# NWASNEWS

Volume26 Issue 10

JUNE 2021

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




## HAVE A SAFE SUMMER WITH SAFE VIEWING

Could we be seeing an end of the lock down, maybe, maybe not. Certainly a lot of our older members are now jabbed up, but we still can't relax with new variants of Covid 19 about. Like the flu virus, we are probably stuck with this virus in the human race for good, but annual injections will suppress it's worst affects. Even injected it is a virus that we can pass on to others so masks will still need to be used. It also means that we cannot have an official partial solar eclipse meeting on June the 10th, but I will be at Silbury car park if anyone wants to join me 'freelance'.

Not sure about 21st June doors open either, diseases don't run to calendars. We have checked with the hall at Seend for our meetings next year, and we are booked in for the first Tuesday of every month, but this now presents another problem, with some speakers now so used to Zoom meetings that they prefer to work from this. We can do it, the new projector works on this type of working so I have a mini wifi hub to try out and get working that should help, and we may be looking at Zoom and Hall combination meetings.

But it would be good to see you all September 7th in some form or other.

Summer is also a great time for wide field astro photography, with the Milky Way making a great back drop. We are lucky to have a great speaker and natural scientist and photographer tonight. I have a couple of his books, and get a little envious with his timing and location choices for his pictures. I think he sums it well with the word determination in photography. \\\\\\those of us who dabble in astrophotography or even landscape photography have gone through the pains of worse than optimal shots, and hopefully learn a bit every time, but we could all do with that determination to got out at the crazy hour, the right location that might mean walking that extra mile… then suffer the cloud, the forgotten dew heater… but we have to get out to do it.

Or experience second hand and learn from others. Thank you Robert for coming along. I also know our own Gavin James works with him on some projects.

Technically we are due an AGM but how can we be firm on this? Bob will prepare the all important accounts for September, and if any of our members need to stand down from committee positions, or would like to be considered please let me know.

Topic: Wiltshire AS Zoom Meeting

Time: Jun 1, 2021 07:45 PM London

Join Zoom Meeting

https://us02web.zoom.us/j/82205514510?pwd=NWhGcENoYkZ3bFpORktONzZTTkNoZz09

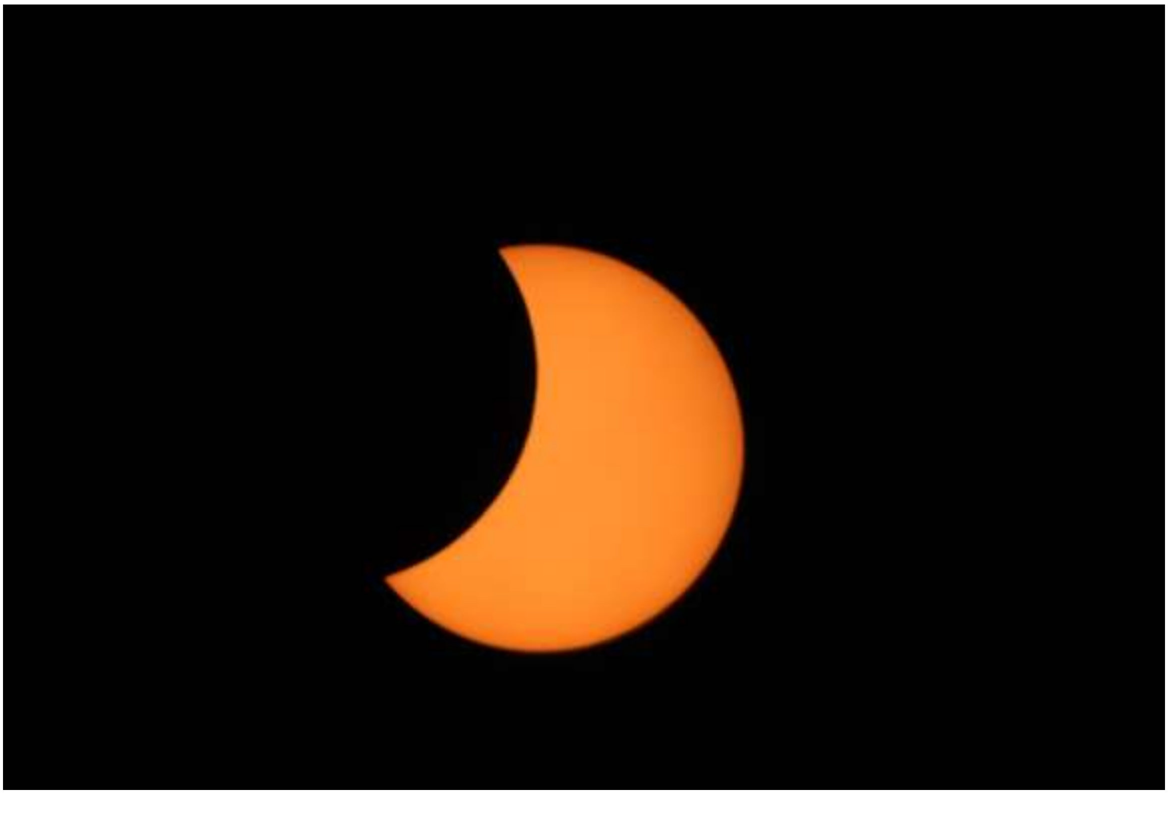
Meeting ID: 822 0551 4510

Passcode: 637001

Good summer to you all, stay safe and those around you.

Clear skies

Andy



Partial Solar Eclipse from March 2015.

On June the 10th peaking at 11:10am and an hour either side for 1st and 4th contact we will have a partial Solar Eclipse in Wiltshire again.

The peak eclipse is an annular eclipse that goes through Canada at sunrise, but in remote St James's Bay and Hudson bay, over Baffin Island, Greenland and over the north pole into remote Siberia for sunset.

Be careful and use safe viewing and imaging practices!

Andy

# 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.**

**During COVID19 ZOOM meetingd**

**HALL VENUE the Pavilion, Rusty Lane, Seend**

**Meet 7.30 for 8.00pm start**

**SEASON 2020/21**

2021

1 Jun Robert Harvey/Understanding the Universe.

7th September Prof Mike Edmunds, The Clockwork Universe.

Colin Stuart, Time in Einstein's Universe.

Andrew Lound, The Moon at Christmas, The Epic Voyage of Apollo 8.

Katrin Raynor-Evans, Exploring Astronomy Through Philately.

***Robert Harvey ARPS EFIAP CEnv CSci MCIWEM***

He has a degree in Natural Sciences from the University of Cambridge and an Associate of the Royal Photographic Society. He created Natural World Photography to share his passion for the complexity of nature in all its forms, wild landscapes and the beauty of the night sky. He brings a scientific understanding of landscapes and astronomy to his astrophotography, technical knowledge of photographic techniques and creative determination (we've all been there, at the wrong time, wrong weather etc) showing the natural world in new ways. Much of his work has been accepted in international photographic exhibitions.

Widefield Astrophotography has taken him throughout the British Isles, the Arctic, Western USA, Turkey, Jordan, South America and the deserts of Namibia. He is the tutor in astrophotography at Lacock Photography in Wiltshire.

He also was worked with our own Gavin James.

**Membership Meeting nights £1.00 for members £3 for visitors**

**Wiltshire AS Contacts**

Andy Burns Chair, anglesburns@hotmail.com

Andy Burns Outreach and newsletter editor.

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

Philip Proven (Hall coordinator) Dave Buckle (Teas)

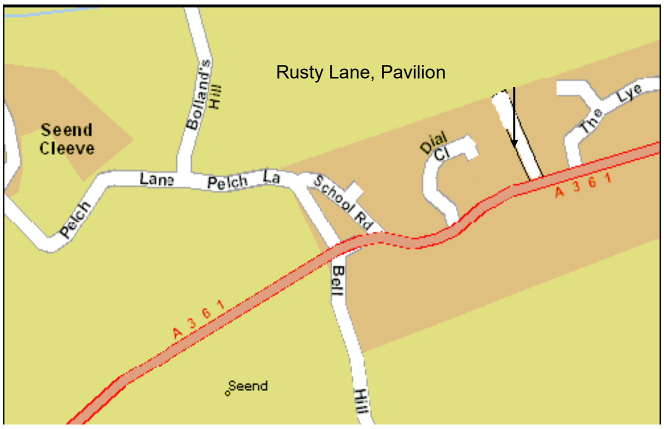
Peter Chappell (Speaker secretary)

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

# Swindon's own astronomy group

**Physical meetings suspended**

Due to the Covid crisis our meetings, like many other physical meetings have been suspended and replaced with Zoom meetings.

**Next Zoom Meeting: Graham Bryant**

Our next meeting will be held on Friday, 18 June when the speaker will be Graham Bryant.

Graham is a Fellow of the Royal Astronomical Society and President of the Hampshire Astronomical Group. Graham was given an Honorary Fellowship of the University of Portsmouth in recognition of the decades of collaboration between the University's Mathematics and Physics departments and the Clanfield Observatory. Currently Graham is the Vice-President of the Federation of Astronomical Societies.

Graham is also a tour guide for Aurora tour companies operating in Iceland and more recently arctic Norway, although the Covid pandemic has temporarily stopped his sojourns to the arctic.

His talk: Pluto: from Myth to a Voyage of Discovery

**Ad-hoc viewing sessions postponed**

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

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

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

For insurance reasons you need to be a club member to take part. If you think you might be interested email the organiser Robin Wilkey (see below). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.

We are a small keen group and I would ask you to note that you DO NOT have to own a telescope to take part, just turn up and have a great evening looking through other people's scopes. We are out there to share an interest and the hobby. There's nothing better than practical astronomy in the great cold British winter! And hot drinks are often available, you can also bring your own.

Enjoy astronomy at it's best!

**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

**Friday 18 June 19.30 Meeting or Zoom**

Programme: Graham Bryant: Pluto: from Myth to a Voyage of Discovery

**July & August - No Meetings**

**Friday 17 September 19.30 onwards - Meeting or Zoom**

Programme: Dr Elizabeth Pearson: Planetary Rovers

**Friday 15 October 19.30 onwards - Meeting or Zoom**

Programme: Charles Barclay: Oldest GOTO telescope in the World (Provisional)

**Friday 19 November 19.30 onwards - Meeting or Zoom**

Programme: TBA

**Friday 10 December 19.30**

Programme: Christmas Social

**Website:**
**http://www.swindonstargazers.com**

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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

## STAR QUEST ASTRONOMY CLUB

This young astronomy club meets at the

Sutton Veny Village Hall.

Second Thursday of the Month.

Meet at Sutton Veey near Warminster.

## BATH ASTRONOMERS

Bath Astronomers are holding webinar sessions linking in with Stargazers web sight.

Feb24
**Talk by Nora Eisner, Planet Hunters TESS: discovering exoplanets using citizen science**
24 Feb - Zoom
Wednesday 24th February – Monthly meeting. This month's talk will be given by Nora Eisner, Department of Physics, University of Oxford. She is a PhD student at the University of Oxford where her research focuses on citizen-powered exoplanet discoveries using NASA's TESS (Transiting Exoplanet Survey Satellite) data. She is working under the supervision of Professor Chris Lintott and Professor Suzanne Aigrain. The talk is entitled "Planet Hunters TESS: discovering exoplanets using citizen science". Nora's research focuses on citizen-powered exoplanet discoveries using TESS data via Planet Hunters TESS. As the leader of this exciting project she collates the returns from the citizen science campaigns, analyse them, and follows-up on the most promising detections using ground based facilities. The analysis of the extremely large time-series data sets has a strong emphasis on applying various statistical processes, as well as using machine learning in order detect exciting new planet systems that were missed by the main pipelines and other teams of professional astronomers. Abstract: Since the first unambiguous discovery of an exoplanet in 1995, over 4,000 more have been confirmed, and studies of their characteristics have unveiled an extremely wide range of planetary properties in terms of their mass, size, system architecture and orbital periods. While dedicated planet detection algorithms are able to identify the vast majority of planets in data obtained with spaced satellites, they miss certain types of planets that are key to the further development of our understanding of how these systems form and evolve. In this talk, I will discuss how we can harness the power of citizen science, and in particular Planet Hunters TESS, to find these more elusive planets with the help of tens of thousands of volunteers. I will present some of our exciting findings, including both planets and exotic stellar systems, and show that human classification still plays a vital role in a world that is becoming increasingly automated. Bath Astronomers monthly meeting for all members and new comers to meet up, enjoy perhaps a new topic and a cup of tea and a biscuit. Held on the last Wednesday of every month online or at the Herschel Museum of Astronomy, 19 New King Street.

Jun30
**Talk by Chris Starr, Cassini and Saturn**
30 Jun - Herschel Museum of Astronomy
Wednesday 30th June – Monthly meet

# PROCESSING INTERNET AVAILABLE HUBBLE IMAGES

New member Steve Allen keeps his eye in processing FITS images freely available on the web.

Further to my post on our facebook page about processing Hubble data, here is a bit more information for anyone wishing to emulate the process.

The Youtube channel was by a lady who goes by the name of "Peculiar Galexy Astronomy" (sic) and the particular video for M51 was https://www.youtube.com/watch?v=1XR1DQRO69E&t=132s

Within that page she has provided links to the Hubble Legacy Archive: https://hla.stsci.edu/ and to FITS liberator software that can be used to convert the FITS files to 16 bit TIFFs. The FITs data in the Hubble archive comes in various data sets to do with the filter used and the size/quality of the data. The data set for M51 was a mosaic.

The file set I used was for M51 but the archive is full of other targets and her channel is well worth a visit or subscribing to for those wishing to improve their processing skills within Photoshop.

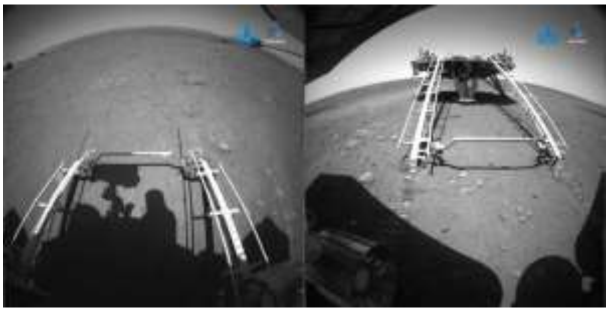
Below are a couple of examples of the raw filtered FITS data sets in Ha, Blue and Green.

# SPACE NEWS JUNE 2021

## Zhurong is Rolling on Mars

On May 22nd, 2021, the *Zhurong* rover – part of *Tianwen-1*, China's first mission to Mars – descended from its lander and drove on the Martian surface for the first time. According to the mission's official social media account, the rover drove down its descent ramp from the *Tianwen-1* lander at 10:40 a.m. Beijing time (07:40 p.m. PDT; 10:40 p.m. EDT) and placed its wheels upon the surface of Mars.
Mission controllers were treated to a video taken by the rover shortly thereafter, which showed the empty landing platform with its descent ramp extended. This comes about a week after the first images were taken by the rover (released on May 19th) that showed surface from the lander and the descent ramp deployed in front of it. The rover has now commenced science operations, which currently involve exploring its landing site.

This is the second milestone achieved by the China National Space Agency (CNSA) in recent weeks, the first being the successful landing of the Tianwen-1 lander on May 14th. This made China the third nation to send a robotic mission to the surface of Mars, the others being the United States and the former Soviet Union. The Soviets were the first to land with the *Mars 2* mission (1971), but communications were lost with the lander seconds later.



*Zhurong Images released by the Tianwen-1 mission team on May 19th and May 22nd, before and after it disembarked from the lander. Credit: CNSA*

On top of that, China is now the first nation to orbit, land, and deploy a rover as part of its first mission to Mars. Whereas all other nations – the US, Russia, the EU, and India – began by sending orbiters, then landers, then orbiters, landers, and rovers, China has pulled off all three with its very first mission. Equipped with a suite of six scientific instruments, Zurong will spend a total of 90 days gathering data on the Martian surface. These include:

- **Multi-Spectrum Camera** (MSCam) – a radiometer that will capture different wavelengths of radiation on the surface

- **Navigation and Topography Cameras** (NaTeCam) – high-resolution cameras for mapping out the Martian surface

- **Rover ground-Penetrating Radar** (RoPeR) – for imaging features about 100 m (330 ft) beneath the Martian surface

- **Mars Surface Magnetic Field Detector** (RoMAG) for surveying Mars' variable magnetic field

- **Mars Meteorological Measurement Instrument** (MMMI) – aka. Mars Climate Station (MCS), this instrument includes a thermometer, anemometer, and pressure sensor

**Mars Surface Compound Detector** (MarsSCoDe) – a spectrometer capable of conducting infrared and laser-induced breakdown spectroscopy

The objectives of the Tianwen-1 mission include characterizing the internal structure of Mars, the composition of its surface material, its climate and environment, the distribution of water ice, the planet's morphology and geology, the planet's variable magnetic field, ionosphere, and other key characteristics. In essence, Zhurong will be joining the three NASA surface missions to learn more about what Mars once looked like.
This includes studying features that formed in the presence of water and searching for possible indications of past life. It is for these very reasons that the Zhurong and its lander set down in Utopia Planitia, a plains region in the Northern Lowlands that was once covered by an ocean that enclosed much of the northern hemisphere. Utopia Planitia is also where NASA's *Viking 2* lander set down on September 3rd, 1976, to search for biosignatures.
The rover will also be looking for indications of what happened to Mars' surface water, which scientists now theorize may have escaped underground. Finding existing caches of water and ice underground will also help pave the way for human exploration, as well as the creation of long-term habitats on the surface. The orbiter will monitor Zhurong and operate as a relay to provide a steady information conduit to the mission controllers back on Earth.
According to China Space News (quoted by Reuters), Zhurong has spent its first three days away from the lander exploring the surface in slow and small intervals – never venturing more than 10 m (33 ft) at a time. "The slow progress of the rover was due to the limited understanding of the Martian environment, so a relatively conservative working mode was specially designed," said Jia Yang, an engineer and member of the mission team. Jia added that the pace may increase as the mission continues.
Zhurong is currently one of four missions exploring the Martian surface, the others being NASA's *Perseverance* rover, Curiosity rover, and *Insight* lander. Next year, they will be joined by the ExoMars 2022 mission that will consist of Roscosmos' *Kazachok* lander and the ESA's *Rosalind Franklin* rover. By 2027-8, the elements that make up the *Mars Sample Return* are scheduled to arrive (a lander, rover, ascent vehicle, and Earth-return orbiter).

Back in February, the *Emirates Mars Mission* (aka. Hope) probe arrived in orbit, becoming the first mission sent by an Arab (or Muslim majority) nation to the Red Planet. It is now one of six orbiter missions, which include NASA's *2001 Mars Odyssey*, *Mars Reconnaissance Orbiter* (MRO), *MAVEN*, and the ESA's *Mars Express* and *ExoMars 2016 Trace Gas Orbiter* (TGO).

These missions will carry on in the quest to learn more about Mars' past and potential habitability. They will also help pave the way for crewed missions to the Red Planet, which are expected to begin sometime in the 2030s. The data obtained from all surface, orbiter, robotic, and crewed missions to Mars will also contribute to our overall understanding of how the rocky planets of our Solar System formed and evolved over the course of billions of years.

With any luck, we might even learn a thing or two about when and how life first emerged in our little corner of the cosmos. That slice of knowledge could also go a long way toward helping us find life beyond the Solar System someday.

## Is the Hubble constant not…Constant?

Cosmologists have been struggling to understand an apparent tension in their measurements of the present-day expansion rate of the universe, known as the Hubble constant. Observations of the early cosmos – mostly the cosmic microwave background – point to a significantly lower Hubble constant than the value obtained through observations of the late universe, primarily from supernovae. A team of astronomers have dug into the data to find that one possible way to relieve this tension is to allow for the Hubble constant to paradoxically evolve with time. This result could point to either new physics… or just a misunderstanding of the data.

"The point is that there seems to be a tension between the larger values for late universe observations and lower values for early universe observation," said Enrico Rinaldi, a research fellow in the University of Michigan Department of Physics and coauthor on the study. "The question we asked in this paper is: What if the Hubble constant is not constant? What if it actually changes?"

