NWASNEWS

Volume24, Issue 10

June 2019

Newsletter for the Wiltshire, Swindon, Beckington Astronomical Societies and Salisbury Plain Observing Group

THANK YOU and Happy Recess

Wiltshire Astronomical Society moves into a summer recess, well for club house meetings.

So can I as vice chair, newsletter editor and outreach coordinator thank all the committee members and stand ins called on in the year, plus coffee makers, dish washers and out reach volunteers. It has been a difficult year for our chair and I have (and am currently very much) had a lot of arthritic pain or pain killer side affects to deal with, so the help has been very gratefully received.

May I single out Sam Franklin for his stoically work in sorting out our web page and getting into a good shape going forward. The introduction of the members page of Facebook has also been working very well, and will enable us to keep in touch over the summer months with ad hoc viewing sessions and calls for help.

We (well Peter Chappell and Tony Vale) have put together some dates for the beginning of next season and I am able to include them on page 2 and the back page of the newsletter.

Also John Dartnell has taken a shared message about ISS passes of the surface of the Sun due this week, and has found three racks going close to, or through, Wiltshire in the next 4 days… but the weather is not due to brilliant.

Don't forget from now until late July there may be noctilucent clouds in the evening North West or morning North East skies. Around and hour to two hours before or after Sun rise/set.

I am able to keep watching because of blooming pain/pain killer cycles, but they are worth a look.

Clear skies

Andy Burns.

Summer skies bring us the Milky Way (not here), Noctilucent clouds and meteors. At the end of May I managed to capture some noctilucent clouds just above the northern horizon at the some time as a very bright fireball meteor streaked down to the north.
The meteor was around –7 magnitude, easily outshining the noctilucent cloud and 1st Magnitude Capella in the centre of the picture.
Nikon D7200 with 12-24mm lens at 15mm, f4.5 and 6 seconds exposure.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

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

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

Date	Speaker	Title
2019		
4 Jun	Owen Brazell	Observing Planetary Nebulae

NEXT SEASON 2019/2020

3rd Sep: Steve Tonkin, Time & Calendar + AGM
1st Oct: TBC (awaiting come back e mail from possible speaker)
5th Nov: Andrew Lound:, Uranus – George's planet
3rd Dec: Dr Dirk Froebrich, Making stars & planets – The Hoys=Caps Citizen Science Project.

Owen Brazell:

Thank you Owen for standing in for our postponed speaker.

As member of the Webb Society and an avid eye to the telescope exponent, Owen is a very learned astronomer and will be sharing his viewing of the planetary nebulae, many of which are visible in our summer skies.

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Keith Bruton Chair, keisana@tiscali.co.uk

Vice chair: Andy Burns and newsletter editor.
Email anglesburns@hotmail.com

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

Philip Proven (Hall coordinator) Dave Buckle (Teas)

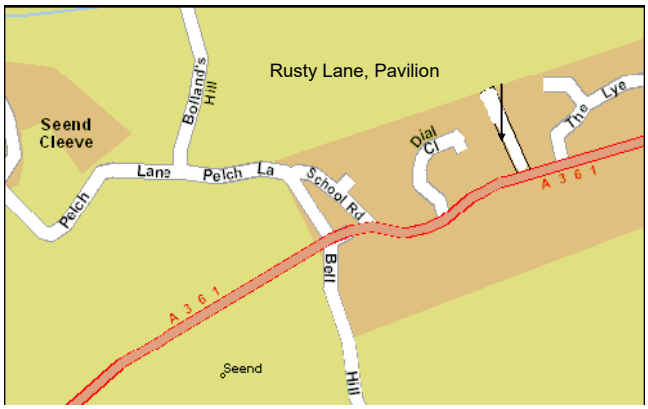
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

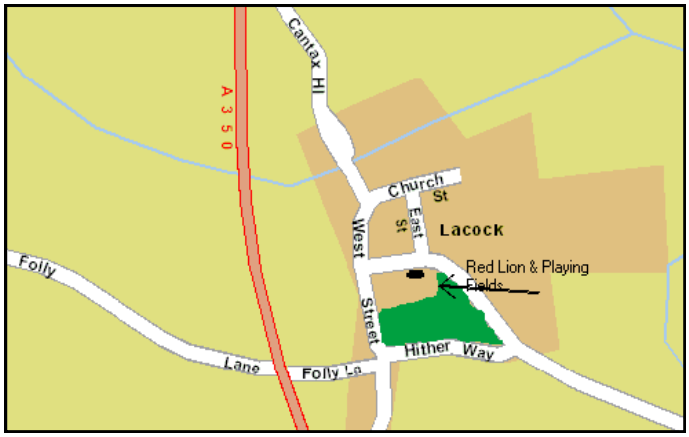
Observing Sessions coordinators: Jon Gale, Tony Vale

Web coordinator: Sam Franklin

Contact via the web site details.



Observing Sessions



The Wiltshire Astronomical Society's observing sessions are open, and we welcome visitors from other societies as well as members of the public to join us.

We will help you set up equipment (as often as you need this help), and let you test anything we have to help you in your choice of future astronomy purchases.

Please treat the lights and return to full working order before leaving. With enough care shown we may get the National Trust to do something with them!

PLEASE see our proposed changes to the observing sessions, contacting and other details. Back Page

Note this year we have moved away from the '4th Friday of the month' routine to get away from nights when the Moon is too bright to view other objects, so may be 1st Friday of month...

Swindon's own astronomy group

June Meeting: Peter Chappell

He will be speaking on 'My Aurora Adventure'.

His main interests is visual viewing of Solar System objects especially the surface of the Sun which changes quite quickly and also the planets. He is very keen on observing Solar eclipses and has seen around eight in total from the Feroe Islands to China.

Peter is a member of three local astronomy groups: Wiltshire AS (speaker secretary), Swindon Stargazers and Salisbury Plain Observing Group.

Ad-hoc viewing sessions

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

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!
Members of the Wiltshire Astronomical Society always welcome!

Meetings at Liddington Village Hall, Church Road, Liddington, SN4 0HB – 7.30pm onwards

The hall has easy access from Junction 15 of the M4, a map and directions can be found on our website at:

http://www.swindonstargazers.com/clubdiary/directions01.htm

Meeting Dates for 2019
Friday 17 May 2019

Programme: Mark Woodland FRAS: Exoplanents and the Charterhouse Exoplanet Project

Friday 21 June 2019
Programme: Peter Chappell: My Aurora Adventure

July & August: Summer break

Friday 20 September 2019
Programme: Dr. Lilian Hobbs: How Astronomy Has Changed

Friday 18 October 2019

Programme: Robert Slack: The Grand Tour

Friday 15 November 2019
Programme: TBA

Friday 13 December 2019
Programme: TBA

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.

17th May	*The Herschel 400*	Jonathan Gale
21st June	Annual General Meeting *Member Talks*	

STAR QUEST ASTRONOMY CLUB

This young astronomy club meets at the Sutton Veny Village Hall.
Second Thursday of the Month.

Jupiter Shines in June

By David Prosper

Jupiter stakes its claim as the king of the planets in June, shining bright all night. **Saturn** trails behind Jupiter, and the **Moon** passes by both planets mid-month. **Mercury** puts on its best evening appearance in 2019 late in the month, outshining nearby **Mars** at sunset.

Jupiter is visible almost the entire evening this month. Earth will be between Jupiter and the Sun on June 10, meaning Jupiter is at **opposition**. On that date, Jupiter rises in the east as the Sun sets in the west, remaining visible the entire night. Jupiter will be one of the brightest objects in the night sky, shining at magnitude -2.6. Its four largest moons and cloud bands are easily spotted with even a small telescope.

What if your sky is cloudy or you don't have a telescope? See far more of Jupiter than we can observe from Earth with NASA's **Juno** mission! Juno has been orbiting Jupiter since 2016, swooping mere thousands of miles above its cloud tops in its extremely elliptical polar orbits, which take the probe over 5 million miles away at its furthest point! These extreme orbits minimize Juno's exposure to Jupiter's powerful radiation as it studies the gas giant's internal structure, especially its intense magnetic fields. Juno's hardy JunoCam instrument takes incredible photos of Jupiter's raging storms during its flybys. All of the images are available to the public, and citizen scientists are doing amazing things with them. You can too! Find out more at bit.ly/JunoCam

Saturn rises about two hours after Jupiter and is visible before midnight. The ringed planet rises earlier each evening as its own opposition approaches in July. The **Moon** appears near both gas giants mid-month. The Moon's tour begins on June 16 as it approaches Jupiter, and its visit ends on June 19 after swinging past Saturn.

Mercury is back in evening skies and will be highest after sunset on June 23, just two days after the summer solstice! Spot it low in the western horizon, close to the much dimmer and redder **Mars**. This is your best chance this year to spot Mercury in the evening, and nearly your last chance to see Mars, too! The two smallest planets of our solar system pass close to each other the evenings of June 17-18, coming within just ¼ degree, or half the width of a full Moon, making for a potentially great landscape photo at twilight.

Discover more about NASA's current and future missions at nasa.gov

Caption: A giant storm in Jupiter's north polar region, captured by JunoCam on February 4, 2019. Image processing performed by citizen scientists Gerald Eichstädt and Seán Doran.

Source: bit.ly/JupiterSpiral

Caption: Mars and Mercury after sunset the evenings of June 17-18, 2019. Image created with assistance from Stellarium.

SPACE NEWS FOR MAY

Our Facebook page carries a lot of these news items throughout the month.

Can You Spot a Planetary Nebula from a Few Blurry Pixels? Astronomers Can – Here's How

A planetary nebula is one of the most beautiful objects in the universe. Formed from the decaying remnants of a mid-sized star like a sun, no two are alike. Cosmically ephemeral, they last for only about 10,000 years – a blink of a cosmic eye. And yet they are vitally important, as their processed elements spread and intermingle with the interstellar medium in preparation for forming a new generation of stars. So studying them is important for understanding stellar evolution. But unlike their stellar brethren, since no two are alike, it's hard to efficiently pick them out of astronomical deep-sky surveys. Thankfully, a research team has recently developed a method for doing just that, and their work could open up the door to fully understanding the great circle of stellar life.

Out with a Whimper

When stars like our sun finally kick the bucket, they don't do it in a neat and tidy fashion. Instead, over the course of a million years or so they slowly turn themselves inside out, ejecting their outer layers into the surrounding solar system. Ragged gasp by ragged gasp, the star sheds its layers, leaving behind only a blazing hot core. This core, now properly called a white dwarf, has a temperature of around a million degrees and emits copious amounts of X-ray radiation.

This radiation strikes the gas surrounding the now-dead star. That gas is mostly hydrogen and helium, just like everything else in the universe, but also contains bits and pieces of heavier elements and molecules like carbon, oxygen, and even water. Energized by the intense radiation blasting off the white dwarf, the elements absorb that energy and re-emit it in all sorts of colorful wavelengths. In case you were wondering, this is exactly how fluorescent light bulbs work but on a much bigger and messier scale.

Over time the white dwarf will cool down and no longer be able to sustain lighting up the entire nebula surrounding it, at which point it the nebula will fade from view. This happens roughly 10,000 years after the initial exposure of the core.

This is what we call a planetary nebula (I won't get into the history of the name because it basically makes no sense and we're just going to have to live with it). Every single planetary nebula is unique because the physics of forming them – from ejecting layer upon layer of a star's material – is so complex that it can never be exactly repeated. Even though planetary nebulae don't last long, they are surprisingly common, because the stars they come from are themselves relatively common. So ultimately we see them all over the place, twinkling like Christmas ornaments in the deep sky.

The Circle of Stellar Life

Finding, categorizing, and understanding planetary nebulae are critically important for wrapping our astronomical heads around the full evolution of stars within a galaxy. This is because planetary nebulae form the material for new generations of stars. Through slow dispersion of the dust and gases in the nebulae, and sometimes even violent explosions due to extreme radiation and winds, the material makes its way into interstellar space. There it mixes and mingles with the general galactic milieu and eventually finds its way into a new baby stellar system, and the cycle continues.

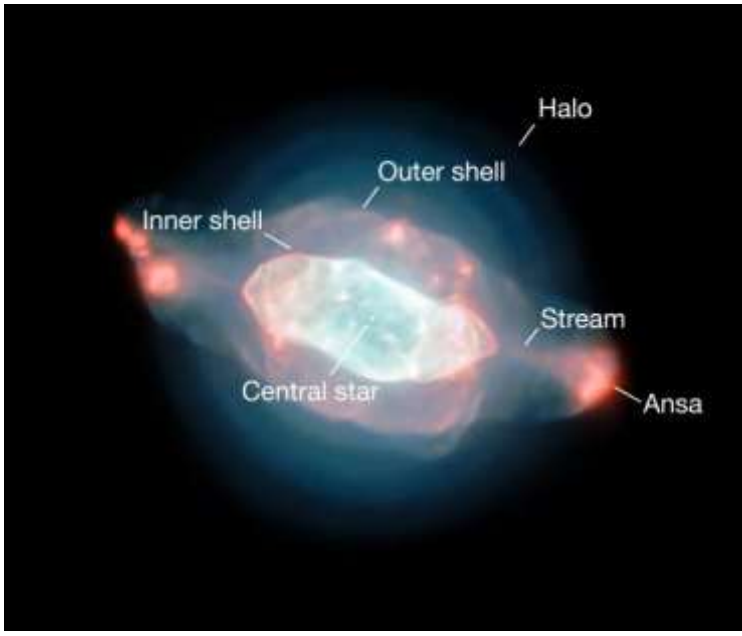
What's more, we need to understand planetary nebulae because they give us a picture into how stars like our sun die. In our surveys we see all sorts of planetary nebulae. Sometimes we see beautiful helical or spiral structures. Sometimes we see spheres or ovals. And sometimes we just see a bunch of tattered rags that can barely call themselves a nebula. How do such intricate and disparate patterns emerge? How can two stars that are seemingly very similar give rise to radically different planetary nebulae? We don't know.

And that's not the end of the questions. How critical are planetary nebulae to enriching the interstellar medium? Compared to say supernova. How quickly can material disperse and find its way embedded into some new generation of stars?

These are all very good questions, all without any very good answers

A Few Good Pixels

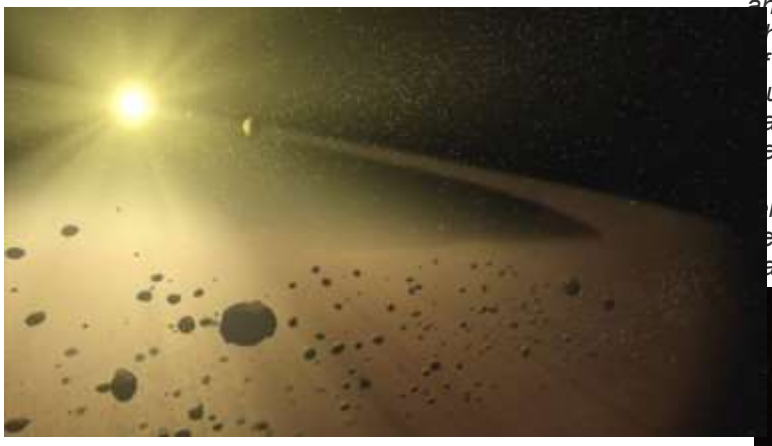
The proper response to any set of questions like this is usually more data. We need a lot of observations of a lot of planetary nebulae to try to build up a decent statistical database so we can start comparing and contrasting in a solid scientific way. But there's a problem that appears if we want to start developing massive surveys to pick out thousands upon thousands of planetary nebulae in the sky. The problem is that no two nebulae are alike, so it's very hard to come up with a simple classification scheme that picks out planetary nebulae from some other random bits of space stuff.



