NWASNEWS

Volume24, Issue 9

May 2019

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

Black Holes, Good Water and NASA Moon plans

April was a good news month for confirming a lot of common-sense guesses with information coming from the science bodies.

The asteroid material collection mission Hayabusat has already revealed a lot about the water on the asteroids and its resemblance to the water here on Earth begins to square the problem of where Earth's water come from after the discovery of comet water not looking like the likely source. At the same time it was shown that asteroids have a lot of water available. The old divide between comets and asteroids as ice and rock is laid to rest.

Also in this month closer examination of some meteorites found here on Earth have also come up with a new but logical theory. A small but significant number of meteorites have their beginnings around stars other than our Sun (which is 4th generation material anyway).

The same storm that finished Opportunity on Mars does give us information that may explain where the water went on ancient Mars.

Big news of the early month was the imaging of a Black Hole in the centre of M87 in Virgo. A big lenticular galaxy not too far away that can be seen spitting out material from its core (easily images when I was in Spain), contains a big black hole that became the target for a huge base interferometry linked radio telescopes across the Earth. The detail gained enabled the team to image the event horizon activity around the black hole.

Meanwhile NASA has been working on the figures to match the presidential aim for putting America on the Moon again in 2024, a few years after the 50th anniversary of the last landing there. However the budget to do it is encountering a few problems and the government based programme needs help from private investors. How much hasn't been revealed, but certainly the lander could be in private hands.

Tonight we welcome our friend from over the border, Mark Radice who will be giving us some practical observing tips for our own Solar System.

Clear Skies Andy

Looking ahead for most of us, this is the early summer Milky Way as seen at 3:30am in Spain on the 26th April. This will be the phase visible at 2:00am in the UK late May, Midnight mid June.
There is an extra extension of 17º to the south below the pipe nebula seen here.
24mm on zoom lens 20 seconds, 1600 ISO. Z7 full frame Nikon mirrorless camera.
The white lights are from a town to the east of the high viewing point.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

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

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

Date	Speaker	Title
2019		
7 May	Mark Radice:	Observing the Solar System.
4 Jun	Owen Brazell	Observing Planetary Nebulae

Mark Radice

Mark is a very accomplished practical viewer, building his own telescope, binocular viewing platform, an excellent Astro sketcher, and now getting into imaging.

He is a qualified pilot and lives in Hampshire now

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Keith Bruton Chair, keisana@tiscali.co.uk

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

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

Philip Proven (Hall coordinator) Dave Buckle (Teas)

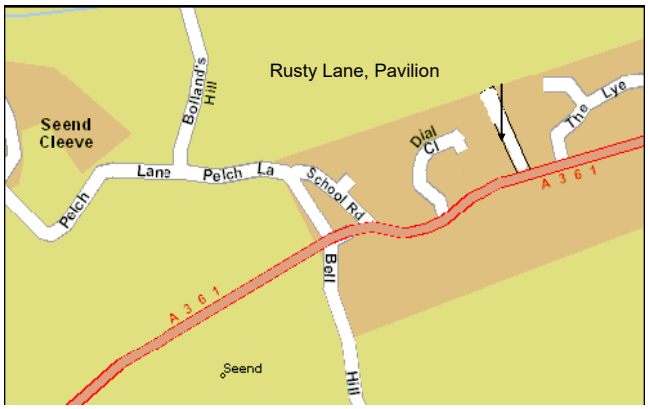
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

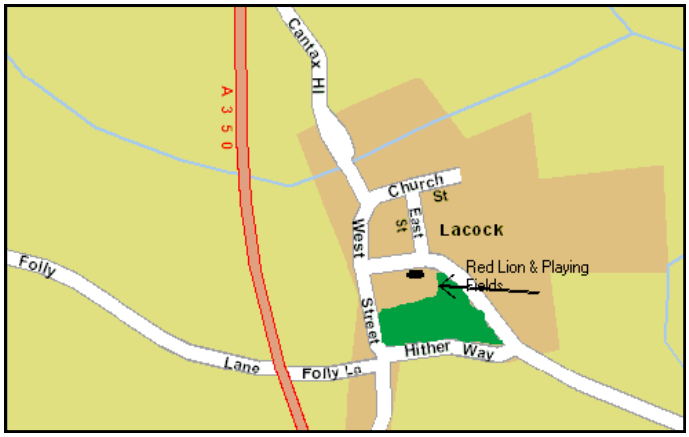
Observing Sessions coordinators: Jon Gale, Tony Vale

Web coordinator: Sam Franklin

Contact via the web site details.



Observing Sessions



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

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

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

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

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

Swindon Stargazers

Swindon's own astronomy group

May Meeting: Mark Woodland FRAS

He will be speaking on 'Exoplanents and the Charterhouse Exoplanet Project'

Mark is a fellow of the Royal Astronomical Society and committee member of the

Wells & Mendip Astronomers group.

He is an Astrophysics undergraduate with the Open University an works as an IT specialist in the NHS.

Since December 2014 he has been heading up the Charterhouse Exoplanet Project with the aim

of bringing research astronomy to the public and connecting with universities in the UK & USA to verify KEPLER data.

Ad-hoc viewing sessions

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

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

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

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

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

If you think you might be interested email the organiser Robin Wilkey (see below). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.

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

Members of the Wiltshire Astronomical Society always welcome!

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

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

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

Meeting Dates for 2019
Friday 17 May 2019

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

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

July & August: Summer break

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

Friday 18 October 2019

Programme: Robert Slack: The Grand Tour

Friday 15 November 2019
Programme: TBA

Friday 13 December 2019
Programme: TBA

Website:

http://www.swindonstargazers.com

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.

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

STAR QUEST ASTRONOMY CLUB

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

Watching the Late Spring Skies

By David Prosper

Late spring brings warmer nights, making it more comfortable to observe a good showing of the **Eta Aquarids** meteor shower. Skywatchers can also look for the delicate **Coma Star Cluster**, and spot the **Moon** on the anniversary of **Apollo 10**'s "test run" prior to the Moon landing in 1969.

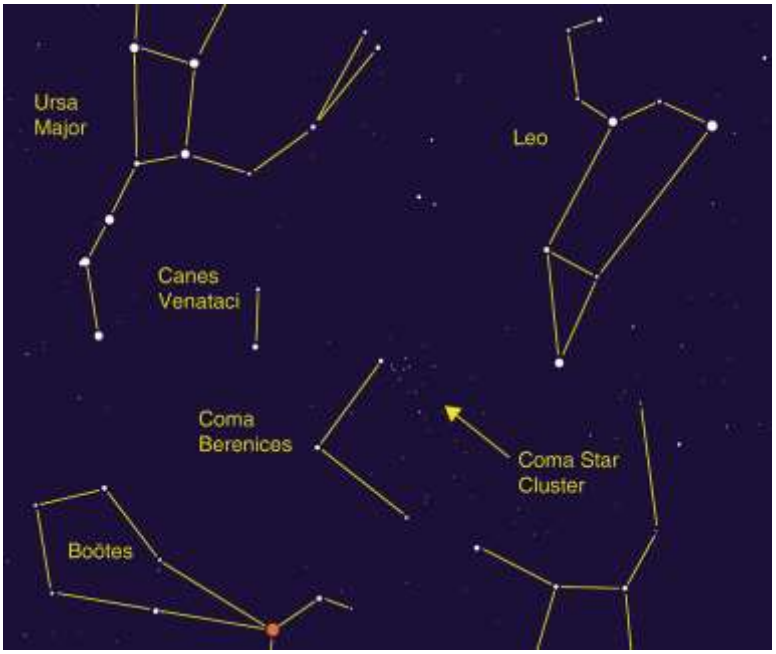
The **Eta Aquarids** meteor shower should make a good showing this year, peaking the morning of May 6. This meteor shower has an unusual "soft peak," meaning that many meteors can be spotted several days before and after the 6th; many may find it convenient to schedule meteor watching for the weekend, a night or two before the peak. You may be able to spot a couple dozen meteors an hour from areas with clear dark skies. Meteors can appear in any part of the sky and you don't need any special equipment to view them; just find an area away from lights, lie down on a comfy lawn chair or blanket, relax, and patiently look up. These brief bright streaks are caused by Earth moving through the stream of fine dust particles left by the passage of Comet Halley. While we have to wait another 43 years for the famous comet grace our skies once more, we are treated to this beautiful cosmic postcard every year.

While you're up meteor watching, try to find a delightful naked eye star cluster: the **Coma Star Cluster** (aka Melotte 111) in the small constellation of Coma Berenices. It can be spotted after sunset in the east and for almost the entire night during the month of May. Look for it inside the area of the sky roughly framed between the constellations of Leo, Boötes, and Ursa Major. The cluster's sparkly members are also known as "Berenice's Hair" in honor of Egyptian Queen Berenices II's sacrifice of her lovely tresses. Binoculars will bring out even more stars in this large young cluster.

May marks the 50th anniversary of the Lunar Module's test run by the A**pollo 10** mission! On May 22, 1969, NASA astronauts Thomas Safford and Eugene Cernan piloted the Lunar Module - nicknamed "Snoopy" - on a test descent towards the lunar surface. Undocking from "Charlie Brown" - the Command Module, piloted by John Young – they descended to 47,400 feet above the surface of the Moon before returning safely to the orbiting Command Module. Their success paved the way for the first humans to land on the Moon later that year with Apollo 11. Look for the Moon on the morning of May 22, before or after dawn, and contemplate what it must have felt like to hover mere miles above the lunar surface. You'll also see the bright giant planets Saturn and Jupiter on either side of the Moon before sunrise. When will humans travel to those distant worlds?

You can catch up on all of NASA's current and future missions at nasa.gov

A view of Apollo 10's Lunar Module from the Command Module as it returned from maneuvers above the lunar surface. Photo Credit: NASA
Source: http://bit.ly/apollo10view



Try to spot the Coma Star Cluster! Image created with assistance from Stellarium

SPACE NEWS FOR MAY

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

Hayabusa1's Samples of Itokawa Turned up Water That's Very Similar to Earth's Oceans

Right now, the Japanese Aerospace Exploration Agency's (JAXA) *Hayabusa2* spacecraft is busy exploring the asteroid 162173 Ryugu. Like it's predecessor, this consists of a sample-return mission, where regolith from the asteroid's surface will be brought back home for analysis. In addition to telling us more about the early Solar System, these studies are expected to shed light on the origin of Earth's water (and maybe even life).

Meanwhile, scientists here at home have been busy examining the samples returned from 25143 Itokawa by the *Hayabusa1* spacecraft. Thanks to a recent study by a pair of cosmochemists from Arizona State University (ASU), it is now known that this asteroid contained abundant amounts of water. From this, the team estimates that up to half the water on Earth could have come from asteroid and comet impacts billions of years ago.

This study, which was the first time samples from the surface of an asteroid were examined for water, recently appeared in the journal *Science Advances*. The study team consisted of Ziliang Jin and Maitrayee Bose, a postdoctoral scholar and an assistant professor in ASU's School of Earth and Space Exploration (SESE).

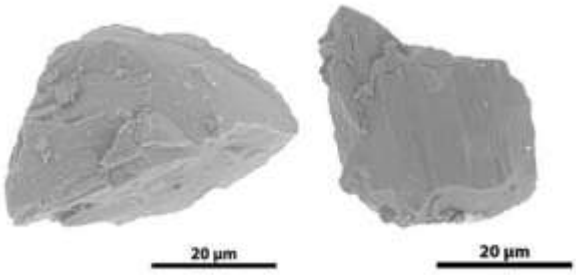
Artist's impression of Hayabusa leaving Earth, a Japanese sample-return mission to the asteroid 25143 Itokawa. Credit: JAXA

The current scientific consensus is that asteroids are composed of material leftover from the formation of the Solar System. The study of these bodies is therefore expected to reveal things about its early history and evolution. What Jin and Bose found, after examining the samples provided by JAXA, was that they were enriched in water compared to the average for objects found in the inner Solar System.

And Bose indicated in an interview with *ASU Now*, this study was made possible thanks to the cooperation between the ASU and JAXA, though they were surprised to hear what she and Jin were looking for:

"It was a privilege that the Japanese space agency JAXA was willing to share five particles from Itokawa with a U.S. investigator. It also reflects well on our school… Until we proposed it, no one thought to look for water. I'm happy to report that our hunch paid off."

To study the five samples, each of which measure 50 to 250 microns in diameter (about half the width of a human hair), the team used ASU's Nanoscale Secondary Ion Mass Spectrometer (NanoSIMS). This instrument is one of only 22 spectrometers in the entire world that can examine tiny mineral grains with a high degree of sensitivity.