## Something's rotten in the state of the Universe

Cosmologists employ a variety of probes and observations to determine the fundamental properties of our universe. They try to measure its age, its contents, its expansion rate, and more. After almost a century of intense scrutiny, those cosmologists have developed a coherent, consistent model of the universe. In short, our cosmos is about 13.77 billion years old, is constantly expanding, and is made of mostly dark energy and dark matter – with normal matter like stars and planets and clouds of gas making up a brightly-lit minority of the ingredients of the universe.

Leaving aside the gigantic mysteries of the true nature of dark energy and dark matter, in recent years cosmologists have run into another frustrating puzzle: different probes disagree about the present-day expansion rate, known as the Hubble constant.

Measurements taken of the young universe, like the cosmic microwave background (the afterglow light pattern that was released when the universe cooled from a plasma state when it was 380,000 years old), tell us that the Hubble constant is somewhere around 68 km/s/Mpc (which means that for every million parsecs away from our vantage point, the expansion rate of the universe increases by 68 kilometers per second).

But more local, late-universe measurements, like observations of supernovae, lean towards a different answer: a Hubble constant of more like 74 km/s/Mpc.

### Bin it

A team of astronomers led by Maria Dainotti, an assistant professor at the National Astronomical Observatory of Japan and the Graduate University for Advanced Studies, SOKENDAI in Japan and an affiliated scientist at the U.S. Space Science Institute dug into this discrepancy more. The work was published in May in *The Astrophysical Journal*.

The team focused their work on Type-1a supernovae, which are a particular kind of explosion that happens when white dwarf stars accumulate too much mass from a companion star, which triggers a runaway nuclear fusion event. This fusion event has roughly the same brightness every time it happens, so astronomers can use these supernovae as "standard candles" – since they know how bright the supernovae should be, they can compare that to how bright they appear to be and calculate a distance. By combining many such measurements over a wide range of distances, astronomers can calculate the expansion history of the universe.

The team used a catalog of over 1,000 supernovae observations and separated them into different bins of distance ranges, with each bin representing the same number of supernovae. They then used each bin to measure the Hubble constant. In the standard cosmological picture, the expansion rate of the universe is constantly changing as the cosmos evolves, but the Hubble constant is a fixed number – it's the expansion rate of the universe right now.

Each bin of supernovae should yield the same Hubble constant, but in their analysis the researchers allowed the Hubble constant to not be so constant – they allowed for the possibility that it could change with time. By using different bins, they could test to see if the Hubble constant stayed fixed across the different bins, or if it did indeed vary.

"If it's a constant, then it should not be different when we extract it from bins of different distances. But our main result is that it actually changes with distance," Rinaldi said. "The tension of the Hubble constant can be explained by some intrinsic dependence of this constant on the distance of the objects that you use."

### Not very constant

Ultimately, the astronomers found in the study that by adding a little bit of flexibility to the standard cosmological models – by allowing the Hubble constant to change with time – they could relieve almost all of the tension between the supernovae and cosmic microwave background measurements. The researchers were able to extrapolate their evolving Hubble constant back to the time of the cosmic microwave background and match it up with those results.

"The extracted parameters are still compatible with the standard cosmological understanding that we have," he said. "But this time they just shift a little bit as we change the distance, and this small shift is enough to explain why we have this tension."

The new results are not altogether surprising. It's always possible to make differing observations agree by adding more complexity to models. In this case, the researchers added a new variable – how quickly the Hubble constant changes with time – and they were able to find a way to connect the early- and late-time measurements of the Hubble constant. Also, the work did not find a statistically significant measurement of this varying Hubble constant. Although they were able to relieve the tension in cosmological observations,

they were not able to conclusively say that the Hubble constant is changing with time.
These results, if they hold up, could give theorists a pathway to introducing new physics into the universe to explain the Hubble constant tension. Or it might also mean that supernovae aren't as "standard" as we think they are, and that perhaps some bias is creeping into the observations to spoil those measurements of the Hubble constant.

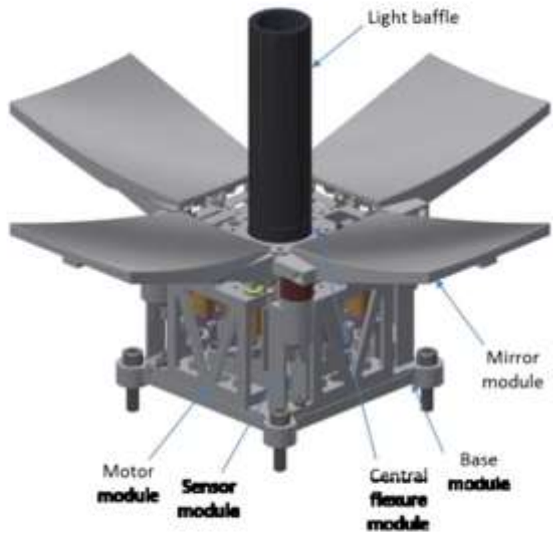
## Teeny Tiny CubeSats Could Have Deployable Mirrors Like James Webb

When you think of a space telescope, you probably think of ones such as the Hubble, which probes deep space using precision optics. But optical space telescopes are also pointed at Earth, giving us detailed views of everything from weather, to traffic patterns, to the movement of military troops. While Earth-focused telescopes are extremely useful, they can also be fairly large and expensive to launch into space. But that could change with a new proposed design for cube satellites.

Example of a 1U CubeSat. Credit: Wikipedia user Svobodat

A cube satellite, or CubeSat, is a type of tiny satellite standardized to weight and size. The basic size of CubeSats is known as a unit or "U," which is a cube 10 centimeters on a side, though some CubeSats are multiple units in size. Their low mass and standard dimensions mean they can be launched in groups or constellations, which significantly reduces the cost. But this small size also limits the amount of optics you can fit into one.
For optical telescopes, the sharpness of your image depends upon the size of your aperture. The Hubble space telescope, for example, has a 2.4-meter wide mirror. If the mirror were smaller, Hubble's images would be less detailed. That's because of a wave effect known as diffraction. When waves of light pass through an aperture of a limited area, they can interfere with each other, blurring the resulting image. This diffraction limit reduces the resolving power of your telescope.

Since a 1U CubeSat can only be 10cm across, the optical aperture of a CubeSat can only be a few centimeters across. Given the diffraction limit, a CubeSat in orbit 500km above Earth would only be able to resolve features on Earth that are 3m wide at best or about 10 feet across. That's not awful, but it is much lower than the resolution of modern commercial satellites. But a team of researchers has developed a design that could improve that limit significantly, and they do it using the same trick used by the James Webb Telescope.




How folded mirrors might work on a CubeSat. Credit: Schwartz, et al

The James Webb Space Telescope has a primary mirror that's 6.5 meters across. When launched later this year, it will provide far more detailed images than the Hubble ever could. The problem is that Webb will be launched on an Ariane 5 rocket, which is only 5.4 meters wide. So the Webb's mirror has to be folded to fit. Only after launch will it unfold to its full size. The CubeSat design uses the same approach. Four folded mirrors allow the satellite to fit within 1U while providing a larger aperture for the CubeSat when unfolded after launch. This is much easier said than done. Folding and unfolding mirrors is easy, but to work they have to be aligned with extreme precision. This is difficult to do even with Webb's 10 billion-dollar budget, so how do you do it for a cheap CubeSat?
The team proposes doing this in stages. After launch, the CubeSat mirrors could be unfolded and placed into a "close enough" position, then using active and adaptive optics to sharpen the image. The use of adaptive optics would also allow the CubeSat to compensate for heating and cooling effects, which could shift the mirrors out of alignment. Base on their initial studies, the team estimates a 1U CubeSat could achieve a resolution of 80 centimeters when orbiting at 500 kilometers, which is in the range of current commercial satellites.
The low cost of CubeSats means that CubeSat telescopes could make real-time high-resolution imaging of Earth much more cost-effective. A constellation of them could track both long-term and sudden changes on our planet. It would be tremendously helpful for things such as natural disasters, where information can be limited. But it would also mean that these tiny satellites would always be watching with a view from above.
**Reference:** Schwartz, Noah, et al. "High-resolution deployable CubeSat prototype." *Space Telescopes and Instrumentation 2020: Optical, Infrared, and Millimeter Wave*. Vol. 11443. International Society for Optics and Photonics, 2020.

## Dark Energy Survey is out. 29 Papers Covering 226 Million Galaxies Across 7 Billion Light-Years of Space

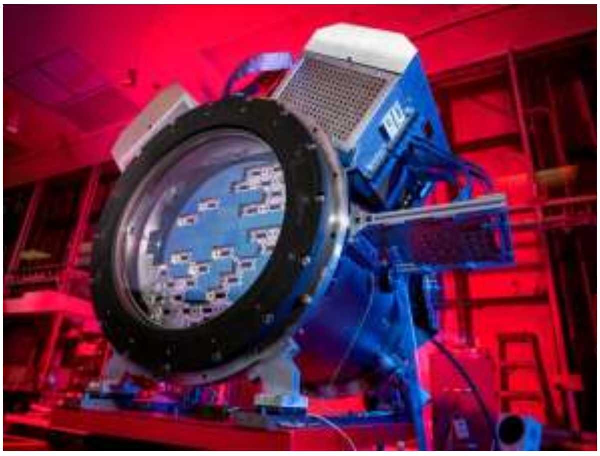
Cosmology is now stranger to large scale surveys. The discipline prides itself on data collection, and when the data it is collecting is about galaxies that are billions of years old its easy to see why more data would be better. Now, with a flurry of 29 new papers, the partial results from the largest cosmological survey ever – the Dark Energy Survey (DES) – have been released. And it largely confirms what we already knew.

The DES took place over 6 years from 2013 to 2019, and looked at over 1/8th of the night sky for a total of 758 nights. Results released on May 27th contain analysis of the data from the first half of that observational period, having already released results from the first year back in 2017.

Video describing the work by the DES.
Credit: NOIRLab YouTube Channel

Even using just half the data, the survey, which included 400 individual scientists from 25 institutions in 7 countries, observed over 226 million galaxies. Observations were done with the Victor M Blanco telescope at Cerro Tololo Inter-American Observatory in Chile. Measuring 4 meters in width, the Blanco telescope has a resolution of 570 megapixels – almost 50 times as much as a standard iPhone camera.

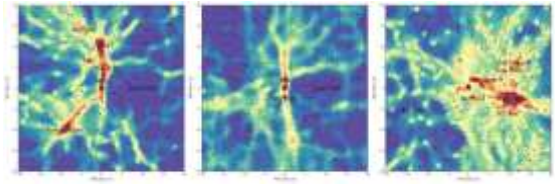
All that observational power is great to collect data, but the scientists need to know what to do with it when collected. The goal of the survey was to "quantify the distribution of dark matter and the effect of dark energy" according to a press release by Fermilab, which built and tested the camera used in the survey. These two poorly understood cosmic features make up 95% of all the known "stuff" in the universe.



The Dark Energy Survey camera (DECam) at the SiDet clean room. The Dark Energy Camera was designed specifically for the Dark Energy Survey. It was funded by the Department of Energy (DOE) and was built and tested at DOE's Fermilab.
Credit: NOIRLab

Despite their prevalence, they are very hard to detect, hence the name "dark". However, DES provides more insight that ever before into some characteristics of these little understood phenomena. In particular, two cosmological features were central to the survey's efforts. The first was the "cosmic web", while the second were weak gravitational lenses.

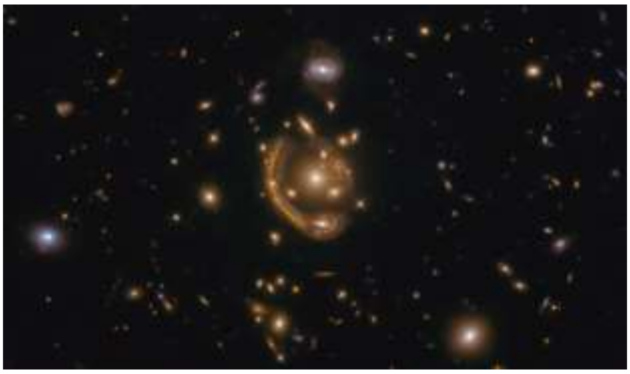
The cosmic web is what cosmologists use to describe the structure of galaxies. These massive clusters of gravitationally bound stars aren't randomly distributed, as one might assume if the universe was all started from the same state. They form a pattern, with clumps of galaxies banding together to form galaxy clusters.



Maps of some recent work to map clustering due to dark matter.
Credit: Hong et. al., Astrophysical Journal

Cosmologists normally attribute those clumped up areas to the presence of higher densities of dark matter and, therefore, gravity. Mapping where they occur in space provides insight into what areas of the galaxy might feature high concentrations of dark matter to study. Results from universe growth models can then be compared to the cosmic web as a way to check their accuracy in predicting how the universe actually turned out.

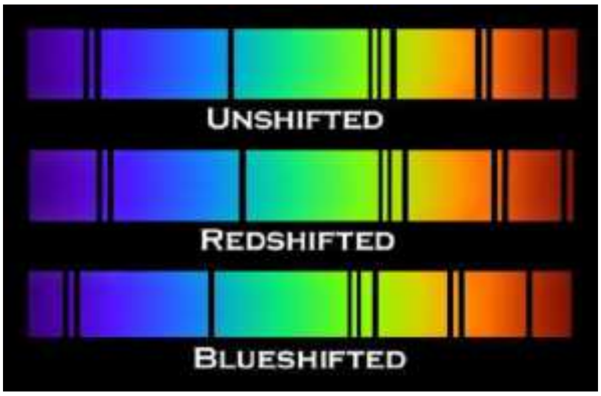
Clustering isn't the only way to detect dark matter though. DES scientists also utilized a well-studied cosmological phenomena called gravitational lensing. This effect happens when light is bent around areas of high gravity, which pockets of dark matter certainly are. Strong gravitational lensing, such as that around black holes, is a common enough feature of cosmology, producing features such as Einstein rings that look spectacular.



**The "Molten Ring" is one of the most complete Einstein Rings ever discovered.**
Credit: ESA / Hubble & NASA, S. Jha, L. Shatz

Weak gravitational lensing doesn't have quite as much visual impact as its stronger cousin, but it does provide more insight into that important map of dark matter and dark energy. It can also be notoriously difficult to calculate what effect the lensing has, which is where some additional analytical tools developed by the DES team come into play.

Redshifting is a feature of astronomical observations where things that are far away and getting further away appear to have the light they emit shifted to the red side of the light spectrum. It is notorious for confounding observational data of features like gravitational lensing or even of clustering itself.




This diagram shows the difference between unshifted, redshifted and blueshifted targets.
Credit: NASA

To deal with this issue, the DES team came up with a novel calibration technique. They chose 10 different regions of the sky to perform "deep field" searches of, which allowed them to see galaxies that were even farther away than their normal observational area. They then used the redshift values calculated in these deep fields to calibrate redshift values in the rest of the surveyed sky.

Even having removed the redshift, more data is always more useful in understanding cosmological phenomena. The DES team also analyzed a number of other phenomena, which included baryonic acoustic oscillations, frequency measurements for massive galaxy clusters, and calculations of some of the features of Type Ia supernovae captured in the survey.

This image shows an immersive view from inside the dome of the Víctor M. Blanco 4-meter Telescope at the Cerro Tololo Inter-American Observatory (CTIO), a Program of NSF's NOIRLab. The Dark Energy Survey photographed the night sky using the 570-megapixel Dark Energy Camera on the Blanco.
Credit: NOIRLab

The overall result of all this effort is another feather in the cap of the current model of the evolution of the universe. Survey results from the DES fit well with the predicted model that is used to map the universe from the beginning of time. In fact, it contradicts previous claims that there was a few percentage difference between the observed universe and the predicted one.

But the team's effort isn't done yet. They still have only analyzed half the data, so the other half is expected to add even more detail to the picture of dark energy and dark matter. In addition, new surveys using new instruments, such as the Vera Rubin Observatory, are already planned. There's always more cosmological data to be collected.

## Virgin Galactic Reaches the Space Frontier Over New Mexico for the First Time

Virgin Galactic's SpaceShipTwo rocket plane crossed its 50-mile-high space boundary over New Mexico for the first time today, after months of challenges.

The trip by VSS Unity marks the first time a spacecraft has been launched so high from a New Mexico spaceport. Unity passed the 50-mile mark twice during tests at California's Mojave Air and Space Port, in 2018 and 2019. Since then, the plane and its WhiteKnightTwo carrier airplane, dubbed VMS Eve, have been transferred to their operational home base at New Mexico's Spaceport America.

"Today's flight sees New Mexico become the third U.S. state to launch humans to space," after Florida and California, Virgin Galactic said in a post-mission press release.

Virgin Galactic goes with the U.S. Air Force's 50-mile definition for the boundary of space — rather than the internationally recognized 100-kilometer (62-mile) boundary, known as the Karman Line.

Today's flight followed the standard profile for a SpaceShipTwo trip: The twin-fuselage Eve made an airplane-style takeoff from Spaceport America with Unity bolted to its underbelly. Around the target altitude of 44,000 feet, Unity was released from its mothership and fired up its hybrid rocket engine to rise spaceward.

Test pilots Dave Mackay and CJ Sturckow guided Unity to its peak altitude of 55.45 miles, cheered on by Virgin Galactic founder Richard Branson and other VIPs who gathered at Spaceport America.

At the top of the ride, Mackay and Sturckow experienced a few minutes of weightlessness and saw a wide swath of the American Southwest spread beneath the black sky of space. Passengers are due to get a similar experience once Virgin Galactic begins commercial flights.

Unity glided back to a runway landing at Spaceport America — and Eve's pilots, Kelly Latimer and Michael Masucci, landed their mothership soon afterward. Virgin Galactic noted that Sturckow, a former NASA astro-

naut, is now the first person to take part in space launches from three states. (The others include Florida space shuttle launches and Unity's California test flight in 2018.)
Branson noted that the drive to create the world's first purpose-built commercial spaceport began in New Mexico 15 years ago.
'Today, we launched the first human spaceflight from that very same place, marking an important milestone for both Virgin Galactic and New Mexico," he said. "I am proud of the team for their hard work and grateful to the people of New Mexico who have been unwavering in their commitment for commercial spaceflight from day one. Their belief and support have made today's historic achievement possible."

## Pictures From China's Mars Rover Fuel NASA Chief's Funding Pitch to Congress

The first pictures from a Chinese probe on the surface of Mars were released May 19, sparking a plea from NASA's recently appointed chief for more funding to keep America in the lead on the space frontier.
China's Zhurong rover, which landed on the Red Planet on May 14, sent back pictures as it sat atop its landing platform on the flat plain of Utopia Planitia. One picture provides a rover's-eye view of the ramp that the six-wheeled robot will use to roll down onto the surface.
The probe also sent back video clips that were captured by China's Tianwen-1 orbiter during the lander's separation.
In a statement, NASA Administrator Bill Nelson congratulated the China National Space Administration on the Zhurong rover's pictures.
"As the international scientific community of robotic explorers on Mars grows, the United States and the world look forward to the discoveries Zhurong will make to advance humanity's knowledge of the Red Planet," said Nelson, a former U.S. senator who was sworn in as NASA's chief two weeks ago. "I look forward to future international discoveries, which will help inform and develop the capabilities needed to land human boots on Mars."
NASA has been sending rovers to Mars since 1997 and currently has two Red Planet rovers in operation: Curiosity, which landed in 2012; and Perseverance, which arrived in February. Each of those machines is twice as big as China's Zhurong rover.

