very condensed centre. The galaxy is found five degrees north-northeast of Cor Caroli.

M94 is another spiral, seen practically face-on, and sometimes described as "comet-like". This is a very compact circular spiral and very bright (8.1 magnitude). To find it draw a line between Cor Caroli and beta CVn, and at the half-way point draw a perpendicular off to the northeast. About two degrees up this perpendicular is found M94.

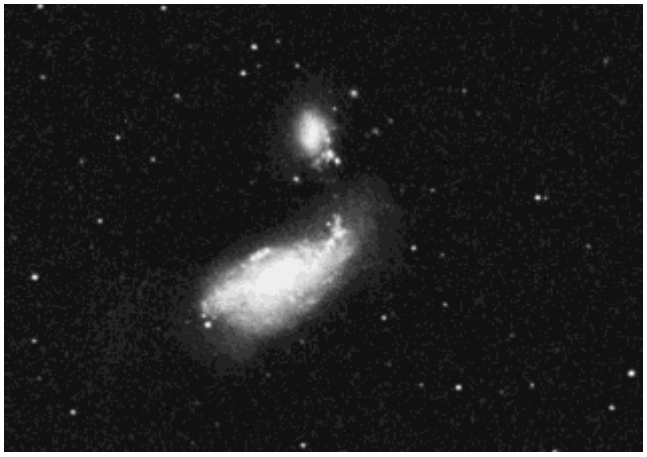
M106 (NGC 4258) is another bright spiral. Burnham doesn't list this object as a Messier, but gives a fine photograph (p 375). The galaxy is six degrees north north-west of beta CVn.

Below are listed a selected number of galaxies considered the best of the non-Messiers.

NGC 4244: a large edge-on spiral, found eight degrees

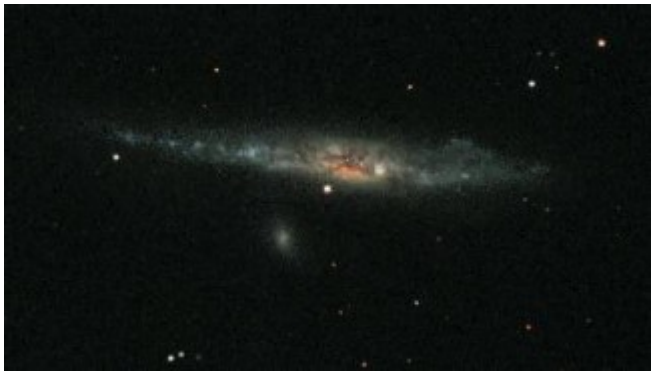
west of Cor Caroli.

NGC 4485 and *NGC 4490* are two splendid galaxies in the



same field: 4485 is more compact (this one is sometimes called the Cocoon Galaxy), while 4490 is larger and brighter. Located less than one degree northwest of beta CVn.

NGC 4631: very large and bright, seen edge-on. Found in a rather barren field, six degrees south of Cor Caroli and



two degrees west. In the same field are two more galaxies, NGC 4656 and 4657, just southwest of 4631.

