NWASNEWS

Volume25, Issue 9

May 2020

Newsletter for the Wiltshire, Swindon, Beckington Astronomical Societies

Experimenting in Odd Times

Well thank you for all your kind comments about the nervous dabble into the webinar session we did last month. Luckily Gavin had a bit more hands on experience so with one or two very minor glitches I thoroughly enjoyed the session, with over 25 members getting on line and rejuvenating some members who have moved away.

Martin Griffiths will be giving us his talk this evening, and now I know some of the background issues I will start the meeting at 19:45 to give us 15 minutes to get settled and me to remember to click people in as we go.

The 'I want to ask a question icon' needs to be found, and be prepared to mute yourselves if someone comes in to ask questions. I don't want to mute everybody because I feel it adds that live feel, and I am not having to check everybody on line for who has their hand up!

It was worth my getting the pro version so we have lots of time, and lots of members and visitors can check in.

Please try and join us, I have had interest from members who have moved away, so some old faces may be seen.

Meeting ID number and password (numerical) have been e-mailed to members and on the Facebook Members Page.

The lock down instructions coming from on high (trying no to be political here), are constantly changing so we have to play it be ear, I suspect early June will still be restrictions for some members so I think we should work on the basis that the June meeting will also be online, which makes the AGM impossible so it will all be moved to September.

If any committee members wish to resign or change their position let me know over the summer. I still wish to take a break from being chair, so if anybody wants to stand then again reconfirm or let me know.

The observing and outreach has been severely hit by the isolation rules, I was quite worried being called into a school in Lugershall with a lot of international parents and children from forces from across the globe, but luckily got through that in good health (just my sanity in question, but they were let down by Andover AS).

Chris has put together an observing topic that is on the last page, and on the Society Members Facebook page, and hopefully Sam may update our web page, but his father unfortunately has just died from this virus. Our condolences go out to Sam.

Despite all of this we have had splendid observing weather since the isolation began, means skies were ruined by Starlink satellites (over a third of all images streaked), plus we had a promising comet die, but we have another at the end of the month (SWANN)2020 F8. Near Capella it may reach 5th magnitude. Details in this Newsletter.

Keep good health...

Clear skies Andy Burns.

Venus from 1st May.

DMK 52AU on 5" esprit scope. 500 frames merged in registax.

What was stunning was how bright the planet was. Trying to set an exposure that allowed me to see the shape and dim to just where I get a 'grey' midtone point I was down to 1/2000th of a second exposure. I had just imaged the gibbous Moon at the same exposure and showed all the features.

It is getting closer to us as its crescent gets thinner so the total brightness remains roughly the same throughout its orbit until it moves in front of the Sun (or at an angle to small to show a crescent).

Beware looking for the planet a week before or two weeks after this perigee pass

Andy

Volume25, Issue9

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

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

Meetings 2019/2020Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

NEW SEASON 2019/2020
2020
5th May ZOOM SESSION: Martin Griffiths 'The Habitable Zone – What is it and How is it determined'.
2nd Jun Paul Money 'Triumphs of Voyager (part 2) – Where no probe has gone before'.

Martin Griffiths BSc. (First Class Honours) MSc. (Distinction) FRAS. FHEA.

Martin Griffiths is an enthusiastic science communicator, lecturer, writer and professional astronomer utilizing astronomy, history and science fiction as tools to encourage greater public understanding of science.

He was a founder member of NASA's Astrobiology Institute Science Communication Group, active between 2003-2006 and managed a multi-million pound ESF programme in Astrobiology for adult learners between 2003-2008. Martin has written and presented planetarium programmes for key stages 1, 2 and 3 and has been an adviser to several museum projects

Martin continues to promote cross-disciplinary links between science and culture that reflect his educational background and interests. He has written monographs on the science communication of the proto-feminist Margaret Cavendish, Duchess of Newcastle; and the 18th century scientist, assay master and political adviser Joseph Harris of Breconshire. He is also a regular contributor to the online science journal LabLit: the culture of science in fiction and fact. Recently he assisted the Brecon Beacons National Park in surveying the darkness of the night sky for their successful bid for the International Dark Sky Association's Dark Sky Reserve Status – the first such reserve in Wales.

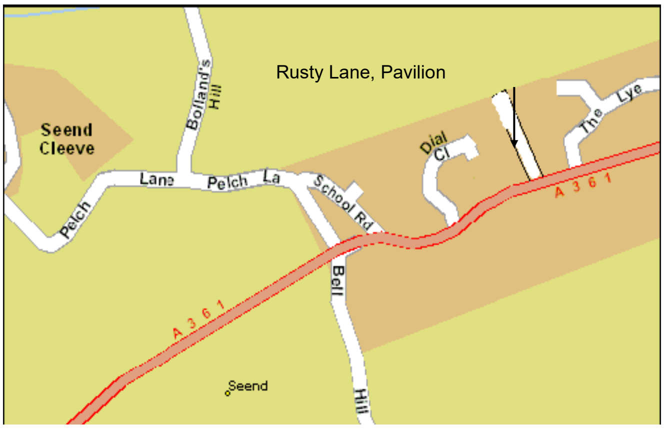
Martin is a Fellow of the Royal Astronomical Society; a Fellow of the Higher Education Academy; a member of the British Astronomical Association; the Webb Deep-Sky Society; the Society for Popular Astronomy, The Astronomical Society of the Pacific and the Astronomical League. He is also a local representative for the BAA Campaign for Dark Skies. Martin broadcasts regularly on BBC Wales radio and has appeared on science programmes for the BBC, Einstein TV, Granada TV and the Discovery Channel. He is also a member of the Honourable Society of Cymmrodorion, dedicated to promoting the science, arts and literature of Wales.

He is now working for Dark Sky Wales in their outreach work to schools and adult learning groups. He has now written four books in the Springer Astronomy Series. And completed another book on the myths in the skies.

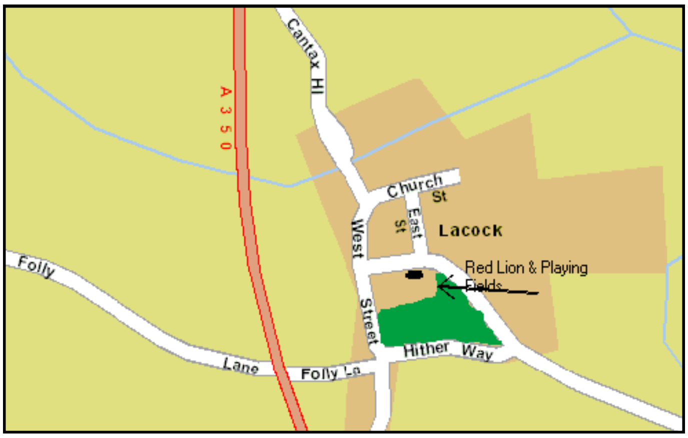
Membership Meeting nights £1.00 for members £3 for visitors

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

Meetings cancelled

Due to the current crisis our meetings, like many others have been cancelled at least until the summer break. We hope to reconvene again in September when the postponed AGM will be held.

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 2020

Friday 17 April
Programme: Cancelled

Friday 15 May
Programme: Cancelled

Friday 19 June
Programme: Cancelled

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

Friday 18 September

Programme: AGM if restrictions lifted.

Friday 16 October

Programme: Dr James Fradgley MSc, FRAS: The Universe - 'A brief overview of what we know, or think we know'

Friday 20 November

Programme: Dave Eagle FRAS PGCE BSc (Hons): 'Comets, Enigmatic and Beautiful Visitors'

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

Date	Title	Speaker
17th April	*Cancelled*	
15th May	*To be informed*	
19th June	To Be Informed	

This young astronomy club meets at the Sutton Veny Village Hall.

STAR QUEST ASTRONOMY CLUB

Second Thursday of the Month.

BATH ASTRONOMERS

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

SPACE NEWS FOR MAY 2020

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

SpaceX is launching Starlink to provide high-speed, low-latency broadband connectivity across the globe, including to locations where internet has traditionally been too expensive, unreliable, or entirely unavailable. We also firmly believe in the importance of a natural night sky for all of us to enjoy, which is why we have been working with leading astronomers around the world to better understand the specifics of their observations and engineering changes we can make to reduce satellite brightness. Our goals include:

Making the satellites generally invisible to the naked eye within a week of launch. We're doing this by changing the way the satellites fly to their operational altitude, so that they fly with the satellite knife-edge to the Sun. We are working on implementing this as soon as possible for all satellites since it is a software change.

Minimizing Starlink's impact on astronomy by darkening satellites so they do not saturate observatory detectors. We're accomplishing this by adding a deployable visor to the satellite to block sunlight from hitting the brightest parts of the spacecraft. The first unit is flying on the next launch, and by flight 9 in June all future Starlink satellites will have sun visors. Additionally, information about our satellites' orbits are located on space-track.org to facilitate observation scheduling for astronomers. We are interested in feedback on ways to improve the utility and timeliness of this information.

To better explain the details of brightness mitigation efforts, we need to explain more about how the Starlink satellites work.

Starlink Orbits

Starlink has three phases of flight: (1) orbit raise, (2) parking orbit (380 km above Earth), and (3) on-station (550 km above Earth). During orbit raise the satellites use their thrusters to raise altitude over the course of a few weeks. Some of the satellites go directly to station while others pause in the parking orbit to allow the satellites to precess to a different orbital plane. Once satellites are on-station they reconfigure so the antennas face Earth and the solar array goes vertical so that it can track the Sun to maximize power generation. As a result of this maneuver, the satellites become much darker because the solar array visibility from the ground is greatly reduced.

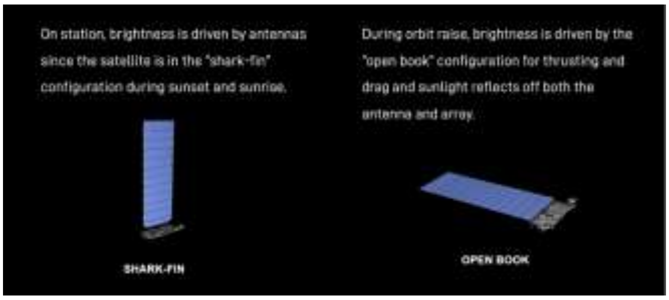
Currently, about half of the over 400 satellites are on-station and the other half are orbit raising or in the parking orbit. Satellites spend a small fraction of their lives orbit raising or parking and spend the vast majority of their lives on-station. It's important to note that at any given time, only about 300 satellites will be orbit raising or parking. The rest of the satellites will be in the operational orbit on-station.

Starlink Satellite

The Starlink satellite design was driven by the fact that they fly at a very low altitude compared to other communications satellites. We do this to prioritize space traffic safety and to minimize the latency of the signal between the satellite and the users who are getting internet service from it. Because of the low altitude, drag is a major factor in the design. During orbit raise, the satellites must minimize their cross-sectional area relative to the "wind," otherwise drag will cause them to fall out of orbit. High drag is a double-edged sword—it means that flying the satellites is tricky, but it also means that any satellites that are experiencing problems will de-orbit quickly and safely burn up in the atmosphere. This reduces the amount of orbital debris or "space junk" in orbit.

This low-drag and thrusting flight configuration resembles an open book, where the solar array is laid out flat in front of the vehicle. When Starlink satellites are orbit raising, they roll to a limited extent about the velocity vector for power generation, always keeping the cross sectional area minimized while keeping the antennas facing Earth enough to stay in contact with the ground stations.

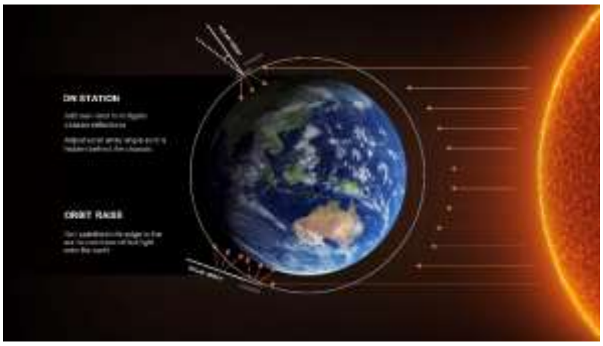
When the satellites reach their operational orbit of 550 km, drag is still a factor—so any inoperable satellite will quickly decay—but the attitude control system is able to overcome this drag with the solar array raised above the satellite in a vertical orientation that we call "shark-fin." This is the orientation in which the satellite spends the majority of its operational life.



Satellite Visibility

Satellites are visible from the ground at sunrise or sunset. This happens because the satellites are illuminated by the Sun but people or telescopes on the ground are in the dark. These conditions only happen for a fraction of Starlink's 90-minute orbit.

This simple diagram highlights why satellites in orbit raise are so much brighter than the satellites that are on-station. During orbit raise, when the solar array is in open book, sunlight can reflect off of both the solar array and the body of the satellite and hit the ground. Once on-station, only certain parts of the chassis can reflect light to the ground.



Physics of Satellite Brightness

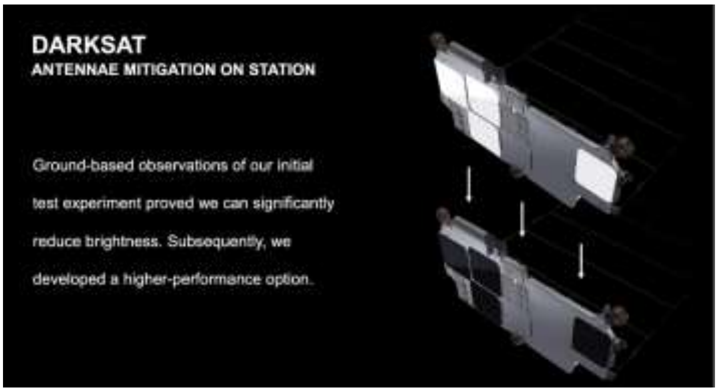
The apparent magnitude of an object is a measure of the brightness of a star or object observed from Earth. It is a reverse logarithmic scale, so higher numbers correspond to dimmer objects. A star of magnitude 3 is approximately 2.5 times brighter than a star of magnitude 4. Based on observations that have been taken by us and by members of the astronomical community, current Starlink satellites have an average apparent magnitude of 5.5 when on-station and brighter during orbit raise. Objects up to about magnitude 6.5-7 are visible to the naked eye (naked-eye visibility is closer to 4 in most suburbs), and our goal is for Starlink satellites to be magnitude 7 or better for almost all phases of their mission.

There are two types of reflections off of Starlink satellites: diffuse and specular. Diffuse reflections occur when light is scattered in many different directions. Imagine shining a flashlight at a white wall. Specular reflections happen when light is reflected in a particular direction. For example, the glint of sunlight off of a mirror. Diffuse reflections are the biggest contributor to observed brightness on the ground, because diffuse reflections go in all directions. You can see diffuse reflections as long as the satellite is visible. This is why Starlink satellites can create the "string of pearls" effect in the night sky. It's a little counter-intuitive, but the shiny components of the Starlink satellites are a much smaller problem. Whether diffuse or specular, having a high reflectance helps the satellites stay cool in space. When sunlight hits a specular surface of the spacecraft and reflects, the vast majority of light reflects in the specular (mirror reflection) direction, which is generally out toward space (not toward Earth). Occasionally when it does, the glint only lasts for a second or less. In fact, specular surfaces tend to be the dimmest part of the satellite unless you are at just the right geometry.

The biggest contributors to Starlink being bright are the white diffuse phased array antennas on the bottom of the satellite, the white diffuse parabolic antennas on the sides (not shown below), and the white diffuse back side of the solar array. These surfaces are all white to keep temperatures down so components do not overheat. The key to making Starlink darker is to prevent sunlight from illuminating these white surfaces and scattering via reflection toward observers on the ground. While in orbit raise and the parking orbit the solar array dominates due to the much larger surface area. However, once the satellites are at their operational altitude, the antennas dominate because the bright backside of the solar array is shadowed.

Solutions In-Work

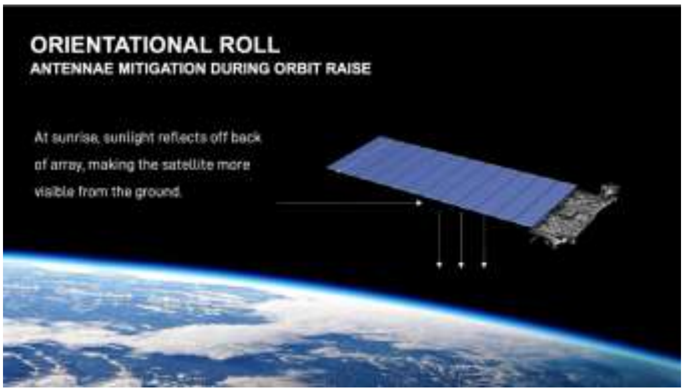
We've taken an experimental and iterative approach to reducing the brightness of the Starlink satellites. Orbital brightness is an extremely difficult problem to tackle analytically, so we've been hard at work on both ground and on-orbit testing. For example, earlier this year we launched DarkSat, which is an experimental satellite where we darkened the phased array and parabolic antennas designed to tackle on-station brightness. This reduced the brightness of the satellite by about 55%, as was verified by differential optical measurements comparing DarkSat to other nearby Starlink satellites. This is nearly enough of a brightness reduction to make the satellite invisible to the naked eye while on-station. However, black surfaces in space get hot and reflect some light (including in the IR spectrum), so we are moving forward with a sun visor solution instead. This avoids thermal issues due to black paint, and is expected to be darker than DarkSat since it will block all light from reaching the white diffuse antennas.

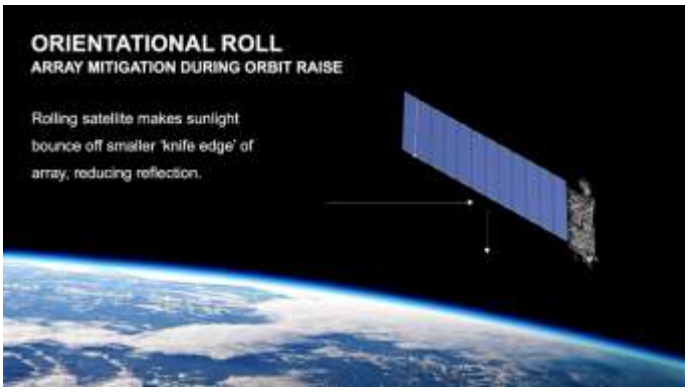


Early Mission (Orbit Raise and Parking Orbit) Roll Maneuver

Since the visor is intended to help with brightness while on-station, it does not shade the back of the solar array, which means that it will not prevent orbit raise and parking orbit brightness. For this, we are working on changing the way the satellite flies up from insertion to parking orbit and to station. We're currently testing rolling the satellite so the vector of the Sun is in-plane with the satellite body, i.e. so the satellite is knife-edge to the Sun. This would reduce the light reflected onto Earth by reducing the surface area that receives light. This is possible when orbit raising and parking in the precession orbit because we don't have to constrain the antennas to be nadir facing to provide coverage to internet users. However, there are a couple of nuanced reasons why this is tricky to implement. First, rolling the solar array away from the Sun reduces the amount of power available to the satellite. Second, because the antennas will sometimes be rolled away from the ground, contact time with the satellites will be reduced. Third, the star tracker cameras are located on the sides of the chassis (the only place they can go and have adequate field of view). Rolling knife edge to the Sun can point one star tracker directly at the Earth and the other one directly at the Sun, which would cause the satellite to have degraded attitude knowledge.

