NWASNEWS

Volume26 Issue 7

MARCH 2021

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

A LITTLE PERSEVERANCE AND EARTH STRIKE

Another fantastic landing for a probe to Mars. After two other missions arrive earlier in the the month the 18th was full of tension in the mission control.

Initial images confirmed perfect landing, and even the Mars Reconnaissance Orbiter picked up the landing parachute (which had it's own coded message in the panels),and later showed the lander, the delivery vehicle and detached parachute.

So it is going to look for life, well collect samples for a later mission to return.

But hidden in our monthly round up evidence is mounting that life is on Mars. BUT not Martian life. This is microbes that have hitched a ride on equipment sent from Earth, and it appears they are not only surviving on Mars but thriving.

Meanwhile the solar system has been happily throwing itself into the Earth. A large iron rich meteorite fell into Sweden and locals were able to recover pieces including a large 30lb sample from near Upsalla but the fall was last November so the samples may already be corrupted by Earth microbes.

Then on Sunday night a large bollide was seen over England, and parts of breaking up meteorite fell in the Cheltenham area (missing GCHQ by not a lot. Imagine the kerfuffle had a chunk hit that building). Because of lock down the experts cannot go in and search so they are asking locals to photograph on site and not collect pieces. Not to use magnets to pick up, and if they do get any samples to use clean kitchen foil or plastic bags without touching the sample. I hope they will be suitably rewarded, knowing how much these fresh samples can be worth for science and value to collectors AFTER study.

Perhaps these meteorites are left from formation of the solar system (or before) and possible failed moons ripped apart by gravitational pull. (BIG SEGWAY) Our speaking at the zoom meeting tonight is Pete Williamson (FRAS) who will be talking about the moons in our solar system…

Andy Burns is inviting you to a scheduled Zoom meeting.

Topic: Andy Burns' WAS monthly Zoom Meeting

Time: Mar 2, 2021 07:45 PM London

Join Zoom Meeting

https://us02web.zoom.us/j/89631378335?pwd=Mi8wVUZsQ2g4MWsycGp3enlIWmZ3Zz09

Meeting ID: 896 3137 8335

Passcode: 294566

Clear skies

Andy

The Lion chases the little dog over the White Horse at Cherhill.

"0mm lens on Nikon D810a.

The half Moon was bright enough to put features in the foreground.

The thin high cloud also caught the Moon light, and stopped more detailed shooting.

Andy

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

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

Meetings 2020/2021.

During COVID19 ZOOM meetingd

HALL VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

SEASON 2020/21
2021
2 Mar Pete Williamson/The moon & Moons of the Solar System.
6 Apr Paul Money and 'Triumphs of Voyager (part 2) – Where no probe has gone before'.
4 May TBC
1 Jun Robert Harvey/Understanding the Universe.

Thank you Peter and those that have helped get a list together in the circumstances.

Pete Williamson FRAS

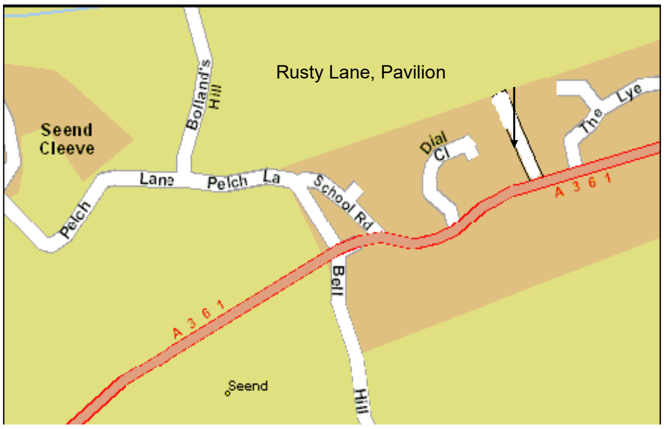
After leaving school 1973 I continued with astronomy and Kidderminster Astronomical Society still using my 6" Telescope and was getting quite proficient in the art of Astro Photography using hypered film and dark room techniques. As time moved on relationships, work in the music business and the IT sector forced astronomy to take a back seat and eventually sadly had no place in my life at this time.
In 1989 we moved to rural Shropshire and the first thing I did was to go out and buy a 10" Astro Systems reflector and have it mounted on a permanent pier in the centre of the garden, astronomy was again high on my agenda with good dark skies and a beautiful setting.
I had a major accident later that year and ended up being unable to work for over 12 months or get out to the telescope. It was around this time I looked for a local society to join and found none listed in Shropshire. I set about forming the Whittington Astronomical Society with the help and assistance of Sir Patrick Moore, the society grew quickly with the help of my wife Sybil and Daughter Sarah, we renamed the society to The Shropshire Astronomical Society which is still in existence today. My work in astronomy started to make headways and had media attention, to that end in 1994 I was elected a Fellow of the Royal Astronomical Society hence FRAS.
In 1991 I set about building and founding the on line service Starbase Four a bulletin board which exchanged early Astronomical Shareware and early versions of email plus posting Astronomical News.
As time went on and work situations changed with my work in the music business astronomy again had to take a back seat but kept my hand in with observations whenever possible and still wrote and had articles published in many journals.
In 2012 things changed as far as music was concerned enabling me to concentrate on astronomy in earnest again. I went back to University (home study) and obtained full astronomical certification with UCLAN & Planetary Geology with John Moors University. I purchased many new pieces of equipment and found a new calling which is Solar Astronomy. Not being one to sit on the sidelines I looked for work within the world of astronomy and before long was presenting BBC Radio Shropshire Eye On the Sky, a regular sky guide with features for the beginner plus any other astronomical events the BBC require.
I now do solar imaging, Deep Sky Imaging with robotic Telescope workshops for organisations or the individual and not just in the UK, I also have many images published in the major Astronomical Journals and books around the globe plus I write articles for publications when asked to do so.
In 2015 I created and built an internet based radio station entitled Astro Radio and now have many people working as volunteers within the organisation with sponsorship via Astronomy Now Magazine , Faulkes Telescope Project & iTelescopes Australia.
Solarsphere Astronomical & Music Festival is another one of my projects along with my Daughter Sarah in which we try to bring the world of astronomy and music together .
I still do the occasional bit of planetary imaging but am not very proficient in that area. I have got a few Lunar, I am a DEEP SKY Imaging consultant with the Faulkes Telescope Educational Project that has 2 metre, 1 metre and 0.4 metre class telescopes across the globe in both northern and southern hemisphere locations. Recently I have started working on a European project through Cardiff University Astro Physics Department.
Working with Cardiff University on a part time basis on the On - Line Observatory Project linked to the EU Erasmus.
Am a Slooh Space Ambassador (Remote Telescope Community Observatories).

My membership's are honorary member of 8 astronomical societies across the UK & Ireland and a ***Fellow of The Royal Astronomical Society & European Astronomical Society***.

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Andy Burns Chair, anglesburns@hotmail.com
Andy Burns Outreach and newsletter editor.
Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)
Philip Proven (Hall coordinator) Dave Buckle (Teas)
Peter Chappell (Speaker secretary)
Nick Howes (Technical Guru)
Observing Sessions coordinators: Chris Brooks, Jon Gale,
Web coordinator: Sam Franklin
Contact via the web site details.



Observing Sessions see back page

Swindon's own astronomy group

Physical meetings suspended

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

Next Zoom Meeting: AGM & Viv Williams

Our AGM will be held on the 19 March, postponed from March last year.

Our speaker will be Viv Williams**:**

Viv has been interested in astronomy since an early age. He had his first telescope in his early teens which allowed very poor views of Jupiter and Saturn, but good views of the Moon. Being a child of the Space race era his interest continued. However, eventually when he moved to Highworth in the late 1980's he purchased his first proper telescope, a Meade 8 inch Newtonian. He quickly realized that in the light polluted skies of Highworth that visual astronomy was difficult and having modified a webcam was amazed at what was revealed with just 90 second exposures.

He was hooked on astrophotography. He is now what he would classify as an "Astro Tourist". He likes to take images of several objects in a session and uses a very simple processing routine. He particularly enjoys the Hickson Galaxies in Leo.

His talk: 'A Guide to Amateur Telescope Mounts and how to set up'.

Ad-hoc viewing sessions postponed

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

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

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

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

Information about our evenings and viewing spots can be found here:

http://www.swindonstargazers.com/noticeboard/noticeboard06.htm

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

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

Enjoy astronomy at it's best!

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

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

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

Meeting Dates for 2021

Friday 19 March Zoom meeting
Programme: AGM, Speaker: Viv Williams 'A Guide to Amateur Telescope Mounts and how to set up'

Friday 16 April 2021 19.30 Meeting or Zoom

Programme: Mike Foulkes: Herschel's Planet
Friday 21 May Meeting or Zoom

Programme: Gary Poyner: Variable Stars and the Double Cluster

Friday 18 June 19.30 Meeting or Zoom

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

July & August - No Meetings

Website:
http://www.swindonstargazers.com

Chairman: Robin Wilkey

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

Secretary: Hilary Wilkey

Tel No: 01793 574403
Email: hilary@wilkey.org.uk
Address: 61 Northern Road
Swindon, SN2 1PD

BECKINGTON ASTRONOMICAL SOCIETY

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

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

Our Committee for 2016/2017 is

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

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

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

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

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm

STAR QUEST ASTRONOMY CLUB

This young astronomy club meets at the

Sutton Veny Village Hall.

Second Thursday of the Month.

Meet at Sutton Veey near Warminster.

BATH ASTRONOMERS

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

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

Mar31
Talk by Dr Julian Onions - Aperture Fever
31 Mar - Online
Wednesday 31st March – Monthly meeting. Topic: Aperture Fever - does my mirror look big in this? After a very brief review of how telescopes work, we look at some of the existing telescopes, both visible and other wavebands, and consider why they are so big, what they can and can't see and what the telescopes planned for the next few years will deliver.
Talk by Mary McIntyre
28 Apr - Zoom
Wednesday 28th April – Monthly meeting. This month's talk will be given by Mary McIntyre. Mary is a well renown astro artist and astrophotographer. The format is open and comprises an update for the month and a talk on an astronomy topic within the reach of amateurs.
May26
Talk by Pete Williamson FRAS
26 May - Herschel Museum of Astronomy
Wednesday 26th May – Monthly meeting. Topic: From Herschel to Hawkwind
Jun30
Talk by Chris Starr, Cassini and Saturn
30 Jun - Herschel Museum of Astronomy
Wednesday 30th June – Monthly meet

© Provided by Space A 30-pound chunk of iron meteorite found in Uppsala, Sweden.

A half-melted hunk of iron-rich rock found in Uppsala, Sweden, is part of a meteorite that fell there in November 2020.

The lumpy meteorite is about the size of a loaf of bread and weighs around 31 pounds (14 kilograms), according to the Swedish Museum of Natural History. It was once part of a larger space rock, probably weighing more than 9 tons (8.1 metric tons), that created a dramatic fireball over Uppsala on Nov. 7

SPACE NEWS MARCH 2021

SpaceX scrubs launch attempt from pad 39A

February 28, 2021

A Falcon 9 rocket was set to haul 60 more Starlink broadband satellites into orbit Sunday night for SpaceX, but the countdown was aborted at T-minus 1 minute, 24 seconds. The next opportunity to launch the two-stage Falcon 9 from the Kennedy Space Center is at 8:15 p.m. EST Monday (0115 GMT Tuesday). The rocket's reusable first stage — flying on its eighth mission — will target a landing downrange on SpaceX's drone ship in the Atlantic Ocean.

Perseverance Seen From Space by ESA's ExoMars Orbiter

A little over a week ago (February 18th, 2021),
NASA's *Perseverance* rover landed in the Jezero crater on the surface of Mars. In what was truly a media circus, people from all over the world tuned to watch the live coverage of the rover landing. When *Perseverance* touched down, it wasn't just the mission controllers at NASA who triumphantly jumped to their feet to cheer and applaud.

In the days that followed, the world was treated to all kinds of media that showed the surface of Mars and the descent. The most recent comes from the *Trace Gas Orbiter* (TGO), which is part of the ESA-Roscosmos *ExoMars* program. From its vantage point, high above the Martian skies, the TGO caught sight of *Perseverance* in the Jezero crater and acquired images that show the rover and other elements of its landing vehicle.

Since 2016, the TGO has orbited Mars and gathered vital data on the composition of its atmosphere. Specifically, TGO has been looking for traces of atmospheric methane and other gases that could be the result of geological or biological activity. These efforts are part of a larger effort to determine if life existed on Mars billions of years ago (and whether or not it still does).

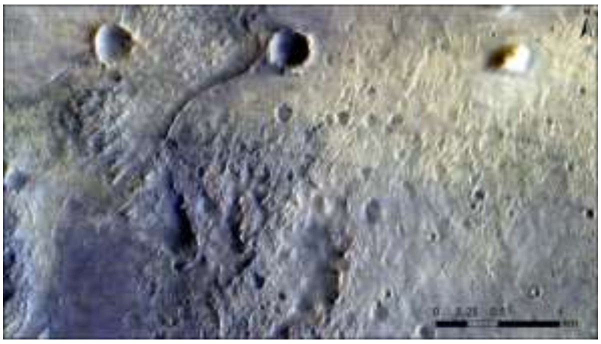


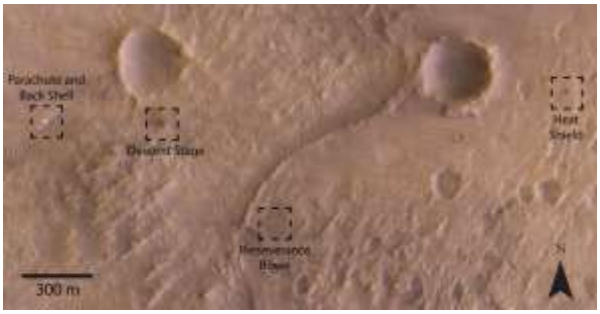
Image of Perseverance and mission elements, as captured by the orbiter's CaSSIS camera on Feb. 23rd, 2021. Credit: ESA

In addition, the orbiter has conducted other important scientific operations, like relaying data from robotic missions on the surface and acquiring images of space. On February 23rd, the TGO took advantage of its orbit to snap pictures with its Colour and Stereo Surface Imaging System (CaSSIS) that showed the *Perseverance* rover – as well as its parachute, heat shield, and descent stage elements – within the Jezero crater.

In the first image (above), the elements are discernible as a series of dark and bright pixels, which are indicated in the second image (below). As you can see, the descent stage and heatshield are dark spots spaced around two smaller craters while the parachute and backshell are visibly bright spots in close proximity to each other.
The *Perseverance* rover, near the bottom centre, is a relatively faint spot by a small ridge leading from one crater.

It is here that *Perseverance* will spend the next two years (which will likely be extended) searching for signs of past microbial life. Based on its features, which include a preserved river delta and clay-rich sedimentary deposits, the Jezero crater is known to have hosted a standing body of water billions of years ago. For this reason, it was selected as the landing site for the mission, since it is believed to be a good place to find evidence of past life.

Perseverance will also conduct an ambitious and unprecedented operation, where it will collect samples of Martian rocks and soil and set them aside in a cache. These will be returned to Earth by a separate ESA-NASA Mars Sample Return mission that will consist of a lander, a rover (to retrieve the samples), and small launcher (for launching them to orbit). Once there, an orbiter will pick them up and bring them home for analysis.



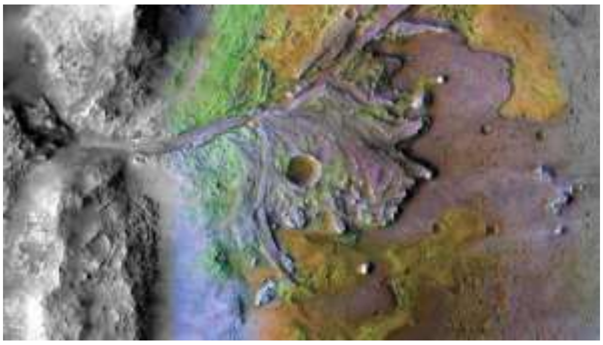
Close-up of the images taken by the TGO of Perseverance and mission elements in the Jezero crater. Credit: ESA

The ExoMars TGO also provided a significant amount of assistance for the *Perseverance* rover during its landing, such as data relay services. Videos of the landing, as well as imagery and sound recordings, were captured by instruments aboard the rover's Entry, Descent, and Landing (EDL) vehicle. These were sent back to Earth with the assistance of the TGO, as well as NASA's *Mars Reconnaissance Orbiter* (MRO).

The orbiter will continue to provide data relay support between Earth and Mars for future missions to the surface, particularly the next ExoMars mission. Known as *ExoMars 2022*, this mission will launch from the Baikonur Cosmodrome on Sept. 20th, 2022, and arrive at the Red Planet by June 10th, 2023. It will consist of the Russian Kozachok surface platform and the Rosalind Franklin rover.

Meanwhile, the Trace Gas Orbiter will continue to orbit Mars and conduct its own science operations, focusing on the analysis of Mars' atmosphere and the search for gases that point the way towards past (or present) life. Recently, the orbiter detected traces of hydrogen chloride gas leaving the planet's atmosphere, indicating that this salt exists on the surface which made it to orbit.

On Earth, this process has been observed with sodium chloride salts, where salt water evaporates from our oceans and is pushed into the upper atmosphere by strong winds. The TGO has also monitored water vapor leaving the Martian atmosphere and escaping to space. Together, these findings have provided new clues as to where the abundant surface water Mars had billions of years ago escaped to.



Orbital picture of the Jezero crater, showing its fossil river delta. Credit: NASA/JPL/JHUAPL/MSSS/BROWN UNIVERSITY

ESA is Working on a Mission to Explore Caves on the Moon

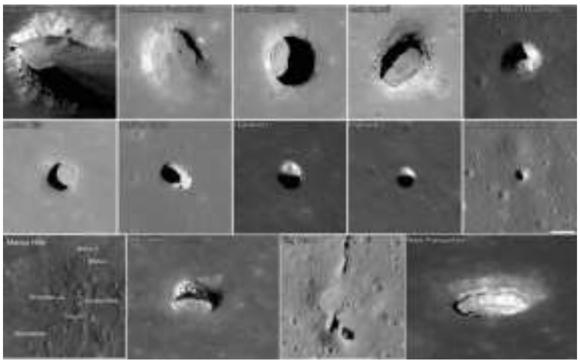
Infrastructure is going to be one of the biggest components of any permanent human settlement on the moon. NASA Artemis missions are focused directly on building up the facilities and processes necessary to support a moon base. ESA is also contributing both material and knowledge. Most recently they made another step in their path to explore some lava tubes and caves in the subterranean lunar world.