The two Itokawa particles studied by Jin and Bose are tiny: for comparison, a human hair is 100 to 500 microns in diameter. ASU's NanoSIMS instrument made it possible to extract information on the particles' water content. Credit: Z. Jin and M. Bose/ASU/JAXA

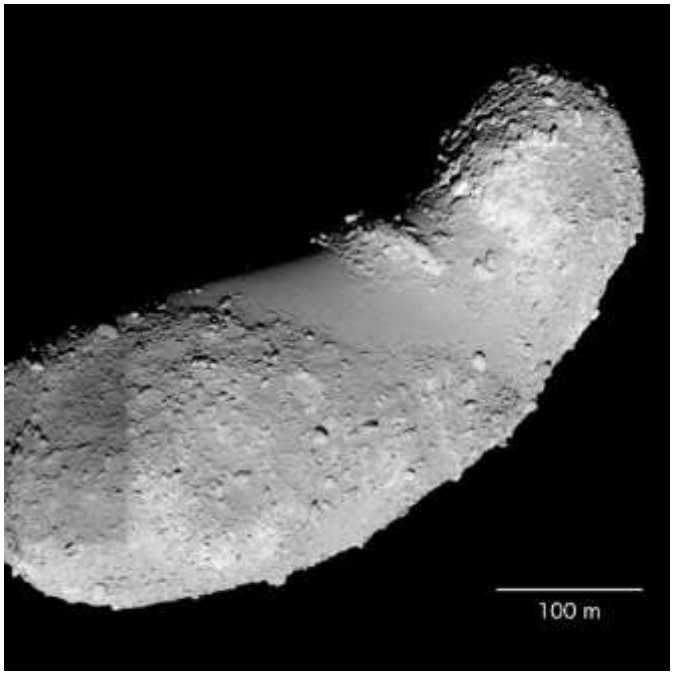
In two of the five particles, the team identified pyroxene, a mineral which (on Earth) has water as part of its crystalline structure. Jin and Bose also suspected that the grains might contain traces of water, though they were unclear as to how much. Itokawa's long history would have included heating events, impacts, shocks and fragmentation, all of which would have raised its temperature and caused water to be lost to space.

The NanoSIMS measurements confirmed this hypothesis, revealing that the sample grains themselves were rich in water. But what was surprising was just how rich they were. This indicates that asteroids such as Itokawa (which are considered to be "dry") are capable of harboring more water than scientists previously thought.

Because of its composition, which is predominantly made up of silicate minerals and metals, planetary scientists have designated Itokawa as an S-class asteroid. Measuring just 500 meters (1800 ft) in length and 215 to 300 (700 to 1000 ft) in diameter, the asteroid circles the Sun every 18 months at an average distance of 1.3 AU – passing inside Earth's orbit to a little beyond that of Mars.

Objects that are Itokawa's size are believed to be fragments that broke off of larger S-class asteroids. Despite being small, these asteroids are believed to have kept whatever water and volatile materials (nitrogen, carbon dioxide, methane, ammonia, etc.) they had at formation. As Bose explained:

"S-type asteroids are one of the most common objects in the asteroid belt. They originally formed at a distance from the sun of one-third to three times Earth's distance."



The samples studied by Jin and Bose came from the feature called the Muses Sea, which is the smooth area in the middle of Itokawa. Credit: JAXA

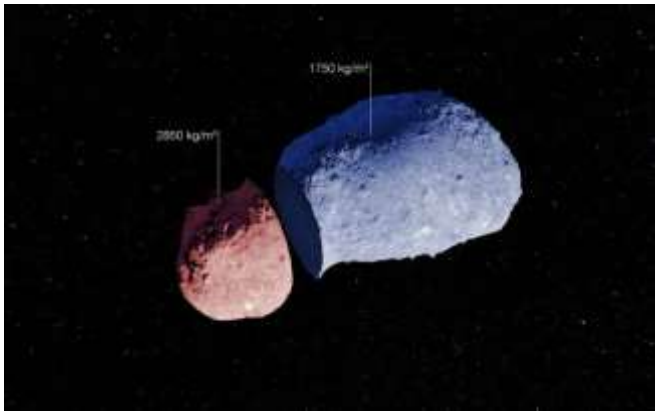
From its structure, which consists of two boulder-strewn main lobes (with different densities) that are joined by a narrower section, it is believed that Itokawa is the remnant of a parent body measuring about 19 km (12 mi) in width. During its history, it would have been heated to between 550 and 800 °C (1000 and 1500 °F) and suffered multiple impacts, with one big event that broke it apart.

In the aftermath, two of the fragments merged to form Itokawa, which assumed its current size and shape by about 8 million years ago. Despite the catastrophic breakup that led to its formation and the fact that the sample grains were exposed to radiation and micrometeorite impacts, the minerals still showed evidence of water that was lost to space.

"Although the samples were collected at the surface, we don't know where these grains were in the original parent body," said Jin. "But our best guess is that they were buried more than 100 meters deep within it… The minerals have hydrogen isotopic compositions that are indistinguishable from Earth."

What this shows is that asteroid impacts during the Late Heavy Bombardment (ca. 4.1 to 3.8 billion years ago) were responsible for distributing water to Earth shortly after if formed. As Bose added, this makes S-class asteroids a high-priority target for sample-return missions in the future.

"This means S-type asteroids and the parent bodies of ordinary chondrites are likely a critical source of water and several other elements for the terrestrial planets. And we can say this only because of in-situ isotopic measurements on returned samples of asteroid regolith – their surface dust and rocks."



Itokawa, a peanut-shaped asteroid that has different densities in its small body. Credit: ESO/JAXA

When those missions take place, ASU will likely be playing a significant role. Right now, Bose is working on the creation of a clean-lab facility at ASU that – along with the NanoSIMS – will be the first public university facility capable of analyzing samples of material obtained from asteroids and bodies in the Solar System.

Professor Meenakshi – the director of ASU's Center for Meteorite Studies and the new director of the SESE – is also part of the analysis team that will be studying the samples returned by the *Hayabusa2* mission. The spacecraft will be leaving the asteroid Ryugu in December of 2019 and is scheduled to return to Earth by December of 2020.

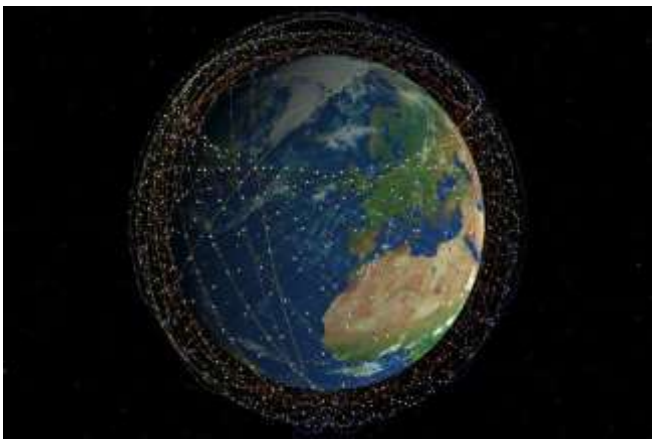
ASU is also responsible for contributing the Thermal Emission Spectrometer (OTES) instrument aboard NASA's *OSIRIS-REx* spacecraft, which is currently conducting a sample-return mission with the near-Earth asteroid Bennu. OSIRIS-REx is scheduled to collect samples from Bennu next summer and bring them back to Earth by September of 2023.

These and other missions will expand scientist's understanding of how our Solar System came to be, and might even shed some light on how life began on our planet. As Bose concluded:

"Sample-return missions are mandatory if we really want to do an in-depth study of planetary objects. The Hayabusa mission to Itokawa has expanded our knowledge of the volatile contents of the bodies that helped form Earth. It would not be surprising if a similar mechanism of water production is common for rocky exoplanets around other stars."

Further Reading: ASU Now, *Science Advances*

Starlink's Satellites Will be Orbiting at a Much Lower Altitude, Reducing the Risks of Space Junk



Among Elon Musk's many plans for the future, one of the more ambitious has been the creation of a constellation of satellites that will offer broadband internet access to the entire world. Known as "Starlink", the company's long-term plan is to deploy over 12,000 internet satellites to Low Earth Orbit (LEO) by the mid-2020s.

Despite criticism and dismissal, Musk and SpaceX have taken some major steps in recent years to get the ball rolling on this proposal. And according to a recently-released official statement from the company, mass production is well underway and the first batch of operational satellites are already in Florida awaiting their scheduled May 2019 launch.

16 Years of Hubble Images Come Together in this one Picture Containing 265,000 Galaxies

Even after almost three decades of faithful service, the Hubble Space Telescope continues to operate and provide breathtaking images of the cosmos. As one of NASA's Great Observatories, its observations of distant galaxies, exoplanets, and the expansion of the Universe have had a revolutionary impact on astronomy, astrophysics and cosmology.

Hubble's latest contribution comes in the form of a deep-sky mosaic image that was constructed using 16 years' worth of observations. Known as the "Hubble Legacy Field", this mosaic is being described as the largest and most comprehensive "history book" of galaxies. All told, it contains roughly 265,000 galaxies that date back to just 500 million years after the Big Bang.

Nearly 7,500 individual exposures went into the creation of the Hubble Legacy Field, providing a wide portrait of the distant Universe that looks back to the earliest visible times. In so doing, the image shows how galaxies have changed over time, growing through mergers to become the giant galaxies we see in the Universe today. This effectively means that 13.3 billion years of cosmic evolution have been chronicled in this one image.

This ambitious endeavor comprises the collective work of 31 Hubble programs by different teams of astronomers. It also incorporated observations taken by several Hubble deep-field surveys. These include the Hubble Deep Field in 1995, the Great Observatories Origins Deep Survey (GOODS) of 2003, the Hubble Ultra Deep Field of 2004, and the eXtreme Deep Field (XDF) of 2012, which is the deepest view of the Universe to date.

As Garth Illingworth, Professor Emeritus at UCSC and head of the team that assembled the image, said in a recent NASA press release:

"Now that we have gone wider than in previous surveys, we are harvesting many more distant galaxies in the largest such dataset ever produced. No image will surpass this one until future space telescopes like James Webb are launched."

In addition to showing galaxies in the visible light, the wavelength range spans from the ultraviolet to the near-infrared part of the spectrum. This is key in modern astronomy and cosmology, in that it allows key features of galaxy assembly to be made apparent. A good example is cosmic dust and gas, which are not always visible unless they illuminated by nearby stars.

"Such exquisite high-resolution measurements of the numerous galaxies in this catalog enable a wide swath of extragalactic study," said catalog lead researcher Katherine Whitaker of the University of Connecticut, in Storrs. "Often, these kinds of surveys have yielded unanticipated discoveries which have had the greatest impact on our understanding of galaxy evolution."

About a century ago, Edwin Hubble (for whom the HST is named) described galaxies are the "markers of space". At the time, he was observing distant galaxies and noted how light coming from the majority of them was shifted towards the red end of the spectrum – aka. "redshifted", which is an indication that astronomical objects are moving away from us.

These observations confirmed a prediction made by Einstein's Theory of General Relativity – that the Universe was either in a state of expansion or contraction. Subsequent surveys have used galaxies to measure the rate of cosmic expansion (known as the Hubble Constant), which has also offered clues as to the underlying physics of the cosmos, when chemical elements originated, and how our Solar System and life eventually appeared.

This wider view is especially helpful in that respect since it contains about 30 times as many galaxies as the previous deep fields. The Legacy Field has also revealed several unusual objects, many of which are the remnants of collisions and mergers that took place during the early Universe – what are referred to as galactic "train wrecks".

As you can imagine, assembling this image was no easy task. As Dan Magee, of the University of California, Santa Cruz, the team's data processing lead, explained:

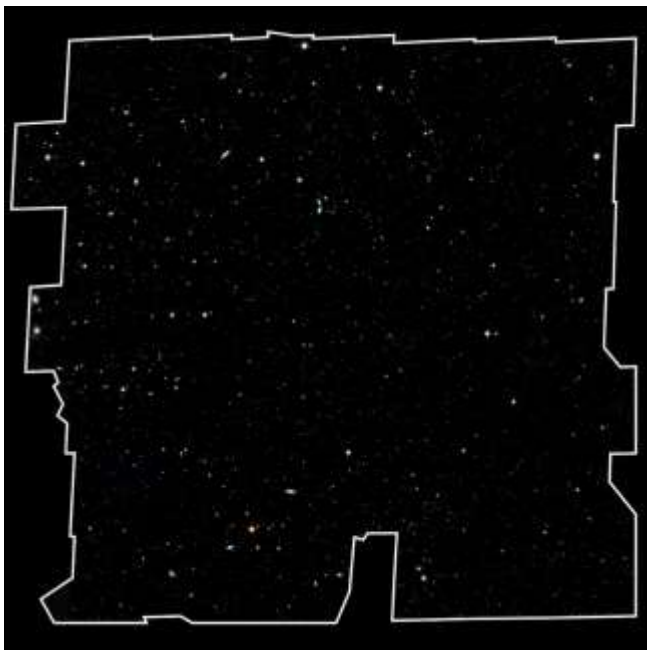
"Our goal was to assemble all 16 years of exposures into a legacy image. Previously, most of these exposures had not been put together in a consistent way that can be used by any researcher. Astronomers can select the data in the Legacy Field they want and work with it immediately, as opposed to having to perform a huge amount of data reduction before conducting scientific analysis."

Despite being the most detailed and expansive image of galaxies ever taken, this new image is merely the first in a series of Hubble Legacy Field images. The team is currently working on another set of images, which total more than 5,200 Hubble exposures, from another area of the sky. Looking ahead, astronomers hope to broaden the multiwavelength range in the legacy images to include even more data on galaxies.