Nelson's statement may have sounded collegial toward China, but during a House subcommittee budget hearing, he warned lawmakers that China was "a very aggressive competitor" in space exploration. Nelson said China's space successes should spark concern about funding levels for NASA's Artemis program, which aims to send astronauts to the moon by the mid-2020s and then onward to Mars.
The administrator pointed to China's plans to send future landers to the moon's polar regions, which are thought to hold deposits of water ice. Such deposits could be converted into rocket fuel as well as drinkable water and breathable air for future lunar residents. That's why China — and NASA — are targeting the lunar south polar region for robotic missions and eventually human exploration.
In March, China and Russia announced that they would work together to create an international research station near the moon's south pole.
China's success on Mars, and its aspirations for future moon missions, are "adding a new element as to whether or not we want to get serious and get a lot of activity going in landing humans back on the surface of the moon," Nelson said.
"They're going to be landing humans on the moon," Nelson said of the Chinese. "That should tell us something about our need to get off our duff and get our human landing system going vigorously."
NASA's Human Landing System program is currently a point of contention. The space agency had organized a three-way competition for lunar lander proposals, with the intention of choosing two companies to go to the next phase. But Congress allocated only a fraction of the money that NASA requested for the current fiscal year. As a result, NASA picked SpaceX's Starship as its sole selection.
The other two competitors — Dynetics, and a team led by Amazon founder Jeff Bezos' Blue Origin space venture — have protested NASA's decision. It's up to the Government Accountability Office to decide whether the competition will have to be redone.
In the meantime, Congress is considering legislation that would require NASA to pick a second provider for lunar landers, in order to promote competition and provide redundancy. Nelson called on Congress to set aside $5.4 billion in its infrastructure and jobs bill to boost the lander program and address NASA's other infrastructure needs.
Even if NASA's award to SpaceX remains as is, Nelson pledged that the space agency would conduct a follow-up competition for commercial lunar landing services that'd come into play after the Artemis program's astronauts make their first moon landing. "Within the bounds of law, I will insist on that future competition," he said.

## A Solution to Space Junk: Satellites Made of Mushrooms?

According to the latest numbers from the ESA's Space Debris Office (SDO), there are roughly 6,900 artificial satellites in orbit. The situation is going to become exponentially crowded in the coming years, thanks to the many telecommunications, internet, and small satellites that are expected to be launched. This creates all kinds of worries for collision risks and space debris, not to mention environmental concerns.
For this reason, engineers, designers, and satellite manufacturers are looking for ways to redesign their satellites. Enter Max Justice, a cybersecurity expert, former Marine, and "Cyber Farmer" who spent many years working in the space industry. Currently, he is working towards a new type of satellite that is made out of mycelium fibers. This tough, heat-resistant, and environmentally friendly material could trigger a revolution in the booming satellite industry.
As it stands, one of the biggest concerns with satellites is the risk of collision they pose once they become defunct. Until such time that their orbit decays and they burn up in the atmosphere, satellites are likely to collide with each other and produce small pieces of space debris. To mitigate this, and prevent the exponential rise of debris in orbit (aka. Kessler Syndrome), satellite manufacturers are investigating ways to deorbit them quicker.

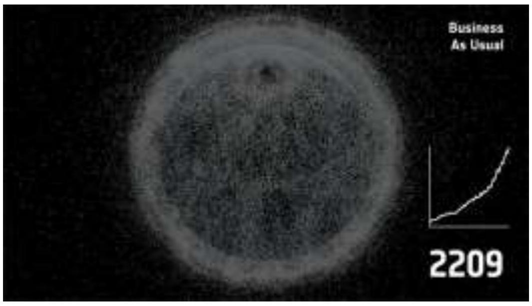
However, this overlooks another hazard, which is the way satellites that re-enter our atmosphere will leave traces of aluminum particles and other toxic residues behind. These particles will float in the upper atmosphere for many years and could create another source

of environmental problems. Max Justice believes that mycelium fungus could address both of these hazards when used to manufacture satellite chassis. Basically, mycelium fibers are a protein-rich, multi-celled material extracted from the root structure of fungi that grow into macro-structures – the most well-known being mushrooms. As these structures grow, the mycelia release enzymes that convert sugars or plant waste into usable nutrients, which allows them to create extensive networks in whatever substrate they occupy – usually soil.
When dried, mycelium fibers are lightweight, extremely tough, and have tensile strength comparable to that of silk. Because of this, mycelium is one of many organic fibers that are being investigated for the sake of building materials and manufacturing. For instance, multiple designers are investigating mycelium as an inexpensive, durable, and non-toxic means for building eco-friendly housing, insulation, and plastics.
Examples include architecture and design firms Evocative and The Living, which have been using mycelium for years to create materials and finished products. In the construction industry, mycelium has also been shown to have applications for removing harmful chemicals in building waste. When paired with 3D printing, mycelium can also be used to fabricate chairs and other pieces of furniture.

Other applications include "mushroom paper," surfboards, "mushroom leather, "mushroom shoes," bacon, and even coffins that turn human remains into compost. When actor Luke Perry passed away in 2019, his daughter indicated that he was interred in a "mushroom suit." As Justice told Universe Today via email, this natural fiber occupies an important place in the revolution currently taking place in manufacturing and materials:

*"People are realizing every day how mushrooms (in particular, mycelium) can be used as a replacement for bacon (as well as pork, cow, and chicken), leather (and they're finding it's stronger), shoes, hats, clothes, as building/construction materials such as bricks, soundproofing, fire retardant insulation, as well as packing materials, furniture, bolts of threads, handbags, pet food, the sky is the limit. There are even several mycologists and other scientists working with mycelium to eat oil and plastic. It's pretty amazing."*
But what about commercial space, another industry that is undergoing a seismic shift in terms of purpose and practices? This is where Justice's efforts are ultimately directed, and which were inspired by research that is currently being conducted by Sumitomo Forestry and Kyoto University in Japan. Under the direction of Takao Doi, a former JAXA astronaut and a professor of Aerospace Engineering at the University of Kyoto, this collaborative effort seeks to build the first "wooden satellites."

The idea is to use layers of cellulose fiber (aka. wood) that are highly resistant to temperature changes and direct sunlight. "We are very concerned with the fact that all the satellites which re-enter the Earth's atmosphere burn and create tiny alumina particles which will float in the upper atmosphere for many years," said Doi in a recent interview with the BBC. "Eventually, it will affect the environment of the Earth."
But as Justice indicated, mycelium is not only a stronger and more flexible material than wood is, it's also much more renewable and sustainable as a resource. And that's just the tip of the iceberg, as he explained:
*"Depending on the type of mycelium used, it can be more flexible than wood and/or stronger than wood, it's lighter than wood, and naturally much more fire-retardant. I even took a propane torch to one of my mycelium blocks for over 5 minutes and all it did was smoke.*
*"Mycelium is very light in weight, it naturally floats on water, it can withstand the cold of space where we don't have to worry about cold welding, and we can add in fine strains of metal material which is used to transmit almost any type of signal. As you can see, there are numerous reasons why mycelium is quite suitable for our satellites in space, on land, and in the air on its way to space.*
Of course, there's also the all-important issue of space debris, which is projected to become a severe hazard to satellites and spacecraft in Low Earth Orbit (LEO) in the coming years. According to the SDO, more than 560 break-ups, explosions, collisions, or anomalous events that resulted in fragmentation have taken place since the launch of the first artificial satellite in 1957 (*Sputnik 1*). With the proliferation of small satellites and the mega-constellations that are (or soon will be) deployed, the risk of collision rises considerably.
This could result in a phenomenon known as "Kessler Syndrome," where collisions and breakups lead to more collisions and more still, and so on. Fore decades, space agencies and astronomers have feared this prospect and have been looking for mitigation measures to prevent and clean up "space junk." As Justice indicated, materials like mycelium fibers would constitute a mitigation measure at the production end.




*Why Space Debris Mitigation is needed. Credit: ESA*
"Well, space debris is space debris," he said. "And when flying around at 26,875 km (16,700 mph), it can still ruin someone's day. Because mycelium has such strong bonds and is what some consider fire-proof, it will take a lot of energy in space to break it apart, which is actually a good thing because it is the small pieces of space junk that are the real killer."
Given the advantages and the ways in which mycelium has caught on with several different industries, one has to wonder why the space sector is lagging behind in the adoption of this material. While there are some examples – for instance, Mars City Design (MCD) is exploring the use of mycelium to create habitats for Mars – there currently isn't a similar effort to develop mycelium satellites.
As it stands, Justice describes himself as an "army of

one when it comes to making mycelium-based satellites." The operation, known as Setas Mushrooms (located in Falling Waters, West Virginia) specializes in growing and delivering fresh, fully organic edible mushrooms. In addition, they grow and deliver 0.45, 2.25, and 4.5 kg (1, 5, and 10 lbs) blocks of Mycelium, which typically take less than 2 months to create and can be grown into any required shape. Said Justice:

*"I've been working in the space industry (predominately with the NGO [Natiopnal Reconnaissance Office], NGA [National Geospatial-Intelligence Agency], and NASA) for over 15 years and no one else is doing this or talking about it. Until they meet me, then people are blown away about the uses for mycelium. I'd love to see NASA, other government agencies, or the private sector like SpaceX, Bigelow, ISISpace, Visioneering, or many others get interested in this low cost, lightweight, fire-retardant, and highly sustainable product."*

*Artist's impression of the orbital debris problem. Credit: UC3M*

At present, there are about 4,000 functioning satellites in orbit, with new ones being added all the time. SpaceX began launching batches of its Starlink broadband internet satellites in May of 2019, starting with batches of 60 a few times a month. Since March of 2021, they are averaging about 300 a month and now have a constellation of 1,443 satellites – with plans for a megaconstellation of 12,000.

Meanwhile, multinational e-commerce giant Amazon has plans of its own for a constellation of 3,236 broadband satellites. Since 2012, Viasat and Hughes (a subsidiary of EchoStar) have also offered broadband internet services through their telecom satellite constellations. With internet access expected to reach 8.73 billion people worldwide by 2050 (that's 90% of the global population), there is considerable growth (no pun!) to be had in this sector!

## Bright Ejecta Reveals a Fresh Crater on Mars

Meteors hit much harder on Mars than they do on the Earth. Lack of atmosphere obviously contributes to that, but its proximity to the asteroid belt also makes the red planet a more likely target for some gravitationally disturbed rock to run into. Now that we have a satellite infrastructure consistently monitoring Mars, we are able to capture the aftermath of what happens when it is pummeled by space debris, and the results can be dramatic.

One powerful tool in that impact hunting toolkit is the Mars Reconnaissance Orbiter (MRO). It has a variety of instruments on it that make it possible to both track down areas of interest and then follow up with high resolution imagery, incluidng HiRISE, the camera that took the picture above. That is exactly what happened with a new crater that the satellite noticed on one of its flybys.

Anton Petrov discusses Martian crater formation. Credit: Anton Petrov YouTube Channel

The new crater shows up as a bright spot, which scientists theorize might be shallow subsurface materials that were blasted into the open on impact. This contrasts with many new craters, which show up as dark spots as dust from the ejecta is covered in a darker material. Those bright spots are significantly bright in the attached image though, as it was color enhanced in post processing.

The new crater is 13m in diameter, and shows up spectacularly on the newly released image. It goes to show just how active our solar system still is, and how a little rock can make a big impact when there's little to nothing to stop it.

## 60 Years Later, is it Time to Update the Drake Equation?

On November 1st, 1961, a number of prominent scientists converged on the National Radio Astronomy Observatory in Green Bank, West Virginia, for a three-day conference. A year earlier, this facility had been the site of the first modern SETI experiment (Project Ozma), where famed astronomers Frank Drake and Carl Sagan used the Green Bank telescope (aka. "Big Ear") to monitor two nearby Sun-like stars – Epsilon Eridani and Tau Ceti.

While unsuccessful, Ozma became a focal point for scientists who were interested in this burgeoning field known as the Search for Extraterrestrial Intelligence (SETI). As a result, Drake and Sagan were motivated to hold the very first SETI conference, wherein the subject of looking for possible extraterrestrial radio signals would be discussed. In preparation for the meeting, Drake prepared the following heuristic equation:

$$N = R^* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

This would come to be known as the "Drake Equation," which is considered by many to be one of the most renowned equations in the history of science. On the sixtieth anniversary of its creation, John Gertz – a film producer, amateur astronomer, board-member with BreakThrough Listen, and the three-term former chairman of the board for the SETI Institute – argues in a recent paper that a factor by factor reconsideration is in order.

*Frank Drake writing his famous equation on a white board. Credit: SETI.org*

In this paper, which was recently accepted for publication by the *Journal of the British Interplanetary Society* (JBIS), Gertz makes the case for a revised equation and a lot more searching! To break it down, the Drake Equation consists of the following parameters:

- *N is the number of civilizations in our galaxy we could communicate with*
- *$R^*$ is the average rate of star formation in our galaxy*
- *$f_p$ is the fraction of stars with planetary systems*
- *$n_e$ is the number of planets that can support life*
- *$f_l$ is the number of those planets that will develop life*
- *$f_i$ is the number of those planets that will develop intelligent life*
- *fc is the number of civilizations that might develop transmission technologies*
- *L is the amount of time that these civilizations would have to transmit their signals into space.*

Rather than being an actual means for quantifying the number of intelligent species in our galaxy, the purpose of the equation was meant to frame the discussion on SETI. In addition to encapsulating the challenges facing scientists, it was intended to stimulate scientific dialogue among those attending the meeting. As Drake would later remark:

*"As I planned the meeting, I realized a few day[s] ahead of time we needed an agenda. And so I wrote down all the things you needed to know to predict how hard it's going to be to detect extraterrestrial life. And looking at them it became pretty evident that if you multiplied all these together, you got a number, N, which is the number of detectable civilizations in our galaxy. This was aimed at the radio search, and not to search for primordial or primitive life forms."*

*The Green Bank Telescope monitoring the galaxy for Fast Radio Bursts (FRBs). Credit: Danielle Futselaar/UC Berkeley*

The Drake Equation has since gone on to achieve great fame and great notoriety. Whereas some scientists will laud it as one of the most important contributions to scientific inquiry, others have criticized it for its obvious uncertainties and conjectural nature. Such criticisms emphasize that by multiplying uncertain variables, the level of uncertainty grows exponentially, to the point where no firm conclusions are possible.

As John Gertz explained to the Universe Today via email, the problems associated with the Drake Equation have not diminished over time. For many scientists, the profound discoveries that have taken place in the past few decades (which have reduced the level of uncertainty with some of the equation's variables) have called into question the very utility of the equation itself.

"The Drake Equation was an extraordinarily useful heuristic at the outset of the modern search for extraterrestrial intelligence in the early 1960s," he said. "It guided our first draft thoughts on the subject. 60 years on, however, it is a creaky and aging edifice that should be swept away in favor of fresh new thinking."

For the sake of his study, Gertz reconsidered each of the variables of the Drake Equation to determine if they were still useful for placing constraints on the possibility of intelligent life. For starters, there was the parameter *R**, which Gertz described as "useless" for a number of reasons. These include the fact that the rate of new star formation changes over time and that Drake confined himself to Sun-like stars (which have a low birthrate compared to several other types).

*Frank Drake standing before the Green Bank Telescope. Credit: NRAO/NSF/AUI*

Also, there is the possibility that ET signals could be ex-

tragalactic in origin, and that the number of civilizations is unrelated to the birth of new stars. For these reasons, he suggests that *R** should be replaced with $n_s$, which denotes the number of candidate stars in the Milky Way that fall within our field of view (FOV). This would be considerable since stars that are thought to be good candidates for habitability include G-type, K-type, and M-type (over 80% of stars), as well as seemingly dead white dwarfs (another 10% of all stars).
Next up, there's the number of stars that have a planet or system thereof orbiting them (the $f_p$ parameter), which was largely unknown in Drake's time. However, in the past two decades, the number of confirmed exoplanets has grown exponentially (4,383 and counting!), thanks in large part to the *Kepler Space Telescope*. When extrapolated, these discoveries suggest that planets are ubiquitous to stars, which makes this parameter largely irrelevant.

Next up is another important consideration that has emerged from recent exoplanet discoveries. This is the number of Earth-like planets (aka. "terrestrial" or rocky) that orbit within their parent star's habitable zone (HZ) – $n_e$. But as multiple lines of research have shown, simply orbiting within a star's HZ is hardly the only consideration. There's also a planet's size, atmosphere, and the presence of water and tectonic activity.
The definition of HZ is also limited to planets, whereas moons like Ganymede, Europa, Enceladus, Titan, and others show that life could exist in "ocean world" environments. There's also the case of Mars and Venus, both of which had flowing water and relatively stable temperatures at one time. Ergo, Gertz recommends that $n_e$ should be replaced by $n_{tb}$, which denotes the total number of bodies (planets, moons, planetoids, etc.) that could support life either on their surfaces or beneath them.
The parameter $f_l$ (planets that will develop life) is also hopelessly uncertain, mainly because scientists are not certain of how life began here on Earth. Current theories range from primordial pools and hydrothermal vents to seeding from space (lithopanspermia) and between star systems and galaxies (panspermia). There is also no consensus on whether or not life is ubiquitous or rare, owing to the fact that the search for extraterrestrial life (basic or otherwise) is so data-poor.
Next up, the fraction of life-bearing planets that will give rise to a technologically competent species ($f_i$), which is especially problematic. In this case, the issue comes down to evolutionary pathways and whether or not the factors leading to the emergence of homo sapiens are at all common. In short, we have no idea if evolution is convergent (favors intelligence) or non-convergent.
The penultimate parameter, the fraction of intelligent species that could be attempting to communicate with us right now ($f_c$), is similarly riddled with problems. On the one hand, it recognizes that not all technologically competent species will be able to communicate with us, or willing (a la The Dark Forest Hypothesis). On the other, it doesn't take into account two very important considerations.
For one, it doesn't consider the amount of time it takes for a transmitter or receiver to make a single circuit through a number of objects in our galaxy. Unless signals are being constantly broadcast directly at Earth (or in all directions), but also very high energy levels to boot, the chances of any being received are quite unfavorable. In addition, it doesn't take into account the possibility that technosignatures (such as radio transmissions) will be detected unintentionally.
Hence, Gertz recommends that $f_c$ be replaced by the parameter $f_d$, which is more broad in nature. In addition to considering an extraterrestrial civilization's attempts to communicate with us, it also factors in our capability of detecting a civilization's technosignatures. After all, what good are signaling efforts if the intended recipients are not even capable of receiving the message?
Last, but certainly not least, there's the ever-so tricky parameter of *L,* the amount of time a technologically dependent civilization will spend attempting to communicate with Earth. Over time, this parameter has come to be identified as the lifespan of civilizations, or how long they can be in an advanced state before succumbing to self-destruction or environmental collapse.
Carl Sagan himself admitted that of all the parameters in the Drake Equation, this was by far the most uncertain. Put simply, we have no way of knowing how long a civilization can persist before it is no longer able to communicate with the cosmos. We could no more predict how and when an extraterrestrial civilization might end than we could our own (though some people doubt we'll make it out of this century!)
Another common consideration is the likelihood that by the time an extraterrestrial signal or messenger probe is found by another species, the civilization responsible for sending it will have long since died. This argument is part of the "Brief Window" Hypothesis, which conjectures that advanced civilizations will invariably succumb to existential threats before another civilization can receive and respond to their transmissions. As Gertz explained:

*"[T]he Drake Equation was predicated upon the notion that there is a finite number of currently existing alien civilizations ensconced among the stars, some of whom will be signaling their presence to us using radio beams or optical lasers. However, this ignores another school of thought which holds that ET's far better strategy would be to send physical probes to our solar system to surveil and ultimately make contact with us.*
*"Such probes could represent information from innumerable civilizations, many of whom may have long ago perished. If this is the case, Drake's L is irrelevant, since the probe might far outlive its progenitor, and his N reduces to one, the single probe that makes its presence known to us through which alone we might communicate with the rest of the galaxy."*

*Artist's impression of the Breakthrough Listen Network. Credit: Breakthrough Listen/Univ. of Machester/Daniëlle Futselaar*

Ultimately, an updated version of the Drake Equation (based on Gertz's analysis) would look like this:

$$N = n_s \times f_p \times n_{tb} \times f_l \times f_i \times f_d \times L$$

- *$n_s$ is the number of spots on the sky within our FOVs*
- *$f_p$ is the fraction of stars with planets*
- *$n_{tb}$ is the average number of bodies within each that could engender life*
- *$f_l$ is the fraction of those that actually do give birth to life.*
- *$f_i$ is the fraction of systems with life that evolves technological intelligence*
- *$f_d$ is the fraction of technological life that is detectable by any means*
- *L is the duration of detectability.*

Alas, when all the parameters (and their respective levels of uncertainty) are considered, we are left with some uncomfortable implications. On the one hand, it would empirically simpler to conclude that humanity is currently the only technologically advanced civilization in the observable Universe. Or, as Gertz concludes, it could serve as a call to action to reduce or eliminate these levels of uncertainty!