ESA recently started the third round of a series of studies that focus on exploring lunar caves. The current round, called a Concurrent Design Facility (CDF) study builds off the work done in two previous rounds of Sysnova studies. Originally encompassing five studies ranging from how to lower a probe into a cave to how to communicate with and power any probes that make that descent, ideas were elicited from the public as part of the CAVES and PANGAEA programs.

UT Vide on Lava Tubes, with a special focus on the Moon.

From the five original concepts in the first Sysnova studies, ESA winnowed it down two three "mission scenarios" – one to find cave entrances, one to thoroughly study a cave entrance, and one explore a lava tube using autonomous rovers. ESA then decided to further evaluate two mission concepts that focus exclusively on exploring a cave entrance, but combining aspects of all three original mission concepts.

Understanding even the entrance of lunar caves can prove invaluable to understanding the resources that might be available in the subterranean world of the moon. It is also key to understanding the radiation protection afforded by the lunar regolith. That protection, depending on its efficacy, can prove to be a game changer in where any potential permanent lunar base would be located.



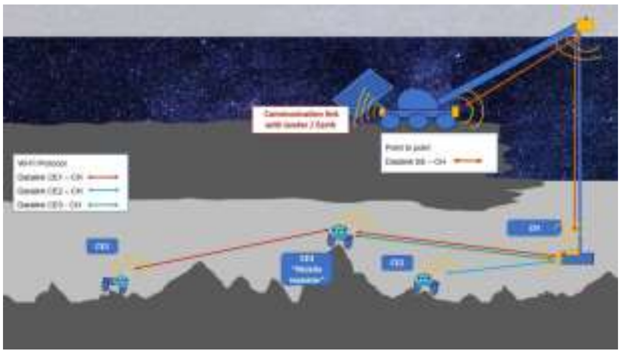
Images of open lava tubes on the Moon. Image credit: NASA/LRO

The first selected mission plan is on led by the University of Würzburg. They developed a spherical probe that can be lowered into a cave mouth by a crane attached to a rover. The probe itself is encased in a clear plastic shell and will contain 3D lidar, an optical camera, and a dosimeter that will allow the probe to read radiation levels at the cave entrance.

Wireless power and communication is the focus of the second mission plan, developed by the University of Oviedo. In its scenario a "charging head" is attached to the end of a rover-based crane which is then used to power and directly communicate with autonomous rovers that do not have their own internal power source. Power for the rover and charging head will come directly from solar panels connected to the rover.

Image of the spherical camera system developed by the University of Würzburg.
Credit: University of Würzburg

Mission duration for these experiments would be planned for one lunar day, or approximately 14 Earth days. ESA plans to link the mission outcomes of these two project directly to two of their concerted lunar exploration efforts, known as the European Large Logistics Lander (EL3), which will help build up the infrastructure needed for a permanent presence, as well as the Moonlight initiative, which focuses on wireless communication and navigation for lunar exploration vehicles.



Graphic depicting the concept of the University of Oviedo wireless power and control system.
Credit: University of Oviedo

Both of these mission concepts are still conceptual at this stage, and neither has received full funding for anything close to planning a fully fledged mission. However, it is clear that ESA's step-wise process is providing value even before any mission is launched – the concepts that have resulted from it already are novel and potentially executable with enough willpower and funding. Missions that have made it this far in the process do indeed stand a good chance at eventually becoming reality and contributing to our effort to permanently colonize the moon.

Some Earth Life Could Already Survive on Mars

Mars' surface is a harsh environment for life. But life on Earth is notoriously resilient as well. No one is quite sure yet how microbes from Earth would fare on the Martian surface. However, the impact of a potential transmigration of microbes to the red planet could be immense. Not only could it skew any findings of potential real Martian life we might find, it could also completely disrupt any nascent biosphere that Mars might have.

To understand whether that much disruption is really possible, first we must understand whether any Earthly life can survive on Mars itself. According to a new study recently published in Frontiers in Microbiology, the answer to that is yes.

UT discussion of whether we've accidentally infected Mars already.

The research, led by a team of scientists at NASA and the German Aerospace Center, used a unique approach to test the viability of live bacteria on the Martian surface. They sent it up to the stratosphere in a balloon.

The stratosphere is a surprisingly similar environment to the Martian surface, specifically in terms of radiation and temperature. The researchers introduced bacteria to that environment using a tool called the Microbes in Atmosphere for Radiation, Survival, and Biological Outcomes experiment (MARSBOx).

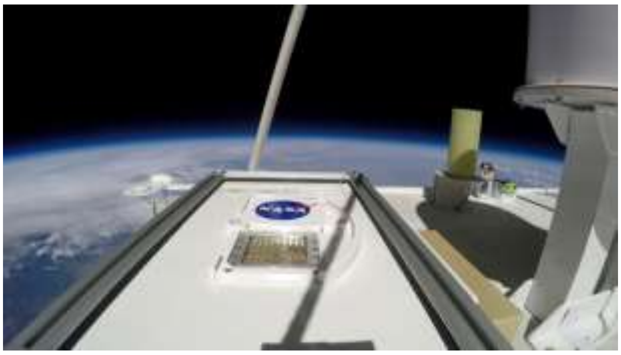


Image of the MARSBOx in the stratosphere where it was used for the recent microbe experiments.
Credit: NASA

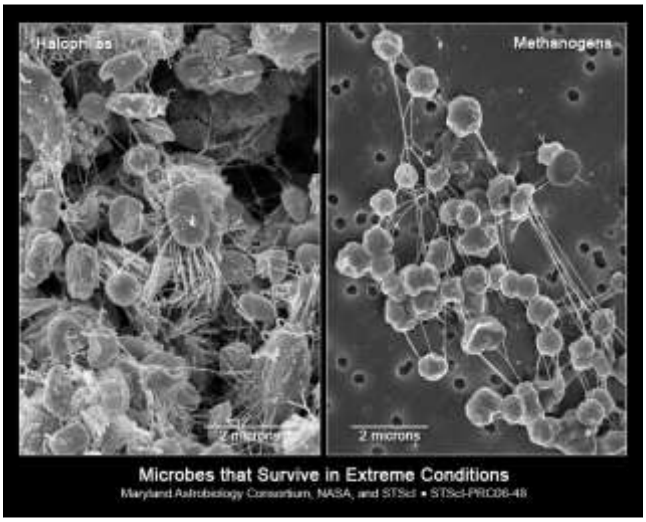
MARSBOx allowed the researchers to maintain a pressure similar to that of the Martian atmosphere as well as exposing them to a mixture of gas that was remarkably similar to the actual atmospheric makeup on Mars. The pressure, temperature, radiation, and gaseous contents of the box all provide a decent simulacra of what conditions would be like on the Martian surface. As one added control, the researchers designed the box to contain two separate chambers, including a shielded one that would allow them to isolate the effects of radiation on the microbes.

Of the various microbes, including both bacteria and fungi, that were introduced to the environment, only a few survived. Black mold fungus seemed to do particularly well in the harsh environment. That did not particularly surprise the scientists, as that hardy fungi had been seen previously happily residing on the International Space Station.

Image of the black fungus mold growing on the ISS.
Credit: NASA

Despite its ability to exist in the freezing temperatures and high radiation environment of the stratosphere, even the black mold fungus had to be "revived" once it was safely back on the ground. It is not yet clear what, if anything, could induce that revival on the actual surface of Mars.

If scientists are in fact able to figure out how to leverage microbes effectively on other worlds, it could be a huge potential boon as well as a cause for concern. Bacteria and other microbes are necessary to human's biological functions. They also provide access to biochemical processes that would otherwise be unobtainable in the cold, sterile environment of the red planet.



Other microbes have been tested to survive in Martian-like conditions, but never have they been exposed to the environment of the stratosphere before.
Credit: Maryland Astrobiological Consortium, NASA, STSci

This preliminary study shows how important it is for us to better understand the survival capabilities of the microbes on our own world. If used correctly, they could prove a huge boon for space travel. However, if used incorrectly, they could destroy any chance we have of understanding biogenesis on other worlds.

What a Geologist Sees When They Look at Perseverance's Landing Site

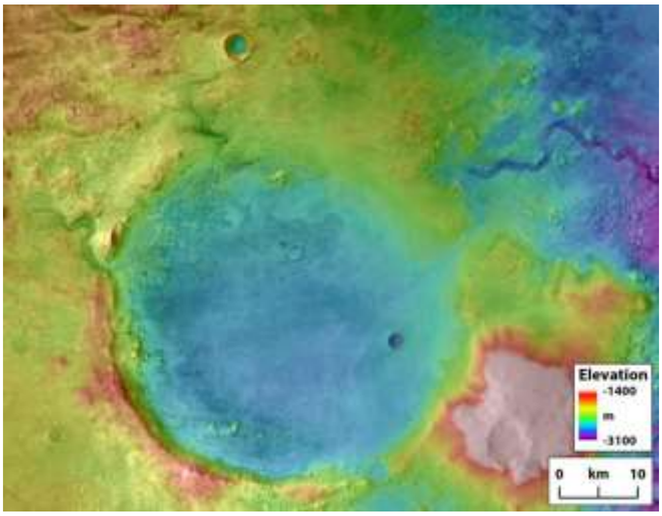
Geologists love fieldwork. They love getting their specialized hammers and chisels into seams in the rock, exposing unweathered surfaces and teasing out the rock's secrets. Mars would be the ultimate field trip for many of them, but sadly, that's not possible.

Instead, we've sent the Perseverance rover on the field trip. But if a geologist were along for the ride, what would it look like to them?

Geologists tell us there's no substitute for fieldwork. Jezero Crater is where Perseverance is going on its field trip, and fortunately, the crater has been examined in different ways by different satellites. To a geologist's eyes, the crater is a bonanza.

NASA chose the Jezero Crater for Perseverance's mission partly because of its geology. Though geology is primarily concerned with the physical structure of a planet, it's a growing part of understanding how a planet could have supported life. Biology is inextricably intertwined with geology. With its collection of sediments and its ancient shoreline, the Jezero Crater is a prime target for modern planetary geology.

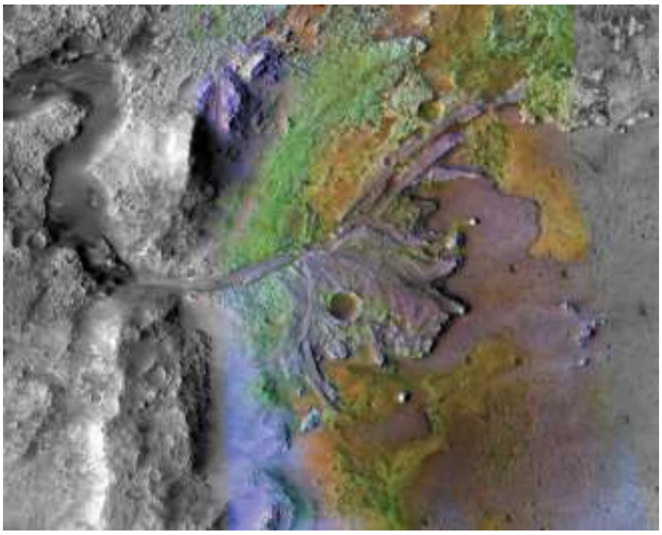
Jezero Crater was a lake at one time in its past, possibly twice, according to some research. Scientists who study Jezero say the lake probably formed when there was a period of continual surface runoff. Two incoming watercourses fed the lake, and overflow carved a channel out of the lake.



The Perseverance rover is on the ground in the Jezero crater. The outlet canyon carved by overflow flooding is visible on the upper right side of the crater. Ancient rivers carved the inlets on the left side of the crater. Credit: NASA/Tim Goudge.

The image above shows the Jezero Crater in elevation detail. Perseverance landed near the western side of the crater, near the clearly visible river delta. That river sediment contains ancient clays, which are especially good at trapping and preserving organic matter. If a real live geologist were along for the ride with Perseverance, they would likely head straight for those clays.

NASA's Mars Reconnaissance Orbiter has been studying the Jezero Crater. One of its instruments is an imaging spectrometer named Compact Reconnaissance Imaging Spectrometer for Mars (CRISM). It's especially good at identifying clays. The image below shows some of the clays in Jezero.



This image of Jezero Crater on Mars comes from the CRISM instrument on the MRO. CRISM is an imaging spectrometer built to detect clays on Mars. In this image, the clays appear green. Image Credit: NASA/JPL-Caltech/ASU

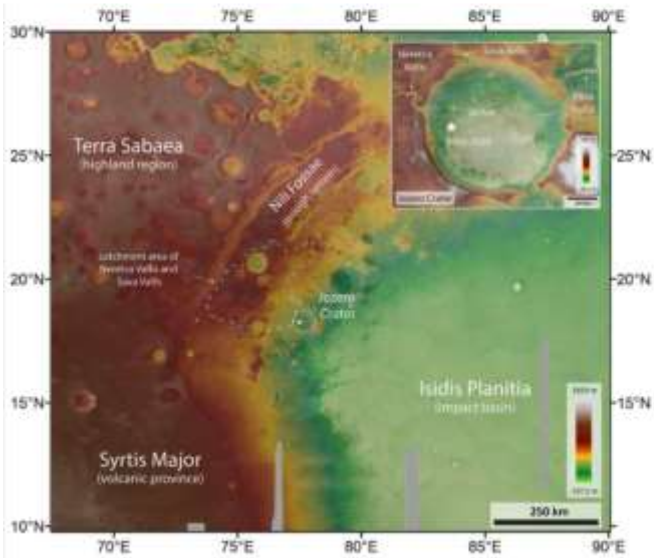
The river sediment is piled so high that its edge is like a cliff. Perseverance will traverse along the bottom of that cliff before working its way up and across the delta, hopefully making it to the ancient shoreline. Then, depending on mission length, the rover would climb Jezero's 610 meters (200 ft.) crater rim and explore some of the plains surrounding the crater. Perseverance's prime mission length is about one Mars year (about two Earth years) and NASA thinks that it could complete about half of this traverse during that time.

While a geologist—or really any other scientist or science-minded person—would be agape at the secrets that Jezero Crater holds, that would only be a start. If all goes well and Perseverance leaves the crater for the highlands, our fictional geologist would be alive with wonder at the geological richness of the region surrounding the crater.

This image shows with a green dot where NASA's Perseverance rover landed in Jezero Crater on Mars on Feb. 18, 2021. The base image was taken by the HiRISE camera aboard NASA's Mars Reconnaissance Orbiter (MRO). Along with the Mars Express Orbiter, the MRO has imaged Jezero in detail. Image Credit: NASA/JPL-Caltech/University of Arizona

The DLR (German Aerospace Center) operates a special camera on the ESA's Mars Express Orbiter. It's called the High-Resolution Stereoscopic Camera (HRSC). The HRSC is a powerful unit that's mission is to image and study the surface of Mars. Among its tasks is the characterization of the planet's geological evolution. Part of its job is to create hi-res Digital Terrain Models (DTM) of Mars, including the region surrounding Jezero.

The DLR recently released two images of Jezero Crater and the surrounding area, highlighting some of the geological context and the topography. The images help explain the area's geological diversity and why it was chosen as Perseverance's target area.



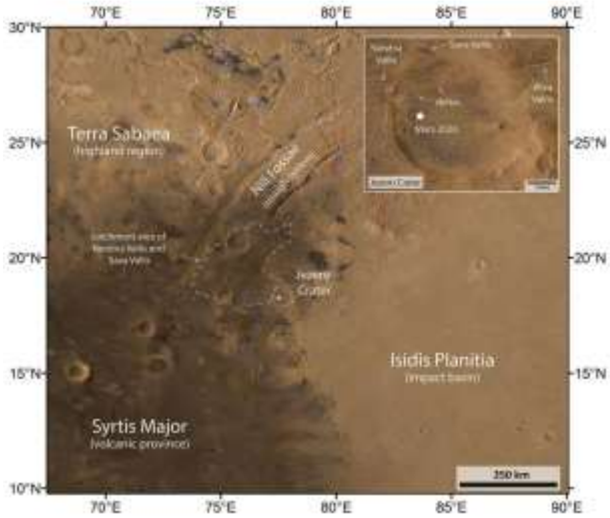
A topographic image of Jezero and its surroundings from the High-Resolution Stereoscopic Camera. Of note is the catchment area of Neretva Vallis and Sava Vallis, the two rivers that flowed into Jezero. Image Credit: ESA/DLR/FU Berlin, BY-SA 3.0 IGO

As the images show, the Jezero Crater lies on the border between different geological areas of different ages. The Terra

Sabaea highland region contains rocks from Mars' Palaeozoic (the Noachian: 4.1–3.7 billion years ago). The Isidis impact basin dates from the same time. The Isidis Planitia plain is much younger, dating back to the Hesperian (3.7–3.0 billion years ago) and the Martian Modern (the Amazonian 3.0 billion years to the present day). The result is that rocks and other deposits around Jezero Crater come from each of the three Martian geological epochs. To a geologist, this is a big rocky bonanza.

The nearby Syrtis Major is a volcanic province whose lava flows also date to the Hesperian. The Nili Fossae region is a trough system that was formed by the shocks from the Isidis impact. This is a geologist's dream field trip. If Perseverance can complete its primary mission, it will explore some of the regions outside the Jezero crater.

Of particular interest are agglomerate debris called megabreccia that formed during the Isidis impact. They're located west of Jezero in Noachian bedrock, igneous bedrock, and lava flows from Syrtis Major. Megabreccias can be very large, up to a kilometre across, and can hold valuable clues to Mars' early history.



Another image from the HRSC. Terra Sabea is about 4.1–3.7 billion years old, and the Isidis impact basin is from the same time period, about 3.9 billion years ago. Syrtis Major is about 3.7 to 3 billion years old, and the Isidis Planitia is younger, forming between about 3 billion years ago into modern times. So Perseverance has an opportunity to look at rocks from all throughout Martian geologic history. Image Credit: ESA/DLR/FU Berlin, BY-SA 3.0 IGO

Though Perseverance can act as a kind of field geologist in some ways, it has its limitations. Its drill can only reach shallow depths. Any life that existed on Mars probably dates back to between 3.7 billion to 3.4 billion years ago, which is also when life appeared on Earth. Any shallow-surface evidence of microscopic life was probably destroyed by UV radiation, though some might be preserved in the sediments and clays.

Perseverance will collect its samples, and hopefully, a future mission will return them to Earth for deeper and more thorough study. That's in line with how geologists work, too. Field samples are subjected to rigorous study back in labs.

Perseverance will teach us a lot about Mars' geological history and how life might have existed there. Now that it's safely on the surface of Mars, its mission is almost a success already. But it's not the only rover to go on a field trip to Mars in the 2020s.

An artist's illustration of the ExoMars/Rosalind Franklin rover on Mars. Image Credit: ESA/ATG medialab

The ESA's Rosalind Franklin Rover is going on its own trip to Mars. It'll land in Oxia Planum, a region that holds a vast exposure of clay-bearing rock. It's also a very geologically diverse region. The Rosalind Franklin will be able to take deeper samples than Perseverance can, down to two meters.