This will include longer-wavelength IR and high-energy X-ray observations from two other NASA Great Observatories – the *Spitzer Space Telescope* and the Chandra X-ray Observatory. As team member Rychard Bouwens of Leiden University in the Netherlands said in ESA press release:

"One exciting aspect of these new images is the large number of sensitive color channels now available to view distant galaxies, especially in the ultraviolet part of the spectrum. With images at so many frequencies, we can dissect the light from galaxies into the contributions from old and young stars, as well as active galactic nuclei."

In the meantime, no image of the Universe is expected to surpass the Hubble Legacy Field images one until next-generation space telescopes are launched. These include the *James Webb Space Telescope* (JWST) and the *Wide-Field Infrared Space Telescope* (WFIRST), both of which have instruments will that offer improved resolution and sensitivity over *Hubble* and thus enable more in-depth surveys.



Hubble Legacy Field image. Credit: NASA/ESA/G. Illingworth and D. Magee (UCSC), K. Whitaker (University of Connecticut), R. Bouwens (Leiden University), P. Oesch (University of Geneva)/Hubble Legacy Field team

The vast number of galaxies in the Legacy Field image are also prime targets for future telescopes. As Illingworth said in a HubbleSite press release:

"We've put together this mosaic as a tool to be used by us and by other astronomers. The expectation is that this survey will lead to an even more coherent, in-depth and greater understanding of the universe's evolution in the coming years… This will really set the stage for NASA's planned Wide-Field Infrared Survey Telescope (WFIRST). The Legacy Field is a pathfinder for WFIRST, which will capture an image that is 100 times larger than a typical Hubble photo. In just three weeks' worth of observations by WFIRST, astronomers will be able to assemble a field that is much deeper and more than twice as large as the Hubble Legacy Field."

In addition, the JWST's imaging capabilities in the IR band (which are beyond the limits of *Hubble* or *Spitzer*) will allow astronomers to probe much deeper into the Legacy Field image to reveal more about how infant galaxies grew. The image (along with the individual exposures that went into making it) is available through the Mikulski Archive for Space Telescopes (MAST).

Further Reading: ESA, *NASA*, *Hubble*

The Global Dust Storm that Ended Opportunity Helped Teach us how Mars Lost its Water

The enduring, and maybe endearing, mystery around Mars is what happened to its water? We can say with near-certainty now, thanks to the squad of Mars rovers and orbiters, that Mars was once much wetter. In fact that planet may have had an ocean that covered a third of the surface. But what happened to it all?

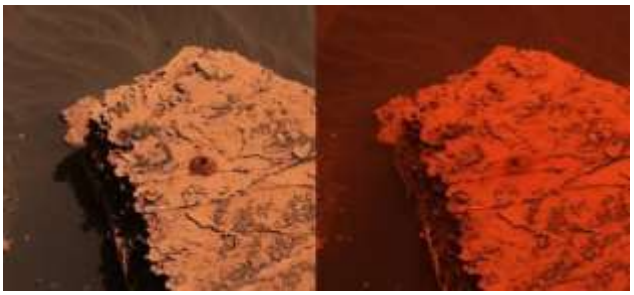
As it turns out, the global dust storms that envelop Mars, and in particular the most recent one that felled the Opportunity rover, may offer an explanation.

Dust storms on Mars are common. They tend to be seasonal, taking place during the spring and summer in the southern hemisphere. They last a couple days and cover areas as large as the US. But then there are the planet-encircling, or global, dust storms.

In mid-July 2018 the NASA/ESA Hubble Space Telescope observed Mars, only 13 days before the planet made its closest approach to Earth in 2018. While previous images showed detailed surface features of the planet, this new image is dominated by a gigantic sandstorm enshrouding the entire planet. Global dust storms — lasting for weeks or months — tend to happen during the spring and summer in the southern hemisphere, when Mars is closest to the Sun and heating is at a maximum, leading to greater generation of winds. Image Credit: NASA/ESA/Hubble STscI

The global dust storms are more unpredictable than their smaller, seasonal counterparts. They appear every few years and can cover the entire planet. And they can stick around for months on end. During the last one, which lasted from June 2018 to September 2018, six orbiting spacecraft and two surface rovers observed the

storm, though unfortunately Opportunity didn't survive it.



Images of a drill site from NASA's Curiosity rover. The image on the left was taken during normal Mars daytime, prior to the 2018 global dust storm. The image on the right was captured when the global dust storm was in full effect. Image Credit: NASA/JPL-Caltech/MSSS

The question is, what causes these massive storms? How are they a part of the Martian climate and atmosphere? Did they and do they contribute to water loss? NASA scientists are trying to answer those questions.

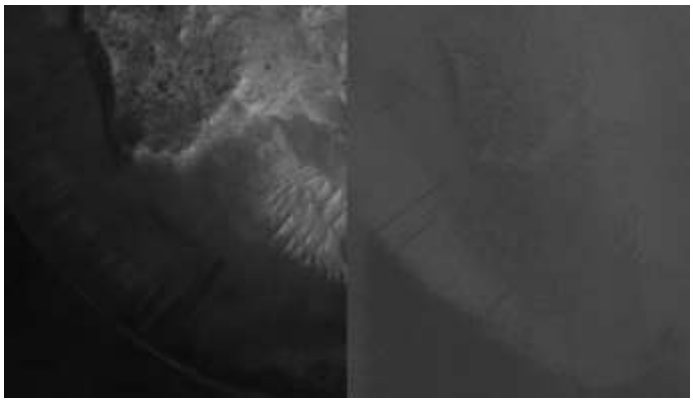
First of all, a quick answer to an often-asked question: Why did Opportunity perish in the global dust storm while Curiosity survived it? Opportunity was solar powered, and the dust blotted out the Sun. There may have been other causes, because no rover lasts forever, but the lack of solar energy certainly played a part. But Curiosity is a nuclear-powered machine, and it doesn't care about the Sun.

A panorama image of the Opportunity rover, showing the solar panels. The rover's science operations were shut down because of the growing global dust storm. By NASA/JPL-Caltech/Cornell – http://marsrovers.jpl.nasa.gov/gallery/press/opportunity/20060104a.html / http://photojournal.jpl.nasa.gov/catalog/PIA03270, Public Domain, https://commons.wikimedia.org/w/index.php?curid=514339

Back to the global dust storms.

We've witnessed several global dust storms on Mars. In 1971, the Mariner 9 spacecraft arrived at Mars and found it shrouded in dust. Since then, we've seen storms in 1977, 1982, 1994, 2001, 2007 and 2018. There were actually two separate global storms in 1977, adding to the mystery of their cause.

Scott Guzewich is a NASA atmospheric scientists at the Goddard Space Flight Center. He's leading NASA's investigation into Martian dust storms. In a press release, Guzewich said, "We still don't know what drives the variability, but the 2018 storm gives another data point." And science is all about accumulating data points.



This image from the HiRise camera on the MRO shows a crater on Mars. On the left is the crater before the global Martian dust storm, and on the right is the same crater during the storm. Image: NASA/JPL/University of Arizona

The dust storms may offer a clue to the case of Mars' disappearing water.

Geronimo Villaneuva is a NASA scientist at the Goddard Space Flight Center who has spent his career studying Martian water. Together with colleagues at the European Space Agency and at the Roscosmos Russian space agency, they think they may have it, at least partially, figured out. "The global dust storm may give us an explanation," Villaneuva said in a press release.

It may come down to a combination of dust, the lofting of H2O into the upper atmosphere, and the Sun's radiation.
"When you bring water to higher parts of the atmosphere, it gets blown away so much easier."

Geronimo Villaneuva, NASA's Goddard Space Flight Center

Global dust storms on Mars don't only lift dust high into the atmosphere. They also carry water. Typically, water is carried as high as 20 km (12 miles) into the atmosphere. But Villaneuva and his colleagues used the ExoMars Trace Gas Orbiter to detect water as high as 80km (50 miles) in the atmosphere during these global dust storms. At 80 km altitude, the Martian atmosphere is extremely thin, and the water is exposed to solar radiation. That radiation can split apart the H2O molecule, and the solar wind can blow the hydrogen and oxygen into space.

"When you bring water to higher parts of the atmosphere, it gets blown away so much easier," says Villanueva,

On Earth, lofted moisture condenses and falls to Earth as rain. But on Mars, this may have never been the case. It's possible that Mars slowly lost its water over a long period of time through this mechanism.

Villaneuva and his colleagues presented their findings in a paper published on April 10th, 2019 in the journal Nature.

When the Impact that Created the Moon Happened, the early Earth was still a ball of magma

Since the late 19th century, scientists have struggled to explain the origin of the Moon. While scientists have long-theorized that it and the Earth have a common origin, the questions of how and when has proven to be elusive. For instance, the general consensus today is that an impact with a Mars-sized object (Theia) led to the formation of the Earth-Moon System shortly after the formation of the planets (aka. the Giant Impact Hypothesis).

However, simulations of this impact have shown that the Moon would have formed out of material primarily from the impacting object. This is not borne out by the evidence, though, which shows that the Moon is composed of the same material Earth is. Luckily, a new study by a team of scientists from Japan and the US has offered an explanation for the discrepancy: the collision took place when Earth was still composed of hot magma.

The study that describes their findings, "Terrestrial magma ocean origin of the Moon", recently appeared in the journal *Nature Geoscience.* The study was led by Natsuki Hosono of the RIKEN Center for Computational Science and included researchers from Yale University, the RIKEN Center for Computational Science, and the Earth-Life Science Institute (ELSI) at the Tokyo Institute of Technology.

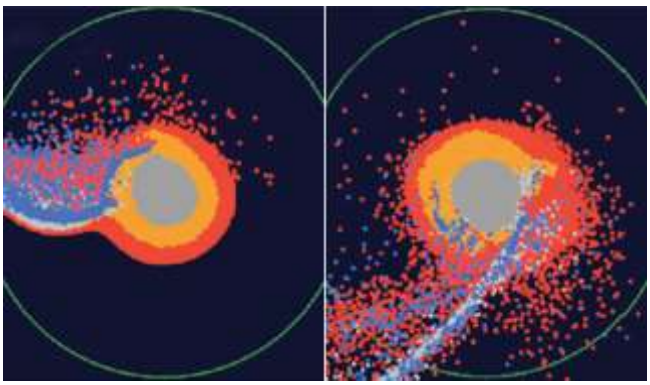
Aside from simulations that model the impact scenario, the Giant Impact Hypothesis is also plagued by the fact that in an impact, most of the material forming the Moon would be silicate minerals. This would result in Earth's satellite being iron-poor, but seismological studies have shown that the Moon likely has a core like Earth's (composed of iron and nickel) and that convection in its core also powered a magnetic field at one time.

Again, the new study offers a scenario which can account for this. According to the model they created, when the Earth and Theia collided roughly 50 million years after the formation of the Sun (ca. 4.6 billion years ago), Earth was covered by a sea of hot magma while Theia was likely composed of solid material.

This model showed that after the collision, the magma on Earth would have been heated far more than solids from the impacting object. This would cause the magma to expand in volume and escape into orbit to form the Moon. This latest model, which takes into account the different degree of heating between the proto-Earth and Theia, effectively explains how there is much more Earth material in the makeup of the Moon.

Shun-ichiro Karato, a professor of geology at Yale University and a co-author on the paper, has conducted extensive research on the chemical properties of proto-Earth magma in the past. As he explained in an interview with Yale News:

"In our model, about 80% of the moon is made of proto-Earth materials. In most of the previous models, about 80% of the moon is made of the impactor. This is a big difference."



Snapshots from the team's simulation of the Giant Impact that created the Earth-Moon system. Red points indicate materials from the ocean of magma in a proto-Earth; blue points indicate the impactor materials. Credit: Yale News/Natsuki Hosono (et al.) 2019

For the sake of the study, Karato led the team's research efforts into the compression of molten silicate. The task of developing a computational model to predict how material from the collision would be distributed, meanwhile, was performed by a group from ELSI at the Tokyo Institute of Technology and the RIKEN Center for Computational Science.

Taken together, the new model demonstrated that superheated magma would be lost to space and coalesce to form a new body in orbit faster than the material lost from the impactor. It also showed that material from Earth's interior (which would be rich in iron and nickel) would also go into the formation of the Moon – which would then sink to the center to form the Moon's core.

Essentially, the new model confirms previous theories about how the Moon formed by doing away with the need for unconventional collision conditions. Until now, this is what scientists have done in order to account for the discrepancy between impact simulations and data obtained from the study of Moon rocks and the lunar surface.

This study could also lead to more refined theories of how the Solar System formed and what took place immediately after. Since the impact between the proto-Earth and Theia may have played a role in the eventual emergence of life on Earth, it could also help scientists constrain what is needed in order for a star system to have habitable planets.

Further Reading: Yale News, Nature Geoscience

InSight Just Detected its First "Marsquake"

In November of 2018, the NASA *Interior Exploration using Seismic Investigations, Geodesy and Heat Transport* (InSight) lander set down on Mars. Shortly thereafter, it began preparing for its science operations, which would consist of studying Mars' seismology and its heat flow for the sake of learning how this planet – and all the other terrestrial planets in the Solar System (like Earth) – formed and evolved over time.

With science operations well-underway, InSight has been "listening" to Mars to see what it can learn about its interior structure and composition. A few weeks ago, mission controllers discovered that the lander's Seismic Experiment for Interior Structure (SEIS) instrument

detected its strongest seismic signal (aka. a “marsquake”) to date. This faint quake could reveal much about the Red Planet and how it came to be.

