NWASNEWS

Volume27 Issue 5

January 2022

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

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Happy New Year - Great JWST News

The recent astronomy news is dominated by the delayed but very successful launch of the James Webb Space Telescope on Christmas day A new Christmas star was seen. It proved to be such a good launch from Ariane in French Guyana that two subsequent course corrections have required much less fuel to keep it on track, and this means more fuel left when it reaches its final destination in the gravitationally neutral Lagrange point beyond the Moon's orbit. This extra fuel means it has more than doubled the projected usefulness from 5years to more than 12 (Hubble ST is in its 33rd year after extensive and expensive refits that are no longer possible after the loss of the space shuttle fleet. And better news yesterday and today the crucial 5 layers of shield material have been unfurled and now tensioned. Lets hope the lens cover has been removed...

See the news pages for more.

Meanwhile Terraforming on Mars is in the mind of the retiring NASA Director.

Seeing a Netflix movie this weekend 'Don't Look Up' was very strong on parody of the view of science in the USA (probably why the movie flopped over their) but there was some reasonable science behind the film. The end was highly amusing… you can put your own names to the key characters as you see fit. Who needs a pandemic when you can have an Earth destroying comet in 6 months 14 days. If you don't look up you won't see it so it doesn't exist.

Back here on real Earth cloud destroyed much of the observing of the comet Leonard before it went south, but I did manage some pictures on the 9th of December, and also some other test images for my own reference on the 10th, but other than that occasional Moon images through cloud. No logs received, but Mike Alexander has survived the long volcanic activity on his back door to report on the business as usual at the observatory on Las Palma.

But the cloud resulted in the cancelling of our Christmas week viewing session, but hopefully we can squeeze in some viewing this Friday 7th December at Lacock.

Also despite the peak for the quanterid meteors bring heavy rain, tonight and tomorrow night (4th 5th) should give some clear skies.

Zoom meeting tonight:

Time: Jan 4, 2022 07:45 PM London time

Martin Lunn The Star of Bethlehem

Meeting ID: 862 1605 2459

Passcode: 563532

Clear skies Andy

Comet Leonad from when it was in the northern hemisphere and spluttering.
The extended core is because this is from 6 frames of exposure using Nikon D810, 60 seconds, stacked using Sequator.
Mounted on Skywatcher 125mm Elite pro telescope with field flattener attached.
It has now moved into the southern hemisphere skies and after an unexpected dimming (when I took this picture December 7th, it has now brightened considerably and the tail lengthened and shows so much more detail because of the out gassing that made it dim. Typical.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

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

Meetings 2020/2021.

HALL VENUE the Pavilion, Rusty Lane, Seend

Some Speakers have requested Zoom Mweetings and these will be at home sessions.

Meet 7.30 for 8.00pm start

SEASON 2020/21

2021

4th Jan	Martin Lunn	The Star of Bethlehem (Zoom)
1st Feb	Prof David Southwood	TBN (Zoom)
1st Mar	Martin Griffiths	Dark Energy and Matter (Zoom)
5th Apr	Pete Williamson	Herschel to Hawkwind, Astronomy & Music & How each other influence each other
3rd May	Andrew Lound	The Moon at Christmas: The Epic Voyage of Apollo 8
7th Jun	Prof Matt Griffin	The hazards of Asteroid Impacts on the Earth – Should we worry?

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.

Bob Johnston (Treasurer)

Philip Proven (Hall coordinator)

??? (Teas and Projector)

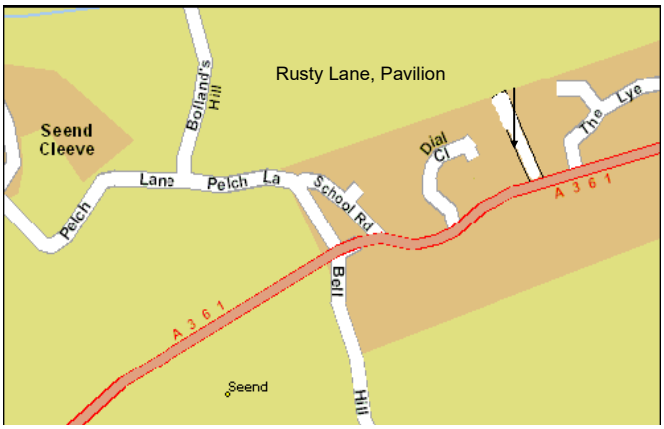
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

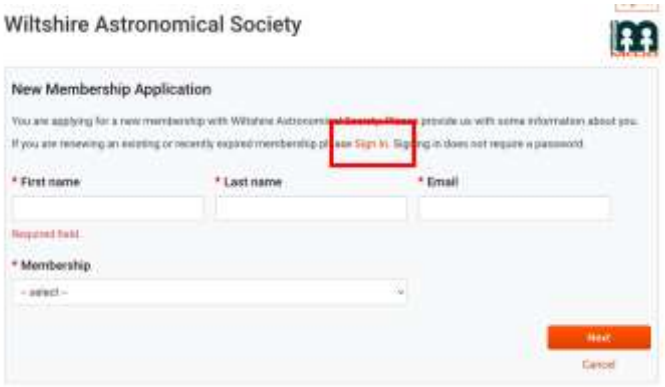
Observing Sessions coordinators: Chris Brooks, Jon Gale,

Web coordinator: Sam Franklin

Contact via the web site details.



Observing Sessions see back page



Martin Lunn MBE FRAS

I studied for my degree in astro-physics whilst working as a guard on British Rail in the 1970s. From 1989 until 2011 I was Curator of Astronomy at the Yorkshire Museum in York, where I helped organise large educational events for children. In 1998 I was presented with an MBE for services to astronomy and education. Until the pandemic I had a mobile planetarium which I took to hundreds of schools in the north of England.

I am a Fellow of the Royal Astronomical Society and currently sit on the council. I present lectures on cruise ships all over the world, and to various clubs and societies at home. I have my own weekly Astronomy Show on a community radio station called Drystone Radio, which can be heard on line. I also write a monthly 'What's in the night sky?' feature for the Craven Herald newspaper which covers the Yorkshire Dales. In 2020 I was a guest on an episode of the BBC's Antiques Road Trip, talking about Thomas Cooke, Instrument Maker of York.

It is a star that most people have heard of, yet we know virtually nothing about it. Was it a miracle, was it a myth or was it a genuine astronomical event? This is an astronomer's view of what the Star of Bethlehem could have been; perfect for the Christmas season.

Swindon Stargazers

Swindon's own astronomy group

Physical meetings continuing!

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

Next meeting: Nick Howes

Nick Howes FRAS and Director of Aerolite Meteorites in Europe. He is the Space R&D Lead for UK Defence Company BMT, and previously worked for both the European Space Agency and the Square Kilometre Telescope Array (SKA)

His Talk: How do you solve a problem like debris-Ahh

Debris causes huge problems, both on Earth and in space. Currently, there are over 130 million pieces of debris orbiting the Earth, ranging from microscopic pieces to ones the size of a bus. Nick Howes, in this lecture, which was delivered at the Marlborough Dark Skies Festival 2021 and also scheduled for the Cheltenham Science Festival , will talk about the possible consequences of this debris.

A piece of debris the size of a pea travelling at 17500 mph would have devastating consequence, like damaging a spacecraft or killing an astronaut, creating a knock-on effect, creating more and more debris. This is known as Kessler Syndrome. A growing concern, with the recent Russian ASAT test, the implications of this will be (not could be) dire for humanity.

Ad-hoc viewing sessions postponed

All ad-hoc meetings are currently postponed until further notice.

Regular stargazing evenings are being organised near Swindon. To join these events please visit our website for further information.

Membership of Swindon Stargazers is required for insurance purposes (PLI)

Lately we have been stargazing at Blakehill Farm Nature Reserve near Cricklade, a very good spot with no distractions from car headlights.

We often meet regularly at a lay-by just outside the village of Uffcott, near Wroughton. Directions are also shown on the website 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 2022

Friday, 21 January 19.30

Programme: Nick Howes - How do you solve a problem like debris-Ahh

Friday, 18 Feb 19.30 onwards

Programme: Prof Matt Griffin: The Hazards of Asteroid Impacts on the Earth - should we worry?

Friday, 18 Mar 19.30 onwards

Programme: AGM

Friday, 22 April 19.30 onwards

Programme: Jon Gale - The Herschel 400

Friday, 20 May 19.30 onwards

Programme: Hugh Allen - Binary Stars - A history of making waves

Friday, 17 June 19.30 onwards

Programme: Steve Tonkin - Journey Into Space

Website: http://www.swindonstargazers.com

Chairman: Robin Wilkey

Tel No: 07808 775630 Email: robin@wilkey.org.uk
Address: 61 Northern Road Swindon, SN2 1PD

Secretary: Hilary Wilkey

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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

GRESHAM ON LINE SESSIONS

Dear Local Astronomy Society,
I was hoping to invite your members to our free Astronomy lectures in 2022 by Professor Katherine Blundell and Professor Roberto Trotta.
You can register for any of these lectures by clicking the link.
I have listed the lectures below by month in case you share information with your members in this way.
JANUARY
Structures in the Universe by Professor Katherine Blundell
Wednesday, January 19, 2022 6:00 PM gres.hm/structures-universe
Museum of London/ Online Or watch later
How did the cosmos transition into space characterised by galaxies in a plethora of different shapes of great beauty? This lecture will consider what happens when groups of galaxies interact with one another and what happens when these galaxies collide and merge.
The Broken Cosmic Distance Ladder by Professor Roberto Trotta
Monday, January 31, 2022 1:00 PM gres.hm/cosmic-distance
Barnard's Inn Hall/ Online Or watch later
Measuring distances to astronomical objects outside our Galaxy is a surprisingly hard challenge: it wasn't until 1929 that Edwin Hubble obtained proof that Andromeda is indeed a galaxy in its own right. Today, astronomers extend distance measurements in the cosmos to the edge of the visible Universe, building up a 'cosmic distance ladder' made of several rungs. This talk will explore a major conundrum of contemporary astronomy: as observations have become more precise, the distance ladder appears today to be broken.
FEBRUARY
Magnetic Universe by Professor Katherine Blundell
Wednesday, February 23, 2022 6:00 PM gres.hm/magnetic-universe
Museum of London / Online Or watch later
Magnetic fields have mysterious effects that can be dramatically counterintuitive, and they are ubiquitous throughout the Universe and can have influence on large scales. This lecture will explore how some of the exotic and energetic phenomena in the Universe can only be explained in terms of these magnetic fields that pervade space.
MARCH
Planetary Universe by Professor Katherine Blundell
Wednesday, March 30, 2022 6:00 PM gres.hm/planetary-universe
Museum of London / Online Or watch later
How can new worlds be discovered, and how many exoplanets might be out there? What does today's technology in astronomical observatories now enable, and what is it that holds us back from finding what is actually out there? What hinders us from pushing forwards the frontiers of space science?
MAY
The Future of Life on Earth by Professor Roberto Trotta
Monday, May 9, 2022 1:00 PM gres.hm/future-life
Barnard's Inn Hall/ Online Or watch later
Although life is probably widespread in the universe, our pale blue dot, Earth, is the only known place harbouring intelligent life. Even if we manage to stave off extinction by climate change, avoid a nuclear apocalypse and the dangers of runaway AI, biological life on our planet will eventually come to an end in about 5 billion years' time. What are the astrophysical dangers to life on Earth, and the prospects for life's survival into the distant future? JUNE
Life in the Universe by Professor Katherine Blundell
Wednesday, June 1, 2022 6:00 PM gres.hm/life-universe
Museum of London / Online Or watch later
How can life form in the Universe, and what are the necessary ingredients for habitability so that planets can sustain life? Can we expect life elsewhere in the solar system, or on exo-planets? This lecture offers a broader perspective from astrobiology, astrochemistry, and astrophysics on the habitability or otherwise of other planets beyond Planet Earth.
Their website
www.gresham.ac.uk
////////
Best wishes for the new Year
Martin
Martin Baker

SPACE NEWS TO JANUARY 22

James Webb Space Telescope

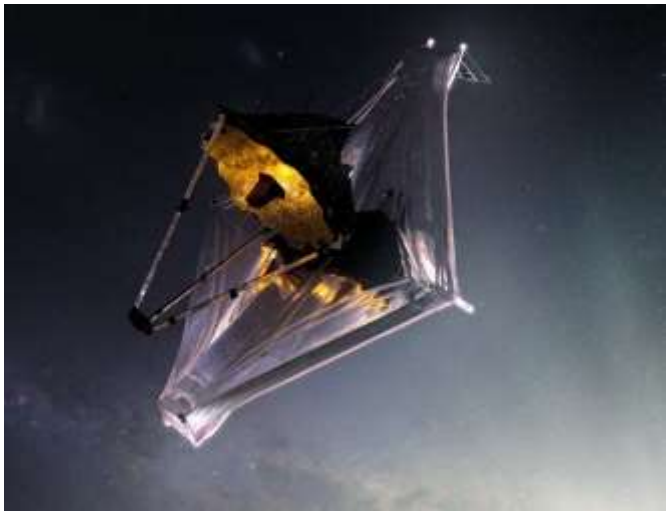


IMAGE SOURCE,NASA

Image caption,
Artwork: The fully deployed Webb telescope will have a kite-like shield the size of a tennis court

So far, so good. The US space agency says the post-launch set-up of the new James Webb telescope has gone very well.

"As smoothly as we could have hoped for."

Engineering teams are in the middle of unpacking the observatory from its folded launch configuration to the layout needed for operations.