But we're getting ahead of ourselves.

One day, an actual human geologist may very well set foot on Mars. Maybe several. But until then our rover geologists will have to do it for us.

If past missions are any indication, Perseverance will last well beyond its primary mission. NASA's MSL Curiosity landed on Mars in August 2012 and is still going, thanks largely to its Multi-Mission Radioisotope Thermoelectric Generator (RTG). Perseverance has the same type of energy source, so barring mishaps, it's reasonable to hope that the rover will make it out of Jezero Crater and into the surrounding areas, looking at and sampling rocks from all throughout Mars' geologic history.

If that happens, it won't just be our imaginary geologist that's on a field trip of a lifetime. Probably every geologist on Earth will be living vicariously through that journey.

Our Part of the Galaxy is Packed with Binary Stars

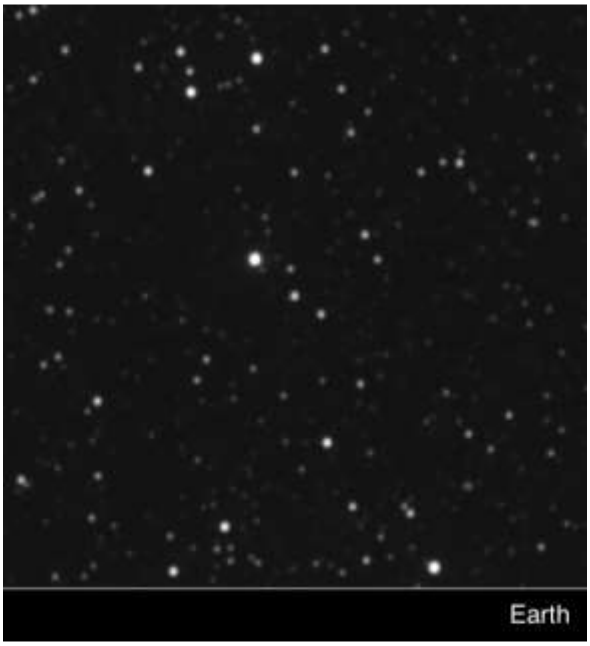
Binary star systems are everywhere. They make up a huge percentage of all known solar systems: from what we can tell, about half of all Sun-like stars have a binary partner. But we haven't really had a chance to study them in detail yet. That's about to change. Using data from the European Space Agency's Gaia spacecraft, a research team has just compiled a gigantic new catalog of nearby binary star systems, and it shows that at least 1.3 million of them exist within 3000 light-years of Earth.

This detailed survey of our local galactic neighborhood offers an enormous sample of binary stars for researchers to dig into. Previous surveys of binary stars, like the Tycho and Hipparcos catalogs (which were compiled between 1997 and 2002), only found around 13,000 paired stars. The new Gaia survey sample size is 100 times larger, which will allow astronomers to make far more accurate models of star system formation.

The bright spherical swarm to the left of the galactic center in this artist's representation shows the 3000 light-years around Earth surveyed in the new catalog of binary stars. Image Credit: Kareem El-Badry/UC Berkeley and Jackie Faherty/ AMNH

Confirming the existence of a binary system isn't an easy task. Two stars that appear close to each other in the sky from our perspective may actually be very distant from each other; they just happen to lay along a similar line of sight.

To find out if the stars are actually close to one another, astronomers rely on the parallax effect: the apparent motion of a distant object as the observer's point of view changes. In other words, astronomers need to observe the distant stars twice, from two different positions in Earth's orbit around the Sun. The stars' positions in the sky will appear to change from one perspective to the second. If the stars being observed appear to move together, they are close; if they do not, they are far apart.



This GIF demonstrates parallax by comparing two images of Proxima Centauri (the nearest star to our Sun). The first image was taken from Earth, the second from New Horizons, out beyond Pluto. It is clear from the comparison that Proxima Centauri is much closer to us than the background stars, which do not appear to move with it. Credit: NASA/Johns Hopkins Applied Physics Laboratory/Southwest Research Institute/Las Cumbres Observatory/Siding Spring Observatory/Edward Gomez

Parallax is most useful for measuring nearby stars. Beyond about 3000 light-years from Earth, the apparent motion is just too small to measure accurately. That's why this new catalog focuses on nearby binary systems rather than distant ones.

The researchers – Kareem El-Badry, Hans-Walter Rix, and Tyler M. Heintz – hope that the new dataset will provide astronomers with a wealth of new research opportunities. The team is particularly interested in studying binary pairs which include white dwarfs (old stars in their final stages of evolution). White dwarfs no longer produce fusion reactions in their core, meaning they slowly cool over time at a measurable rate. This makes it possible to estimate the age of white dwarfs, whereas main-sequence stars (middle-aged stars like our Sun) are much harder to date.

This is where studying binary systems become useful. As the researchers explain, stars in binary pairs usually form at the same time as their partners. Both stars were born "from the same gas cloud and have orbited one another ever since. They thus have essentially the same age, initial composition, and distance, but generally different masses and occasionally different evolutionary phases." As a result, if you can date one star in the pair (because it is a white dwarf, for example), then you also know the age of the other star by association, even if it is a (normally undatable) main-sequence star.

In the new catalogue, there are 15,982 of these white dwarf/ main-sequence binaries – a huge sample size beyond anything available before, and it will allow astronomers to better understand the history, age, and evolution of nearby Sun-like stars.

The data also holds some surprises. One of the strangest discoveries so far is that binary stars tend to be the same mass as their partners.

"That is really weird," said El-Badry, "because most of these are separated by hundreds or thousands of AU, so they are so far apart that, by conventional star formation theories, their masses should be random. But the data tells a different story: They know something about their companions' masses."

El-Badry thinks that the best explanation for this phenomenon is that the stars must have formed close to each other, and been thrown apart later by the gravitational pull of other stars and objects passing through the system.

More surprises are sure to turn up as astronomers dig into the new catalogue. We have only just begun to map out the composition of our local galactic neighbourhood. Binary systems offer new tools to characterize our surroundings, and when combined with our expanding knowledge of star types, gas clouds, and exoplanets, binary star systems will help us understand our place in the galaxy better than ever before.

There was a Secret Code in the Perseverance Parachute

A secret coded message was hidden on the gigantic parachute used to land the Perseverance rover safely on the surface on Mars. And no, it wasn't a clandestine message to the Martians. It was a message of inspiration for us humans.

But it also came as a challenge.

During a news briefing on February 22, Allen Chen, the entry, descent and landing lead for the mission revealed there was a secret message in the parachute.

"In addition to enabling incredible science, we hope our efforts in our engineering can inspire others," he said. "Sometimes we leave messages in our work for others to find for that purpose, so we invite you all to give it a shot and show your work."

Puzzle lovers around the world quickly went to work, and it didn't take long.

Adam Steltzner, Perseverance's chief engineer, confirmed "the internet" had cracked the code late Monday night on Twitter.

Hidden in the 70-foot (21-meter) parachute's red and white pattern was a binary code with the phrase "Dare mighty things" — a famous expression from President Theodore Roosevelt, espoused by those who work at the Jet Propulsion Laboratory. The outer rings of the pattern also feature

GPS coordinates for JPL's offices in Pasadena, California: 34°11'58" N 118°10'31" W.

Chen later confirmed on Twitter that the code was the brain child of systems engineer Ian Clark, who helped conduct tests of the supersonic parachute, as well as performing several other tasks for the Perseverance rover team.

Clark is a crossword hobbyist, and said only about six people knew about the coded message before this week.

Chen expressed how grateful he is for the ability to work with such creative people at JPL. "It's a feeling of being very fortunate at the end… that I get to work at a place with people who are both great engineers and great people, and we still get to dare mighty things together," he said at Monday's briefing.

The "Dare Mighty Things" sign at JPL. Image by Nancy Atkinson.

Secret messages on the rovers are not new. The Curiosity rover has holes in its wheels that creates marks in the Mars regolith that spells out "JPL" in Morse Code.

This image shows a close-up of track marks left by the Curiosity rover. Holes in the rover's wheels, seen here in this view, leave imprints in the tracks that can be used to help the rover drive more accurately. The imprint is Morse code for 'JPL,' and aids in tracking how far the rover has traveled. Credit: NASA/JPL-Caltech.

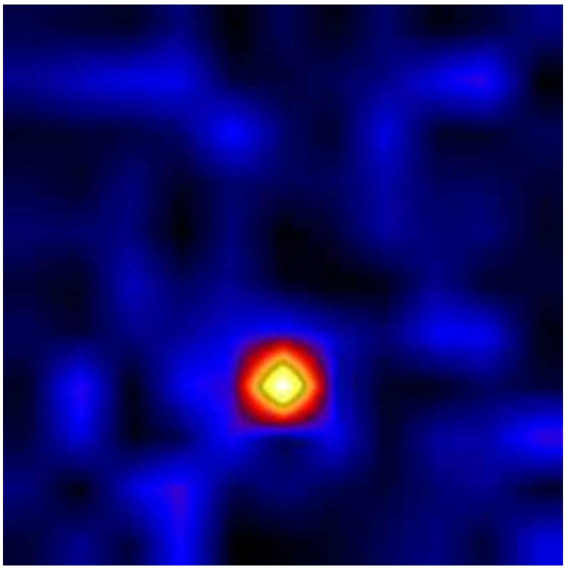
It was also revealed that Perseverance bears a plaque depicting all five of NASA's Mars rovers in increasing size over the years — reminiscent of the decals on cars that portray the family riding inside.

Deputy project manager Matt Wallace said more hidden "Easter eggs" should start showing up on Perseverance when more images of the rover itself are taken and beamed back to Earth.

"Definitely, definitely should keep a good lookout," he said.

Cygnus X-1 was the First Black Hole Ever Found. New Measurements Show it's Much More Massive Than Previously Believed

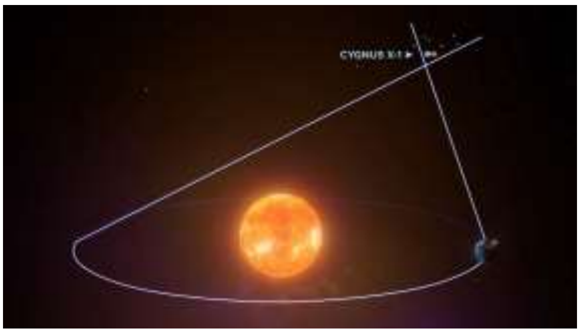
In 1964 two Aerobee suborbital rockets were launched with the goal of mapping x-ray sources in the sky. Each rocket contained a directed Geiger counter, so that as the rocket rotated at the peak of its trajectory to measure the direction of x-ray sources. The project discovered eight x-ray sources, including a particularly bright one in the constellation Cygnus. It became known as Cygnus X-1.



Cygnus X-1 as imaged by a balloon bourne telescope. Credit: NASA/Marshall Space Flight Center

As x-ray telescopes became more precise, it was clear that Cygnus X-1 wasn't connected to a bright optical source. The x-rays were quite bright and came from a region almost starlike in size. This suggested that it could be a (then hypothetical) stellar-mass black hole. The idea was so controversial that it inspired a bet between Stephen Hawking and Kip Thorne in 1974, with Hawking betting against the idea. By the 1990s it was clear Cygnus X-1 could only be a black hole, and Hawking conceded the wager.

Over the years Cygnus X-1 has become one of the most studied objects in the sky. We now know that it is an x-ray binary, where the black hole closely orbits a blue supergiant star known as HDE 226868. The two orbit each other so closely that material from the star is captured by the black hole. As the stellar material becomes superheated in the accretion disk of the black hole, it emits the powerful x-rays we first detected. But there is still a great deal we don't know about Cygnus X-1, and one of the most basic is its distance.



Using parallax to measure the distance of Cygnus X-1. Credit: International Centre for Radio Astronomy Research

We've known that Cygnus X-1 is a few thousand light-years away, but pinning down the exact distance is a challenge. The distance of nearby celestial objects is typically measured using parallax, where the apparent position of the object is measured relative to more distant objects. X-ray sources are difficult to pinpoint, so this method isn't effective for x-ray objects. Cygnus X-1 also emits radio light, so you could use radio observations to measure its parallax, but that also isn't very precise.

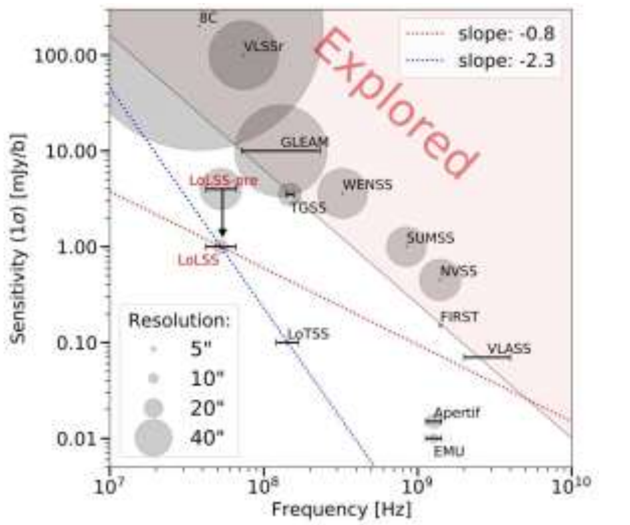
But a new study uses a couple of tricks to get an accurate distance measurement. Rather than using a single radio antenna to measure parallax, the team used the Very Long Baseline Array (VLBA), which has ten antenna dishes scattered across the United States. Together they create an America-sized virtual telescope, which gives you greater precision. But the team also measured the motion of the black hole and its stellar companion. This lets them measure the distance between them. Combining this with VLBA parallax observations, the team calculated that Cygnus X-1 is about 7,000 light-years away.

This is a greater distance than we'd thought. Since our estimation of the black hole's mass is based on our distance measure, this also means the black hole is more massive than we thought. The team calculated its mass to be 21 times that of the Sun, which is 50% larger than previous estimates.

Cygnus X-1 isn't the closest black hole to Earth, but with its proximity and bright x-rays, it will continue to be the most studied local black hole. And as this latest research shows, we still have much to learn.

A map of 25,000 Supermassive Black Holes Across the Universe

The Low-Frequency Array (LOFAR) is a different kind of radio telescope. Although radio light has the longest wavelengths and lowest frequencies of the electromagnetic spectrum, much of radio astronomy has focused on the higher frequency end. Observatories such as ALMA study radio light at frequencies of hundreds of Gigahertz, and the VLA studies the fifty Gigahertz range, LOFAR captures radio signals below 250 Megahertz, which is in the range of the lowest radio frequencies that can be seen from Earth.



Most low frequency radio sources are yet to be explored. Credit: de Gasperin, et al

Low-frequency radio astronomy is challenging because astronomical radio sources are very faint. Low-frequency light also has a longer wavelength, which means that it is hard to capture radio images with good resolution. To overcome these challenges, LOFAR uses an array of omnidirectional antennas. It has about 20,000 antennas clustered at 52 stations across Europe. Together they create a virtual telescope more than 1,000 kilometers across. With such a large number of antennas, processing the data is extremely complex. Other radio telescopes also combine multiple signals from an antenna array, but LOFAR operates at such low frequencies that Earth's ionosphere can distort the signals. It's similar to the way visible light can be distorted when viewed through ripples of water. So powerful new software had to be developed to convert the radio data into images of the sky.

Recently, LOFAR released the first data on its Long Baseline Array Sky Survey. They have only mapped 4% of the northern sky so far, but have already mapped 25,000 supermassive black holes. While the universe is filled with radio sources, most low-frequency radio light comes from concentrated sources such as black holes at the hearts of galaxies. LOFAR has a high enough resolution that the black hole map looks like a starry night, with each black hole as an isolated radio dot, as you can see in the image above.

It will take several more years for the team to make a full map of the northern sky. When completed, the sky survey could help us learn not only about black holes but also about the large-scale structure of the cosmos.

How Long Will Space Junk Take to Burn Up? Here's a Handy Chart

If the Roman Empire had been able to launch a satellite in a relatively high Low Earth Orbit – say about 1,200 km (750 miles) in altitude – only now would that satellite be close to falling back to Earth. And if the dinosaurs had launched a satellite into the furthest geostationary orbit – 36,000 km (23,000 miles) or higher — it might still be up there today.

While we've *really* only launched satellites since 1957, those examples show how long objects can stay in orbit. With the growing problem of accumulating space junk in Earth orbit, many experts have stressed for years that satellite operators must figure out how to responsibly dispose of derelict satellites at the end of their lives.

The European Space Agency (ESA) and the United Nations Office for Outer Space Affairs (UNOOSA) have collaborated for a new infographic to show how long it would take satellites at different altitudes to naturally fall back to Earth.

Credit: ESA & UNOOSA

While the natural de-orbit process can be relatively fast for satellites flying at low altitudes — taking less than 25 years — for satellites launched into orbits tens of thousands of kilometers away, it can be thousands of years before they return.

Gravity has little effect on a satellite's return to Earth. The biggest factor in satellites decreasing their orbit is the amount of drag they encounter from Earth's atmosphere. A satellite can remain in the same orbit for a long period of time as the gravitational pull of the Earth provides a balance to the centrifugal force satellites experience in orbit. For satellites in orbit outside the atmosphere, there is no air resistance, and therefore, according to the law of inertia, the speed of the satellite is constant resulting in a stable orbit around the Earth for many years.

"If we look at our statistics, we have about 300 objects per year returning to Earth, burning up in the atmosphere," said Francesca Letizia, a space debris engineer at ESA, in a podcast on space debris. "Below 500 km, the effect of the atmosphere, the spacecraft can reenter within 25 years. At 800 km above Earth, it will take about 100-150 years to fall back to Earth."

Letizia said the biggest risk for old satellites that aren't currently operating is the risk they pose for exploding and creating more fragments, or for colliding with other satellites and either causing damage or destruction and also creating additional objects in Earth orbit.

In Depth: This is What Happens to Spacecraft When They Reenter Earth's Atmosphere

This means that as we launch satellites to space we must consider how they will be removed at the end of their lives, or else the area around Earth will be filled with old, defunct spacecraft at risk of collision, explosion, and the near-certain creation of vast amounts of space debris.

Perseverance has Landed. Here are its First Pictures

From the Surface of Mars

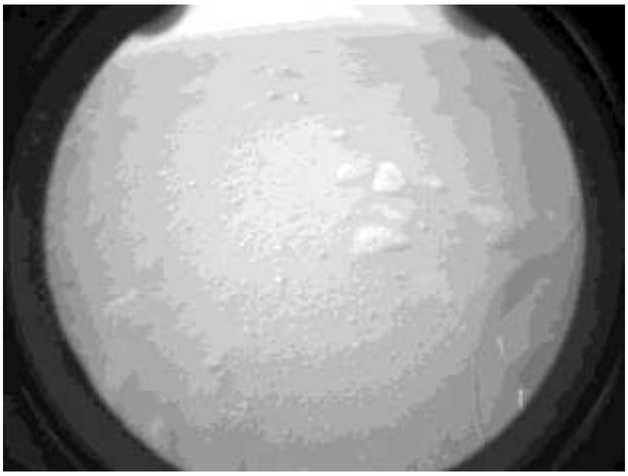
They've done it again. After a journey of nearly seven months, the Perseverance rover teams successfully guided their intrepid traveler to a pinpoint landing inside Jezero Crater on Mars on February 18, 2021.