The faint seismic signal, detected by the lander’s Seismic Experiment for Interior Structure (SEIS) instrument, was recorded on April 6th, or the 128th Martian day (Sol 128) since the lander touched down. This is the first recorded seismic signal that appears to have originated from inside the planet, as opposed to being caused by something like wind.

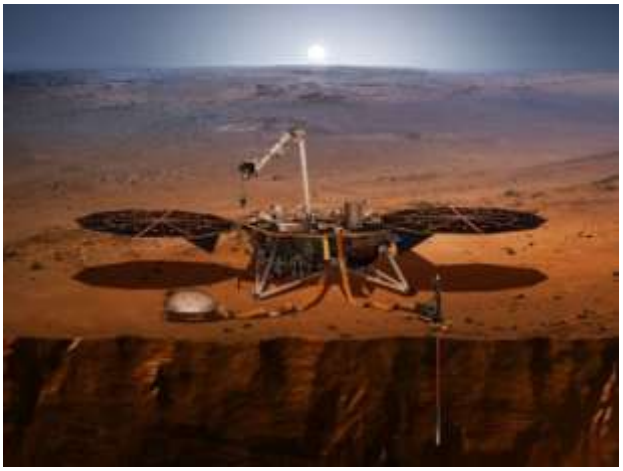
NASA scientists are now examining the SEIS data to determine the exact cause of the signal, which may have originated from inside Mars or been caused by a meteorite crashing into the planet’s surface and sending ripples through the mantle. On Earth, seismic activity (aka. “earthquakes”) are the result of action between tectonic plates, particularly along fault lines.

While Mars and the Moon do not have tectonic plates, they still experience quakes, which are largely the result of the continual heating and cooling of their surfaces. This causes expansion and contraction, which eventually results in stress strong enough to break the crust. While the new seismic event was too small to provide solid data on the Martian interior, it is giving the mission team an idea of how seismic activity on Mars works.

For instance, the faint nature of this event is similar to those measured by the Apollo astronauts during the late 1960s and early 1970s. Beginning with *Apollo 11*, NASA astronauts installed a total of five seismometers on the lunar surface that measured thousands of moonquakes between 1969 and 1977. The data obtained by these sensors allowed scientists to learn a great deal about the Moon’s interior structure and composition.

In this respect, InSight is carrying on in a tradition that began with the Apollo missions. As Renee Weber, a planetary scientist at NASA’s Marshall Space Flight Center, explained in a recent NASA press release:

“We thought Mars was probably going to be somewhere between Earth and the Moon [in terms of seismic activity]. It’s still very early in the mission, but it’s looking a bit more Moon-like than Earth-like.”



Artist’s interpretation of the InSight mission on the ground on Mars. Credit: NASA

Unlike Earth’s surface, which is constantly quivering from seismic noise created by the planet’s oceans and weather, the Martian surface is extremely quiet. This allows SEIS, which was provided by France’s National Center for Space Studies (CNES) and built by the French National Higher Institute of Aeronautics and Space (ISAE) in Toulouse, to pick up faint rumbles that would go unnoticed on Earth.

As Lori Glaze, the Planetary Science Division director at NASA Headquarters, said:

“The Martian Sol 128 event is exciting because its size and longer duration fit the profile of moonquakes detected on the lunar surface during the Apollo missions.”

InSight’s SEIS, which it placed on the surface in December of 2018, is allowing scientists to gather similar data about Mars. And much like how composition data on the Moon allowed scientists to hypothesize that the Earth-Moon system has a common origin (the Giant Impact Theory), it is hoped that this data will shed light on how the rocky planets of our Solar System formed.

This is the fourth seismic signal detected by the InSight lander, the previous three having taken place on March 14th (Sol 105), April 10th (Sol 132) and April 11th (Sol 133), respectively. However, these signals were even fainter than the one detected on April 6th which makes them even more ambiguous as far as their origins are concerned. Here too, the team will continue studying them to try to learn more.

The InSight Lander’s seismometer underneath its protective wind and thermal shield. Image Credit: NASA/ JPL-Caltech

Regardless of what caused the April 6th signal, its detection is an exciting milestone for the team. As Philippe Lognonné, the SEIS team lead at the Institut de Physique du Globe de Paris (IPGP) in France, said:

“We’ve been waiting months for a signal like this. It’s so exciting to finally have proof that Mars is still seismically active. We’re looking forward to sharing detailed results once we’ve had a chance to analyze them.”

From the four events recorded since December, the SEIS team has indicated that the instrument has surpassed their expectations in terms of sensitivity. “We are delighted about this first achievement and are eager to make many similar measurements with SEIS in the years to come,” said Charles Yana, the SEIS mission operations manager at CNES.

The lander continues to study the planet’s interior from its spot in Elysium Planitia, a plain near Mars’ equator. At present, mission controllers are still trying to figure out how to dislodge the Heat and Physical Properties Package (HP3) heat probe, which became stuck in buried rock back in February while trying to hammer itself into the ground to measure the temperatures there.

Be sure to check out this recording of the seismic event, courtesy of NASA JPL and the SEIS team:

Further Reading: NASA, Nature

Astronomers Think a Meteor Came from Outside the Solar System

When 'Oumuamua was first detected on October 19th, 2017, astronomers were understandably confused about the nature of this strange object. Initially thought to be an interstellar comet, it was then designated as an interstellar asteroid. But when it picked up velocity as it departed our Solar System (a very comet-like thing to do), scientists could only scratch their heads and wonder.

After much consideration, Shmuel Bialy and Professor Abraham Loeb of the Harvard-Smithsonian Center for Astrophysics (CfA) proposed that 'Oumuamua could in fact be an artificial object (possibly an alien probe). In a more recent study, Amir Siraj and Prof. Loeb identified another (and much smaller) potential interstellar object, which they claim could be regularly colliding with Earth.

The study, "Discovery of a Meteor of Interstellar Origin", recently appeared online and was submitted for publication in *The Astrophysical Journal Letters.* In it, Siraj and Loeb expand upon previous research they conducted which indicated that there is an abundance of interstellar objects in the Solar System that could be researched.

Artist's impression of Oumuamua leaving the Solar System. Credit: NASA

However, for the sake of this study, Siraj and Loeb chose to focus on meter-sized interstellar objects that made their way into our Solar System over time. Many of these could have found there way into Earth's atmosphere as meteorites, presenting humanity with the opportunity to study objects that come from extrasolar systems. As Prof. Loeb shared with Universe Today via email:

"This is a new way to learn about interstellar objects. The traditional search method uses the Sun as a lamppost and searches for objects based on their reflected sunlight. This is how`Oumuamua was detected by Pan STARRS, which is effective for objects larger than 100 meters in size. One expects many more objects of smaller size, some of which will hit the Earth."

To determine how often meter-sized objects enter our Solar System and/or collide with Earth, Siraj and Loeb analyzed data from the Center for Near Earth Objects (CNEOS), which is tasked with monitoring the orbits of asteroids and comets to determine if they will ever impact Earth. Specifically, they were looking for particularly bright and explosive events (bolides) from the past three decades.

These events have become the focus of considerable attention ever since the Chelyabinsk meteor exploded in the skies over a small Russian town in 2013. And with the recent meteor that exploded above the Bering Sea in December of 2018 – which was observed by the NASA *Terra* satellite – Prof. Loeb was inspired to examine the CNEOS catalog to determine how common these types of bolide events are.

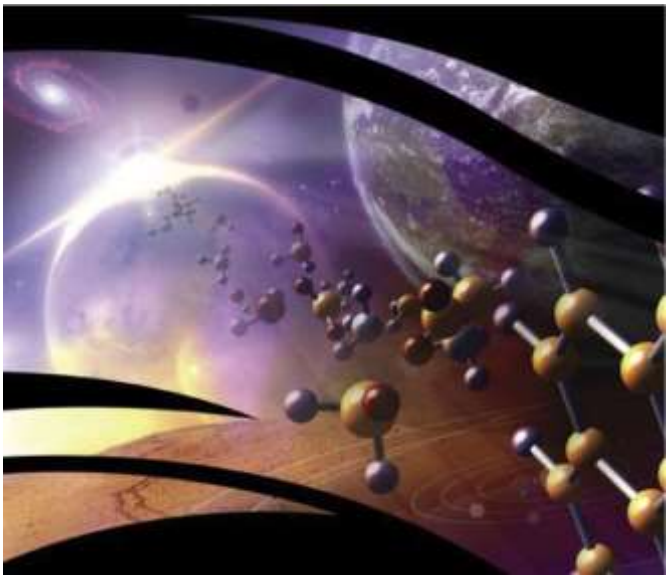
Vapor trail captured about 200 km (125 mi) from the Chelyabinsk meteor event, about one minute after it entered Earth's atmosphere. Credits: Alex Alishevskikh

"About two weeks ago I had a radio interview in which I was asked about a meteor that was seen above the Bering Sea in December 2018," said Loeb. "In preparation for this interview I read the literature on meteors and found the catalog of all meteors over the past three decades. I then asked an undergraduate student working with me, Amir Siraj, to integrate the orbits of the fastest meteors back in time taking account of the gravity of the Earth, the Sun and all other planets in the Solar System, using the three components of velocity, position and time of impact [for] the meteors."

After looking into three decades of meteorites, they discovered one bolide event which could very-well have been the result of an interstellar meteor entering Earth's atmosphere. This meteor was spotted just north of Manus Island, off the coast of Papua New Guinea, on January 8th, 2014, and measured an estimated 1 meter (3.28 ft) in diameter, with a mass of 500 kg (1100 lbs).

Based on the object's size, motion, and velocity – 60 km/s (37 mi/s) relative to Earth's motion – they determined that the meteor is likely to have been interstellar in nature. Based on its likely origin, this discovery could have profound implications concerning the study of how life originated here on Earth. As Loeb explained:

"Such a high ejection speed can only be produced in the innermost cores of planetary system (interior to the orbit of the Earth around a star like the Sun, but in the habitable zone of dwarf stars – hence allowing such objects to carry life from their parent planets).



A new study expands on the classical theory of panspermia, addressing whether or not life could be distributed on a galactic scale. Credit: NASA

Aside from constraining this meteor's origin, Siraj and Leob also calculated just how often such objects would impact Earth (once per decade) and how often they would need to be ejected from their respective systems in order for some to make it to other stars. While the numbers were rather (ahem!) astronomical, they found that the necessary mass of ejected meter-sized objects was the same as ejected 'Oumuamua-sized objects (100 m; 328 feet).

"Altogether, each star needs to eject about 10^{22} objects of 1 meter size to account for the population of this meteor," said Loeb. "This is roughly the total number of stars in the observable volume of the Universe… Each star needs to eject about an Earth mass of rocks with this mass, which is challenging because this is the total mass in planetesimals inferred in the appropriate inner region of the early Solar System."

Beyond the implications this study could have for the spread of life throughout the cosmos (aka. panspermia) and the abundance of interstellar objects in our Solar System (and others), this study presents a new detection method from which it will be possible to infer the composition of interstellar objects. The way to do this, said Loeb, is to conduct spectral analyses of the gases they leave after they burn up in our atmosphere:

"In the future, astronomers can establish an alert system that triggers spectroscopic observations by the nearest telescope for meteors of a possible interstellar origin. We already have alert systems for gravitational wave sources, gamma-ray bursts, or fast radio bursts."

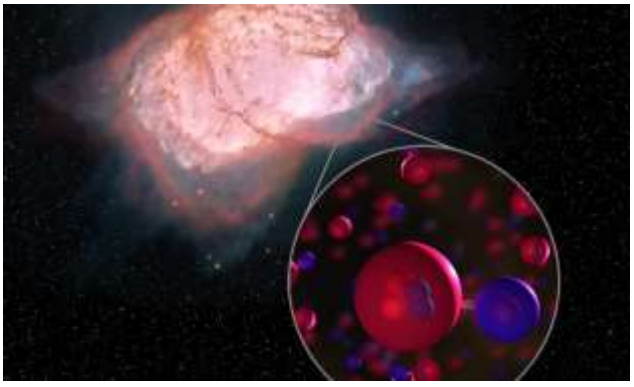
Artist's impression of the interstellar object, `Oumuamua, experiencing outgassing as it leaves our Solar System. Credit: ESA/Hubble, NASA, ESO, M. Kornmesser

This echoes suggestions made by Dr. Zdenek Sekanina of the NASA Jet Propulsion Laboratory, who recently conducted a study that claimed that 'Oumuamua could be the remains of an interstellar comet that broke up as it approached out Sun. As Sekanina argued, examining the spectra of the dust left behind after the comet exploded would reveal things about the system in which the comet originally formed.

While this alert system would admittedly only detect a small percentage of interstellar meteors entering our atmosphere, the scientific payoff of studying them would be immeasurable. At the very least, we will be able to learn things about distant star systems without having to actually send missions there. At most, there's the remote possibility that one or more of these meteors could be space junk from another civilization.

Imagine what we could learn if that were the case!

The First Molecule that was Possible in the Universe has been Seen in Space



It takes a rich and diverse set of complex molecules for things like stars, galaxies, planets and lifeforms like us to exist. But before humans and all the complex molecules we're made of could exist, there had to be that first primordial molecule that started a long chain of chemical events that led to everything you see around you today.