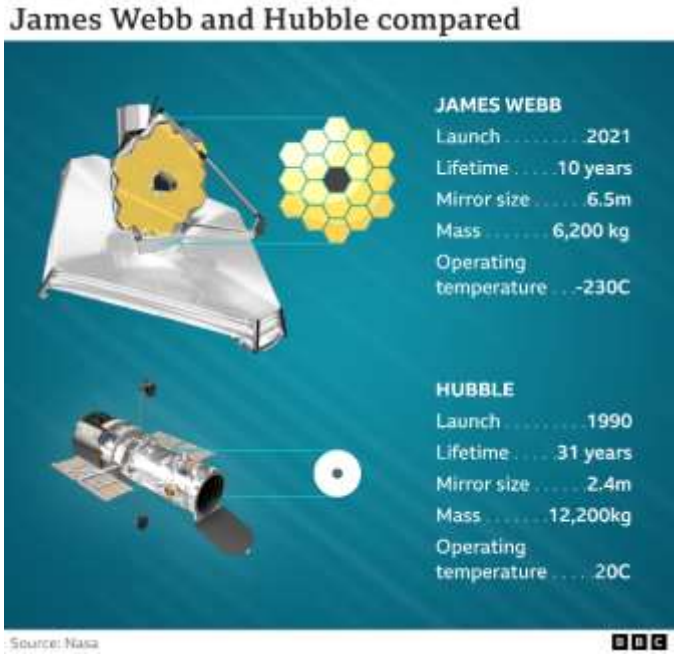
This involves the deployment of several structures, the most critical of which are Webb's mirrors and sun shield.

Monday saw the start of what is probably the most complex set of activities - the separation and tensioning of the five individual layers that make up the shield.

Media caption,
Watch the moment Webb moves away from its launch rocket to begin its mission

Each membrane in the shield is as thin as a human hair and must be gently pulled tight to form a rigid, kite-like barrier the size of a tennis court.

The task was practised multiple times on the ground with full-scale and sub-scale models, which Nasa's Bill Ochs says gives him confidence that all will go well.



"I don't expect any drama," the project manager told reporters on Monday. "The best thing for operations is 'boring'. And that's what we anticipate over the next three days - to be boring."

Engineers refer to "single point failures" to describe the actions, which, if they don't occur on cue and in the right order, are likely to scupper the whole undertaking. Webb must get past 344 of these hurdles to achieve its operational layout.

If the sun shield opens perfectly - which may even be accomplished as early as Tuesday - then 75% of those failure modes will have been overcome.

Mission controllers at the Space Telescope Science Institute (STScI) in Baltimore, Maryland, would then move on to deploying Webb's mirrors

The telescope has a secondary reflector that must be extended on long booms in front of the primary mirror. Friday is the current target for this.

The main mirror has "wings" that were tucked back for launch but which must now be rotated through 90 degrees to make a full, 6.5m-wide surface. Again, assuming things continue to run like clockwork, this should happen over the weekend.

The unfolding schedule has slipped somewhat from the pre-launch plan, but not because of any particular problems, said Bill Ochs. The engineering teams were simply taking a steady, methodical approach to their work, he stressed.

"We are still in the 'getting to know you' phase with the telescope. All satellites will be a little bit different on orbit than they are on the ground," he explained.

"It takes time to get to understand their characteristics, and that's a lot of what we've been doing over the last week, as well as still making excellent progress on the commissioning timeline."

IMAGE SOURCE,NASA

Image caption,
Practice makes perfect: Engineers have rehearsed the sun shield deployment over and over again

One of these learning moments involved the teams getting a better handle on how to manage the temperatures inside the motors that are used to drive the sun shield's deployment. A second involved the fine-tuning of Webb's solar array so that it can output the necessary power for the separation and tensioning of the membranes - as well as the mirror unpacking.

"Everything is hunky dory and doing well," said Amy Lo from Northrop Grumman, the American aerospace company that assembled Webb.

"The rebalancing of the array gives us quite a lot of margin for the expected increase in power that we will be needing as we proceed on commissioning."

James Webb was launched on 25 December on an Ariane rocket from French Guiana.

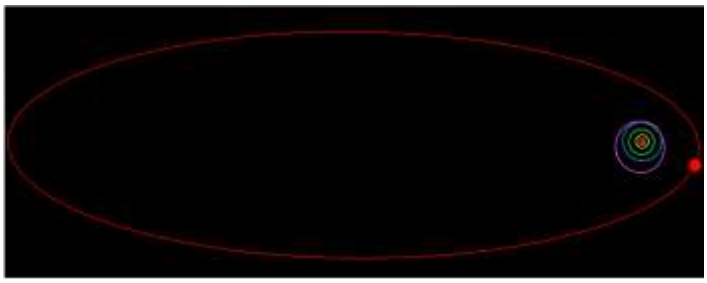
The telescope is regarded as the successor to the Hubble space observatory which is now 31 years old and nearing the end of its operational life.

Webb will do similar science to Hubble but with the next-generation technologies that allow it to see deeper into cosmos and, therefore, further back in time. Indeed, scientists

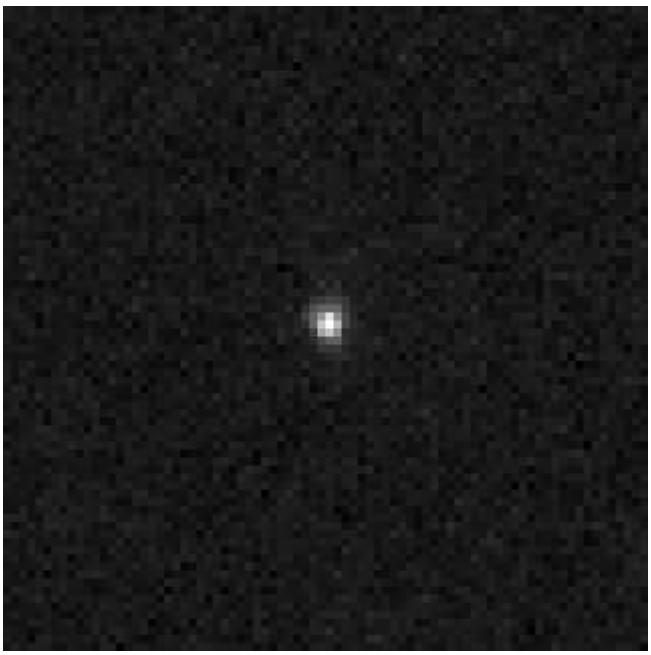
expect the new facility to detect the very first stars to ignite after the Big Bang more than 13.5 billion years ago.
But, unlike Hubble, Webb cannot be serviced by astronauts and so cannot achieve the same longevity as its predecessor.
That said, officials now think Webb will work for "a lot more" than the 10 years originally envisaged because its Ariane rocket was so accurate.
The European booster put Webb on a near-perfect trajectory with just the right amount of velocity. This performance meant the telescope didn't have to use so much of its own fuel when making later course refinements. The saved fuel will now be available for the everyday manoeuvres required to keep Webb sitting tidily at its observing position 1.5 million km from Earth.
James Webb is a joint venture between the American, European and Canadian space agencies.

2029 Will be the Perfect Year to Launch a Mission to Sedna

Object 90377 Sedna – a distant trans-Neptunian object known best for its highly elliptical, 11,390-year long orbit – is currently on its way towards perihelion (its closest approach to the Sun) in 2076. After that, Sedna will swing out into deep space again and won't be back for millennia, making this flyby a once-in-a-lifetime (or, once in ~113 lifetimes) opportunity to study an object from the far reaches of our solar system. There are no missions to Sedna in the works just yet, but astronomers are beginning to plan for the possibility, and the ideal launch date for such a mission is approaching fast, with two of the best launch windows coming up in 2029 and 2034.
Sedna was discovered in 2003 by Caltech astronomer Mike Brown and his team, and was one of a series of potential dwarf planets (alongside similar-sized bodies like Haumea, Makemake, and Eris) whose discovery led to the demotion of Pluto in 2006.
As best we can tell from a distance, Sedna is about the same size as Ceres, the largest object in the asteroid belt, but its composition and origins are very different. Its chemical makeup suggests it may be covered in deep reddish organic compounds known as tholins, the same material seen on Pluto and other Kuiper belt objects. Unlike Pluto, it is usually too cold for the methane abundant on its surface to evaporate and fall back as snow, though Sedna may briefly gain an atmosphere of nitrogen as it approaches the Sun.
What really sets Sedna apart from the other known dwarf planet candidates is its enormous orbit, which takes it out towards the inner edge of the Oort cloud, the most distant region of the Solar System, where long-period comets lurk. There are several competing theories to explain how Sedna ended up in this position. Perhaps the most high-profile theory is the possibility that a yet unknown ninth planet, perhaps ten times the size of Earth, disrupted Sedna's orbit and swept it and several other objects out into highly elongated orbits. Visiting Sedna probably won't solve this particular mystery, but it will tell us a lot about the composition of these extreme trans-Neptunian objects.



The orbit of dwarf planet candidate 90377 Sedna (red) compared to Jupiter (orange), Saturn (yellow), Uranus (green), Neptune (blue), and Pluto (purple). Credit: Szczureq/kheider/NASA (Wikimedia Commons).
Reaching Sedna with a spacecraft won't be a simple task. Even at its closest approach, Sedna will only come about 76AU from the Sun. For comparison, Neptune is about 30AU, and the Voyager missions, launched in 1977, are just now crossing 150AU and 125AU respectively. That means the time to launch is sooner, rather than later.
In planning a mission to Sedna, the Voyager spacecraft are not bad places to look for inspiration. They famously took advantage of a lucky alignment of planets to take a grand tour of the outer Solar System, stealing energy from Jupiter to pick up speed and reach their more distant targets. Similar gravity assists will be required to make the trip to Sedna manageable. A team of scientists led by Vladislav Zubko from the Space Research Institute of the Russian Academy of Sciences recently modeled a series of possible trajectories to Sedna, favoring a 2029 launch date as the most feasible option.
The 2029 trajectory, they determined, would take the spacecraft to Venus first, then back to Earth (twice), before passing Jupiter on the way to Sedna, with flight times as short as 20 years but more optimally in the 30-year range. The longer flight time would increase the altitude of the spacecraft over Jupiter during the gravity assist, reducing the time spent exposed to the gas giant's harmful radiation.
A 30-year flight plan would also mean passing by Sedna more slowly, providing more time to gather data on the object. Choosing this option would give the spacecraft a relative velocity of 13.70km/s as it passed Sedna, comparable to the speed at which New Horizons approached Pluto in 2015.



90377 Sedna as seen by the Hubble Space Telescope in 2004. Credit: NASA.
As a bonus, this trajectory would also take the spacecraft past a 145km diameter asteroid named Massalia, providing the team with an additional scientific target to study, as well as a chance to test the spacecraft's systems.
A second trajectory proposed by the team would consist of a 2034 launch, and would provide a similar additional flyby, this time of the metallic asteroid 16 Psyche.
At the moment, it's unclear whether a mission to Sedna will actually make it to the launch pad with all the competing options available to mission planners in the coming decade, but as it's our only chance in the next 11,000 years, the idea is sure to be given due diligence.

A Detailed Scan of the Milky Way Finds Possible "Fossil" Spiral Arms

As we learn more about the cosmos, it's interesting how some of the greatest discoveries continue to happen close to home. This is expected to continue well into the future, where observations of Cosmic Dawn and distant galaxies will take place alongside surveys of the outer Solar System and our galaxy. In this latter respect, the ESA's Gaia observatory will continue to play a vital role. As an astrometry mission, Gaia has been to determine the proper position and radial velocity of over a billion stars to create a three-dimensional map of the Milky Way.
Using data from *Gaia's* third early Data Release (eDR3)

and Legacy Survey data – from the Sloan Digital Sky Survey (SDSS) – an international team of astronomers created a new map of the Milky Way's outer disk. In the process, they discovered evidence of structures in this region that include the remnants of fossil spiral arms. This discovery will shed new light on the formation and history of the Milky Way and may lead to a breakthrough in our understanding of galactic evolution.

The research was led by Chervin Laporte of the Institute of Cosmos Sciences of the University of Barcelona (ICCUB-IEEC) and the Kavli Institute for the Physics and Mathematics of the Universe at the University of Tokyo. He was joined by Sergey E Koposov and Vasily Belokurov, astronomers with the Royal Observatory at the University of Edinburgh (ROE) and the University of Cambridge (respectively). Their findings were described in a study that appeared in the *Monthly Notices of the Royal Astronomical Society: Letters*.

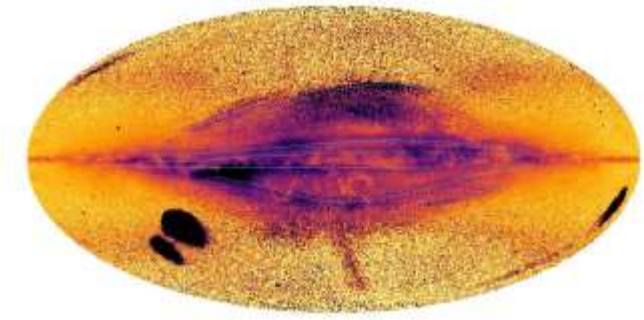
Artist's conception of the Gaia telescope backdropped by a photograph of the Milky Way. Credit: ESA/ATG medialab; background: ESO/S. Brunier

Using data from the *Gaia* mission released in December 2020, Laporte and his team identified coherent structures in the outer disk of the Milky Way to create a sharper map of the region. While this map provided sharper views of previously known structures, it also revealed the existence of previously-unknown spinning filamentary structures. On its face, this discovery was not so surprising since numerical simulations have predicted the existence of such filamentary structures already.

These are attributed to past interactions with satellite galaxies, which our galaxy has done plenty of in the past. Currently, there are 50 satellites surrounding our galaxy, like the Sagittarius dwarf galaxy that has been perturbing the Milky Way on and off for the past 5 or 6 billion years. However, the sheer quantity of substructures observed in these spinning filaments was unexpected and left Laporte and his colleagues mystified.

One possibility is that they are the remains of tidal arms from the Milky Way disk that were excited by various satellite galaxies at different times in the past. For example, before the Sagittarius dwarf galaxy, astronomers suspect that the Milky Way interacted with the Gaia Sausage – the remains of a dwarf galaxy that merged with the Milky Way about 8–11 billion years ago.

In a previous study, Laporte and his colleagues showed that one of the filamentary structures in the outer disk (the Anticenter Stream) contained stars that are mostly 8 billion years old or more. This meant they were too old to have been excited by Sagittarius alone and must have also experienced interaction with the Gaia Sausage. Another possibility is that some of these structures are not fossil spiral arms at all, but are the crest of large-scale vertical distortions in the Milky Way disk.