There will be a small percentage of instances when the satellites cannot roll all the way to true knife edge to the Sun due to one of the aforementioned constraints This could result in the occasional set of Starlink satellites in the orbit raise of flight that are temporarily visible for one part of an orbit.

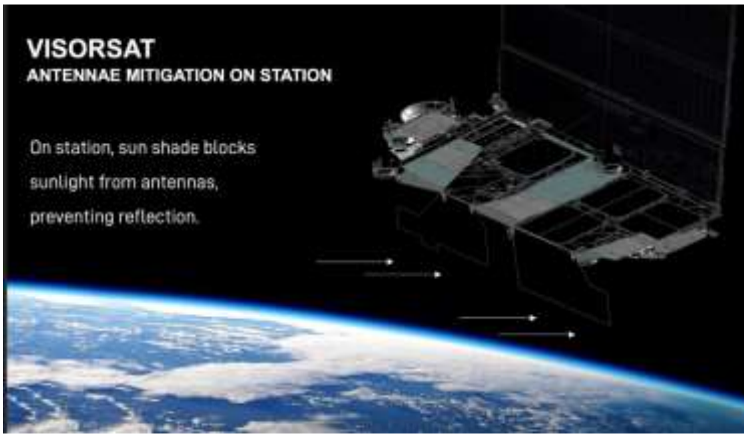




On-Station Brightness

Satellites spend most of their lives on-station, where they will always be in the shark-fin configuration during visible passes. We can adjust the solar array positioning in this configuration to reflect light from its largely specular solar cells away from Earth and to partially hide it behind the chassis. The main remaining goal is to block the phased arrays and antennae from direct view of the sun. The goal is to cover the white phased array antennas and the parabolic antennas on the sides of the satellite.

Using our low orbital altitude and flat satellite geometry to our advantage, we designed an RF-transparent deployable visor for the satellite that blocks the light from reaching most of the satellite body and all of the diffuse parts of the main body. This visor lays flat on the chassis during launch and deploys during satellite separation from Falcon 9. The visor prevents light from reflecting off of the diffuse antennas by blocking the light from reaching the antennas altogether. Not only does this approach avoid the thermal impacts from surface darkening the antennas, but it should also have a larger impact on brightness reduction. As previously noted, the first VisorSat prototype will launch in May and we will have these black, specular visors on all satellites by June. The parabolic antennas on the sides of the Starlink satellite also have visor-like coverings that darken them.



We have been working with leading astronomical groups in this effort—in particular the American Astronomical Society and the Vera C. Rubin Observatory—to better understand the methods and instruments employed by the astronomy community. With AAS, we have increased our understanding of the community as a whole through regular calls with a working group of astronomers during which we discuss technical details, provide updates, and work on how we can protect astronomical observations moving forward. A post on some of our sessions is here. One particularly useful presentation from a member of this working group is here.

While community understanding is critical to this problem, engineering problems are difficult to solve without specifics. The Vera C. Rubin Observatory was repeatedly flagged as the most difficult case to solve, so we've spent the last few months working very closely with a technical team there to do just that. Among other useful thoughts and discussions, the Vera Rubin team has provided a target brightness reduction that we are using to guide our engineering efforts as we iterate on brightness solutions.

These technical and community discussions are paired with our existing efforts to make the satellites easier for astronomers to avoid. Starlink trajectories are published through Space-track.org and celestrak.com, which many astronomers use in timing their observations to avoid satellite streaks. We've also started publishing predictive data prior to launch at the request of astronomers. These allow observatories to schedule around the satellites in the first few hours of deployment (as satellites de-tumble and enter the network).

Vera Rubin has been described as the limiting case for Starlink, due to its enormous aperture and wide field of view. These two characteristics work in concert to produce the perfect storm for satellite observations. Most astronomical systems look at an extremely small section of the sky (less than 1 degree), which makes it exceedingly unlikely that a satellite will cross in front of the imaging system in a given observation. On the other hand, systems with very large fields of view normally aren't extremely sensitive, meaning that, while streaks will occur, they will have a small impact on the overall data collection. This is why we've been working so closely with the team at the Rubin Observatory. In fact, despite its wide field of view, the Vera C. Rubin Observatory is sensitive enough to detect a sunlit golf ball as far away as the Moon.

So what can we do to mitigate our impact on these edge cases of wide, fast survey telescopes?

Minimizing the Impact on Astronomy

The huge collecting area of a larger telescopes like Vera C. Rubin Observatory leads to a sensitivity that will render even the darkest satellites visible.They are so sensitive that it won't be possible to build a satellite that will not produce streaks, in a typical long integration. There is much that can be done to reduce the impact of satellite streaks, and that starts with an understanding of how astronomical sensors work.

The astronomical community has done a great job of educating us on their imaging techniques. Optical systems use

mirrors or lenses to focus light onto an imaging sensor. Most optical astronomy instruments use sensors called charge-coupled-devices (CCDs) as their detectors because astronomical targets, such as distant supernovae and galaxies, are generally dim–at the limit of what can be detected by a sensor. For these applications, the lower noise level of CCDs allows for a higher signal-to-noise ratio for a given image, making it easier to see very faint features in the universe.
However, CCDs suffer from a key drawback: when compared to other common sensors, like the CMOS sensor in your cell phone. If you point your cell phone at a bright light, you'll see all the pixels saturate and turn white in the region of the bright source. If you look at the same target with an optical system that uses a CCD sensor, you'll notice that this bright spot extends to create vertical stripes on the image.
This difference is due to the way each sensor type reads the values for each pixel. While a CMOS sensor essentially has an amplifier at each pixel that turns the light collected into a digital value, a CCD sensor has a limited number of amplifiers and moves the collected light (in the form of electrons) across the sensor, to be digitized. This mechanism means that a saturated pixel on a CCD tends to wipe out data from an entire column of pixels.
This effect, commonly referred to as 'blooming,' is one example of how a very small but bright source of light can impact an astronomical observation. This principle is the core of our mitigation efforts. While it will not be possible to create satellites that are invisible to the most advanced optical equipment on Earth, by reducing the brightness of the satellites, we can make the existing strategies for dealing with similar issues, such as frame-stacking, dramatically more effective.

Future Satellites

SpaceX is committed to making future satellite designs as dark as possible. The next generation satellite, designed to take advantage of Starship's unique launch capabilities, will be specifically designed to minimize brightness while also increasing the number of consumers that it can serve with high-speed internet access.
While SpaceX is the first large constellation manufacturer and operator to address satellite brightness, we won't be the last. As launch costs continue to drop, more constellations will emerge and they too will need to ensure that the optical properties of their satellites don't create problems for observers on the ground. This is why we are working to make this problem easier for everyone to solve in the future.

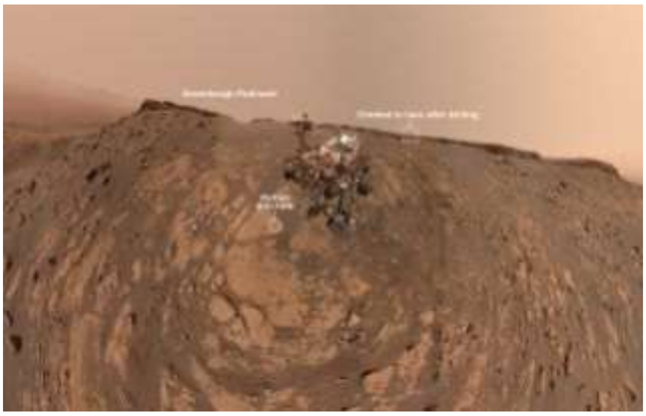
The Companies Taking NASA Back to the Moon in 2024: Blue Origin, SpaceX and Dynetics

In less than four years, NASA plans to send astronauts back to the Moon for the first time since the Apollo era (Project Artemis). But this time, NASA plans to build the infrastructure needed to ensure a “sustainable program” of lunar exploration. In short, we’re going back to the Moon and this time, we plan to stay! To help them get there, the agency has partnered with commercial aerospace companies to provide logistical support.
In addition, NASA recently named three companies to develop vehicles for the *Artemis* missions that will be capable of landing astronauts on the lunar surface. They include the commercial space powerhouses SpaceX and Blue Origin, as well as the Alabama-based Dynetics, all of whom are tasked with developing Human Landing Systems (HLS) that can be deployed from their respective heavy launch systems (or another commercial provider).

NASA budget cuts at Mars threaten 'crisis' for Curiosity rover and prolific orbiters

By Mike Wall 4 days ago

The Curiosity team may soon be forced into a difficult exploration decision.



NASA's Curiosity Mars rover took this selfie on Feb. 26, 2020. The crumbling rock layer at the top of the image is the Greenheugh Pediment, which Curiosity crested on March 6. (Image: © NASA/JPL-Caltech/MSSS)

Budget cuts may force NASA's Curiosity rover to slam on the brakes just as it's reaching its highly anticipated home stretch.
Curiosity landed inside Mars' 96-mile-wide (154 kilometers) Gale Crater in August 2012, tasked with determining if the site could ever have supported microbial life. The rover's work quickly answered that question in the affirmative, showing that Gale hosted a long-lived lake-and-stream system in the ancient past.
The $2.5 billion mission also seeks to shed light on Mars' long-ago shift from a relatively warm and wet world to the cold and dry planet we know today. Gale is well suited for such inquiry; it harbors a 3.4-mile-high (5.5 km) massif called Mount Sharp, whose many rock layers preserve a long history of Martian environmental conditions.

Budget cuts at Mars

Curiosity has been climbing through Mount Sharp's foothills since September 2014, studying clay-rich sediments that are evidence of ancient aqueous environments. The six-wheeled rover has gotten about 1,350 feet (410 meters) above the crater floor to date — so high that it's nearing a transition zone between the clay unit and the sulfate-rich rocks above, which are evidence of a much drier Mars.
But the funding situation may make exploring this new and potentially revelatory region tougher and more time-consuming than the Curiosity team had thought. The White House's 2021 federal budget request allocates just $40 million to the mission, a decrease of 20% from the rover's current funding. And that current funding is 13% less than Curiosity got in the previous year, said Curiosity project scientist Ashwin Vasavada, of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California.
If the 2021 request is passed by Congress as-is, Curiosity's operations would have to be scaled back considerably. Running the mission with just $40 million in 2021 would leave unused about 40% of the science team's capability and 40% of the rover's power output, which comes from a radioisotope thermoelectric generator (RTG), Vasavada said.
"The team feels a bit under a crisis now because of the funding situation," Vasavada said on April 17 during a meeting of NASA's Mars Exploration Program Analysis Group (MEPAG), which aids agency efforts to explore the Red Planet. "This is a big morale hit for us."
In addition to the clay-sulfate boundary region, the Curiosity team wants to spend some time studying a nearby formation called the Greenheugh Pediment. Just atop Greenheugh is a

ridge that may have been formed by debris-carrying liquid water that originated higher up on Mount Sharp, long after Gale's lakes dried up, Vasavada said in his MEPAG presentation.
"This is just a huge climate signature that we want to be able to explore," he said.

An end in 2022?

Vasavada said that Greenheugh and the clay-sulfate transition zone are the mission's two major exploration objectives for the near future. But enactment of the 2021 budget request would probably force the mission team to push one of those two activities beyond 2022, he said — and such a delay might end up consigning the unlucky objective to the dustbin.
That's because Curiosity's outlook gets far more uncertain after next year. For starters, the 2021 federal budget request zeroes out the mission in 2022, projecting no money for the mission that year or in any future years.
And, even if funding does eventually come through, the output of the rover's RTG — which converts to electricity the heat generated by the radioactive decay of plutonium-238 — will likely have declined enough by 2022 to start taking a significant toll on science work, Vasavada said. (Curiosity remains in good health otherwise, he stressed.)
"NASA and the Mars science community have the great fortune of having this flagship rover in great shape with an experienced team, ready to further advance our study of ancient habitability," he said. "There's a window that's closing to use Curiosity because of the RTG."

Not just Curiosity

Vasavada isn't the only Mars mission lead with budget laments; the 2021 funding request is rough for most of the space agency's other robotic Mars probes currently in operation as well.
For example, proposed cuts to the Mars Atmosphere and Volatile Evolution (MAVEN) orbiter mission would "require a significant downsizing of the science team starting this year, this coming year, and then each year into the future," principal investigator Bruce Jakosky, of the University of Colorado Boulder's Laboratory for Atmospheric and Space Physics, said during his MEPAG talk on April 17. (Leaders of NASA's robotic Mars missions gave updates on that day.)
The $2.5 million proposed cut to the Mars Reconnaissance Orbiter (MRO) in 2021 would force the venerable mission to reduce its targeted imaging observations by 50% and its radar observations by 30%, said project scientist Richard Zurek of JPL.
Then there's Mars Odyssey, an orbiter that has been studying the Red Planet since 2001. The 2021 budget request allocates just $1 million to Odyssey. As a result, the mission "would have to end this calendar year — really, in the next few months," said project scientist Jeff Plaut, also of JPL, in his MEPAG presentation.
All of these orbiters remain in good health, the MEPAG presenters said, and all of them provide vital communications-relay services in addition to their science work. Odyssey, for example, relays to Earth 62% of the data collected by NASA's marsquake-hunting InSight lander, which touched down in November 2018.
And those communications needs are going to increase less than a year from now, when NASA's next Red Planet rover touches down. The life-hunting, sample-caching Mars 2020 rover Perseverance is scheduled to launch this July and land inside the Red Planet's Jezero Crater in February 2021.
Plaut ended his MEPAG talk by saying he hopes the Mars science community sees value in the continuation of Odyssey's mission and voices that value to decisionmakers — namely, Congress, which controls the nation's purse strings and therefore has final budgetary say. (A White House federal budget request is just that — a request — before Congress enacts it.)
He found a receptive audience. One of the findings of the three-day MEPAG meeting, as determined by the steering committee and chairwoman Aileen Yingst of JPL, was an objection to the budgetary treatment of Odyssey, MRO, MAVEN and Curiosity (whose mission is officially called the Mars Science Laboratory, or MSL).
"MEPAG finds that the substantial reduction of funding for the extended missions of MSL, Odyssey, MRO and MAVEN and the projected closeout of MSL in 2022 and Odyssey in 2021 are inconsistent with their high rankings by the Planetary Mission Senior Review," Yingst said on April 17, reading the finding for meeting participants.
"This would result in major, perhaps unrecoverable, losses for science and does not reflect community priorities," she added.
Overall, the 2021 federal budget request allocates $25.2 billion to NASA, a 12% boost for the space agency over its 2020 funding. But a big chunk of this money would go toward NASA's crewed exploration projects, especially its Artemis lunar program, which aims to land two people on the moon in 2024. The space agency's planetary science funding next year would decrease by 1.9% from 2020 levels.
Trump's NASA budget request could spell big changes for Mars missions
7 biggest mysteries of Mars
Ancient Mars lakes and laser blasts: Curiosity rover's 10 biggest moments in 1st 5 years
Mike Wall is the author of "Out There" (Grand Central Publishing, 2018; illustrated by Karl Tate), a book about the search for alien life. Follow him on Twitter @michaeldwall. Follow us on Twitter @

Earth 'buzzed' by Asteroid

A small newfound asteroid gave Earth a close shave today (April 28) on the event of another flyby by a much larger space rock, according to NASA.
The asteroid, called 2020 HS7, is between 13 and 24 feet (4 to 8 meters) in size and passed Earth at a distance of 23,000 miles (36,400 kilometers) when it made its closest approach at 2:51 p.m. EDT (1851 GMT). That range is close to the orbits of some geosynchronous satellites about 22,000 miles (36,000 km) above Earth.
While that sounds close, there was never any risk to our planet, NASA officials said.
"Small asteroids like 2020 HS7 safely pass by Earth a few times per month," NASA's Planetary Defense Officer Lindley Johnson, the program executive for the Planetary Defense Coordination Office at agency's Washington, D.C. headquarters, said in a statement. "It poses no threat to our planet, and even if it were on a collision path with Earth it is small enough that it would be disintegrated by our Earth's atmosphere."

This NASA graphic shows the path of the newfound asteroid 2020 HS7, which passed safely by Earth on April 28, 2020 at a distance of 23,000 miles (36,400 km). (Image credit: NASA/JPL-Caltech)
Asteroid 2020 HS7's flyby comes just one day before the close approach of a much bigger space rock: the asteroid 1998 OR2. That space rock will pass Earth early Wednesday, April 29, at 5:55 a.m. EDT (0955 GMT).
With a diameter of about 1.5 miles (2 km), asteroid 1998 OR2 is much larger than 2020 HS7, but it's also passing Earth at a much greater distance -- about 3.9 million miles (6.9 million km). That's about 16 times the distance between the Earth and the moon (about 239,000 miles, or 385,000 km).
Despite its size, asteroid 1998 OR2 is too small and dim to be seen with the unaided eye. But you can see it through telescopes tonight thanks to a webcast from Slooh.com.
The webcast, which you can also see here courtesy of Slooh, begins at 7 p.m. EDT (2300 GMT) and will last an hour.
Scientists at NASA and around the world regularly track asteroids that come close to the Earth in order to identify ones that might one day endanger our planet. These so-called "near-Earth objects" are ones that approach within 4.6 million miles (7.5 million km).
To date, astronomers have discovered 22,776 near-Earth objects, and new ones are being found at a rate of 30 each day, NASA officials said. More than 95% of those objects were found through NASA-funded surveys, they added.

Mile-long asteroid 1998 OR2 dons 'mask' before Earth flyby (photos)
About 17,000 big near-earth asteroids remain undetected
Huge asteroid will zip by Earth April 29. See the latest telescope photos.
Email Tariq Malik at tmalik@space.com or follow him @tariqjmalik.