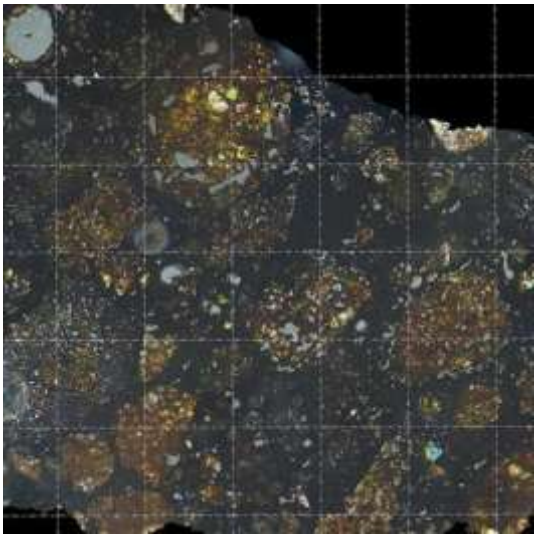
Though it's been long theorized to exist, the lack of observational evidence for that molecule was problematic for scientists. Now they've found it and those scientists can rest easy. Their predictive theory wins!

The World's Biggest Aircraft – the Rocket-Launching Stratolaunch – Completes its First Test Flight

In 2011, Microsoft co-founder Paul G. Allen and Scaled Composites founder Burt Rutan announced the creation of Stratolaunch Systems. With the goal of reducing the associated costs of space launches, the company set out to create the world's largest air-launch-to-orbit system. After many years, these efforts bore fruit with the unveiling of the massive Scaled Composites Model 351 Stratolaunch air carrier in the Summer of 2017.

Similar in principle to Virgin Galactic's SpaceShipTwo, this behemoth is designed to deploy rockets from high altitudes so they can send payloads to Low-Earth Orbit (LEO). After multiple tests involving engine preburns and taxiing on the runway, the aircraft made its inaugural flight last weekend (Saturday, April 13th) and flew for two and half hours before safely landing again in the Mojave Desert

Astronomers Find a Chunk of a Comet Inside a Meteorite



The early days of the Solar System are hard to piece together from our vantage point, billions of years after it happened. Now a team of scientists have found a tiny chunk of an ancient comet inside an ancient meteorite. They say it sheds light on the early days of the Solar System when planets were still forming.

It's Finally here. The First Ever Image of a Black Hole

"*We have taken the first picture of a black hole.*"

EHT project director Sheperd S. Doeleman of the Center for Astrophysics Harvard & Smithsonian.

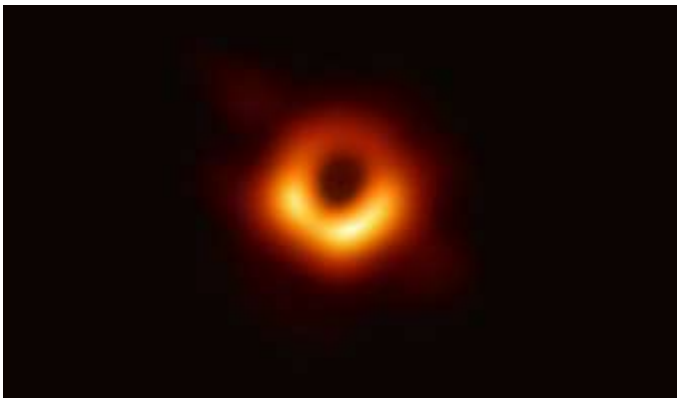
What was once un-seeable can now be seen. Black holes, those difficult-to-understand singularities that may reside at the center of every galaxy, are becoming seeable. The Event Horizon Telescope (EHT) has revealed the first-ever image of a black hole, and with this image, and all the science behind it, they may help crack open one of the biggest mysteries in the Universe.

The black hole in this image resides at the center of M87, a massive galaxy that's in the Virgo cluster of galaxies. Called M87* (M87-star), it's a behemoth, at about 6.5 billion times the mass of the Sun. M87* is about 55 million light years from Earth. For now we only have this picture of M87*, but pictures of our very own black hole, Sagittarius A* at the center of the Milky Way, are still coming.

This may be the worst kept secret of the past couple weeks. Ever since the EHT said they would be announcing some important results, the excitement has built.

"*This is an extraordinary scientific feat accomplished by a team of more than 200 researchers.*"

"*We have taken the first picture of a black hole,*" said EHT project director Sheperd S. Doeleman of the Center for Astrophysics | Harvard & Smithsonian. "*This is an extraordinary scientific feat accomplished by a team of more than 200 researchers.*"



The Event Horizon Telescope (EHT) — a planet-scale array of eight ground-based radio telescopes forged through international collaboration — was designed to capture images of a black hole. The first image is of M87* at the center of the M87 galaxy. Image Credit: EHT Collaboration.

We already knew, or were pretty sure we knew, what it would look like. Even a year ago, scientists at the EHT were pretty certain, and they released a simulated image of what this first-ever image of a black hole would look like. But with science, you don't know until you know. That's why this image is so important.

Simulated view of a black hole released by the EHT in April, 2017. Credit: Bronzwaer/Davelaar/Moscibrodzka/ Falcke, Radboud University

The image matches with what astrophysicists theorized it would look like. This is a real feather in the cap for science, and shows the power of theory developed from evidence. It shows that even though black holes are mysterious, and that their ultimate nature is still unknowable at this moment in history, we can still nibble around the edges. Over time we can remove more and more of the mystery until we understand what remains.

"Once we were sure we had imaged the shadow, we could compare our observations to extensive computer models that include the physics of warped space, superheated matter and strong magnetic fields. Many of the features of the observed image match our theoretical understanding surprisingly well," remarks Paul T.P. Ho, EHT Board member and Director of the East Asian Observatory [5]. "*This makes us confident about the interpretation of our observations, including our estimation of the black hole's mass.*"

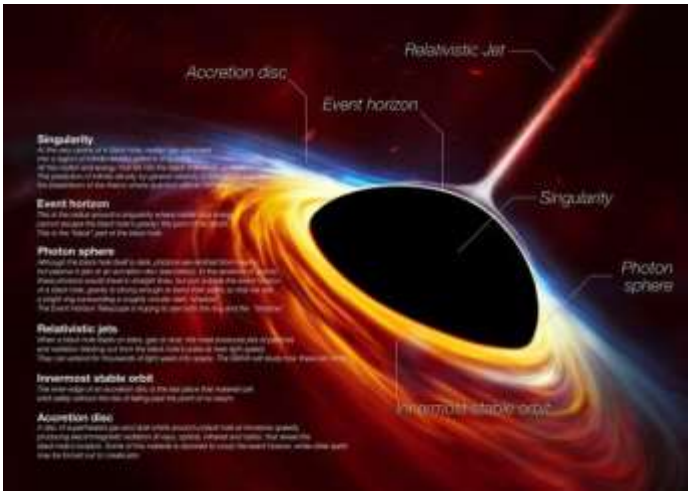
"*The confrontation of theory with observations is always a dramatic moment for a theorist. It was a relief and a source of pride to realise that the observations matched our predictions so well,*" elaborated EHT Board member Luciano Rezzolla of Goethe Universität, Germany.

An optical image of the M87 galaxy captured by the European Southern Observatory's Very Large Telescope. M87* lies at the very center of that bright mass. Image Credit: ESO

Black holes are extreme objects. They are massive, almost incomprehensibly massive, yet in terms of size they are tiny. Because of their extreme nature, they affect their environment in extreme way.

As they attract matter to themselves with their massive gravitational pull, that matter begins to rotate around the hole, forming a disc. The closer it gets to the black hole, the faster the matter rotates. It heats up, and emits energy we can see. This is the source of light that can be imaged, even though the singularity at the center of M87* can not be seen.

What can be seen is the shadow that the black hole casts on this light.



This artist's impression depicts a rapidly spinning supermassive black hole surrounded by an accretion disc. This thin disc of rotating material consists of the leftovers of a Sun-like star which was ripped apart by the tidal forces of the black hole. Shocks in the colliding debris as well as heat generated in accretion led to a burst of light, resembling a supernova explosion.

"*If immersed in a bright region, like a disc of glowing gas, we expect a black hole to create a dark region similar to a shadow — something predicted by Einstein's general relativity that we've never seen before,*" explained chair of the EHT Science Council Heino Falcke of Radboud University, the Netherlands. "*This shadow, caused by the gravitational bending and capture of light by the event horizon, reveals a lot about the nature of these fascinating objects and has allowed us to measure the enormous mass of M87's black hole.*"

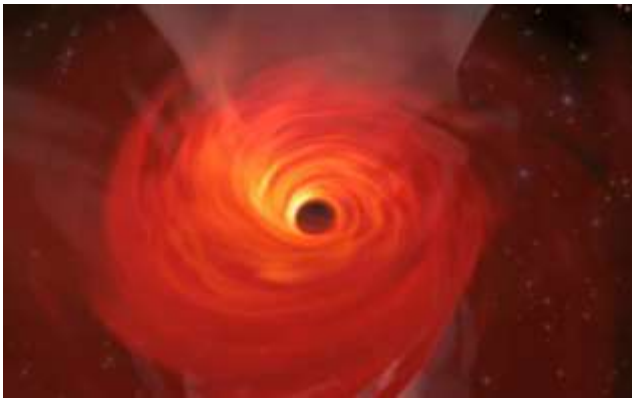
This artist's impression depicts the black hole at the heart of the enormous elliptical galaxy Messier 87

(M87). This black hole was chosen as the object of paradigm-shifting observations by the Event Horizon Telescope. The superheated material surrounding the black hole is shown, as is the relativistic jet launched by M87's black hole.
ESO/M. Kornmesser

The EHT isn't a single telescope. It's more like a virtual telescope, and it's more properly called a Very Long Baseline Interferometer. What that means is they've linked up radio antennae around the globe to observe the same object. This gives the telescope "high angular resolving power." Basically, the bigger the 'scope, the more detail we can see. And no telescope is as big as the Earth, except for the EHT. The extremely high resolving power of the EHT means it can see a credit card on the surface of the Moon.

The EHT combines the power of radio-telescope facilities in Hawaii, Mexico, high in the Chilean Atacama Desert, down in Antarctica, and other locations. The data they produce is taken to computing centres at the Max Planck Institute for radio astronomy and the MIT Haystack Observatory, where special atomic clocks are used to calibrate and combine the data, producing this image.

If one of humanity's goals is to understand nature, then the people behind the Event Horizon Telescope are well on their way. The EHT isn't done yet. There will be more science results coming from the over 200 researchers working on the project.



In anticipation of the first image of a black hole, Jordy Davelaar and colleagues built a virtual reality simulation of one of these fascinating astrophysical objects. Their simulation shows a black hole surrounded by luminous matter. This matter disappears into the black hole in a vortex-like way, and the extreme conditions cause it to become a glowing plasma. The light emitted is then deflected and deformed by the powerful gravity of the black hole. Image Credit: Jordy Davelaar et al./Radboud University/ BlackHoleCam

This first black hole image isn't exactly a surprise, but the EHT may still reveal some surprising things about black holes.

The EHT is focused on two holes: M87* in Virgo, and Sagittarius A*, at the heart of our Milky Way galaxy. They represent two types of black holes. M87* emits jets of material, while Sag. A* doesn't. We don't why.

Images of Sag. A* are still coming, so stay tuned. Maybe the EHT will be able to answer why some black holes emit these relativistic jets, and why some don't.

If you're curious about black holes, and who isn't, then the following video may contain some of the answers you're looking for.

NASA begins outlining roadmap for 2024 moon landing

May 1, 2019 Stephen Clark

Bill Gerstenmaier, head of NASA's human spaceflight programs, speaks April 8 during a meeting at the Space Symposium in Colorado Springs. Credit: NASA/Aubrey Gemignani

A senior NASA official said Tuesday that the Space Launch System, a huge heavy-lift rocket years behind schedule, could launch astronauts on a moon landing mission in 2024 on just its third flight to meet a goal announced last month by Vice President Mike Pence, while commercial companies will be entrusted with more responsibility to develop a lunar lander and a modest mini-space station, or Gateway, in lunar orbit.

The accelerated schedule, which would bring forward a moon landing from 2028 to 2024, is likely to require billions of dollars in additional funding per year, and new authority from lawmakers and the Trump administration, according to officials familiar with planning for a budget proposal NASA expects to soon send to Congress.

Bill Gerstenmaier, head of NASA's human exploration and operations mission directorate, said Tuesday that the space agency is developing a "compelling presentation" for Congress with sufficient technical details on the 2024 moon landing plan to convince lawmakers to support the accelerated schedule, and the supplemental funding needed to make it happen.

"We'll know in the next couple of weeks whether we're successful or not," Gerstenmaier said in a presentation to the National Academies of Sciences, Engineering and Medicine's Space Studies Board.

Gerstenmaier's presentation Tuesday offered more detail on NASA's planning for a 2024 moon landing than the agency has previously disclosed.

"I will tell you it's not easy, and it is not risk-free," he added.

Before Vice President Pence's **March 26 speech** announcing the Trump administration's goal of landing humans on the moon by 2024, NASA's schedule targeted a moon landing in 2028, allowing more time to build out a multi-module space complex in lunar orbit and a landing craft.