The spectacular planetary nebula NGC 7009, or the Saturn Nebula, emerges from the darkness like a series of oddly-shaped bubbles, lit up in glorious pinks and blues. This colourful image was captured by the powerful MUSE instrument on ESO's Very Large Telescope (VLT), as part of a study which mapped the dust inside a planetary nebula for the first time. This annotated ver-

sion labels the features of this curious object. Image Credit: ESO/J. Walsh
Even more frustratingly, at the scale and resolution of most sky surveys, planetary nebulae are just a few fuzzy pixels across. How can you possibly tell one from another? This is where the new research comes in. A team of astronomers performed an enormous number of simulations and simulated observations of planetary nebulae, in addition to other sources that they might be confused with like galaxies and quasars.
They then chopped up this data in as many different ways as possible, seeing how planetary nebulae looked at certain wavelengths compared to others. They identified a key series of tests that allowed them to filter out almost any other contaminant, leaving only a population of clean (still fuzzy) planetary nebulae. With this technique future automated sky surveys could easily incorporate planetary nebulae into their catalogs, perhaps helping to answer some of the questions of how exactly the circle of seller life goes round and round in the galaxy.
Read more: "Planetary Nebulae and How to Find Them: Color Identification in Big Broadband Surveys"

Most of the Solar System Should be a Protected Wilderness. One-Eighth Left for Mining and Resource Exploitation



There is no doubt that our world is in the midst of a climate crisis. Between increasing levels of carbon dioxide in our atmosphere, rising temperatures and sea levels, ocean acidification, species extinctions, waste production, diminishing supplies of fresh water, drought, severe weather, and all of the resulting fallout, the "Anthropocene" is not shaping up too well.
It is little wonder then why luminaries like Stephen Hawking, Buzz Aldrin, and Elon Musk believe that we must look off-world to ensure our survival. However, there are those who caution that in so doing, humans will simply shift our burdens onto new locations. Addressing this possibility, two distinguished researchers recently published a paper where they suggest that we should set aside "wilderness" spaces" in our Solar System today.

Messier 86 – the NGC 4406 Elliptical Galaxy

Welcome back to Messier Monday! Today, we continue in our tribute to our dear friend, Tammy Plotner, by looking at the elliptical (lenticular) galaxy known as Messier 86!
During the 18th century, famed French astronomer Charles Messier noticed the presence of several "nebulous objects" while surveying the night sky. Originally mistaking these objects for comets, he began to catalog them so that others would not make the same mistake. Today, the resulting list (known as the Messier Catalog) includes over 100 objects and is one of the most influential catalogs of Deep Space Objects.
One of these objects is the elliptical (lenticular) galaxy known as Messier 86. Located in the southern constellation Virgo, roughly 52 million light years from Earth, this galaxy is another member of the Virgo Cluster – the closest large galaxy cluster to the Milky Way. Because of its distance and proximity to other bright galaxies, this galaxy can only be seen with a telescope, or as a faint patch with binoculars when viewing conditions are sufficient.

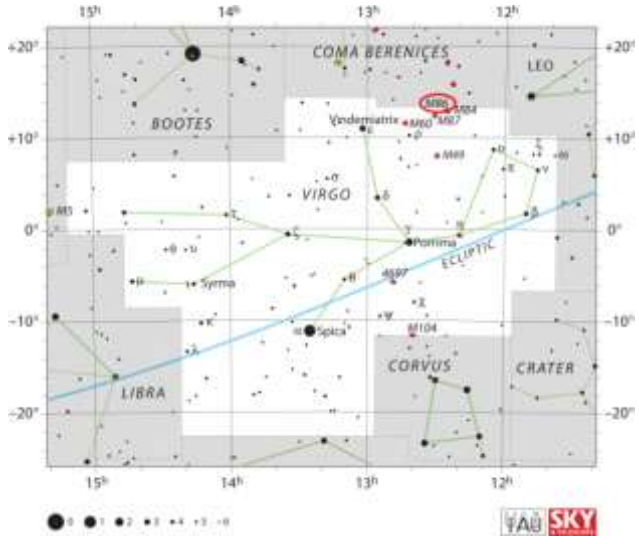
It's heading our way… Messier 86 is the highest blue shift object in Charles' entire catalog – is approaching us at 419 kilometers per second – or about 3 million miles per hour! As C. Jones (et al.) determined in a 2003 study:
"The supersonic motion of M86 produces pressure that is stripping gas from the galaxy and forming the spectacular tail. M86 has been pulled into the Virgo galaxy cluster and accelerated to a high speed by the enormous combined gravity of dark *matter, hot gas, and hundreds of galaxies that comprise the cluster. The infall of the galaxy into the cluster is an example of the process by which galaxy groups and galaxy clusters form over the course of billions of years. The galaxy is no longer an "island universe" with an independent existence. It has been captured and its gas is being swept away to mix with the gas of the cluster, leaving an essentially gas-free galaxy orbiting the center of the cluster along with hundreds of other galaxies."*

The Virgo Cluster. Credit: Wikisky
With so many nearby galaxies – both visual and physical – it would almost be a given that any galaxy moving at such a reckless speed has got to be encountering its cluster members. Is it possible that M86 is catching others in its wake? As A. Finoguenov (et al) of the Max Planck Institut explained in a 2003 study:
"The environmental influence of cluster media on its

member galaxies, known as Butcher-Oemler effect, has recently been subject to revision due to numerous observations of strong morphological transformations occurring outside the cluster virial radii, caused by some unidentified gas removal processes. In this context *we present new XMM-Newton observations of M 86 group. The unique combination of high spatial and spectral resolution and* large *field of view of XMM-Newton allows an in-depth investigation of the processes involved in the spectacular disruption of this object. We identify a possible shock with* Mach *number of 1.4 in the process of crushing the galaxy in the North-East direction. The latter is ascribed to the presence of a dense X-ray emitting filament, previously revealed in the RASS data. The shock is not associated with other previously identified features of M 86 X-ray* emission*, such as the plume, the north-eastern arm and the southern extension, which are found to have* low *entropy, similar to the inner 2* kpc *of M 86. Finally,* mere *existence of the large scale gas halo around the M 86 group, suggests that the disruptions of M 86's X-ray halo may be caused by small-scale types of interactions such as galaxy-galaxy collisions."*

History of Observation:

M86 was discovered by Charles Messier in 1781. On the night of March 18th he writes: "Nebula without star, in Virgo, on the parallel and very near to the nebula above, No. 84: their appearances are the same, and both appear together in the same field of the telescope."
The great Sir William Herschel would also observe M86 and felt he was able to get some resolution from this smooth, featureless galaxy. While we might not catch any details, his son John, also described some details: "Very bright; large; round; gradually brighter toward the middle where there is a nucleus; mottled." One can only wonder how these great observers would have reacted had they known everything we know about things like Messier 86 today!



The location of Messier 86 in the Virgo constellation. Credit: IAU/Sky & Telescope magazine (Roger Sinnott & Rick Fienberg)

Locating Messier 86:

M86 and nearby M84, can be located by aiming almost exactly centered between Beta Leonis (Denebola) and Epsilon Virginis (Vindemiatrix). While you won't catch them in the average finderscope, both galaxies can be seen in the same low (or medium) power eyepiece. Because this pair is bright and basic, it's a great starhop starting point for observing the Virgo Cluster and other nearby Messier objects.
For dark sky areas, the M84/86 pairing can often be spotted with smaller binoculars – and on clear, dark nights can easily be captured with larger ones. For telescope users, M86 will never have any definition because of its galactic type, but its high surface brightness qualities will make you appreciate it on those "less than perfect" nights.
Enjoy your galaxy cluster adventures…

Chang'e-4 Lander and its Rover Have Turned up new Mysteries on the Moon's far side. The Moon's Mantle Blasted Onto the Surface?

On January 3rd, 2019, the Chinese National Space Administration (CNSA) successfully landed their *Chang'e-4* mission on the far side of the Moon. This mission represents a major milestone for China, being the fourth lander-rover mission to be sent to the Moon, and the first mission in history to land on the "dark side of the Moon". And what it manages to uncover there is sure to excite and inspire scientists for many years to come.
For example, the mission's Yutu-2 (Jade Rabbit-2) rover made an impressive find that may confirm a theory about lunar impacts. After collecting spectral data from the moon's largest crater (the South Pole-Aitken Basin) the *Chang'e-4* mission team from the Chinese Academy of Sciences (CAS) concluded that the impact that created the Basin turned up material from deep within the Moon's mantle. This finding could offer new insight into how the Moon evolved over the course of billions of years.

A paper that describes the team's findings was recently published in the scientific journal *Nature.* The team was led by Li Chunlai, a professor of the National Astronomical Observatories of Chinese Academy of Sciences (NAOC), and consisted of multiple members from the CAS' Key Laboratories of Lunar and Deep Space Exploration and Space Active Opto-Electronics Technology.

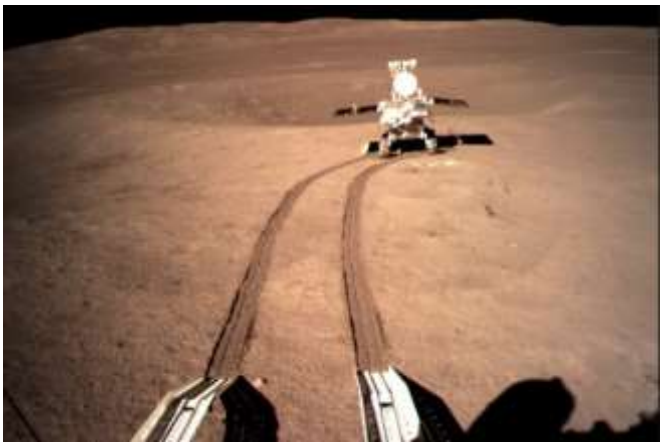


Image of the Yutu-2 rover moving away from the Chang'e-4 mission's landing zone. Credit: CNSA
For about 60 years, robotic spacecraft and even a handful of crewed missions have been exploring the lunar surface. Based on the data they collected, a theory emerged in the 1970s that early in its history, the Moon's surface was covered by an ocean of magma. As the surface began to cool and solidify, lighter minerals (like basalt) floated to the top while heavier ele-

ments (olivine and pyroxene) sank deeper to the core. In keeping with this theory, scientists also speculated that impacts by asteroids, meteors and space junk would crack through the crust and kick up heavier material from the mantle. As Li explained in a recent CAS press statement:

"Understanding the composition of the lunar mantel is critical for testing whether a magma ocean ever existed, as postulated. It also helps advance our understanding of the thermal and magmatic evolution of the Moon."

Located at the Moon's south pole, the SPA basin is the largest, oldest, and deepest known crater on the Moon. Measuring about 2,500 km (930 mi) in diameter and 13 km (8.1 mi) deep, it is believed to have formed as a result of a massive impact that took place 3.9 billion years ago. This corresponds to the Late Heavy Bombardment period, when the planets of the inner Solar System were struck by a disproportionately large number of asteroids.

Image captured by Chang'e-4 showed the landscape near the landing site. Credit: NAOC/CNSA

To test this theory, the mission team collected spectral data samples from the flat stretches of the SPA basin, as well as from smaller and deeper impact craters within it. What they expected to find was a wealth of mantle material on the flat stretches, but were instead surprised to find mere traces of olivine. On Earth, this rock-forming mineral is a primary component of the upper mantle.

On its own, this finding could be seen as an indication that predictions about the composition of the lunar mantle have been incorrect. However, samples taken from deeper impacts revealed higher concentrations of olivine, which presented a real conundrum. A possible explanation, according to Li, is that the mantle consists of equal parts olivine and pyroxene, rather than being dominated by one.

In order to confirm these findings, the *Chang'e-4* will need to explore the area around its landing site and gather more spectral data to get a better understanding of its geology. What it reveals may inevitably cause scientists to reassess their theories about the composition of the lunar mantle, not to mention the Moon's geological history.

In addition, an improved understanding of the Moon's evolution may provide a window into the evolution of Earth and the other terrestrial planets as well. Not only is the surface of the Moon very well preserved compared to Earth's (owing to the absence of an atmosphere, weather patterns or geological activity), but the predominant theory is that the Earth and Moon formed from the same basic materials.

These and other theories about how our Solar System and its celestial bodies came to be will be tested thanks to Chang'e-4 and its brave Yutu-2 rover.

The Collision that Created the Moon Might Have Also Brought Water to the Early Earth

Scientists at the University of Munster have discovered that Earth got its water from a collision with Theia. Theia was the ancient body that collided with Earth and formed the Moon. Their discovery shows that Earth's water is much more ancient than previously thought.

The standing theory for the formation of the Moon involves an ancient body called Theia. About 4.4 billion years ago, Theia collided with Earth. The collision created a massive debris ring, and the Moon formed from that debris.

Standing theory also says that Earth gathered its water over time, after the collision with Theia, with comets and asteroids delivering the water. But the new study from the University of Munster presents evidence that supports a different source for Earth's water: Theia itself.

"Our approach is unique because, for the first time, it allows us to associate the origin of water on Earth with the formation of the Moon."

Thorsten Kleine, Professor of Planetology at the University of Münster.

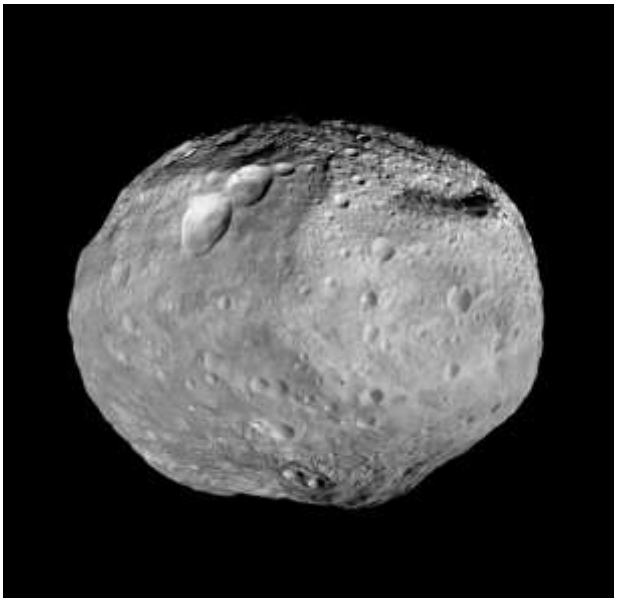
Scientists have long thought that Theia was a body from the inner solar system, since it was rocky in nature. But the new study says that's not the case. Instead, Theia had its origins in the outer Solar System.