"The Drake Equation sets out to determine N, the number of extant communicating civilizations," he said. "There is simply no way to determine this by any known means other than by making contact with our first ET and asking it what it might know of the matter. The failure of the Drake Equation paradoxically makes a robust SETI program all the more important, since no amount of armchair speculation can determine N."

As to what a robust SETI program would look like, he acknowledges that current efforts – epitomized by Breakthrough Listen – are a good start. As part of Breakthrough Initiatives (a non-profit organization founded by Yuri and Julia Milner in 2015) this 10-year, $100 million program is the most comprehensive survey ever undertaken in the search for technosignatures in the Universe.

The project relies on radio wave observations made by the Green Bank Observatory and the Parkes Observatory in Southeastern Australia, as well as visible-light observations from the Automated Planet Finder at the Lick Observatory in San Jose, California (among others). Combined with the latest in innovative software and data analysis techniques, the project will survey one million nearby stars, the entire galactic plane, and 100 nearby galaxies.

However, in order for SETI research to truly advance to the point where the Drake Equation can be helpful again, two things are necessary. Said Gertz, these include secure funding and dedicated observatories:

*"Breakthrough Listen is a game-changer. Because of it, more SETI is accomplished in a single day than was ever before accomplished in a full year. However, over the long term, much more needs to be done. Foremost, is perpetual funding that can only be assured through an endowment.*

*"Also, there is a need to build more telescopes dedicated to 24/7, particularly wide field of view telescopes because we can only guess from where ET's signal might arrive, and to train additional scientists who in turn might know that they can plan a career around SETI assured by a funded endowment."*

Aside from the rigorous nature of looking for the proverbial needle in the cosmic haystack, one of the greatest challenges of SETI research is ensuring that funding will remain available. This is not unique to the field of SETI, but compared to space exploration and related endeavors, there is the constant battle to justify its existence. But considering that the payoff will be the single greatest discovery in the history of humanity, it is definitely worth the cost!

## Astronomers Measure the Background Brightness of the Night sky Across the World. Canary Islands are the Darkest in the Survey

Being able to look up at a clear, dark sky is becoming more and more rare in the rich world. Authors, artists, and even scientists have started to express concern about what our lack of daily exposure to a dark night time sky might mean for our psyche and our sense of place in the universe. Now a team has collected photometric data at 44 sites around the world in an attempt to quantify how dark the night sky actually is at different places on the globe. So where was the darkest place surveyed? The Canary Islands.

It just so happens that the lead researcher on the project, Dr. Miguel Alarcón is from that set of islands off the west coast of Africa. The paper he and his colleagues wrote, soon to be published in The Astronomical Journal, used a series of photometers, confusing called TESS (not to be confused with the Transiting Exoplanet Survey Satellite) to try to get a baseline of how dark the night sky is throughout the world.


Example of a standardized TESS photometer.
Credit: TESS / Stars4all

The team collected 11 million points of data from places as far apart as Namibia, Australia, and the US. While this did not include some more popular astronomy spots, such as the highlands of Antarctica, it was a good sample of different conditions. As mentioned above, the Canary Islands had the lowest levels of background light of anywhere studied. Only about 2% of the light in the sky at night comes from artificial light at the Roque de los Muchachos Observatory in Garafia.

However, there are other, natural sources of light pollution that affect different geographies differently. The moon and the milky way are standard features of the night sky and certainly contribute to the natural brightness of it. However, there are other, more variable sources that this study monitored. These include a glow in the upper atmosphere that is caused by a combination of factors, such as the solar cycle, geographical location, and the time of year.


Example of different types of light sources in the night sky, including the gegenschein effect.
Credit: Juan Carlos Casado

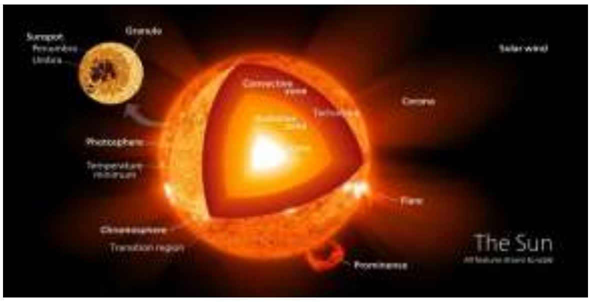
Another source is known as the "gegenschein" or the anti-solar point, directly opposite from the sun in the night sky. This can only be seen in extremely dark places, and the astronomy institute on the Canary Islands (IAC) is one of them.

Just because it has some of the darkest skies does not mean it's the best place for all observations though. Other factors, such as atmospheric seeing and temperature fluctuations can cause problems with observations. The real take away from this research is that if you truly want to see the night sky as our ancestors did, it might be worth a trip to some islands off the coast of Africa.


Vertical panorama showing the night sky over the Canary Islands.
Credit: Juan Carlos Casado

## Massive Stars Mix Hydrogen in Their Cores, Causing Them to Pulse Every few Hours or Days

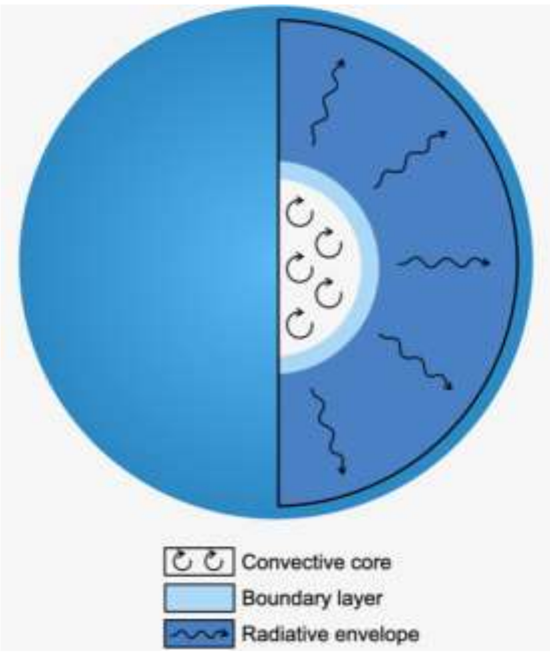
Main sequence stars fuse hydrogen in their cores. It's how they produce the energy they need to shine and keeps them from collapsing under their own weight. As hydrogen is fused into helium, there is less hydrogen available in the core. This can pose a challenge for large stars. They need to fuse a tremendous amount of hydrogen to keep shining, and they can't do that when core hydrogen is depleted. Fortunately, they can solve this problem by mixing more hydrogen into their core. A new study in *Nature Astronomy* shows us how this mixing happens.




The interior of our Sun. Credit: Kelvin Ma, via Wikipedia

With stars like the Sun, the core is surrounded by a radiative layer. This layer is so dense that it takes photons tens of thousands of years to move through it. The atoms in this layer don't churn much, so there isn't much mixing. Above the radiative layer is a convective layer, which does mix. Hydrogen within the Sun's core isn't replenished as it's fused into helium, but there is still plenty of core hydrogen to power the Sun for billions of years.

If larger stars had a similar internal structure as our Sun, they would burn through core hydrogen fairly quickly, filling the core with "helium ash" that would limit the star's ability to fuse hydrogen. So astronomers have thought that large stars have a convective core, which would allow hydrogen from higher layers to be mixed into the core. But how do you prove that?




The interior of large stars. Credit: May Gade Pedersen

This new study used a method known as asteroseismology, which looks at how the surface of a star moves and changes in brightness. While some of this can be caused by things like stellar flares, much of it is caused by sound waves within the star. The process is similar to the way you might study the vibrations of a bell by listening to its ring. Since a star's internal vibrations are affected by the density and motion of its interior, asteroseismology is a powerful way to study stars.

The team looked at 26 B-type stars that are known to pulse in brightness. These bright blue stars are between 3 and 20 times the mass of our Sun, and they pulse at a rate from 12 hours to 5 days. Using data from NASA's Kepler mission, the team was able to show that many of these stars have a convective core, thus allowing hydrogen to mix.

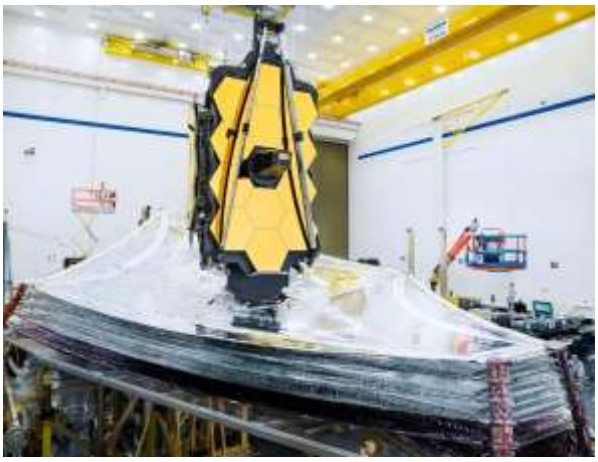
One interesting result was that the amount of mixing doesn't correlate with the age of the star. It is not the case that mixing increases as a star ages and gets hotter. Instead, the rate of mixing is quite variable. Some stars have very little core mixing, while others mix at a rate a million times higher. Rather than age, the mixing seems to be related to the amount of internal rotation a star has.

There is plenty more to study here. The level of mixing in a star's core can affect the lifetime and evolution of the star. While large stars typically have much shorter lifetimes than our Sun, their lifetimes may not simply depend on their mass. As we apply asteroseismology to more stars in the future, we will likely find more factors that are in the mix.

## Concerns About James Webb's Ariane 5 Rocket Might Push the Launch Back

A new report from the US Government Accountability Office (GAO) says that the launch of the long-awaited, highly anticipated James Webb Space Telescope (JWST) will very likely be delayed due to an anomaly identified in the Ariane 5 launch vehicle. Launch for JWST is currently scheduled for October 31, 2021, but that date could slip by at least a couple of weeks.

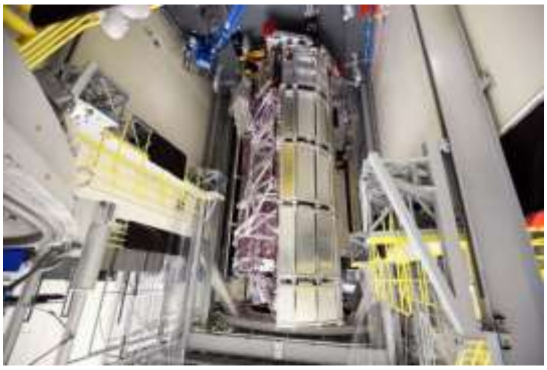
As we reported yesterday, the usually reliable Ariane 5 has experienced problems on two previous launches where unexpected vehicle accelerations occurred when the fairing separated from the rocket. The fairing is the nose cone used to protect a spacecraft payload during launch and acceleration through Earth's atmosphere. The Ariane 5 has been grounded for several months while the European Space Agency and Arianespace investigate the issue. In both anomalies, the payloads were successfully placed in orbit, however. There are two Ariane launches on the manifest before the JWST launch, and those launches are now expected no earlier than June and August 2021, respectively.



*During a recent test, engineers and technicians fully deployed all five layers of the James Webb Space Telescopes sun-shield. Image Credit: NASA/Chris Gunn*

During a media briefing on May 11, Greg Robinson, Program Director for JWST at NASA's Science Mission Directorate said that ESA and Arianespace are going

through the process of getting the rocket ready for the upcoming first launch, and once the first launch takes place, "we'll be able to launch in about four months after that."
The two Ariane 5 launches are scheduled to carry the Eutelsat Quantum satellite and Star One D2 satellite.
The GAO report, released on May 13, 2021, said that Arianespace must demonstrate that the issue has been corrected on at least one of those launches before JWST will be allowed to launch. As of now, "the JWST launch had not been rescheduled; however, project officials assessed the risk that the JWST launch date could be rescheduled as highly likely. The project has received briefings on the investigation's progress from its international partners and is continuing to monitor the situation."
NASA officials at the media briefing this week admitted that the margin in their schedule in preparing and shipping JWST to South America is basically zero. "When we ship, the schedule margin will be pretty close to zero, but still on plan," Robinson said, "Right now, we are not working any liens, and we're in a really good place."
The GAO report indicated the JWST project has used schedule reserves—extra time set aside to accommodate unforeseen risks or delays—faster than expected to address issues such as repairing and strengthening the sunshield.
"As a result, the project has less schedule reserve than planned to complete remaining activities," the report said. "The project is also completing redesigns for key parts of the observatory, including actuators, which help unfurl the sunshield. Further, the project continues to address technical problems that could affect the project's ability to meet cost commitments if the contractor workforce is needed longer than planned."
Including the launch delay risk, the report said JWST project managers are working on managing 39 risks. Of the 39 risks, NASA will continue to manage 26 after launch, including those related to sunshield deployment and the functionality of the observatory's sensitive, near-infrared camera.
Alarmingly, some of these risks could result in loss of mission, but NASA has assessed that they are unlikely to occur.

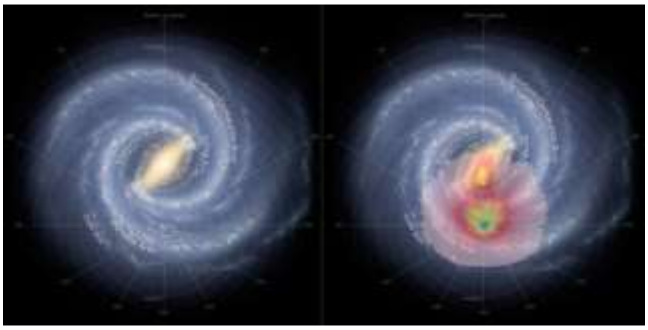


*Technicians and engineers needed to take special precautions when preparing, and transporting Webb's spacecraft element for entry into Northrop Grumman's environmental testing chambers. Credits: Northrop Grumman*

As is well known, the JWST program has a history of significant schedule delays and project cost increases. The entire project was replanned in both the 2011 and 2018.
"Since the project's schedule and costs were baselined in 2009," the GAO report says, "the launch date has been delayed by over 7 years and costs have increased by 95 percent. Due to early technical and management challenges, contractor performance issues, and low levels of cost reserve, the JWST program experienced schedule overruns, launch delays, and cost growth."
But recently, the project has completed significant technical milestones, such as successfully completing the final set of acoustics and vibration testing in October 2020, and performing sunshield deployment exercises in December 2020.
In a mission that has seen significant postponements, it seems an iconic irony that now as JWST seems finally ready to launch, it might experience another unexpected delay.

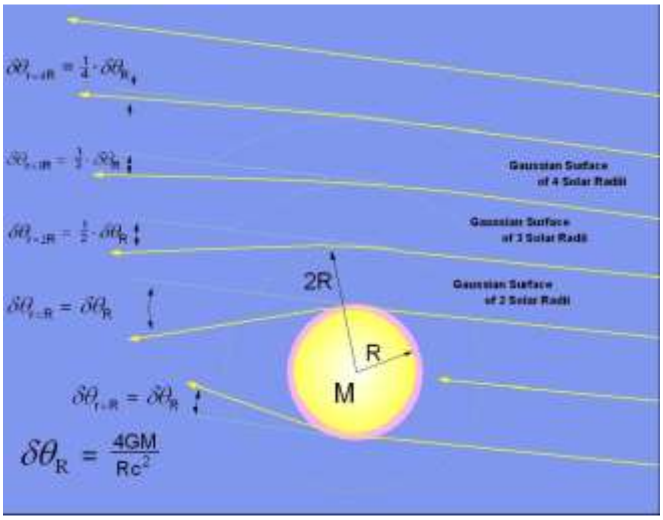
## Gaia Might Even be Able to Detect the Gravitational Wave Background of the Universe

The Gaia spacecraft is an impressive feat of engineering. Its primary mission is to map the position and motion of more than a billion stars in our galaxy, creating the most comprehensive map of the Milky Way thus far. Gaia collects such a large amount of precision data that it can make discoveries well beyond its main mission. For example, by looking at the spectra of stars, astronomers can measure the mass of individual stars to within 25% accuracy. From the motion of stars, astronomers can measure the distribution of dark matter in the Milky Way. Gaia can also discover exoplanets when they pass in front of a star. But one of the more surprising uses is that Gaia could help us detect cosmic gravitational waves.



The area of the Milky Way observed by Gaia. Credit: X. Luri & the DPAC-CU2

A new study shows how this can be done. The work is based on an earlier study done using Very Long Baseline Interferometry (VLBI) where radio telescopes measured the position and apparent motion of quasars. Quasars are bright radio sources billions of light-years away. Because quasars are so far away, they act like fixed points in the sky. By precisely measuring quasars, we can pinpoint positions on Earth so accurately that we can see how continents drift due to plate tectonics, and how the rotation of Earth slows down over time. While the quasars are essentially fixed points, their light can be deflected slightly through gravitational lensing. If a star passes into a quasars line of sight, the quasar would appear to shift slightly. Since gravitational waves can also deflect light, we could detect the presence of gravitational waves through the apparent wobble of quasars. The VLBI observations of quasars have found no indication of gravitational waves, placing an upper limit on them in our region of space.




The grazing of starlight passing the Sun. Credit: Wikipedia

Although the position measurements of Gaia aren't as accurate as VLBI, they are accurate enough to detect gravitational lensing. In fact, astronomers have to account for the lensing effect of the Sun when analyzing Gaia data. So the team looked at Gaia's position data for 400,000 quasars. Although quasars aren't stars, many of them are optically bright, and Gaia measures their position just as if they were stars. The team looked for statistical evidence of wobble in the Gaia quasar data and found none. But given the large number of quasars observed, they could place a stronger upper bound on local gravitational waves. From this study, the team showed that there are no binary supermassive black holes within our local group, which includes both the Milky Way and the Andromeda galaxy.

What's great about this study is that it shows the power of big data. When we observe the heavens with both great scale and great precision, astronomers can use the data in innovative ways. Gaia was never intended to study gravitational waves, and yet it can all the same. As we continue to move into the realm of big data astronomy, who knows what more we will discover.

**Reference:** Shohei Aoyama, et al. "Gaia 400,894 QSO constraint on the energy density of low-frequency gravitational waves." *arXiv preprint* arXiv:2105.04039 (2021).

## In 1.3 Million Years, a Star Will Come Within 24 Light-Days of the Sun

Within the Milky Way, there are an estimated 200 to 400 billion stars, all of which orbit around the center of our galaxy in a coordinated cosmic dance. As they orbit, stars in the galactic disk (where our Sun is located) periodically shuffle about and get closer to one another. At times, this can have a drastic effect on the star that experience a close encounter, disrupting their systems and causing planets to be ejected.

Knowing when stars will make a close encounter with our Solar System, and how it might shake-up objects within it, is therefore a concern to astronomers. Using data collected by the *Gaia Observatory*, two researchers with the Russian Academy of Sciences (RAS) determined that a handful of stars will be making close passes by our Solar System in the future, one of which will stray pretty close!

The study was conducted by Vadim V. Bobylev and Anisa T. Bajkova, two researchers from the Pulkovo Observatory's Laboratory of Galaxy Dynamics in St. Petersburg, Russia. As they indicated, they relied on astrometric data from the Gaia mission's Early Data Release 3 (EDR3), which revealed kinematic characteristics of stars that are expected to pass within 3.26 light-years (1 Parsec) with the Solar System in the future.

*Gaia mapping the stars of the Milky Way. Credit: ESA/ATG medialab; background: ESO/S. Brunier*

To start things off simple: our Solar System is composed of eight designated planets and several minor (aka. dwarf) planets orbiting our main sequence G-type yellow dwarf Sun, which is surrounded by an outer ring of icy objects known as the Kuiper Belt. Beyond this, at a distance of roughly 1.63 light-years from the Sun (0.5 parsecs), is a massive cloud of icy debris known as the Oort Cloud, which is where long-period comets originate.