All-sky map of the Milky Way in motion using the Gaia data, showing a number of large-scale filamentary disk structures around the midplane. Credit: Laporte et al.

"We believe that discs respond to satellite impacts which set up vertical waves that propagate like ripples on a pond," said Laporte in a recent RAS press release. To look into this further, the team has secured a dedicated follow-up program with the William Herschel Telescope on the island of Las Palmas. Using its optical and spectroscopic instruments, Laporte and his colleagues will attempt to study the properties of the stellar populations in each substructure.

Their efforts, and other surveys mounted in the near future, will help shed light on the nature and origin of these wispy structures, which will improve our understanding of how galaxies evolve through interaction and mergers. Said Laporte: *"Typically this region of the Milky Way has remained poorly explored due to the intervening dust which severely obscures most of the Galactic midplane. While dust affects the luminosity of a star, its motion remains unaffected. We were certainly very excited to see that the Gaia motions data helped us uncover these filamentary structures! Now the challenge remains to figure what these things exactly are, how they came to be, why in such large numbers, and what they can tell us about the Milky Way, its formation and evolution."*

Want Updates on JWST? NASA's Site Will Bury you in Data: Distance, Temperatures, Deployment Stats… Everything

Want to know the latest details on the James Webb Space Telescope? NASA has a "dashboard" where you can see all the data: location, the current deployment info, temperatures and more.

The "Where's Webb" site includes everything you want to know as Webb unfolds during its travels out 1.5 million km (1 million miles) to the second Lagrange point, or L2. NASA said the deployments should wrap up about 2 weeks after launch, but it will take another 2 weeks to reach L2.

NASA also has a frequently updated blog on JWST, with details on the latest events.

Additionally, on Twitter you can find the latest news via NASA's Webb Telescope account, ESA's Webb Telescope account, and the Space Telescope Science Institute's feed.

Also, NASA said today that over about the next two weeks, they will provide broadcast coverage, media briefings, and other updates on major deployment milestones. Broadcasts of milestone events will air live on NASA TV, the NASA app, and the agency's website.

As of today (December 30), the Where's Webb site reports how the telescope's momentum flap deployed shortly after 9am EST (1400 UTC). This flap will help counteract forces from the solar wind on the telescope's gigantic sunshield, helping to conserve propellant. (Find out how the observatory has already conserved propellant, likely extending the mission!) Photons of sunlight hitting the sunshield surface exert pressure on the sunshield. The aft momentum flap uses the pressure of these photons to balance the sunshield and keep

Webb steady.
With the momentum flap deployed, the most challenging phase of Webb's activation can begin: sunshade deploy. Launch restraints holding the folded membranes in place will be released today and protective covers rolled up out of the way.
These deployments all lead to the big one: the actual sunshade extraction, which will begin Friday, December 31. Two midbooms will extend at right angles to the two pallets that were deployed this week. The midbooms will pull out both sides of the 5-layer sunshield. The process is expected to begin around 9:20am (1420 UTC) on the 31st.
Want your own checklist of Webb's deployment schedule? Dr. Heidi Hammel and colleagues from AURA (Association of Universities for Research in Astronomy) have put one together than you can download and print. The AURA site also has a blog updated by Hammel on the latest deployments.

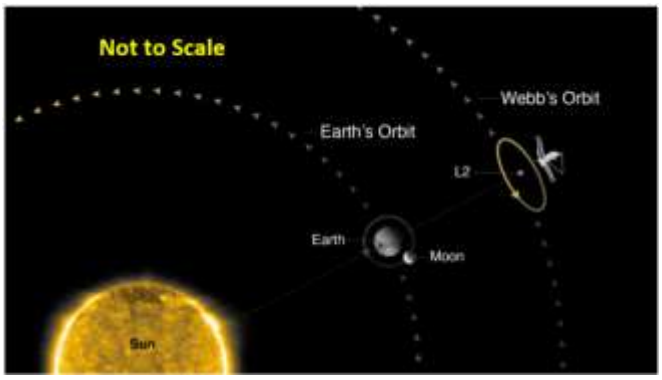
If all goes according to plan, the telescope will be fully deployed 13 days after launch, on January 7, and will reach its final destination orbiting L2 at 29.5 days after launch on January 23. After that, the observatory will undergo five months of turning on instruments and commissioning them, preparing the entire observatory for science operations, expected to begin in the summer of 2022.
In the meantime, enjoy this new high-resolution view of JWST's separation from the Ariane 5 upper stage, just released today. You can also see the solar array deploy in Earth orbit.
JWST's Precise Launch and Near-Perfect Course Corrections Mean Fuel Savings. And That Means a Longer Mission
After a detailed analysis of where the James Webb Space Telescope is now (Dec. 29, 2021) and how it got there, NASA determined the observatory should have enough propellant to operate in space for significantly more than 10 years in space.
Webb's mission lifetime was designed to be at least 5-1/2 years, and mission engineers and scientists were hoping for closer to 10 years.

The "significantly more than 10 years" announced today comes from two factors: the precision of the Ariane 5 launch on December 25, which experts say exceeded the requirements needed to put Webb on the right path. And now, because of how precise JWST's trajectory has been, the first two mid-course correction maneuvers took significantly less fuel than expected.
The first course correction was a 65-minute burn after that took place about 12.5 hours after launch. While 65 minutes sounds like a long time, a burn lasting as long as 3 hours could have been required. That first burn put the observatory on an even more precise path and added approximately 45 mph (20 meters/sec) to the observatory's speed. A second shorter correction maneuver on December 27, added around 6.3 mph (2.8 meters/sec) to the speed.

JWST's lifetime is limited by the amount of fuel used for getting to L2 and maintaining its orbit, and also by the possibility that Webb's components will degrade over time in the harsh environment of space.

The precise trajectory the observatory is now on means more propellant for orbit maintenance and momentum management down the road, which means a longer operational lifetime.

Which also means more science!



Webb's orbit is around L2—a point of gravitational balance on the other side of Earth from the Sun—but it does not reside exactly at the L2 point. Right at that point, Earth's shadowing of the Sun would be large enough to greatly reduce the amount of power available for Webb's solar arrays, without greatly simplifying the cooling challenges. In addition, when Webb's communication antennas point at Earth to receive commands, they would be blinded by the huge radio emission of the Sun in the same direction. Instead, as the diagram indicates, Webb operates in a very loose orbit (many hundreds of thousands of km in diameter) around L2, in constant sunlight and with clean communications with the ground stations. Credit: NASA

"The largest and most important mid-course correction (MCC), designated MCC-1a, has already been successfully executed as planned, beginning 12.5 hours after launch," wrote Randy Kimble, JWST Integration, Test, and Commissioning Project Scientist, at NASA Goddard, in a blog post detailing the course correction maneuvers. "This time was chosen because the earlier the course correction is made, the less propellant it requires."

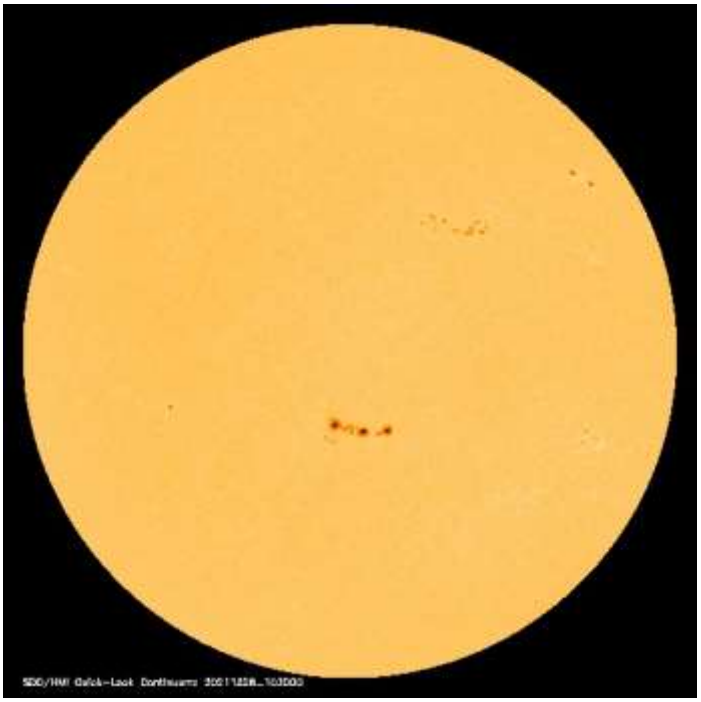
The other big news from Webb is that the first parts of the tennis-court-sized sunshields have successfully deployed. On December 28, the forward and aft sunshield pallets were unfolded. As this report is being written, the Deployable Tower Assembly is being extended, a six-hour operation that was commanded remotely from the Operations Center. This tower creates space between the spacecraft and the telescope, giving the sunshield room to deploy. Once everything is deployed, this space will also help to keep the telescope cold.
If all goes well today, the next steps will be the release of the sunshield covers, the extension of the mid-booms, and finally the tensioning of the five Kapton layers of the sunshield itself. This will take place over the next several days. NASA says that because the deployment of the sunshield is one of the most challenging spacecraft deployments NASA teams have ever attempted, the mission operations team built flexibility into the planned timeline, so that the schedule and even sequence of the next steps could change in the coming days.

NASA also noted that on the "Where is Webb" website — where you can find all sorts of information about the observatory — new details are being added. You can now track the temperatures the spacecraft. Webb actually will have two different temperatures, due to being warm on one side and cold on the other. The sunshield will always be facing the Sun to block out heat and light, as Webb's mirrors need to stay extremely cold to observe faint heat signals in the universe.
On the hot side, parts of Webb will reach temperatures as high as 85 degrees Celsius, or 185 degrees Fahrenheit. On the cold side Webb will be about -233 degrees Celsius, or -388 degrees Fahrenheit. NASA said temperatures will continue to change as Webb unfolds and then cools down to operating temperatures over the next months.

Astronomy 2022: Top Skywatching Events for the Coming Year

Meteor showers, eclipses and a fine opposition of Mars top out astronomy 2022.

2022 offers another fine sky watching year. 2021 brought us a remote Antarctic total solar eclipse, a surprise Christmas comet C/2021 A1 Leonard, and a return of solar activity with solar cycle Number 25. 2022 promises more of the same, as the solar cycle heads towards an active maximum in 2025. But there's lots more in store in the sky in 2022. Alas, no 'red nova' is expected in 2022.



The active Earthward face of Sol at the end of 2021. Credit: NASA/ESA/SOHO

Here's what we're looking forward to in the sky in 2022. Let's start with the very 'best of the best' for the year;

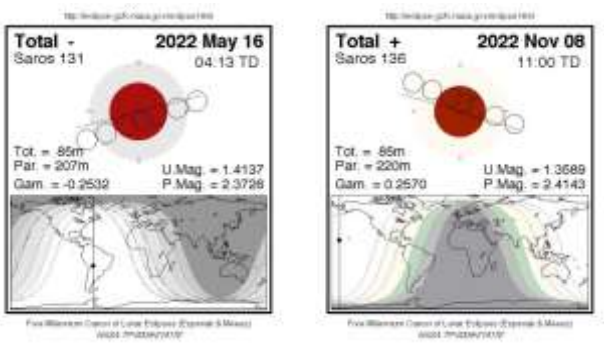
Top 10 Astronomical Events for 2022

-Solar cycle 25 heads towards its peak
–January 3rd: Comet A1 Leonard reaches perihelion
-January 3rd: The Quadrantid meteor shower occurs near New Moon
–April 30th: Partial Solar Eclipse
–May 16th: Total Lunar Eclipse
-October 4th: Asteroid 23 Thalia occults a +6th magnitude star
–October 25th: Partial Solar Eclipse
–November 8th: Total Lunar Eclipse
-December 8th: The nearly Full Moon occults Mars
–December 8th: Mars at opposition

You can see an expanded, in-depth list of events for the coming year in our book *The Universe Today's Guide to Viewing the Cosmos* and Guy Ottwell's new digital *Astronomical Calendar 2022*. We'll also be tweeting all of the astronomical action in 2022 as @Astroguyz on Twitter.

Eclipses in 2022

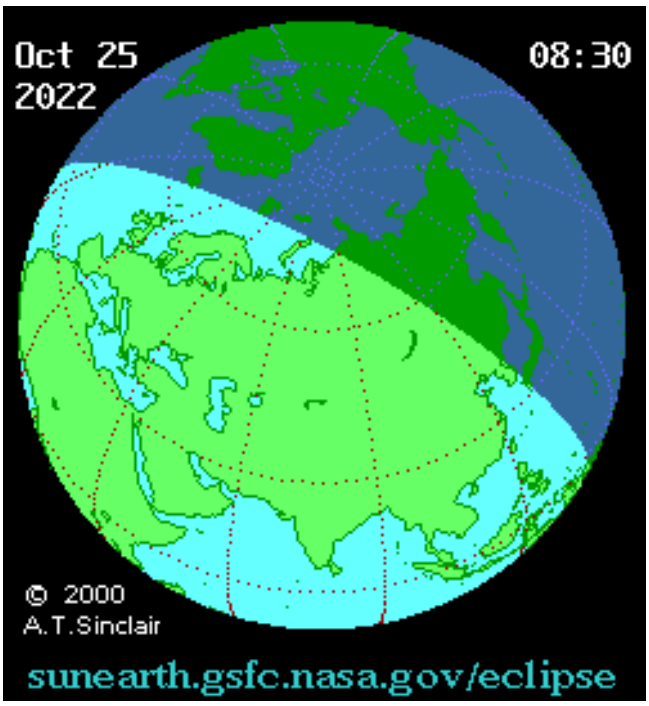
There are four eclipses in 2022 (the minimum that can occur in a calendar year), two solar and two lunar.



A tale of two total lunar eclipses in 2022. Credit: NASA/GSFC/Fred Espenak.