Earth-rise from the Moon. Image Credit: NASA, Goddard.

Key to understanding these events is the idea of the wet and dry parts of our Solar System. The Solar System was formed about 4.5 billion years ago, and we know that the way it was structured led to a dry inner region and a wet outer region. Earth is a little bit of a mystery, because it formed in the dry region, closer to the Sun, yet it has an abundance of water. So studies like this one, which try to understand how Earth got its water, are important.

Much or our understanding of Earth's water come from two types of meteorites: carbonaceous meteorites, which are rich in water, and non-carbonaceous meteorites, which are drier. And carbonaceous meteorites come from the outer Solar System, while the drier non-carbonaceous meteorites come from the inner Solar System. Got all that?

There's lots of evidence that Earth's water was delivered by the wet carbonaceous meteorites from the outer Solar System, but when and how that happened has never been certain. This study brings some certainty to the issue.



The asteroid Vesta, courtesy of NASA's Dawn spacecraft. Meteorites ejected from Vesta may have helped form Earth's water. Credit: NASA/JPL-Caltech/UCAL/MPS/DLR/IDA

"We have used molybdenum isotopes to answer this question."

Dr. Gerrit Budde, lead author, Institute of Planetology in Munster.

The study is called "Molybdenum isotopic evidence for the late accretion of outer Solar System material to Earth," and it's published in the journal Nature Astronomy. As the title makes clear, it's all about isotopes of molybdenum, and the difference between the molybdenum in the Earth's core, and the molybdenum in Earth's mantle.

"We have used molybdenum isotopes to answer this question. The molybdenum isotopes allow us to clearly distinguish carbonaceous and non-carbonaceous material, and as such represent a 'genetic fingerprint' of material from the outer and inner solar system," explains Dr. Gerrit Budde of the Institute of Planetology in Münster and lead author of the study.

Why molybdenum? Because it has a very helpful property when it comes to answering the question of the origin of Earth's water. Molybdenum is very iron-friendly, meaning most of it exists in the Earth's core, which is largely iron.

The core is ancient, because the Earth was a molten ball in its early days and heavier elements like iron migrated to form the core. Since molybdenum loves iron, molybdenum went to the core too. But there's also molybdenum in the Earth's crust, which must have been delivered to Earth after it cooled, or else it would have migrated to the core too. So the Earth has two populations of molybdenum, and they're each different isotopes.

The layers of the Earth. Since molybdenum loves iron, it sank to the core when the Earth was molten. Any molybdenum in the mantle or crust must have come to Earth later, when the planet had cooled. Image Credit: By Kelvinsong – Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=23966175

And that late-to-the-party molybdenum in the Earth's mantle must have come from bodies that crashed into Earth later on in its formation. "The molybdenum which is accessible today in the Earth's mantle, therefore, originates from the late stages of Earth's formation, while the molybdenum from earlier phases is entirely in the core," explains Dr. Christoph Burkhardt, second author of the study.

What's these results make clear, for the first time, is that carbonaceous material from the outer, wet area of the Solar System arrived on Earth late.

But the paper goes further than that. Since the molybdenum in the mantle had to have come from the outer Solar System, due to it being a different isotope, that means that Theia also had to come from the outer Solar System. The scientists behind this research show that the collision with Theia provided enough carbonaceous material to account for the majority of Earth's water.

"Our approach is unique because, for the first time, it allows us to associate the origin of water on Earth with the formation of the Moon. To put it simply, without the Moon there probably would be no life on Earth," says Thorsten Kleine, Professor of Planetology at the University of Münster.

Catching a Ride on the Starlink Satellite Train: Midnight Marvel, or Night Sky Menace?

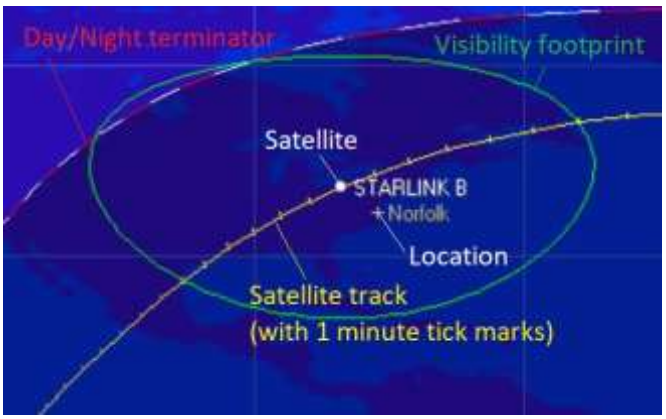
Have you seen Starlink? It all started, as all good breaking astronomical events seem to do, late on a Friday night. We got the notification first from veteran satellite tracker Dr. Marco Langbroek over in the Netherlands via the venerable See-Sat-L message board, and on Twitter soon after:
"I could not help shouting 'OAAAAH!!!'" says Langbroek, recounting the event on his blog: "Here is the video I shot, be prepared to be mind-blown!":
SpaceX Starlink objects train 24 May 2019 from Marco Langbroek on Vimeo.

Wow, indeed.
Soon, reports started trickling in about a strange 'trail of lights' crossing the European sky.
It didn't take the satellite tracking community long to pinpoint the culprit: Elon Musk's SpaceX had launched a Falcon-9 rocket from Cape Canaveral Air Force Station in Florida the night before, with the first batch of Starlink satellites. This was the first of 60 satellites in a touted constellation that is expected to grow in number out to 12,000 satellites in low Earth orbit.

Starlink passes near the constellation Lyra. Credit: Steven Brown.
Each Starlink satellite weighs in at 227 kilograms (500 pounds), has a single solar panel for power, and uses krypton gas ion thrusters to maneuver. Musk plans to build a space-based Internet communication platform with the constellation, in a globe-spanning network that has the potential to be a key market disruptor, and perhaps a game-changer in the worldwide internet market.
But it was the visibility of the first Starlink batch that caught even seasoned observers by surprise last Friday night… and soon grew into a spirited debate over the weekend on their impact on the night sky. Contrary to expectations, the satellite train was easily visible as a glittering string of +2 to +3 magnitude stars, with some flaring up to +1st magnitude. Even now as the constellation disperses and heads to a higher orbit, we're still getting sighting reports, three days later.

Adventures in Sat-spotting

Satellite-spotters worldwide played a crucial role in the very opening hours of the event. Typically, United States Combined Space Operations Center (CSpOC) releases tracking elements (known as Two-Line Elements or TLEs) that then percolate out to respective satellite tracking programs and apps for use by observers. Large batches like Starlink, however, are often problematic and take time to produce; NORAD's Space-Track didn't list the first three Starlink elements until Sunday, May 26th.



Anatomy of a Starlink pass. Created by the author using Orbitron.
This left folks clamoring for predictions across social media. As excitement grew, we swung into action, using TLEs provided by Dr Langbroek and plugging them into the satellite tracking program Orbitron to make hand-crafted predictions for anyone that wanted 'em.

Observing Starlink

As of writing this, the new satellite train is still visible, though quickly dispersing. We're still making nightly predictions for Europe and North America (we're @Astroguyz on Twitter). We're also happy to make predictions for anyone based in far-flung locales worldwide, just ask.
One interesting aspect that made the first batch of Starlink satellites so conspicuous to observers worldwide was the orbit they were placed in. The first set of Starlink satellites deployed in an orbital inclination of about 53 degrees, very similar (though not in the same path or altitude) as the International Space Station. With an initial orbital altitude of 445 kilometers (277 miles), it takes a Starlink satellite 93 minutes to orbit the Earth. This also means the the Starlink train soon entered a span of full illumination shortly after launch, much like the ISS does biannually near either solstice. This brings to mind our sighting of another satellite constellation 'train' in Alaska at dusk back in February 18th, 1998 when a batch of five Iridium satellites were launched from Vandenberg Air Force base. But Iridium was made up of 66 active satellites… Starlink nearly matched that number on its *first launch*. Satellite constellations are nothing new to those who are familiar with the night sky, though SpaceX has now definitely raised the bar. For example, NOSS military satellites move as doubles or triplets, and the Chinese Yaogan constellation of satellites also has a similar appearance.
Starlink and their ilk have also done what other touted reflector sats such as Mayak, Orbital Reflector and Humanity Star could not: get folks out actually *looking* at the night sky. I think it's intriguing that some of the very best 'flare sats' such as the Iridiums and Starlink were actually never designed to do so, and those that are hyped as the next 'brightest object in the sky!' generally tend to fizzle out.

Of course, the conversation soon turned to the possible impact that Starlink will have on the night sky. Light pollution and unwanted streaks of satellites through astrophotos are nothing new, though Starlink will exponentially add to the problem. Perhaps, the controversy around Starlink in the astronomical community will inadvertently serve to bring the issue of mounting space

debris and light pollution into public consciousness. Musk has stated that engineers plan to look at ways to minimize satellite visibility on subsequent launches as they fan out into their respective orbital slots. Maybe they can take a hint from the U.S. Department of Defense's infamous 'vanishing spy satellite' Lacrosse-5? There is also no word from SpaceX as the whether they plan to make provisions for reentry of the satellites at the end of their respective careers.

This also comes as other companies, including Amazon (Project Kuiper), Leosat Enterprises, One Web and Telesat all plan to launch communications constellations of their own. The next Starlink launch is tentatively set for September 2019.

Heavens-Above is now listing the Starlink constellation on its main page. In the meantime, keep watching the skies, for a Starlink pass near you.

18 – Yes, 18 – New Earth-sized Exoplanets have been Found in Kepler's Data

Scientists working with data from the Kepler mission have discovered an additional 18 Earth-sized worlds. The team used a newer, more stringent method of combing through the data to find these planets. Among the 18 is the smallest exoplanet ever found.

The Kepler mission was very successful and we now know of more than 4,000 exoplanets in distant solar systems. But there's an understood sampling error in the Kepler data: it was easier for the spacecraft to find large planets rather than small ones. Most of the Kepler exoplanets are enormous worlds, close in size to the gas giants Jupiter and Saturn.

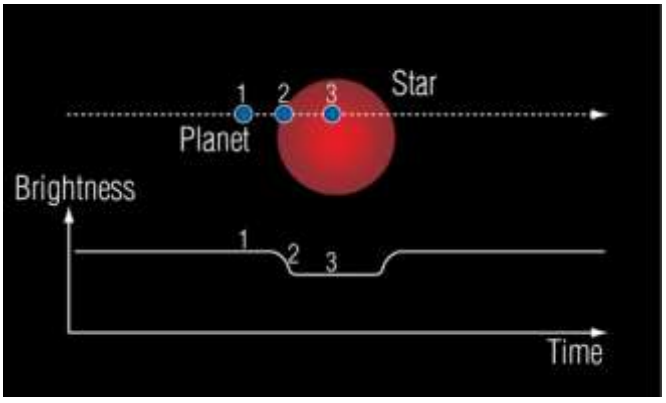
It's easy to understand why this is so. Obviously, larger objects are easier to find than smaller objects. But a team of scientists in Germany have developed a way to scour Kepler's data and they've found 18 small planets that are about the size of Earth. This is significant.

"Our new algorithm helps to draw a more realistic picture of the exoplanet population in space."

Michael Hippke, Sonneberg Observatory.

In case you're not familiar with planet-hunting techniques, and the Kepler spacecraft specifically, it used what's called the "transit method" of finding planets. Each time a planet passes in front of its star, that's called a transit. Kepler was finely-tuned to detect the drop in starlight caused by an exoplanet's transit.

The drop in starlight is miniscule, and very hard to detect. But Kepler was built for the purpose. The Kepler spacecraft, in combination with follow-up observations with other telescopes, could also determine the size of the planet, and even get an indication of the planet's density and other characteristics.



As the planet moves in front of its star, the star's luminosity dips, and then returns to its former level when the transit is complete. Image Credit: *NASA, ESA, G. Bacon (STSci)*

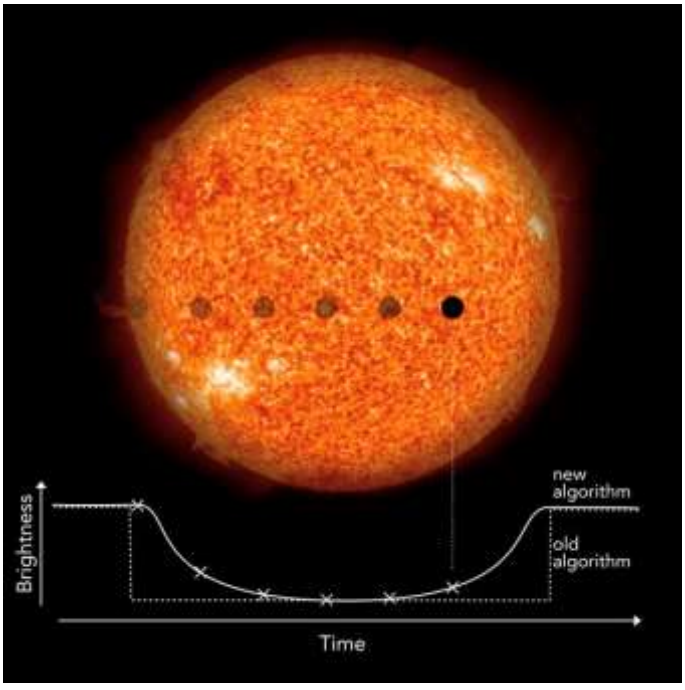
Scientists strongly suspected that the Kepler data was not representative of the population of exoplanets because of the sampling bias. It all comes down to the specifics of how Kepler uses the transit method to find exoplanets.

Since Kepler examined over 200,000 stars to detect dips in starlight caused by transiting exoplanets, much of the analysis of the Kepler data had to be done by computers. (There aren't enough impoverished astronomy grad students in the world to do the work.) So scientists relied on algorithms to comb the Kepler data for transits.

"Standard search algorithms attempt to identify sudden drops in brightness," explains Dr. René Heller from MPS, first author of the current publications. "In reality, however, a stellar disk appears slightly darker at the edge than in the center. When a planet moves in front of a star, it therefore initially blocks less starlight than at the mid-time of the transit. The maximum dimming of the star occurs in the center of the transit just before the star becomes gradually brighter again," he explains.

Here's where exoplanet detection gets tricky. Not only does a larger planet cause a greater drop in brightness than a smaller planet, but a star's brightness naturally fluctuates too, making smaller planets even harder to detect.

The trick for Heller and the team of astronomers was to develop a different or perhaps "smarter" algorithm that takes into account the light curve of a star. To an observer like Kepler, the middle of the star is the brightest, and large planets cause a very distinct, quick dimming of the light. But what about on the edge, or limb, of a star. Was it possible that transits of smaller planets were going undetected in that dimmer light?