These comets are generally the result of objects making close flybys with the Solar System and knocking objects loose, to the point that they periodically fly through the Solar System and around the Sun before heading back out. The outer edge of the Oort Cloud is estimated to be 0.5 parsecs (1.6 light-years) from our Sun, which makes them particularly responsive to perturbations from a number of sources. As Dr. Bobylev told Universe Today via email:

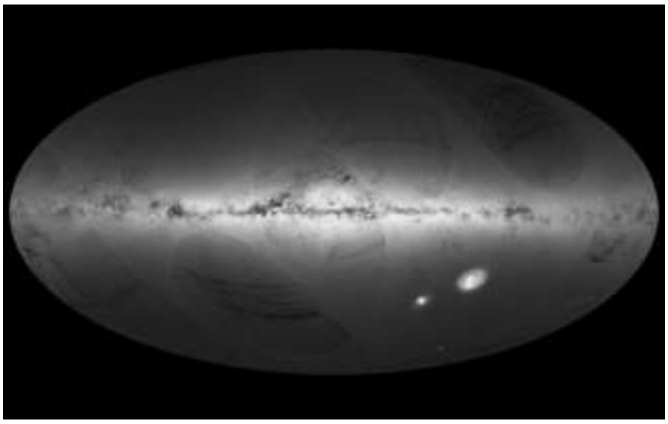
*"These perturbations include, first of all, the effect of the gravitational attraction of the Galaxy – the so-called galactic tide, secondly, the effect from giant molecular clouds – when the solar system flies at a sufficiently close distance to them, and thirdly – the effect from approaching single stars fields.*

*"The approach of the solar system with single stars in the field is a very rare event. Moreover, the impact depends (according to Newton's law of attraction) both on the mass of the passing star and on the distance to which the approach takes place."*

For astronomers, the process of searching for stars that may have flown by our Solar System in the past (and which may pass us by in the future) began in the 1960s. The research has improved as more sophisticated instruments have become available, leading to

more detailed catalogs on nearby celestial objects. In order to know which stars will make a close encounter, said Bobylev, you need to know their distance and their three velocities.
The consists of the two properties of proper motion – right ascension, declination – and radial velocity. Once you have all that, you can conduct astrometry, which is the precise measurement of the positions and movements of stars and other celestial bodies. It was for this very purpose that the ESA's *Hipparcos* satellite (1989-1993) and *Gaia Observatory* (2013-present) were created.

Thanks to the precise data they have provided, and the updated catalogs on millions of stars and other celestial objects, astronomers are able to determine which of them are likely to make a close encounter in the future. For the sake of their study, Bobylev and Bajkova relied on the following three methods:
*"The methods consist in constructing galactic orbits of the studied stars and the Sun. Then, for each star, two main parameters of approach are determined – the minimum distance between the orbit of the solar system and the star and the moment of approach. Integration occurs on the +/-5 Myr interval.*
*"Therefore, in our work, we used, firstly, the simplest linear method, secondly, the integration of motion in the axisymmetric potential of the Galaxy, and thirdly, in the nonaxisymmetric potential of the Galaxy, where the influence of the spiral structure on the motion of objects was taken into account."*



*Gaia's first sky map. Credit: ESA/Gaia/DPAC. Acknowledgement: A. Moitinho & M. Barros (CENTRA – University of Lisbon), on behalf of DPAC.*

In the end, all three methods yielded similar results: one star, designated 4270814637616488064 in the Gaia EDR3 database, would be making a particularly close encounter a little over a million years from now. Better known as Gliese 710 (HIP 89825), this variable K-type orange dwarf star is about 60% as massive as our Sun and located some 62 light-years from Earth in the Serpens constellation.
"What is remarkable about it is that it is a candidate for a very close approach to the solar system in the future," said Bobylev. "This candidate was first identified by Garcia-Sanchez et al., Astron. J. 117, 1042 (1999) in the analysis of stars from the Hipparcos catalog (1997)."
Specifically, the simulations Bobylev and Bajkova conducted showed that Gliese 710 would be making its close flyby 1.32 million years from now and would pass within 0.02 parsecs (just shy of 24 light days) of our Sun.
As for what this could entail for our Solar System (and anything living here by then), Bobylev explained that considerable research has already been done on that, and the indications were not so frightening:
*"A very interesting simulation of the close flight of the star Gliese 710 past the solar system was carried out by Berski, F. and Dybczynski, P., A&A, v. 595, L10, 2016. They showed that after the approach, a cometary shower will occur from the outer boundaries of the Oort Cloud towards the inner region of the Solar System. True, the flux is small – about a dozen comets a year, and it will appear with a delay of 1 million years after the flight of the star."*

*This artwork shows a rocky planet being bombarded by comets. Credit: NASA/JPL-Caltech*

So, assuming human beings (or their genetic progeny) are still living in the Solar System 2.32 million years from now, they will be treated to some added comet activity. This could pose some hazards, depending on the trajectories of these comets and the extent of human infrastructure in space. Or it could just mean more opportunities for backyard astronomy, or whatever the futuristic equivalent is!
In any case, it's always good to know when shakeups will happen and how serious they will be. Such is the significance of this research, in that it eliminates much of the uncertainty surrounding stellar close encounters and the effect they can have. Said Bobylev:
*The main significance of our work is that we know with certainty that, both in the past, and in the future, there may be close encounters of stars with the solar system. There can be all sorts of surprises in the form of the appearance of comets and asteroids near the Earth.*
Our Solar System has experienced more than a few in the past, and these played a significant role in its evolution. It's entirely possible that life as we know it owes its existence to close encounters, so best to keep track of any future events!

## Starlink and OneWeb Have Their First Avoidance Manoeuvre With Each Other's Constellations

Two companies, OneWeb and SpaceX, are racing to put fleets of thousands of communication satellites into orbit. In March they had their first near-miss. Avoidance maneuvers were successful, but how many more close calls will they face in the future?
SpaceX has already launched over a thousand of its Starlink global broadband internet satellites, and competitor OneWeb has lofted 146 of its own. Both companies – and several others – are actively prepping for dozens of more launches and thousands of more satellites.
But while space is a big place, orbits are a precious resource, especially with so many satellites already up

and so many more planned. Near-misses are unavoidable, as both companies found out on March 30th, when they received several "red alerts" from the US Space Force's 18th Space Control Squadron, warning of a possible collision.

The red alert came just 5 days after OneWeb launched 36 satellites from Russia. While the OneWeb constellation orbits at a higher altitude than Starlink, they must pass through those orbits to get to their operational location.

The Space Force alert noted that two satellites would pass within 190 feet of each other – which isn't a lot when both spacecraft are flying at thousands of miles per hour. The probability of collision was calculated to be 1.3%.

SpaceX claims it has an AI-powered automated collision avoidance system onboard its spacecraft, but the company strangely shut down its system and allowed OneWeb to alter the course of its satellite instead. SpaceX did not provide public commentary on the event.

The near-miss has renewed calls for more transparency, accountability, and coordination of orbital activities. There is no law or authority that forces companies or agencies to move their satellites in the case of a potential collision – just a desire not to wreck perfectly good hardware and contribute to the spread of pernicious space junk.

Still, no satellites were harmed in the event, which is a good thing.

"This event was a good example of how satellite operators can be responsible given the constraints of global best practices," says Diana McKissock, the head of the Space Force 18th Space Control Squadron's data sharing and spaceflight safety wing. "They shared their data with each other, they got in contact with each other, and I think in absence of any global regulation, that's… the art of the possible."

## Ingenuity Makes a one-way Trip for the First Time, Flying to a new Landing Site

Ever feel like no matter how far you fly you end up in the same spot? Ingenuity certainly does. The helicopter that has been making dozens of headlines lately for all of the firsts it is achieving as part of its mission on Mars so far has only returned back to its original take-off point. Named Wright Brothers Field, after the brothers who first brought controlled powered flight to Earth, it has been the site of all of Ingenuity's firsts so far. But now the basic science of Ingenuity's mission is over and it is time to start moving on, which it did last week to a new "air field".

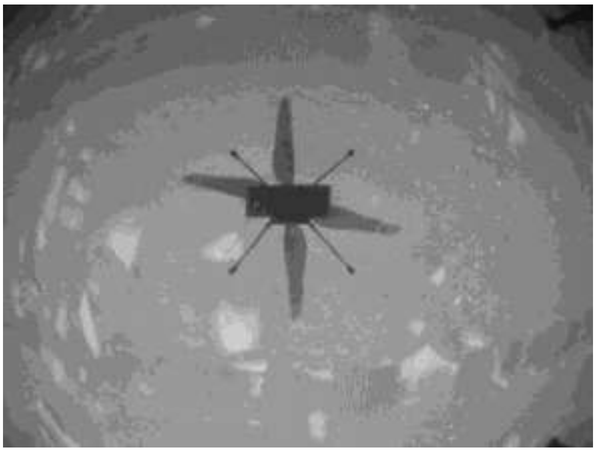
That air field hasn't yet received a name, but is located about 130m (450 ft) south of the Wright Brothers field. Ingenuity first scouted the area and found it flat and clear of debris on one of its four earlier flights. The small helicopter set another altitude record of 10m (33ft) on the 108 second flight. While it wasn't Ingenuity's farthest flight (which clocked in at 266 meters round-trip), it was the first time the helicopter set down on terrain it had only scouted previously.

Video of Ingenuity's control room during its fifth flight on May 7th

Credit: JPL YouTube Channel

Ingenuity's primary mission completed with data from five flights under its belt. Now the NASA team commanding it has switched into an operational demonstration mode. They want to prove how practical it is to send these kinds of flying robotic explorers to other worlds. And if the extended length of other exploration missions on Mars are any indication, it will have a while to go yet. However, Ingenuity does have two constraints – it has relatively small solar panels to recharge its battery, and it has to stay close to Perseverance for it's communications and controls.

Currently Perseverance itself is driving south in short bursts to complete its primary scientific mission and collect Martian samples that will be picked up by a later sample return mission. So Ingenuity will occasionally hop along with its rover hub to maintain contact with its handlers at NASA.



The now famous image of Ingenuity's shadow on Mars it lifted off in late April.

Credit: NASA / JPL-Caltech

With its primary job completed, any additional data the tiny helicopter is able to collect is an added bonus. While it's unclear how many more such hops Ingenuity is capable of, it has already earned its place in the pantheon of great robotic space explorers.

## NASA is Getting Serious About a Radio Telescope on the Moon

It's widely known by now that the "dark side" of the moon, made famous by Pink Floyd, isn't actually dark. It gets as much sunlight as the side that is tidally locked facing Earth. However, it is dark in one very important way – it isn't affected by radio signals emanating from Earth itself. What's more, it's even able to see radio waves that don't make it down to Earth's surface, such as those associated with the cosmic "Dark Ages" when the universe was only a few hundred million years old. Those two facts are the main reasons the far side of the moon has continually been touted as a potential location for a very large radio telescope. Now, a project sponsored by NASA's Institute for Advanced Concepts (NIAC) has received more funding to further explore this intriguing concept.

The project, known as the Lunar Crater Radio Telescope (LCRT), is part of NIAC's Phase II program, and recently received $500k in additional funding to push the project further towards becoming a fully fledged NASA mission. This isn't the first time a radio telescope on the moon has been proposed. But the LCRT team, led by Saptarshi Bandyopadhyay at JPL, have suggested two new and interesting features that make their approach much more attractive than previous alternatives.

UT video discussing the usefulness of a radio telescope on the far side of the moon.
The first feature has to do with limiting the sheer amount of material that is needed to construct a radio telescope. LCRT's proposed instrument would be a one kilometer wide circle in a three kilometer wide crater. Traditional radio telescopes, such as the Five-hundred-meter Aperture Spherical Telescope (FAST) and the recently destroyed Arecibo Observatory use hundreds of radio-reflective panels to any signals to an observing platform suspended by cable above the receiving dish.

In order to complete a 1km wide telescope, thousands of reflecting panels would have to be created on Earth, launched into space, and then placed precisely where they need to go. That's a lot of launches and a lot of weight, and it made the entire concept of a lunar radio telescope untenable.

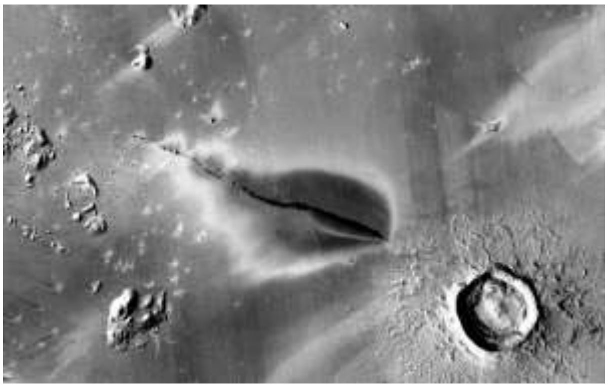
Artist's concept of what a completed LCRT would look like.
Credit: Vladimir Vustyansky
Dr. Bandyopadhyay's solution to this problem is to use a wire mesh instead of solid panels to reflect the radio waves to the antenna. This mesh would be much lighter, and less bulky, but will still need to be set precisely in order to work properly. For that, the team turned to their other novel solution – dual robots.
Roboticists at JPL, of which Dr. Bandyopadhyay is one, have been working on a concept called DuAxel. These robots have two separate configurations. In one, they look like a standard four wheeled rover. In the other, the two halves separate. One anchors itself to a specific point while the other uses a tether to ease itself into otherwise unreachable terrain.

Image of the two halves of a DuAxel rover working together.
Credit: NASA / JPL-Caltech / J.D. Gammell
Crater walls would likely be such unreachable terrain, so having a robot that is able to access both the bottom of the crater and up above the rim where any landed supplies would be located is invaluable to any such telescope mission. It would also allow the robots to mount the antenna, the critical sensing piece of the telescope, above the crater's center by applying tension in the mounting wires and lifting it into position.
Some major hurdles still remain, two of which will be the focus of this Phase II NIAC grant. The first is the design of the wire mesh network. It's physical structure has to be exactly right in order for the telescope to work properly. In addition, it must be able to withstand the extreme temperature differences on the moon, which swing between -173 C and +127 C. If the mesh warps even slightly, the whole project could fail.
DuAxels in an operational test in the Mojave.
Credit: JPL YouTube Channel
DuAxels themselves pose another quandary – should they be automated or have some sort of human intervention. Are they the only tools needed for the massive undertaking of constructing the largest ever radio telescope?
While Dr. Bandyopadhyay and his team work out these questions other factors put a time limit on the possibility of constructing a telescope in this most unique of locations. Part of the appeal of the far side of the moon is its lack of interference from artificial radio sources. However, that silence is not guaranteed. Already there is a satellite orbiting there, and other missions could be planned in the near future that would add confounding signals to the data mix.
Presentation by Dr. Banyopadhyay on the LCRT concept for a NIAC meeting.
Credit: Saptarshi Bandyopadhyay YouTube Channel
That being said, the LCRT is still a long way from reality, and in its press release NASA is quick to point out that it hasn't been accepted as a full NASA mission. But the intent of the NIAC program is to develop concepts to the point where they could become one. With that in mind, the extra half a million dollars will keep pushing the concept forward and hopefully result in a Phase III grant, which would then transition into a fully fledged NASA program after an additional two years of study. Though it might take awhile, the benefits of having such a massive telescope in one of the most radio quiet place in the solar system cannot be understated.

## Volcanoes on Mars Might Still be Active

Back in March, NASA's InSight lander detected two large quakes from a geologically active region of Mars called the Cerberus Fossae. Now, using imagery from the Mars Reconnaissance Orbiter, which circles the red planet at an altitude of about 300km, researchers have discovered that the Cerberus Fossae region holds the most recent evidence of volcanic activity ever seen on Mars.
The newly observed volcanic deposit could have been created as recently as 46,000 years ago, though outer estimates suggest that, at the oldest, it might be 200,000 years old. In either case, on geological time scales, this is a very young deposit. Most of the volcanic rock elsewhere on Mars is orders of magnitude more ancient, forming during a period of heavy geological activity between 3 and 4 billion years ago. More recent volcanic eruptions occurred with regularity on Mars up to

about 3 million years ago, but until now, we have never seen any evidence of volcanism that can be dated in the thousands of years. This new deposit is unique. As lead researcher David Horvath from the Planetary Science Institute explains, “if we were to compress Mars geologic history into a single day, this would have occurred in the very last second.”



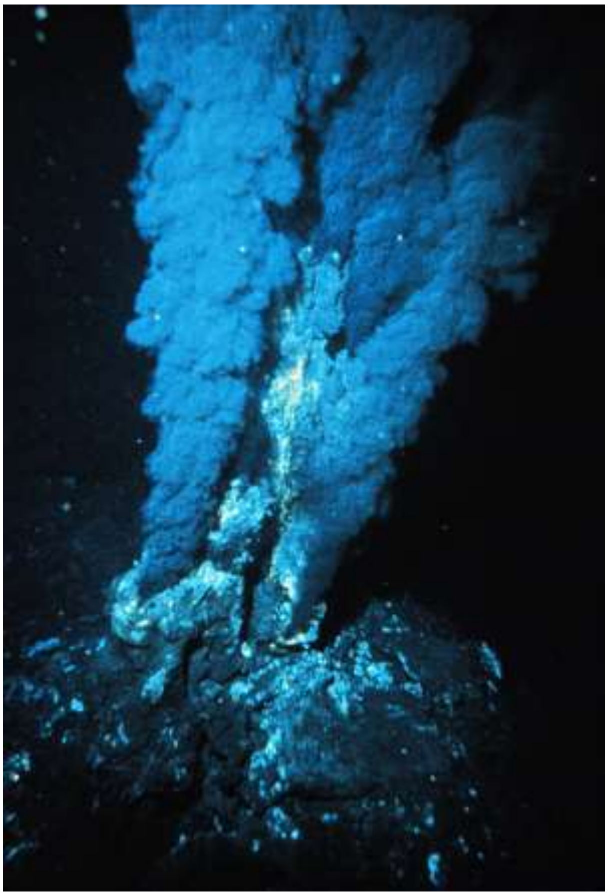
The dark splotch extending to either side of this fissure in the Cerberus Fossae region marks the most recent volcanic activity ever found on Mars. It is about 13km across. Image Credit: NASA/JPL/MSSS/The Murray Lab.

The eruption that created the deposit appears to have been explosive in nature, with a pyroclastic cloud that could have reached as high as 6km. The dark layer of ash and volcanic material leftover from the explosion now covers a 13km wide region on either side of one of the large fissures from which the Cerberus Fossae takes its name.

Most volcanic rock found on Mars today is the result of lava flowing slowly across the surface. Explosive volcanism like this seems much rarer, though its rarity is not necessarily a result of it occurring less frequently. Instead, it is because explosive volcanism leaves behind thinner layers of material, so it is more easily eroded by wind and other geological activity, or hidden beneath sand and dust. In other words, the only reason we can see this new deposit at all is because it’s so young – it hasn’t yet vanished from the geological record.

When the observations from orbit are combined with the seismic data from InSight, they offer the tantalizing possibility that the Cerberus Fossae region could still see future eruptions, and that magmatic activity is still ongoing just beneath the surface there.

One speculative, but not altogether unreasonable hypothesis, suggests that this ongoing underground magma flow might have melted ice embedded in the nearby Martian subsurface, creating habitable environments for microbial life in the present day.



Hydrothermal vents deep under the oceans on Earth are prime habitats for chemotropic bacteria: life that relies on inorganic molecules like iron and magnesium, rather than sunlight, to create energy. The mixture of magma and ice-water beneath the surface of Mars in the Cerberus Fossae region might provide a similarly viable habitat for this kind of microbial life. Image Credit: P. Rona / OAR/National Undersea Research Program (NURP); NOAA.

The researchers believe that “these environments would be analogous to locations on Earth where volcanic activity occurs in glacial environments such as Iceland, where chemotropic [bacteria that gains energy from oxidizing inorganic molecules], cryophilic [cold-loving], and thermophilic [heat-loving] bacteria thrive.”

For now, we have no way of testing this theory, though InSight will continue to listen for further seismic activity from it’s position about 1,600km away. In the ongoing search for microbial extra-terrestrial life, however, the Cerberus Fossae may be a promising location for future missions to explore.

The researchers published their findings in Icarus.

You can read more about it here:

“Volcanoes on Mars Could Be Active, Raise Possibility of Recent Habitable Conditions.” Planetary Science Institute.