Those four eclipses are:

-April 30th: a 64% partial solar eclipse favoring the SE Pacific and southern South America.
-May 16th: a total lunar eclipse (totality is 1 hour and 25 minutes in duration) favoring the Americas, Europe and Africa.
-October 25th: an 86% partial solar eclipse favoring Europe, NE Africa, the Middle East and western Asia.
-November 8th: a total lunar eclipse (totality is also 1 hour and 25 minutes in duration) favoring Asia, Australia, the Pacific and the Americas.



The October 25th partial solar eclipse. Credit: AT Sinclair/ NASA/GSFC

The Sun, Moon and Seasons in 2022

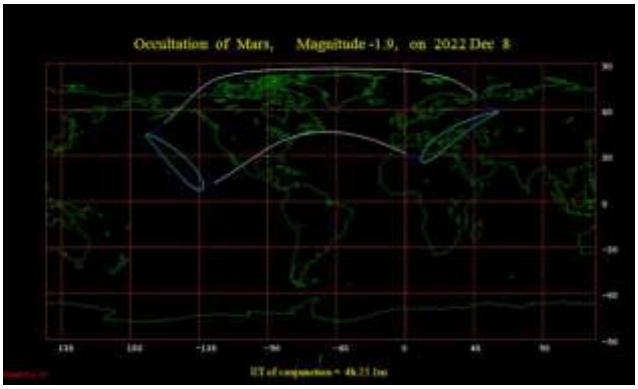
The biannual solstices and equinoxes mark the start of the astronomical seasons. Either equinox in September and March are good times to watch for peaks in auroral activity, via a phenomenon known as the Russell-McPherron effect. In 2022, aurorae in general should become more frequent, as Solar Cycle 25 intensifies. The equinoxes also mark the start of geostationary satellite flare and eclipse season, as the distant satellites rise briefly into naked eye visibility, only to be extinguished as they hit the Earth's shadow. And speaking of satellites, the International Space Station enters spans of full illumination near either solstice, with sighting opportunities favoring the northern hemisphere in June, and the southern hemisphere in December.

Here are the seasonal dates and more for 2022:

January 4th: Earth is at perihelion.
March 20th: Northward equinox.
June 21st: Northward solstice.
July 4th: Earth is at aphelion.

September 22nd: Southward equinox.
December 21st: Southward solstice.
The path of the Moon continues to roughly follow the ecliptic plane in 2022, as we head towards the steep years around the Major Lunar Standstill in 2025. We also have 12 Full Moons and 13 New Moons in 2022, with the 2nd New Moon of April on the 30th being a 'Black Moon'. And while two Full Moons (aka Supermoons) fall near lunar perigee in 2022 on July 13th and August 10th, no Full Moons fall within a day of apogee in 2022.

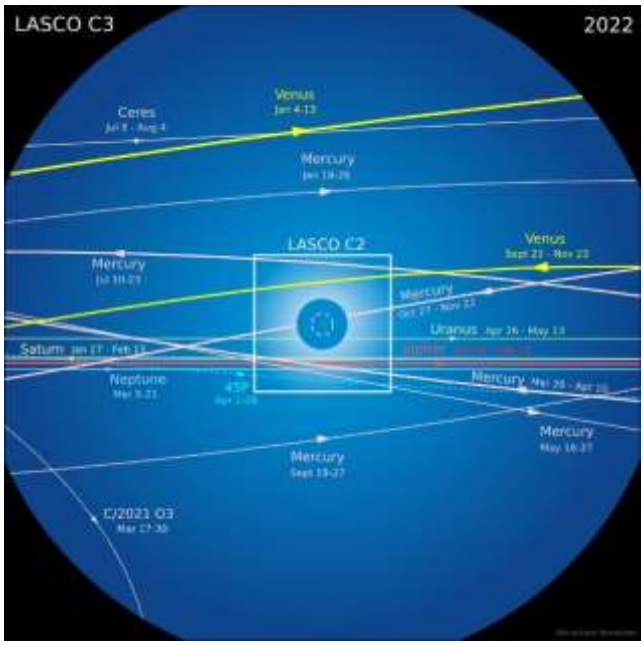
Lunar Occultations in 2022
The Moon sweeps out a half degree wide path through the sky on its trek, occasionally passing in front of a planet or star. In 2022, the Moon occults 3 planets 7 times, including:
-May 27th: The 11% illuminated waning crescent Moon occults Venus for Madagascar.
-June 22nd: The 33% illuminated waning crescent Moon occults Mars for Antarctica.
-July 21st: The 39% illuminated waning crescent Moon occults Mars for NE Asia.
-October 24th: The 1% illuminated waning crescent Moon occults Mercury for NW North America.
-October 25th: The slim crescent Moon occults Venus for South Africa, only an hour after a partial solar eclipse.
-November 24th: the 1% waxing crescent Moon occults Mercury for Antarctica.
-December 8th: the Full Moon occults Mars (at opposition) for North America and Europe.



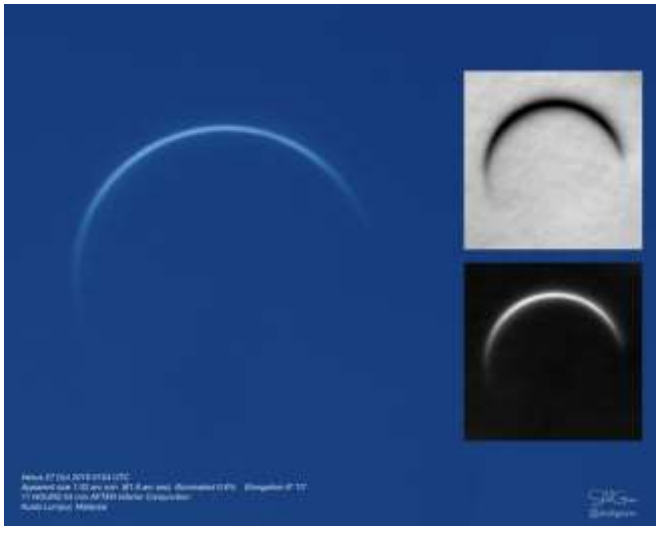
The occultation footprint for the Moon versus Mars on December 8th. Credit: Occult 4.2.
The Moon versus stars- The Moon does not occult a +1 magnitude or brighter star in 2022.

The Best Asteroid Occultations in 2022
These are tougher events to catch, as the 'shadow' of a distant asteroid briefly passes in front of a distant star. Still, such events can yield information of the asteroid's size, shape and position… and occasionally, tiny orbiting moonlets even make themselves known.
Here are the top asteroid occultations (+6 magnitude stars only) for 2022:
-514 Armida occults a +6.8 magnitude star on March 12th for South America.
-410 Chloris occults a +6.4 magnitude star on May 11the for Australia.
-23 Thalia occults a +6.7 magnitude star on October 4th for eastern Canada/USA

The Planets in 2022
We're coming off of 2020 and 2021's complex series of mutual events for the Galilean moons, as Jupiter's outermost major moon Callisto ends shadow transits in July 2022, and won't begin to do so again until 2025, heralding the next series of eclipses and occultations for Jupiter's major moons. Saturn's rings head towards edge on in March 2025, and are tilted about 12 degrees open, with the northern hemisphere of the planet tipped towards the Earth in 2022. Finally, Mars is at opposition at the end of the year, though oppositions for the Red Planet are getting closer to aphelion this decade, and are getting increasingly unfavorable now until 2029.
Here's the best times to catch the outer planets in 2022:
July 20th-Pluto at opposition
August 14th-Saturn at opposition
September 16th-Neptune at opposition
September 26th-Jupiter at opposition
November 9th-Uranus at opposition
December 8th-Mars at opposition



Transits of solar system objects in 2022 through SOHO's LASCO C3/C2 fields of view. Credit: Worachate Boonplod.
Also, we have another span on time where you can see all five planets in the dusk sky at once at the end of 2022, from December 1st to January 5th, 2023.
Meanwhile in the inner solar system, razor thin Venus reaches inferior conjunction between the Earth and the Sun on January 9th, casting its brilliance back into the dawn sky for most of 2022 afterwards.



Venus at inferior conjunction in 2018. Credit: Shahrin Ahmad.
Inner planets- Mercury reaches greatest elongation 7 times in 2022, While Venus does so once:
-January 7th: Mercury at greatest eastern (dusk) elongation, 19.2 degrees from the Sun.
-February 16th: Mercury at greatest western (dawn) elongation, 26.2 degrees from the Sun.
-March 20th: Venus at greatest western (dawn) elongation, 46.6 degrees from the Sun.
-April 29th: Mercury at greatest eastern (dusk) elongation, 20.6 degrees from the Sun.

-June 16th: Mercury at greatest western (dawn) elongation, 23.2 degrees from the Sun.
-August 27th: Mercury at greatest eastern (dusk) elongation, 27.3 degrees from the Sun.
-October 8th: Mercury at greatest western (dawn) elongation, 18.0 degrees from the Sun.
-December 21st: Mercury at greatest eastern (dusk) elongation, 20.1 degrees from the Sun.

Conjunctions in 2022

Conjunctions are pairings of bright stars or planets. Here are the very best conjunctions of naked eye planets and stars for 2022, with separations of less than a degree:
April 5th-Mars from 18' Saturn (53 degrees west of the Sun at dawn).
April 30th-Venus from 12' Jupiter (42 degrees west of the Sun at dawn).

Jupiter meets Venus on the morning of April 30th. Credit: Stellarium.

May 29th-Mars from 36' Jupiter (64 degrees west of the Sun at dawn).
August 4th-Mercury from 42' Regulus 19 degrees east of the Sun at dusk).
September 5th-Venus from 42' Regulus (13 degrees west dawn).

Comets at Perihelion in 2022

Comets come and go, and often over- or under-perform versus predictions. In the past two years, we had two comets turn up and flirt with naked eye visibility: F3 NEOWISE in 2020, and A1 Leonard in 2021. You just never know when the next 'great comet' will turn up. Here are the perihelion dates for periodic and known long-term comets inbound to watch for topping out over +10th magnitude in 2022:
-January 3rd: Comet C/2021 A1 Leonard (magnitude +4 in the constellation Piscis Austrinus, 37 degrees from the Sun).
-January 11th: Periodic Comet 104P/Kowal (magnitude +9 in Cetus, 79 degrees from the Sun).
-February 1st: Periodic Comet 19P/Borrelly (magnitude +9 in Pisces, 70 degrees from the Sun).
-April 20th: Comet C/2021 O3 PanSTARRS (magnitude +5, 17 degrees from the Sun).
-April 26th: Comet 45P/Honda-Mrkos-Pajdusakova (magnitude +9 in Aries, 8 degrees from the Sun).
-September 1st: Periodic Comet 255P/Levy (magnitude +9 in Cancer, 30 degrees from the Sun).
-December 19th: Comet C/2017 K2 PanSTARRS (magnitude +6 in Pavo, 37 degrees from the Sun).

Meteor Showers in 2022

Meteor showers are always fun to watch for, with no equipment necessary: just a dark sky and a working set of Mk-1 eyeballs. One shower worth watching for in particular in 2022 is the June Boötids hailing from the Comet 7P Pons-Winnecke, which just reached perihelion just last year. Here are meteor showers to watch for the 2022, with a favorable Moon less than 50% illuminated near the respective peaks:
January 3rd– Quadrantids peak at ZHR~60, with the Moon a 1% waxing crescent.

The radiant for the elusive January Quadrantids. Credit: Stellarium.

May 6th– The Eta Aquarids peak at ZHR~50, with the Moon a 27% illuminated waxing crescent.
June 27th– The June Boötids peak at ZHR~50, with the Moon a 2% illuminated waning crescent.
July 30th– The Delta Aquariids peak at ZHR~30, with the Moon a 3% illuminated waxing crescent.
October 21st– Orionids peak at ZHR~20, with the Moon a 16% illuminated waning crescent.
November 17th– Leonids peak at ZHR~20, with the Moon a 40% illuminated waning crescent.
December 22nd– Ursids peak at ZHR~50, with the Moon a 15% waning crescent.
Finally in the deep-sky department, two notable double stars reach periastron or apastron in 2022:
-13 Ceti (magnitudes +5.6, +6.9) and a minimum separation of 0.3" in 2022, with a 6.9 year period
-Tau Cygni (magnitudes +4, +6) and a maximum separation of 1.0" in 2022, with a 50 year period
You can read all about 'double stars with orbits you might live through' and much more in our new *Deep-Sky Field Guide*.
Will it be cloudy or clear? Will the next great 'Comet of the Century' make itself known? Will artificial 'stars' by way of Starlink satellites and friends soon outnumber real stars? Get ready for another exciting year of astronomy 2022.

The Real Science Behind the Movie "Don't Look Up"

The new movie "Don't Look Up" — now available on Netflix — is not your usual sci-fi disaster film. Instead, it is a biting parody on the general public's dismissal and indifference to science. While the movie is about a comet on a collision course with Earth, filmmakers originally meant "Don't Look Up" to be a commentary on climate change denial. But it also is reflective of the current COVID denial and mask/vaccine resistance, as well as our existing political polarization. It also lays bare our preoccupation with social media. While the movie is sometimes funny, it can also be depressing and frustrating.

"Don't Look Up" includes a star-studded cast: Leonardo DiCaprio, Jennifer Lawrence, Jonah Hill, and Cate Blanchett. Meryl Streep, who plays the president of the US, has said this is the most important film she's ever made.

Filmmaker Adam McKay wanted this film to portray the science — and the challenges faced by scientists — as realistically as possible. He brought in well-known astronomer Dr. Amy Mainzer to serve as the film's science consultant.

Mainzer is a professor at the Lunar and Planetary Laboratory at the University of Arizona and one of the world's leading scientists in asteroid detection and planetary defense. As principal investigator of NASA's NEOWISE mission (Near-Earth Object Wide-field Infrared Survey Explorer) Mainzer has overseen the largest space-based asteroid-hunting project in history. A comet named after the mission, Comet NEOWISE, was discovered by astronomers who work with the spacecraft in March of 2020. Mainzer talked with Universe Today 's Nancy Atkinson about the science in "Don't Look Up."

Nancy Atkinson: When you received a call about working on a film about a comet, what was your first reaction?