The new algorithm from Heller, Rodenbeck, and Hippke does not search for abrupt drops in brightness like previous standard algorithms, but for the characteristic, gradual dimming and recovery. This makes the new transit search algorithm much more sensitive to small

planets the size of the Earth. Image Credit: NASA/SDO (Sun), MPS/René Heller

By improving the sensitivity of the search algorithm, the team was able to answer that question with a convincing "yes."

"In most of the planetary systems that we studied, the new planets are the smallest."

Kai Rodenbeck, University of Gottingen, MPS.

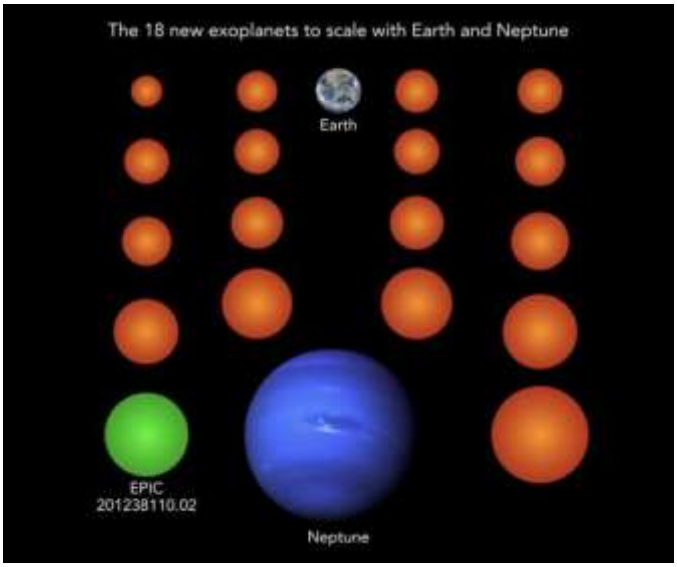
"Our new algorithm helps to draw a more realistic picture of the exoplanet population in space," summarizes Michael Hippke of Sonneberg Observatory. "This method constitutes a significant step forward, especially in the search for Earth-like planets."

The result? "In most of the planetary systems that we studied, the new planets are the smallest," said co-author Kai Rodenbeck of the University of Göttingen and Max Planck Institute for Solar System Research. Not only did they find an additional 18 Earth-sized planets, but they found the smallest exoplanet yet, only 69% the size of the Earth. And the largest of the 18 is barely twice the size of Earth. This is in sharp contrast to most of the exoplanets found by Kepler, which are in the size range of Jupiter and Saturn. Not only are these new planets small, but they're closer to their stars than their previously-discovered siblings. So not only is the new algorithm giving us a more accurate picture of exoplanets populations by size, it's also giving us a clearer picture of their orbits.

Due to their proximity to their stars, most of these planets are scorchers with surface temperatures in excess of 100 Celsius, and some exceeding 1,000 Celsius. But there's one exception: one of them orbits a red dwarf star and appears to be in the habitable zone, where liquid water may persist.

There may be more smaller exoplanets hidden in the Kepler data. So far, Heller and his team have only used their new technique on some of the stars examined by Kepler. They focused on just over 500 Kepler stars that were already known to host exoplanets. What will they find if they examine the other 200,000 stars?

It's a scientific fact that each method of measuring something has an inherent sampling bias. It's one of the constraints in any scientific study. The team behind this new exoplanet algorithm fully acknowledges that their method may also contain a sampling bias.



Almost all known exoplanets are larger than Earth and typically as large as the gas planet Neptune. The 18 newly discovered planets (here in orange and green), for comparison, are much smaller than Neptune, three of them even smaller than Earth and two more as large as Earth. Planet EPIC 201238110.02 is the only one of the new planets cool enough to potentially host liquid water on its surface. Image Credit: NASA/JPL (Neptune), NASA/NOAA/GSFC/Suomi NPP/VIIRS/Norman Kuring (Earth), MPS/René Heller

Smaller planets at more distant orbits can have very long orbital periods. In our Solar System, Pluto takes 248 years to complete one orbit around the Sun. To detect a planet like that, it may take up to 248 years of observation before we detected a transit.

Even so, they project that they will find more than 100 other Earth-sized exoplanets in the rest of the Kepler data. That's quite a few, but might be a modest estimate, considering that the Kepler data covers over 200,000 stars.

The strength of the new search algorithm will extend beyond the Kepler data. According to Prof. Dr. Laurent Gizon, Managing Director at the MPS, future planet-hunting missions can also use it to refine their results. "This new method is also particularly useful to prepare for the upcoming PLATO (PLAnetary Transits and Oscillations of stars) mission to be launched in 2026 by the European Space Agency", said Prof. Gizon.

The team published their results in the journal Astronomy and Astrophysics. Their paper is titled "Transit least-squares survey. II. Discovery and validation of 17 new sub- to super-Earth-sized planets in multi-planet systems from K2."

Different Conditions From Earth Drive the Movement of Sand Dunes on Mars

Mars is a sandy planet and the HiRISE camera on the Mars Reconnaissance Orbiter (MRO) has given us tons of beautiful pictures of Martian sand dunes. But Mars' dunes are much different than dunes here on Earth. Their movement is governed by different factors than Earth dunes.

The movement of sand dunes on Mars is of interests to scientists. How far the winds move them, and where they're deposited, are some of the important questions. The study of all dune processes contribute to atmospheric and sedimentary science.

"This work could not have been done without HiRISE."

Matthew Chojnacki, Lead Author, University of Arizona.

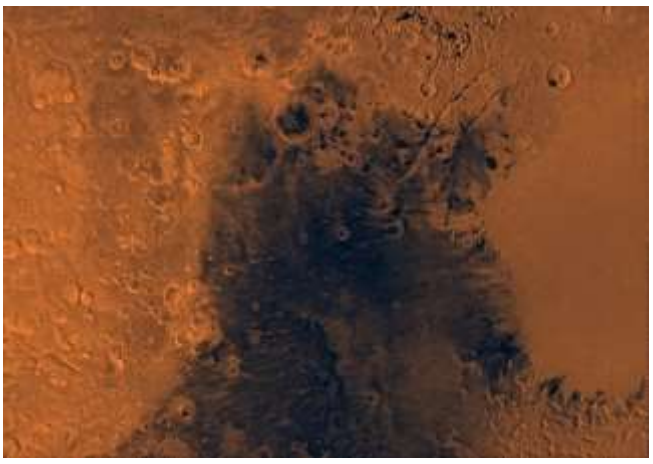
A team of planetary scientists at the University of Arizona Planetary Sciences Lab performed a detailed analysis of sand dunes on Mars. Matthew Chojnacki, associate scientist at the U of A, led the study, which was published in the journal Geology. The paper is called "Boundary condition controls on the high-sand-flux regions of Mars."

The study found that large-scale features on Mars, and the temperature differences of landforms, play a strong role in Martian dunes. The same is not true here on Earth.

The Victoria Crater on Mars. NASA's MRO has been delighting us with images of dune-filled craters for years now. HiRISE images from the MRO allowed the authors to study Martian dunes and how they move. Image Credit: By NASA/JPL/University of Arizona – http://photojournal.jpl.nasa.gov/catalog/PIA08813, Public Domain, https://commons.wikimedia.org/w/

index.php?curid=4211043
The team focused their efforts on regions of Mars with large sand dunes. “Because there are large sand dunes found in distinct regions of Mars, those are good places to look for changes,” said Chojnacki.
“We wanted to know: Is the movement of sand uniform across the planet, or is it enhanced in some regions over others?” Chojnacki said. “We measured the rate and volume at which dunes are moving on Mars.” The researchers mapped sand volumes, dune migration rates and heights for 54 dune fields, encompassing 495 individual dunes.
“We have a smal

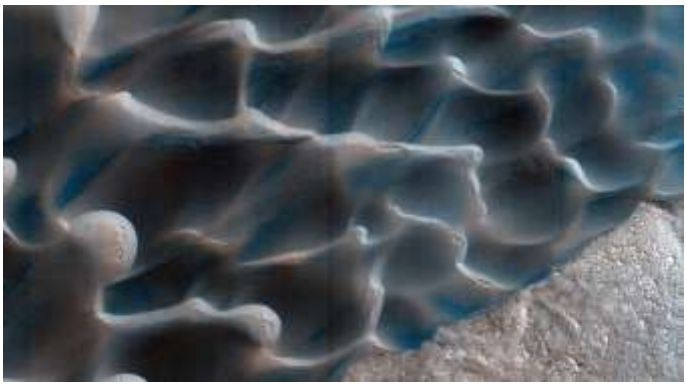
l army of undergraduate students…”
Matthew Chojnacki, University of Arizona
The team relied on HiRISE (High Resolution Imaging Science Experiment) to study the dunes. HiRISE is on the Mars Reconnaissance Orbiter. It’s mapped about 3% of the Martian surface in high-resolution images.
“This work could not have been done without HiRISE,” said Chojnacki, who is a member of the HiRISE team. “The data did not come just from the images, but was derived through our photogrammetry lab that I co-manage with Sarah Sutton. We have a small army of undergraduate students who work part time and build these digital terrain models that provide fine-scale topography.”



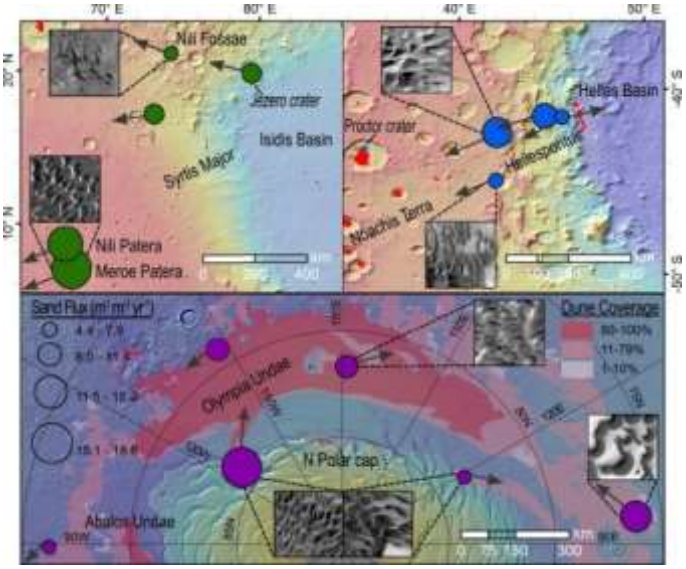
The Syrtis Major region on Mars is one of the three areas on Mars with the largest dune movement. Image Credit: By NASA – http://photojournal.jpl.nasa.gov/catalog/PIA00173, via en:Image:Syrtis Major MC-13.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=978884
What did they find?
“On Earth, the factors at work are different from Mars.” **Matthew Chojnacki, Lead Author, University of Arizona**
In this study, the team found observed dunes that ranged from 2 meters to 122 meters tall (6 to 400 feet). The dune movement was clocked at about 0.6 (2 ft) per Earth year. This is in stark contract to dunes on Earth. Some of the fastest-moving dunes on Earth are in North Africa and move at about 30.5 meters (100 ft.) per year.
Planetary scientists have debated the nature of Martian dunes, wondering if they’re relics from the ancient past, or if they’re still being actively created and moved around the surface. Now we know. Mars may be a lazy planet in terms of dune movement, but it’s still active.
On Mars, the atmosphere is much thinner than here on Earth, and that’s key to understanding these results. Basically, the wind isn’t powerful enough to move sand dunes the same way it does on Earth. There must be other factors.
Across Mars, the survey found active, wind-shaped beds of sand and dust in structural fossae – craters, canyons, rifts and cracks – as well as volcanic remnants, polar basins and plains surrounding craters.

The Hellespontus Montes is one of the three areas with the largest sand movement. Image Credit: By European Space Agency – Perspective view of Hellespontus Montes, CC BY-SA 3.0-igo, https://commons.wikimedia.org/w/index.php?curid=37364167
But it also found, surprisingly, that the largest movements of sand are near three distinct landforms: Syrtis

Major, Hellespontus Montes, and the North Polar Erg.
Syrtis Major is a dark spot on Mars called an albedo feature. It's just west of the Isidis Impact Basin. It's dark because of the basaltic rock in the region and the lack of sand cover. The authors say that sand movement here is strongly influenced by the nearby Isidis Basin, which is 4 to 5 km deep.
Hellespontus Montes is a mountain range 711 km long, running roughly north-south. It's also an albedo feature. It's located in the Noachus Triangle. The team found that seasonal CO2 volatility played a role in dune formation here.
The North Polar Erg is a sand sea high in the northern latitudes. It's also known as the Vastitas Borealis. It encircles the entire polar region. The North Polar Erg is the most active dune region on Mars. The team found that seasonal CO2 contributes to the movement here. The sand is largely locked in place when the CO2 is frozen, and then the melt contributes to sand movement, largely due to the lowered albedo.

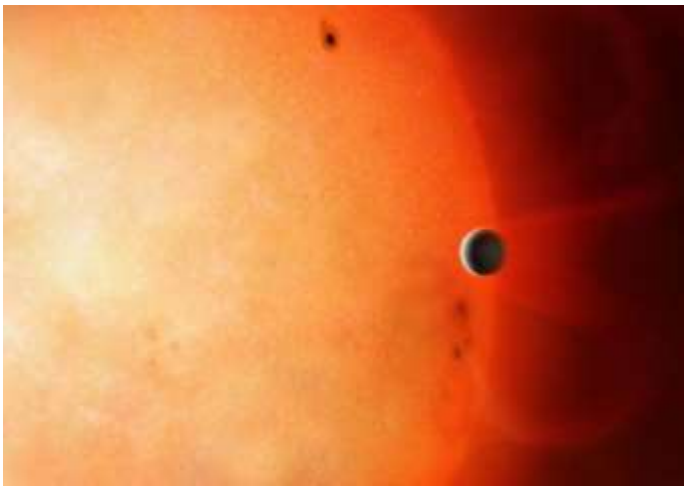


Dunes in the North Polar Erg. An erg is a sand sea, and this region is one of the three regions with the largest movement of sand. Image Credit: NASA/JPL/University of Arizona
Why did these three large regions see the greatest dune movement? What sets them apart? Stark transitions in geography, for one thing. Also, surface temperatures. On Earth, neither of these factors shapes sand dune movement.
"Those are not factors you would find in terrestrial geology," Chojnacki said. "On Earth, the factors at work are different from Mars. For example, ground water near the surface or plants growing in the area retard dune sand movement."



The team concluded that large transitions in geological formations shapes Martian sand dune migration. It's aided by temperature changes near albedo features like Syrtis Major.
The team also found that sand movement is greater near small basins filled with bright dust. "A bright basin reflects the sunlight and heats up the air above much more quickly than the surrounding areas, where the ground is dark," Chojnacki said, "so the air will move up the basin toward the basin rim, driving the wind, and with it, the sand.
This study makes it clear that "large-scale topographic and thermophysical variabilities play a leading role in driving sand fluxes on Mars," as the authors say in their paper. The authors also say that the results of this study will help in the planning of future missions to areas that aren't easily monitored and may have implications for studying ancient potentially habitable sites.