Don't panic about Russia's recent anti-satellite test, experts say

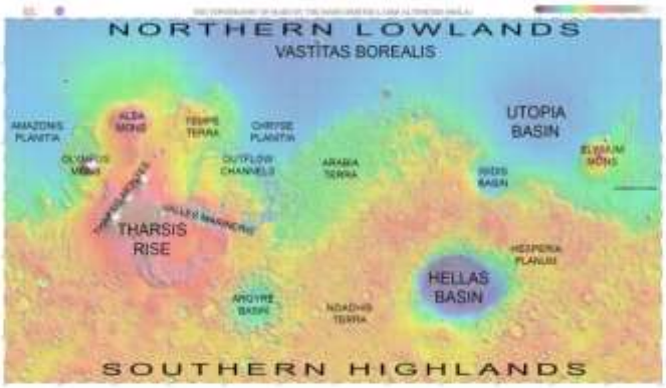
By Mike Wall 4 days ago
There are real questions about the utility of ASAT tech.

Plesetsk Cosmodrome in northern Russia, the launch site for an anti-satellite test on April 15, 2020.
(Image: © Roscosmos)

Russia's recent anti-satellite (ASAT) test wasn't as big of a deal as you may think.
On April 15, Russia conducted a trial of its Nudol interceptor, a mobile rocket system that's designed to take out satellites in Earth orbit. The event generated buzz in national-security circles and in the mainstream media, but it's not cause for too much alarm, experts said.
For starters, this was not a contact test. Unlike China's infamous 2007 ASAT trial or the one performed by India in March 2019, the Nudol did not hit anything on April 15. It therefore didn't generate a new swarm of orbital debris that could complicate life for the entire space community.
In addition, though Russia has now tested the Nudol 10 times or so, the system does not appear to be ready for action.
"As far as we can tell, it's not operational," Brian Weeden said on April 24 during a webinar about the Russian ASAT test. Weeden is director of program planning for the Secure World Foundation, a nonprofit organization dedicated to space sustainability, which hosted the webinar.
"That is probably at least a few years away," Weeden added.
Then there's the matter of the Nudol's limited reach: The system apparently can target satellites only in low Earth orbit (LEO), Weeden said. LEO tops out around 1,240 miles (2,000 kilometers) above the planet's surface. That's far lower than the United States' most capable reconnaissance and military communications satellites, which tend to reside in geostationary orbit, about 22,200 miles (35,730 km) up.
Finally, it's not clear that ASAT technology in general is terribly useful, said analyst Pavel Podvig, director of the Russian Nuclear Forces Project and a senior research fellow at the United Nations Institute for Disarmament Research.
"Basically, with this kind of ASAT, or even with a more kind of advanced ASAT," Podvig said during the April 24 webinar, "it's hard to imagine a military mission in which this capability would be useful."
That's because any nation whose security could be significantly compromised by ASAT tech will naturally take steps to reduce its vulnerability to such attacks, he explained.
"There are clear ways of doing that. You go to distributed capability, you go to smaller satellites, you go to redundancy. And in the end, you can shoot down a satellite, but so what?" he said. "In that sense, I'm an optimist. I do believe that these capabilities will not be used, just because I do believe that they don't give you much in terms of military capability."
Podvig cited some historical precedent for this view. Officials in both the U.S. and the Soviet Union came to this same basic conclusion during the Cold War, cooling off considerably on the potential of ASAT weapons after some initial excitement, he said. (That said, both nations didn't totally give up on the tech. Russia just tested the Nudol, after all, and the U.S. blasted one of its own dead and rapidly descending spy satellites out of the sky with an SM-3 missile in February 2008.)
Weeden said he generally agrees with Podvig's assessment. However, he did offer a caveat: Bureaucratic and other barriers can make it tough for a nation to safeguard its space assets.
"The U.S. has been trying to do that for a decade, and so far has not really made any progress in making their system more resilient," Weeden said.
U.S. military officials have repeatedly stressed over the past few years that the nation's long-held space dominance is at serious risk, saying that both China and Russia have big ambitions in the final frontier. And the Nudol, while not particularly threatening in itself, is indeed part of a broad Russian "counterspace" portfolio, Weeden said.
That portfolio, he added, includes electronic warfare, which Russia is already using operationally, and directed energy (laser) weapons, which the country is researching.
"Finally, Russia has a pretty advanced space situational awareness capability, which is what one would need to be able to target other satellites," Weeden said.

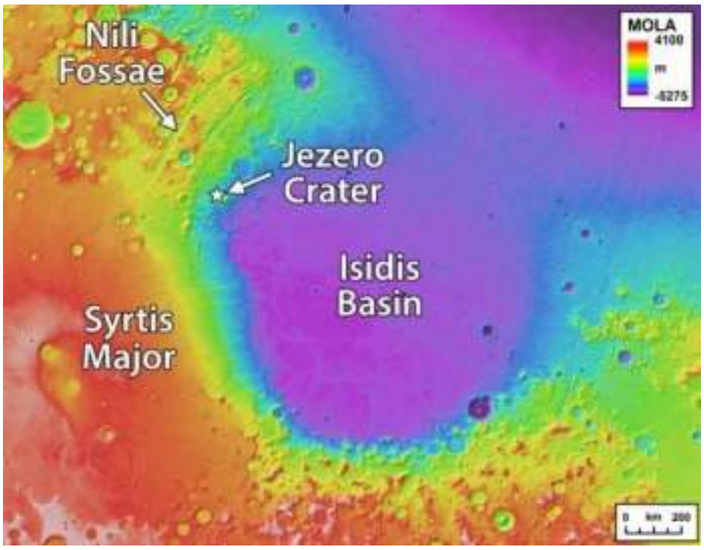
NASA's Perseverance Rover is Going to Jezero Crater, Which is Looking Better and Better as a Place to Search for Evidence of Past Life on Mars

In 2018, NASA decided that the landing site for its Mars 2020 Perseverance rover would be the Jezero Crater. At the time, NASA said the Jezero Crater was one of the "oldest and most scientifically interesting landscapes Mars has to offer." That assessment hasn't changed; in fact it's gotten stronger.
A new research paper says that the Jezero Crater was formed over time periods long enough to promote both habitability, and the preservation of evidence.
The Jezero Crater is a dried up paleo-lakebed, with a preserved river delta and sediments. It contains at least five different rock types that can be sampled. The crater also holds geological features that are approximately 3.6 billion years old. It's an excellent feature to study, and hopefully to collect samples from for eventual return to Earth. Scientists are hopeful that the Perseverance Rover may find fossilized evidence of early, single-celled life.
"Being able to use another planet as a lab experiment for how life could have started somewhere else or where there's a better record of how life started in the first place – that could actually teach us a lot about what life is."
Mathieu Lapôtre, Lead Author, Stanford University
A new study based on the analysis of satellite imagery reinforces Jezero's scientific desirability.
The study is titled "The Pace of Fluvial Meanders on Mars and Implications for the Western Delta Deposits of Jezero Crater."
It's published in the journal AGU Advances. The lead author is Mathieu Lapôtre, an assistant professor of geological sciences at Stanford's School of Earth, Energy & Environmental Sciences. The other author is Alessandro Ielpi from Laurentian University.



This map of Mars was created using data from the Mars Orbiter Laser Altimeter (MOLA) on the Mars Global Surveyor. The Isidis Basin, which contains the Jezero Crater, is on the middle right. Image Credit: NASA / JPL / GSFC. Map by Emily Lakdawalla at the Planetary Society.

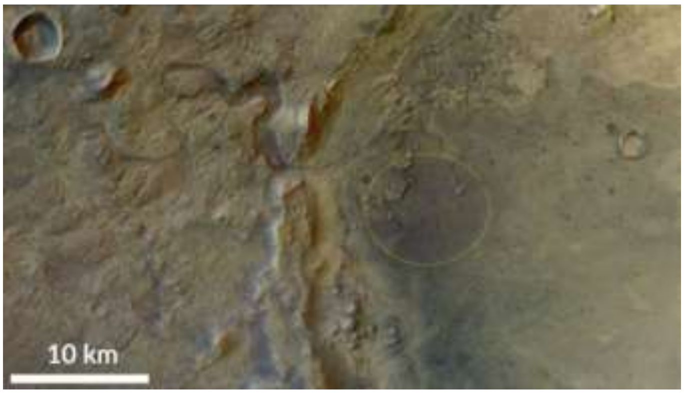
One of science's main roadblocks to understanding Mars' history is timing. With telescopes, orbiters, landers, and rovers, we've learned a lot about Mars. Over the past couple decades especially, scientists have uncovered compelling evidence showing that Mars was once warm, wet, and habitable. But questions of timing remain.



Jezero Crater is located on the edge of the Isidis Basin (or Isidis Planitia), a massive impact basin. In this MOLA (Mars Orbital Laser Altimeter) image, purple is low elevation and red is high elevation. Image Credit: By NASA / JPL / USGS – [1], Public Domain, https://commons.wikimedia.org/w/index.php?curid=74634265

There's ample evidence of ancient river-beds on Mars, and some of the timing questions revolve around those rivers. How long did rivers flow on Mars, and how often? How long ago? How long did it take form deltas like the one in Jezero Crater? Mars was likely habitable at the same time that life was evolving on Earth, and understanding the age of Mars' ancient rivers, and how long they lasted, is one key to understanding habitability.

In their paper the authors write, "Here we develop a new model to calculate the pace of shifting Martian rivers, which, when applied to orbital observations of the Jezero delta, allows us to determine a minimum duration for delta formation." Combined with other modelling and the work of other scientists, the pair of authors say that "…our results suggest that the delta took a few decades to form over a total timespan of, most likely, hundreds of thousands of years."



The landing area for NASA's Perseverance Rover is circled in yellow in this image of Jezero Crater. The dry river bed is clearly running into the crater from the left, and the landing circle borders includes part of the delta sediment area. Image Credit: NASA/JPL/University of Arizona.

During that hundreds of thousands of years, there were many dry, arid periods. They say that the river that flowed into the Jezero Crater likely flowed for only one day every 15 to 30 years; maybe a little more often. On Earth, sediments preserve organic molecules, and the same is likely true on Mars. So if the sediments at Jezero were buried quickly, there's a strong possibility that organic molecules are preserved there, as well.

"There probably was water for a significant duration on Mars and that environment was most certainly habitable, even if it may have been arid," said lead author Mathieu Lapôtre in a press release. "We showed that sediments were deposited rapidly and that if there were organics, they would have been buried rapidly, which means that they would likely have been preserved and protected."

Rivers on Earth, Rivers on Mars

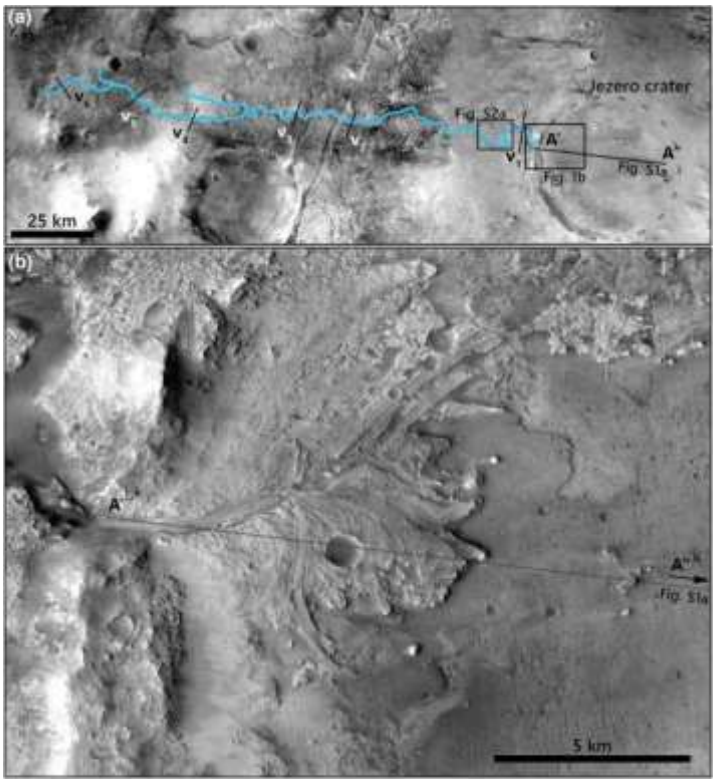
This study is related to another recent study from 2019 by the same authors into rivers here on our planet, specifically a type of river called 'single-threaded sinuous rivers.'

That paper showed that single-threaded sinuous rivers without plants stabilizing their banks drift sideways ten times faster than the same type of rivers with banks stabilized by plants. That sideways movement of river channels is called meander migration.

The tendency of rivers to meander migrate has been studied for a long time. The authors say in their 2019 paper that river meander is "among the most unequivocal indicators of hydrologically mature planets."

Based on the likely fact that Martian rivers did not have plants to stabilize their banks, and accounting for the gravity on Mars, the pair of researchers say that the Jezero delta took at least 20 to 40 years to form, but that length of time was intermittent, and spread out over about 400,000 years. And that brings us back to the time problem again.

"This is useful because one of the big unknowns on Mars is time," Lapôtre said. "By finding a way to calculate rate for the process, we can start gaining that dimension of time."



An image from the study showing Jezero crater and catchment of the western Jezero delta. The feeder valley to the Jezero delta is highlighted in blue. Image Credit: Lapôtre and Ielpi, 2020.

On Earth, single-threaded meandering rivers are most often found with vegetation on their banks. Only recently were these types of rivers detected without plants, and prior to that, scientists thought that before plants appeared on Earth, only braided, multi-threaded rivers existed. But now scientists have found many single-threaded rivers without vegetated banks.

One of the rivers in the study is in the Toyiabe Basin in Nevada. It's an example of a meandering river without vegetation to contain it. Image Credit: Alessandro Ielpi

"This specifically hadn't been done before because single-threaded rivers without plants were not really on anyone's radar," Lapôtre said. "It also has cool implications for how rivers might have worked on Earth before there were plants."

All rivers can go through drier spells, and it's the wet spells that created sediment build up in deltas. The researchers think that on Mars, the dry spells were 20 times more frequent than on Earth today. "People have been thinking more and more about the fact that flows on Mars probably were not continuous and that there have been times when you had flows and other times when you had dry spells," Lapôtre said. "This is a novel way of putting quantitative constraints on how frequently flows probably happened on Mars."

Artist's impression of the Perseverance rover on Mars. Credit: NASA-JPL

If there was life at Jezero Crater, most scientists seem to think that it never evolved much, and was restricted to single-celled organisms. With this new understanding of how the sediment deposits in Jezero Crater were formed, and how it likely preserved evidence of life, it makes the Perseverance Rover mission even more exciting to look forward to.

Life on Earth began about 3.5 billion years ago, at about the same time that Jezero Crater was formed. Any life on Earth would have been single-celled when the crater was formed. If single-celled life was present at Jezero long before multicellular life evolved on Earth, then something stalled Martian life, depleting the atmosphere and sterilizing the planet.

Since Earth is such a geologically active planet compared to Mars, a lot of ancient evidence for life has been erased. But that never happened on Mars. In that sense the Jezero Crater may be a kind of time capsule, waiting to be opened by NASA's Perseverance Rover.

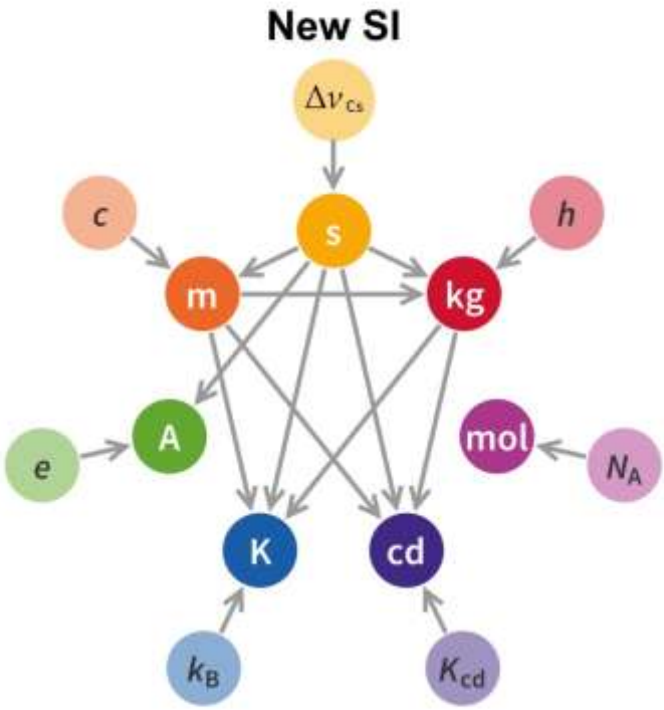
It's possible, that we might finally, unequivocally, have evidence for past life on Mars.

"Being able to use another planet as a lab experiment for how life could have started somewhere else or where there's a better record of how life started in the first place – that could actually teach us a lot about what life is," Lapôtre said. "These will be the first samples that we've seen as a rock on Mars and then brought back to Earth, so it's pretty exciting."

Could The Physical Constants Change? Possibly, But Probably Not

The world we see around us seems to be rooted in scientific laws. Theories and equations that are absolute and universal. Central to these are fundamental physical constants. The speed of light, the mass of a proton, the constant of gravitational attraction. But are these constants really constant? What would happen to our theories if they changed?

Although our physical theories give us a powerful understanding of the universe, they don't explain physical constants. We don't know why the speed of light is 299,792,458 meters per second. That is just the result we get when we measure the speed of light. The same is true with every universal constant. They lay at the heart of physical science, yet all we can do is measure their value.