And within minutes of the landing, Perseverance sent back two images from the front and rear Hazard Avoidance Cameras, revealing its surroundings on the Red Planet.

NASA's Mars Perseverance rover acquired this image of the area in front of it using its onboard Front Left Hazard Avoidance Camera A. This image was acquired on Feb. 18, 2021 (Sol 0) at the local mean solar time of 20:58:24. Credit: NASA/JPL-Caltech

I love the first image, above, from the Front Left Hazard Avoidance Camera A, because it shows Perseverance's shadow on Mars. To me, this image says, "I'm here, we made it!"

Below is the view from the second picture the rover beamed back, from the Rear Right Hazard Avoidance Camera, showing all the things planetary rover scientists like to see: rocks to study, and an immediate flat place to drive around.



NASA's Mars Perseverance rover acquired this image of the area in back of it using its onboard Rear Right Hazard Avoidance Camera. This image was acquired on Feb. 18, 2021 (Sol 0) at the local mean solar time of 20:59:31. ***Credit:*** *NASA/JPL-Caltech*

For the first time, the rover teams were able to quickly determine exactly where Perseverance had landed. That's because part of Perseverance's new landing system was a new navigation package that took images of the landing area and compared them with maps to pick out a safe spot to touch down. "This is finally like landing with your eyes open," said NASA scientist Swati Mohan who provided the play-by-play during the NASA livestream of the landing.

There's a rumor more images will be released today, perhaps even some from the Entry Descent and Landing (EDL). Another rumor says by Monday, NASA may be able to release the video and audio the rover's landing system took. Audio from one of the rover's microphones (read more about them here) will be paired with full-color video taken by the EDL cameras. This will allow viewers to experience what landing on Mars both looks and sounds like for the very first time. So, stay tuned!

The Surprising Discovery of Ceramic Chips Inside Meteorites Means There Were Wild Temperature Variations In the Early Solar System

Meteorites are excellent windows into early solar system formation. Many were formed in the those early days, and unlike rocks on the Earth, most are not affected by billions of years of tectonic activity that wipes away any of their original structure. Recently a team led by Nicolas Dauphas and Justin Hu at the University of Chicago (UC) found that the formation process for many of these meteorites was much more violent than previously thought.

Typical models of the early formation of the solar system have the sun starting out hot and then gradually cooling down as it aged. That model does not fit the findings data present in the paper recently accepted to Science Advances.

UT Q&A Session Discussing the origins of some meteorites

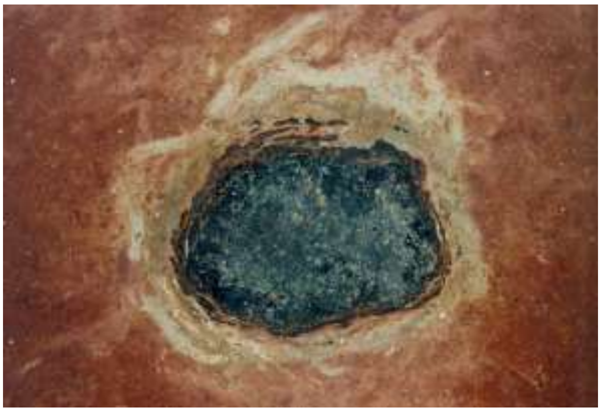
In it, the team looks carefully at some ceramic chips that were present inside of a meteorite sample. Normally, these ceramics are thought to be even older than the surrounding meteorite itself and were likely formed in the first 100,000 years of the solar system. This isn't the first time scientists have attempted to analyze these ceramics, knowing that they held the key to understanding the early solar system.

Previously efforts were held back by technological limitations however, and if there's one thing that engineering is very good at it is overcoming technological limitations. The research team at UC actually invented a completely new type of high specialized purification system to analyze isotopes found in the ceramic chips of meteorites.

Meteorites don't only come from the early solar system – some, such as this "Black Beauty" meteorite, come from Mars, and have a very different chemical composition than those studied by the UC team.
Credit: NASA

The new tool showed that the isotopes present in the ceramic chips must have been formed at extremely high temperatures (1,300 degrees C) over extremely long periods of times (tens of thousands of years). In short, environmental conditions needed to form these early stage ceramics were not the same as those in the current early models of the solar system.

Findings such as these fit into a newer narrative about solar system formation that is starting to take shape. Scientists have already had some data pointing to a much more violent early period of the sun, but the new data from the analysis of the ceramic add a new layer of evidence to the more violent models of early solar system formation.



Some meteorites embedded themselves in the Earth, such as this "fossil meteorite".
Image credit – Birger Schmitz

That formation impacts not only meteorites but also planetary formation processes such as those of Earth, Mars, and Venus. Insight into early solar system formation models could lead to better understanding of why only one of the three main rocky planets is believed to be habitable, and other mysteries of planetary formation that have long eluded scientists.

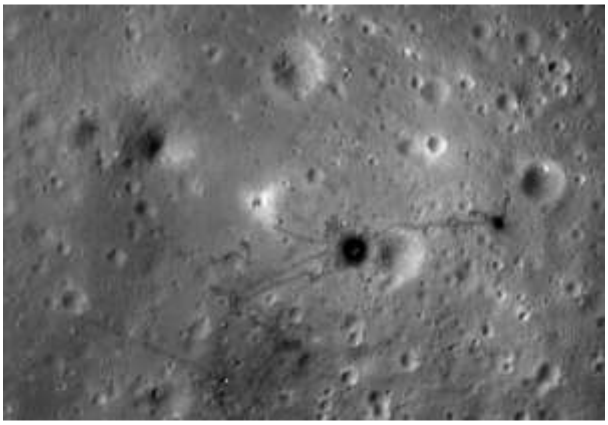
Close up image of the meteorite, and associated ceramic chips, that was used as part of the UC study.
Credit: Hu et all. / University of Chicago

Understanding meteorite composition is only one small part of that effort though. With new technology and ever increasing evidence in the form of new data, someday scientists will have a much more complete and accurate picture of the very early days of our solar system.

Lunar Spacecraft Gets an Upgrade to Capture New Perspectives of the Moon

Eleven years into its mission, the Lunar Reconnaissance Orbiter (LRO) is starting to show its age, but a recent software update promises to give the spacecraft a new lease on life. As NASA's eye in the sky over the Moon, the LRO has been responsible for some of the best Lunar observations since the days of Apollo. This new upgrade will allow that legacy to continue.

Launched in June 2009, the LRO quickly succeeded in mapping over 98% of the Moon's surface at a resolution of 100 meters per pixel. The orbiter is also famous for taking incredible high-resolution images of the Apollo landing sites, in which landers, rovers, tire tracks, and astronaut footprints are clearly visible.

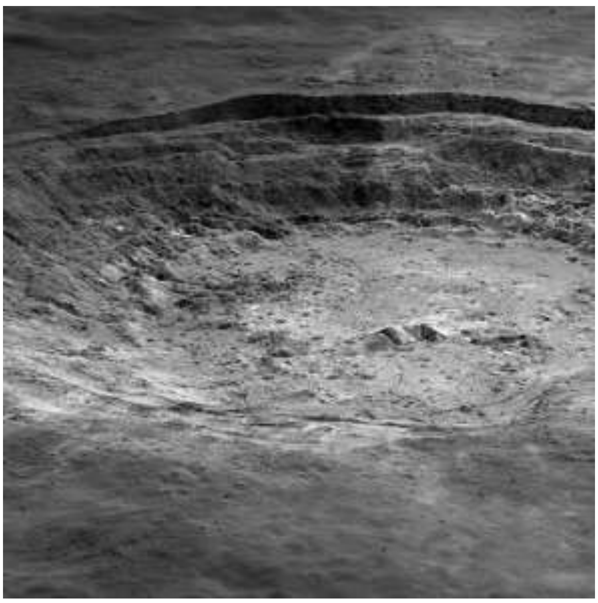


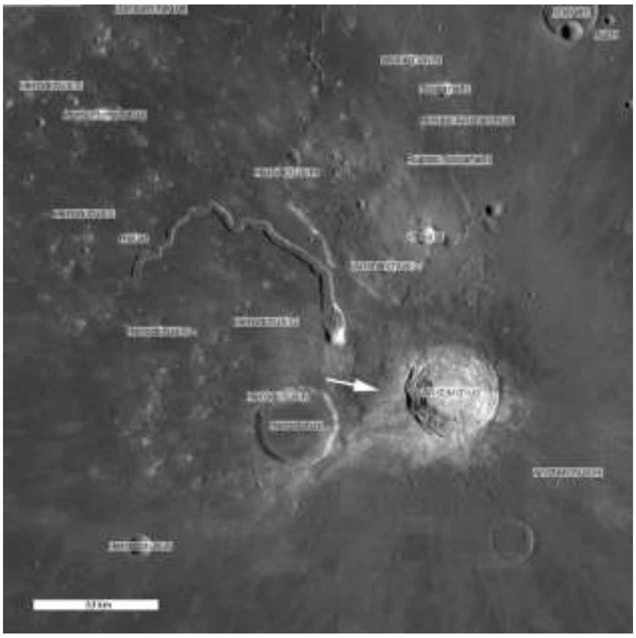
LRO image of the Apollo 16 landing site. Credit: NASA/GSFC/Arizona State University.

In 2016, the LRO found evidence that the Moon is geologically active as a result of tidal forces from the Earth, and also because the Moon is shrinking as its core cools. More recently, the LRO was able to observe the impact sites of both the Indian Space Research Organization's Vikram lander, and SpaceIL's Beresheet lander (both impressive and record-breaking missions, despite their 'explosive' endings).

The LRO's monumental record of achievement has not made it immune to trouble, however. Its woes began in 2018, when the LRO's aging Miniature Inertial Measurement Unit (MIMU), an instrument used to measure the spacecraft's rotation, had to be shut down. Without the MIMU, the LRO has to rely solely on star trackers to orient itself. Star tracking is a perfectly feasible alternative to the MIMU, using stellar positions like a map to tell the spacecraft which direction it's facing.

Without new software, however, the star tracking method prevented the LRO from making quick, complicated maneuvers required to take side-angle images of the Moon. These side-angle shots are important for two reasons. The first is that they allowed for photometry, or the ability to study how surface brightness changes from different perspectives. Second, they provide the ability to produce spectacular 3D images, giving the Moon's geographical features a sense of depth and realism, which is sometimes missing from the map-like images created by taking straight-down shots.



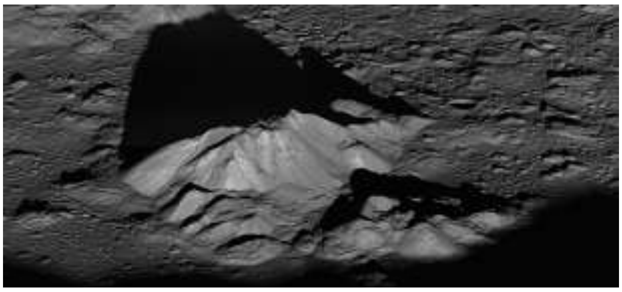


Compare these two images of Aristarchus Crater taken by the LRO: the first from a side-angle, the second from straight overhead. Credit (both images): NASA/GSFC/ Arizona State University.

To recover the LRO's ability to quickly reorient itself for side-angle shots, the LRO team had to write a new algorithm, which they called 'FastMan,' short for 'Fast Maneuvering'. It was brought online for the first time in 2020 and has proven to be a great success so far.

One of the challenges FastMan had to overcome was that if the star trackers were accidentally pointed at a bright object like the Sun, Moon, or Earth, they would lose their ability to orient the spacecraft. FastMan ensures that this does not occur.

Initially, FastMan required input from the ground in order to work in tandem with the flight software, but it has now been integrated so that FastMan can perform side-view maneuvers autonomously.



The central peak of Tycho Crater, as seen by the LRO from an oblique angle. Credit: NASA/GSFC/Arizona State University.

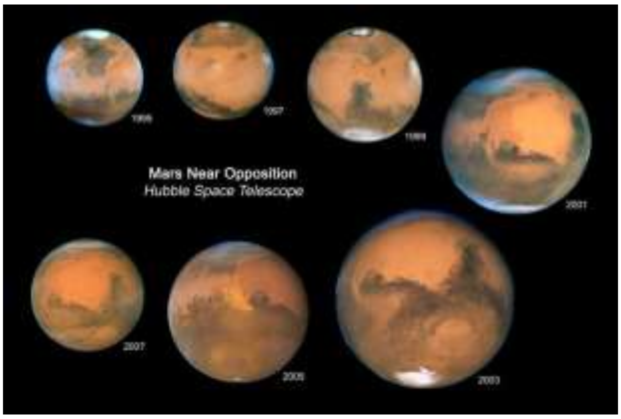
With the upgrade installed, the LRO is set to continue doing science well into the next decade. Regarding the LRO's lifespan going forward, Noah Petro, Project Scientist for LRO at NASA Goddard, said that "fuel may be our rate-limiting factor, current estimates place us at having at least five more years of fuel onboard, if not more."

Although the LRO has surpassed its initial mission goals, the spacecraft's continued well-being will still be an asset in the coming years, not least because it will be able to support the Artemis program, which is ramping up to achieve the next human Lunar landing sometime this decade. Long Live the LRO!

February 7th Was the Start of a New Year on Mars

Happy New Year – from Mars. It's always mind expanding to think about the passage of time from other perspectives than the ones we are most familiar with. So let's celebrate that our slightly colder red cousin completed another spin around the sun. The 36th Martian year began on February 7th, with a noticeable lack of fireworks or people singing Auld Lang Syne.

Despite the lack of festivities on the planet's surface (maybe Curiosity could play Auld Lang Syne to itself?), the planet's friends at ESA put together a bulleted list of some fun facts about the Martian year. Here are some highlights.



Every 26 months Mars is opposite the Sun in our nighttime sky. Since 1995, Mars has been at such an "opposition" with the Sun seven times. A color composite from each of the seven Hubble opposition observations has been assembled in this mosaic to showcase the beauty and splendor that is The Red Planet. This mosaic of all seven globes of Mars shows relative variations in the apparent angular size of Mars over the years. Mars was the closest in 2003 when it came within 56 million kilometers of Earth. The part of Mars that is tilted towards the Earth also shifts over time, resulting in the changing visibility of the polar caps. Clouds and dust storms, as well as the size of the ice caps, can change the appearance of Mars on time scales of days, weeks, and months. Other features of Mars, such as some of the large dark markings, have remained unchanged for centuries.
Credit: NASA/ESA

Year 36 might seem a little young, based on the fact that the planet is a few billion years old. That is because humans, with our anthropomorphic inclinations, decided arbitrarily to start counting Martian years in the human year 1955. Each year takes about 687 Earth days, leading us to the 36th Martian year beginning this month.

An important question is at what point in Mars' spin around the sun does its year actually start? Astronomers have decided that the northern equinox marks the start of a new Martian year. This point is the beginning of spring in the northern hemisphere and autumn in the southern. That at least makes more sense than the arbitrary date slightly after the beginning of winter that our species has picked for at least most of Earth's western hemisphere to begin a new year.

UT video discussing Martian weather and how the atmosphere could be rebuilt.

The choice of that date might be partly due to another fun fact about Mars' year – it's seasons are not all the same length.   Mars has a highly elliptical orbit compared to Earth, meaning that its northern hemisphere's spring (194 days) is much longer than its autumn (142 days). This path has predictably large impacts on the weather of the red planet. Increases in luminosity when the sun is closer (during the southern hemisphere's summer and spring) cause large dust storms that blanket the planet almost annually, such as in

Martian Year 1 with the aptly named "great dust storm of 1956".

Those dust storms are not the only annual weather events though – another interesting one is the Arsia Mons Elongated Cloud, an 1800 km cloud of ice crystals which pops up for at least 80 Martian days ("sols") a year and then disappears. Like many other features of Mars, it goes to show how the planet is dynamic and changing, despite appearing to be just a ball of rock with barely any atmosphere.

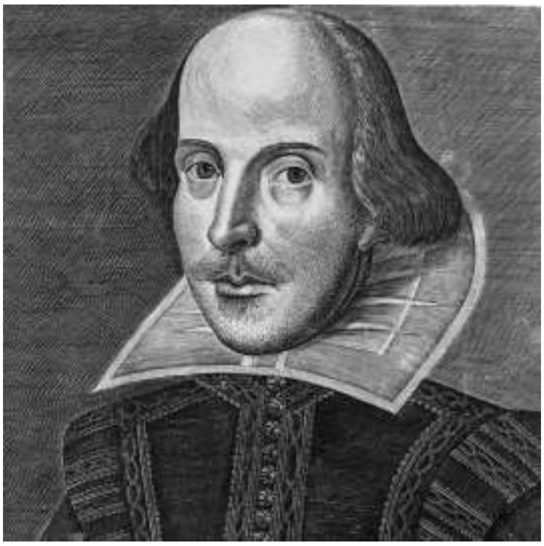
Image of the Arsia Mons Elongated Cloud – a cloud of ice particles 1800 km long that appears annually on Mars. Credit: ESA/GCP/UPV/EHU Bilbao

As we learn more about our sometimes nearest neighbor, we will undoubtedly find more annual phenomena that take place there. But even now we can appreciate that time passes differently depending on how you look at it. If nothing else, you can tell your coworkers that you're only 53% of your Earth age on Mars at least.

Moons in the Solar System
There are currently 181 known moons in our solar system orbiting the various planets and dwarf planets. Of the 13 planets and dwarf planets, there are four which don't have any moons. These are the planets Mercury and Venus, and the dwarf planets Ceres and Makemake.

How Moons Get Their Names

Most moons in our solar system are named for mythological characters from a wide variety of cultures. The newest moons discovered at Saturn, for example, are named for Norse gods such as Bergelmir, a giant.



Shakespeare's characters are immortalized in orbit at Uranus.

Uranus is the exception. Uranus' moons are named for characters in William Shakespeare's plays so you'll find Ophelia and Puck in orbit. Other Uranian moon names were chosen from Alexander Pope's poetry (Belinda and Ariel).

Moons are given provisional designations such as S/2009 S1, the first satellite discovered at Saturn in 2009. The International Astronomical Union approves an official name when the discovery is confirmed.