Amy Mainzer: I am in favor of anything that features comets and asteroids in a script, as these are subjects near and dear to my heart! I'm happy to see that they are part of the cultural conversation through movies, and it was really fun to work on the project.

Atkinson: As a science advisor, what were some of your tasks?

Mainzer: I helped to bring in some science realism for the movie. This this is obviously a science fiction movie, since we don't know of any asteroid or comet that is on an impact trajectory to hit the Earth, or any that have a reasonable chance to do so in the near future. So right off the bat we are in sci-fi territory. But that said, we wanted to anchor the movie in science realism so that it provides a framework that is not so "out there" that viewers would have to suspend belief. But the team behind the film is very interested in science and its portrayal in movies is important for them, and so that's why it has so much science in it.

We helped design the comet — one that would fit the bill for the movie, but also be scientifically accurate. We described the circumstances of the discovery — how such an object might be recognized, how the trajectory would be determined, and how the scientists would react as they started to learn more about the object. The other part was to help portray scientists as human beings: what are we like, and how do we communicate science? Sometimes we succeed when we communicate, other times we do have challenges.

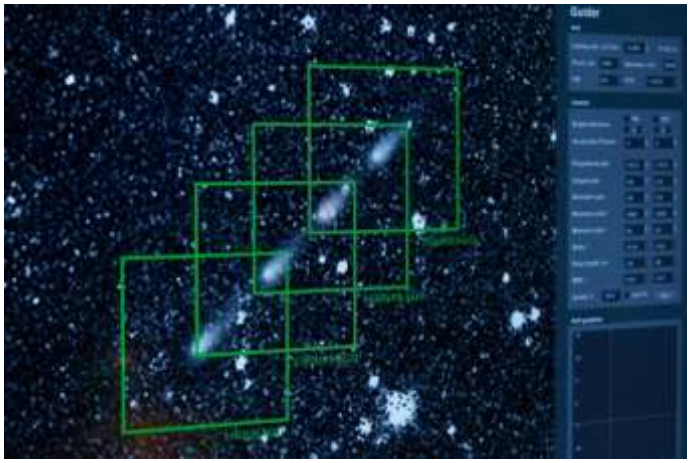
Atkinson: What stood out to me about the movie was that the scientists who try to warn of a disaster weren't listened to. Given everything going on in our world – climate change and a raging pandemic – that indifference felt a little **too** real! How did that feel to you?

Mainzer: This movie has a lot to do with how we as a society take news from science and react to it. As you know, Nancy, as a science communicator, you are deeply steeped into trying to translate complex technical ideas into words that everyone will understand. And that's a real challenge, because scientists sometimes use words in completely different ways than they are used in everyday life.

For example, how we communicate 'uncertainty' – that word in science means that there is a range of possible values within the measurements we make, and not that we don't know what we've measured! That's just one example, but it exemplifies there's sometimes a language barrier, because words are used differently.

To me, the movie is about how scientists try to take what we are learning about the world and bring that knowledge to everyone else so that decisions can be made based on the science. That's a really challenging thing to do. But in the end, this movie is a comedy and hopefully people who see it will laugh a little at how all of us – while we try to do our best – don't always succeed.

Atkinson: Could you share some of the science tidbits in the movie, and any chance that the real NEOWISE mission gets a mention?



A movie still from DON'T LOOK UP, showing the incoming comet's trajectory. Credit: Netflix © 2021, used by permission.

Mainzer: I actually did model the comet in the movie loosely after Comet NEOWISE! This is a long period comet, which can come in at incredible speeds from the outer solar system relative to the Earth. We discovered NEOWISE in March 2020 and close approach to Earth was in July, and so like the comet in the movie, there was a very short window of time between its discovery and close approach.

The good news is that in reality, we have found most of the really large near-Earth asteroids out there – things that are capable of causing global catastrophes. When we get to asteroids that are 1 km or larger, we know of more than 90% of those and none pose any hazard that we know of.

However, long period comets are a different story. They are much rarer than asteroids but they are out there. And while we keep watch for them, we don't know as large of percentage of that population. From my standpoint, an object making a close approach to Earth is a non-zero probability, so we do want to be knowledgeable and prepared. Therefore, the reasonable thing to do is to look for comets and asteroids, and track them with comprehensive surveys.

One of the things I spent a lot of time talking with the director about is how our system is designed for transparency. When we find an asteroid or comet, there's a system set up to take the observations and associate it with previously known objects If the object is not something we already know about, the system is to make it public so that other astronomers can look at it.

DON'T LOOK UP (L to R) Mark Rylance as Peter Isherwell, Meryl Streep as President Janie Orlean, and Jonah Hill as Jason Orlean. Cr. NIKO TAVERNISE/NETFLIX © 2021. Used by permission.

From the scientists' perspective, we are doing all we can to get the information out there, but the question is, how do people react? We are trying to do what we can to get the knowledge out there, and that process is portrayed in the movie.

Also, in the movie, the scientists who make the discovery are people who don't do systematic surveys of comets for a living. They serendipitously discover the comet and the movie walks through the process of how they recognized this comet, how they determined its orbit and then how they communicated the results to the rest of the science community. Hopefully viewers will recognize the grains of real science, even though the movie definitely takes some artistic license.

Atkinson: There are several big-name actors in this film. What was your reaction when you heard who was in the cast?

Mainzer: These actors are legends for good reason. They are incredibly talented, and they are all people who really feel they could play an important role in portraying scientists as human beings — in all our human glory! They all care passionately about science and its role in society, along with the idea that we really should make decisions based on science in order to tackle problems as best we can. I spent a lot of time working with the cast on the dialogue, because some of the scientific terminology is cumbersome. And also, to express how scientists feel when we aren't being listened to.

One of the things I've always thought interesting is the interaction between science and the arts. Science tells us what is happening with nature, but the arts deal with is how we react: how do we feel and process what we learn from science? So, this movie deals with how both scientists and the general public react to what we are learning. The tension of trying to change society to make science-based decisions and how to get people to listen to science is very much at the heart of the movie.

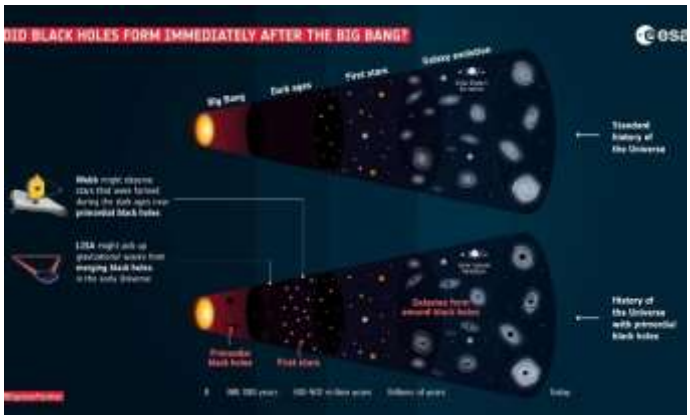
Atkinson: A common thread in science denial is that NASA or the government is hiding things from the public. All the scientists I talk to always say that if they discovered a dangerous object in space, they'd be shouting it from the rooftops!

Mainzer: In my experience that is absolutely the case! When we learn something new and cool in science, it's like going on a great trip and when you get home you might bore everyone because you can't stop talking about it. Most scientists won't stop talking about the things we learn because we love it. And we want other people to know about it because if they know about it they might love it too! That is part of the process that gets explored in the movie.

Atkinson: What's the biggest thing you hope people take away from the movie?

Mainzer: Hopefully the movie conveys that scientists are humans – and that this process of science is a human process. As scientists, we may sometimes have communication challenges, but we are trying, and we are going to keep trying!

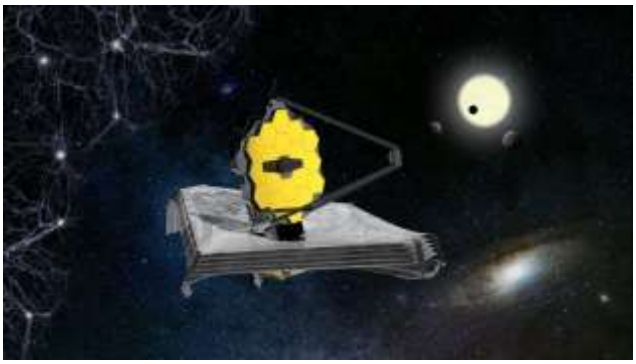
Primordial Black Holes Could Explain Dark Matter and the Growth of Supermassive Black Holes at the Same Time



It's that time again. Time to look at a possible model to explain dark matter. In this case, a perennial favorite known as primordial black holes. Black holes have long been proposed as the source of dark matter. In many ways, they are the perfect candidate because they only interact with light and matter gravitationally. But stellar-mass black holes have been ruled out observationally. There simply aren't enough of them to account for dark matter.

Primordial black holes are a possible solution. Unlike stellar black holes that would have a mass larger than the Sun, primordial black holes could have the mass of a mere planet or less. A planet-mass black hole would be smaller than an apple, and an asteroid-mass black hole could be smaller than a grain of sand. They are known as primordial black holes because they are thought to have formed during the early moments of the universe. The idea hasn't been tremendously popular, and we have no observational evidence that primordial black holes exist, but a new study has looked at the idea once again.

This study tweaks the original model slightly, proposing that primordial black holes with a range of masses formed almost instantly after the big bang. From their model, they show that some of these black holes could form the seeds of the first stars, and the largest primordial black holes could have rapidly grown into supermassive black holes by gobbling up surrounding hydrogen and helium. This would explain how galaxies and their supermassive black holes seem to have formed so early in the universe. Finally, the smallest primordial black holes would be common enough to explain dark matter.



The James Webb telescope could discover evidence of primordial black holes in the near future. Credit: ESA

Being able to explain black holes, galactic evolution, and dark matter all in one would be a tremendous theoretical boon. But the idea is useless unless the model can be proven. But the authors think the James Webb telescope might be able to do just that.

One of the things about primordial black holes is that they likely emit light via [Hawking radiation](/post/great-escape/). According to Hawking's model, tiny black holes should cause an excess of infrared light in the early universe, which the Webb telescope should be able to pick up.

So if the James Webb Space Telescope does launch this week as planned, and all goes well, we should be able to put this idea to the test. It would be a great holiday gift to finally understand what dark matter truly is.

Reference: Cappelluti, Nico, Günther Hasinger, and Priyamvada Natarajan. "Exploring the high-redshift PBH-LCDM Universe: early black hole seeding, the first stars and cosmic radiation backgrounds." *arXiv preprint* arXiv:2109.08701 (2021).

Now We Know Why Pluto has These Strange Features on its Surface

After New Horizons made its close flyby of Pluto in July of 2015, scientists were astounded at the incredible closeup views of Pluto's surface. One of the most intriguing and mysterious features was a bright plain inside the prominent heart-shaped feature on Pluto, called "Tombaugh Regio" (Tombaugh Region) named after Clyde Tombaugh, who discovered Pluto in 1930.

The region is composed of a broken surface of irregularly-shaped segments that appear to be geologically young because no impact craters are part of the terrain.

"This terrain is not easy to explain," said Jeff Moore, leader of the New Horizons Geology, Geophysics and Imaging Team (GGI), back in 2015. "The discovery of vast, craterless, very young plains on Pluto exceeds all pre-flyby expectations. There are a few ancient impact craters on Pluto. But other areas like "Tombaugh Regio" show no craters. The landform change processes are occurring into current geologic times."

Now, a new study of this fascinating landscape reveals with more certainty how the unusual features were formed. A team led by Adrien Morison from the University of Exeter in the UK used sophisticated modelling techniques to show that these ice polygons are formed by the sublimation of nitrogen ice. This is a phenomenon where the solid ice turns directly from the solid to the gas phase due to the extremely negligible atmospheric pressure.

"Pluto is still geologically active despite being far away from the Sun and having limited internal energy sources," said Morison, in a press release. "The surface conditions allow the gaseous nitrogen in its atmosphere to coexist with solid nitrogen."

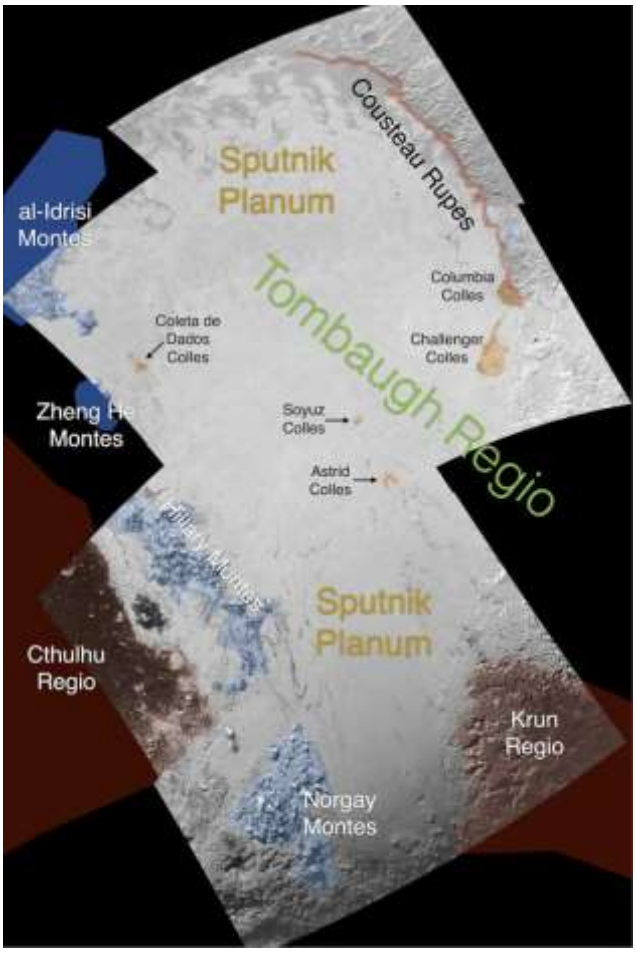
New Horizon's July 2015 flyby of Pluto captured this iconic image of the heart-shaped region called Tombaugh Regio. Credit: NASA/JHUAPL/SwRI.