# E Mails Viewings Logs and Images from Members.

## Viewing Log for 6th of May

With the skies not starting to get dark until 21:15 onwards, this would probably be my last viewing session of the current season? Earlier on I was doing a sunset session at Hackpen Hill and had found both Venus and Mercury in the western skies after sunset. So it was a case of driving about one mile to get to my usual viewing place near Uffcott, while driving to the place I could see Mercury still above the horizon and hopefully might be able to see it with the telescope before it disappeared?

I had my Meade LX90 GOTO telescope set up and ready by 21:46 and would be using a 14 mm Pentax eye piece, with no wind and a temperature of 4 °C the conditions should be pretty good? While doing my set ups, three cars went past me and another also went past while I was hunting for Mercury! So first target had to be Mercury as now it was just above the hedge line, to my surprise the inner most planet was in the eye piece field of view, normally they are nearby BUT not in actual field of view, slight adjustment is normal! Could not make anything out apart from a point of light, the light rays from Mercury were coming thru too much atmosphere to get any detail? On to the only other planet currently on show and Mars, like the last two sessions I could not make anything out on this planet, being mag 1.1 and 4 arc seconds in diameter it is well past it's best viewing for the time being?

So finished with the planets I thought I would carry on with my Messier marathon list, all of the objects would be in the eastern direction with some going overhead? First object was M 3, a very nice globular cluster (G C) which had a bright core, big and nice to look at, could give M 13 a run for its money? Another G C was M 53, this also had a bright core but was not as big as M 3? Now it was time to visit the 'Realm of Galaxies' in the bowl of Virgo and Coma Berenices or better known to me as fuzzy blobs (F B) or even faint fuzzy blobs (F F B)! First object was M 64 AKA the Black-Eye galaxy which is a spiral galaxy (S G), to me it was an F B and no more! I managed to locate M 60 and M 59 in the same field of view, both of these are elliptical galaxies (E G) and I thought M 60 was the brighter of the two giving it a title of F B! Checking their magnitudes later on M 60 was brighter by one mag? Next on the list was M 58, an S G and F F B to look at? Another car went past me while viewing this object, after the car had gone I went after M 89, an E G and F F B, had to use adverted vision to make out this galaxy? M 90 and M 88 were similar, both S G's and F B's to look at. Another S G was M 91, again this was an F F B to look at when suddenly the telescope lost power! The power lead to connector had moved slightly which caused the problem, when I get home I would need to a modification to this area, put a spacer bar between to two leads and then secure them together? Re done the set up's it was off to M 87, probably the brightest galaxy in this area of sky? This had a bright but small core, not bad for an E G? I could make out M 86 and M 84 in the same field of view both are E G's and F B's to look at. Had to use adverted vision to locate M 100, this S G was really faint to find? Another car went past me, which was a lot for a mid-week session? Next target was M 85, an E G and F B to look at. Over the border and into Coma Berenices to view M 98, this S G was an F B to look at? M 99 was easy to miss, again it was an S G but F F B to look at? Going south of the Realm I came across M 49, this is an E G and F B to look at. Still further south was M 61, an S G and F F B to look at? Finally I had something I could give some time to and M 104, the Sombrero galaxy, this S G had a bright centre and slightly elongated to look at? Back to a G C and M 68 in the tail of Hydra, this was an F F B to look at, did not help viewing this object thru branches of a tree! Going east slightly was M 83, this S G I could not locate at all, no problems from the Moon as it was not up, coming in at mag 8.3 I should be able to see it but I could not? Some confusion with M 102, the list I was using had it as a E G and F F B to look at but if

I use the Sky & Telescope chart it says it is a duplicate of M 101, anyway still a F F B! Finally finished with these faint fuzzes and on to G C's. Started with M 5, very nice to look at, even managed to make a few stars out? The best in the northern sky and M 13 in Hercules, slightly bigger than M 5, again I could make out some stars, very nice to look at? Often overlooked is M 92 in Hercules, this G C is smaller but had a bright centre, again very nice to look at! Final object for the evening was M 12 which was not far clear of the eastern horizon, this G C was dimmer to look at?

By now it was 23:27 and time to pack up and go home. To view other Messier objects I would either have to stay up late into the night or wait until August when they have crossed the sky more? Probably do the second idea and call it a day for astronomy apart from the partial solar eclipse which comes our way on 10th of June starting at 10:06, need clear skies for that! Only time will tell for that?

And an image of the Space Station from Swindon

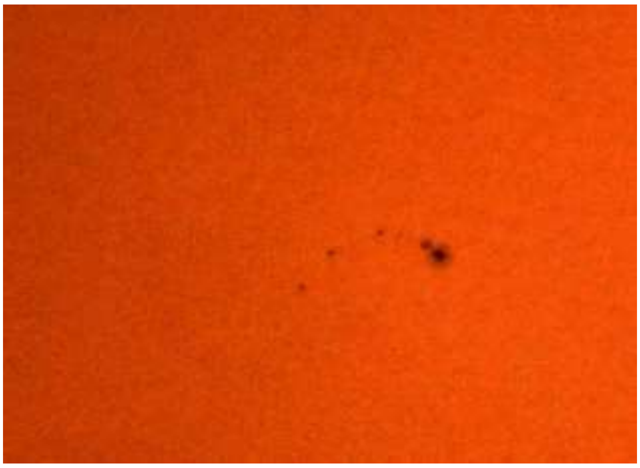
Clear skies.

Peter Chappell

Now some personal images from the cloudy May.

Well the first two are from this morning, getting ready for next week's partial solar eclise I have a thousand oaks

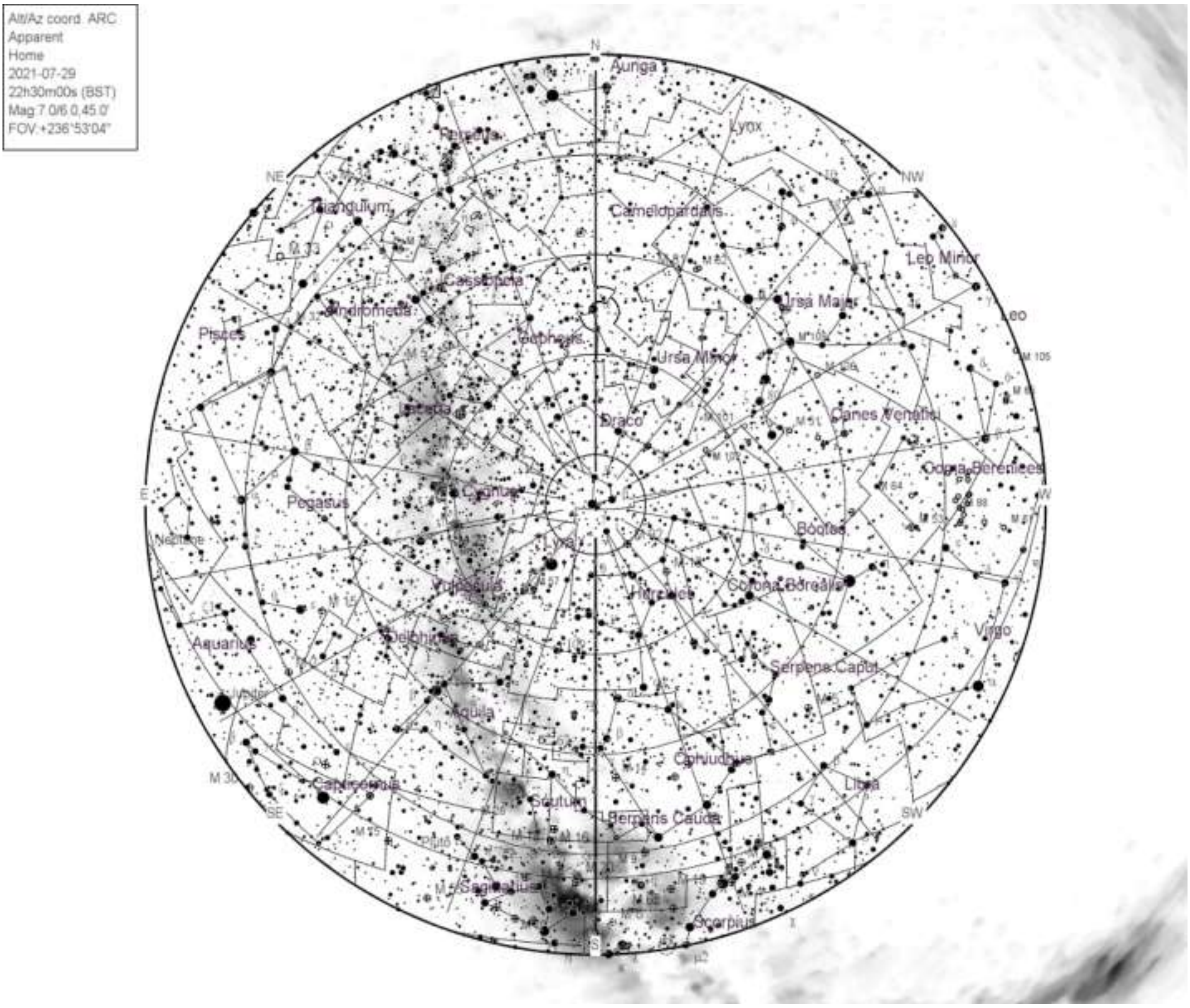
glass solar filter 77mm that fits a few of my Nikkor lenses, but also fits on the P1000 bridge camera with its full zoom. The complete sun shows good granulation of the solar



surface and the zoom is long enough to grab a shot of the arc region sunspots of AR 2827.

May the 10th managed a telescope session so went for M67 cluster then grabbed the Polaris diamond ring as mentioned in Martin's talk last month.

# WHATS UP, JULY 2021




The image above is for 22:30BST at the end of July. Note the Milky Way intersects the horizon due South.

**June 10** - **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 10:54 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.

**June 10** - **Annular Solar Eclipse.** An annular solar eclipse occurs when the Moon is too far away from the Earth to completely cover the Sun. This results in a ring of light around the darkened Moon. The Sun's corona is not visible during an annular eclipse. The path of this eclipse will be confined to extreme eastern Russia, the Arctic Ocean, western Greenland, and Canada. A partial eclipse will be visible in the north-eastern United States, Europe, and most of Russia. (**NASA Map and Eclipse Information**) (**NASA Interactive Google Map**)

**June 21** - **June Solstice.** The June solstice occurs at 03:21 UTC. The North Pole of the earth will be tilted toward the Sun, which will have reached its northernmost position in the sky and will be directly over the Tropic of Cancer at 23.44 degrees north latitude. This is the first day of summer (summer solstice) in the Northern Hemisphere and the first day of winter (winter solstice) in the Southern Hemisphere.

**June 24** - **Full Moon, Supermoon.** 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 18:40 UTC. This full moon was known by early Native American tribes as the Strawberry Moon because it signaled the time of year to gather ripening fruit. It also coincides with the peak of the strawberry harvesting season. This moon has also been known as the Rose Moon and the Honey Moon. This is also the last of three supermoons for 2021. The Moon will be near its closest approach to the Earth and may look slightly larger and brighter than usual.

**July 4** - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 21.6 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

**July 10** - **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 01:17 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.

**July 24** - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 02:37 UTC. This full moon was known by early Native American tribes as the Buck Moon because the male buck deer would begin to grow their new antlers at this time of year. This moon has also been known as the Thunder Moon and the Hay Moon.

**July 28, 29** - **Delta Aquarids Meteor Shower.** The Delta Aquarids is an average shower that can produce up to 20 meteors per hour at its peak. It is produced by debris left behind by comets Marsden and Kracht. The shower runs annually from July 12 to August 23. It peaks this year on the night of July 28 and morning of July 29. The nearly full moon will be a problem this year. It's glare will block block most of the faintest meteors. But if you are patient, you should still be able to catch a few good ones. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Aquarius, but can appear anywhere in the sky.

**August 2** - **Saturn at Opposition.** The ringed planet will be at its closest approach to Earth and its face will be fully illuminated by the Sun. It will be brighter than any other time of the year and will be visible all night long. This is the best time to view and photograph Saturn and its moons. A medium-sized or larger telescope will allow you to see Saturn's rings and a few of its brightest moons.

**August 8** - **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 13:51 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.

**August 12, 13** - **Perseids Meteor Shower.** The Perseids is one of the best meteor showers to observe, producing up to 60 meteors per hour at its peak. It is produced by comet Swift-Tuttle, which was discovered in 1862. The Perseids are famous for producing a large number of bright meteors. The shower runs annually from July 17 to August 24. It peaks this year on the night of August 12 and the morning of August 13. The waxing 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 Perseus, but can appear anywhere in the sky.

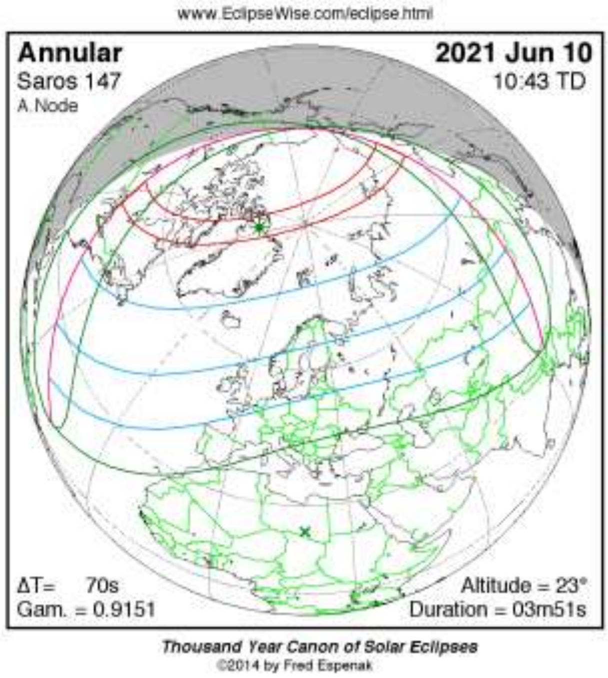
**August 19** - **Jupiter at Opposition.** The giant planet will be at its closest approach to Earth and its face will be fully illuminated by the Sun. It will be brighter than any other time of the year and will be visible all night long. This is the best time to view and photograph Jupiter and its moons. A medium-sized telescope should be able to show you some of the details in Jupiter's cloud bands. A good pair of binoculars should allow you to see Jupiter's four largest moons, appearing as bright dots on either side of the planet.

**August 22** - **Full Moon, Blue Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 12:02 UTC. This full moon was known by early Native American tribes as the Sturgeon Moon because the large sturgeon fish of the Great Lakes and other major lakes were more easily caught at this time of year. This moon has also been known as the Green Corn Moon and the Grain Moon. Since this is the third of four full moons in this season, it is known as a blue moon. This rare calendar event only happens once every few years, giving rise to the term, “once in a blue moon.” There are normally only three full moons in each season of the year. But since full moons occur every 29.53 days, occasionally a season will contain 4 full moons. The extra full moon of the season is known as a blue moon. Blue moons occur on average once every 2.7 years.

**September 7** - **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 00:52 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.

## PARTIAL SOLAR ECLIPSE JUNE 10th

On 10 June 2021 an annular solar eclipse will be visible in the far northern hemisphere, sweeping from northern Canada across Greenland and the North Pole (the only eclipse of the century to do so) before ending over Siberia.




From these areas eclipse-chasers will get to appreciate the annular eclipse or so-called ‘ring of fire’ in full, but from the UK, north America, northern Europe and other parts of the world, viewers will be treated instead to a partial Solar Eclipse.

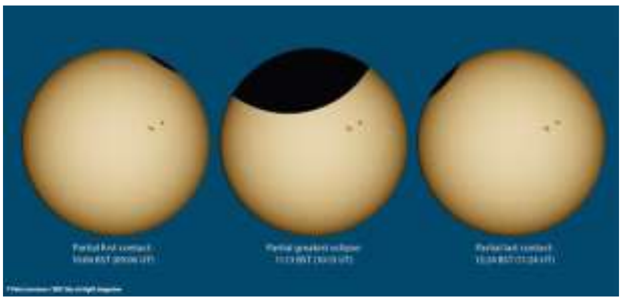
Here we’ll go through how to see the 10 June eclipse, what you can expect to see if you’re along the path of annularity and how to view the partial solar eclipse from the UK.

From **Birmingham**, first contact occurs at 10:06 BST (09:06 UT), with the point of greatest eclipse at 11:13 BST (10:13 UT), when the eclipse magnitude reaches 35.2%.

Last contact occurs at 12:24 BST (11:24 UT), bringing the event to a close. **Birmingham’s** maximum obscuration is 23.6%.

**Northwest Scotland** under clear skies will give the best views. From **Lochinver**, last contact starts at 10:08 BST (09:08 UT) with a maximum magnitude of 48.8% reached at 11:19 BST (11:35 UT).

Last contact from Lochinver is at 12:35 BST (11:35 UT), marking the eclipse’s end. **Lochinver’s** maximum obscuration is 36.8%.



# *Observing Notes - June 2021*

## Deep Sky Delights in Hercules

As we move into summer, a constellation well your time exploring is Hercules (The Strongman), which contains two globular clusters, M13 and M92, considered to be the jewels of the northern skies. Both are visible in binoculars and are easily found. In addition, there are planetary nebula, galaxies and an asterism to spot.

### Mythology

Hercules is a well-known character from Roman and Greek mythology, named after the Greek hero Heracles. The son of Zeus, Hercules was an immortal whose claim to fame was the series of tasks known as "The Labours of Hercules" which is also reflected in the constellations. Leo represents the Nemean lion he was tasked to kill, Hydra, the multi headed beast, and Cancer the crab sent to distract Hercules from his tackling of Hydra.

Hercules is the fifth largest constellation in the sky but has no first magnitude stars. In traditional drawings, the star Ras Algethi (Alpha Herculis) represents Hercules' head and a prominent asterism, the Keystone, marks his torso, as he stands victoriously on Draco's head (the victim of another of his tasks!)

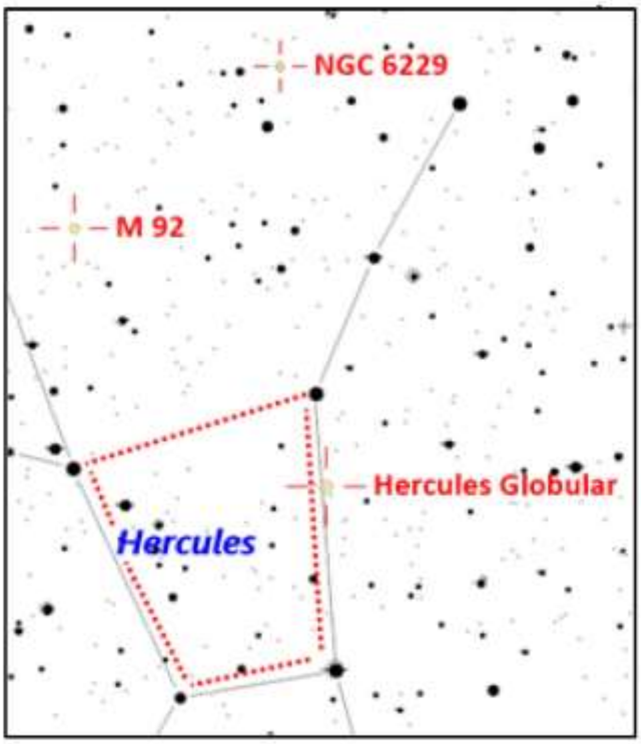
### Deep Sky Objects

#### Messier 13 – the Great Globular Cluster

Considered the jewel of the northern skies - M13 is easily located once you have identified the Keystone (the dotted line on the map) – I learnt to locate it by just finding the Keystone regularly over a few nights then moved on to locating the objects within.

Lying some 26,000 light years away, M13 is around 150 light years across and comprises some 600,000 solar masses; it is an easy binocular object (or in the darkest of skies, naked eye) and rewards magnification even in smaller apertures. Using my 6" reflector, I can begin to resolve stars at a magnification of around 60x and have gone up to 100x. Slightly larger apertures (8"+) can resolve the "propeller"; this is a shape reminiscent of the Mercedes Benz logo which can be seen towards the south east of


▲ Looking South East to Hercules, Lyra and Cygnus




▲ The keystone of Hercules & positions for M13, M92 and NGC 6229

cluster. The propeller can be tricky to image but is a very worthwhile feature to sketch.