Assuming NASA can secure funding to pay for the accelerated moon program, there are numerous technical and schedule hurdles to overcome.

"We recognize that we're going to be challenged, and we're going to have to be prepared to back off some of these requirements in order to achieve schedule," Gerstenmaier said. "That's what we're doing now to see which ones we can trade if we start running into some technical problems."

"The biggest risk is schedule," Gerstenmaier said, adding that Congress must approve a budget with the extra funding by the start of the next fiscal year in October.

"If we're going to do this procurement stuff, I honestly need a budget come Oct. 1," he said.

NASA Administrator Jim Bridenstine is scheduled to testify before a Senate appropriations subcommittee Wednesday afternoon, but it's unclear if he will offer any new details on the budget required for the moon landing initiative.

"What happens when we go to 2024 is all the funding that was out there (for a 2028 lunar landing) … that now all moves forward," Gerstenmaier said. "So you're going to see a lot of budget move into 2020, 2021 and 2022 to allow for that first phase."

"The first piece is we will have to get approval to move that significant amount of work forward," he said. "That's what we're doing with now, is spending an inordinate amount of time building budgets, building plans."

NASA officials have long said the new lunar landing program is not meant to be a redo of the Apollo missions, when six two-man crews reached the moon's surface for stays lasting no more than three days. But the next landing, if achieved in 2024, would have to use existing satellite technology adapted for moon missions.

"I think you're going to see a pretty minimalist kind of mission for that 2024 mission because of the constraints that we've got," Gerstenmaier said.

NASA seeks commercial lunar lander options

The development of a lander may be the most pressing item needed to achieve the 2024 landing goal. Several companies are working on concepts for a human-rated lunar lander, but they have yet to progress to an advanced level of hardware testing.

On Friday, NASA released an updated a procurement notice to solicit integrated lunar lander proposals from industry. The update amended the original procurement notice, released April 8 in the wake of Pence's speech, that outlined NASA's plans to buy individual lander elements, such as a descent stage, ascent stage and a transfer vehicle.

NASA now plans to ask companies to design and build the entire lander, and launch pieces of the spacecraft on commercial rockets to be assembled at the Gateway in the vicinity of the moon, providing "essentially an all-in-one service for landing," Gerstenmaier said. The ascent stage of the lander could be used on multiple landing missions, ferrying crews between the Gateway and the lunar surface.

"It looks like it reasonably fits, by pushing some of this work off to the private sector, rather than us doing all three pieces (of the lander), and then figuring out how to integrate those, this gives us some degrees of freedom," Gerstenmaier said.

The quick change illustrates how quickly NASA officials are upending their previous lunar exploration plans after Pence's announcement, in which he called for new urgency within NASA to land humans on the moon in 2024 "by any means necessary."

This illustration is Lockheed Martin's concept of a two-stage crewed lunar lander that NASA could use to go to the surface of the moon. The ascent module is derived from the Orion spacecraft to ensure quicker development. Credit: Lockheed Martin

NASA announced partnerships last year with nine U.S. companies working on privately-developed robotic moon landers to carry experiments to the lunar surface. The agreements in the Commercial Lunar Payload Services, or CLPS, program are designed to foster technologies on smaller-scale, less risk-averse robotic missions that could feed into bigger spacecraft capable of landing with astronauts.

Gerstenmaier said NASA's experience with the CLPS providers will inform the agency about the readiness of commercial companies to oversee development of a human-rated lander.

"If we find out industry is not really ready to even support 100 kilograms (220 pounds) to the surface of the moon because of maybe hazard avoidance and other things, then that gives us a clue about these bigger procurements for human systems, that maybe we've got to rework our strategy," he said.

In his presentation Tuesday, Gerstenmaier did not discuss any plans for a test of a human-rated lander before the 2024 mission with astronauts.

In order to meet the 2024 schedule, Gerstenmaier repeatedly stressed NASA and its commercial partners will be forced to choose from technology that is available today, not technology that could lay the foundation for a more enduring lunar exploration program.

Instead of a more efficient cryogenic engine, the lander will have to use a throttleable hydrazine-fueled engine, similar to the propulsion system used on the Apollo lunar lander.

“Almost all this hardware that we’re going to use has to be available today,” Gerstenmaier said. “We don’t have a chance to go develop a new engine. Tanks are typically long-lead items. Those tanks are going to have to be available today.”

Avionics and life support systems designed for the Orion crew capsule could be applied to the moon lander, too.

Lockheed Martin, the Orion spacecraft’s lead contractor, unveiled a new human lander concept last month at the Space Symposium in Colorado Springs. Blue Origin, the space company founded by billionaire Jeff Bezos, has teased an announcement next week that is expected to involve a commercial moon lander.

“This urgency of 2024 is going to force us to take and select components moving forward,” Gerstenmaier said.

“But it’s not pretty,” he said. “There will not be a ton of time on the surface for this first flight.”

Lunar landing crew to launch on third SLS/ Orion mission

In his March 26 speech, Pence said NASA should be willing to switch contractors if companies working on elements of the moon landing program underperform. Boeing is the prime contractor on the Space Launch System’s core stage, delays of which NASA has primarily blamed for a series of schedule slips that have pushed back the first SLS test launch from 2017 to late 2020 or early 2021.

The Space Launch System is designed to send Orion crew capsules into deep space, and Gerstenmaier said NASA’s new flight sequence would move up the crewed moon landing to occur on the third SLS/Orion mission, called Exploration Mission-3.

The first SLS/Orion flight, named Exploration Mission -1, will serve as a key test for NASA’s new rocket and a deep space demonstration for the Orion spacecraft in lunar orbit without astronauts on-board.

“We’re probably looking at, best case, probably a late 2020 kind of launch, but probably more likely some time in 2021 (for EM-1),” Gerstenmaier said Tuesday.

Delays in outfitting the SLS core stage’s engine section have been responsible for the rocket’s recent delays. The SLS team in March said the issues were likely to push back the EM-1 launch to 2021, prompting Bridenstine, NASA’s administrator, to order a review of options to launch the Orion spacecraft around the moon in 2020 on a commercial booster.

Artist’s concept of the Space Launch System lifting off from launch pad 39B at NASA’s Kennedy Space Center in Florida. Credit: NASA/MSFC

Engineers identified an option that could couple parts of SpaceX’s Falcon Heavy and United Launch Alliance’s Delta 4-Heavy rockets to lift the Orion capsule to the moon, but Bridenstine said the difficult work to design and develop the new rocket stack would take longer to complete than the Space Launch System.

NASA and Boeing teams have reworked the SLS core stage production schedule to complete some assembly of the 27.6-foot-diameter (8.4-meter), 212 -foot-tall (65-meter) rocket structure in parallel, instead of sidelining some of the integration tasks until the engine section is ready.

“The big rocket is coming together fairly well,” Gerstenmaier said. “The thing that’s been problematic to us is the engine section. That’s the section down at the very bottom of the rocket.”

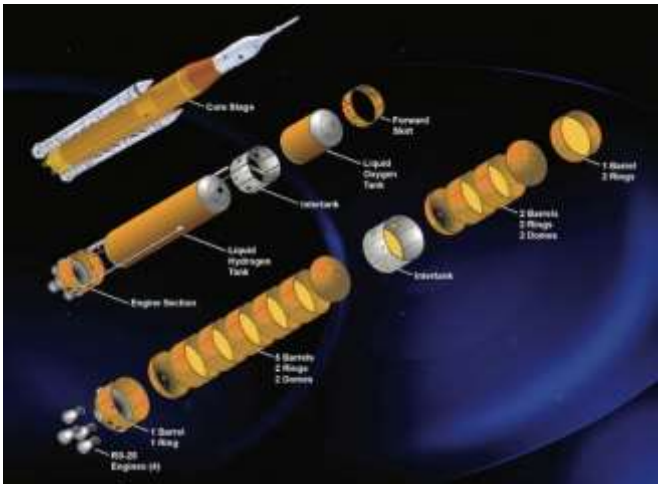
This is all the plumbing and wiring and feed-throughs, the big ducts that come from the hydrogen tank, that come from two big oxygen feed lines … They all go through these big feed likes to feed these engines,” he said.

Four hydrogen-fueled RS-25 engines will power the SLS core stage. The engines are left over from the space shuttle program.

The cramped conditions inside the engine section have proved a challenge for workers.

“Just getting physically inside for the workers … to be in there has slowed down the process in that work,” Gerstenmaier said. “There’s nothing that’s fundamentally wrong. It’s just that I think we misinterpreted how long its going to take to do this work, and the other problem is it’s first-time work.”

Gerstenmaier said the replanned schedule saves three-and-a-half months of time.



The SLS core stage's major components include the engine section, liquid hydrogen tank, the intertank segment, and the liquid oxygen tank. Credit: NASA

Boeing previously planned to connect the core stage's liquid hydrogen tank to engine section vertically, then rotate the assembly horizontally to connect to the intertank, which is already mated with the core stage liquid oxygen tank.

The new plan will see the hydrogen tank horizontally integrated with the intertank and liquid oxygen tank first in the coming weeks at the Michoud Assembly Facility in New Orleans. Once the engine section is ready, it will be installed horizontally to the base of the core stage, instead of in a vertical orientation.

The factory's roof is not high enough to assemble the entire core stage vertically.

"We talked about knocking a hole in the assembly building," Gerstenmaier joked. "That motivated some creative thought on our teams' part when we suggested that … When you're faced with a problem, you give them a ridiculous solution that's so bad that normal human begins cringe at."

Later this year, workers will add the four RS-25 engines, which have completed qualification testing at higher thrust levels than they saw on space shuttle missions.

Gerstenmaier said the core stage should be completed by the end of this year in preparation for shipment via barge to the Stennis Space Center in Mississippi for a full-duration eight-minute firing of the four RS-25 engines on a test stand.

NASA has considered cancelling the "green run" test at Stennis to save time.

"We're looking at either deferring the green run or expediting the green run to look and see if we can save some time," Gerstenmaier said Tuesday.

But the green run test is the only chance for engineers to assess how the core stage will perform through an entire launch sequence, with the engines throttling to different power settings and a checkout of the rocket's pressurization system.

"We could do a shorter duration firing at Florida (on the launch pad) if you wanted to, but then you get a six-second, 10-second kind of firing," Gerstenmaier said. "We'd like to run a little bit longer to actually go through the thrust profile."

Once in Florida, the core stage will be attached to two solid rocket boosters, a cryogenic upper stage derived from ULA's Delta 4 rocket and the Orion spacecraft.

The Lockheed Martin-built crew module and the European-built service module for the EM-1 mission are being readied for launch inside a clean room at the Kennedy Space Center. The Orion sections will be mated this summer before going to a NASA test site in Ohio for testing in the cold, airless environment of space.

If that testing goes according to plan, the Orion spacecraft should be ready to begin its launch campaign in early 2020, but the start of final flight preps will wait until the SLS is delivered to KSC.

Gerstenmaier said the first SLS/Orion flight with astronauts, designated EM-2, could take off in 2022 on a "free return trajectory" around the moon and back to Earth.

Meanwhile, the power and propulsion module and an austere habitat would launch on commercial rockets to dock in lunar orbit to form the Gateway. Elements of the lander would arrive at the Gateway after commercial launches in time for a 2024 landing.

"Then the third (SLS/Orion) flight, you go to Gateway, you meet up with some lander elements, and then you can support a 2024 landing," Gerstenmaier said.

Outline emerges for more modest Gateway

This industry concept for an "early Gateway" in lunar orbit shows the mini-space station's Power and Propulsion Element, a small habitat, the ascent stage of a lunar lander and NASA's Orion spacecraft linked together in lunar orbit. Credit: Lockheed Martin

The new urgency triggered by Vice President Pence in March has raised questions about the utility of the Gateway, the mini-space station NASA originally aimed to build in lunar orbit before mounting a landing expedition.

The Gateway is still a critical piece of NASA's plans, Gerstenmaier said, but the agency's focus now is to launch the first two pieces of the outpost by 2023 to ensure the Gateway can act as a safe haven and staging point for a moon landing mission.

Under the plan outlined Tuesday, a Canadian-built robotic arm, an airlock and refueling module provided by the European Space Agency, and other segments of the Gateway would be deferred after the 2024 moon landing.

There is no commercial rocket currently in service that could launch all the pieces of a lunar lander in one flight, according to Gerstenmaier. That means the lander will be assembled at the Gateway.

NASA is already well along in the procurement of the first Gateway module, called the Power and Propulsion Element, or PPE. The module will have plasma thrusters, a propulsion system using xenon fuel and solar power to maneuver between different orbits around the moon more efficiently than with conventional rocket propellants.

Multiple companies have submitted bids to build the PPE, and Gerstenmaier said NASA is on track to select a contractor for the module this summer. The Gateway's core module was initially expected to launch on an SLS flight, but NASA asked proposers interested in building the PPE to arrange to launch the spacecraft on a commercial heavy-lift rocket.

The winner of the PPE contract, which is framed as a commercial procurement, will deliver the module to NASA in space.

"The Power and Propulsion Element would in orbit around the moon in December of 2022," Gerstenmaier said.