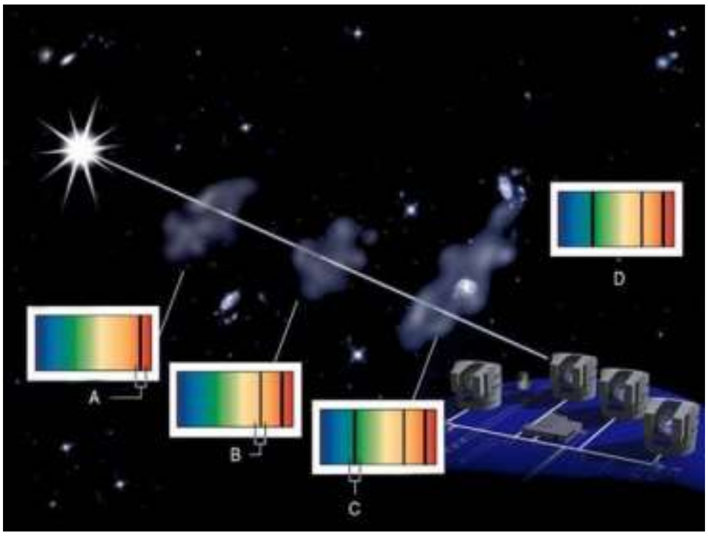


The metric system is defined by physical constants. Credit: Emilio Pisanty/Wikimedia

Since these constants are rooted in physical properties, it is generally thought they cannot change over space and time. Every electron, for example, has the same charge. They should have the same charge whether they are here on Earth or in a galaxy billions of light-years away. The charge they have now should be the same charge they had at the dawn of time.

While that makes sense, it isn't necessarily true. Lots of our "obvious" assumptions have been proven wrong, from the idea that the Earth is the center of the cosmos to the idea that space is Euclidian. So there have been many scientific experiments trying to prove whether this assumption is true.

Most of these experiments are astronomical. Because light takes time to travel, when we look deep into the cosmos we also look deep into the past. A galaxy a billion light-years away appears to us as it was a billion years ago. So if the physical constants are the same in distant galaxies as they are here, this means they are constant not only in space but also in time. And this is what most experiments have shown. But a recent study suggests at least some of them might not be.



Measuring spectra at different distances. Credit: ESO

This latest study looked at what is known as the fine structure constant, alpha. This constant is a ratio of the charge of an electron with the speed of light and Planck's constant of quantum theory. It's known as a unitless constant because the units cancel out, so it has the same value regardless of which units of measure you use. It is also central to the energy levels of an atom. If it were to have a different value, then the line spectra of atoms and molecules would change in a measurable way.

The team looked at light from a quasar known as J1120+0641. The light left the quasar when the universe was only 800 million years old, and it passed through several interstellar gas clouds before reaching us. They measured the line spectra of the light as it passed through four regions at different distances, and found no evidence of a change in alpha, meaning it doesn't appear to change over time. But the value of alpha they got is slightly different from the value found from similar studies. This would suggest that the fine structure constant could have a different value depending on where you are in space.

This has led some popular news articles to declare that physical constants do change after all, but that conclusion is unwarranted. To begin with, the deviation found by the team is very small, and well below a level considered conclusive.

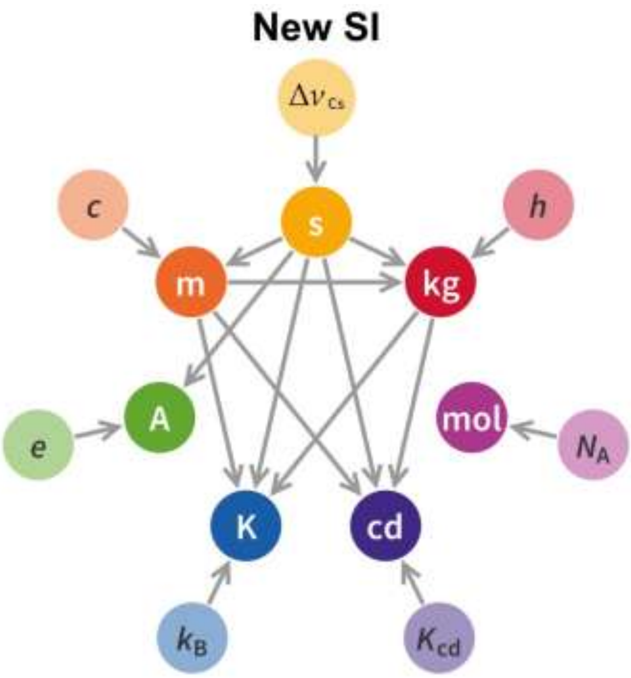
The team also only looked at light from one quasar. That's understandable given that this kind of study can be difficult to do, but it means there is nowhere near enough data to draw radical conclusions. This is only one study of several, and the others have all support the idea that physical constants don't change.

The best evidence remains on the side of unchanging physical constants.

Could The Physical Constants Change? Possibly, But Probably Not

The world we see around us seems to be rooted in scientific laws. Theories and equations that are absolute and universal. Central to these are fundamental physical constants. The speed of light, the mass of a proton, the constant of gravitational attraction. But are these constants really constant? What would happen to our theories if they changed?

Although our physical theories give us a powerful understanding of the universe, they don't explain physical constants. We don't know why the speed of light is 299,792,458 meters per second. That is just the result we get when we measure the speed of light. The same is true with every universal constant. They lay at the heart of physical science, yet all we can do is measure their value.



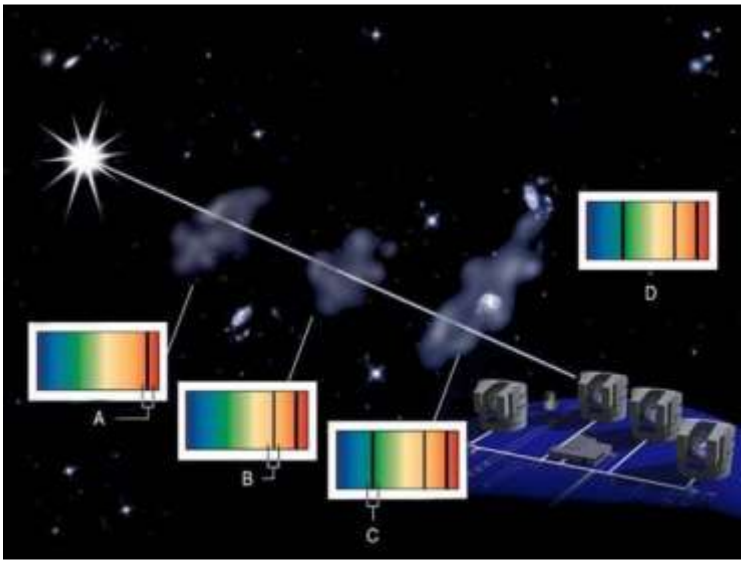
The metric system is defined by physical constants. Credit: Emilio Pisanty/Wikimedia

Since these constants are rooted in physical properties, it is generally thought they cannot change over space and time. Every electron, for example, has the same charge. They should have the same charge whether they are here on Earth or in a galaxy billions of light-years away. The charge

they have now should be the same charge they had at the dawn of time.

While that makes sense, it isn't necessarily true. Lots of our "obvious" assumptions have been proven wrong, from the idea that the Earth is the center of the cosmos to the idea that space is Euclidian. So there have been many scientific experiments trying to prove whether this assumption is true.

Most of these experiments are astronomical. Because light takes time to travel, when we look deep into the cosmos we also look deep into the past. A galaxy a billion light-years away appears to us as it was a billion years ago. So if the physical constants are the same in distant galaxies as they are here, this means they are constant not only in space but also in time. And this is what most experiments have shown. But a recent study suggests at least some of them might not be.



Measuring spectra at different distances. Credit: ESO

This latest study looked at what is known as the fine structure constant, alpha. This constant is a ratio of the charge of an electron with the speed of light and Planck's constant of quantum theory. It's known as a unitless constant because the units cancel out, so it has the same value regardless of which units of measure you use. It is also central to the energy levels of an atom. If it were to have a different value, then the line spectra of atoms and molecules would change in a measurable way.

The team looked at light from a quasar known as J1120+0641. The light left the quasar when the universe was only 800 million years old, and it passed through several interstellar gas clouds before reaching us. They measured the line spectra of the light as it passed through four regions at different distances, and found no evidence of a change in alpha, meaning it doesn't appear to change over time. But the value of alpha they got is slightly different from the value found from similar studies. This would suggest that the fine structure constant could have a different value depending on where you are in space.

This has led some popular news articles to declare that physical constants do change after all, but that conclusion is unwarranted. To begin with, the deviation found by the team is very small, and well below a level considered conclusive. The team also only looked at light from one quasar. That's understandable given that this kind of study can be difficult to do, but it means there is nowhere near enough data to draw radical conclusions. This is only one study of several, and the others have all support the idea that physical constants don't change.

The best evidence remains on the side of unchanging physical constants.

How Do You Weigh The Universe?

The weight of the universe (technically the mass of the universe) is a difficult thing to measure. To do it you need to count not just stars and galaxies, but dark matter, diffuse clouds of dust and even wisps of neutral hydrogen in intergalactic space. Astronomers have tried to weigh the universe for more than a century, and they are still finding ways to be more accurate.

Knowing the mass of the cosmos is central to understanding its history and evolution. While dark energy drives the universe to expand, matter tries to keep the universe from expanding. Together they form an average density of matter and energy in the universe, known as the cosmic density parameter. This parameter is central to the standard model of cosmology, also known as the LCDM model

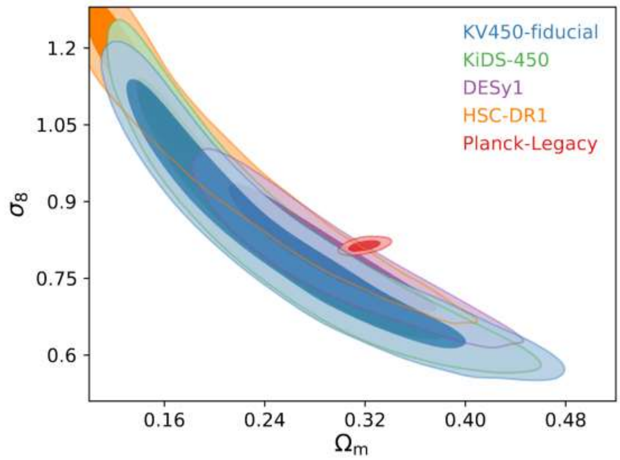
One way to measure this parameter is to look at the Cosmic Microwave Background (CMB). This remnant glow from the big bang has small variations in temperature. The scale of these fluctuations tells us the rate of cosmic expansion, which in turn lets us know the cosmic matter density.

Galaxies bend light gravitationally. Credit: Agentur der RUB

Another way to weigh the universe is to look at how the light of distant galaxies is deflected by galaxies. It's an effect known as gravitational lensing. The challenge with this method is determining which light is lensed and which is not. To do that we would need to compare the distorted shape of the galaxy we see with the actual shape of the galaxy, which we don't know.

It's not possible to make a comparison for a single galaxy, but we can compare them statistically. Since we know the shape of an average galaxy, we can compare this to the lensed shapes we see to get a statistical measure of how much lensing occurs. This was the goal of a project called the "Kilo-Degree Survey."

While the lensing effect gives you a statistical measure of the amount of mass between us and a distant galaxy, it doesn't give you the cosmic density. For that, you need to know how far away the galaxy is. The greater the distance, the more mass you'd expect between it and us. So the team also determined galactic distances by measuring their redshifts at several wavelengths.



The disagreement between this study and CMB results. Credit: Hildebrandt, H., et al

The result is a cosmic density parameter that differs slightly from that found from the CMB. This is not the first time we've seen a strange disagreement in cosmology. In their work, the authors speculate that this could indicate the standard cos-

mological model is wrong. In the standard model, it is assumed that the amount of dark energy in the universe is constant. But this latest data fit an alternative model where dark energy changes over time.
It’s an interesting idea, but it’s a big jump. While this latest result does disagree with CMB data, other similar studies do not. It is quite possible that there is a systematic bias in this study. So don’t throw out your old cosmology textbooks quite yet. In the end it is the weight of evidence that will determine whether the authors of this new study are right.
Reference: Hildebrandt, H., et al. “KiDS+ VIKING-450: Cosmic shear tomography with optical and infrared data

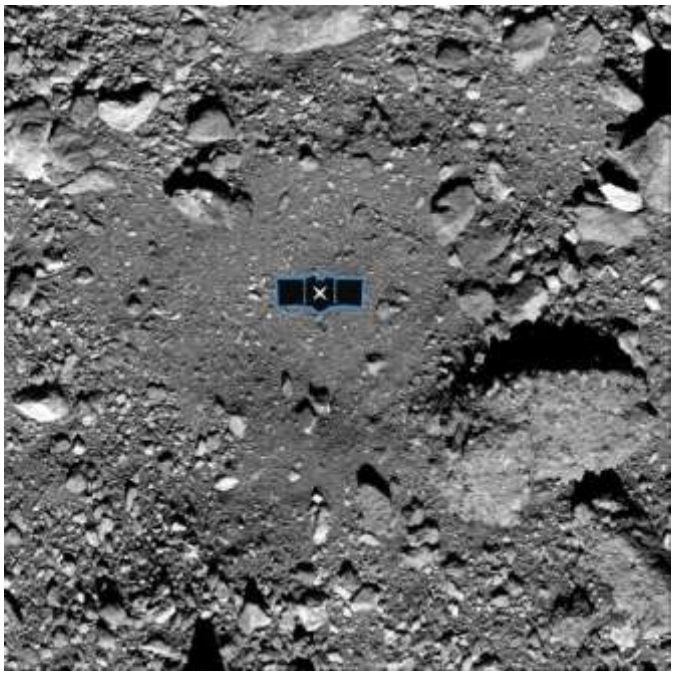
How Will Covid-19 affect the Future of Science?

The full ramifications of the recent novel coronavirus pandemic are not yet known, and probably won’t be known or even felt for quite some time. Entire industries have been shifted and shuttered over the course of only a few tumultuous weeks due to Covid-19. Some industries and professions have been able to adapt quickly, some have had to close down or to send their workers home, while others are faltering and collapsing.
A perhaps surprising outcome of this might be in the realm of research. Modern science thrives on collaborations, from a handful of authors on a single study to hundreds of people engaged in some of the largest experiments mankind has ever know. But at the end of the day, they all require human contact.
Most of that contact is thankfully virtual. Emails, conference calls, and chat messages carry the bulk of the communication workload to enable international collaborations that drive modern-day science.
But there’s something special about the human touch that cannot be replicated by any remote platform. Collaborators visit each other to talk, to share ideas, to stand in front of a chalkboard together. Young students show up at conferences to show off their latest work, hoping to make a name for themselves in front of the most respected members of their communities. Large collaborations gather in auditoriums to share their results and updates from their internal groups.
All that stopped this spring with the outbreak of the Covid-19 disease. Conferences were cancelled, collaboration meetings were cut short, and even academia itself closed its doors.
What will be the result? Will this mark the end of large science collaborations? Will travel restrictions last so long that this form of science becomes nonviable? Will people simply be shy about hopping from country to country to build a large network or to get a job?
It’s impossible to say, and only time will tell. But the spring of 2020 may go down in the history books as an interesting turning point in the history of science, where the uber-expensive, large collaborations that drove science forward in the opening decades of the twenty-first century simply faded away, to be replaced with a new paradigm.
No matter what, fundamental research will continue and scientists will continue working hard to unlock the mysteries of the universe, but the way science has been done for decades may be over with.

OSIRIS-REx Descended Down to Just 75 Meters Above the Surface of Bennu in a Recent Test

NASA’s OSIRIS-REx spacecraft is getting ready for its big moment. OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer) is at asteroid Bennu, preparing to collect a sample of ancient rock. And collecting that sample means taking step after meticulous step.
OSIRIS-REx performed a series of rehearsal maneuvers in recent weeks. Each of these maneuvers brought it closer to Bennu’s surface, before the spacecraft retreated into orbit again. Eventually, it will perform its risky touch-and-go sampling procedure.
The most recent maneuver was the “Checkpoint” maneuver. Checkpoint brought the spacecraft to within 75 meters (246 ft) of Bennu’s surface. Previous maneuvers saw it approach within 620 meters (2034 ft), then 250 meters (820 ft.)

The Checkpoint Rehearsal was the most recent rehearsal maneuver, as OSIRIS-REx inches closer toward its goal: sample collection from asteroid Bennu. Image Credit: NASA/Goddard/University of Arizona.
OSIRIS-REx is a long way away from Earth, and its sampling operation will all be done autonomously. The latest maneuver is called Checkpoint because at 75 meters away from the surface, the spacecraft’s autonomous system will check its position and velocity and adjust its trajectory before continuing to the surface.
In this maneuver, it reached its Checkpoint for the first time. Since this is only a rehearsal, OSIRIS-REx then performed its checkpoint burn and backed away from the asteroid, to orbit at a safe distance.
During these increasingly close approaches, NASA’s spacecraft is capturing a wealth of images of its sampling site. These images are stored onboard as part of the spacecraft’s Natural Feature Tracking (NFT) system. When the time for the sampling maneuver comes, OSIRIS-REx will compare its real-time images from its cameras to its onboard images, and will use those comparisons to guide itself down to the sampling site on Bennu’s boulder-strewn surface.



Nightingale is the primary sampling site for NASA’s OSIRIS-REx spacecraft. When the mission was planned, NASA personnel didn't think that the surface of Bennu would be so littered with boulders. That's made the sampling maneuver more challenging. Image Credit: NASA

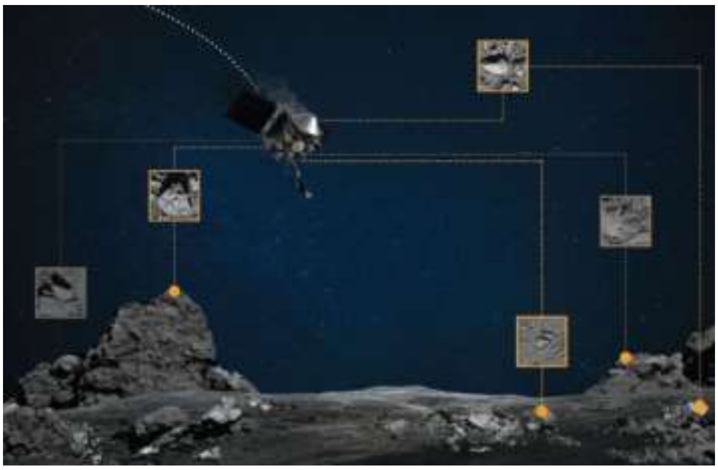
During the Checkpoint maneuver OSIRIS-REx also deployed its sampling mechanism, the Touch-And-Go Sample Acquisition Mechanism, or TAGSAM. Normally TAGSAM is folded onto the spacecraft, and this test of its deployment was successful. Numerous instruments on OSIRIS-REx also gathered data during this closest-yet approach.