The research team show this sublimation of the nitrogen ice powers convection in the ice layer of Sputnik Planitia by cooling down its surface. The team said this is consistent with numerous other data points from New Horizons – including the size of polygons, amplitude of topography and surface velocities.

The polygonal shaped areas are roughly 12 miles (20 kilometers) across.

The new study's data is also consistent with the timescale at which climate models predict sublimation of the region, beginning around 1 – 2 million years ago. It showed that the dynamics of this nitrogen ice layer echo those found on Earth's oceans, being driven by the climate.

Previous studies of Pluto's polygons showed that the ice could be warmed by heat from the interior welling up in the center of cells, spreading and then sinking, creating the ridged margins. However, in the new paper, Morison's team wrote, "Our proposed mechanism for the convective dynamics requires that the surface cooling be predominant over the heat flux at the bottom of the layer due to radiogenic heating in the rocky core and secular cooling/heating of the interior."



A close-up slice of Plutonian landscape centered on Tombaugh Regio with informal names waiting for approval. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

The team said that climate-powered dynamics of a solid layer could also occur at the surface of other planetary bodies, such as Neptune's moon Triton, or the Kuiper Belt objects Eris and Makemake.

The research was published in the journal Nature.

Paper: Sublimation driven convection in Sputnik Planitia on Pluto

University of Exeter press release.

Astronomy Jargon 101: Irregular Galaxies

In this series we are exploring the weird and wonderful world of astronomy jargon! You'll feel a little odd after today's topic: irregular galaxies!

When it comes to galaxies, there are the beautiful striking spirals, with their glowing arms stretching for tens of thousands of lightyears. There are the proud and stately ellipticals, demanding respect for their vast and ancient populations of stars.

And then there are…the irregular galaxies. The weirdos. The oddballs. The ones that defy description and categorization, and wind up in a category all their own, simply because they don't fit.

If there was an Island of Misfit Galaxies, the irregulars would be dropped off there.

Irregular galaxies tend to be small, with most no more than a tenth the mass of the Milky Way. The smallest irregulars are no more than a handful of kiloparsec across. They usually have no central bulge, no spiral arms, and really no structure at all. But despite their oddity, they make up roughly a quarter of all known galaxies. They are difficult to detect, this they have very little active star formation and appear much dimmer than regular galaxies of the same mass.

There are technically three different categories of irregulars, but that's really stretching the definition of "category". The three categories are: a) mostly irregular but with a little bit of structure, b) totally and completely irregular, and c) both irregular and very small.

Seriously, that's it. Those are the three categories.

Besides that, irregulars tend to be older than spiral galaxies but younger than ellipticals, so they might represent some cast-off in the normal process of how galaxies evolve.

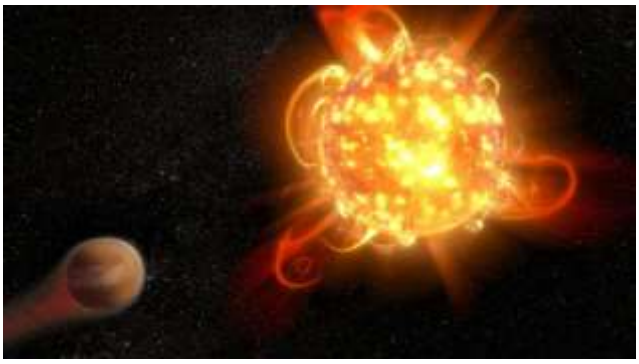
A Sun-Like Star Just Blasted out a Flare That Would be Devastating if it Happened Here

In the search for "potentially-habitable" extrasolar planets, one of the main things scientists look at is stellar activity. Whereas stars like our own, a G-type (G2V) yellow dwarf, are considered stable over time, other classes are variable and prone to flare-ups – particularly M-type red dwarf stars. Even if a star has multiple planets orbiting within its habitable zone (HZ), the tendency to periodically flare could render these planets completely uninhabitable.

According to a new study, stars like our own may not be as stable as previously thought. While observing EK Draconis, a G1.5V yellow dwarf located 110.71 light-years away, an international team of astronomers witnessed a massive coronal mass ejection that dwarfed anything we've ever seen in our Solar System. These observations suggest that these ejections can worsen over time, which could be a dire warning for life here on Earth.

The study, which appeared in the December 9th issue of the journal Nature Astronomy, was led by Dr. Kosuke Namekata, a researcher at Kyoto University, the National Astronomical Observatory of Japan (NAOJ) and the National Solar Observatory (NSO). He was joined by researchers from CU Boulder's Laboratory for Atmospheric and Space Physics (LASP), the Nishi-

Harima Astronomical Observatory (NHAO), the Tokyo Institute of Technology, the Graduate School of Advanced Integrated Studies in Human Survivability, and multiple universities.



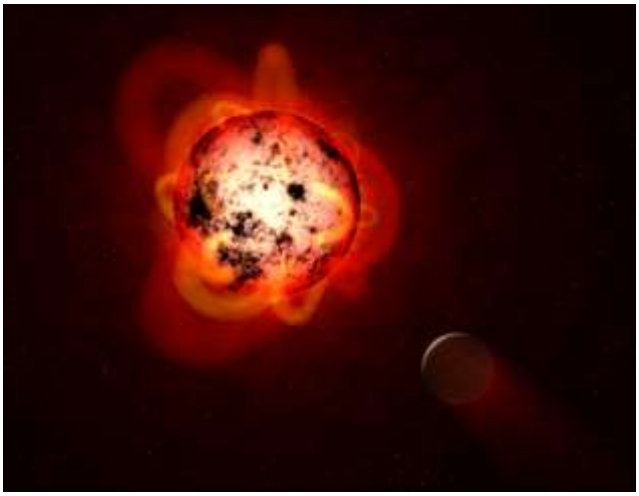
Stellar flares could threaten life on red dwarf planets. Credit: NASA/ESA/D. Player (STScI)

Their study explores a stellar phenomenon known as a "coronal mass ejection" (CME), aka. a solar storm. These ejections, which occur with our Sun regularly, often accompany a stellar flare (or sudden and bright burst of radiation). When they happen, CMEs send clouds of extremely hot charged particles (aka. plasma) at extremely high velocities into space. While Earth is protected from charged particles by its planetary magnetic field, a CME could cause significant damage if it hit Earth head-on.

Astronauts in orbit would be exposed to lethal radiation levels, satellites would be disabled, and Earth-based infrastructure (like electrical grids) would be knocked out. Earth has experienced several powerful geomagnetic storms over time, the most well-known example of which was the Carrington Event in 1859. Several such events have occurred in Earth's history and are usually several thousand years apart.

While studying EK Draconis, the research team observed evidence that superflares may become worse for Sun-like stars over time. As co-author Yuta Notsu (LASP) explained in a recent CU Boulder Today press release:

"Coronal mass ejections can have a serious impact on Earth and human society. This kind of big mass ejection could, theoretically, also occur on our sun. This observation may help us to better understand how similar events may have affected Earth and even Mars over billions of years."



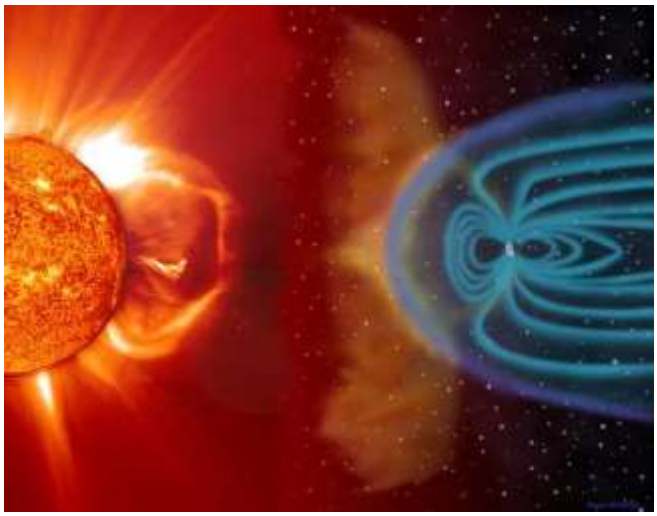
Artist's impression of a flaring red dwarf star, orbited by an exoplanet. Credit: NASA, ESA, and G. Bacon (STScI)

The research builds on previous research by co-author Yuta Notsu, who was joined by many of the researchers who conducted this latest study. They showed how young Sun-like stars experience frequent superflares that are tens to hundreds of times more powerful than solar flares. The Sun has been known to experience superflares, which appear to happen once every several thousand years. This raised the question: could a superflare also lead to an equally massive "super coronal mass ejection"?

While astronomers have speculated about a possible relationship between these two phenomena, no evidence has been found for it before. To investigate this possibility, Namekata, Notsu, and their colleagues decided to study EK Draconis, which is similar to our Sun in terms of size and mass but is significantly young by comparison (100 million years old compared to our Sun, which is 4.6 billion years old).

For the sake of their observations, Namekata, Notsu, and their colleagues used NASA's Transiting Exoplanet Survey Satellite (TESS) and Kyoto University's SEIMEI Telescope to observe EK Draconis (which looks like a young version of the Sun) for 32 nights in the winter and spring 2020. On April 5th, 2020, the team observed EK Draconis erupt into a superflare, followed 30 minutes later by a massive ejection of super-hot plasma. Said Notsu:

"This kind of big mass ejection could, theoretically, also occur on our Sun. This observation may help us to better understand how similar events may have affected Earth and even Mars over billions of years. It's what our Sun looked like 4.5 billion years ago."



This visualization depicts what a coronal mass ejection might look like as it interacts with the interplanetary medium and magnetic forces. Credit: NASA/Steele Hill

The team was only able to observe the first step in the ejection's life – the "filament eruption" phase – but were still able to obtain mass and velocity estimates. According to their study, the cloud was more than ten times as large as the most powerful CME ever recorded from a Sun-like star and had a top speed of roughly 1.6 million km (1 million mph). The event could indicate just how dangerous space weather can be.

If such an eruption were to occur from our Sun, it would

have the potential to strip Earth's atmosphere and render our planet largely sterile. While their findings indicate that the Sun could be capable of such violent extremes, they also suggest that superflares and super CMEs are probably rare for stars as old as the Sun. But as Notsu explained, super CMEs may have been much more common billions of years ago when our Solar System was still forming.
Super CMEs, in other words, could have played a role in the evolution of planets like Earth and Mars, which includes how one gave rise to life while the other did not. "The atmosphere of present-day Mars is very thin compared to Earth's," he said. "In the past, we think Mars had a much thicker atmosphere. Coronal mass ejections may help us to understand what happened to the planet over billions of years." This same knowledge could come in handy if and when future generations begin to live on Mars. Protecting the atmosphere from solar activity (including CMEs) will allow the atmosphere to replenish over time, making the planet warmer, wetter, and altogether more liveable!
Further Reading: CU Boulder Today, *Nature*

Giant Stars and the Ultimate Fate of the Sun

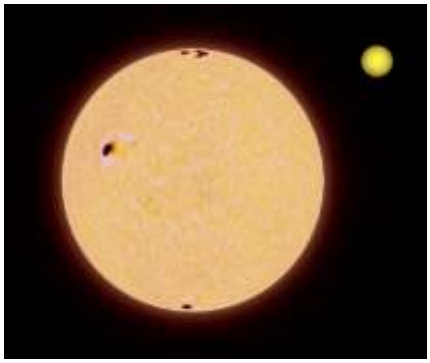
Astronomers have a new tool to help them understand giant stars. It's a detailed study of the precise temperatures and sizes of 191 giant stars. The authors of the work say that it'll serve as a standard reference on giant stars for years to come.

It'll also shed some light on what the Sun will go through late in its life.

The study began in 1997 when a group of astronomers started making high-precision measurements of giant stars with the Palomar Observatory's Testbed Interferometer (PTI). It was built as a testbed for the upcoming Keck Interferometer in Hawaii. The PTI closed down in 2008 and astronomers kept collecting data on giant planets until it closed. After that, astronomers used telescopes at the Lowell Observatory to keep collecting data, and amateur astronomers chipped in, too.

Gerard van Belle from the Lowell Observatory led the study and is the lead author. He's an expert in interferometry and is a member of the astronomer faculty at Lowell. He's also Chief Scientist for the Navy's Precision Optical Interferometer. The study is titled "Direct Measurements of Giant Star Effective Temperatures and Linear Radii: Calibration against Spectral Types and *V* ? *K* Color" and it's published in The Astrophysical Journal.

Giant stars are different from main-sequence stars or dwarf stars. All of the hydrogen available for fusion in their cores is depleted and they've left the main sequence. Compared to a main-sequence star or dwarf star with the same temperature, a giant star will be more luminous and have a larger radius. They can be between tens and thousands of times more luminous than the Sun and have radii a few hundred times greater than the Sun's. Stars more luminous than giant stars are called supergiants and hypergiants.



Pollux is an orange-hued giant star in the constellation Gemini. It's the closest giant star to the Sun. The image shows Pollux's size in relation to the Sun. Image Credit: Omnidoom 999. Public Domain.

This isn't the first time astronomers have done a detailed survey of giant stars. One 2003 study surveyed 85 giant stars with the Mark III Stellar Interferometer at the Mount Wilson Observatory. But this new one is noteworthy not only for the number of stars measured but also for its high precision. The PTI was highly-efficient and partly robotic. This allowed it to collect "… large amounts of stellar fringe visibility data on any given night…" according to the authors. It also gathered data in between other scheduled observing tasks. In a press release Van Belle said, "At best, every other study is only half this size, in terms of the number of stars."

The temperature measurements are particularly precise and are two to four times more accurate than previous studies. "This means that if you tell me what colour a star is or if you tell me what type of star it is, I can tell you its temperature and be much more confident in that," van Belle explained.

CW Leonis, not a part of this study, glowers from deep within a thick shroud of dust in this image from the NASA/ESA Hubble Space Telescope. Lying roughly 400 light-years from Earth in the constellation Leo, CW Leonis is a carbon star — a luminous type of red giant star with a carbon-rich atmosphere. The dense clouds of sooty gas and dust engulfing this dying star were created as the outer layers of CW Leonis itself were thrown out into the void. Image Credit: ESA/ Hubble & NASA, T. Ueta, H. Kim

This study is valuable for a number of reasons, including in exoplanet studies.