A Very Rare Planet Discovered. Less Massive than Neptune, Hotter than Mercury. Very Few Should Exist

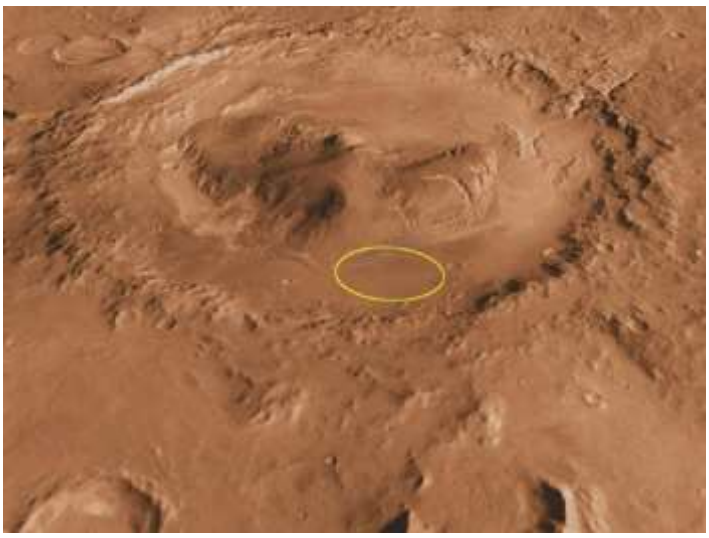


Astronomers have discovered a very rare, very unusual planet in a distant solar system. The planet, called NGTS-4b, is three times the size of Earth, and about 20% smaller than Neptune. It's hotter than our very own Mercury. At about 1,000 degrees Celsius, it would be the hottest planet if it were in our Solar System.
But what really separates this planet is its location. It's located in what's called the Neptunian Desert.

Curiosity has Found the Mother Lode of Clay on the Surface of Mars

Clay is a big deal on Mars because it often forms in contact with water. Find clay, and you've usually found evidence of water. And the nature, history, and current water budget on Mars are all important to understanding that planet, and if it ever supported life.
Right now, MSL Curiosity is at Mt. Sharp inspecting rocks for clay. Orbiters were the first to find evidence of clay at Mt. Sharp. When NASA chose Gale Crater as MSL Curiosity's landing site, the clay at Mt. Sharp inside the crater was one of the objectives. Now Curiosity has sampled two of the rocks in what NASA's calling the 'clay-bearing unit' and they've confirmed the presence of clay.

In fact, the two rocks show the highest concentrations of clay that Curiosity has found so far. The rocks are called "Aberlady" and "Kilmarie." They're located at the lower part of Mt. Sharp, which is the mission's primary objective.

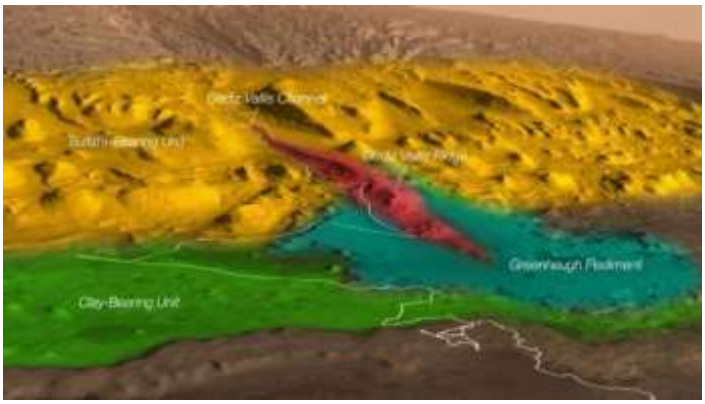


An oblique image of Mt. Sharp inside Gale Crater on Mars. The yellow ellipse is Curiosity's landing spot. Image Credit: NASA/JPL

Mt. Sharp rises 5.5 km (18,000 ft.) above the crater floor, meaning it is an accessible, layered record of Martian geology. Over time, wind has exposed its different layers, making them easy targets for Curiosity's drill.

Scientists are interested in Mt. Sharp, also called Aeolis Mons, because of how they think it formed. Gale Crater is an ancient impact crater that was likely filled with water, and they think that Mt. Sharp formed over a time period of two billion years, as sediment was deposited at the bottom of the lake. It's possible that at one time the entire crater was filled with sediment, which gradually eroded, leaving Mt. Sharp behind.

There's some uncertainty around the timeline of Mt. Sharp's formation, which is one of the things MSL Curiosity hopes to uncover. In any case, Mt. Sharp itself appears to be an eroded mountain of sediment, and as Curiosity continues its work, scientists may finally get a clearer picture of how exactly it formed.



A coloured, annotated map of Mt. Sharp and a proposed route through the different regions scientists would like to explore with MSL Curiosity. Currently, the rover is exploring the Clay-Bearing Unit. The goal is to explore all these regions to learn about how Mars dried up over time, and how that may have affected its ability to support life. Image Credit: NASA/JPL-Caltech/ESA/Univ. of Arizona/JHUAPL/MSSS/USGS Astrogeology Science Center

Curiosity's new findings show that there was once an abundance of water in Gale Crater, as expected. But other than that, the details are still to be determined. It seems that these clay-rich rocks at the lower range of the mountain formed as sediment at the bottom of a lake. Over geological time periods, water and sediment interact to form clays.

Finding specific types of clays at specific layers tells scientists about the timeline of Martian water. We know that the mountain has different layers containing different minerals. As mentioned, the lower layers contain clays, but above that are layers containing sulfur, and above that are layers containing oxygen-bearing minerals. The sulfur indicates that the area dried out, or the water became more acidic.

Gale crater also contains a river channel called Gediz Vallis Channel, which formed after the clay and sulfur layers. That channel is also a piece of the puzzle, and Curiosity's task is to continue its way up Mt. Sharp, sampling as it goes, and fill in the picture of the mountain's geology and history. By extension, we'll learn something about Martian history.

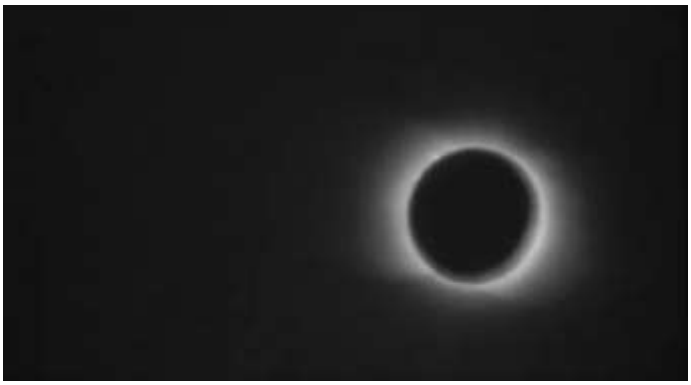
Layers at the base of Mt. Sharp. These visible layers in Gale Crater show the chapters of the geological history of Mars in this image from NASA's Curiosity rover. The image shows the base of Mount Sharp, the rover's eventual science destination, and was taken with Curiosity's Mast Camera on Aug. 23, 2012. Credit: NASA/JPL-Caltech/MSSS.

Curiosity will also give us a much more detailed view of the clay-bearing unit than orbiter's gave us. Orbital readings couldn't say for sure if the clay it sensed was in the bedrock of the mountain, or if it was from eroded pebbles and rocks that had eroded out of the upper layers of the mountain and tumbled down to the floor of the crater. Curiosity has clarified that to some degree, with the discovery of clay in Aberlady and Kilmarlie, but there's still lots of work to do.

"Each layer of this mountain is a puzzle piece," said Curiosity Project Scientist Ashwin Vasavada of JPL. "They each hold clues to a different era in Martian history."

Curiosity is doing a fine job of piecing it all together.

The First-Ever Film of a Total Solar Eclipse – in 1900 – was Just Discovered and Restored



The first film of a total solar eclipse has been restored by specialists at the British Film Institute (BFI) and made available for viewing. The film was taken in North

Caroline in 1900 by Nevil Maskelyne. Maskelyne was a British man who was a magician turned film-maker. He took the film as part of a Royal Astronomical Society (RAS) expedition.

Rovers on Mars should be searching for rocks that look like pasta – they're almost certainly created by life

According to a new NASA-funded study that appeared in *Astrobiology*, the next missions to Mars should be on the lookout for rocks that look like "fettuccine". The reason for this, according to the research team, is that the formation of these types of rocks is controlled by a form of ancient and hardy bacteria here on Earth that are able to thrive in conditions similar to what Mars experiences today.
This bacteria is known as *Sulfurihydrogenibium yellowstonense*, which belongs to a lineage that evolved over 2.35 billion years ago, a time that coincides with the earlier portion of the Great Oxygenation Event. Using sulfur and carbon dioxide as energy sources, this hardy bacteria thrives in heat and extremely low oxygen environments and can withstand exposure to ultraviolet light.
In hot springs, the microbe assembles itself into strands and promotes the crystallization of calcium carbonate rock (aka. travertine), which is what gives it its "pasta-like" appearance. This behavior makes it relatively easy to detect when conducting geological surveys and would make it easy to identify when searching for signs of life on other planets.

Sufuri Fieldshot at Yellowstone National Park. Credit: Bruce Fouke.
Bruce Fouke, a professor of geology and an affiliate professor with the Carl R. Woese Institute for Genomic Biology (IGB) at the University of Illinois, was also the lead researcher on the study. "It has an unusual name, Sulfurihydrogenibium yellowstonense," he said in an interview with the Illinois News Bureau. "We just call it 'Sulfuri… Taken together, these traits make it a prime candidate for colonizing Mars and other planets."

The unique-shape and structure of these strands are the result of the environment this bacteria evolved to survive in. Given that they inhabit fast-flowing water, the Sulfuri bacteria form into chains in order to prevent from being washed away. This way, they are able to remain fixed to rock formations and absorb nutrients from the hot springs. As Fouke explained:
"They form tightly wound cables that wave like a flag that is fixed on one end. The waving cables keep other microbes from attaching. Sulfuri also defends itself by oozing a slippery mucus. These Sulfuri cables look amazingly like fettuccine pasta, while further downstream they look more like capellini pasta."
To analyze the bacteria, the researchers collecting samples from Mammoth Hot Springs in Yellowstone National Park, using sterilized pasta forks (of all things!) The team then studies the microbial genomes to evaluate which genes were being actively transplanted into proteins, which allowed them to discern the organism's metabolic needs.

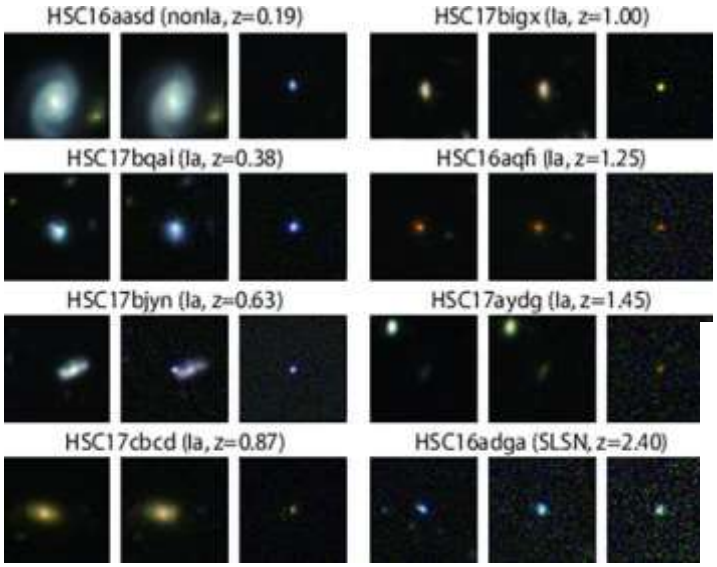
Close up of Sufuri bacteria and the strands they form at Yellowstone National Park. Photo by Bruce Fouke.
The team also examined the bacteria's rock-building capabilities and found that proteins on the bacterial surface dramatically increase the rate at which calcium carbonate crystallizes in and around the strands. In fact, they determined that these proteins cause crystallization at a rate that is one billion times faster than in any other natural environment on the planet.
As Fouke indicated, this type of bacteria and the resulting rock formations are something Mars rovers should be on the lookout for, as they would be an easily-discernible biosignature:
"This should be an easy form of fossilized life for a rover to detect on other planets. If we see the deposition of this kind of extensive filamentous rock on other planets, we would know it's a fingerprint of life. It's big and it's unique. No other rocks look like this. It would be definitive evidence of the presences of alien microbes."
A little over a year from now, NASA's *Mars 2020* rover will be heading to the Red Planet to carry on in the hunt for life. One of the rover's main objectives will be to collect samples and leave them in a cache for eventual return to Earth. If the rover does come across formations of mineral strands where hot springs were once thought to exist, it is entirely possible that they will contain the fossilized remains of bacteria.

Subaru Telescope Sees 1800 Supernovae

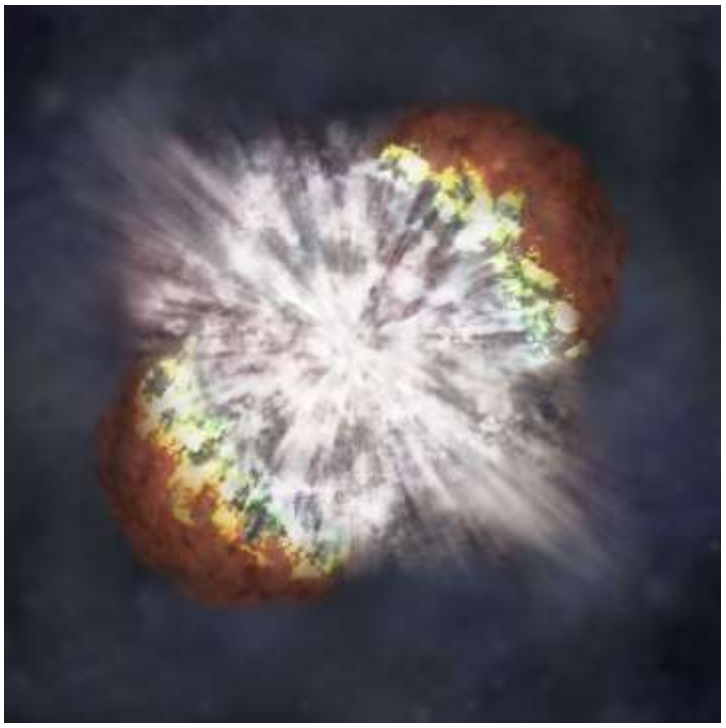
Japanese astronomers have captured images of an astonishing 1800 supernovae. 58 of these supernovae are the scientifically-important Type 1a supernovae located 8 billion light years away. Type 1a

supernovae are known as ‘standard candles’ in astronomy.
The team of astronomers used the Subaru Telescope and one of the world’s most powerful digital cameras to find these supernovae. The astronomers come from the Kavli Institute for the Physics and Mathematics of the Universe (IPMU), Tohoku University, Konan University, the National Astronomical Observatory of Japan, and other institutions. The team was led by Professor Naoki Yasuda of the IPMU, and their results were published online at Publications of the Astronomical Society of Japan.