That will be followed by another Gateway module that doubles as basic living quarters for astronauts and a docking connector for a lunar lander. Five companies have developed habitat module prototypes for ground testing, and Gerstenmaier said NASA aims to select a commercial builder for the Gateway's habitat module by December, in time for a launch — also on a commercial rocket — in 2023.

"It fits on paper," Gerstenmaier said. "The challenge will be to industry."

E Mails Viewings Logs and Images from Members.

Hi Andy.

I have responded to Joy and ask if mention could be in your news letter for Tuesday the telescope was purchased 2000/1.

Keith

Subject: Telescope

Dear Mr Bruton,

My husband, Ivan Sverdloff, was a member of the WAS at Seend for a couple of years and regrettably I recently notified the Society of his passing on 29 March after a short and very aggressive illness.

My reason for contacting you is that he had a Meade 10" Schmidt Cassegrain Telescope with a tracker and various other additional equipment, which despite his having it for several years has never really been used. It is currently assembled outside under a purpose made cover as he had planned to finally try it out during the darker winter nights but sadly was too ill to do so. As I plan to move nearer to family in the not too distant future I need to find a new home for this large item but before advertising it I wondered whether it may be of interest to any of the WAS members? If anyone is interested in looking at it I can be contacted on 07787 547961 or joy.sverdloff@gmail.com. I have no idea of its current value although I do know that it cost approx.£4,000 new in 2000/2001 as it was purchased with a legacy from his Dad.

Regards,

Joy Sverdloff

Hi Andy,

Here are my submissions for the May WAS newsletter.

From my tour of Australia a view from the Australian night sky at Kangaroo Island an image of the "Emu in the Sky" and the Southern Cross. This is part of Aboriginal culture/folklore in Australia. The Aborigines used the position of the "Emu in the sky" to indicate when they could collect Emu eggs for food. It is defined by dark nebulae that are visible against the Milky Way background. The Emu's head is the very dark Coalsack nebula, next to the Southern Cross; the body and legs are other dark clouds trailing out along the Milky Way to Scorpius. Canon G16, 28mm, F1.8, 15 sec, ISO 800.

I did hope to get more Australian night sky images but I was defeated by weather. Even the night sky at Uluru (Ayer's Rock) was cloudy and a lot of light pollution at the resort when I was there!

A rare sunspot at the moment - 11/04/2019 Sunspot AR2738

Canon SX50HS, 1800mm (50x Optical and 25 x Digital), ISO 100, F8, 1/1600 sec.

20/04/2019

A very orange Moonrise looking more like Sunrise (99.4% Waning Moon). The second of the images shows Spica and Arcturus. Taken at the lake at Center Parcs, Longleat.

Canon G16, 28mm, ISO 400, F1.8, 6 and 4 sec.

Clear Skies,

John Dartnell

Viewing Log for 10th of April

I had a free evening and as the sky was clear should I go out and do some viewing or play Chess instead (usual thing for me on Wednesday evenings, viewing won!).

I arrived at my usual viewing spot of Uffcott just south of Swindon off the A4361 and started setting up at 20:50. When I was at the recent Practical Astronomy Show I brought a new 9 x 50 finder scope which I was going to fit to my Meade LX90 GOTO telescope. At fitting the finder scope I had to align the finder scope with the telescope, I choose Polaris as it was part of my initial set up. Once sorted, for a change I decided I would use my 13 mm Tele Vue Ethos eye piece instead of the Pentax eye pieces, this required a second weight on the balance arm to keep everything in check. Going to my second star alignment, the telescope choose Arcturus and should have slewed to the right, for some reason it went left, what! Was my reaction? Switched off the scope and redid the set-up, same thing happen, it went left; it also did it a third time! Something was mighty wrong with the telescope? I decided to do a manual set up, no GPS fix. Checking the time, it was pretty close but the date was like over 80 years out! It said the date was 29/8/2099 and not 10/4/2019, this had me totally confused! Anyway I changed the date to the correct one and did the set up and this time it went right!

Totally baffled by what happened with my set up, I was finally ready to do some viewing at 21:25. As I had started my Messier marathon list last time out I thought I would carry on from where I had left off and number 34 on the list and the first object in Ursa Major was M81 a nice Spiral galaxy (S G) with a bright core, not far away is M82 which is long and thin to view, this time an Irregular Galaxy. Once my nemesis, M97 the Owl Nebula could just be made out even though it was right overhead. M108 a very faint S G was hard to make out, like its neighbour M109, I had to use adverted vision to confirm it? Both of these are S G's. The double star that makes up M40, probably the most boring object on this list? Over the border and into Canes Venatici and M106 a Fuzzy Blob (F B) to look at, its friend the Sunflower galaxy (M63) was harder to see, I thought this was a Faint Fuzzy Blob (F F B) to look at? Back into Ursa Major and M51, the Whirlpool Galaxy, this had a bright core and I think I saw the other smaller galaxy attached to it? M101 is a large S G and has a bright surface but comes across as an F B due to the brightness over such a larger area. Some people say M102 is a duplication of M101 but some lists have it in Draco, to me the one in Draco was an F B to see. Into Coma Berenices and galaxy areas, this is where you galaxy hop and not star hop if using the older method of finding deep sky objects. First on the list is M53, not a galaxy but a nice small Globular Cluster (G C), the Black-Eye galaxy (M64) was large and reasonably bright to look at. M3 is a very nice G C to look at and is similar to M13 in brightness, M3 is 6.4 and M13 is 5.9 in mag? M98 an S G was hard to locate. Both M99 and M100 were F F B's to look at and I had to use adverted vision to nail 100. My final object for this evening was M85, a faint Elliptical gal-

axy. I would be coming back into Coma after viewing the odd galaxy in Virgo; this was my plan for the third part of my marathon plans.

It was now 22:59 and time to pack up, the evening temperature was reasonable at 7 °C and with no wind made it a good night apart from the major problem in setting up my telescope using GPS technology!

Clear skies.

Peter Chappell

The following evening

As I am a member of Stargazers lounge I thought I would ask the question about the GPS giving me the wrong date. I got several answers back about this problem and it is known! This is what a fellow member said about the problem: This is related to the week number roll over of satellites! This happens every 1024 weeks and the last time this happened was in 1999? A new patch has been released, so for me to fix this problem I will have to connect my telescope to computer and download the patch and hopefully be then able to carry on using my GPS system on the telescope. Newer GPS systems do not have this fault as they have already been sorted out, whether I have this problem in 19 years, only time will tell J?

(Editors note - I have been encountering a similar problem with Deep Sky objects using the Synscan Skywatcher controller paddle for the EQ8 in Spain. Tony Vale noted a similar issue before I went. It could find bright stars to star align no problem, but then key in a deep sky object or solar system and it went very wrong. A temporary fix is the align on a star in the region of the objects being sought and then find deep space objects from that. Not quite perfect depending on distance from index star but it works. The full fix is to upload the latest software download from the web site and reflash the memory.

Annoying when you are using 4G on your phone to access the internet so I will be doing this from home and taking out a lap top and a refreshed Synscan with me in September. Meanwhile Tony will have to use the single star align.

One tool that has proved invaluable is the Polemaster camera and software from QHY. One 15 minute session on each of the mounts in Spain and I was tracking without a guide scope for over 10minutes on very southerly sky objects with no trailing! Brilliant bit of kit.)

Viewing Log for 13th of April

I had been asked by fellow WAS member Ian Pass if I could bring my telescope down to Bath for an evening's viewing for the local Girl Guides of which his daughter is a member of. I had been given the address which turned out to be a field on the northern edge of Bath.

On the way down the sky did not look that great but I carried on and arrived to find Ian and Kristen (his wife) already outside with a couple of telescopes looking at the Moon thru high thin cloud. I set up my telescope (Meade LX90 GOTO with 14 mm XW Pentax eye piece) ready for viewing but could not complete the set up as it was not dark enough for me to locate Polaris and do the alignment checks! So we had a quite a few keen girls wanted to look at the night sky which still had a lot of light in it, best I could do was show them Arcturus in Bootes and keep adjusting the scope manually until it become dark enough. I did explain to the crowd what this star was; the brightest in the northern hemisphere and 4th brightest in the whole night sky? After a while Ian took the whole crowd inside and explains about meteors. This gave me a chance finally to go thru my complete set up, I was ready by 21:00 and the air temperature was 4 °C, now all I needed was some customers so I could show them some night sky delights!

M42 was only just above the building which Ian and the guides were in, with the horizon still not totally dark I could not really make out much detail! So I went across to Mars and waited until everybody came out. Mars is the only planet (apart from the Earth) currently on show, got a few interested people looking at this planet. After that it was a case of showing the people various items in the sky including open clusters, globular clusters, galaxies and double stars. I started with M38 in Auriga, a nice open cluster; again the sky did not help showing this object? Slewed around to M3, one of the better glob's on show before heading off to M51 for the galaxy option. I even managed to make out the spiral arms of M51 which I had never seen before? Off to a good double star and Mizar and Alcor in Ursa Major. Ian asked if I could find M31 which I thought might be too low and yes it was, behind a hedge row! Went to Castor in Gemini, this is a tight double star before finishing on the Moon and killing my vision for the evening!

Started packing up my telescope at 22:10 as all of the customers had gone to bed. The evening I think had great interest for the children, hopefully some of it will rub off? I was given an Astronomy badge for my efforts that evening J.

Clear skies.

Peter Chappell

Viewing Log for 25th April

All morning I had spent working around the house and mid-afternoon I went out for a game of golf. At the start of the game, there were a few clear patches but most of the sky had clouds but it should get better as the day went on, only time will tell there? By the time we had finished the game and was enjoying a beer at the 19th hole, the sky had cleared quite a lot J, so I thought I would go out and do some more viewing. As I had started going thru the Messier list it made sense to carry on with my Messier marathon, now part 3.

I arrived at my usual viewing place of Uffcott just south of Swindon off the A4361 and started setting up. This time I manually set up my Meade LX90 as the GPS system was still down (I have since leant there is a fix for it, need to put telescope in comm's with computer for that?) and had everything sent up and ready by 21:34. Temperature when I started was 8 °C with no wind present, earlier in the day there had been a fairly strong wind which calmed down during my game of golf. This time I would be using the 20 mm Pentax XW eye piece, giving me mag of 100 on the telescope. While looking at my

first object which was Mars, still hanging in the western sky, the third car of the evening came up but this time slowed up and actually stopped in the layby! I was thinking my night vision would be lost but the headlights were then switched off and out popped Peter Eslick. He was surprised to see me and I was to see him? He had a new toy and wanted to try it out, turns out it was a new tracking mount which he would put his camera on and getting longer pictures of the night sky and hopefully remove star trail? I am sure there are pictures of his efforts elsewhere within this magazine? As usual Mars was not giving anything away tonight, being only 4 arc seconds in diameter and about 1.5 AU away?

Now onto the marathon and the first object (of 12) in Virgo (only Sagittarius has more with 15) and M84 an Elliptical Galaxy (E G), this looked like a Fuzzy Blob (F B) to view, also in the same field of view was M86 which I did not notice until I moved the telescope to it, another E G and yes a F B! M87 is probably the brightest of all the galaxies within the Virgo area, it was an F B but looked larger than the other two I had just looked at? M89 was my first real Faint Fuzzy Blob (F F B) to look at and yes it was yet another E G. M90 is a Spiral Galaxy (S G) which is the least popular of objects I like to look at, normally very dull and no detail to see? Now over the border and into Coma Berenices and look at M88, a faint fuzzy S G. The final object in this constellation is M91 another S G! One thing I noticed how clear some of these galaxies were to look at, I guess the rains earlier in the day had cleared the sky of dust? Back into Virgo for the next six objects and start with M58 an F B, S G. M59 and M60 were seen in the same field of view, I thought M60 looked the brighter of the two and the charts agreed with me, mag 9.8 to 8.8 both of these are E G's. M49 was another E G but had a bright centre. M62 which was an S G also looked like an F B. By far the best of the Messier objects in Virgo is M104 (the Sombrero Galaxy), this is located far away from the Realm of the other Galaxies within Virgo, it is not far from the border of Corvus. It looked quite good tonight, might even say it is the best I have ever seen it from this country? Now into a constellation I never really look at and Hydra as it is very close to the southern horizon from Uffcott, within this constellation is M68 the first Globular Cluster (G C) since M79 in Lepus. This G C looked dull to look at, probably looking thru a lot of atmosphere? Much lower down at – 29 ° Dec is M83, I had to use adverted vision to pick out this F F B, S G and just above a cloud bank I think I was lucky to find it? I was now climbing the sky a bit and found M5 a very nice G C which could give M13 a hunt for being the best in the northern hemisphere? Next object on the list was M13 in Hercules and yes it is slightly bigger and only 0.1 mag less in brightness. Both of them are fine G C's to look at, if I had a bigger scope I might be able to start to pick out stars from these clusters? The other G C in Hercules is M92 which often gets overlooked for M13, this G C had a bright centre. My final objects in the marathon were in Lyra which was close to the eastern horizon and light from Swindon could affect the viewing. These objects were M57, the Ring Nebula and M56 a faint G C.