Pictures Andy Burns

Bluewalker 3 communication sail will be making itself seen. MAY 2023

Date	Bright-ness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
15 May	3.1	03:32:07	19°	SSW	03:34:10	30°	SE	03:37:37	10°	E
16 May	3.0	03:12:24	23°	S	03:13:56	31°	SE	03:17:24	10°	E
17 May	3.0	02:52:38	27°	S	02:53:41	31°	SE	02:57:11	10°	E
17 May	2.0	04:28:04	10°	WSW	04:31:59	87°	NNW	04:35:55	10°	ENE
18 May	2.8	02:32:47	30°	SSE	02:33:26	32°	SE	02:36:57	10°	E
18 May	2.0	04:07:50	10°	WSW	04:11:44	86°	NNW	04:15:41	10°	ENE
19 May	2.8	02:12:54	32°	SSE	02:13:10	33°	SE	02:16:42	10°	E
19 May	2.0	03:47:35	10°	WSW	03:51:30	85°	NNW	03:55:26	10°	ENE
20 May	2.7	01:52:57	33°	SE	01:52:57	33°	SE	01:56:27	10°	E
20 May	2.0	03:27:36	12°	WSW	03:31:14	84°	NNW	03:35:10	10°	ENE
21 May	2.7	01:32:55	34°	SE	01:32:55	34°	SE	01:36:12	10°	E
21 May	2.0	03:07:34	13°	WSW	03:10:58	84°	NNW	03:14:54	10°	ENE
22 May	2.7	01:12:48	34°	SE	01:12:48	34°	SE	01:15:56	10°	E
22 May	2.0	02:47:27	14°	WSW	02:50:42	83°	NNW	02:54:37	10°	ENE
23 May	2.7	00:52:33	34°	SE	00:52:33	34°	SE	00:55:39	10°	E
23 May	2.0	02:27:12	15°	WSW	02:30:25	82°	NNW	02:34:20	10°	ENE
23 May	2.3	04:05:15	10°	WNW	04:09:09	69°	N	04:13:04	10°	E
24 May	2.6	00:32:07	35°	SE	00:32:07	35°	SE	00:35:22	10°	E
24 May	2.0	02:06:46	13°	WSW	02:10:08	81°	NNW	02:14:03	10°	ENE
24 May	2.3	03:44:58	10°	WNW	03:48:52	69°	N	03:52:47	10°	E
25 May	2.4	00:11:23	37°	SSE	00:11:28	37°	SSE	00:15:05	10°	ENE
25 May	2.0	01:45:59	10°	WSW	01:49:50	80°	NNW	01:53:45	10°	ENE
25 May	2.3	03:24:40	10°	WNW	03:28:35	70°	N	03:32:29	10°	E
25 May	2.4	23:49:55	29°	S	23:51:09	38°	SSE	23:54:46	10°	ENE
26 May	2.0	01:25:39	10°	W	01:29:32	80°	NNW	01:33:27	10°	ENE
26 May	2.2	03:04:23	10°	WNW	03:08:16	70°	N	03:12:11	10°	E
26 May	2.4	23:27:13	10°	SW	23:30:50	39°	SSE	23:34:29	10°	ENE
27 May	2.0	01:05:20	10°	W	01:09:13	79°	NNW	01:13:08	10°	ENE
27 May	2.2	02:44:04	10°	WNW	02:47:57	70°	N	02:51:52	10°	E
27 May	2.3	23:06:53	10°	SW	23:10:30	39°	SSE	23:14:10	10°	ENE
28 May	2.0	00:45:02	10°	W	00:48:54	78°	NNW	00:52:49	10°	ENE
28 May	2.2	02:23:45	10°	WNW	02:27:39	71°	N	02:31:33	10°	E
28 May	2.1	04:02:21	10°	WNW	04:06:10	52°	SSW	04:09:58	10°	SE
28 May	2.3	22:46:32	10°	SW	22:50:10	40°	SSE	22:53:50	10°	ENE
29 May	2.0	00:24:42	10°	W	00:28:35	78°	N	00:32:29	10°	ENE
29 May	2.2	02:03:26	10°	WNW	02:07:20	71°	N	02:11:14	10°	E
29 May	2.1	03:42:02	10°	WNW	03:45:50	51°	SSW	03:49:37	10°	SE
29 May	2.3	22:26:12	10°	SW	22:29:50	41°	SSE	22:33:30	10°	ENE
30 May	2.1	00:04:22	10°	W	00:08:15	77°	NNW	00:12:09	10°	ENE
30 May	2.2	01:43:06	10°	WNW	01:46:59	72°	N	01:50:54	10°	E
30 May	2.1	03:21:42	10°	WNW	03:25:29	50°	SSW	03:29:17	10°	SE
30 May	2.3	22:05:50	10°	SW	22:09:29	42°	SSE	22:13:10	10°	ENE
30 May	2.1	23:44:02	10°	W	23:47:55	76°	NNW	23:51:49	10°	ENE

ISS PASSES For MAY 2023

from Heavens Above website maintained by Chris Peat.