This artist's concept shows the trajectory and configuration of NASA's OSIRIS-REx spacecraft during Checkpoint rehearsal, which was the first time the mission practiced the initial steps of collecting a sample from asteroid Bennu. Credit: NASA/Goddard/ University of Arizona

When it is time to collect the sample, OSIRIS-REx will descend to the surface, but the spacecraft itself won't land. Instead, TAGSAM will be deployed to the surface. TAGSAM will emit a puff of nitrogen to kick up dust from the asteroid. The nitrogen will propel small pieces of the regolith into TAGSAM's sampling head. There are also passive contact pads on the end of the instrument that will collect samples.

The goal is to collect 60 grams (2.1 oz) of material in particles smaller than 2 cm (0.8 in).

The Natural Feature Tracking system will guide OSIRIS-REx down to the surface, and there's enough fuel for multiple attempts. TAGSAM also has enough nitrogen for three sample-collection attempts, should there be problems.



During the sample collection event, Natural Feature Tracking (NFT) will guide NASA's OSIRIS-REx spacecraft to asteroid Bennu's surface. The spacecraft takes real-time images of the asteroid's surface features as it descends, and then compares these images with an onboard image catalog. The spacecraft then uses these geographical markers to orient itself and accurately target the touchdown site. Credits: NASA/Goddard/ University of Arizona

The latest maneuver was also a successful test for the NFT. NASA confirmed that NFT performed well, saying in a press release "Checkpoint rehearsal also gave the team confirmation that OSIRIS-REx's Natural Feature Tracking (NFT) guidance system accurately estimated the spacecraft's position and speed relative to Bennu as it descended toward the surface."

"This rehearsal let us verify flight system performance during the descent, particularly the autonomous update and execution of the Checkpoint burn," said Rich Burns, OSIRIS-REx project manager at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Executing this monumental milestone during this time of national crisis is a testament to the professionalism and focus of our team. It speaks volumes about their 'can-do' attitude and hopefully will serve as a bit of good news in these challenging times."

The April 2020 sample collection rehearsal that brought OSIRIS-REx 65 m (213 ft) from the surface. In this series of SamCam images the TAGSAM arm is fully extended and the Nightingale sample site comes into view at the top of the frame. Credit: NASA/Goddard/University of Arizona.

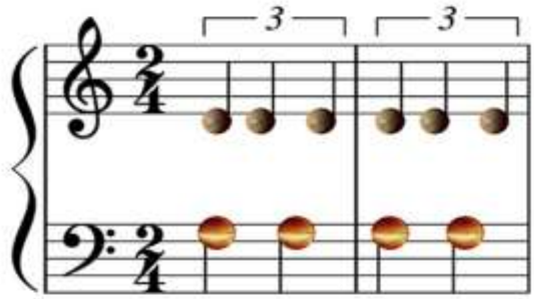
OSIRIS-REx's first sampling attempt is scheduled for August 25th. TAGSAM will contact the surface for about five seconds, and collect its sample. If all goes well, that sample should be returned to Earth on September 24th, 2023.

Astronomers Find a Six-Planet System Which Orbit in Lockstep With Each Other

To date, astronomers have confirmed the existence of 4,152 extrasolar planets in 3,077 star systems. While the majority of these discoveries involved a single planet, several hundred star systems were found to be multi-planetary. Systems that contain six planets or more, however, appear to be rarer, with only a dozen or so cases discovered so far.

This is what astronomers found after observing HD 158259, a Sun-like star located about 88 light-years from Earth, for the past seven years using the SOPHIE spectrograph. Combined with new data from the Transiting Exoplanet Space Satellite (TESS), an international team reported the discovery of a six planet system where all were in near-perfect rhythm with each other.

The international team responsible for this discovery was led by Dr. Nathan Hara, a postdoctoral researcher at the University of Geneva (UNIGE), a member of the Swiss PlanetS institute, and a Fellow with the European Space Agency's (ESA) CHaracterising ExOPlanets Satellite (CHEOPS) mission. The study that describes their findings recently appeared in the journal *Astronomy & Astrophysics*.



In the planetary system HD 158259, all pairs of subsequent planets are close to the 3:2 resonance : the inner one completes about three orbits as the outer completes two. Credit and ©: UNIGE/NASA

Using SOPHIE, astronomers have been conducting velocity measurements of many stars in the northern hemisphere to determine if they have exoplanets orbiting them. This method, known as the Radial Velocity Method (or Doppler Spectroscopy), consists of measuring the spectra a star to see if it is moving in place – which is an indication that the gravitational force of one or more planets is working on it.

Interestingly enough, it was SOPHIE's predecessor (the ELODIE spectrograph) that led to one of the earliest exoplanet discoveries in 1995 – the "hot Jupiter" 51 Peg b (Dimidium). After examining HD 158259 for seven years, SOPHIE succeeded in obtaining high -precision radial velocity measurements that revealed the presence of a six planet system.

This system consists of an innermost large rocky planet (a "super-Earth") and five small gas giants ("mini-Neptunes") that have exceptionally regular spacing between them. As François Bouchy, a professor of astronomy and science at UNIGE and the coordinator of the observation program, explained in a UNIGE press release:

"The discovery of this exceptional system has been made possible thanks to the acquisition of a great number of measurements, as well as a dramatic improvement of the instrument and of our signal processing techniques."

Artist's impression of 51 Pegasi b (Bellerophon), a hot Jupiter discovered by SOPHIE that orbits a star about 50 light-years from Earth. Credit: ESO/M. Kornmesser/Nick Risinger (skysurvey.org)

These planets range from being 2 (the innermost "super-Earth") to 6 times (the "mini-Neptunes") as massive as Earth. The system is also very compact, with all of six planets orbit closely to the star and the outermost being just 0.38 times as distant as Mercury is from the Sun. This places the planets well inside the star's habitable zone (HZ), which means none are likely to have water on the surfaces or dense enough atmospheres to support life.

Meanwhile, TESS monitored HD 158259 for signs of transits (aka. the Transit Method) and observed a decrease in the star's brightness as the innermost planet passed in front of the star. According to Isabelle Boisse, a researcher at the Marseille Astrophysics Laboratory and co-author of the study, the TESS readings (combined with the radial velocity data) allowed them to constrain the properties of this planet (HD 158259 b) further.

"The TESS measurements strongly support the detection of the planet and allow to estimate its radius, which brings very valuable information on the planet's internal structure," she said. But as noted earlier, the most impressive feature of this system is its regularity. Basically, the planets in the system have an almost exact 3:2 orbital resonance

This means that for every three orbits the innermost planet makes, the second one will complete about two. In the time it takes the second planet to complete three orbits, the third will complete about two. This ratio applies to all six planets in the system and came as quite a surprise to Hara and his colleagues.

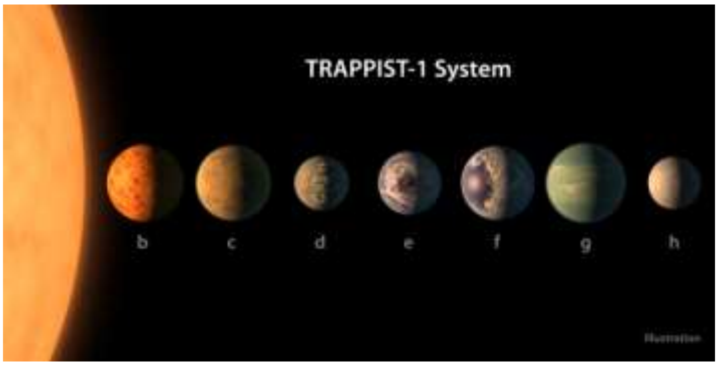
When describing the planets' orbits, Hara compared it to an orchestra playing music, though the arrangement is not quite perfect:

"This is comparable to several musicians beating distinct rhythms, yet who beat at the same time at the beginning of each bar. Here, "about" is important. Besides the ubiquity of the 3:2 period ratio, this constitutes the originality of the system."

Resonances, even imperfect ones, are of interest to astronomers because of how they provide hints to a star system's formation and evolution. In astronomical circles, there is still considerable debate about how star systems come together and change over time. A particularly contentious point is whether planets form close to their final position in the system, or if they change their orbits after forming.

This latter scenario (known as planetary migration) has been gaining traction in recent years thanks to the discovery of exoplanets like "Hot-Jupiters", leading many astronomers to question if planetary "shake-ups" occur. This theory would appear to explain the formation of the six planets in the HD 158259 system. Said Stephane Udry, a professor of astronomy and science at UNIGE:

"Several compact systems with several planets in, or close to resonances are known, such as TRAPPIST-1 or Kepler-80. Such systems are believed to form far from the star before migrating towards it. In this scenario, the resonances play a crucial part."



This artist's concept shows what each of the TRAPPIST-1 planets may look like, based on available data about their sizes, masses and orbital distances. Credits: NASA/JPL-Caltech

The fact that HD 158259's planets are close to a 3:2 resonance, but not exactly within one, suggests that they were trapped in one in the past. However, they would have subsequently undergone synchronous migration and moved away from the resonance. According to Hara, that's not all that this system can tell us.

"Furthermore, the current departure of the period ratios from 3:2 contains a wealth of information," he said. "With these values on the one hand, and tidal effect models on the other hand, we could constrain the internal structure of the planets in a future study. In summary, the current state of the system gives us a window on its formation."

The more we learn about this multi-planet system and others like it, the more we can learn about how star systems like our own came to be. The resolution of these and other questions about the formation and evolution of planetary systems will put us one step closer to knowing how life can emerge (and perhaps where to look for it!)

Further Reading: University of Geneva, Astronomy & Astrophysics

Crew Dragon Will Be Launching on May 27th

NASA and SpaceX are targeting May 27, 2020 for an historic mission: the launch of the first astronauts on the SpaceX Crew Dragon spacecraft, with the destination as the International Space Station (ISS). The crew, NASA astronauts Robert Behnken and Douglas Hurley, are scheduled to launch on a Falcon 9 rocket at 4:32 pm EDT that day from Kennedy Space Center's Launch Complex 39A. If all goes well, the Crew Dragon will autonomously dock with the space station about 24 hours later.

NASA is heralding the mission, dubbed Demo-2, as a new era of human spaceflight and SpaceX bills it as turning point for America's future in space exploration. Indeed, this scheduled flight will be the first crewed mission launched from the U.S. since the final space shuttle flight on July 8, 2011, which also took off from Kennedy Space Center's Launchpad 39A. Ever since the space shuttle's retirement, NASA astronauts have flown to the ISS on Russian Soyuz rockets, launched from the Baikonur Cosmodrome in Kazakhstan.

NASA astronauts Bob Behnken, left, and Doug Hurley, wearing SpaceX spacesuits, walk through the Crew Access Arm connecting the launch tower to the SpaceX Crew Dragon spacecraft during a dress rehearsal at NASA's Kennedy Space Center in Florida on Jan. 17, 2020. Credit: SpaceX

The duration of the Demo-2 mission has not been officially announced, but is rumored to last about two weeks, with Hurley and Behnken joining the three current occupants of the ISS, NASA astronaut Chris Cassidy and Russian cosmonauts Anatoly Ivanishin and Ivan Vagner. Hurley and Behnken have both flown on the space shuttle, and while in space for this mission, will perform tests on Crew Dragon in addition to conducting research and other tasks with the space station crew.

Of course, this launch to space is set to take place during an unprecedented time on Earth. Much of the world is staying at home in an effort to slow down the spread of the coronavirus. NASA has faced criticism for scheduling the flight at this time, but somehow they list it as essential.

NASA Administrator Jim Bridenstine has said that the US needs access to the ISS, and that "it's essential for our country to have that capability."

However, NASA also says they are "proactively monitoring the coronavirus (COVID-19) situation as it evolves. The agency will continue to follow guidance from the Centers for Disease Control and Prevention and the agency's chief health and medical officer and communicate any updates that may impact mission planning or media access, as they become available."

Scheduling the flight means that hundreds of NASA and SpaceX employees are required to be on-site at KSC, Johnson Space Center in Houston and SpaceX's mission control in Hawthorne, California. Hurley and Behnken will need to be quarantined so they don't bring the virus to the ISS, but yet will need to be in contact with workers at KSC, who will reportedly wear personal protective equipment when necessary to reduce the chances of spreading COVID-19.

In normal times, the announcement of the launch date would have sent space journalists and reporters like myself scrambling to make flight arrangements and accommodations to be on hand to witness the launch. But due to COVID-19 concerns, I won't be attending the launch, and other journalists are making that decision as well. But some journalists have said they are prepared to make whatever sacrifices are necessary to attend in-person.

One journalist, who has covered space shuttle missions since the 2000s, yet asked not to be named for fear of not being granted access by NASA to cover the mission, and possible retaliation by SpaceX, said they want to attend the launch even though it would put themselves and their family at risk.

"However, the other reality is that Demo-2 is an incredibly important moment in spaceflight history, and being on the ground as a journalist is equally so — especially if anything goes wrong," the journalist told Universe Today. "The press needs to be there to ask tough questions NASA, SpaceX, and its partners may not want to answer, but should be held accountable for. I wish circumstances were different, and I'd strongly prefer the launch be delayed until we better understand COVID-19, have reliable and widespread testing in place, and contact-tracing methods rolled out that don't compromise civil liberties. But I also understand what's at stake in terms of ISS needs for staffing, supplies, and research."

NASA said they will limit the number of journalists allowed on-site at KSC but have not yet announced how they will manage crowds gathering on Florida beaches and causeways to watch the historic launch, in order to maintain social distancing requirements.

Dragon capsules have been bringing cargo to the ISS since 2012, and in March 2019, SpaceX performed a successful test of the Crew Dragon spacecraft's ability to autonomously connect with the ISS. However, a second Crew Dragon was destroyed during an abort engine test last April, which prompted a delay in scheduling the Demo-2 flight. The abort engine issue has now been fixed, and SpaceX conducted a successful in-flight abort test this past January.

The SpaceX Falcon 9 rocket that will launch the Crew Dragon spacecraft, with NASA astronauts aboard, on the company's second demonstration flight and first crewed flight to the International Space Station. NASA's "worm" logo has been added to the rocket. Credit: SpaceX.

The Crew Dragon will launch aboard a specially instrumented Falcon 9 rocket. The rocket will accelerate to approximately 17,500 mph to intercept the ISS. During the flight, the crew will test the spacecraft's control systems and maneuvering thrusters, and conduct more tests once the Crew Dragon is docked. NASA said that although the Crew Dragon being used for this flight test can stay in orbit about 110 days, the specific mission duration will be determined once on station. The operational Crew Dragon spacecraft will be capable of staying in orbit for at least 210 days, per NASA's requirements.

To bring the two astronauts back to Earth, Crew Dragon will autonomously undock depart the space station and re-enter the Earth's atmosphere. Upon splashdown just off Florida's Atlantic Coast, the crew will be picked up at sea by SpaceX's Go Navigator recovery vessel and return to Cape Canaveral.

NASA says that the Demo-2 mission will be the final major step before NASA's Commercial Crew Program certifies Crew Dragon for operational, long-duration missions to the space station.

Astronomers Watch a Nova Go From Start to Finish for the First Time

A nova is a dramatic episode in the life of a binary pair of stars. It's an explosion of bright light that can last weeks or even months. And though they're not exactly rare—there are about 10 each year in the Milky Way—astronomers have never watched one from start to finish.

Until now.

A nova occurs in a close binary star system, when one of the stars has gone through its red giant phase. That star leaves behind a remnant white dwarf. When the white dwarf and its partner become close enough, the massive gravitational pull of the white dwarf draws material, mostly hydrogen, from the other star.

That hydrogen accretes onto the surface of the white dwarf, forming a thin atmosphere. The white dwarf heats the hydrogen, and eventually the gas pressure is extremely high, and fusion is ignited. Not just any fusion: rapid, runaway fusion.

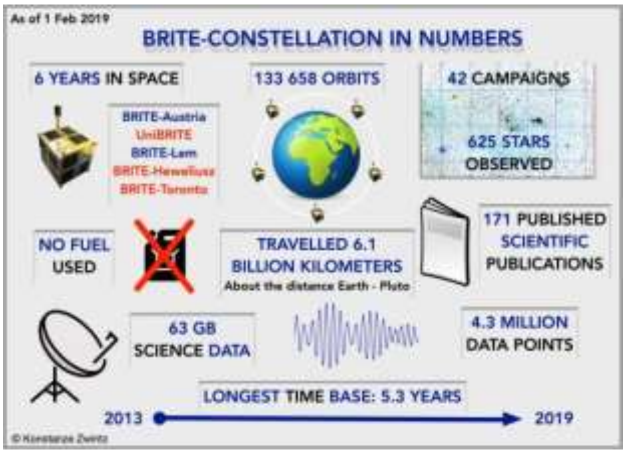
When the rapid fusion ignites, we can see the light, and the new hydrogen atmosphere is expelled away from the white dwarf, into space. In the past, astronomers thought these new bright lights were new stars, and the name "nova" stuck. Astronomers now call these types of nova "classical" novae. (There are also recurrent novae, when the process repeats itself.)

"Suddenly there was a star on our records that wasn't there the day before."

Rainer Kuschnig, BRITE Operations Manager, Graz Technical University

This is an enormously energetic event, that produces not only visible light, but gamma rays and x-rays too. The end result is that some stars that could only be seen through a telescope can be seen with the naked eye during a nova.

All of this is widely accepted in astronomy and astrophysics. But much of it is theoretical. Recently, astronomers using the BRITE (BRIght Target Explorer) Constellation of nanosatellites were fortunate enough to observe the entire process from start to finish, confirming the theory.



A statistical summary chart for the BRITE Constellation from 2019. Image Credit: Konstanze Zwintz.

BRITE is a constellation of nanosatellites designed to "investigate stellar structure and evolution of the brightest stars in the sky and their interaction with the local environment," according to the website. They operate in Low-Earth Orbit and have few restrictions on the parts of the sky that they can observe. BRITE is a coordinated project between Austrian, Polish, and Canadian researchers.

This first-ever observation of a nova was pure chance. BRITE had spent several weeks observing 18 stars for several weeks in the Carina constellation. One day, a new star appeared. BRITE Operations Manager Rainer Kuschnig found the nova during a daily inspection. "Suddenly there was a star on our records that wasn't there the day before," he said in a press release. "I'd never seen anything like it in all the years of the mission!"

An image of the starry sky. On the right side of the picture the NOVA CARINAE 2018 (V906 Carinae) can be seen. CREDIT: W. Paech and F. Hofmann, Chamaeleon and Onjala Observatory Namibia

Professor Werner Weiss is from the Department of Astrophysics at the University of Vienna. In a press release, he emphasized the significance of this observation. "But what causes a previously unimpressive star to explode? This was a problem that has not been solved satisfactorily until now," he said. The explosion of Nova V906 in the constellation Carina is giving researchers some answers and has confirmed some of the theoretical concept behind novae.