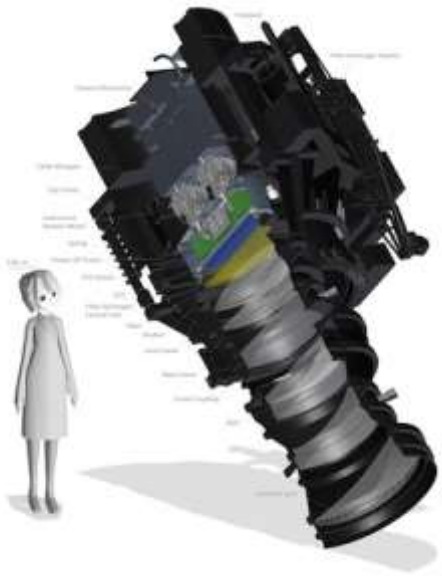
A supernova is a star that has reached the end of its life and exploded brilliantly. Supernovae brighten the sky for up to six months, and can outshine their host galaxy. These type 1a supernovae, or standard candles, are particularly useful because of their steady light. Since their light doesn’t fluctuate much, they are ideal for accurately measuring their distance from Earth. Standard candles are used to measure the expansion rate of the universe.



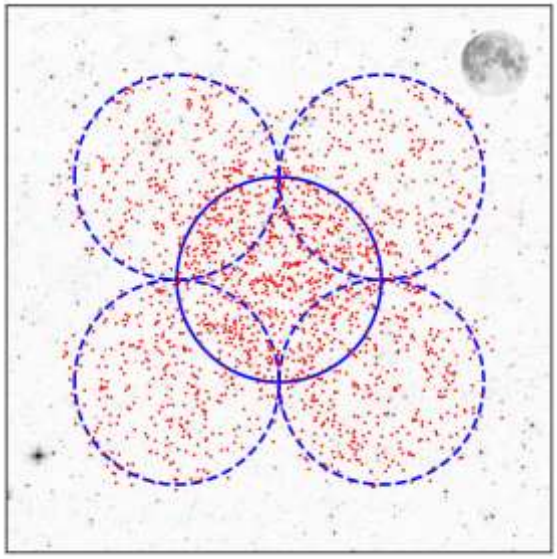
This image shows some of the supernovae imaged in the study. On the left is the star before it exploded, center is after it exploded, and the right is the supernovae itself (difference of the first two images.) Image Credit: N. Yasuda et. al.
Even though the team found 1800 supernovae, of which 58 were standard candles, they were actually looking for something more elusive.
In recent years astronomers have reported another type of supernova even brighter than Type 1a. These are called Super Luminous Supernovae because they’re so bright. They can be up to 10 times brighter than other supernovae, and their extreme brightness allows astronomers to spot them at extreme distances.
This is important, because when astronomers look at objects in the extreme distant universe, they’re seeing the light that left them billions of years ago. So in that way, astronomers are looking back in time to the early days of the universe. They can look back at the conditions in the early universe that allowed these first, massive stars to form.



An artist’s impression of a Super Luminous Supernova (SN 2006gy, not a part of this study.) Image Credit: By Credit: NASA/CXC/M.Weiss – http://chandra.harvard.edu/photo/2007/sn2006gy/more.html#sn2006gy_xray, Public Domain, https://commons.wikimedia.org/w/index.php?curid=2080784
Even though this survey found 1800 supernovae, they are still rare events. And there are only a handful of telescopes that can capture sharp images of them. This effort by the Japanese team used one of those ‘scopes, the Subaru Telescope, and combined it with one of the world’s best digital cameras to find these supernovae.
The camera is the Hyper Suprime-Cam (HSC). It’s a gigantic camera larger than a human and it’s attached to the 8.2 meter Subaru Telescope at Maunakea Hawaii. The Hyper Suprime-Cam boasts a whopping 870 megapixels.

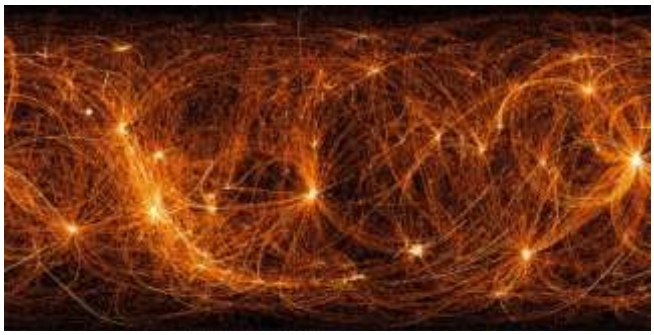


An illustration of the Hyper Suprime-Cam with a human figure next to it for scale. Image Credit: National Astronomical Observatory of Japan.
Over a six month period, Professor Yasuda and his team took repeated images of the same areas of the night sky. By looking for stars that appeared suddenly brighter before fading out, they were able to identify the supernovae.



This map of the sky shows all of the 1800 supernovae discovered in this survey. Each red dot is a supernova. The blue circles are the areas Hyper Suprime-Cam was able to capture in one shot. The background is an image from the Sloan Digital Sky Survey. The Moon is shown to indicate the area of night sky that the HSC can capture. Image Credit: Kavli IPMU, Partial data supplied by: SDSS
Overall, the team found 1800 supernovae, an astonishing number. (Compare that to the Hubble Space Telescope, which took 10 years to discover 50 supernovae greater than 8 billion light years from Earth.) Of those, 400 were the desirable Type 1a supernovae, with 58 of them over 8 billion light years from Earth. Even more remarkable, they identified 5 super luminous supernovae.
“The Subaru Telescope and Hyper Suprime-Cam have already helped researchers create a 3D map of dark matter, and observation of primordial black holes, but now this result proves that this instrument has a very high capability finding supernovae very, very far away from Earth. I want to thank all of my collaborators for their time and effort, and look forward to analyzing our data to see what kind of picture of the Universe it holds,” said Yasuda.
Determining the expansion rate of the universe is one of the over-arching goals in astronomy and cosmology. The supernova data from this study will help astronomers refine their estimate of that rate, and will also help them understand dark energy, the mysterious force that drives the expansion.

NASA is building up a map of the entire sky seen in X-rays, line by line with its NICER experiment



In June of 2017, NASA’s Neutron Star Interior Composition Explorer (NICER) was installed aboard the International Space Station (ISS). The purpose of this instrument is to provide high-precision measurements of neutron stars and other super-dense objects that are on the verge of collapsing into black holes. NICER is also be the first instrument designed to test technology that will use pulsars as navigation beacons.

Recently, NASA used data obtained from NICER’s first 22 months of science operations to create an x-ray map of the entire sky. What resulted was a lovely image that looks like a long-exposure image of fire dancers, solar flare activity from hundreds of stars, or even a visualization of the world wide web. But in fact, each bright spot represents an x-ray source while the bright filaments are their paths across the night sky.

E Mails Viewings Logs and Images from Members.

Hi Andy,
Here are my submission for the WAS May 2019 Newsletter.
First:

Sunspots AR2740 and AR2741. 10th May
Canon SX50HS, 1200mm (50x Optical), ISO 100, F8, 1/1600 sec
Second:

Jupiter rising over the left flank of Silbury Hill and Antares sitting on top. Spica is visible on the top right of the image. The scene was illuminated by a 70% waxing gibbous Moon. I assume the background glow is from the lights of Marlborough.
This was a try out of my new Samyang F2.8 14mm lens to get the ground as a daylight image with the night sky as background. It is not a day shot merged with a night shot. As my 1300D is APS-C the focal length on the camera is approx. 22mm but if I do manage to get a full frame in the future it will work on that as well.
While taking the images is was quite spooky hearing the Avebury church clock strike twelve midnight!
14th May at 00:40.
Canon 1300D, Samyang 14mm (effective focal length 22mm), ISO 1600, F2.8, 30 sec. Post processed with Canon DPP.

Clear Skies,
John Dartnell

Hi Andy,

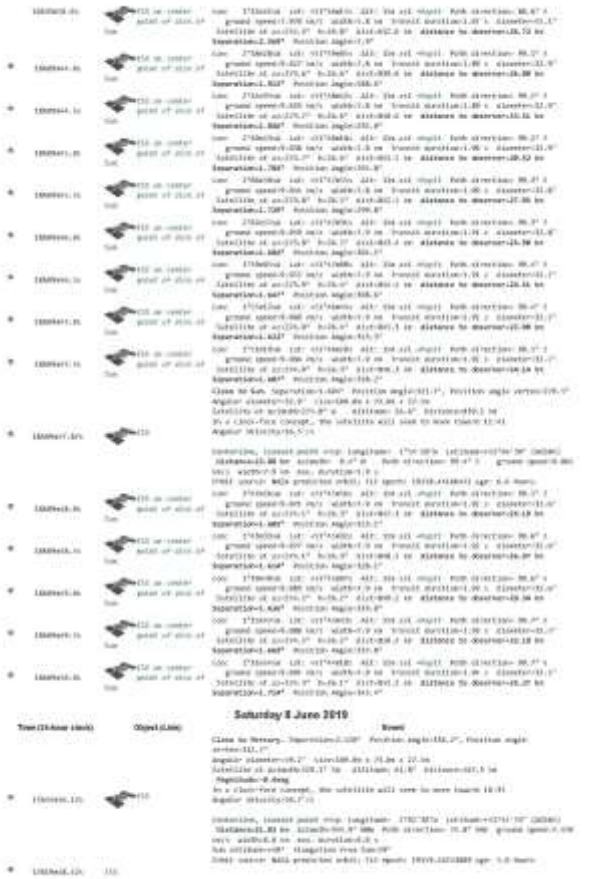
Re your post there are several ISS Solar Passes this week in the vicinity - 4th, 5th, 6th and 7th - assuming I set up calc sky correctly!

The 5th June tracks across Avebury area but the weather forecast is not great.

Please see attached.

Clear Skies,

John Dartnell



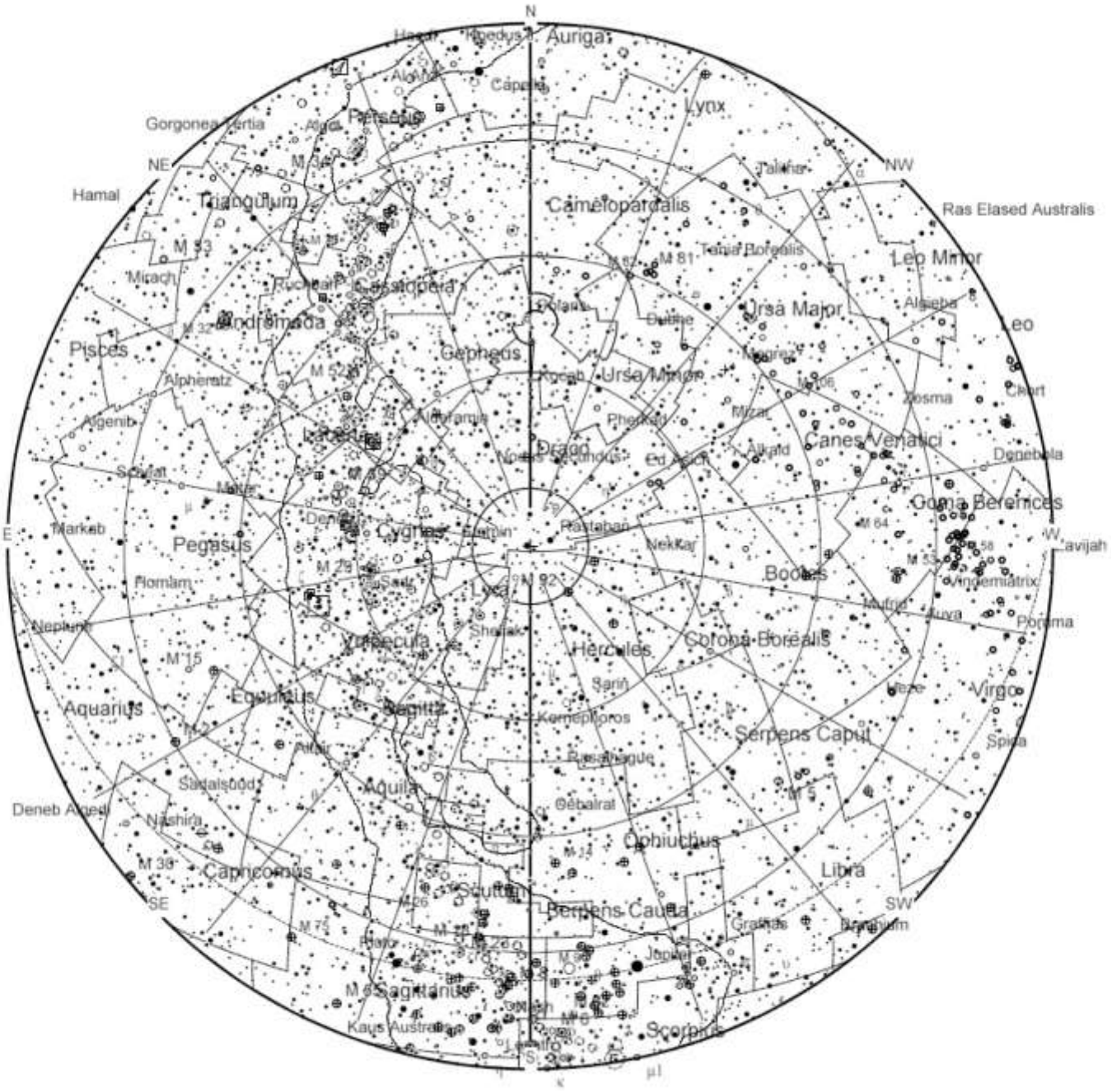


CHART
This is the sky chart for 30 July at 10:30pm. It shows the planets of Jupiter and Saturn surrounding the central Milky Way running through due south. A great time to image the Milky Way running up from due south… find an interesting landmark and image widefield.