Moons of the Inner Solar System

Earth's Moon probably formed when a large body about the size of Mars collided with Earth, ejecting a lot of material from our planet into orbit. Debris from the early Earth and the impacting body accumulated to form the Moon approximately 4.5 billion years ago (the age of the oldest collected lunar rocks). Twelve American astronauts landed on the Moon during NASA's Apollo program from 1969 to 1972, studying the Moon and bringing back rock samples.

Usually the term moon brings to mind a spherical object, like Earth's Moon. The two moons of Mars, Phobos and Deimos, are different. While both have nearly circular orbits and travel close to the plane of the planet's equator, they are lumpy and dark. Phobos is slowly drawing closer to Mars and could crash into the planet in 40 or 50 million years. Or the planet's gravity might break Phobos apart, creating a thin ring around Mars.

Moons of the Giant Planets

Jupiter's menagerie of moons includes the largest in the solar system (Ganymede), an ocean moon (Europa) and a volcanic moon (Io). Many of Jupiter's outer moons have highly elliptical orbits and orbit backwards (opposite to the spin of the planet). Saturn, Uranus and Neptune also have some irregular moons, which orbit far from their respective planets.

Saturn has two ocean moons—Enceladus and Titan. Both have subsurface oceans and Titan also has surface seas of lakes of ethane and methane. The chunks of ice and rock in Saturn's rings (and the particles in the rings of the other outer planets) are not considered moons, yet embedded in Saturn's rings are distinct moons or moonlets. These shepherd moons help keep the rings in line. Titan, the second largest in the solar system, is the only moon with a thick atmosphere.

In the realm of the ice giants, Uranus's inner moons appear to be about half water ice and half rock. Miranda is the most unusual; its chopped-up appearance shows the scars of impacts of large rocky bodies.

Neptune's moon Triton is as big as Pluto and orbits backwards compared with Neptune's direction of rotation.

Moons of Dwarf Planets

Pluto's large moon Charon is about half the size of Pluto. Like Earth's Moon, Charon may have formed from debris resulting from an early collision of an impactor with Pluto. Scientists using the Hubble Space Telescope to study Pluto found four more small moons.

Eris, another dwarf planet even more distant than Pluto, has a small moon of its own, named Dysnomia. Haumea, another dwarf planet, has two satellites, Hi'iaka and Namaka. Ceres, the closest dwarf planet to the Sun, has no moons.

More Moons

Scientists weren't sure if asteroids could hold moons in their orbits until the Galileo spacecraft flew past asteroid Ida in 1993. Images revealed a tiny moon, later named Dactyl.

Moons — also called satellites — come in many shapes, sizes, and types. They are generally solid bodies, and few have atmospheres. Most of the planetary moons probably formed from the discs of gas and dust circulating around planets in the early solar system. Some moons are large enough for their gravity to cause them to be spherical, while smaller moons appear to be captured asteroids, not related to the formation and evolution of the body they orbit. The International Astronomical Union lists 146 moons orbiting planets in our solar system — this number does not include the moons awaiting official recognition and naming, the eight moons of the dwarf planets, nor the tiny satellites that orbit some asteroids and other celestial objects. Of the terrestrial (rocky) planets of the inner solar system, neither Mercury nor Venus has any moons at all, Earth has one, and Mars has its two small moons. In the outer solar system, the gas giants (Jupiter, Saturn) and the ice giants (Uranus and Neptune) have numerous moons. As these huge planets grew in the early solar system, they were able to capture objects with their large gravitational fields. Earth's Moon probably formed when a large body about the size of Mars collided with Earth, ejecting material from our planet into orbit. This material accumulated to form the Moon approximately 4.5 billion years ago (the age of the oldest collected lunar rocks). Twelve American astronauts landed on the Moon during NASA's Apollo program in 1969 to 1972, studying the Moon and bringing back rock samples. Usually the term "moon" brings to mind a spherical object, like Earth's Moon. The two moons of Mars, Phobos and Deimos, are somewhat different. Both have nearly circular orbits and travel close to the plane of the planet's equator, and they are lumpy and dark. Phobos is slowly drawing closer to Mars, and could crash into Mars in 40 or 50 million years, or the planet's gravity might break Phobos apart, creating a thin ring around Mars. Jupiter has 50 known moons (plus 17 awaiting official confirmation), including the largest moon in the solar system, Ganymede. Many of Jupiter's outer moons have highly elliptical orbits and orbit "backwards" (opposite to the spin of the planet). Saturn, Uranus, and Neptune also have some "irregular" moons, which orbit far from their respective planets. Saturn has 53 known moons (plus 9 awaiting official confirmation). The chunks of ice and rock in Saturn's rings (and the particles in the rings of the other outer planets) are not considered moons, yet embedded in Saturn's rings are distinct moons or "moonlets." Small "shepherd" moons help keep the rings in line. Saturn's moon Titan, the second largest in the solar system, is the only moon with a thick atmosphere. Beyond Saturn, Uranus has 27 known moons. The inner moons appear to be about half water ice and half rock. Miranda is the most unusual; its chopped-up appearance shows the scars of impacts of large rocky bodies. Neptune's moon Triton is as big as the dwarf planet Pluto, and orbits backwards compared with Neptune's direction of rotation. Neptune has 13 known moons plus a 14th awaiting official confirmation. Pluto's large moon, Charon, is about half the size of Pluto, and some scientists consider Pluto/Charon to be a double system. Like Earth's Moon, Charon may have formed from debris from an early collision of an impactor with Pluto. Scientists using the Hubble Space Telescope to study Pluto have found five additional smaller moons. Eris, a dwarf planet even more distant than Pluto, has a small moon of its own, named Dysnomia. Haumea, another dwarf planet, has two satellites, Hi'iaka and Namaka. FAST FACTS — PLANETS AND SELECTED MOONS Mean Radius Mean Radius Planet Moon (km) (mi) Earth Moon 1,737.4 1,079.6 Mars Phobos 11.1 6.9 Mars Deimos 6.2 3.9 Jupiter Io 1,821.6 1,131.9 Jupiter Europa 1,560.8 969.8 Jupiter Callisto 2,410 1,498 Jupiter Ganymede 2,631 1,635 Saturn Mimas 198.6 123.4 Saturn Enceladus 249.4 154.9 Saturn Tethys 529.9 329.3 Saturn Dione 560 348 Saturn Rhea 764 475 Saturn Titan 2,575 1,600 Saturn Iapetus 718 446 Uranus Miranda 235.8 146.5 Uranus Ariel 578.9 359.7 Uranus Umbriel 584.7 363.3 Uranus Titania 788.9 490.2 Uranus Oberon 761.4 473.1 Neptune Triton 1,353.4 841 Neptune Nereid 170 106 SIGNIFICANT DATES 1610 — Galileo Galilei and Simon Marius independently discover four moons orbiting Jupiter. Galileo is credited and the moons are called "Galilean." This discovery changed the way the solar system was perceived. 1877 — Asaph Hall discovers Mars' moons Phobos and Deimos. 1969 — Astronaut Neil Armstrong is the first of 12 humans to walk on the surface of Earth's Moon. 1979 — Voyager 1 photographs an erupting volcano on Jupiter's moon Io; the first ever seen anywhere other than Earth. 1980 — Voyager 1 instruments detect signs of surface features beneath the hazy atmosphere of Saturn's largest moon, Titan. 2005 — The Cassini spacecraft discovers jets or geysers of water ice particles venting from Saturn's moon Enceladus. 2000–present — Using improved ground-based telescopes, the Hubble Space Telescope, and spacecraft observations, scientists have found dozens of new moons in our solar system. Newly discovered moons (as well as other solar system objects) are given temporary designations until they are confirmed by subsequent observations and receive permanent names from the International Astronomical Union. ABOUT THE IMAGES Selected solar system moons, displaying a variety of surface features, are shown at correct relative sizes to each other and to Earth. Miranda, a moon of Uranus, has many rugged features: canyons, grooved structures, ridges, and broken terrain. The large cliff in this image is a 12-mile-high vertical drop. This false-color image of Neptune's moon Triton shows what appear to be volcanic deposits. This Voyager 1 close-up of Saturn's moon Rhea shows the moon's ancient, cratered surface. A portion of a Cassini radar image of Saturn's largest moon, Titan, showing the complexity of the surface. Cassini imaged the small irregular moon Phoebe when the spacecraft was inbound for Saturn orbit insertion in June 2004.

EXTRA SOLAR MOONS

An **exomoon** or **extrasolar moon** is a natural satellite that orbits an exoplanet or other non-stellar extrasolar body.[1]
It is inferred from the empirical study of natural satellites in the Solar System that they are likely to be common elements of planetary systems. The majority of detected exoplanets are giant planets. In the Solar System, the giant planets have large collections of natural satellites (see Moons of Jupiter, Moons of Saturn, Moons of Uranus and Moons of Neptune). Therefore, it is reasonable to assume that exomoons are equally common.
Though exomoons are difficult to detect and confirm using current techniques,[2] observations from missions such as *Kepler* have observed a number of candidates, including some that may be habitats for extraterrestrial life and one that may be a rogue planet.[1] To date there are no confirmed exomoon detections.[3] Nevertheless, in September 2019, astronomers reported that the observed dimmings of Tabby's Star may have been produced by fragments resulting from the disruption of an orphaned exomoon.[4][5][6]
Although traditional usage implies moons orbit a planet, the discovery of planet-sized satellites around brown dwarfs blurs the distinction between planets and moons, due to the low mass of such failed stars. To resolve this confusion, the International Astronomical Union declared, "Objects with true masses below the limiting mass for thermonuclear fusion of deuterium, that orbit stars or stellar remnants, are planets.
Characteristics of any extrasolar satellite are likely to vary, as do the Solar System's moons. For extrasolar giant planets orbiting within their stellar habitable zone, there is a prospect a terrestrial planet-sized satellite may be capable of supporting life.
In August 2019, astronomers reported that an exomoon in the WASP-49b exoplanet system may be volcanically active.[
For impact-generated moons of terrestrial planets not too far from their star, with a large planet–moon distance, it is expected that the orbital planes of moons will tend to be aligned

with the planet's orbit around the star due to tides from the star, but if the planet–moon distance is small it may be inclined. For gas giants, the orbits of moons will tend to be aligned with the giant planet's equator because these formed in circumplanetary disks.[

Planets close to their stars on circular orbits will tend to despin and become tidally locked. As the planet's rotation slows down the radius of a synchronous orbit of the planet moves outwards from the planet. For planets tidally locked to their stars, the distance from the planet at which the moon will be in a synchronous orbit around the planet is outside the Hill sphere of the planet. The Hill sphere of the planet is the region where its gravity dominates that of the star so it can hold on to its moons. Moons inside the synchronous orbit radius of a planet will spiral into the planet. Therefore, if the synchronous orbit is outside the Hill sphere, then all moons will spiral into the planet. If the synchronous orbit is not three-body stable then moons outside this radius will escape orbit before they reach the synchronous orbit.

A study on tidal-induced migration offered a feasible explanation for this lack of exomoons. It showed the physical evolution of host planets (i.e. interior structure and size) plays a major role in their final fate: synchronous orbits can become transient states and moons are prone to be stalled in semi-asymptotic semimajor axes, or even ejected from the system, where other effects can appear. In turn, this would have a great impact on the detection of extrasolar satellites.[12]

Artist's impression of a hypothetical Earth-like moon

around a Saturn-like exoplanet

The existence of exomoons around many exoplanets is theorized.[8] Despite the great successes of planet hunters with Doppler spectroscopy of the host star,[13] exomoons cannot be found with this technique. This is because the resultant shifted stellar spectra due to the presence of a planet plus additional satellites would behave identically to a single point-mass moving in orbit of the host star. In recognition of this, there have been several other methods proposed for detecting exomoons, including:

Direct imaging

Direct imaging of an exoplanet is extremely challenging due to the large difference in brightness between the star and exoplanet as well as the small size and irradiance of the planet. These problems are greater for exomoons in most cases. However, it has been theorized that tidally heated exomoons could shine as brightly as some exoplanets. Tidal forces can heat up an exomoon because energy is dissipated by differential forces on it. Io, a tidally heated moon orbiting Jupiter, has volcanoes powered by tidal forces. If a tidally heated exomoon is sufficiently tidally heated and is distant enough from its star for the moon's light not to be drowned out, it would be possible for future telescopes (such as the James Webb Space Telescope) to image it.[

Doppler spectroscopy of host planet

Doppler spectroscopy is an indirect detection method that measures the velocity shift and result stellar spectrum shift associated with an orbiting planet.[15] This method is also known as the Radial Velocity method. It is most successful for main sequence stars The spectra of exoplanets have been successfully partially retrieved for several cases, including HD 189733 b and HD 209458 b. The quality of the retrieved spectra is significantly more affected by noise than the stellar spectrum. As a result, the spectral resolution, and number of retrieved spectral features, is much lower than the level required to perform doppler spectroscopy of the exoplanet.

Detection of radio wave emissions from the magnetosphere of host planet

During its orbit, Io's ionosphere interacts with Jupiter's magnetosphere, to create a frictional current that causes radio wave emissions. These are called "Io-controlled decametric emissions" and the researchers believe finding similar emissions near known exoplanets could be key to predicting where other moons exist.

Microlensing

In 2002, Cheongho Han & Wonyong Han proposed microlensing be used to detect exomoons.The authors found detecting satellite signals in lensing light curves will be very difficult because the signals are seriously smeared out by the severe finite-source effect even for events involved with source stars with small angular radii.

Pulsar timing

In 2008, Lewis, Sackett, and Mardling[18] of the Monash University, Australia, proposed using pulsar timing to detect the moons of pulsar planets. The authors applied their method to the case of PSR B1620-26 b and found that a stable moon orbiting this planet could be detected, if the moon had a separation of about one fiftieth of that of the orbit of the planet around the pulsar, and a mass ratio to the planet of 5% or larger.

Transit timing effects

In 2007, physicists A. Simon, K. Szatmáry, and Gy. M. Szabó published a research note titled 'Determination of the size, mass, and density of “exomoons” from photometric transit timing variations'.[19]

In 2009, University College London-based astronomer David Kipping published a paper[2][20] outlining how by combining multiple observations of variations in the time of mid-transit (TTV, caused by the planet leading or trailing the planet–moon system's barycenter when the pair are oriented roughly perpendicular to the line of sight) with variations of the transit duration (TDV, caused by the planet moving along the direction path of transit relative to the planet–moon system's barycenter when the moon–planet axis lies roughly along the line of sight) a unique exomoon signature is produced. Furthermore, the work demonstrated how both the mass of the exomoon and its orbital distance from the planet could be determined using the two effects.

In a later study, Kipping concluded that habitable zone exomoons could be detected by the *Kepler Space Telescope* using the TTV and TDV effects.

Transit method

When an exoplanet passes in front of the host star, a small dip in the light received from the star may be observed. The transit method is currently the most successful and responsive method for detecting exoplanets. This effect, also known as occultation, is proportional to the square of the planet's radius. If a planet and a moon passed in front of a host star, both objects should produce a dip in the observed light. A planet–moon eclipse may also occur[23] during the transit, but such events have an inherently low probability.

Orbital sampling effects[

If a glass bottle is held up to the light it is easier to see through the middle of the glass than it is near the edges. Similarly a sequence of samples of a moon's position will be more bunched up at the edges of the moon's orbit of a planet than in the middle. If a moon orbits a planet that transits its star then the moon will also transit the star and this bunching up at the edges may be detectable in the transit light curves if a sufficient number of measurements are made. The larger the star the greater the number of measurements are needed to create observable bunching. The Kepler spacecraft data may contain enough data to detect moons around red dwarfs using orbital sampling effects but won't have enough data for Sun-like stars.

In December 2013, a candidate exomoon of a free-floating planet MOA-2011-BLG-262, was announced, but due to degeneracies in the modelling of the microlensing event, the observations can also be explained as a Neptune-mass planet orbiting a low-mass red dwarf, a scenario the authors consider to be more likely. This candidate also featured in the news a few months later in April 2014.

In October 2018, researchers using the Hubble Space Telescope published observations of the candidate exomoon Kepler-1625b I, which suggest that the host planet is likely several Jupiter masses, while the exomoon may have a mass and radius similar to Neptune. The study concluded that the exomoon hypothesis is the simplest and best explanation for the available observations, though warned that it is difficult to assign a precise probability to its existence and nature.[32][33] However, a reanalysis of the data published in April 2019 concluded that the data was fit better by a planet-only model. According to this study, the discrepancy was an artifact of the data reduction, and Kepler-1625b I likely does not exist.[

A paper by Chris Fox and Paul Wiegert examined the Kepler dataset for indications of exomoons solely from transit timing variations. Eight candidate signals were found that were consistent with an exomoon, however the signals could also be explained by the presence of another planet. Fox & Wiegert's conclusion was more and higher quality transit timing data would be required to establish whether these are truly moons or not.[35] However, in August 2020 David Kipping examined six of the eight targets (based on a pre-peer review version) and evaluated the evidence as uncompelling. The same study finds that Kepler-1625b I remains an exomoon candidate

First suspected 'exomoon' discovered 8,000 light-years away

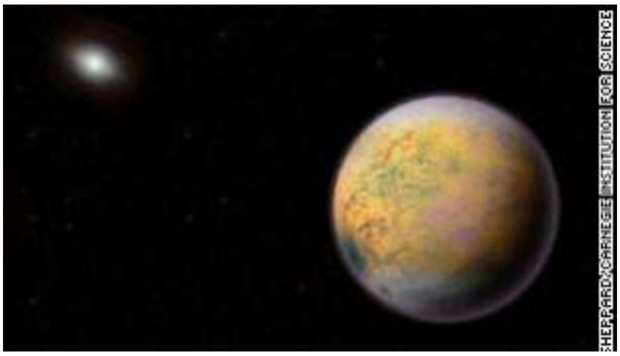
For the first time, astronomers have discovered what could be an exomoon, a moon outside our solar system. The so-called exomoon, which is estimated to be the size of Neptune, was found in orbit around a gigantic gas planet 8,000 light-years from Earth.

Although moons are common in our solar system, which has nearly 200 natural satellites, the long search for interstellar moons has been an empty one. Astronomers have had success locating exoplanets around stars outside our solar system, but exomoons are harder to pinpoint because of their smaller size.

"This would be the first case of detecting a moon outside our solar system," said David Kipping, an assistant professor of astronomy at Columbia University and one of the discoverers of the potential exomoon. "If confirmed by follow-up Hubble observations, the finding could provide vital clues about the development of planetary systems and may cause experts to revisit theories of how moons form around planets."

Kipping has spent a decade working on the "exomoon hunt."

But the scientists behind this discovery are hesitant to confirm that the new find is an exomoon due to some of its peculiarities and the fact that more observation is needed. Their results were published Wednesday in the journal Science Advances.