When astronomers find an exoplanet, nearly everything they can learn about it is in relation to the star it orbits. The mass and luminosity and size of the star are used to infer the characteristics of the planet, like its mass, size, and density. So the more accurate star measurements are, the more accurate planet measurements are.

The study can also tell us what's in store for the Sun.

Astronomers know that eventually the Sun will become a red giant and will swell in size, engulfing Mercury and Venus, maybe Earth, too. But there's a lot we don't know about that process, and about giant stars in general. The amount of swelling is unclear, with estimates ranging from 10 to 100 times its current size. The data in this study will help astronomers understand what will happen to the Sun when it swells, and will also explain some of our star's current processes.

E Mails Viewings Logs and Images from Members.

La Palma looks to the stars again to recover after the eruption with the opening of the new Visitor Centre at the Roque de los Muchachos.

The visitor centre of the Roque de los Muchachos Observatory (ORM), located at the highest point of the island opened its doors on the 19th December 2021 to scientific tourism and will be the window into the universe that will contribute to economic revitalisation.

Roque de Los Muchachos Observatory at night.
Abián San Gil / Star Island La Palma (Cabildo de La Palma).

In the Welcome room, the Gran Telescopio de Canarias (GTC) stands out from the scale models that recreate the instruments that observe the universe from ORM. Considered the crown jewel of the Observatory, it is currently the World's largest single aperture optical-infrared telescope, with a segmented mirror measuring 10.4 metres in diameter, but it has not been open to visitors since the coronavirus pandemic began. However, it is possible to see its reproduction in the Visitor Centre. Inaugurated on the 19th December, almost a week prior to the official declaration of the end of the eruption, it is a gateway to the universe explored by scientists, who investigate its mysteries from the *Isla Bonita* at 2,396 metres above sea level. It is also "…a key piece for the recovery of the island of La Palma", according to the president of the La Palma Government, Mariano Zapata. The Spanish Tourism Minister, Reyes Maroto, declared during the inauguration of the new building, that it was the "best way to revitalise the island."

The ORM is already working at full capacity after its activities were curtailed by the ash expelled by the volcano. Although it is possible to visit the site, the tours of the telescopes have been suspended since March 2020, the Visitor Centre after numerous vicissitudes that have delayed its development (Such as the transfer of the land) and following the investment of 6 million euros from the Canary Islands Development Fund, serves as a link between the public and the scientists.

Roque de los Muchachos Visitor Centre

The Director of the Astrophysical Institute of the Canary Islands (IAC), Rafael Rebolo, pointed out during the opening ceremony that "…with its opening, a long-held dream is fulfilled, and it stands as a fair tribute to the ORM as a gateway to the universe, one of the best in the World." In addition, he assured that the IAC would do its part "to promote the recovery of the island". A study, prepared by Carlos Fernández, Jorge Araña and Carmelo León on the economic impact of Astrotourism on La Palma estimated that the Visitor Centre would generate between 1 and 1.3 million euros per year.

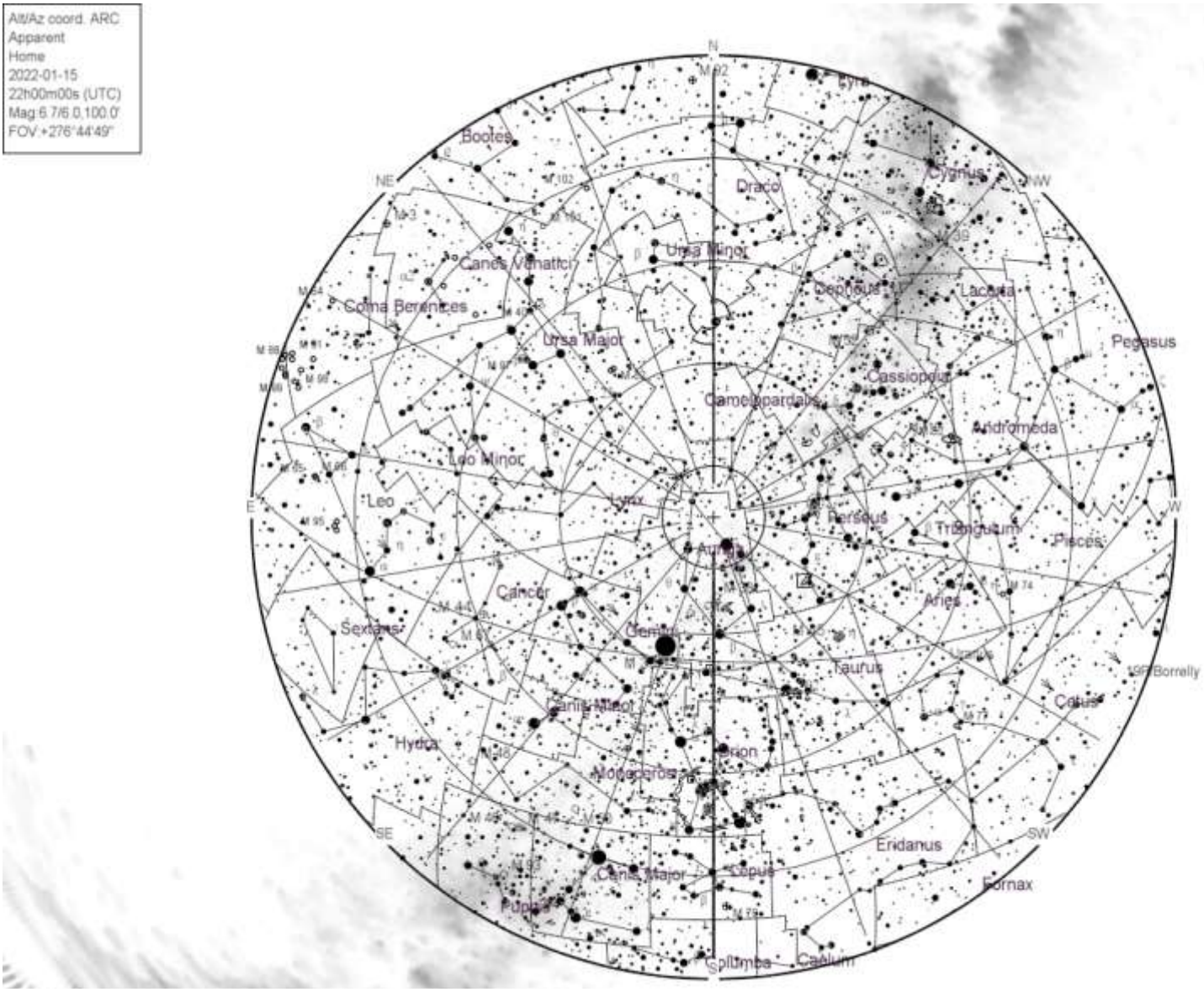
With an area of 1,400 square metres, the facilities are covered in basalt to blend in with the volcanic environment. The building imitates a large rock with an eye that allows you to see its interior from the sky, which has exhibition and projection rooms as well as a shop, a cafeteria, and a restaurant. The objective is to attract scientific tourism and during its first months of operation, the Centre can be visited for free. "The main task is to provide citizens with detailed information about the universe and how the Observatory works," explains one of the guides from the Starlight Foundations, who has worked at ORM since 2011.

In Room 1, called *Canarias, a window to the universe,* "it is explained why La Palma has an ideal sky for night observation "details the guide from the Starlight Foundation. The so-called Sky Law of 1988 protects its quality from, light pollution so that "…our towns are smart when it comes to public lighting. On La Palma, we have a special kind of light which are orange streetlights – low-pressure sodium lamps – which today are beginning to be replaced by LEDs, and this light must have an angle of 45 degrees on the ground", adds the guide. In addition, the regulations also dictate atmospheric, radioelectric and pollution caused by air routes (there are no airways over the island).

One of the telescopes at the Roque de Los Muchachos Observatory over the 'sea of clouds'. Star

The IAC created the Air Quality Group at the end of the 'eighties to preserve the conditions of the observatories on the island. On the 20th April 2007, the World Declaration in Defence of the Night Sky and Right to Observe the Stars was signed on La Palma. "The foundation watches of the right of humanity to be able to observe the stars and have a clean sky", sums up the Visitor Centre guide. In addition, since 2012, La Palma has been a Starlight Destination, a title which recognises the ability to properly enjoy the vision of the stars and to know the associated scientific, cultural, natural and landscape values.

WHATS UP, JANUARY 2022



January 2 - **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 18:35 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.

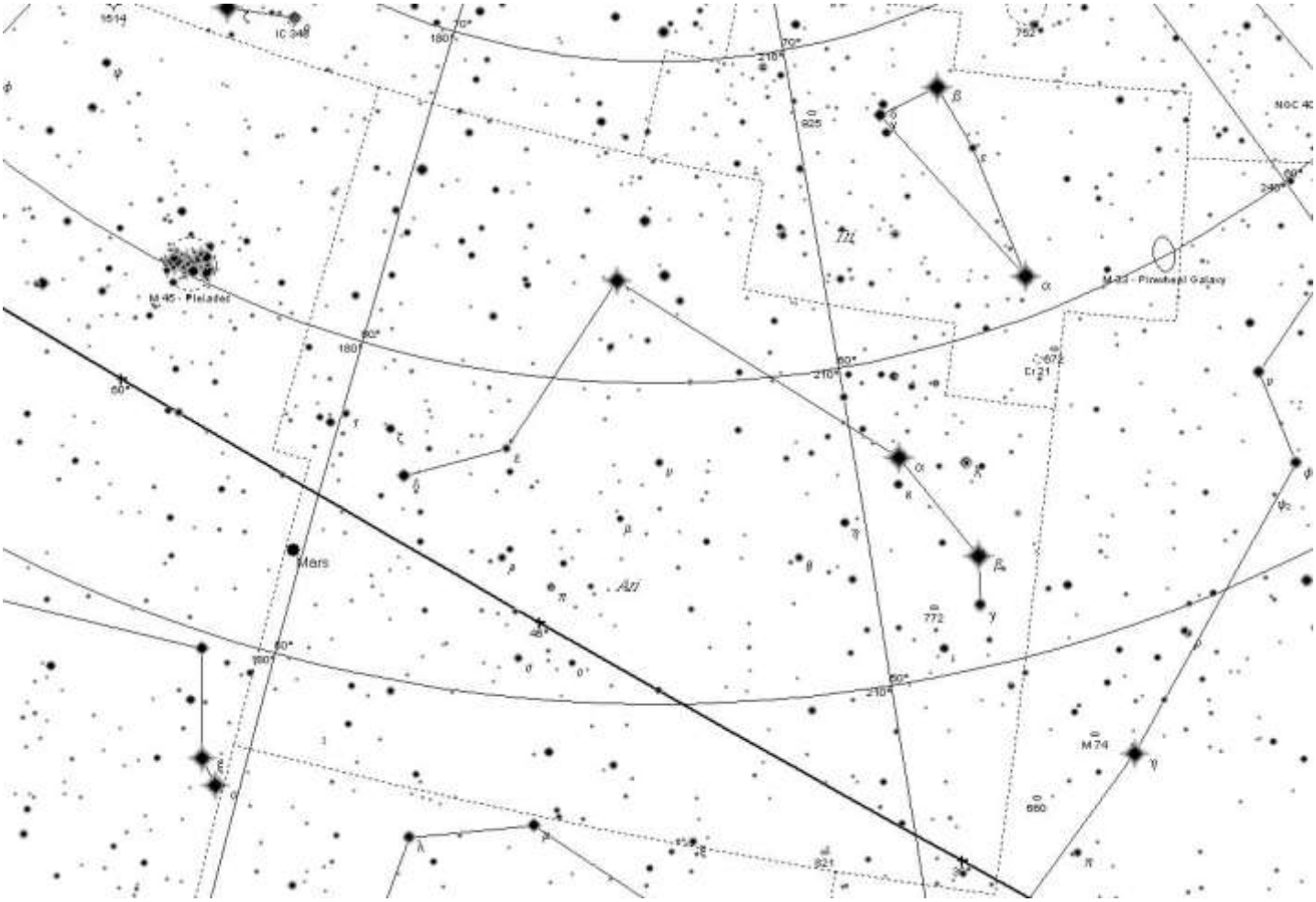
January 3, 4 - **Quadrantids Meteor Shower.** The Quadrantids is an above average shower, with up to 40 meteors per hour at its peak. It is thought to be produced by dust grains left behind by an extinct comet known as 2003 EH1, which was discovered in 2003. The shower runs annually from January 1-5. It peaks this year on the night of the 3rd and morning of the 4th. The thin, crescent moon will set early in the evening leaving dark skies for what should be an excellent show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Bootes, but can appear anywhere in the sky.

January 7 - **Mercury at Greatest Eastern Elongation.** The planet Mercury reaches greatest eastern elongation of 19.2 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 evening sky. Look for the planet low in the western sky just after sunset.

January 17 - **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 23:51 UTC. This full moon was known by early Native American tribes as the Wolf Moon because this was the time of year when hungry wolf packs howled outside their camps. This moon has also been know as the Old Moon and the Moon After Yule.

February 1 - **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 05:48 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

CONSTELLATIONS OF THE MONTH: ARIES and TRIANGULUM



Aries

Aries, "The Ram", is an ancient constellation which was of considerable importance since the sun passed through it at the vernal equinox.

> This point has now moved into Pisces, but the vernal equinox is still known as the First Point of Aries. (As a matter of possible interest, in the year 2000 the point will be at zero degrees and zero hours; about 6.5º south of omega Psc.) In another six hundred years the point will have moved into Aquarius.

The Ram in question may have been the one whose golden fleece was the object of Jason's quest.

There is some reason to believe that the Greeks just took over a much older horned animal at this time of the year; the horn being a symbol for fecundity, renewal, and so on. As the Sun came into this constellation, at the vernal equinox, the year itself was being renewed.

Aries' stars are rather faint except for alpha and beta, which are only second magnitude stars.

Double stars:

Gamma Arietis is a well-known binary of similar stars: 4.8, 4.8; PA 360º, separation 7.8".