June 3 - **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 10:02 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 - **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.
June 17 - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 08:31 UTC. This full moon was known by early Native American tribes as the Full 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 Full Rose Moon and the Full Honey Moon.
June 21 - **June Solstice.** The June solstice occurs at 15:54 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 23 - **Mercury at Greatest Eastern Elongation.**

The planet Mercury reaches greatest eastern elongation of 25.2 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the evening sky. Look for the planet low in the western sky just after sunset.
July 2 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 19:16 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 2 - **Total Solar Eclipse.** A total solar eclipse occurs when the moon completely blocks the Sun, revealing the Sun's beautiful outer atmosphere known as the corona. The path of totality will only be visible in parts of the southern pacific Ocean, central Chile, and central Argentina. A partial eclipse will be visible in most parts of the southern Pacific Ocean and western South America. (**NASA Map and Eclipse Information**)
(**NASA Interactive Google Map**)
July 9 - **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.
July 16 - **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 21:38 UTC. This full moon was known by early Native American tribes as the Full 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 Full Thunder Moon and the Full Hay Moon.
July 16 - **Partial Lunar Eclipse.** A partial lunar eclipse occurs when the Moon passes through the Earth's partial shadow, or penumbra, and only a portion of it passes through the darkest shadow, or umbra. During this type of eclipse a part of the Moon will darken as it moves through the Earth's shadow. The eclipse will be visible throughout most of Europe, Africa, central Asia, and the Indian Ocean. (**NASA Map and Eclipse Information**)
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 waning crescent moon will not be too much of a problem this year. The skies should be dark enough for what could be a good show. 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 1 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 03:12 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 9 - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 19.0 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.
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 nearly full moon will block out most of the fainter meteors this year, but the Perseids are so bright and numerous that it could still be a good 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 15 - **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 12:30 UTC. This full moon was known by early Native American tribes as the Full 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.
August 30 - **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 10:37 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.

When the Eclipse Happens Worldwide — Timeline

Lunar eclipses can be visible from everywhere on the night side of the Earth, if the sky is clear. From some places, the entire eclipse will be visible, while in other areas the Moon will rise or set during the eclipse.

Penumbral Eclipse begins	16 Jul, 18:43:51	16 Jul, 19:43:51	No, below the horizon
Partial Eclipse begins	16 Jul, 20:01:43	16 Jul, 21:01:43	No, below the horizon
Maximum Eclipse	16 Jul, 21:30:44	16 Jul, 22:30:44	Yes
Partial Eclipse ends	16 Jul, 22:59:39	16 Jul, 23:59:39	Yes
Penumbral Eclipse ends	17 Jul, 00:17:38	17 Jul, 01:17:38	Yes

Eclipse calculations usually accurate to a few seconds.

The magnitude of the eclipse is 0.653.

The penumbral magnitude of the eclipse is 1.704.

The total duration of the eclipse is 5 hours, 34 minutes.

The duration of the partial eclipse is 2 hours, 58 minutes.

CONSTELLATIONS OF THE MONTH: OPHIUCHUS

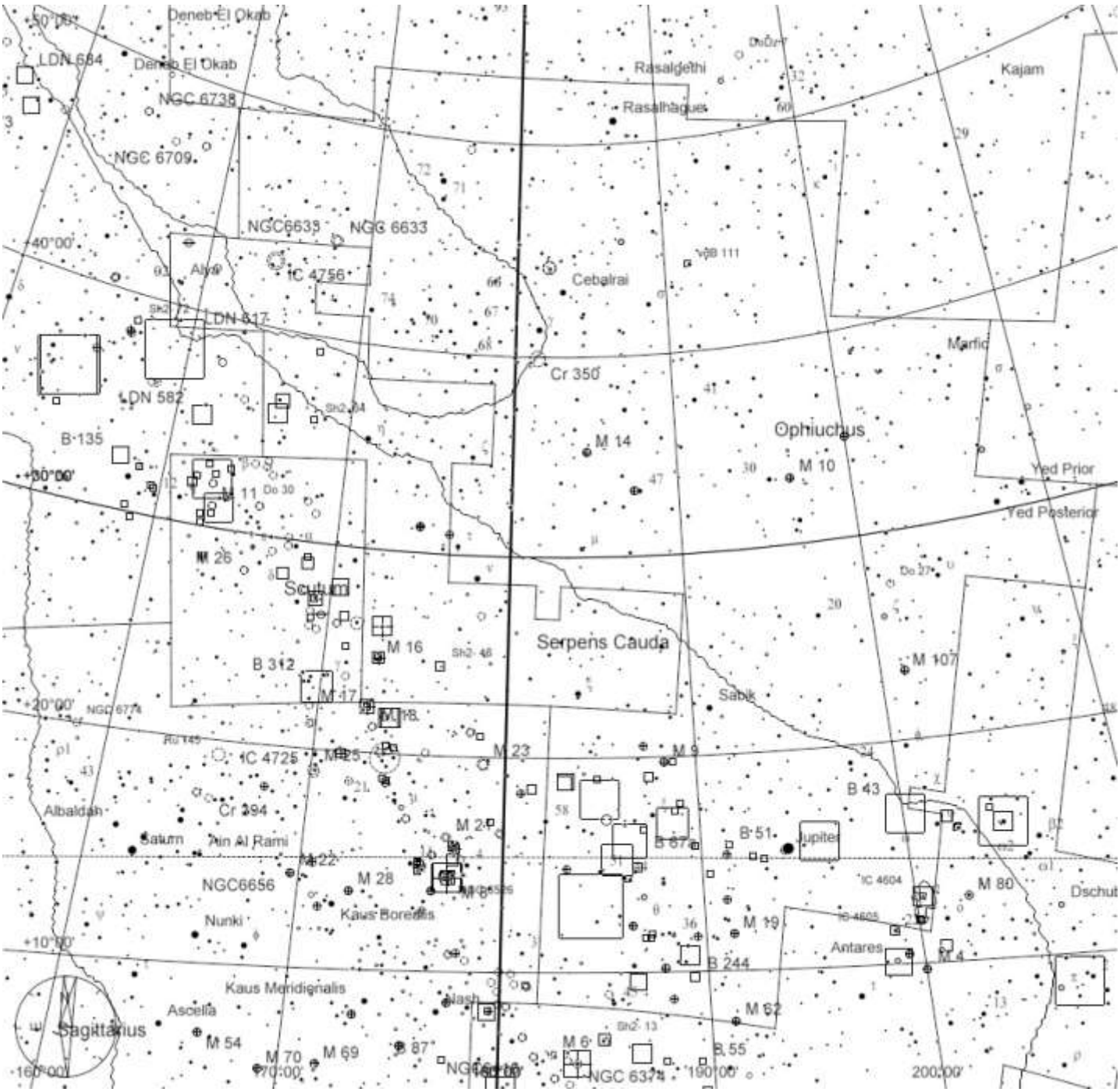


Chart: 30th July 2019, 22:30 BST, Cartes de Ciel.
Note that Jupiter is in Ophiuchus, and Saturn is across the Milky Way lanes in Sagittarius.

The sprawling constellation of Ophiuchus sits on the celestial equator and was one of the 48 original constellations charted by Ptolemy and later adopted by the IAU. Of the 13 zodiacal constellations (constellations through which the Sun passes during the course of the year), Ophiuchus is the only one not designated as an astrological sign. It covers 948 square degrees of sky and ranks 11th in size. Ophiuchus contains 10 main stars in its asterism and has 62 Bayer Flamsteed designated stars within its confines. Ophiuchus is bordered by the constellations of Hercules, Serpens Caput, Libra, Scorpius, Sagittarius, Serpens Cauda and Aquila. It is visible to all observers at latitudes between +80° and ?80° and is best seen at culmination during the month of July.

There is one well documented annual meteor shower associated with the constellation of Ophiuchus which peaks on or about June 20 of each year – the Ophiuchids. The radiant – or point of origin – for this meteor shower is near Sagittarius border. The fall rate varies from average 8 to 20 meteors per hour, with occasionally many more. Watching on a Moonless night when the constellation is at its highest will greatly improve the amount of meteors you see!

At one time, the constellation of Ophiuchus was referred to as “Serpentarius”, whose name literally meant the “serpent bearer”. In most mythology representations, you’ll see Ophiuchus represented as a man grappling with a large snake; his body representing the division of the snake “Serpens” into two parts – Serpens Caput and Serpens Cauda. Even though divided by Ophiuchus, they still are only one constellation. It is possible the mythological figure could represent the healer As-

clepius, placed close to Chirion (Sagittarius), his mentor. The man could also be the Trojan priest Laocoön, who was killed by a pair of sea serpents after warning about the Trojan Horse. It could even be Apollo wrestling with the Python to take control of the oracle at Delphi…. But no matter which figure you choose, this huge constellation holds a vast number of deep sky riches just waiting to be explored!

Let's begin our binocular tour of Ophiuchus with its brightest star – Alpha – the "a" symbol on our map. Located about 47 light years distant from Earth, Rasalhague is an A-type giant star that's recently exhausted its core hydrogen reserves. But, "the Head of the Serpent Collector" isn't alone, but Rasalhague is a binary star. Power up in a telescope to look for a faint, very close companion only 0.5″ away.

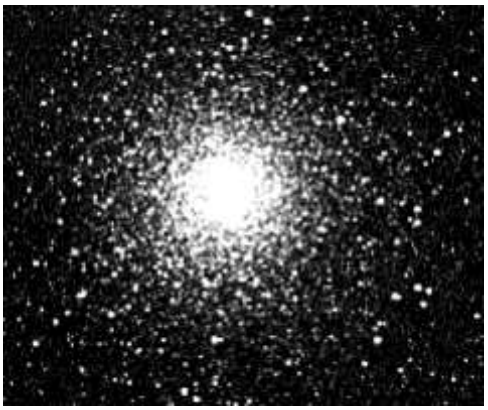
Head on next to Beta Ophiuchi, the "B" symbol on our map. This K-type giant star is located about 82 light years from our solar system and its proper name is Cheleb. Also known as 44 Oph, we have something of a mystery star here. Precise radial velocity measurements taken over 8 consecutive nights in 1992 June and 2 nights in 1989 July revealed the presence of a 0.255 +/- 0.005 day period. A pulsing variable star! It's easy to catch in binoculars, but you might want a telescope for what's nearby…

It's called Barnard's Star and found due east of Beta (RA 17:57:48.5 Dec +04:41:36). Located approximately 6 light-years away from, Barnard's Star is a very low-mass red dwarf star. In 1916, American astronomer E. E. Barnard measured its proper motion as 10.3 arc seconds per year, which remains the largest known proper motion of any star relative to the Sun. Even though it's an ancient star at 7 to 12 billion years old, there are still possibilities of flare events – such as one that occurred in 1998. The flare was surprising because intense stellar activity is not expected around stars of such age.

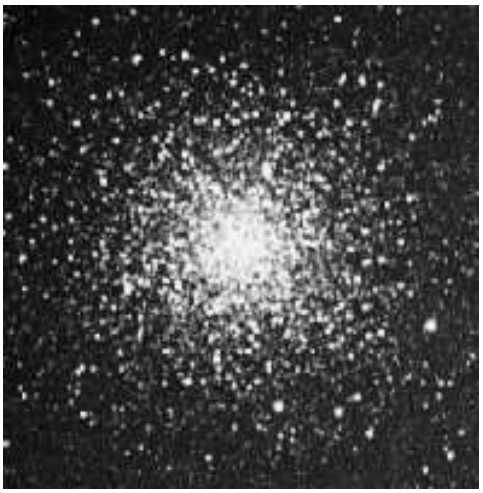
Now have a look at Eta Ophiuchi – the "n" symbol on our map. This time you'll want a telescope because Sabik is a difficult to split binary star system. Here we have two fairly unremarkable A class main sequence stars – close to equal in magnitude and not anything special if taken apart. However, together the Eta binary is strange because they orbit around a common center in a very fast and highly elliptical path.

Now put your binoculars on Deta – the "8" symbol on our map. Known as Yed Prior, you'll quickly notice it is an optical double star with Epsilon whose name is Yed Posterior. Delta Ophiuchi is a red giant star located 170 light years from our solar system, while Epsilon is 108 light years away and a G-class giant star. These two are important, because they'll guide you to our next two objects to the east.

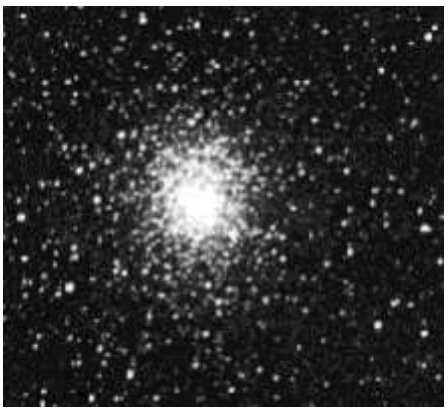
For binoculars and telescopes, it's time to enjoy some of Ophicuhus many Messier Catalog riches and we star with the giant globular clusters, M10 and M12. You'll find Messier 10 located at RA 18:57:0 Dec -04:05:57. Discovered by Charles Messier on May 29, 1764 this awesome globular cluster hangs out about 4,300 light-years and spans about 23 light years of space. You can see it easily



in binoculars, but it will require a telescope to begin resolving stars.



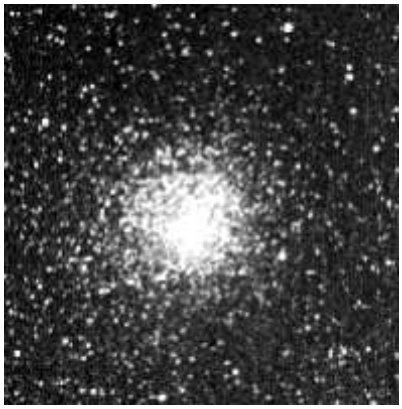
Nearby, Messier 12 (RA 10:47:14 Dec -01:58:52) is also an all instruments type of globular cluster, but with a much looser structure. Why? A study published in 2006 revealed that M12 may have lost as many as one million of its low mass stars to the gravitational influence of the Milky Way!



Large telescopes will love Messier 19 (RA 17:02.6 Dec -26:16). It's one of the most oblate globular clusters in the sky and thanks to the work of Harlow Shapely, we've learned to take a better look, because he estimated there are twice as many stars along M19's major axis than along its minor. This rich, dense globular cluster was one of Charles Messier's original discoveries, but Sir William Herschel was the one to resolve it into "countless stars of mag 14, 15, 16".

Try your hand with Messier 107 (RA 16:32.5 Dec -13:03). This 20,000 light year distant globular cluster is full, too! Discovered by Pierre Méchain in April, 1782 and later added to Messier's catalog by Helen Sayer Hogg, this one is also a resolution delight in larger tele-

scopes. Look for some dark obscured regions. According to SEDS: the star distribution is called “very open” by Kenneth Glyn Jones, who points out that this cluster “enables the interstellar regions to be examined more easily, and globular clusters are important `laboratories’ in which to study the process by which galaxies evolve.”