The hunt for Planet X turns up a new solar system object

"This is not by itself a proof of an exomoon," Kipping said. "It's the unknown of unknowns which are ultimately uncharacterizeable."

However, the finding is both promising and intriguing. The moon, which orbits a giant exoplanet called Kepler-1625b, is incredibly large, comparable to the size of the gas giant Neptune in our solar system. There's no analog for such a large moon in our own system. In our sky, it would appear two times bigger than Earth's moon, the researchers said.

But that size is why it was easier to find, the researchers said. It's comparable to so-called hot Jupiters, gas giant exoplanets that are closer to their stars than Jupiter is to its own, and warmer. These were common discoveries during the early days of exoplanet hunting because they were easy to find, but they represent only about 1% of known exoplanets now.

The planet that the potential exomoon orbits, Kepler-1625b, is several times the mass of Jupiter, which means their mass-ratio is similar to that of Earth and its moon.

It was discovered when Columbia astronomers Kipping and Alex Teachey used NASA's Hubble Space Telescope to follow up on an intriguing find from data in the Kepler Space Telescope's exoplanet catalog. This catalog included 284 planets found by Kepler with wide orbits around their host stars. Kepler-1625b stood out.

"We saw little deviations and wobbles in the light curve that caught our attention," Kipping said. The researchers were awarded with 40 hours of observation time using Hubble, and the data they gathered were four times more precise than what Kepler had captured.

During a transit period, in which the planet passed in front of its star, Hubble detected a second decrease in the star's brightness after the planet. It was like "a moon trailing the planet like a dog following its owner on a leash," Kipping said. "Unfortunately, the scheduled Hubble observations ended before the complete transit of the moon could be measured."

Hubble was also able to measure that the planet began its transit earlier than expected, consistent with the "wobble" that occurs when a planet and moon orbit the same center of gravity. This also happens with Earth, the moon and the sun.

Paging Mr. Spock: 'Star Trek' planet Vulcan found?

Perhaps that wobble could be due to the presence of a second planet, the researchers thought. But Kepler didn't find any other planets around this star.

"A companion moon is the simplest and most natural explanation for the second dip in the light curve and the orbit-timing deviation," Teachey said. "It was a shocking moment to see that light curve. My heart started beating a little faster, and I just kept looking at that signature. But we knew our job was to keep a level head, testing every conceivable way in which the data could be tricking us until we were left with no other explanation."

Although the planet and its possible moon are within the habitable zone of their star, both are considered to be gas giants and "unsuitable for life as we know it," Kipping said. It's not like the exomoon in "Avatar" or Endor from "Star Wars," Teachey said, "but going forward, I think we're opening doors to finding worlds like that."

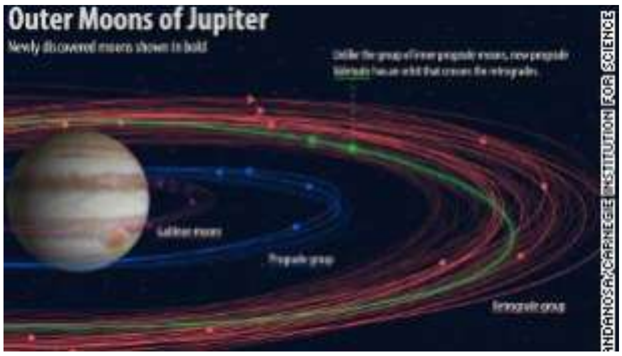
The researchers believe the star system to be 10 billion years old, which means it's had time to evolve. This could explain why the moon is 3 million kilometers from its planet; they were probably closer in the past.

Water ice found at the moon's poles, study says

They estimate the surface temperature of both to be 176 degrees Fahrenheit. The star was probably cooler in the past, so this heat could be a reason for the size of the moon, inflating the gas giant as the temperature rises. But until they have more data, this is only speculation, Kipping said.

How did this moon form in the first place? There are three primary theories about how moons form. One is when planets impact larger bodies and the blasted-off material becomes a moon. Another is capture, when objects are captured and pulled into orbit around a large planet -- like Neptune's moon Triton, which is believed to be a captured Kuiper Belt object. And the third is moons forming from the disc materials that created the planets in the early days of the solar system.

Impact isn't possible here because these are both gaseous objects. And this moon's size defies explanation. So it remains a mystery -- for now.



12 new moons discovered around Jupiter

Teachey and Kipping are submitting proposals for more time on Hubble to observe this planet and its moon during another transit. If they are able to observe a full transit, representative of a "clean moonlike event, then I think we're done," Kipping said. That would confirm that the find is an exomoon. But for now, the researchers welcome comment and criticism of their hypothesis from other astronomers as part of the scientific process.

In the Kepler exoplanet catalog, there are only a few Jupiter-size planets that are farther from their star than Earth is from the sun -- good candidates for moons due to the distance. Once the James Webb Space Telescope launches in 2021, the search for exomoons may be full of possibilities. "We can expect to see really tiny moons," Kipping said.

E Mails Viewings Logs and Images from Members.

Viewing Log for 10th of February

As we are still in lockdown, this would be my second viewing session from the back garden.

For a change, I decided I would use my Skywatcher EQ3-2 Pro mount with the William Optics 80 mm refractor on top, last time I used this mount was on 20th of January 2020, best part of 13 months ago! With the 80 mm scope I would be using my Pentax 14 mm WX eye piece, I had everything set up and ready by 20:21, with a start temperature of -2.8 °C and an air humidity of 28 %. At least being at home if I was getting cold I could pot inside for a hot drink. I had one street light to deal with and another which shinned thru a tree, I found the biggest light problem was from the greenhouse heater which was about five feet away from me. By turning the heat funnel around I could get rid of the extra light affecting my eyes. Doing a three star alignment, the telescope went overhead and using my new Xmas present (a Skywatcher 90 ° polar scope attachment, I did not have to bend down at a stupid angle to align the star).

First port of call was Messier (M) 42, the great nebula in Orion, no adjustment was required as it nearly in the middle of the eye piece (sometimes using the Meade scope, I have to adjust manually the telescope to get the required object centred?) I could only make out three of the trapezium stars as I do not have the large magnification with the Meade, this scope being f6 against an f10. On to M45, the Pleiades, this time I could get all the stars in the field of view, this open cluster (O C) was big, bright but very loose to look at. Slewing in the other direction I came to Castor, the lower bright star in Gemini, I could just make out a slight elongation of this star, being a double but could not spilt them apart? Overhead was Auriga, so time to compare the O C's in this constellation, starting with M36, small, dim and loose but I could make out three arms of stars coming from the centre area? M37 was compact and dim and M38 was also small but had three loose arms of stars within it? On to M35 nearby in Gemini, this was small and compact to look at. Over the border and into Taurus and look at M1, this Supernova remnant was a fuzzy blob (F B) to look at, could not make out any detail with at all and with the Moon being a waning gibbous I would have no light trouble from it and put it down to light pollution from Swindon? Had a look for M82 in Ursa Major, not sure if I could this galaxy even using advert vision?

Thought it was time for a coffee break, came up with the idea of wearing sunglasses while making the coffee (must have looked a bit stupid but at least I could keep some of my night vision with me?). Back outside and on to M81. I could see a FB at the edge of the eye piece, moving it to the centre I noticed two F B's in the field of view, the second object was M82? Onto my old nemesis and M97, the Owl nebula, I was surprised I could just make out this difficult object to view, as for M108 and M109, not sure. I put down a '?' in my notes, probably did not see them at all? Onto M40 and probably the most boring object on Messiers list, yes I could make out two stars and nothing else! Had trouble with M52, it was hiding behind a television aerialJ! Could make out M103 very well, it was a large and very loose O C. Nearby is NGC457, the Owl cluster, I could make out the two bright stars that make up its eyes and the dimmer stars that makes up the wings. The Double Cluster of NGC 869 and 884 or Caldwell 14 filled the eye piece very well, pleasant to look at these O C's. M76, the Little Dumbbell is one of the harder objects on his list to view and this did not change for me, could not make it out at all? Time to turn to the south and look thru a small section of sky that is between my house and my neighbours. Sirius was really bright to look at, being the brightest star in the night sky one would hope so even lower down? M44, the Beehive cluster was big and loose to look at, the other Messier object in this constellation (Cancer), M67 was compact and dim to look at. I found the demon star Algol not very red this evening for some reason? Final object for the evening was Regulus which had just cleared the high hedge behind me, this was bright to look at as well.

With the time being 22:10 and a temperature of -3.9 °C, it was time to pack up as my fingers were starting to feel the cold, rest of the body was fine? To my delight there was no dew on the telescope at all? I would still leave all the equipment time to completely dry overnight before I put them away in their storage cases the following morning.

Clear skies.

Peter Chappell

Viewing Log for 18th of February

Another clear evening (pretty rare recently?) and a free evening meant I had to be outside and doing some viewing? I knew this would be very similar to the one I used eight days ago but this time I decided I would use the Skywatcher EQ6 Pro mount (the heavy weight for telescope equipment I own) and 98 mm William Optics refractor together with a 10 mm Televue Delos eye piece. Last time this equipment got some airing was 14th of June 2017, well over 42 months ago! It took 35 minutes to get everything set up and ready, balancing the scope and then the mount. This time the temperature was a more respectable 4.8 °C with a humidity of 18 % and little wind.

This time I used the two star align system to get everything up and running. With the waxing crescent Moon hiding behind the house I would not get direct Moon light into my eyes but would expect some wash out of some deep sky objects? Like last time I started with M42 in Orion before it went behind the house, this time I could make out the four stars that make up the trapezium. Onto Caster a tight double in Gemini, this time I could make out the second star in this system, being only 1.8 arc seconds apart? Probably helps having more light coming thru the scope plus a higher magnification used? While slewing to Castor I thought I noticed the power supply light going off and on again, this was 20:35? Waited a couple of minutes and the light started to flash again, trying the test button on the battery it was out of power! Now what? For some reason, the Skywatcher mounts take a lot of power yet the Meade hardly uses any at all? Then I remembered I had a power cable with the EQ3-2 set up, upstairs to find said box and pull out the cable and converter (first time these have ever been used). So now using mains power I had to be careful of the trip hazard around my feet, I did a set up again. Onto M42 and again it was in the middle of the eye piece, tried M78 just above the belt stars but I could only just make out two stars in this object, suspect Moon was washing out the rest of the nebula? Decided to change the eye piece for a 17.3 Delos instead of the 10 mmm one, this would give me more sky to see. Start of a long run of open clusters (O C), first was M35 in Gemini, this was slightly loose to look at. M36 was smaller and had less stars in it, M37 was dim and compact and M38 was loose but I could make out the three rows of stars within this O C. Onto Cancer and M67, small and very dim this time, fairly easy to miss this object if I was star hopping? The Beehive cluster (M44) was large, loose but bright to look at. Still could not make out M52, yes that aerial was still blocking my view! The Owl cluster was bright this time, helps having more light coming to the eye ball. As usual, the Double cluster was good and had some bright stars in both clusters. M41 had now cleared the garage roof, this O C was small, dim and loose. When I typed in M50 into the hand controller the telescope went one way before changing direction, must have been near the flip position, this is something EQ mounts have? M50 had just cleared my neighbour's house, this was also small and dim to look at? Had a try at looking at the Rosette nebula (NGC2244, could not make out any of the nebula (Moon and lowness from my house probably) but could see what I thought was an O C, small and very loose? NGC 2264 was sparse and I could only make out one star within it? Across to M45, as usual this O C fills the eye piece with stars. No luck with M76 again, while trying to view this object I noticed high thin cloud had started to roll in. I knew this was coming from checking the weather earlier in the evening. So from now on everything I wished to view would have to be either to the north, east or south as cloud stopped the west view! Tried M101 just above the pan handle in Ursa Major, could not make this galaxy out at all? Could spilt Mizar, the double double star system in the handle. M81 and M82 were just fuzzy blobs to look at, cloud and Moon going against me? No luck this time with M97, so I turned the scope to the south. M47 had just cleared my neighbour's house, sparse and loose to look at. While I had been doing my viewing session the Moon was hiding behind the roof but would soon be in view? So while I waited I went inside and had a coffee, about 20 minutes later it had cleared the house. When I slewed to the Moon it was in the field of view, a pleasant surprise as using my Meade I normally had to do some adjustments to get any Solar System objects in the eye piece? The 7.13 day old or 42 % lit Moon showed some good features along its terminator, Mare Serenitatis (Sea of Serenity) had just cleared the terminator and looked very nice to view.

By now it was 23:02 and time to pack up and take all equipment inside (and give my back more trouble with the heavy weight equipment used) to dry out overnight before putting away. Been a long time since I have managed to get two sessions in one calendar month, normally I am lucky to get one in, and generally I do not view from half Moon to full and back to half as there is too much light in the sky!

Clear skies.

Peter Chappell

PS the following morning my back was not happy with all the heavy weight equipment I had moved around the place, oh the joys of having a dome! Apart from the heaviness of the equipment I have noticed Skywatcher equipment is much quieter than my Meade when slewing to objects, they do not keep the neighbours awake! I wonder what they think the noise is when I am out in the garden viewing.

Hi Andy,
I hope you are well.
Here are submissions for the WAS March 2021 Newsletter.

12/02/2021

Orion and Dragon Tree
Orion - Canon G16 (Star Mode), 28mm, ISO 800, F1.8, 15 sec

Pre and Post Snow Full Moon

The two images capture the pre and post Snow Full Moon at 99.3% lit waxing and waning phases – spot the difference!
26/02/2021 99.3 % lit Waxing Gibbous Moon

Canon SX50HS 1200mm, ISO 200, F8, 1/800 sec

27/02/2021 99.3 % lit Waning Gibbous Moon
Canon SX50HS 1200mm, ISO 200, F8, 1/500 sec
100 raw images converted to tiff in Canon DPP, cropped and centred in Pipp, stacked in Autostakkert, wavelet in Registax 6 and post processed in Affinity Photo.
Regards,
John

Hi Andy

Affinity Photo has just released version 1.9 of the software. It now has dedicated astrophotography processing - stacking, bias, darks plus RGB and so on. Plus it will do stuff I don't understand!
Example videos below:

https://www.youtube.com/watch?v=FR2PZ5EKkLw
https://www.youtube.com/watch?v=fOMF8CScG_A

There are other video's as well.
There's a 30 day free trial and offer to buy for £24! Well worth a look for any WAS members wanting to try imaging.

Regards

John

Thanks to Sam for his work to get the membership fees ball rolling.

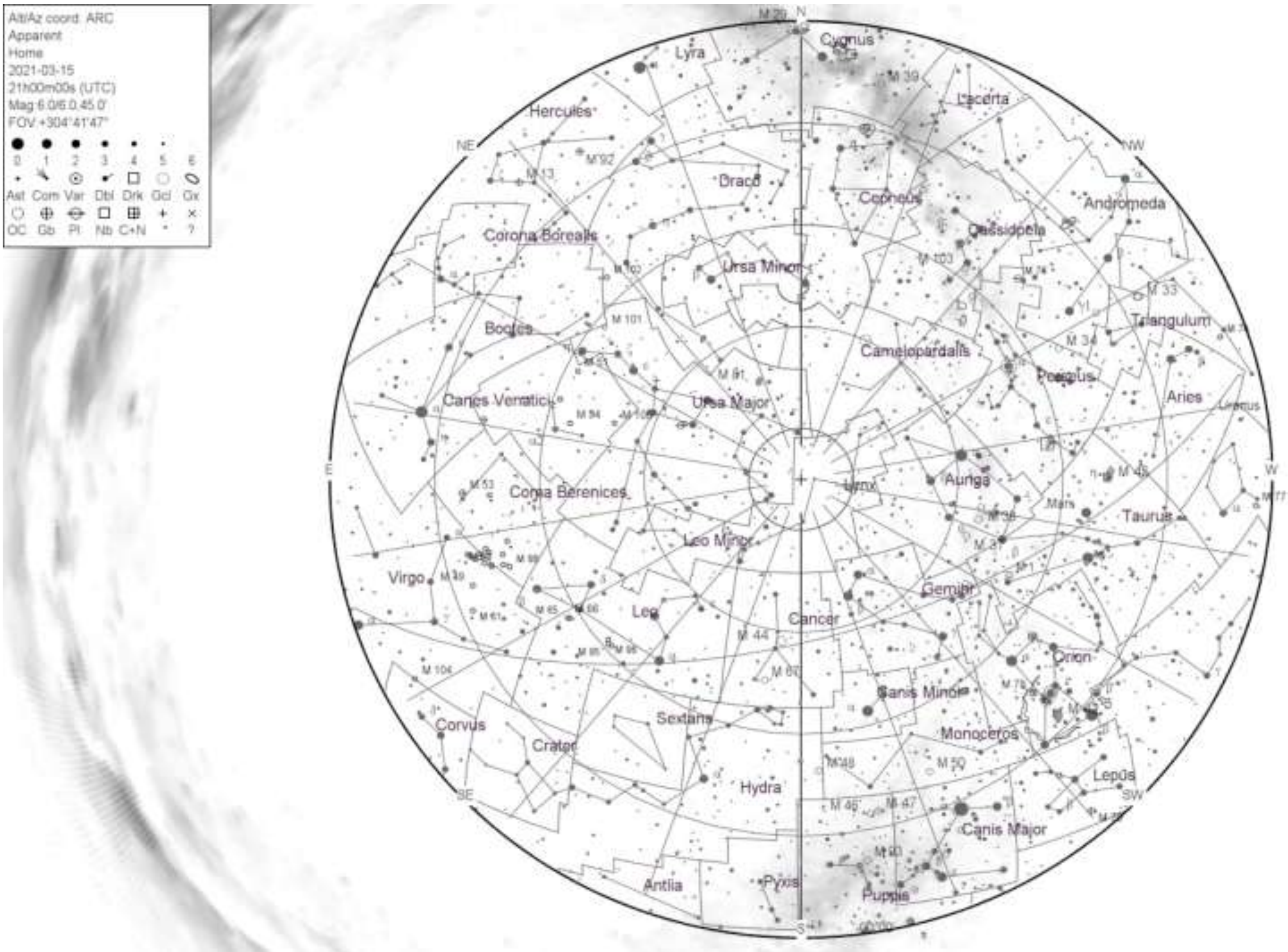
We now have 23 paid up members.

An active area on the Sub has produced a sunspot.

It will be on the edge today and could show some great prominences.

Andy Burns using Nikon Coolpix P1000 and Thousand Oaks solar filter.

The full Moon from Saturday,



March 6 - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 27.3 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.

March 13 - **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 10:23 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.

March 20 - **March Equinox.** The March equinox occurs at 09:27 UTC. The Sun will shine directly on the equator and there will be nearly equal amounts of day and night throughout the world. This is also the first day of spring (vernal equinox) in the Northern Hemisphere and the first day of fall (autumnal equinox) in the Southern Hemisphere.