Date	Brightn	Start	Highest point	End						
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
03 May	**-2.3**	**02:43:24**	**26°**	**ESE**	**02:43:24**	**26°**	**ESE**	**02:45:31**	**10°**	**E**
03 May	-3.8	04:16:17	15°	WSW	04:19:01	83°	SSE	04:22:25	10°	E
04 May	-3.8	03:29:35	37°	WSW	03:30:45	70°	SSE	03:34:08	10°	E
05 May	-3.4	02:42:51	51°	SE	02:42:51	51°	SE	02:45:49	10°	E
05 May	-3.7	04:15:49	10°	W	04:19:12	85°	N	04:22:35	10°	E
06 May	-3.8	03:28:56	24°	W	03:30:51	89°	N	03:34:15	10°	E
07 May	-3.9	02:42:06	66°	WSW	02:42:30	82°	SSE	02:45:53	10°	E
07 May	-3.8	04:15:53	10°	W	04:19:17	88°	S	04:22:40	10°	E
08 May	-2.8	01:55:14	38°	E	01:55:14	38°	E	01:57:30	10°	E
08 May	-3.8	03:28:06	14°	W	03:30:53	86°	N	03:34:16	10°	E
09 May	-3.8	02:41:11	36°	W	02:42:28	85°	N	02:45:51	10°	E
09 May	-3.8	04:15:50	10°	W	04:19:12	64°	SSW	04:22:33	10°	ESE
10 May	-3.8	01:54:14	76°	E	01:54:14	76°	E	01:57:23	10°	E
10 May	-3.9	03:27:24	10°	W	03:30:46	78°	SSW	03:34:09	10°	ESE
11 May	-3.9	02:40:08	20°	W	02:42:18	89°	S	02:45:42	10°	E
11 May	-3.2	04:15:44	10°	W	04:18:53	37°	SSW	04:22:02	10°	SE
12 May	-3.8	01:53:04	52°	W	01:53:48	85°	N	01:57:11	10°	E
12 May	-3.6	03:27:12	10°	W	03:30:28	50°	SSW	03:33:45	10°	SE
13 May	-3.4	01:05:53	57°	E	01:05:53	57°	E	01:08:38	10°	E
13 May	-3.9	02:38:42	10°	W	02:42:00	66°	SSW	02:45:21	10°	ESE
13 May	-3.3	22:37:01	10°	SW	22:40:08	37°	SSE	22:43:16	10°	E
14 May	-3.9	00:13:20	10°	W	00:16:42	89°	S	00:20:05	10°	E
14 May	-3.9	01:50:06	10°	W	01:53:29	80°	S	01:56:51	10°	ESE
14 May	-2.9	03:27:00	10°	W	03:29:57	28°	SSW	03:32:53	10°	SSE
14 May	-2.8	21:48:49	10°	SSW	21:51:41	27°	SSE	21:54:34	10°	E
14 May	-3.9	23:24:46	10°	WSW	23:28:08	78°	SSE	23:31:31	10°	E
15 May	-3.9	01:01:31	10°	W	01:04:53	90°	NW	01:05:05	79°	E
15 May	-3.8	22:36:15	10°	WSW	22:39:33	63°	SSE	22:42:53	10°	E
16 May	-3.8	00:12:55	10°	W	00:16:17	85°	N	00:17:55	28°	E
16 May	-3.5	21:47:45	10°	SW	21:50:59	48°	SSE	21:54:14	10°	E
16 May	-3.8	23:24:16	10°	W	23:27:38	86°	N	23:30:45	12°	E
17 May	-3.3	01:01:01	10°	W	01:03:37	48°	W	01:03:37	48°	W
17 May	-3.8	22:35:37	10°	W	22:38:58	88°	S	22:42:21	10°	E
18 May	-3.9	00:12:22	10°	W	00:15:44	82°	SSW	00:16:29	51°	ESE
18 May	-3.8	21:46:57	10°	WSW	21:50:18	76°	SSE	21:53:39	10°	E
18 May	-3.8	23:23:41	10°	W	23:27:03	88°	N	23:29:19	19°	E
19 May	-3.8	22:34:58	10°	W	22:38:19	85°	N	22:41:42	10°	E
20 May	-3.7	00:11:43	10°	W	00:14:59	55°	SSW	00:14:59	55°	SSW
20 May	-3.7	21:46:13	10°	W	21:49:34	87°	N	21:52:56	10°	E
20 May	-3.9	23:22:58	10°	W	23:26:19	71°	SSW	23:27:49	30°	ESE
21 May	-3.8	22:34:12	10°	W	22:37:33	84°	SSW	22:40:38	12°	ESE
22 May	-2.6	00:11:02	10°	W	00:13:29	29°	SW	00:13:29	29°	SW
22 May	-3.7	21:45:24	10°	W	21:48:46	87°	N	21:52:07	10°	E
22 May	-3.3	23:22:10	10°	W	23:25:22	43°	SSW	23:26:17	34°	SSE
23 May	-3.6	22:33:18	10°	W	22:36:37	58°	SSW	22:39:06	16°	ESE
24 May	-3.7	21:44:27	10°	W	21:47:48	74°	SSW	21:51:09	10°	ESE
25 May	-2.8	22:32:23	10°	W	22:35:28	33°	SSW	22:37:34	17°	SSE

END IMAGES, AND OBSERVING

The 10 day lunation Moon. The North is filled with craters and uplands before the Mare Frigorium crosses the whole of the hemisphere. Then the North West is covered with more mountains and craters including the buried crater make Sinus Iridium the Bay of Showers. The filling came from the very large impact crater and lava fill that made Mare Imbrium.
The bottom and eastern rim made up the Alps, Appenines and Carpathian mountains with later craters including the large crater to the south of this image, Copernicus. The Mare Imbrium impact was around 3.3 billion years age, and the Copernicus around 1.3 billion years ago.

Taken using a single zoom lens bridge camera at 3000mm, Nikon P1000.
Very useful for ducking out between clouds.

Andy Burns

Observing Sessions

Proposed Observation Sessions for 2022-2023

Planned observing evenings will be on a Friday night in the Lacock playing fields behind the Red Lion pub at 19:00 or an Hour after sunset depending on the time of year.
With the New Moon being around the beginning of the month and the full moon generally around the middle, the following dates for observing are proposed:

a ad-hoc session for other reasons and at other locations, such as astro-photography, solar observing etc, with other like-minded members then they can do so through the Society Members Facebook Page or through the WAS contact page on the website.

Opportunity	Day	Date	Month	Set-up	Observe
First	Friday	12th	May	20:30	21:00
Second	Friday	19th	May	20:30	21:00

OUTREACH:

In August we have been asked to prepare an astronomy weekend for the army corp and families based in Colerne. I am enquiring about getting the Dark Sky Wales Planetarium to come along and we will need solar viewing and evening sky viewing. They are looking for the 12th/13th August.