Don’t forget Messier 63 (RA 17:01.2 Dec -30:07)! It’s another globular cluster whose distortion by our own Milky Way’s influences are easily apparent in a telescope. Thanks to studies by the Chandra X-Ray Observatory, we know it contains a large number of X-ray binaries, proving that M63 has undergone core collapse.
How about Messier 14 (RA 17:37:36.1 Dec -03:14:45). Spanning across 101 light years of space and located about 30,000 light years away, this magnificent globular cluster is often overlooked. Discovered by Charles Messier on June 1, 1764, this bright ball of stars is near magnitude 7 and well within range of binoculars and small telescopes. M14 had a nova occur in 1948, but it wasn’t discovered until 1964 when the photographic plates were being surveyed. It wasn’t done with surprises either… In an area where all stars should be about the same age, a carbon star was discovered in 1997!
For challenging large telescope studies, take a look at three planetary nebulae. NGC 6309 (RA 17:14.1 Dec -12:55) is often referred to as the “Box Nebula”, for its unique structure. Far brighter NGC 6572 (RA 18:12.1 Dec +06:51) has the wonderful nickname of the “Blue Racquetball”. In his observing notes, Walter Scott Houston writes: Walter Scott Houston wrote, “My old 10-inch reflector showed the vivid green color of the object with any power more than 50x. It is interesting to note that older observers have described NGC 6572 as green, while the younger ones tend to call it vivid blue.”. I see blue… Do you? And don’t forget to try NGC 6369 (RA 17:29:20.4 Dec -23:45:35)… the “Little Ghost” is a seasonal favorite!
There’s many, many more wonderful objects just waiting in Ophiuchus for you to explore. Be sure to get a good star chart and you’ll see why the “Serpent Bearer” still stands grasping the stars… There’s so much to do!

ISS PASSES For Summer 2019 From Heavens Above website maintained by Chris Peat

Date	Brightness (mag)	Start			Highest point			End		
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
04 Jul	-2.1	03:50:52	10°	SSW	03:53:29	22°	SE	03:56:06	10°	E
05 Jul	-1.7	03:02:44	13°	SSE	03:03:51	15°	SE	03:05:48	10°	ESE
06 Jul	-3.1	03:47:23	12°	SW	03:50:12	39°	SSE	03:53:19	10°	E
07 Jul	-2.6	02:59:10	21°	S	03:00:27	27°	SSE	03:03:20	10°	E
08 Jul	-2.1	02:10:56	19°	SE	02:10:56	19°	SE	02:13:12	10°	E
08 Jul	-3.7	03:43:43	10°	WSW	03:46:59	64°	SSE	03:50:17	10°	E
09 Jul	-1.2	01:22:37	10°	ESE	01:22:37	10°	ESE	01:22:40	10°	ESE
09 Jul	-3.5	02:55:24	23°	SW	02:57:09	48°	SSE	03:00:22	10°	E
10 Jul	-3.1	02:07:03	34°	SSE	02:07:21	34°	SSE	02:10:25	10°	E
10 Jul	-3.8	03:40:29	10°	W	03:43:49	87°	SSE	03:47:08	10°	E
11 Jul	-2.1	01:18:38	21°	ESE	01:18:38	21°	ESE	01:20:21	10°	E
11 Jul	-3.9	02:51:24	16°	WSW	02:53:55	75°	SSE	02:57:14	10°	E
12 Jul	-3.8	02:02:55	36°	SW	02:04:02	58°	SSE	02:07:18	10°	E
12 Jul	-3.8	03:37:18	10°	W	03:40:38	85°	N	03:43:57	10°	E
13 Jul	-3.4	01:14:19	42°	SE	01:14:19	42°	SE	01:17:21	10°	E
13 Jul	-3.8	02:47:22	10°	W	02:50:42	87°	N	02:54:01	10°	E
14 Jul	-2.3	00:25:34	23°	ESE	00:25:34	23°	ESE	00:27:19	10°	E
14 Jul	-3.9	01:58:19	17°	WSW	02:00:45	83°	S	02:04:04	10°	E
14 Jul	-3.9	03:34:05	10°	W	03:37:25	87°	S	03:40:45	10°	E
14 Jul	-1.6	23:36:29	14°	ESE	23:36:29	14°	ESE	23:37:09	10°	E
15 Jul	-3.9	01:09:11	27°	WSW	01:10:48	69°	SSE	01:14:07	10°	E
15 Jul	-3.8	02:44:07	10°	W	02:47:27	86°	N	02:50:47	10°	E
15 Jul	-3.5	04:20:48	10°	W	04:24:00	47°	SSW	04:27:11	10°	SE
15 Jul	-1.7	22:46:05	12°	ESE	22:46:05	12°	ESE	22:46:42	10°	ESE
16 Jul	-3.7	00:18:31	17°	SW	00:20:53	53°	SSE	00:24:08	10°	E
16 Jul	-3.8	01:54:08	10°	W	01:57:28	85°	N	02:00:49	10°	E
16 Jul	-3.8	03:30:48	10°	W	03:34:06	63°	SSW	03:37:23	10°	ESE
16 Jul	-3.3	23:27:52	10°	SW	23:31:00	38°	SSE	23:34:07	10°	E
17 Jul	-3.9	01:04:09	10°	W	01:07:29	90°	NNE	01:10:49	10°	E
17 Jul	-3.9	02:40:49	10°	W	02:44:09	79°	SSW	02:47:28	10°	ESE
17 Jul	-2.8	04:17:39	10°	W	04:20:30	27°	SSW	04:23:21	10°	SSE
17 Jul	-2.8	22:38:16	10°	SSW	22:41:08	27°	SSE	22:44:01	10°	E
18 Jul	-3.9	00:14:10	10°	WSW	00:17:30	79°	SSE	00:20:50	10°	E
18 Jul	-3.9	01:50:49	10°	W	01:54:10	90°	ESE	01:57:30	10°	E
18 Jul	-3.3	03:27:31	10°	W	03:30:39	38°	SSW	03:33:44	10°	SE
18 Jul	-3.9	23:24:13	10°	WSW	23:27:31	63°	SSE	23:30:50	10°	E
19 Jul	-3.8	01:00:48	10°	W	01:04:09	85°	N	01:07:29	10°	E
19 Jul	-3.7	02:37:29	10°	W	02:40:44	52°	SSW	02:43:58	10°	SE
19 Jul	-2.0	04:14:57	10°	WSW	04:16:49	14°	SW	04:18:41	10°	S
19 Jul	-3.6	22:34:21	10°	SW	22:37:34	47°	SSE	22:40:48	10°	E
20 Jul	-3.8	00:10:47	10°	W	00:14:08	86°	N	00:17:28	10°	E
20 Jul	-3.9	01:47:27	10°	W	01:50:46	69°	SSW	01:53:48	12°	ESE
20 Jul	-2.2	03:24:26	10°	W	03:31:18	2°	SSE	03:26:01	18°	WSW
20 Jul	-3.9	23:20:45	10°	W	23:24:05	87°	S	23:27:26	10°	E
21 Jul	-3.9	00:57:25	10°	W	01:00:46	83°	SSW	01:02:23	28°	ESE
21 Jul	-1.7	02:34:11	10°	W	02:35:03	16°	W	02:35:03	16°	W
21 Jul	-3.9	22:30:44	10°	WSW	22:34:04	73°	SSE	22:37:24	10°	E
22 Jul	-3.9	00:07:22	10°	W	00:10:43	87°	N	00:13:06	18°	E
22 Jul	-2.4	01:44:04	10°	W	01:45:50	26°	W	01:45:50	26°	W

21 Jul	-3.9	00:57:25	10°	W	01:00:46	83°	SSW	01:02:23	28°	ESE
21 Jul	-1.7	02:34:11	10°	W	02:35:03	16°	W	02:35:03	16°	W
21 Jul	-3.9	22:30:44	10°	WSW	22:34:04	73°	SSE	22:37:24	10°	E
22 Jul	-3.9	00:07:22	10°	W	00:10:43	87°	N	00:13:06	18°	E
22 Jul	-2.4	01:44:04	10°	W	01:45:50	26°	W	01:45:50	26°	W
22 Jul	-3.8	23:17:19	10°	W	23:20:40	85°	N	23:24:00	10°	E
23 Jul	-3.6	00:53:59	10°	W	00:56:56	55°	SW	00:56:56	55°	SW
23 Jul	-3.8	22:27:14	10°	W	22:30:36	88°	N	22:33:55	10°	E
24 Jul	-3.9	00:03:55	10°	W	00:07:14	75°	SSW	00:08:13	42°	ESE
24 Jul	-1.1	01:40:47	10°	W	01:40:57	11°	W	01:40:57	11°	W
24 Jul	-3.9	23:13:50	10°	W	23:17:11	87°	S	23:19:33	18°	E
25 Jul	-2.2	00:50:34	10°	W	00:52:18	24°	WSW	00:52:18	24°	WSW
25 Jul	-3.8	22:23:44	10°	W	22:27:06	86°	N	22:30:26	10°	E
26 Jul	-3.6	00:00:25	10°	W	00:03:39	48°	SSW	00:03:42	48°	SSW
26 Jul	-3.8	23:10:18	10°	W	23:13:37	65°	SSW	23:15:08	29°	SE
27 Jul	-1.3	00:47:22	10°	W	00:47:54	13°	WSW	00:47:54	13°	WSW
27 Jul	-3.8	22:20:11	10°	W	22:23:32	80°	SSW	22:26:35	12°	ESE
27 Jul	-2.4	23:57:00	10°	W	23:59:21	26°	SW	23:59:21	26°	SW
28 Jul	-3.2	23:06:46	10°	W	23:09:55	39°	SSW	23:10:50	31°	SSE
29 Jul	-3.5	22:16:35	10°	W	22:19:52	54°	SSW	22:22:21	16°	SE
29 Jul	-1.5	23:53:57	10°	WSW	23:55:07	14°	WSW	23:55:07	14°	WSW
30 Jul	-2.3	23:03:23	10°	W	23:06:03	22°	SW	23:06:40	21°	SSW
31 Jul	-2.7	22:13:02	10°	W	22:16:04	32°	SSW	22:18:14	16°	SSE
01 Aug	-1.4	23:00:45	10°	WSW	23:01:59	12°	SW	23:02:36	11°	SSW
02 Aug	-1.7	22:09:45	10°	W	22:12:04	18°	SW	22:14:15	11°	S
28 Aug	-1.0	05:14:01	10°	SSE	05:14:45	11°	SE	05:15:30	10°	ESE
30 Aug	-1.8	05:07:30	10°	SSW	05:10:01	20°	SE	05:12:34	10°	E
31 Aug	-1.4	04:18:59	13°	SSE	04:19:45	14°	SE	04:21:30	10°	ESE
01 Sep	-2.8	05:03:19	17°	SSW	05:05:22	36°	SSE	05:08:28	10°	E

END IMAGES, OBSERVING AND OUTREACH

Some lunar images from May, using the Imaging source DMK52 AU video camera,

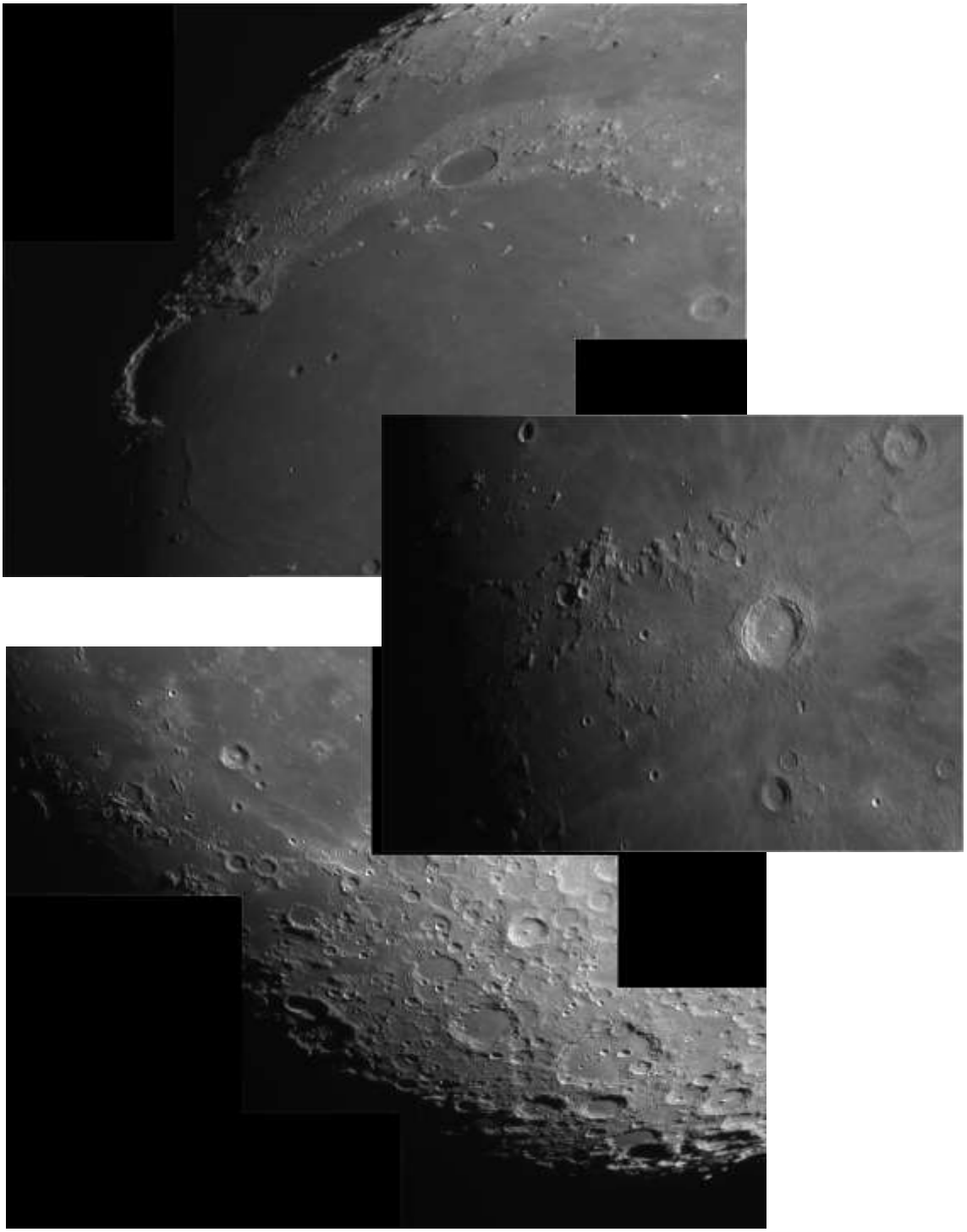
Sky Watcher 120mm elite refractor on Albion mount.

Home Observatory set up.

Plato and Sinus Iriium

Copernicus

SW Moon, including Tycho and Clavius.



Wiltshire Astronomical Society	Observing Sessions 2018 – 2019	And 2019-2020
Date	**Moon Phase (%)**	**Moonrise**
2019		
24th May	Waning gibbous (75%)	After midnight
27th Sept		
25th October		
22nd December		

OUTREACH

Evenings now too light for school link ins.

July 4th-5th Nibley Music Festival

October 4th/11th Queen's Crescent School Astronomy Evening. Help required please. Possible viewing, but meteors, rocket models, books and equipment on show while I give some talks.

How about a Milky Way photo session? End of July will be ideal. Site to be arranged.