## Messier 92

Whilst in Hercules, also visit M92, which, were it not for M13, would have had the Great Globular title! M92 lies only a short star hop away from M13 to the north east and is easily found in binoculars if you are careful– look for the non stellar fuzzy and you have M92! This cluster lies another 1100 light years further than M13 and is 110 light years across so is not much smaller than M13, but only has

▲ M92

around 400,000 solar masses. It has the claim to fame of being an incredibly old cluster estimated to be 14 thousand million years old.

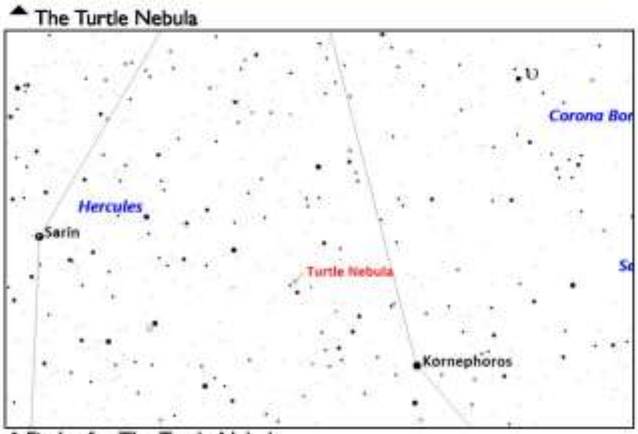
## NGC 6229

Slightly more challenging is NGC 6229, a smaller 9th magnitude cluster colloquially known as the overlooked globular cluster in Hercules. Although it may be a small globular, it is condensed so is comparatively bright; I have spotted it from the Kelling Heath Star Party easily.

## The Turtle Nebula NGC 6210

One of the problems in following an observing programme is that if you follow it slavishly you can miss objects in the constellation; I am guilty of overlooking The Turtle Nebula, a planetary nebula lying some 6,500 light years away. As I have no observing notes, the description below is drawn from the Skyhound website (https://observing.skyhound.com/archives/jun/NGC_6210.html), a reliable source of observing information:

▲ The Turtle Nebula



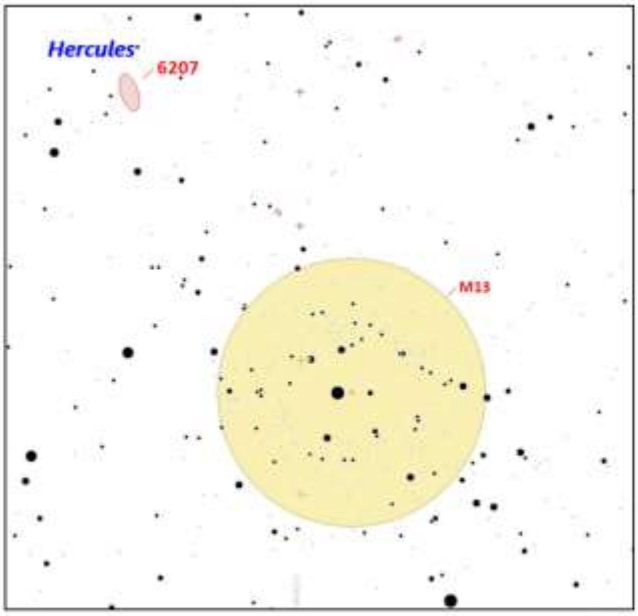

▲ Finder for The Turtle Nebula

"NGC 6210 has a very high surface brightness, making it a good target for small scopes and high magnification. Look for it between two nearly identical stars. In telescopes less than 8 inches NGC 6210 appears as a small, round, blue-green disk. Larger instruments and/or a UHC or OIII filter may reveal a faint outer shell. On nights of good seeing the 12.7 magnitude star should be visible at the centre."

Another fellow observer says "it is very bright but very small so it is a matter of magnification as much as aperture". So I leave it to you to have a hunt for this small planetary; if you have UHC or OIII filters give them a try, some recommend not using OIII on smaller apertures but I have successfully used one on my 6" telescope so never be worried about trying. When I have observed it, I will write up for the newsletter.

## NGC 6207

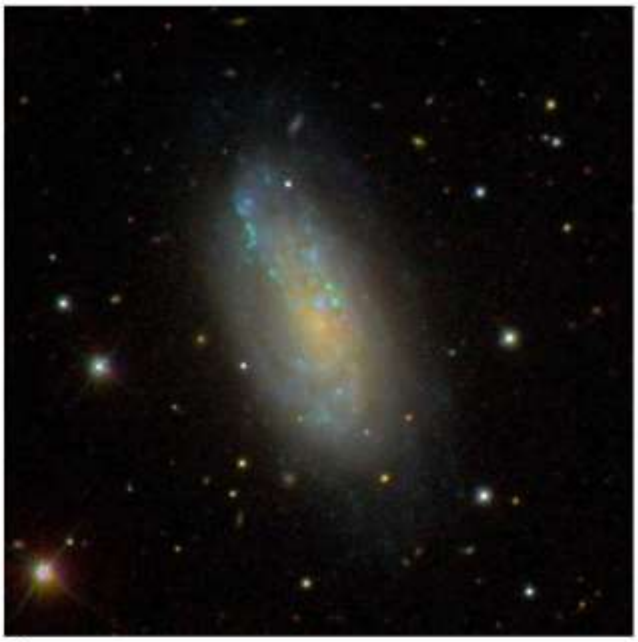
This small, 12th magnitude spiral galaxy just happens to sit about one degree to the northeast of M13. I have tried to spot it in my 6" reflector but never managed it, although I suspect it was there, but I was not being patient enough to spot it; I subsequently observed it easily in my 8". My notes from September 2013 state " I observed this whilst not fully dark, but located 6207 with 30mm eyepiece at 75x." I find it in my reflector by putting M13 in the eyepiece than moving slowly in the direction of 6207 and it slips into view. Another observer's description states "There is a bright Milky Way star superimposed near the centre. This galaxy has complex knotty spiral arms, faint outer arms, and a bright central lens without a definite nucleus." Sobering also to think that that galaxy lying 1200 time further away than M13 no doubt also has its own globular clusters!




▲ Finder for NGC 6207

## The Backwards 5 Asterism

To the right of Zeta Herculis (bottom right hand star of the keystone) lies the asterism the backwards 5! Whilst asterisms have no scientific



▲ NGC 6207

▲ The Backwards 5

value, I think they are fun to track down and are good way of remembering your way around the sky. To locate the Backwards 5, point your telescope at Zeta Herculis, and move a little south west to put the asterism in your eyepiece. The Stellarium free software shows the asterism although does not label it as such.

## Planets

Mercury is too close to the sun to be easily seen.

Venus dominates the evening sky after sunset, not setting until around 11pm. Venus passes to the left of Castor and Pollux on 22 June.

Mars starts the month near Castor and Pollux, moving from Gemini into Cancer. On 23rd June it passes in front of M44 (The Beehive) and although low, it is still well worth observing.

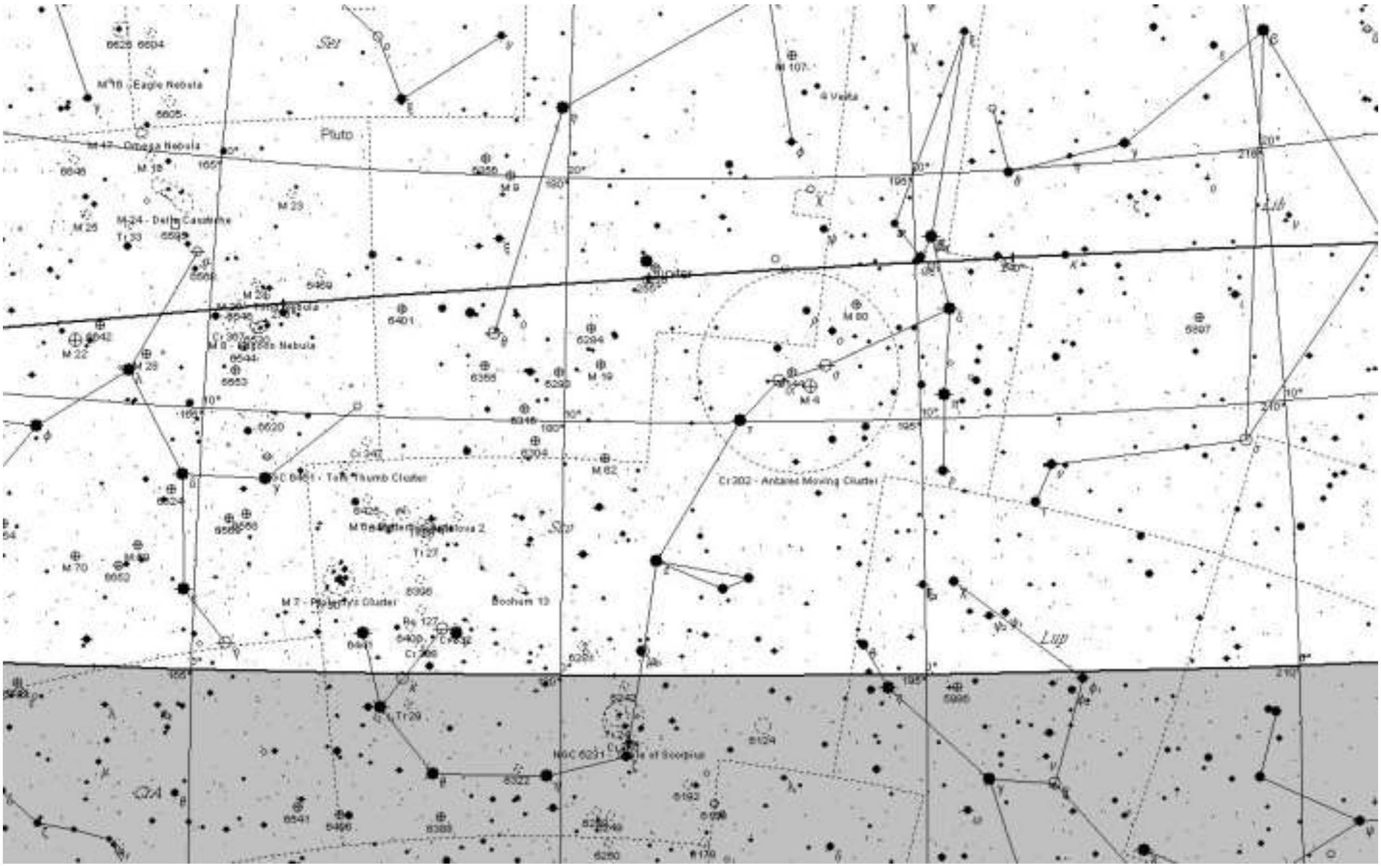
Jupiter and Saturn rise at around midnight at magnitudes +0.5 and -2.5 respectively.

Uranus is too close to the sun to be easily seen

Neptune is on the borders of Aquarius and Pisces this month, rising at about 1.30am at magnitude +7.9

**Chris Brooks**
**Jonathan Gale**
**WAS Observing Team**

# CONSTELLATIONS OF THE MONTH: SCORPIO




The zodiacal constellation of Scorpius resides on the ecliptic plane and was one of the original 48 constellations charted by Ptolemy to be later adopted as a modern constellation by the IAU. It covers 497 square degrees of sky and ranks 33rd in size. Scorpius has 15 main stars in its asterism and 47 Bayer Flamsteed designated stars within its confines. It is bordered by the constellations of Sagittarius, Ophiuchus, Libra, Lupus, Norma, Ara and Corona Australis. Scorpius is visible to all observers located at latitudes between +40° and ?90° and is best seen at culmination during the month of July.

There are two annual meteor showers associated with the constellation of Scorpius. The first is the Alpha Scorpiids – which begin on or about April 16 and end around May 9. The peak date of most activity is on or about May 3 and the radiant is near the brilliant red star, Antares. The second meteor shower, the June Scorpiids peaks on or about June 5 of each year. The radiant for this particular meteor shower is closer to the Ophiuchus border and the activity rate on the peak date is high – with about 20 meteors (average) per hour and many reported fireballs.

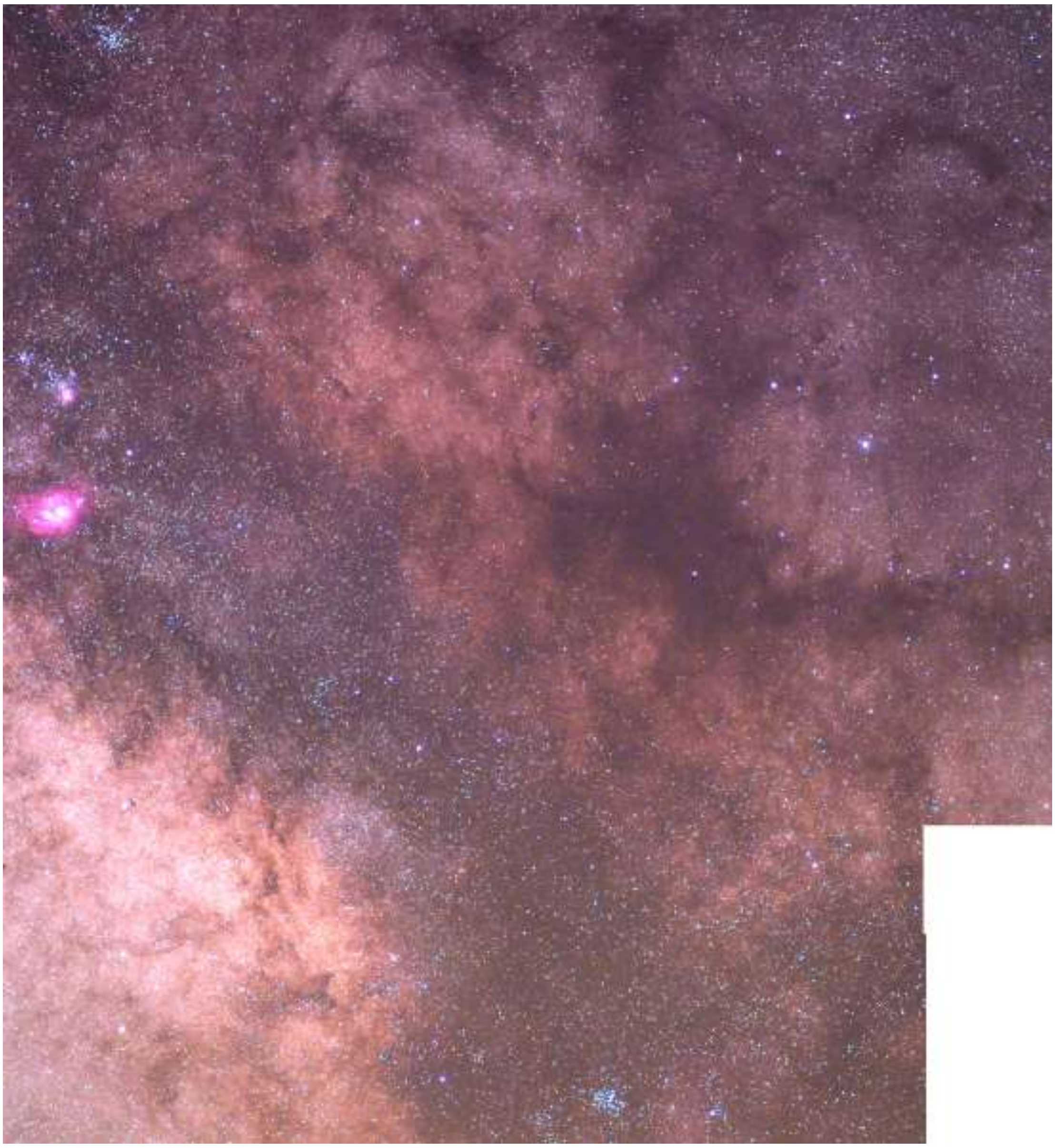
Because Scorpius was easy visible to ancient civilizations and its patterns do resemble the Scorpion which it represents, there is a great deal of mythology associated with this constellation. To the Greeks it represented the creature sent by Hera to eliminate Orion the Hunter – forever kept apart in the sky to continue their heavenly feud. Perhaps it was Apollo who sent the Scorpion and Orion flees it? Scorpius was also said to appear to Phaethon, who wrecked the sun-chariot when the horses balked at the mighty monster's appearance. The Oriental culture recognized this pattern of stars as part of the Dragon, while the Polynesians saw it as a fishhook. No matter what legend you choose to place on this pattern of stars, its curving asterism is very distinctive and easy to recognize!

Let's begin our binocular tour of Scorpius with its brightest star – Alpha – the "a" symbol on our chart. Antares is part of of the Upper Scorpius Association of Stars and is no doubt also a star poised on the edge of extinction. At a safe distance of 500 light-years, you'll find this pulsating red variable equally fascinating to the eye as well as to the telescope. Unlike other stars, Alpha Scorpii also has a companion which can be revealed to small telescopes under steady conditions. Discovered on April 13, 1819 during a lunar occultation, this 6.5 magnitude green companion isn't the easiest to split from such a bright primary – but it's certainly fun to try to spot its 5.4 magnitude green companion. Like winter's Sirius, the Antares pair needs especially still – but not necessarily dark – skies. It also requires a well-chosen magnification – one high enough to separate the two close stars (2.9 arc seconds), but low enough to concentrate the fainter star's (magnitude 5.4) light. Did you know that Antares' true rival is brighter Betelgeuse? Photometric measurements show that more massive Betelgeuse is slightly redder than Antares. Fortunately, the "Rival" does reside along the ecliptic plane allowing us many opportunities to see it accompany other solar system objects and be occulted by the Moon!

Keep your binoculars handy because all you have to know is Antares and go west…

Just slightly more than a degree away you'll find a major globular cluster perfectly suited for every size telescope and binoculars – M4 (RA 16 23 35 Dec 26 31 31). This 5th magnitude Class IX cluster can even be spotted unaided from a dark location! In 1746 Philippe Loys de Cheseaux happened upon this 7200 light-year distant beauty – one of the nearest to us. It was also included in Lacaille's catalog as object I.9 and noted by Messier in 1764. Much to Charles' credit, he was the first to resolve it!

As one of the loosest globular clusters, M4 would be tremendous if we were not looking at it through a heavy cloud of interstellar dust. To binoculars, it is easy to pick out a very round, diffuse patch – yet it will begin resolution with even a small telescope. Large telescopes will also easily see a central "bar" of stellar concentration across M4's core region, which was first noted by William Herschel. As an object of scientific study, the first millisecond



Keep your binoculars or a small telescope handy as well go off to explore a single small globular cluster – Messier 80. Located about 4 degrees northwest of Antares (half a fist), this little globular cluster is a powerpunch. Located in a region heavily obscured by dark dust, the M80 will shine like an unresolvable star to small binoculars and reveal itself to be one of the most heavily concentrated globulars to the telescope. Discovered within days of each other by Messier and Mechain respectively in 1781, this intense cluster is around 36,000 light years distant.

In 1860, the M80 became the first globular cluster to contain a nova. As stunned scientists watched, a centrally located star brightened to magnitude 7 over a period of days and became known as T Scorpii. The event then dimmed more rapidly than expected, making observers wonder exactly what they had seen. Since most globular clusters contain stars all of relatively the same age, the hypothesis was put forward that perhaps they had witnessed an actual collision of stellar members. Given the cluster contains more than a million stars, the probability remains that some 2700 collisions of this type may have occurred during the M80's lifetime.

Now head for Lambda Scorpii and hop three fingerwidths northeast to NGC 6406 (RA 17 40 18 Dec -32 12 00)… We're hunting the "Butterfly!" Easily seen in binoculars and tremendous in the telescope, this brilliant 4th magnitude open cluster was discovered by Hodierna before 1654 and independently found by de Cheseaux as his Object 1 before being cataloged by Messier as M6. Containing about 80 stars, the light you see tonight left its home in space around the year 473 AD. Messier 6 is believed to be around 95 million years old and contains a single yellow supergiant – the variable BM Scorpii. While most of M6's stars are hot, blue, and belong to the main sequence, the unique shape of this cluster gives it not only visual appeal, but wonderful color contrast as well.