"It is fantastic that for the first time a nova could be observed by our satellites even before its actual eruption and until many weeks later."

Professor Otto Koudelka, Project Manager, BRITE Austria.

V906 Carinae was first spotted by the All-Sky Automated Survey for Supernovae. Fortunately, it appeared in an area of the sky that had been under observation by BRITE for weeks, so the data documenting the nova is in BRITE data. "It is fantastic that for the first time a nova could be observed by our satellites even before its actual eruption and until many weeks later," says Prof. Otto Koudelka, project manager of the BRITE Austria (TUGSAT-1) satellite at TU Graz.

V906 Carinae is about 13,000 light years away, so the event is already history. "After all, this nova is so far away from us that its light takes about 13,000 years to reach the earth," explains Weiss.

The BRITE team reported their findings in a new paper. The paper is titled "Direct evidence for shock-powered optical emission in a nova." It's published in the journal Nature Astronomy. First author is Elias Aydi from Michigan State University.

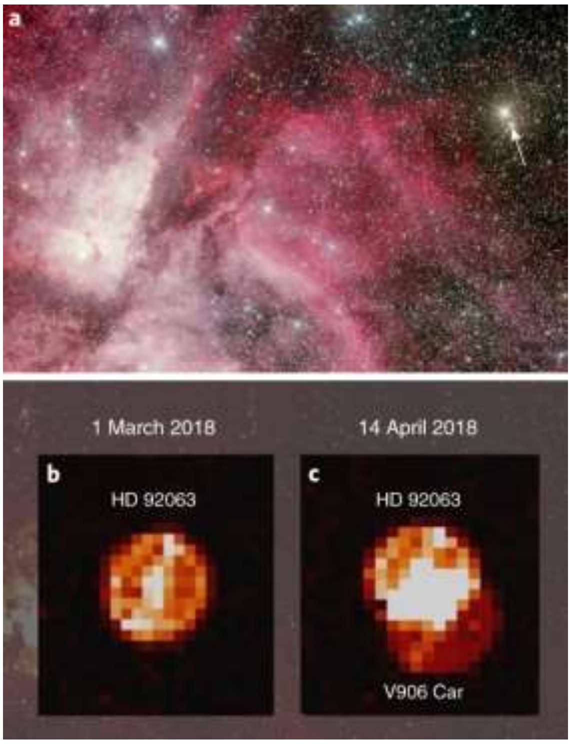
"This fortunate circumstance was decisive in ensuring that the nova event could be recorded with unprecedented precision," explains Prof. Konstanze Zwintz, head of the BRITE Science Team, from the Institute for Astro- and Particle Physics at the University of Innsbruck. Zwintz immediately realised "that we had access to observation material that was unique worldwide," according to a press release.

Novae like V906 Carinae are thermonuclear explosions on the surface of white dwarf stars. For a long time, astrophysicists thought that a nova's luminosity is powered by continual nuclear burning after the initial burst of runaway fusion. But the data from BRITE suggests something different.

In the new paper, the authors show that shocks play a larger role than thought. The authors say that "shocks internal to the nova ejecta may dominate the nova emission." These shocks may also be involved in other events like supernovae, stellar mergers, and tidal disruption events, according to the authors. But up until now, there's been a lack of observational evidence.

"Here we report simultaneous space-based optical and ?-ray observations of the 2018 nova V906 Carinae (ASASSN-18fv), revealing a remarkable series of distinct correlated flares in both bands," the researchers write. Since those flares occur at the same time, it implies a common origin in shocks.

"During the flares, the nova luminosity doubles, implying that the bulk of the luminosity is shock powered." So rather than continual nuclear burning, novae are driven by shocks. "Our data, spanning the spectrum from radio to gamma-ray, provide direct evidence that shocks can power substantial luminosity in classical novae and other optical transients."



"A" shows bright V906 Carinae labelled with a white arrow. "b" and "c" show the star HD 92063 before and after the V906 Carinae nova. Image Credit: A. Maury and J. Fabrega

In broader terms, shocks have been shown to play some role in events like novae. But that understanding is largely based on studying timescales and luminosities. This study is the first direct observation of such shocks, and is likely only the beginning of observing and understanding the role that shocks play.

In the conclusion of their paper the authors write "Our observations of nova V906 Car definitively demonstrate that substantial luminosity can be produced—and emerge at optical wavelengths—by heavily absorbed, energetic shocks in explosive transients."

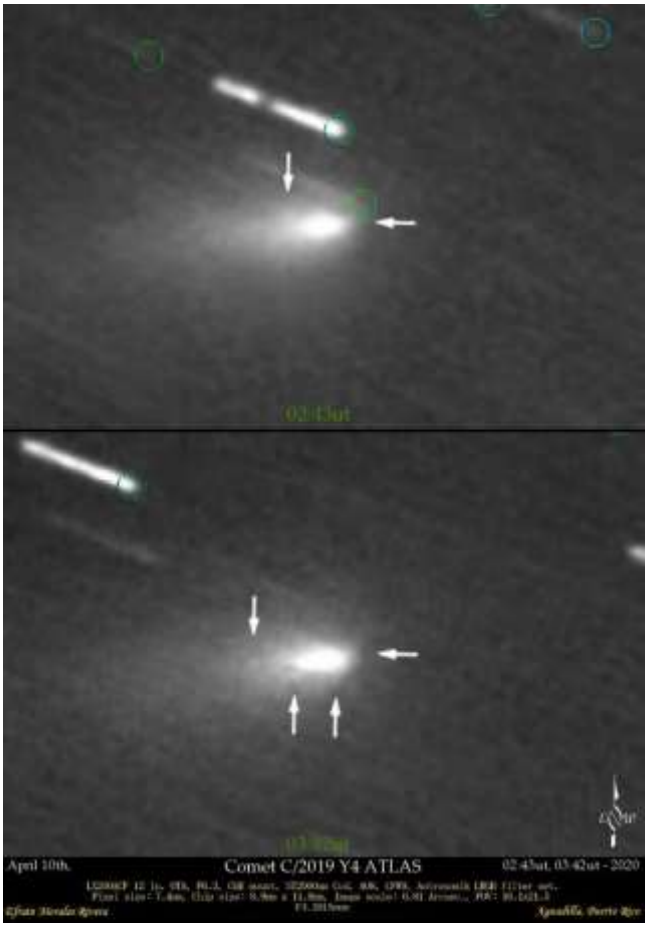
They go on to say that "With modern time-domain surveys such as ASAS-SN, the Zwicky Transient Facility (ZTF) and the Vera C. Rubin Observatory, we will be discovering more—and higher luminosity—transients than ever before. The novae in our galactic backyard will remain critical for testing the physical drivers powering these distant, exotic events."

Comet Y4 ATLAS Breaks Up…

When it comes to comets, the only thing that is certain is the orbital path. Though the cosmos has yet to send us a *really* bright comet for 2020 to keep us occupied during the ongoing worldwide pandemic and lock down, it has sent us a steady stream of descent binocular comets, including C/2017 T2 PanSTARRS, C/2019 Y1 ATLAS, and C/2019 Y4 ATLAS. And though Y4 ATLAS won't match the "Comet of the Century" media hype, another interesting binocular comet has just made its presence known over the past weekend: C/2020 F8 SWAN.

Comet Y4 ATLAS from April 11th, showing a fragmented, elongated nucleus. Credit: Gianluca Masi and the Virtual Telescope Project.

Comet Y4 ATLAS broke its over-performing trend early last week, disintegrating into several fragments as observers watched on. This is not uncommon, especially as a comet nears the Sun. We all remember the painful saga of C/2012 S1 ISON on U.S. Thanksgiving Day 2013. Astronomer Karl Battams at the U.S. Naval Research Laboratory called it back in mid-March, stating "I still worry that this comet is not entirely happy with the conditions it's facing, and might fizzle out," on Twitter.



Comet Y4 ATLAS shedding fragments from April 10th. Credit: Efrain Morales Rivera.

And as is also common with new comets, Y4 ATLAS became the center of a lot of unwarranted hype prior to breakup, with many news outlets exclaiming that it could become a "great daylight comet as bright as the Moon" (spoiler alert: it won't). Some of this stemmed from the comet's brightening ahead of predictions in March, and its orbital similarities and probable relation to the Comet of 1844.

Y4 ATLAS broke up 1.4 Astronomical Units (AU) from the Sun as it was crossing the constellation Camelopardalis. Already, its brightness has taken a hit, fading a full magnitude down to +8.5. It remains to be seen if we'll have anything left to recover during this May's dawn apparition of the comet, but prospects aren't good.

E Mails Viewings Logs and Images from Members.

Viewing Log for 15th of April

While on lock down I have been watching and taking pictures of the ISS flying over my house and noticing Venus shining brightly in the western sky. One night I decided I would try and take a picture of Venus as it was now going into crescent phase? To do this I would need my Meade LX90 as no other equipment I have would show the crescent phase very well? To start with I attached my Canon 60Da camera directly to the back of the telescope, this gave me a lens size of 2,000 mm's! Every time I took a picture I noticed Venus was not sharp, had trouble getting the planet in focus, as the telescope was not tracking correctly (could not line up with either Arcturus or Procyon, houses in the way!) So I tried fixing the camera directly to the back of my 10 mm Pentax XW eye piece, I had a special attachment made up a few years ago, this works with any XW eye piece as the lens cover unscrews and you fit the attachment there. This worked much better and I had no trouble getting the focus this time. Messing around trying to take pictures took well over an hour.

I originally set up my telescope at 20:58, (last time I used this mount was 20th of February), turns out the reason that I had trouble focusing Venus (would go out of the viewing area) was I did not start with Polaris but a star close by, doh! The skies in west Swindon are not that dark, I have one street light take lights up the whole of the front garden

and one hiding behind a small tree in the back and with houses all around me I was limited to anything above 40 ° attitude? As I said before I could not do any proper alignments as Arcturus was in a hedge and Procyon behind the house. I noticed Auriga above my garden, so slewed to M38 and hoped it was in my field of view, it was not! So I manually loosen the clutch knobs and moved the scope around a bit and found the open cluster (OC) not far away? M38 looked spread out and was a bit dim, probably due to the light pollution around the house? At least I could not blame the Moon this time as it was a waning crescent, not due to rise until after midnight. Onto M37, another OC, this one looked dense to view. The final Messier object in this constellation is M36, another OC, again like M38 looked on the lose side? Between my house and our neighbours I could make out Cancer, so I had a look at M67 (the often forgotten Messier object in this constellation?), this is another OC, again looked loose? With M44, the Beehive cluster it is better to look with the finder scope than the main eye piece? Main eye piece looks thru this OC while the finder scope has a wider field of view this picks up the whole of the cluster, same method is used with M45 in Taurus. I suddenly remembered I have 'High Precision' mode on this telescope, when I wish to slew to an object the telescope will first go to a nearby bright star, once I have centred this star, the telescope will then slew to the object I wish to view, should have used this method before! After this all objects I would find with no trouble? So onto Leo and M65 and M66, part of the triplet (with NGC 3628). I was surprised I could make them out (not very well with all the lights around me?) and both were in the same field of view, I think M66 was the better of the two? Like M65 and 66, M105 was a Faint Fuzzy Blob (FFB), only difference was M105 is an Elliptical galaxy (EG) and M65 and M66 were Spiral galaxies (SG). M95 was yet another FFB and I could only find M96 using adverted vision, all these galaxies are around 9th magnitude? Onto the 'Realm of the Galaxies' surrounding the Virgo and Coma Berenices areas, started off with M98, had to use adverted vision to find the SG. As for M99, not sure it was there? Tried different ways of finding it included tapping the eye piece and moving the telescope, coming in at mag 9.8 might be beyond limiting factor for the evening? Next was M100, found this using adverted vision, yet another SG. M85, I classified as a faint blob (FB) and not the usual FFB, maybe because it was an EG it stands out better than a SG? M88, M91 and M90 I had to use adverted vision to find all of them and yes they are all SG's! My final object for the evening was M87, I thought this was a FB, even looked quite bright to look at, and yes it is an EG!

It was now 23:16 and I was getting tired, at least I did not have far to take the equipment this time, normally I have to pack everything into the car, go home unpack everything used and let it dry overnight, this time I took all equipment in to the kitchen and left it there until the following day.

Maybe I can use my rear garden for more viewing session if this lock down stays with us for a few month months? I normally stop viewing from May until mid-August as the sky does not get dark until very late and has a short window for viewing.

One thing I have noticed after this session, I seem to see EG's better than SG's that are around the 9th mag area?

Peter Chappell

IMG 5734a (Venus in crescent phase) shutter speed 1/80th of a second at f10 and ISO of 1000. This picture was attached to 10 mm Pentax XW eye piece attached to telescope.

IMG 5812a (Moon and Venus in conjunction about 6 ° apart) shutter speed of 2 seconds at f5.6 and ISO of 100, zoom set at 150 mm's.

IMG 5717a (Earthshine on the Moon with star 105 Tau nearby) shutter speed of 1.3 seconds at f6.3 and ISO of 1600, zoom set at 600 mm's.

Both Moon pictures were taken with a Canon 60Da camera attached to a Tamron 150 – 600 mm zoom lens.

Peter

Hi Andy,
I hope you are well.
Here are my submissions for the May 2020 WAS Newsletter.
08/04/2020
Red Moon rise - 99.8% Waning Gibbous Moon – this image is as is from the camera (no post processing) a really red Moon just as it cleared the treetops.
Canon SX50HS 1800mm (50x Optical and 25 x Digital),

ISO 200, F8, 1 sec.
13/04/2020
Setting Winter Constellations
These images are timed at 21:22 the start of astronomical night on 13/04/2020. This was to capture the Winter con-

stellations and sights of Orion, Hyades, Pleiades etc already setting just at the start of observing at this time of the year.
Fish Eye - Canon 1100D, Rokinon 8mm (effective focal length 13mm)
ISO 3200, F3.5, 39 sec

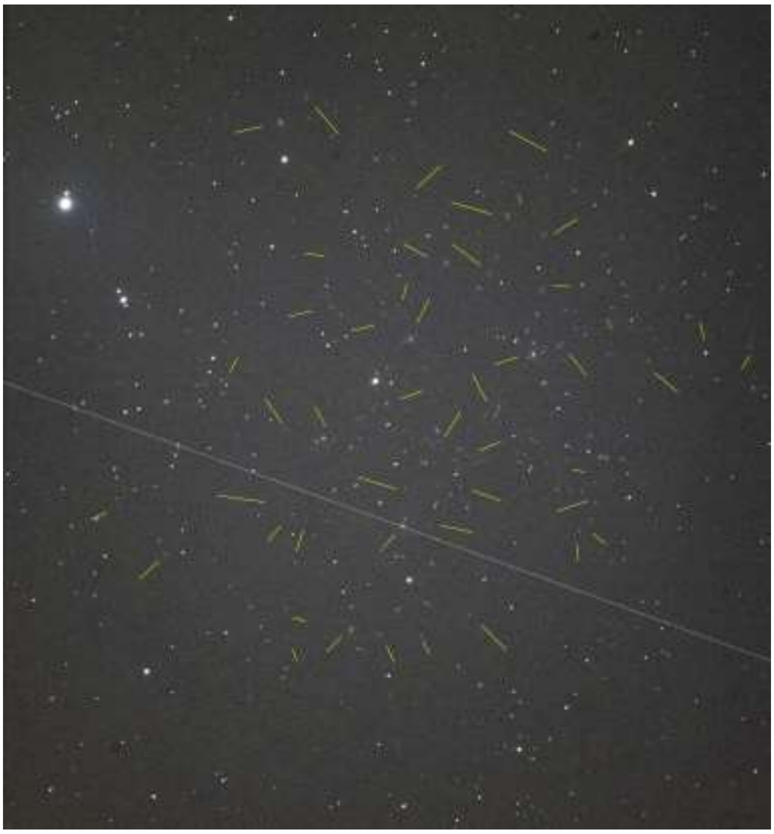
Wide Angle
Canon 1200D, Tokinon F2.8 11-16mm at 11mm (effective focal length 17mm)
ISO 3200, F2.8, 25 sec
26/04/2020
11.4% Waxing Crescent Moon, Earthshine and Venus Crescent

Canon SX50HS 1800mm (50x Optical and 25 x Digital),
ISO 200, F8, 1/60 sec
Earthshine
Canon SX50HS 1800mm (50x Optical and 25 x Digital),
ISO 800, F8, 0.6 sec
Stay safe and well.
Clear skies.
John Dartnell