Lambda Arietis is a wide binary: 4.9, 7.7; PA 46º, separation 37.4".

Epsilon Arietis is a closer binary of nearly equal stars: 5.2, 5.5; PA 203º, separation 1.4".

30 Ari is a fixed binary with wide component: 6.6, 7.4; PA 274º and separation 38.6".

33 Ari is also fixed, with a faint component: 5.5, 8.4; PA 360º, separation 28.6".

Variable stars:

Gamma^2 Arietis is an alpha CV type variable: 4.62-4.66 with a period of 2.6 days.

SX Arietis (56 Ari) is the prototype of a special class of rotating variables, similar to alpha CV variables. SX Ari varies from 5.67 to 5.81 every 17h28m.

Deep Sky Objects:

NGC 772 is a strangely shaped diffuse galaxy with a spiral arm on the northwest.

It's found about one degree ESE of *gamma Ari*.

Triangulum

Triangulum, located just north of the ecliptic plane, was one of the 48 original constellations listed by Ptolemy, and remains one of the 88 modern constellations. It spans 132 square degrees of sky and ranks 78th in size. Triangulum has 3 mains stars in its asterism and 15 Bayer Flamsteed designated stars within its confines. It is bordered by the constellations of Andromeda, Pisces, Aries and Perseus. Triangulum can be seen by all observers located at latitudes between +90° and ?60° and is best seen at culmination during the month of December.
As one of the very few constellations to be named after an object instead of a mythical figure or animal, one of the first names of this constellation was Sicilia – which represented the island of Sicily. This tale came about because it was believed that Ceres, the patron goddess, had begged Jupiter to immortalize her home in the stars. For a time, this region of sky was also known as Triangulum Minus, as recorded by Johannes Hevelius. It was formed from the southern parts of his Triangula, and the name quickly fell into disuse. It eventually simply took on the Latin term for its three primary stars the "triangle" and has been referred to as Triangulum ever since.
Let's begin our binocular tour of Triangulum with its brightest star – Beta – the "B" symbol on our chart. Beta often goes by the name Deltotum, which is a Greek letter – Delta – which also resembles a triangle. Beta is a white A-type giant star located about 124 light years from Earth. Now switch off to the second brightest star – Alpha – the "a". Its name is Mothallah – the head of the triangle. Guess what? It's a binary star! While you won't be splitting this spectroscopic yellow-white F-type subgiant binary star with any optics, it's still fun to know that its diameter is about 3 times as large as the Sun and that its companion orbits it in less than 2 days from a distance of under 4 million miles. That's almost touching in astronomical terms! By the way… They're both about 65 light years away from our solar system. For a binary star you can separate in a telescope, have a look at 6 Trianguli. Its 5.3 and 6.9 components are easy to pick apart even with a small telescope because they are separated by almost 40 arc seconds.

Now, you might need to get out your telescope for the next object… A long term variable star named R Trianguli (RA 02: 34 DEC +34: 03). Depending on when you start, you may have a long time to wait to see changes, because R takes 266 days to go from stellar magnitude 5.7 to an almost invisible 12.4! R Trianguli is an "M-class" Red giant star who owes its changes to pulsations. As it expands, it becomes brighter… As it contracts, it becomes faint. What an incredible star to watch!

For binoculars and rich field telescopes, it's time to head towards the ghostly galaxy, Messier 33 (RA 1 : 33.9 Dec +30 : 39). While this incredible spiral galaxy has an apparent magnitude of 5.7, you're not going to find it quite as easy to find as you might think. Why? Because a lot of times you're going to be missing the forest because you're looking at the trees. M33 is huge! Located some approximately 3 million light-years away, the "Pinwheel Galaxy" contains a host of its own NGC objects and can often be spotted without optical aid from a dark sky location. One of the most positive ways to locate it is to use the very lowest magnification eyepiece you have available and work your way up to study each portion. It is the third largest galaxy in the Local Group, a group of galaxies that also contains the Milky Way Galaxy and the Andromeda Galaxy, and it may be a gravitationally bound companion of the Andromeda Galaxy.

The Triangulum Galaxy was probably discovered by Giovanni Batista Hodierna before 1654, who may have grouped it together with open cluster NGC 752. It was independently discovered by Charles Messier in 1764, who catalogued it as M33 on August 25. M33 was also catalogued independently by William Herschel on September 11, 1784 number H V.17. It was among the first "spiral nebulae" identified as such by Lord Rosse. Herschel also cataloged The Triangulum Galaxy's brightest and largest H II region (diffuse emission nebula containing ionized hydrogen) as H III.150 separately from the galaxy itself, which eventually obtained NGC number 604. As seen from Earth NGC 604 is located northeast of the galaxy's central core, and is one of the largest H II regions known with a diameter of nearly 1500 light-years and a spectrum similar to the Orion Nebula. Herschel also noted 3 other smaller H II regions (NGC 588, 592 and 595).

In 2005, using observations of two water masers on opposite sides of Triangulum via the VLBA, researchers were, for the first time, able to estimate the angular rotation and proper motion of Triangulum. A velocity of 190 to 60 km/s relative to the Milky Way is computed which means Triangulum is moving towards Andromeda. In 2007, a black hole about 15.7 times the mass of the Sun was detected in the galaxy using data from the Chandra X-ray Observatory. The black hole, named M33 X-7, orbits a companion star which it eclipses every 3.5 days. Although we can never see it, we can certainly enjoy this faint galaxy for all the mysteries it holds!

Spiral galaxy M33 is located in the triangle-shaped constellation Triangulum, earning it the nickname the Triangulum galaxy. About half the size of our Milky Way galaxy, M33 is the third-largest member of our Local Group of galaxies following the Andromeda galaxy (M31) and the Milky Way. Comprised of 54 separate Hubble fields of view, this image is the largest high-resolution mosaic of M33 assembled to date by any observatory. It resolves 25 million individual stars in a 14,000-light-year-wide region spanning the center of the galaxy.

Blue-colored regions scattered throughout the image reveal numerous sites of rapid star birth in M33. In fact, Hubble's observations reveal that the Triangulum galaxy's star formation rate is ten times higher than the average found in the Andromeda galaxy, previously surveyed by Hubble in similar detail. A bright blue patch in the lower left of this image, called NGC 604, is the largest star-forming region in M33 and one of the largest stellar nurseries in the entire Local Group.

The Triangulum galaxy's orderly spiral structure displays few signs of interactions with nearby galaxies. However, that could change in the future. Only slightly farther away from us than the Andromeda galaxy, about 3 million light-years from Earth, M33 is a suspected gravitational companion to Andromeda, and both galaxies are moving toward our own. M33 could become a third party involved in the impending collision between the Andromeda and

Milky Way galaxies more than 4 billion years from now.

M33 has a relatively bright apparent magnitude of 5.7, making it one of the most distant objects that keen-eyed observers can view with the unaided eye (under exceptionally clear and dark skies). Although a telescope will start to reveal some of M33's spiral features, the diffuse galaxy is actually easiest to examine with low magnification and a wide field of view, such as through binoculars. It is best observed in October.

Keep your telescope handy as you head off for our next galactic designation, NGC 925 (RA 2 : 27.3 Dec +33 : 35). At magnitude 10 and nearly 10 arc minutes in size, it is also fairly easy for a small telescope and large binoculars. This face-on presentation spiral galaxy is also part of the Hubble Space Telescope project for extra-galactic distances which use Cepheid variable stars to help judge that vast expanse of space between us. Look for a bright core region with elongated wispy spiral galaxy structure!

Now try your hand, and your telescope, and NGC 672 (RA 1 : 47.9 Dec +27 : 26). At close to magnitude 11 and 7 arc minutes in size, it is a bit more of a challenge, but large telescopes will find it and interacting galaxy IC 1727 in the same field of view. The pair is believed to be separated by about 88,000 light years – or about their own diameters. While you won't catch an outstanding amount of detail in either one, you may begin to resolve out some lumpy areas of star birth!

Last, but not least, is NGC 784 (RA 2 : 01.3 Dec +28 : 50). At magnitude 12 and about 6 arc minutes in size, it is the smallest and faintest challenge yet. It is a barred-spiral galaxy presented nearly edge-on, and it is very diffuse. In spite of its expected small distance, NGC 784 has not yet been resolved into stars and is still being studied for velocity and kinematics. Good luck!

ISS PASSES For January and early February 2022

from Heavens Above website maintained by Chris Peat.

Date	Brightness	Start	Highest point	End						
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
03 Jan	-3.4	06:04:28	48°	SW	06:04:39	49°	SSW	06:07:55	10°	SE
04 Jan	-1.6	05:18:13	25°	ESE	05:18:13	25°	ESE	05:19:48	10°	ESE
04 Jan	-1.9	06:51:08	14°	WSW	06:52:48	19°	SW	06:55:16	10°	S
05 Jan	-2.4	06:04:54	27°	SSW	06:04:54	27°	SSW	06:07:35	10°	SSE
06 Jan	-1.2	05:18:42	17°	SSE	05:18:42	17°	SSE	05:19:40	10°	SE
07 Jan	-1.3	06:05:29	12°	SSW	06:05:29	12°	SSW	06:06:18	10°	S
18 Jan	-1.4	18:46:03	10°	S	18:47:00	14°	S	18:47:00	14°	S
19 Jan	-1.4	17:58:51	10°	SSE	18:00:06	12°	SE	18:00:45	11°	SE
19 Jan	-0.9	19:32:59	10°	SW	19:33:40	15°	SW	19:33:40	15°	SW
20 Jan	-2.6	18:44:47	10°	SW	18:47:21	31°	S	18:47:21	31°	S
21 Jan	-2.2	17:56:45	10°	SSW	17:59:28	23°	SE	18:00:58	17°	ESE
21 Jan	-1.4	19:32:32	10°	WSW	19:33:53	22°	WSW	19:33:53	22°	WSW
22 Jan	-3.6	18:44:07	10°	WSW	18:47:23	57°	SSE	18:47:26	57°	SSE
23 Jan	-3.1	17:55:45	10°	SW	17:58:56	43°	SSE	18:00:56	19°	E
23 Jan	-1.6	19:32:13	10°	W	19:33:50	26°	W	19:33:50	26°	W
24 Jan	-4.0	18:43:40	10°	WSW	18:47:01	84°	S	18:47:18	73°	E
25 Jan	-3.7	17:55:09	10°	WSW	17:58:29	71°	SSE	18:00:44	19°	E
25 Jan	-1.7	19:31:52	10°	W	19:33:38	28°	W	19:33:38	28°	W
26 Jan	-3.9	18:43:17	10°	W	18:46:39	85°	N	18:47:03	66°	ENE
27 Jan	-3.8	17:54:42	10°	W	17:58:03	88°	NNW	18:00:28	18°	E
27 Jan	-1.9	19:31:28	10°	W	19:33:22	31°	W	19:33:22	31°	W
28 Jan	-3.9	18:42:53	10°	W	18:46:13	88°	S	18:46:48	58°	ESE
28 Jan	-0.1	20:19:41	10°	W	20:19:42	10°	W	20:19:42	10°	W
29 Jan	-3.8	17:54:15	10°	W	17:57:37	86°	N	18:00:16	15°	E
29 Jan	-2.1	19:31:01	10°	W	19:33:10	33°	WSW	19:33:10	33°	WSW
30 Jan	-3.5	18:42:23	10°	W	18:45:42	63°	SSW	18:46:40	40°	SE
31 Jan	-3.7	17:53:44	10°	W	17:57:05	78°	SSW	18:00:14	11°	ESE
31 Jan	-1.8	19:30:40	10°	W	19:33:08	26°	SW	19:33:08	26°	SW
01 Feb	-2.5	18:41:53	10°	W	18:45:01	37°	SSW	18:46:49	20°	SSE
02 Feb	-3.0	17:53:10	10°	W	17:56:26	50°	SSW	17:59:40	10°	SE
02 Feb	-1.0	19:30:49	10°	WSW	19:32:35	14°	SW	19:33:31	12°	SSW
03 Feb	-1.3	18:41:36	10°	W	18:44:08	20°	SW	18:46:37	10°	SSE
04 Feb	-1.7	17:52:40	10°	W	17:55:36	28°	SSW	17:58:30	10°	SSE
06 Feb	-0.7	17:52:37	10°	WSW	17:54:33	15°	SW	17:56:30	10°	S

END IMAGES, OBSERVING AND OUTREACH

Not mny observing nights in December with cloud cover, and one of those I was helping someone set up their EQ6 mount.
Here is Messier 27, a planetary nebula in Vulpecula, around 815 light years away.
It is around 1.2 light years across, and the gaseous material was thrown off during the death throws of the central star around 48,000 years ago. But this is a multishell planetary nebula whose spinning star we are seeing equator on, so the material is thrown off away from the equator of the star towards the poles.
Andy

Observing Sessions and Covid19 - Update

Proposed Observation Sessions for 2021-2022

Any observing meetings will need to to be safe and follow social distancing recommendations.
A reminder email shall be sent out early on in the week to inform you of the planned event but it should also be noted that like the weather, Government guidelines may change at any time and therefore the usual email will be sent out by 16:00 on the day giving notice of whether observing is 'ON' or 'OFF' that evening, so look out for these. If a session is cancelled we may then possibly plan a new different date.

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:

- **Trying Friday 7th January 2022**
- **Friday 28 January 2022**
- **Friday 25 February 2022**
- **Friday 25 March 2022 (Messier Marathon)**
- **Friday 29 April 2022**
- **Friday 27 May 2022**
- **Friday 03 June 2022 (limited sky darkness)**

The final decision on the planned dates will be advised shortly and published on the website :https://wasnet.org.uk/observing/ **but we shall also try to arrange special evenings for events such as meteor showers/ Lunar eclipses etc.**
Also if members wish to propose 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.

OUTREACH

Zoom sessions and Google Classroom sessions have kept outreach going to schools

I have been asked to return to Westbury Leigh, but Covid has hit...

If any schools or clubs are interested in having talks from WAS please contact Andy Burns.

Dark Skies Wales are starting their live observing sessions, but talks are delayed.