Less than 3 arc minutes east of 3.3 magnitude G Scorpii (the tail star of the Scorpion) is 7.4 magnitude globular cluster NGC 6441. No challenge here. This 38,000 light-year distant compact cluster is around 13 thousand light-years from the galactic core. It was first noted by James Dunlop from southeastern Australia in 1826.

Around two and a half degrees northeast of G Scorpii (and NGC 6441) is another interesting deep sky twosome – bright open cluster M7 and faint globular NGC 6453. M7 was first recorded as a glowing region of faint stars by Ptolemy circa 130 CE. Located 800 light-years away, the cluster includes more than half

pulsar was discovered within M4 in 1987 – one which spins

10 times faster than the Crab Nebula pulsar. Photographed by the Hubble Space Telescope in 1995, M4 was found to contain white dwarf stars – the oldest in our galaxy – with a planet orbiting one of them! A little more than twice the size of Jupiter, this planet is believed to be as old as the cluster itself. At 13 billion years, it would be three times the age of the Sol system!

a dozen 6th magnitude stars easily resolved with the least amount of optical aid. Through telescopes, as many as 80

various stars can be seen and it rocks in binoculars!

Now head northeast and the faint haze of 31,000 light-year distant globular cluster NGC 6453 will reveal itself to mid- and large-sized scopes. Like NGC 6441, this globular cluster was discovered from the southern hemisphere, in this case by John Herschel on June 8, 1837 while observing from the Cape of Good Hope, South Africa.

It's time to aim your telescope at NGC 6302, a very curious planetary nebula located around three fingerwidths west of Lambda Scorpii: it is better known as the "Bug" nebula (RA 17 13 44 Dec -37 06 16). With a rough visual magnitude of 9.5, the Bug belongs to the telescope – but it's history as a very extreme planetary nebula belongs to us all. At its center is a 10th magnitude star, one of the hottest known. Appearing in the telescope as a small bowtie, or figure 8 shape, huge amounts of dust lie within it – very special dust. Early studies showed it to be composed of hydrocarbons, carbonates and iron. At one time, carbonates were believed associated with liquid water, and NGC 6302 is one of only two regions known to contain carbonates – perhaps in a crystalline form.

Ejected at a high speed in a bi-polar outflow, further research on the dust has shown the presence of calcite and dolomite, making scientists reconsider the kind of places where carbonates might form. The processes that formed the Bug may have begun 10,000 years ago – meaning it may now have stopped losing material. Hanging out about 4000 light-years from our own solar system, we'll never see NGC 6302 as well as the Hubble Telescope presents its beauty, but that won't stop you from enjoying one of the most fascinating of planetary nebulae!

Now begin your starhop at the colorful southern Zeta pair and head north less than one degree for NGC 6231 (RA 16 : 54.0 Dec -41 : 48). Wonderfully bright in binoculars and well resolved to the telescope, this tight open cluster was first discovered by Hodierna before 1654. De Cheseaux cataloged it as object 9, Lacaille as II.13, Dunlop as 499, Melotte as 153, and Collinder as 315. No matter what catalog number you chose to put in your notes, you'll find the 3.2 million year young cluster shining as the "Northern Jewelbox!" For high power fans, look for the brightest star in this group – it's van den Bos 1833, a splendid binary.

About another degree north is loose open cluster Collinder 316, with its stars scattered widely across the sky. Caught on its eastern edge is another cluster known as Trumpler 24, a site where new variables might be found. This entire region is encased in a faint emission nebula called IC 4628 – making this low power journey through southern Scorpius a red hot summer treat!

When you are done, hop west (RA 16 25 18 Dec 40 39 00) to encounter the fine open cluster NGC 6124. Discovered by Lacaille and known to him as object I.8, this 5th magnitude open cluster is also known as Dunlop 514, as well as Melotte 145 and Collinder 301. Situated about 19 light-years away, it will show as a fine, round, faint spray of stars to binoculars and be resolved into about 100 stellar members to larger telescopes. While NGC 6124 is on the low side for northern observers, it's worth the wait for it to hit its best position. Be sure to mark your notes, because this delightful galactic cluster is a Caldwell object and a southern skies binocular reward!

There are many, many more splendid object to be discovered in the constellation of Scorpius, so be sure to get a detailed star chart and enjoy!

# ISS PASSES For Summer 2021 **note June and August have few passes.**

from Heavens Above website maintained by Chris Peat.

| Date | Brightness | Start | Highest | End | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (mag) | Time | Alt. | Az. | Time | Alt. | Az. | Time | Alt. | Az. |
| **30 Jun** | **-1.9** | **04:02:53** | **10°** | **SSW** | **04:05:25** | **20°** | **SE** | **04:07:58** | **10°** | **E** |
| 01 Jul | -1.5 | 03:16:29 | 11° | S | 03:18:08 | 14° | SE | 03:19:58 | 10° | ESE |
| 02 Jul | -2.9 | 04:03:49 | 10° | SW | 04:06:58 | 38° | SSE | 04:10:09 | 10° | E |
| 03 Jul | -2.5 | 03:17:41 | 17° | SSW | 03:19:37 | 28° | SSE | 03:22:33 | 10° | E |
| 04 Jul | -2.2 | 02:31:45 | 19° | SSE | 02:32:16 | 20° | SE | 02:34:50 | 10° | E |
| 04 Jul | -3.7 | 04:05:19 | 10° | WSW | 04:08:40 | 66° | SSE | 04:12:02 | 10° | E |
| 05 Jul | -1.5 | 01:45:46 | 13° | SE | 01:45:46 | 13° | SE | 01:46:50 | 10° | ESE |
| 05 Jul | -3.5 | 03:18:42 | 16° | SW | 03:21:14 | 51° | SSE | 03:24:32 | 10° | E |
| 06 Jul | -3.1 | 02:32:40 | 28° | SSW | 02:33:49 | 38° | SSE | 02:36:59 | 10° | E |
| 06 Jul | -3.7 | 04:07:05 | 10° | W | 04:10:28 | 90° | SE | 04:13:52 | 10° | E |
| 07 Jul | -2.7 | 01:46:35 | 28° | SE | 01:46:35 | 28° | SE | 01:49:23 | 10° | E |
| 07 Jul | -3.8 | 03:19:36 | 10° | WSW | 03:22:58 | 80° | SSE | 03:26:21 | 10° | E |
| 08 Jul | -1.7 | 01:00:27 | 16° | ESE | 01:00:27 | 16° | ESE | 01:01:39 | 10° | E |
| 08 Jul | -3.8 | 02:33:22 | 21° | WSW | 02:35:30 | 66° | SSE | 02:38:51 | 10° | E |
| 08 Jul | -3.7 | 04:08:54 | 10° | W | 04:12:18 | 85° | N | 04:15:41 | 10° | E |
| 09 Jul | -3.6 | 01:47:08 | 38° | SSW | 01:48:02 | 51° | SSE | 01:51:20 | 10° | E |
| 09 Jul | -3.7 | 03:21:24 | 10° | W | 03:24:47 | 85° | N | 03:28:10 | 10° | E |
| 10 Jul | -3.8 | 02:33:52 | 10° | W | 02:37:15 | 90° | SW | 02:40:39 | 10° | E |
| 10 Jul | -3.8 | 04:10:43 | 10° | W | 04:14:06 | 79° | SSW | 04:17:29 | 10° | ESE |
| 11 Jul | -2.4 | 00:14:15 | 23° | ESE | 00:14:15 | 23° | ESE | 00:16:10 | 10° | E |
| 11 Jul | -3.9 | 01:47:08 | 16° | WSW | 01:49:45 | 80° | SSE | 01:53:08 | 10° | E |
| 11 Jul | -3.8 | 03:23:11 | 10° | W | 03:26:35 | 89° | SSW | 03:29:58 | 10° | E |
| 11 Jul | -1.9 | 23:27:10 | 16° | ESE | 23:27:10 | 16° | ESE | 23:28:25 | 10° | E |
| 12 Jul | -3.9 | 01:00:00 | 19° | WSW | 01:02:15 | 66° | SSE | 01:05:37 | 10° | E |
| 12 Jul | -3.8 | 02:35:40 | 10° | W | 02:39:04 | 85° | N | 02:42:27 | 10° | E |
| 12 Jul | -3.6 | 04:12:31 | 10° | W | 04:15:49 | 50° | SSW | 04:19:05 | 10° | SE |
| 12 Jul | -2.0 | 22:36:40 | 10° | S | 22:38:32 | 14° | SE | 22:40:25 | 10° | ESE |
| 13 Jul | -3.7 | 00:11:30 | 10° | SW | 00:14:47 | 51° | SSE | 00:18:05 | 10° | E |
| 13 Jul | -3.8 | 01:48:08 | 10° | W | 01:51:32 | 85° | N | 01:54:55 | 10° | E |
| 13 Jul | -3.8 | 03:24:58 | 10° | W | 03:28:20 | 65° | SSW | 03:31:41 | 10° | ESE |
| 13 Jul | -3.3 | 23:24:10 | 10° | SW | 23:27:20 | 38° | SSE | 23:30:31 | 10° | E |
| 14 Jul | -3.8 | 01:00:36 | 10° | W | 01:04:00 | 90° | S | 01:07:24 | 10° | E |
| 14 Jul | -3.9 | 02:37:27 | 10° | W | 02:40:51 | 79° | S | 02:44:13 | 10° | ESE |
| 14 Jul | -2.8 | 04:14:27 | 10° | W | 04:17:22 | 27° | SSW | 04:20:17 | 10° | SSE |
| 14 Jul | -2.9 | 22:36:59 | 10° | SSW | 22:39:56 | 28° | SSE | 22:42:53 | 10° | E |
| 15 Jul | -3.9 | 00:13:05 | 10° | WSW | 00:16:29 | 80° | SSE | 00:19:52 | 10° | E |
| 15 Jul | -3.8 | 01:49:55 | 10° | W | 01:53:19 | 89° | S | 01:56:43 | 10° | E |
| 15 Jul | -3.3 | 03:26:48 | 10° | W | 03:29:58 | 37° | SSW | 03:33:07 | 10° | SE |
| 15 Jul | -3.8 | 23:25:36 | 10° | WSW | 23:28:58 | 66° | SSE | 23:32:20 | 10° | E |
| 16 Jul | -3.8 | 01:02:23 | 10° | W | 01:05:47 | 85° | N | 01:09:10 | 10° | E |
| 16 Jul | -3.6 | 02:39:13 | 10° | W | 02:42:31 | 50° | SSW | 02:45:48 | 10° | SE |
| 16 Jul | -2.0 | 04:16:57 | 10° | WSW | 04:18:45 | 14° | SW | 04:20:33 | 10° | S |
| 16 Jul | -3.6 | 22:38:11 | 10° | SW | 22:41:29 | 51° | SSE | 22:44:48 | 10° | E |
| 17 Jul | -3.8 | 00:14:50 | 10° | W | 00:18:14 | 85° | N | 00:21:38 | 10° | E |
| 17 Jul | -3.9 | 01:51:40 | 10° | W | 01:55:02 | 65° | SSW | 01:58:24 | 10° | ESE |
| 17 Jul | -2.4 | 03:28:54 | 10° | W | 03:31:26 | 20° | SW | 03:33:57 | 10° | SSE |
| 17 Jul | -3.8 | 23:27:17 | 10° | W | 23:30:41 | 90° | SSW | 23:34:05 | 10° | E |
| 18 Jul | -3.9 | 01:04:08 | 10° | W | 01:07:31 | 79° | SSW | 01:09:35 | 22° | ESE |
| 18 Jul | -2.0 | 02:41:07 | 10° | W | 02:42:24 | 18° | WSW | 02:42:24 | 18° | WSW |
| 18 Jul | -3.8 | 22:39:46 | 10° | WSW | 22:43:09 | 80° | SSE | 22:46:33 | 10° | E |
| 19 Jul | -3.8 | 00:16:36 | 10° | W | 00:20:00 | 89° | S | 00:22:29 | 17° | E |
| 19 Jul | -2.4 | 01:53:28 | 10° | W | 01:55:21 | 26° | WSW | 01:55:21 | 26° | WSW |
| 19 Jul | -3.7 | 21:52:16 | 10° | WSW | 21:55:38 | 66° | SSE | 21:59:01 | 10° | E |
| 19 Jul | -3.8 | 23:29:03 | 10° | W | 23:32:27 | 85° | N | 23:35:51 | 10° | E |
| 20 Jul | -3.4 | 01:05:53 | 10° | W | 01:08:47 | 47° | SW | 01:08:47 | 47° | SW |
| 20 Jul | -3.7 | 22:41:29 | 10° | W | 22:44:53 | 85° | N | 22:48:17 | 10° | E |
| 21 Jul | -3.8 | 00:18:19 | 10° | W | 00:21:41 | 65° | SSW | 00:22:24 | 48° | SE |
| 21 Jul | -3.7 | 21:53:55 | 10° | W | 21:57:20 | 90° | SW | 22:00:44 | 10° | E |
| 21 Jul | -3.9 | 23:30:46 | 10° | W | 23:34:10 | 79° | SSW | 23:36:08 | 23° | ESE |
| 22 Jul | -1.8 | 01:07:46 | 10° | W | 01:09:03 | 18° | WSW | 01:09:03 | 18° | WSW |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 21 Jul | -3.8 | 00:18:19 | 10° | W | 00:21:41 | 65° | SSW | 00:22:24 | 48° | SE |
| 21 Jul | -3.7 | 21:53:55 | 10° | W | 21:57:20 | 90° | SW | 22:00:44 | 10° | E |
| 21 Jul | -3.9 | 23:30:46 | 10° | W | 23:34:10 | 79° | SSW | 23:36:08 | 23° | ESE |
| 22 Jul | -1.8 | 01:07:46 | 10° | W | 01:09:03 | 18° | WSW | 01:09:03 | 18° | WSW |
| 22 Jul | -3.8 | 22:43:13 | 10° | W | 22:46:37 | 89° | S | 22:49:56 | 11° | E |
| 23 Jul | -3.0 | 00:20:06 | 10° | W | 00:22:51 | 36° | SW | 00:22:51 | 36° | SW |
| 23 Jul | -3.7 | 21:55:39 | 10° | W | 21:59:04 | 85° | N | 22:02:27 | 10° | E |
| 23 Jul | -3.5 | 23:32:30 | 10° | W | 23:35:48 | 50° | SSW | 23:36:42 | 37° | SSE |
| 24 Jul | -3.7 | 22:44:55 | 10° | W | 22:48:18 | 65° | SSW | 22:50:36 | 19° | ESE |
| 25 Jul | -1.7 | 00:22:09 | 10° | W | 00:23:32 | 17° | WSW | 00:23:32 | 17° | WSW |
| 25 Jul | -3.8 | 21:57:22 | 10° | W | 22:00:45 | 79° | SSW | 22:04:08 | 10° | ESE |
| 25 Jul | -2.6 | 23:34:21 | 10° | W | 23:37:17 | 27° | SSW | 23:37:28 | 27° | SSW |
| 26 Jul | -3.0 | 22:46:40 | 10° | W | 22:49:50 | 37° | SSW | 22:51:26 | 23° | SSE |
| 27 Jul | -3.4 | 21:59:04 | 10° | W | 22:02:22 | 50° | SSW | 22:05:26 | 11° | SE |
| 27 Jul | -1.5 | 23:36:48 | 10° | WSW | 23:38:23 | 14° | SW | 23:38:23 | 14° | SW |
| **28 Jul** | **-1.9** | **22:48:42** | **10°** | **W** | **22:51:14** | **20°** | **SW** | **22:52:26** | **17°** | **S** |
| 29 Jul | -2.4 | 22:00:54 | 10° | W | 22:03:50 | 27° | SSW | 22:06:31 | 11° | SSE |
| 25 Aug | -1.1 | 05:27:48 | 10° | S | 05:29:36 | 14° | SE | 05:31:23 | 10° | ESE |
| 27 Aug | -2.2 | 05:27:49 | 10° | SSW | 05:30:43 | 27° | SSE | 05:33:38 | 10° | E |
| 28 Aug | -1.7 | 04:41:30 | 14° | S | 04:43:13 | 20° | SE | 04:45:44 | 10° | E |
| 29 Aug | -1.3 | 03:55:48 | 14° | SE | 03:55:48 | 14° | SE | 03:57:33 | 10° | ESE |
| 29 Aug | -3.2 | 05:28:45 | 10° | SW | 05:31:59 | 50° | SSE | 05:35:16 | 10° | E |
| 30 Aug | -2.8 | 04:43:00 | 25° | SSW | 04:44:24 | 37° | SSE | 04:47:33 | 10° | E |
| 31 Aug | -2.3 | 03:57:13 | 26° | SE | 03:57:13 | 26° | SE | 03:59:46 | 10° | E |
| 31 Aug | -3.7 | 05:30:10 | 11° | WSW | 05:33:22 | 79° | SSE | 05:36:45 | 10° | E |
| 01 Sep | -0.9 | 03:11:24 | 12° | E | 03:11:24 | 12° | E | 03:11:51 | 10° | E |
| 01 Sep | -3.7 | 04:44:21 | 32° | SW | 04:45:44 | 65° | SSE | 04:49:04 | 10° | E |
| 02 Sep | -3.1 | 03:58:32 | 46° | SE | 03:58:32 | 46° | SE | 04:01:23 | 10° | E |
| 02 Sep | -3.7 | 05:31:29 | 10° | W | 05:34:49 | 85° | N | 05:38:13 | 10° | E |
| 03 Sep | -1.2 | 03:12:43 | 17° | E | 03:12:43 | 17° | E | 03:13:39 | 10° | E |
| 03 Sep | -3.8 | 04:45:39 | 31° | W | 04:47:09 | 89° | SSE | 04:50:32 | 10° | E |
| 04 Sep | -3.6 | 03:59:51 | 66° | ESE | 03:59:51 | 66° | ESE | 04:02:51 | 10° | E |
| 04 Sep | -3.8 | 05:32:55 | 10° | W | 05:36:17 | 90° | NNW | 05:39:40 | 10° | E |
| 05 Sep | -1.3 | 03:14:04 | 19° | E | 03:14:04 | 19° | E | 03:15:09 | 10° | E |
| 05 Sep | -3.8 | 04:47:01 | 29° | W | 04:48:36 | 85° | N | 04:51:59 | 10° | E |
| 06 Sep | -3.5 | 04:01:17 | 68° | ENE | 04:01:17 | 68° | ENE | 04:04:17 | 10° | E |
| 06 Sep | -3.7 | 05:34:21 | 10° | W | 05:37:42 | 67° | SSW | 05:41:03 | 10° | ESE |
| 07 Sep | -1.2 | 03:15:37 | 18° | E | 03:15:37 | 18° | E | 03:16:35 | 10° | E |
| 07 Sep | -3.9 | 04:48:35 | 31° | W | 04:50:02 | 81° | SSW | 04:53:24 | 10° | ESE |

## END IMAGES, OBSERVING AND OUTREACH

*With summer nights beginning to lengthen and the Milky Way hanging in the southern skies just after it gets dark we get an opportunity to image the home galaxy from the inside.*
*Here are shots from the south coast last year in that brief easing of the lock down.*
*Nikon D810a, 60 seconds, f3.5 on Samyang 14mm lens.*
*A camping fire smoke catching the light is not ideal.*

*Andy*

**Wiltshire Astronomical Society Observing Suggestion for June 2021 @ 23:00**

**We have updated the observation target this month for those with binoculars or smaller telescopes have something to look for.**

**As we can no longer gather as one, for the time being, each month the WAS Observing Team will provide recommended socially distant observing sessions for you to do at home.**
**This will continue until we can start our group observing again (hopefully) in the new season.**
**Most target objects can be found around due south between 23:00 and Midnight**
**We have added the observation suggestion in the 'What's Up' link below.**
**Where To Look This Month: Deep Sky Delights in Hercules**

**Upload Link:** WAS_June_2021.pdf

**Also Wiltshire Astronomical Society will produce the monthly newsletter containing further information, which can be downloaded here:** https://wasnet.org.uk/

**OUTREACH**

Zoom sessions and Google Classroom sessions have kept outreach going to schools. In January I did sessions at Stonar and Westbury Leigh. If anyone else has links to schools who might be interested in ‘in the classroom’ sessions ask them to get in touch with me via anglesburns@hotmail.com.