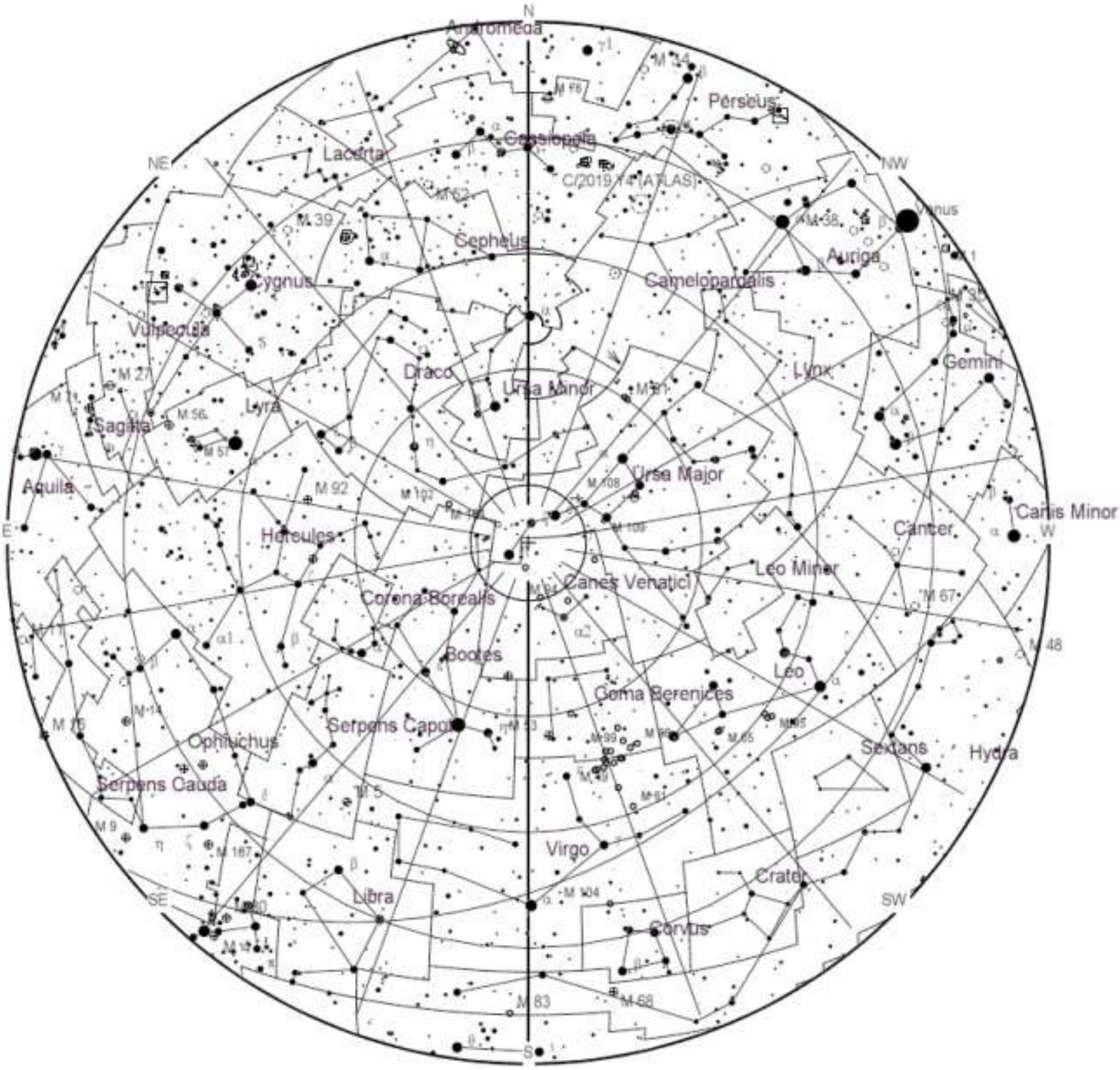
Some personal images from my dome and home over the past month. Again I can say how lucky I have been with the local lighting here close to the middle of Chippenham, and so many clear evenings for observing in April and beginning of May. Normally I would have had 10 days at the Griffon Observatory in Spain but lock down in Spain and here put a cosh on that trip. I do lose something in clarity and longer evening glow here in the UK but quite pleasing until I went for deep sky and discovered more than a third of my images were spoiled by various Star Link constellation satellites and we are still a very long way from complete. Checking times I was picking up trails from series 2, 3, 4, 5 and the latest launch 6. Promises are being made to limit them to magnitude 7.5 to 8 but this doesn't get rid of the mag 3 and 4 satellites up there now, nor does it give me and encouragement when I am regularly imaging down to magnitude 15. He also has some satellites out of control and tumbling.
M81, 82 and Coddingtons with two Star Link trails.

Below, trails from the Star Link satellites 5th launch, A long procession satellites across the sky about magnitude 2.

This is the Leo for group of galaxies at the 'wall' of 13-14th magnitude galaxies. Plus a streak of a 4th launch Star Link. The yellow lines indicate some of the galaxies in this cluster.



The 8.8 day phase Moon last Friday evening.



•**May 4, 5** - **Eta Aquarids Meteor Shower.** The Eta Aquarids is an above average shower, capable of producing up to 60 meteors per hour at its peak. Most of the activity is seen in the Southern Hemisphere. In the Northern Hemisphere, the rate can reach about 30 meteors per hour. It is produced by dust particles left behind by comet Halley, which has known and observed since ancient times. The shower runs annually from April 19 to May 28. It peaks this year on the night of 4th and morning of the 5th. The nearly full moon will be a problem this year, blocking out all but the brightest meteors. But if you are patient, you should still should be able to catch a few good ones. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Aquarius, but can appear anywhere in the sky.

•**May 7** - **Full Moon, Supermoon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 10:45 UTC. This full moon was known by early Native American tribes as the Flower Moon because this was the time of year when spring flowers appeared in abundance. This moon has also been known as the Corn Planting Moon and the Milk Moon. This is also the last of four supermoons for 2020. The Moon will be near its closest approach to the Earth and may look slightly larger and brighter than usual.

•**May 22** - **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 17:39 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

•**May 23** - **Comet Atlas.** Newly discovered comet Atlas will make its closest approach to Earth at a distance of 72 million miles (116 million kilometers). In the months following this close approach, the comet is expected to brighten. All though comets are extremely difficult to forecast, some astronomers believe that comet Atlas could brighten to a magnitude of between + 1 and -5. This could potentially make it the second brightest object in the night sky besides the moon.

Note Venus is just showing in the 11pm May 15th starmap. It will be a very slender crescent due to vanish be 23rd of May too close to the Sun, passing the Sun on 28th May. Otherwise we are in galaxy season until morning hours when the central Milky Way takes over.

COMET 2020 F8 SWANN

Enter Comet SWAN

Rumours abounded this past weekend of an already bright comet found approaching from sunward spotted by a solar observing spacecraft. This is not an unusual occurrence; for example, Comet C/1948 V1 was actually discovered by surprised ground observers during a total solar eclipse while it was near the Sun at an already bright magnitude -2.

Comet C/2020 F8 SWAN from April 11th. Image credit: Remanzacco Observatory.

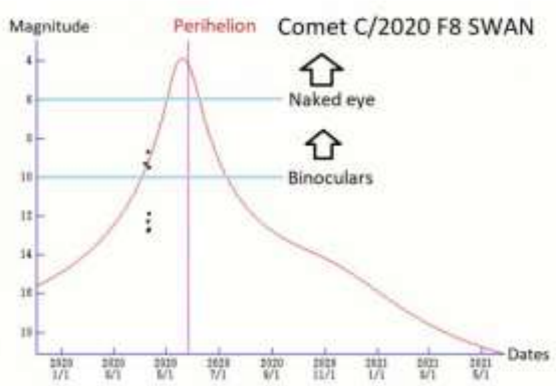
The Minor Planet Center at Harvard finally released circular 2020-G94 on Sunday night, announcing the discovery of Comet C/2020 F8 SWAN. The comet was discovered in March 25th images from the SWAN (the Solar Wind ANisotropies) camera aboard the Solar Heliospheric Observer (SOHO) spacecraft.

F8 SWAN was discovered while it was deep in the southern hemisphere skies at 1.77 AU distant. Currently shining at magnitude +8 in the constellation of Grus the Crane, the comet will pass closest to the Earth at 0.556 AU (51.7 million miles) distant on May 13th , moving about two degrees (four times the diameter of the Full Moon) a day. The comet then reaches perihelion shortly afterwards on May 27th.

It seems like we either caught first sight of the comet in outburst, and/or it's an intrinsically large bright object, another plus.

With a steep orbit inclined 111 degrees relative to the ecliptic plane, Comet F8 SWAN is on an orbit in access of 10,000 years. The comet could also be making its first visit to the inner solar system, meaning its dynamically new and prone to lots of outbursts as it nears the warmth of the inner solar system for the first time.

For northern hemisphere observers at mid-latitudes, the very best time to catch this comet is in mid-to late May, low to the northeast at dawn. Ironically, the comet will greet what remains of Comet Y4 ATLAS in the same region of sky on May 22nd.



The projected light curve for Comet F8 SWAN. Credit: Adapted from Seiichi Yoshida's ***Weekly Information About Bright Comets***.

Here's our look at dates with celestial destiny this Spring for Comet F8 SWAN:

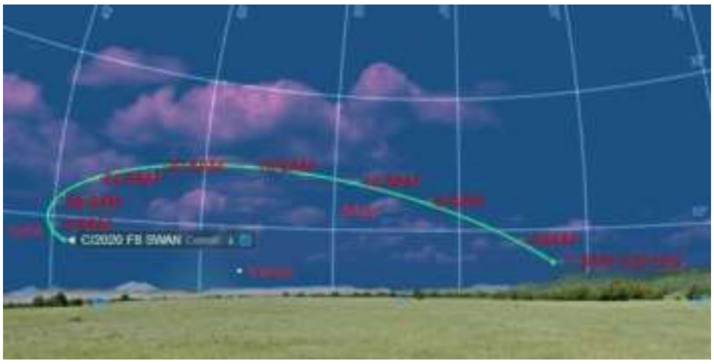
April

(Unless otherwise noted: a close pass is one degree or less)
16-Crosses into the constellation Sculptor
18-Passes +4.4 magnitude Gamma Sculptoris
23-Passes 18 degrees from the southern galactic pole
26-crosses into the constellation Aquarius the Water-Bearer
30-Passes into the constellation Cetus

The celestial path of Comet F8 SWAN through May. Credit: Starry Night Education Software.

May

7-Crosses the celestial equator northward
8-Crosses back into the constellation Pisces
9-Crosses the ecliptic northward
12-Photo-op: passes 2 degrees from +3.4 magnitude Eta Piscium and the galaxy Messier 74
13-Passes closest to Earth at 0.556 AU (51.7 million miles) distant
14-Nicks the corner of the constellation of Aries the Ram
15-Crosses into the constellation Triangulum
16-Photo op: passes 6 degrees from galaxy Messier 33
17-May top out at +4th magnitude
18-Crosses into the constellation Perseus
19-Passes +4.2 magnitude 16 Persei
20-Passes 14' from +2 magnitude Algol
22-Passes 5 degrees from Comet Y4 ATLAS
26-Reaches its farthest point north (declination +46 degrees)
27-Reaches perihelion at 0.429 AU (39.9 million miles) from the Sun
29-Crosses the galactic plane northward
30-Crosses into Auriga

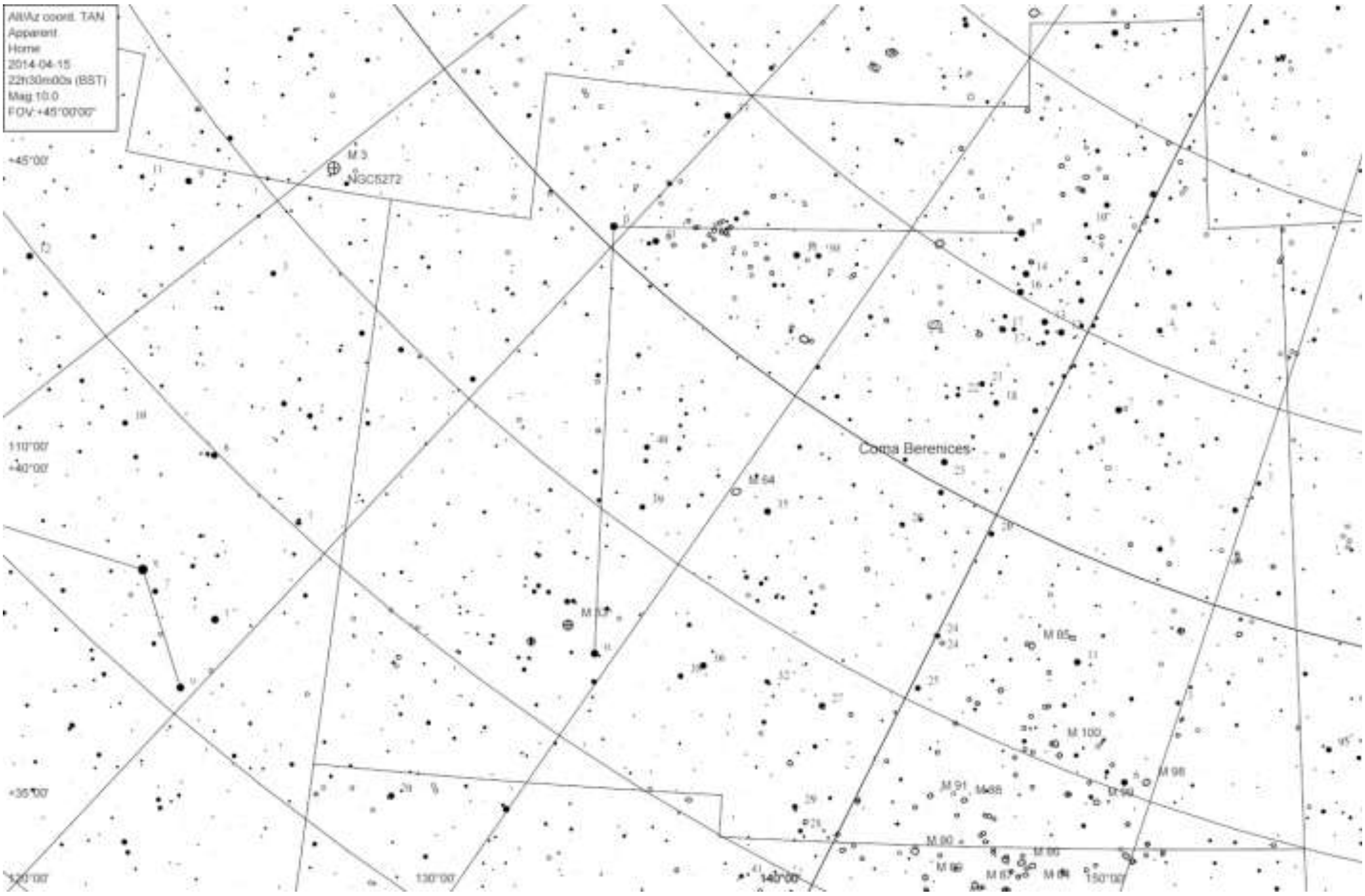


The path of Comet F8 SWAN through May into early June at dawn looking to the northeast from latitude 35 degrees north. Credit: Starry Night Education Software.

June

1-Passes near Capella
15-May drop back below +6th magnitude
16-Passes +2.6 magnitude Theta Auriga
29-Passes less than 10 degrees from the Sun
30-Drops below +10th magnitude

CONSTELLATIONS OF THE MONTH: COMA BERENICES



The Coma Berenices 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 be 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 these is the constellation Coma Berenices, an ancient constellation located in the norther skies. In the *Almagest*, Ptolemy considered the asterism to be part of the constellation Leo. Today, it is one of the 88 constellations recognized by the International Astronomical Union, and is bordered by the constellations of Canes Venatici, Ursa Major, Leo, Virgo and Boötes.

Name and Meaning:

In mythology, it is easy to see why this dim collection of stars was once associated with Leo and considered to be the tuft of hair at the end of the Lion's tail. However, as the years passed, a charming legend grew around this sparkling group of stars. Since the time of Ptolemy, this grouping of stars was recognized and although he didn't list it as one of his 88 constellations, he did refer to is as "Berenice's Hair".

As legend would have it, the good Queen Berenice II of Egypt offered to sacrifice her beautiful long hair to Aphrodite for the safe return of her husband from battle. When she cut off her locks and placed it on the altar and returned the next day, her sacrifice was gone. To save his life, the court astronomer proclaimed Aphrodite had immortalized Berenice's gift in the stars… and thus the Lion lost his tail and the astronomer saved his hide!

History of Observation:

Like many of the 48 constellations recognized by Ptolemy, Coma Berenices traces it routes back to ancient Mesopotamia. To Babylonian astronomers, it was known as *Hegala*, which translated to "which is before it". However, the first recorded mention comes from Conon of Samos, the 3rd century BCE court astronomer to Ptolemy III Euergetes – the Greek-Egyptian king. It was named in honor of his consort, Berenice II, who is said to have cut off her long hair as a sacrifice to ensure the safety of the king.

The constellation was named "*bostrukhon Berenikes"* in Greek, which translates in Latin to "Coma Berenices" (or "Berenice's hair"). Though it was previously designated as its own constellation, Ptolemy considered it part of Leo in his 2nd century CE tract the *Almagest,* where he called it "Plokamos" (Greek for "braid"). The constellation was also recognized by many non-western cultures.

In Chinese astronomy, the stars making up Coma Berenices belonged to two different areas – the Supreme Palace Enclosure and the Azure Dragon of the East. Eighteen of the constellation's stars were in an area known as *Lang wei* ("seat of the general"). To Arabic astronomers, Coma Berenices was known as *Al-Du'aba, Al Dafira* and *Al-Hulba*, forming the tuft of the constellation Leo (consistent with Ptolemy's designation).

Fragment of Mercator's 1551 celestial globe, showing Coma Berenices. Credit: Harvard Map Collection

By the 16th century, the constellation began to be featured on globes and maps produced by famed cartographers and astronomers. In 1602, Tycho Brahe recognized it as its own constellation and included it in his star catalogue. In the following year, it was included in Johann Bayer's famed celestial map, *Uranometria.* In 1920, it was included by the IAU in the list of the 88 modern constellations.

Notable Objects:

Despite being rather dim, Coma Berenices is significant because it contains the location of the North Galactic Pole. It is comprised of only 3 main stars, but contains 44 Bayer/Flamsteed designated members. Of its main stars, Alpha Comae Berenices (aka. Diadem) is the second-brightest in the constellation.

The name is derived from the Greek word *diádema*, which means "band" or "fillet", and represents the gem in Queen Berenice's crown. It is sometimes known by its other traditional name, *Al-Zafirah*, which is Arabic for "the braid". It is a binary star composed of two main sequence F5V stars that are at a distance of 63 light years from Earth.

The Black Eye Galaxy (Messier 64). Credit: NASA/The Hubble Heritage Team (AURA, STScI)

It's brightest star, Beta Comae Berenices, is located 29.78 light years from Earth and is a main sequence dwarf that is similar to our Sun (though larger and brighter). It's third major star, Gamma Comae Berenices, is a giant star belonging to the spectral class K1II and located about 170 light years from Earth.

Coma Berenices is also home to several Deep Sky Objects, which include spiral galaxy Messier 64. Also known as the Black Eye Galaxy (Sleeping Beauty Galaxy and Evil Eye Galaxy), this galaxy is located approximately 24 million light years from Earth. This galaxy has a bright nucleus and a dark band of dust in front of it, hence the nicknames.

Then there is the Needle Galaxy, which lies directly above the North Galactic Pole and was discovered by Sir William Herschel in 1785. It is one of the most famous galaxies in the sky that can be viewed edge-on. It lies at a distance of about 42.7 million light years from Earth and is believed to be a barred spiral galaxy from its appearance.

Coma Berenices is also home to two prominent galaxy clusters. These includes the Coma Cluster, which is made up of about 1000 large galaxies and 30,000 smaller ones that are located between 230 and 300 million light years from Earth. South of the Coma Cluster is the northern part of the Virgo Cluster, which is located roughly 60 million light years from Earth.