March 28 - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 18:49 UTC. This full moon was known by early Native American tribes as the Worm Moon because this was the time of year when the ground would begin to soften and the earthworms would reappear. This moon has also been known as the Crow Moon, the Crust Moon, the Sap Moon, and the Lenten Moon.

Observing Notes - March 2021

Pottering Around Perseus

Perseus appears highest in the evening sky in the months around November but remains around the 50°above the horizon in the western skies this time of the year, at least for the early part of the evening.

It is quite prominent constellation with 16 stars of fourth magnitude or brighter so observable for us townies to a reasonable degree.

Perseus is perhaps best known for the Perseid meteor shower, one of the best annual meteor showers, however that is in the summer, a good few months away yet, so we will have to wait for that even.

The Milky Way also passes through this area of the sky, where it forms a particularly broad band of deep sky objects, including over a dozen bright open clusters. I can never resists looking in this part of the sky with my 16 x 80 binoculars for a while no matter what my targets for the night are, the rich star fields are amazing. However, the main part of the constellation of Perseus is not quite as spectacular as some of the constellation around it but it has a few nice objects to pick up in binoculars and telescopes.

The Myth

The constellation Perseus represents the hero of the same name and is one of the six constellations associated with the Greek myth and legends. Sit tight is a bit of a long one but I will be as brief as I can.

Perseus was the grandson of King Acrisius who ruled Argos. Before Perseus was born, it was foretold to the King that he would die at the hand of his own grandson. On hearing this he had his daughter, Danaë, locked away in a dungeon. But Zeus (who was a bit of a sucker for maidens in distress, a fell in love with her and so took the form of golden rain to visit her. When the rain fell into her lap, Danaë got pregnant (as you do) but Acrisius found out and once Perseus was born, the king locked both Danae and his grandson into a wooden chest and cast them out to sea (harsh!). The chest washed ashore and a fisherman called Dictys found them and took them home with him where he raised Perseus as his own son.

Dictys had a jealous brother, King Polydectes, who wanted Danaë for himself but Perseus defended her from the king's advances. To get rid of Perseus, Polydectes came up with a story about

▲ Looking West / North West to Perseus

being engaged to another woman (Hippodameia, who was the daughter of yet another King). He asked everyone to give him and his bride horses as a wedding present but Perseus did not have any horses and could not afford to buy one, so Polydectes sent the him to bring the head of the Gorgon Medusa who was one of the three hideous sisters with snake hair, whose gaze could turn anyone who looked at them into stone (we have all seen the film).

Polydectes expected Perseus to die in the attempt to kill the Gorgon, but he underestimated Perseus and with the help the goddess Athena's reflective shield, was able to look at Medusa and cut off her head. Perseus returned to King Polydectes with the Gorgan's head in a bag but on hearing that he had been sent away to his death so that the King could stalk his mother, he pulled the head from the bag and turned him in to stone.

Finding the Constellation

Perseus is bordered by Aries and Taurus to the south, Auriga to the east, Camelopardalis and Cassiopeia to the north, and Andromeda and Triangulum to the west.

If we start with the 5 stars that make up familiar 'W' asterism of Cassiopeia (see September 20 Observing notes) located roughly in the North West at around 20:00, noting that the 'W' is more-or-less on its side this time of the year. We then find the 'V' of the Hyades in the constellation of Taurus (see November 20 Observing notes). The constellation of Perseus is located directly between the two and identified by the brightest star Mirfak.

The Major Stars

There are 19 stars in the constellation's main asterism with the most notable being:

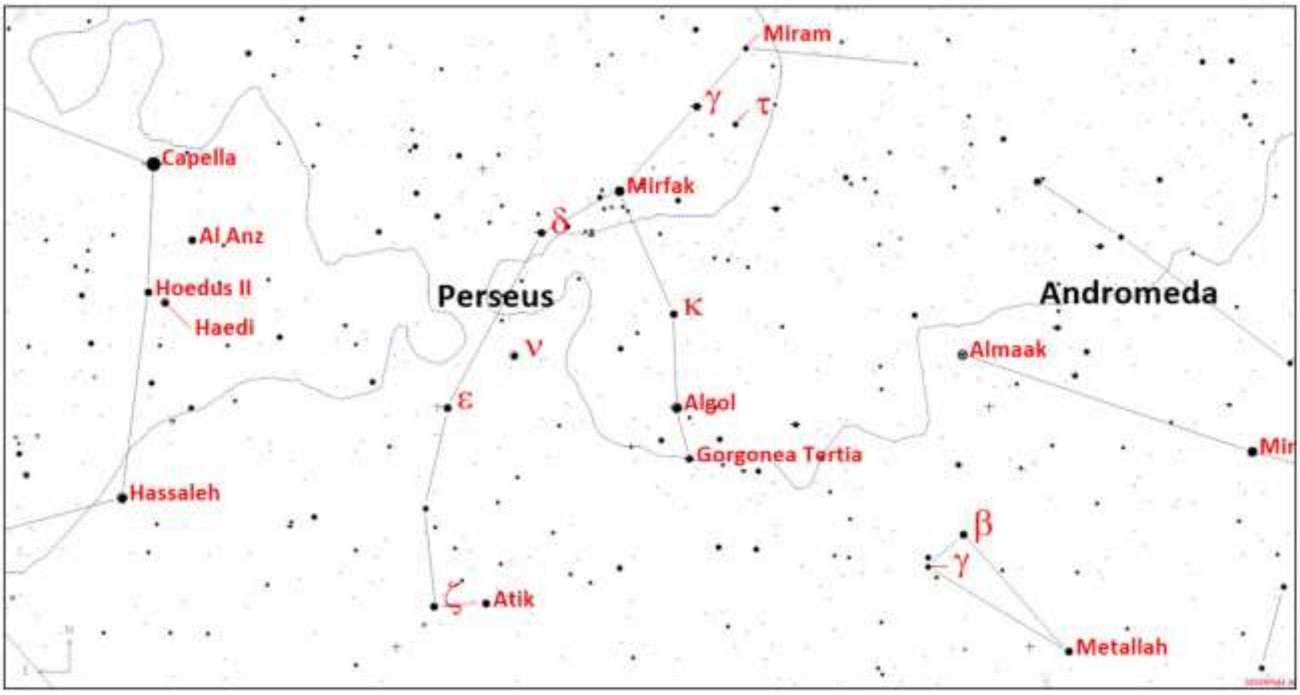
Mirfak – α Persei (Alpha Persei)

Alpha Persei is a supergiant star with a visual magnitude of 1.8 and lying 510 light years distant. It is the brightest star in Perseus constellation and is located in a star cluster known as the Alpha Persei Cluster, which can easily be seen in binoculars.

The star's traditional names, Mirfak and Algenib, mean "elbow" and "flank" or "side" respectively in Arabic.

Algol – β Persei (Beta Persei)

The Demon Star was the first eclipsing binary star ever discovered and one of the first variable stars to be found. Beta Persei is in fact a triple star



▲ Perseus and his main stars

system with an apparent magnitude of around 2.1, but it drops to 3.4 every two days, 20 hours and 49 minutes, and stays dimmer for about 10 hours. Algol is a prototype for a class of stars known as Algol variables.

The star's name is derived from the Arabic phrase *ra's al-ghul* (yes, just like the supervillain in the Batman comics), which means "the demon's head." It was associated with a ghoul in Arabic tradition and with the head of the Gorgon Medusa in Greek mythology.

γ Persei (Gamma Persei)

Gamma Persei is a double star with a combined visual magnitude of 2.9, approximately 243 light years distant from Earth. It is the fourth brightest star in Perseus. The system is a wide eclipsing binary star, with the two stars orbiting each other every 14.6 years.

δ Persei (Delta Persei)

Delta Persei is a binary star with a visual magnitude of 3.0, approximately 520 light years distant. It is seven times more massive than the Sun and a rapid rotator, with a projected velocity of 190 km s−1.

Delta Persei is believed to be a double star, and possibly even a triple star system. Which may be gravitationally bound to the main star and not just an optical double, but this has not been confirmed.

ε Persei (Epsilon Persei)

Epsilon Persei is composed of several stars. The system has a combined visual magnitude of 2.88 and is about 640 light years distant from the Sun.

The two main components in the Epsilon Persei system orbit each other with a period of 14 days but may have a third component, but its existence has not been confirmed.

Atik (Menkhib) – ζ Persei (Zeta Persei)

Zeta Persei is a blue-white supergiant about 47,000 times more luminous than the Sun and 750 light years distant. It has an apparent magnitude of 2.86 and has a 9th magnitude companion located 12.9 arc seconds away. The two stars are suspected to be physically associated as they are on a similar trajectory.

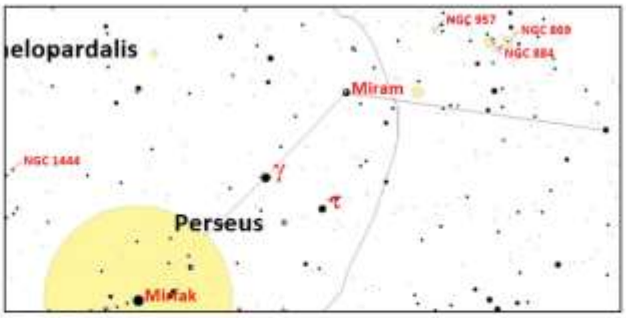
Nova Persei 1901

Nova Persei 1901 is approximately 1500 light years distant from the solar system. Also known as GK Persei, it was a bright nova that occurred in 1901. With a peak magnitude of 0.2, and was the brightest nova of modern times. GK Persei subsequently faded to magnitude 12 or 13, but has occasional outbursts of 2 to 3 magnitudes so visible in larger scopes. In the last 30 years, the outbursts have become pretty regular and last about two months every three years or so, which makes GK Persei resemble not a typical nova, but a dwarf nova-type cataclysmic variable star.

Deep Sky Objects

NGC 869 and NGC 884 - The Double Cluster

These bright open clusters are separated by only half a degree and commonly known as a "Double Cluster" and easily visible to the naked eye and a wonderful sight in binoculars and telescopes. Both clusters have been known since antiquity when the Greek astronomer Hipparchus



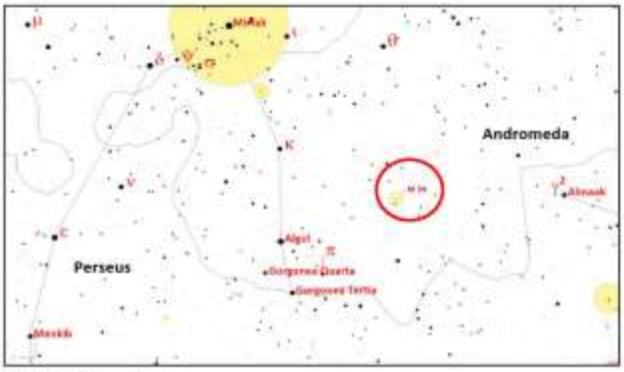
▲ The Double Cluster

first catalogued them around 130 B.C. Early celestial cartographers named them as "h Persei" (NGC 869) and "χ Persei" (NGC 884).

This Double Cluster is located in the far north-western part of Perseus, close to the border with Cassiopeia. To locate the object, draw an imaginary line from Mirfak (α Per - mag +1.8) in a north-westerly direction towards the centre of the "W" of Cassiopeia. The Double Cluster lies just over halfway along this line.

Messier 34 – Open Cluster

The open cluster M34 that may be just about seen with the naked eye and is easily resolved with a small telescope or 10x 50 binoculars. The cluster lies at an approximate distance of 1,500 light years from Earth and has an apparent magnitude of 5.5.



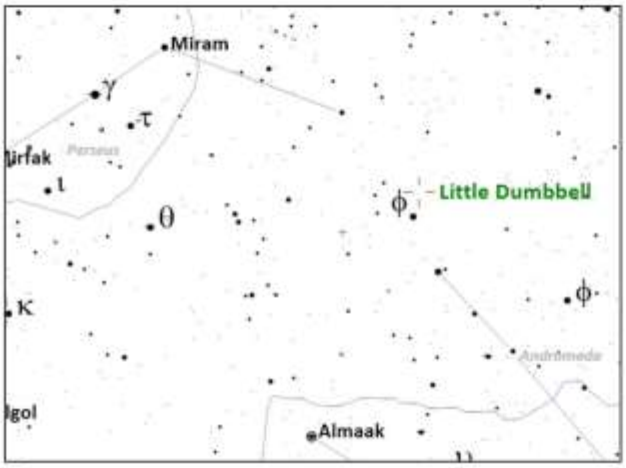
▲ M34 finder chart

The best way to view M34 is in telescopes at low magnifications. Small telescopes will reveal up to 20 stars, while larger telescopes can show as many as 80.

Messier 34 is relatively easy to find located just to the north of the imaginary line drawn from Algol (Beta Persei), to Almach, the third brightest star in the neighbouring constellation Andromeda often referred to as Gamma Andromedae. The cluster lies 5 degrees northwest of Algol.

Messier 76 – The Little Dumbell Nebula

M76 lies at an approximate distance of 2,500 light years from Earth and has an apparent magnitude of 10.1 A planetary nebula that in large binoculars and small telescopes shows as a small, diffuse point of light and so is better seen through a medium-sized telescope. Being regarded as one



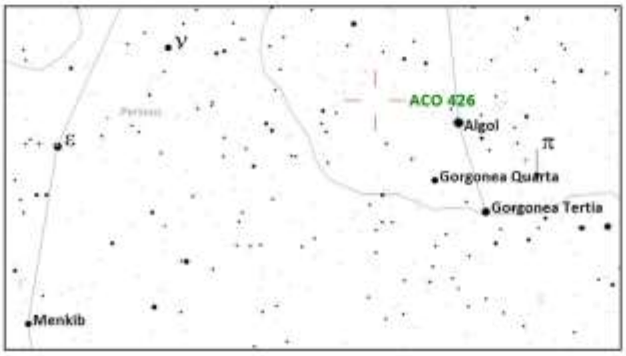
▲ M76 The Little Dumbbell finder chart

of the most difficult Messier objects to spot I am going to make it this month's challenge objects.

Probably the easiest way to find M76 Is to draw an imaginary line between γ Almach (Gamma Andromeda) and δ Ruchbah (Delta Cassiopeia) which is the bottom of the left hand 'V' in the 'W' asterism and M76 lies almost centre between these two stars.

Abell 426

Abell 426 (ACO 426 in the chart) otherwise known as the 'Perseus Cluster' is a massive group of thousands of galaxies. It lies approximately 2°



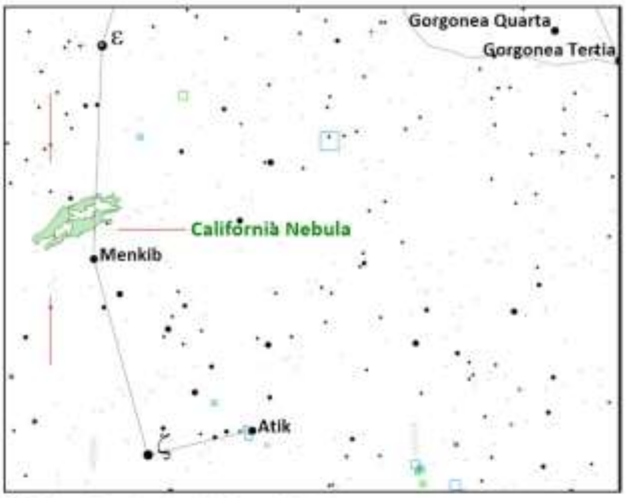
▲ Abell 426 The Perseus Cluster

from Algol. Draw an imaginary line between Algol and Mirfak, go along the line 1.5° from Algol and then turn immediately left 1.5° and the cluster is in this area covering very approximately 1° square.

To be fair there is not a lot to see visually in small telescopes and binoculars. Even in my 4" Refractor which has great contrast, it is difficult to make out much. It looks a little better still in my 10" reflector but still not very exciting. But what actually fascinates me is that when I am staring into this area of space, I are staring into the a cluster of hundreds, if not thousands of galaxies. Most of which I am sure are probably home to other worlds maybe like ours, maybe not. As I sit and look, I just imagine the very likely possibility of others staring back at our own galaxy. Although I have not done so yet I will have a go at photographing this area of space and see if I can capture a handful of the worlds.

California Nebula (NGC 1499)

This is a large and long emissions nebula to the North of Menkib and very hard to observe visually but takes on the shape of the American state when viewed through larger telescopes and binoculars and better still when using an Hbeta filter under darker skies. Jon has seen it in his 8" reflector from Kelling Heath in Norfolk; it is a subtle object and proper dark adaption was required. The Nebula is 2.5° long reflection nebula that is 60 light-years across and roughly 1,500 light-years away from Earth.



▲ Finder Chart for the California Nebula

March 2021 Solar System

Meteor Showers

No meteor showers this month unfortunately.

Moon

The Moon is at last quarter on the 6th March so dark sky viewing is best carried out over the following couple of weeks with the new Moon on the 13th.

There is a good opportunity to observe the Lunar XV on the 20th at around 02:00 GMT.

The Planets

Mercury is poorly positioned morning planet reaching greatest western elongation on 6 March.

Venus reaches superior conjunction on 26 March and is unlikely to be seen this month.

Mars is an evening planet dimming to the naked eye and telescopically small. It can be south of the Pleiades at the start of March.

Jupiter is a morning planet, but badly positioned despite rising 70 minutes before sunrise by the end of the month.

Saturn Morning planet close to Jupiter. Badly positioned for viewing this month.

The *Uranus* observing window is quickly closing as the planet drifts ever closer to the evening twilight.

Neptune is in conjunction with the Sun on 10th March and not visible this month.