The globular cluster Messier 53 (NGC 5024), located in the Coma Berenices constellation. Credit: NASA (Wikisky)

Other Messier Objects include M53, a globular cluster located approximately 58,000 light years away; Messier 100, a grand design spiral galaxy that is one of the brightest members of the Virgo cluster (located 55 million light years away); and Messier 88 and 99 – a spiral galaxy and unbarred spiral galaxy that are 47 million and 50.2 million light years distant, respectively.

Finding Coma Berenices:

Coma Berenices is best visible at latitudes between +90° and -70° during culmination in the month of May. There is one meteor shower associated with the constellation of Coma Berenices – the Coma Berenicid Meteor shower which peaks on or near January 18 of each year. Its fall rate is very slow – only one or two per hour on average, but these are among the fastest meteors known with speeds of up to 65 kilometers per second!

For both binoculars and telescopes, Coma Berenices is a wonderland of objects to be enjoyed. Turn your attention first to the brightest of all its stars – Beta Coma Berenices. Positioned about 30 light years from Earth and very similar to our own Sun, Beta is one of the few stars for which we have a measured solar activity period – 16.6 years – and may have a secondary activity cycle of 9.6 years.

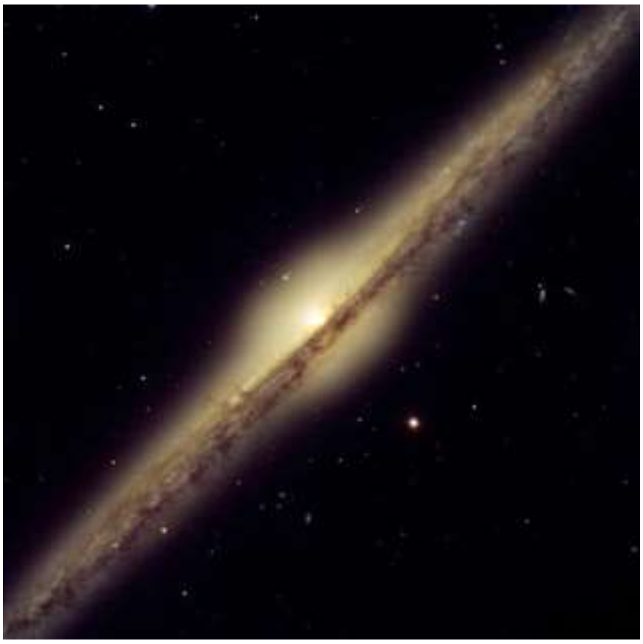
Now look at slightly dimmer Alpha. Its name is Diadem – the Crown. Here we have a binary star of equal magnitudes located about 65 light years from our solar system, but it's seen nearly "edge-on" from the Earth. This means the two stars appear to move back-and-forth in a straight line with a maximum separation of only 0.7 arcsec and will require a large aperture telescope with good resolving power to pull them apart. If you do manage, you're separating two components that are about the distance of Saturn from the Sun!

Another interesting aspect about singular stars in Coma Berenices is that there are over 200 variable stars in the constellation. While most of them are very obscure and don't go through radical changes, there is one called FK Comae Berenices which is a prototype of its class. It is believed that the variability of FK Com stars is caused by large, cool spots on the rotating surfaces of the stars – mega sunspots! If you'd like to keep track of a variable star that has notable changes, try FS Comae Berenices (RA 13 3 56 Dec +22 53 2). It is a semi-regular variable that varies between 5.3m and 6.1 magnitude over a period of 58 days.

For your eyes, binoculars or a rich field telescope, be sure to take in the massive open cluster Melotte 111. This spangly cloud of stars is usually the asterism we refer to as the "Queen's Hair" and the area is fascinating in binoculars. Covering almost 5 full degrees of sky, it's larger than most binocular fields, but wasn't recognized as a true physical stellar association until studied by R.J. Trumpler in 1938.

Located about 288 light years from our Earth, Melotte 111 is neither approaching nor receding… unusual – but true. At around 400 million years old, you won't find any stars dimmer than 10.5 magnitude here. Why? Chances are the cluster's low mass couldn't prevent them from escaping long ago…

Now turn your attention towards rich globular cluster, Messier 53. Achievable in both binoculars and small telescopes, M53 is easily found about a degree northwest Alpha Comae. At 60,000 light years away from the galactic center, it's one of the furthest globular clusters away from where it should be. It was first discovered by Johann Bode in 1755, and once you glimpse its compact core you'll be anxious to try to resolve it.



The Needle Galaxy (NGC 4565). Credit: ESO

With a large telescope, you'll notice about a degree further to the east another globular cluster – NGC 5053 – which is also about the same physical distance away. If you study this pair, you'll notice a distinct difference in concentrations. The two are very much physically related to one another, yet the densities are radically different!

Staying with binoculars and small telescopes, try your hand at Messier 64 – the "Blackeye Galaxy". You'll find it located about one degree east/northeast of 35 Comae. While it will be nothing more than a hazy patch in binoculars, smaller telescopes will easily reveal the signature dustlane that makes M64 resemble its nickname. It is one of the brightest spiral galaxies visible from the Milky Way and the dark dust lane was first described by Sir William Herschel who compared it to a "Black Eye."

Now put your telescope on Messier 100 – a beautiful example of a grand-design spiral galaxy, and one of the brightest galaxies in the Virgo Cluster. This one is very much like our own Milky Way galaxy and tilted face-on, so we may examine the spiral galaxy structure. Look for two well resolved spiral arms where young, hot and massive stars formed recently from density perturbations caused by interactions with neighboring galaxies. Under good observing conditions, inner spiral structure can even be seen!

Try lenticular galaxy Messier 85. In larger telescopes you will also see it accompanied by small barred spiral NGC 4394 as well. Both galaxies are receding at about 700 km/sec, and they may form a physical galaxy pair. How about Messier 88? It's also one of the brighter spiral galaxies in the Virgo galaxy cluster and in a larger telescope it looks very similar to the Andromeda galaxy – only smaller.

How about barred spiral galaxy M91? It's one of the faintest of the Messier Catalog Objects. Although it is difficult in a smaller telescope, its central bar is very strong in larger aperture. Care to try Messier 98? It is a grand edge-on galaxy and may or may not be a true member of the Virgo group. Perhaps spiral galaxy Messier 99 is more to your liking… It's also another beautiful face-on presentation with grand spiral arms and a sweeping design that will keep you at the eyepiece all night!

There are other myriad open clusters and just as many galaxies waiting to be explored in Coma Berenices! It's a fine region. Grab a good star chart and put a pot of coffee on to brew. Comb the Queen's Hair for every last star. She's worth it.

We have written many interesting articles about the constellation here at Universe Today. Here is What Are The Constellations?, What Is The Zodiac?, and Zodiac Signs And Their Dates.

Be sure to check out The Messier Catalog while you're at it!

For more information, check out the IAUs list of Constellations, and the Students for the Exploration and Development of Space page on Canes Venatici and Constellation Families.

Source:

Constellation Guide – Coma Berenices

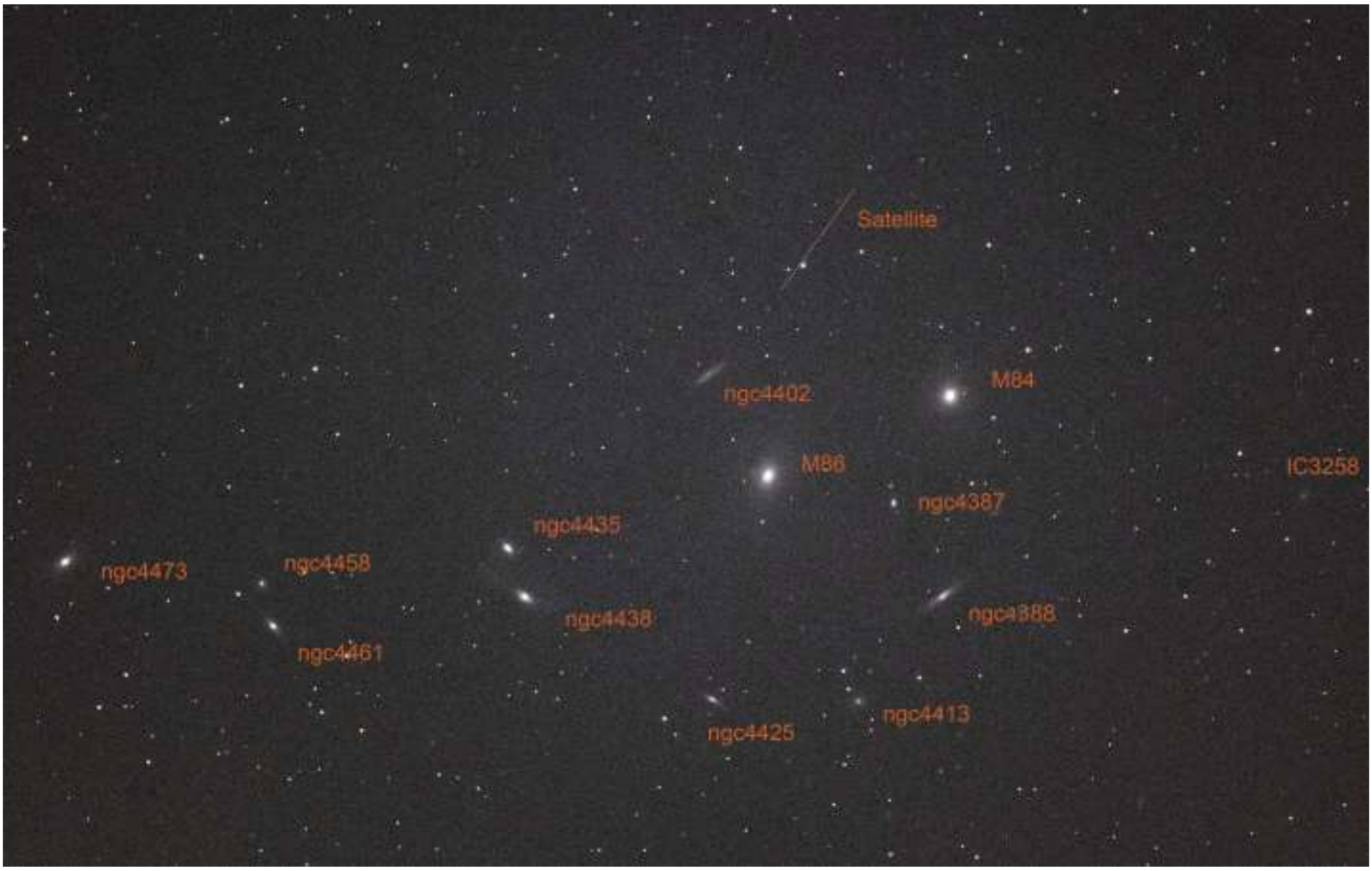
Wikipedia – Coma Berenices

SEDS – Coma Berenices

ISS PASSES For May 2020 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start	Highest point	End						
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
05 May	-2.2	02:55:09	24°	SE	02:55:09	24°	SE	02:57:35	10°	E
05 May	-3.8	04:28:05	11°	WSW	04:31:15	75°	SSE	04:34:38	10°	E
06 May	-1.2	02:09:16	13°	ESE	02:09:16	13°	ESE	02:09:51	10°	E
06 May	-3.7	03:42:13	27°	SW	03:43:50	61°	SSE	03:47:11	10°	E
07 May	-3.4	02:56:18	46°	SSE	02:56:27	47°	SSE	02:59:44	10°	E
07 May	-3.7	04:29:47	10°	W	04:33:10	86°	N	04:36:35	10°	E
08 May	-2.2	02:10:20	25°	ESE	02:10:20	25°	ESE	02:12:12	10°	E
08 May	-3.8	03:43:17	18°	W	03:45:43	87°	S	03:49:06	10°	E
09 May	-3.9	02:57:17	43°	WSW	02:58:15	76°	SSE	03:01:39	10°	E
09 May	-3.7	04:31:42	10°	W	04:35:05	88°	N	04:38:29	10°	E
10 May	-3.5	02:11:15	54°	ESE	02:11:15	54°	ESE	02:14:09	10°	E
10 May	-3.7	03:44:12	10°	W	03:47:36	85°	N	03:51:00	10°	E
11 May	-1.9	01:25:11	22°	E	01:25:11	22°	E	01:26:39	10°	E
11 May	-3.8	02:58:07	23°	W	03:00:06	86°	N	03:03:30	10°	E
11 May	-3.8	04:33:33	10°	W	04:36:56	70°	SSW	04:40:17	10°	ESE
12 May	-3.9	02:11:59	57°	WSW	02:12:36	87°	S	02:16:00	10°	E
12 May	-3.8	03:46:02	10°	W	03:49:26	83°	S	03:52:49	10°	ESE
13 May	-3.4	01:25:47	52°	E	01:25:47	52°	E	01:28:29	10°	E
13 May	-3.8	02:58:42	11°	W	03:01:56	88°	NNE	03:05:19	10°	E
13 May	-3.3	04:35:24	10°	W	04:38:37	41°	SSW	04:41:49	10°	SE
14 May	-2.1	00:39:28	24°	E	00:39:28	24°	E	00:40:58	10°	E
14 May	-3.8	02:12:22	22°	W	02:14:24	85°	N	02:17:47	10°	E
14 May	-3.7	03:47:51	10°	W	03:51:10	55°	SSW	03:54:28	10°	ESE
15 May	-3.8	01:25:36	36°	W	01:26:51	86°	N	01:30:15	10°	E
15 May	-3.9	03:00:18	10°	W	03:03:41	70°	SSW	03:07:03	10°	ESE
15 May	-3.2	22:59:34	10°	SW	23:02:41	35°	SSE	23:05:49	10°	E
16 May	-3.9	00:26:14	10°	WSW	00:29:37	83°	SSE	00:33:00	10°	E
16 May	-3.9	02:03:02	10°	W	02:06:26	87°	S	02:09:49	10°	E
16 May	-3.1	03:39:55	10°	W	03:43:01	34°	SSW	03:46:07	10°	SE
16 May	-2.5	22:02:40	10°	SSW	22:05:20	22°	SE	22:08:01	10°	E
16 May	-3.9	23:38:23	10°	WSW	23:41:45	70°	SSE	23:45:07	10°	E
17 May	-3.8	01:15:10	10°	W	01:18:33	86°	N	01:21:56	10°	E
17 May	-3.6	02:51:59	10°	W	02:55:14	46°	SSW	02:58:30	10°	SE
17 May	-3.7	22:50:36	10°	WSW	22:53:54	55°	SSE	22:57:13	10°	E
18 May	-3.8	00:27:16	10°	W	00:30:39	85°	N	00:34:02	10°	E
18 May	-3.8	02:04:04	10°	W	02:07:25	61°	SSW	02:10:45	10°	ESE
18 May	-2.3	03:41:22	10°	W	03:43:44	18°	SW	03:46:06	10°	S
18 May	-3.3	22:02:53	10°	SW	22:06:05	41°	SSE	22:09:17	10°	E
18 May	-3.8	23:39:21	10°	W	23:42:44	88°	N	23:46:07	10°	E
19 May	-3.9	01:16:10	10°	W	01:19:33	76°	SSW	01:20:07	57°	SE
19 May	-3.9	22:51:27	10°	WSW	22:54:49	83°	S	22:58:13	10°	E
20 May	-3.9	00:28:15	10°	W	00:31:39	87°	S	00:33:09	30°	E
20 May	-3.8	22:03:34	10°	WSW	22:06:56	69°	SSE	22:10:17	10°	E
20 May	-3.8	23:40:20	10°	W	23:43:43	86°	N	23:46:29	15°	E
21 May	-2.8	01:17:09	10°	W	01:19:22	34°	WSW	01:19:22	34°	WSW
21 May	-3.7	22:52:23	10°	W	22:55:46	85°	N	22:59:09	10°	E
22 May	-3.8	00:29:12	10°	W	00:32:32	62°	SSW	00:32:48	59°	S
22 May	-3.7	22:04:27	10°	W	22:07:49	89°	NNW	22:11:12	10°	E
22 May	-3.9	23:41:15	10°	W	23:44:38	77°	SSW	23:46:18	27°	ESE
23 May	-3.8	22:53:18	10°	W	22:56:41	88°	S	22:59:48	12°	E
24 May	-2.8	00:30:10	10°	W	00:32:42	33°	SW	00:32:42	33°	SW
24 May	-3.7	22:05:20	10°	W	22:08:43	86°	N	22:12:06	10°	E
24 May	-3.5	23:42:09	10°	W	23:45:25	48°	SSW	23:46:15	38°	SSE
25 May	-3.7	22:54:09	10°	W	22:57:30	63°	SSW	22:59:48	18°	ESE
26 May	-3.8	22:06:10	10°	W	22:09:32	78°	SSW	22:12:55	10°	ESE
26 May	-2.6	23:43:09	10°	W	23:46:02	26°	SSW	23:46:17	26°	SSW
27 May	-3.0	22:55:01	10°	W	22:58:09	36°	SSW	22:59:53	21°	SSE
28 May	-3.4	22:06:59	10°	W	22:10:15	49°	SSW	22:13:30	10°	SE
29 May	-1.9	22:56:09	10°	W	22:58:38	19°	SW	23:00:04	15°	S
30 May	-2.4	22:07:52	10°	W	22:10:46	27°	SSW	22:13:40	10°	SSE

END IMAGES, OBSERVING AND OUTREACH



Markarian's Chain on the boundary of Virgo (lower 2/3rds) and Coma Berenices. Note the intrusions of one of the starlink satellites (supposedly suppressed) but more shielding is being designed, but the Elon Musk in a slag off and buy back cheap shares mood who knows what are future for astronomy will be. Nikon D810, 2 frames joined, 125mm refractor. Andy Burns

What's Up – The May Night Sky

The month of May marks the end of the normal observation season as the length of daylight extends from early morning to late in the evening leaving only a ever decreasing window of opportunity to observe. The waxing moon provides a good target both at the beginning and again towards the end of the month. During the darker skies in the middle of the Month the constellation of Virgo provides an opportunity to observe with larger binoculars and telescopes, the myriads of galaxies that form the Virgo Cluster. The following web page provides a useful guide. https://lovethenightsky.com/virgo-galaxy-cluster-complete-guide/

The image above can be used to find the Virgo constellation, which will be due south at 23:00 during the middle of May.
The image to the left shows the many galaxies that can be found, some with even the most modest equipment. Its even a chance to enjoy the challenge of some deep sky astrophotography.

The WAS Observation (In Isolation) Team

OUTREACH

On hold during Isolation/Social Distencing