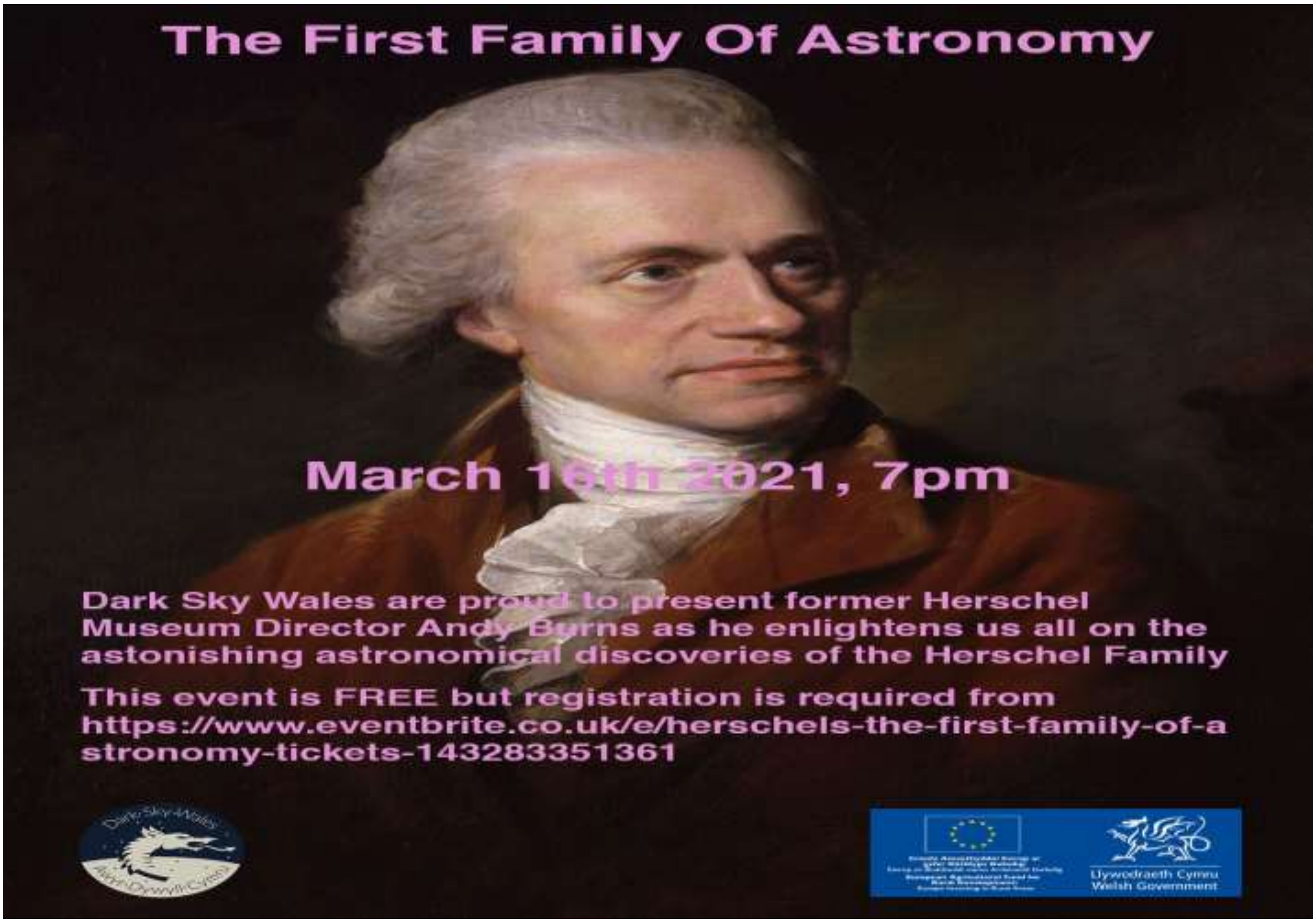
Don't forget the clocks go forward on the 28th March.

Good observing and stay safe.

Chris Brooks
Jonathan Gale
WAS Observing Team

DARK SKY WALES

Dark Sky Wales are running series of on line live talks (using

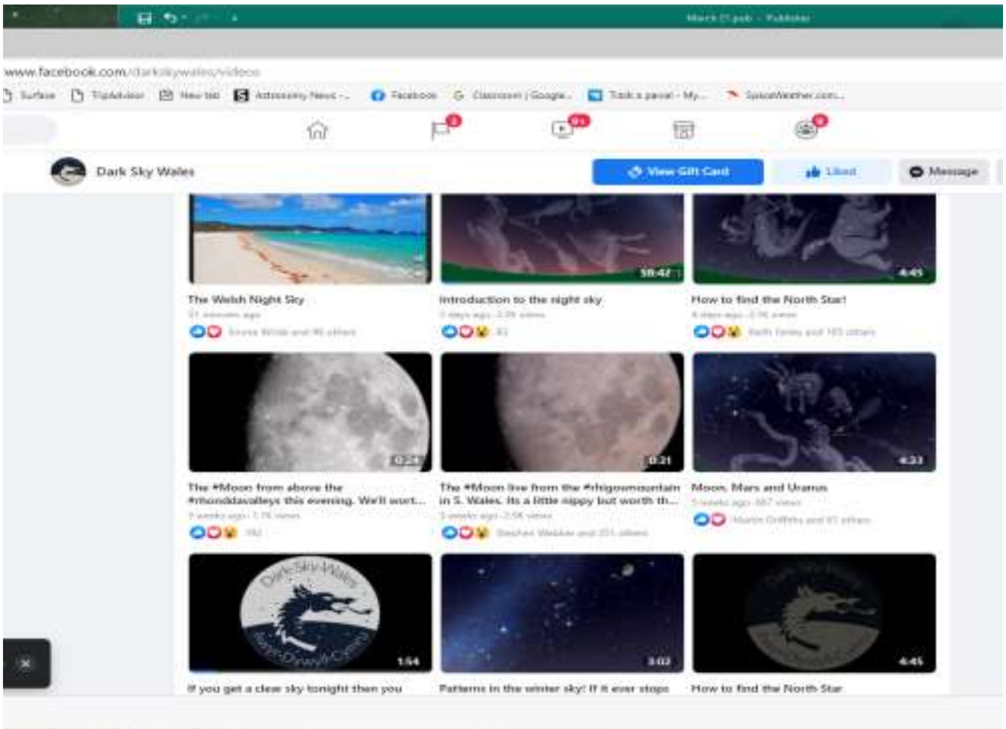


zoom) and are also putting up videos on Facebook so you can watch at home anytime.

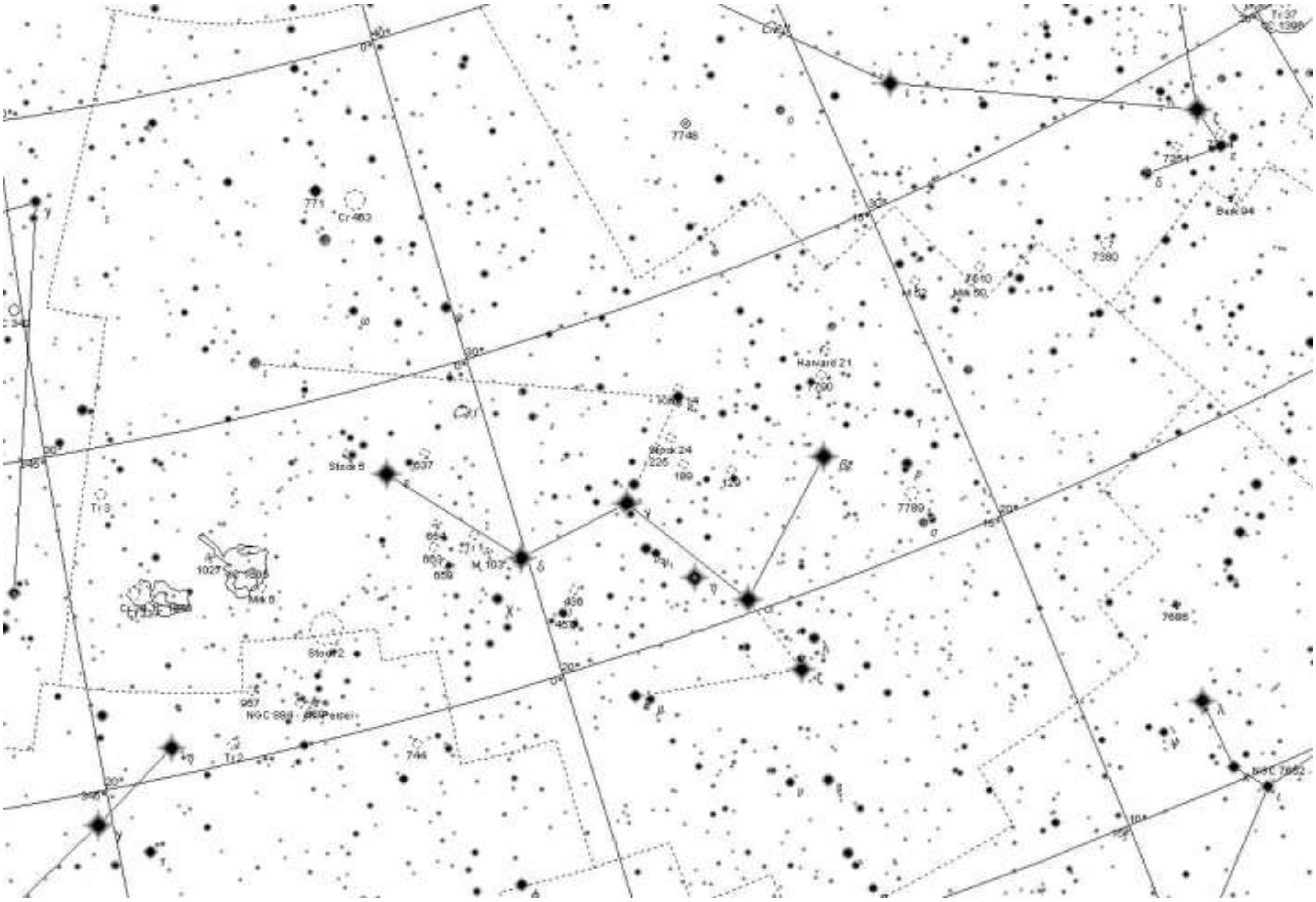
Some topics are interesting basics about how find your way around the sky using their planetarium programme and they are diversifying into other astronomy topics.

I am giving a talk about the whole Herschel family at 7pm on the 16th March.

A lot of these talks are free but require you to register first. See above notice.



CONSTELLATIONS OF THE MONTH: CASSIOPEIA



The Cassiopeia Constellation

by Tammy Plotner

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

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

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

Name and Meaning:

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

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

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

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

History of Observation:

Cassiopeia was one of the traditional constellations included by Ptolemy in his 2nd century CE tract, the *Almagest*. It also figures prominently in the astronomical and astrological traditions of the Polynesian, Indian, Chinese and Arab cultures. In Chinese astronomy, the stars forming the constellation Cassiopeia are found among the areas of the Purple Forbidden enclosure, the Black Tortoise of the North, and the White Tiger of the West.

Chinese astronomers also identified various figures in its major stars. While Kappa, Eta, and Mu Cassopeiae formed a constellation called the *Bridge of the Kings*, when combined with Alpha and Beta Cassiopeiae – they formed the great chariot *Wang-Liang*. In Indian astronomy, Cassiopeia was associated with the mythological figure Sharmishtha – the daughter of the great Devil (Daitya) King Vrishparva and a friend to Devavani (Andromeda).

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

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

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

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

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

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

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

Notable Features:

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

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

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

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

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

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

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

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

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

Finding Cassiopeia:

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

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

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

For larger telescopes, situated about 35′ southwest of M52 is the Bubble Nebula NGC 7635, a diffuse nebula which appears as a large, faint and diffuse oval, about 3.5×3′ around the 7th-mag star HD 220057 of spectral type B2 IV. It is difficult to see because of its low surface brightness. Just immediately south of M52 is the little conspicuous open cluster Czernik 43 (Cz 43).

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

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

It contains nearly one hundred stars and lies over 9,000 light years away from the Sun. The cluster is sometimes referred by amateur astronomers as the Owl Cluster, or the ET Cluster, due to its resemblance to the movie character. Those looking for a more spectacular treat should check out NGC 7789 – a rich galactic star cluster that was discovered by Caroline Herschel in 1783. Her brother William Herschel included it in his catalog as H VI.30.

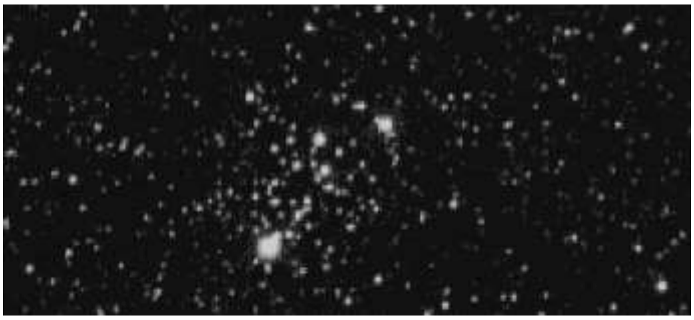
This cluster is also known as "The White Rose" Cluster or "Caroline's Rose" Cluster because when seen visually, the loops of stars and dark lanes look like the swirling pattern of rose petals as seen from above. At 1.6 billion years old, this cluster of stars is beginning to show its age. All the stars in the cluster were likely born at the same time but the brighter and more massive ones have more rapidly exhausted the hydrogen fuel in their cores.

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

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

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

M103



NGC457 Owl CLuster

ISS PASSES For March/April 2021 from Heavens Above website maintained by Chris Peat

Date	Brightness	Start		Highest point	End					
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
01 Mar	-1.0	03:53:50	18°	E	03:53:50	18°	E	03:54:51	10°	E
01 Mar	-3.8	05:26:47	30°	W	05:28:20	88°	N	05:31:43	10°	E
02 Mar	-3.6	04:41:08	73°	ESE	04:41:08	73°	ESE	04:44:14	10°	E
02 Mar	-3.7	06:14:20	10°	W	06:17:42	87°	SSW	06:21:05	10°	E
03 Mar	-1.3	03:55:27	22°	E	03:55:27	22°	E	03:56:46	10°	E
03 Mar	-3.8	05:28:24	25°	W	05:30:13	86°	N	05:33:36	10°	E
04 Mar	-3.9	04:42:44	85°	N	04:42:45	85°	N	04:46:07	10°	E
05 Mar	-1.5	03:57:04	25°	E	03:57:04	25°	E	03:58:38	10°	E
05 Mar	-3.8	05:30:01	21°	W	05:32:05	76°	SSW	05:35:27	10°	ESE
06 Mar	-3.9	04:44:22	75°	W	04:44:37	87°	S	04:47:59	10°	E
07 Mar	-1.8	03:58:45	28°	E	03:58:45	28°	E	04:00:30	10°	E
07 Mar	-3.3	05:31:43	19°	W	05:33:50	46°	SSW	05:37:05	10°	SE
08 Mar	-3.8	04:46:10	58°	SW	04:46:25	61°	SSW	04:49:44	10°	ESE
09 Mar	-1.8	04:00:40	26°	ESE	04:00:40	26°	ESE	04:02:19	10°	ESE
09 Mar	-2.5	05:33:38	16°	WSW	05:35:26	25°	SSW	05:38:16	10°	SSE
10 Mar	-2.9	04:48:16	34°	SSW	04:48:16	34°	SSW	04:51:10	10°	SE
11 Mar	-1.4	04:02:59	17°	SE	04:02:59	17°	SE	04:03:54	10°	SE
11 Mar	-1.6	05:35:58	11°	WSW	05:36:51	12°	SW	05:38:18	10°	SSW
12 Mar	-1.6	04:50:51	15°	S	04:50:51	15°	S	04:51:55	10°	S
18 Mar	-1.8	20:01:30	10°	SSW	20:02:51	18°	S	20:02:51	18°	S
19 Mar	-1.9	19:14:43	10°	S	19:16:49	16°	SE	19:17:58	14°	ESE
19 Mar	-1.6	20:49:48	10°	WSW	20:50:57	19°	SW	20:50:57	19°	SW
20 Mar	-3.3	20:02:27	10°	SW	20:05:39	42°	SSE	20:05:52	41°	SE
21 Mar	-2.8	19:15:12	10°	SSW	19:18:12	31°	SSE	19:20:38	14°	E
21 Mar	-2.5	20:51:25	10°	WSW	20:53:35	37°	WSW	20:53:35	37°	WSW
22 Mar	-3.8	20:03:54	10°	WSW	20:07:15	70°	SSE	20:08:13	42°	E
22 Mar	-0.7	21:40:41	10°	W	21:41:12	14°	W	21:41:12	14°	W
23 Mar	-3.6	19:16:26	10°	WSW	19:19:45	55°	SSE	19:22:45	12°	E
23 Mar	-3.0	20:53:07	10°	W	20:55:43	50°	W	20:55:43	50°	W
24 Mar	-3.8	20:05:33	10°	W	20:08:57	88°	N	20:10:10	37°	E
24 Mar	-0.9	21:42:24	10°	W	21:43:08	16°	W	21:43:08	16°	W
25 Mar	-3.8	19:18:01	10°	WSW	19:21:23	83°	SSE	19:24:34	11°	E
25 Mar	-3.1	20:54:50	10°	W	20:57:32	54°	W	20:57:32	54°	W
26 Mar	-3.8	20:07:16	10°	W	20:10:39	86°	N	20:11:53	36°	E
26 Mar	-0.9	21:44:07	10°	W	21:44:51	15°	W	21:44:51	15°	W
27 Mar	-3.7	19:19:41	10°	W	19:23:04	85°	N	19:26:14	12°	E
27 Mar	-3.0	20:56:31	10°	W	20:59:11	47°	WSW	20:59:11	47°	WSW
28 Mar	-3.8	21:08:57	10°	W	21:12:19	75°	SSW	21:13:31	37°	ESE
28 Mar	-0.8	22:45:59	10°	W	22:46:28	13°	W	22:46:28	13°	W
29 Mar	-3.8	20:21:22	10°	W	20:24:45	87°	S	20:27:51	12°	E
29 Mar	-2.4	21:58:16	10°	W	22:00:48	32°	SW	22:00:48	32°	SW
30 Mar	-3.2	21:10:37	10°	W	21:13:53	46°	SSW	21:15:09	30°	SSE
31 Mar	-3.5	20:23:01	10°	W	20:26:21	61°	SSW	20:29:32	11°	ESE
31 Mar	-1.6	22:00:21	10°	W	22:02:29	18°	SW	22:02:29	18°	SW
01 Apr	-2.1	21:12:28	10°	W	21:15:18	25°	SSW	21:16:54	17°	S
02 Apr	-2.5	20:24:44	10°	W	20:27:50	34°	SSW	20:30:56	10°	SE
03 Apr	-1.1	21:15:05	10°	WSW	21:16:32	12°	SW	21:17:58	10°	SSW
04 Apr	-1.4	20:26:47	10°	W	20:29:09	18°	SW	20:31:30	10°	S

END IMAGES, OBSERVING AND OUTREACH

Orion and Barnards loop taken from my house on the 12th of February as it passed between two houses.
Soe low mist prevented a full view, but this is from 4 x 30second images stacked using Sequator.
F2.8 using no filters and 38mm on 24-70mm zoom. Nikon D810A Camera.
In the upper left we have the Rosette nebula.
Andy Burns

Wiltshire Astronomical Society Observing Suggestions for March 2021 @ 21:00

We have updated some of the observation targets this month for those with binoculars or smaller wide field telescopes to have something to search for.

The WAS Observing Team will provide recommended observing sessions for you to do while under lockdown at home or as part of your social bubble. Please always follow the latest government guidelines if observing away from the home.

These observing recommendations will continue until we can start our group observing again.

Most target objects can be found around due South at about 21:00.

Where To Look This Month:
This month we Potter Around Perseus.

OUTREACH

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