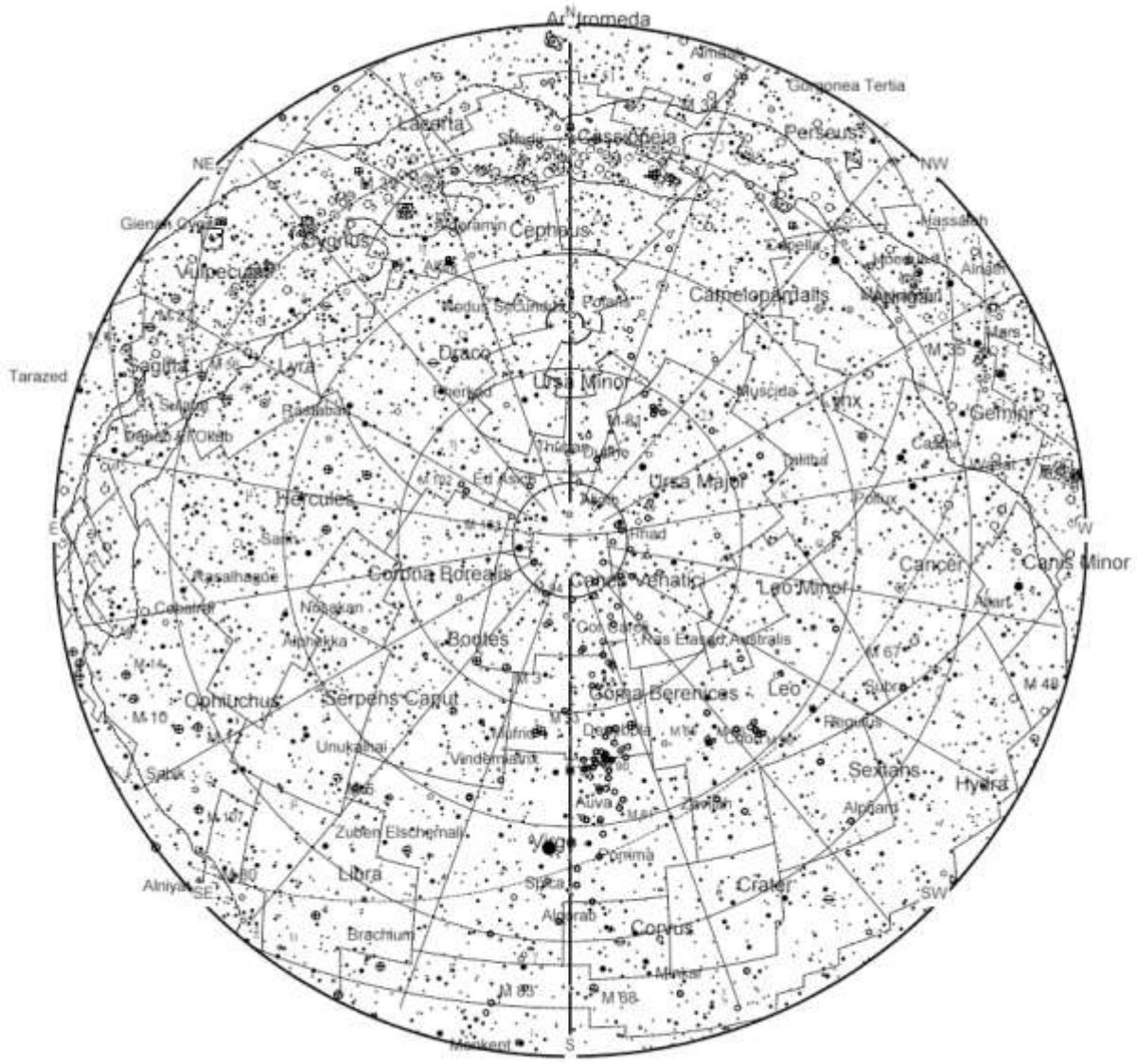
I was thinking of packing up as Peter's camera had packed up, dead battery! But I thought is there any Caldwell (C) objects I could look at, there was still about six I have not seen from these shores? On my list is C 60 and C 61 the Antennae galaxies in Corvus, as I had already been further south tonight in finding M68 I should be able to find these two? I had to move the scope left and right, up and down to find these objects, I was not sure if they were there but something did move, so using adverted vision I can say I found them, I think? I had ago at C66 which is in Hydra but came up with nothing. Will have to try another night for that one or go further south!

It was now 23:00 and time to pack everything up and go home. It was nice having company for the evening with Peter Eslick, it made the night go much quicker. By the time I got back into the car, the temperature had only dropped to 7 °C but there was a reasonable presents of dew which meant all equipment used that night would need drying over night before putting away for storage.

Clear skies.

Peter Chappell

WHATS UP, MAY 2019



May 6, 7 - **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 May 6 and the morning of the May 7. The thin crescent moon will set early in the evening leaving dark skies for what should be a good show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Aquarius, but can appear anywhere in the sky.

May 18 - **Full Moon, Blue Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 21:11 UTC. This full moon was known by early Native American tribes as the Full Flower Moon because this was the time of year when spring flowers appeared in abundance. This moon has also been known as the Full Corn Planting Moon and the Milk Moon. Since this is the third of four full moons in this season, it is known as a blue moon. This rare calendar event only happens once every few years, giving rise to the term, “once in a blue moon.” There are normally only three full moons in each season of the year. But since full moons occur every 29.53 days, occasionally a season will contain 4 full moons. The extra full moon of the season is known as a blue moon. Blue moons occur on average once every 2.7 years.

May 19th—Mars is close to M35 c;luster in the evening sky

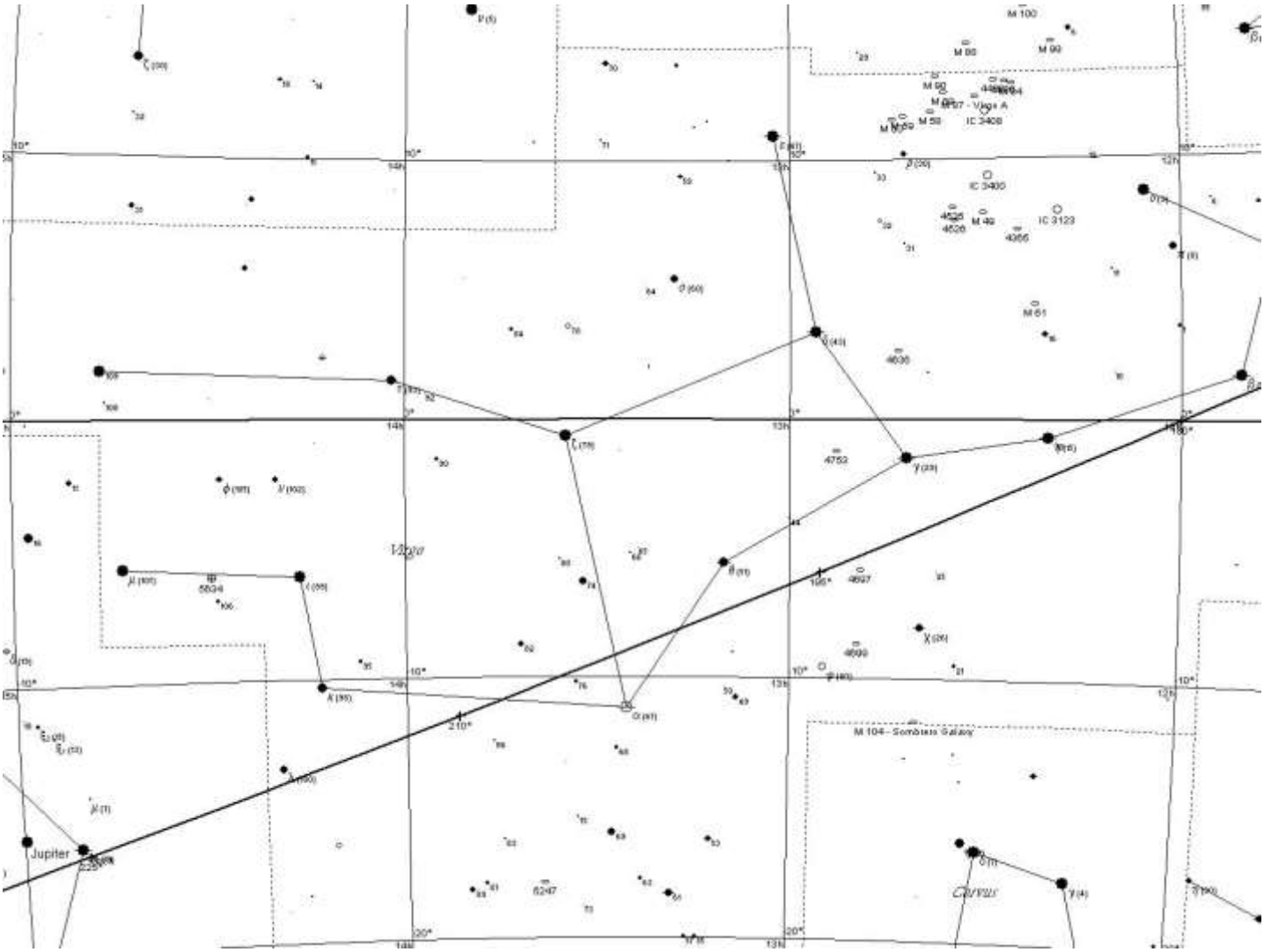
May 20th Moon rises close to Jupiter late evening.

May 23rd M<oon is close to Saturn morning.

May 29th Mercury becomes a visible evening object.

June 3 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 10:02 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

CONSTELLATIONS OF THE MONTH: VIRGO



As one of the zodiacal signs, Virgo resides directly on the ecliptic plane and was one of the original 48 constellations charted by Ptolemy. It spans 1294 degrees and is the second largest constellation in the sky. Virgo also contains the point where the celestial equator crosses the ecliptic plane – the the autumn equinox. Between 9 and 15 stars make up its asterism and it contains 96 Bayer Flamsteed designated stars within its confines. Virgo is bordered by the constellations of Bootes, Coma Berenices, Leo, Crater, Corvus, Hydra, Libra and Serpens Caput. It is visible to all observers located at latitudes between +80° and ?80° and is best seen at culmination during the month of May.

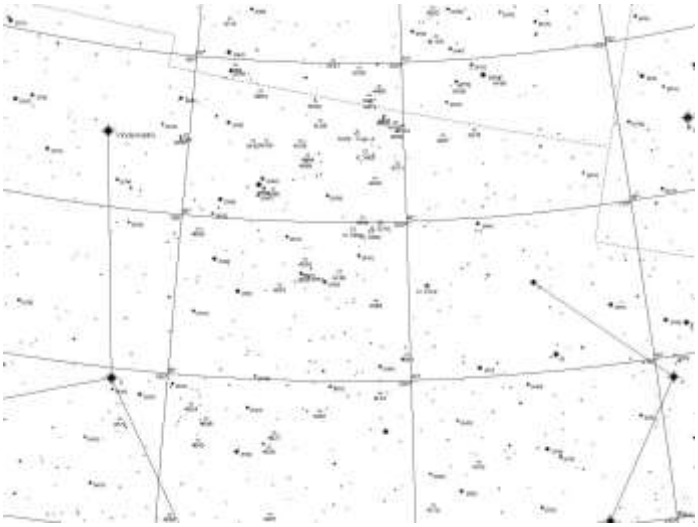
There are two annual meteor showers associated with constellation Virgo. The Virginids peak on or about April 10th of each year and will appear to come from a point in the sky near Gamma. This is a relatively active and predictable meteor shower and you can expect to see about 10 meteors per hour on the average during a dark night from a dark location. The second is the Mu Virginids, which peak on or about April 25th. This is also a fairly reliable meteor shower and you can expect to see 7 to 10 meteors per hour on the average coming from an area near the Virgo/Leo border.

In mythology, Virgo is meant to represent the “Virgin”, but who exactly this woman is has never been established – only that she plays an important cultural role. Virgo is often portrayed carrying two sheaves of wheat, one of which is marked by the bright star Alpha – Spica – and it is the only astrological sign represented by a female. Perhaps she is Astraea, the virgin daughter of Zeus who was known as the goddess of justice. After all, Libra, the scales of justice is nearby!

Let’s begin our tour of Virgo with its brightest star – Alpha – the “a” symbol on our map. Alpha Viriginis is best known as Spica. Located 262 light-years away from Earth, 1.0 magnitude Spica glows with the combined light of four unresolved stars and has a visual luminosity 2100 times that of the Sun. As a rotating ellipsoidal variable, the four stars cause complex changes in luminosity by distorting the shape of the brightest components. The dominant star – Spica A – has a mass 11 times that of the Sun and fluctuates in physical size as it varies in brightness. The primary star is at maximum when smallest, giving it the highest photospheric surface temperature. Spica B has a mass of 7 suns. As a spectral type B, these two components produce more light in ultraviolet due to exceedingly high surface temperatures. Spica has two distant telescopic companions – magnitude 12 to the north-northeast, and magnitude 10.5 to the east-northeast.

Now head towards Beta – the “B”. Named Zavijava (sounds like something you’d get at Starbuck’s doesn’t it?) and located about 36 light years away from our solar system, this star holds a very special place in history because of its position in the sky. Since it is so near the ecliptic plane, it can frequently be occulted by the Moon, occasionally a planet, and even the Sun. In Zavijava’s case, it had the honor of being the star Einstein used during the solar eclipse of September 21, 1922 to determine the speed of light in space! What’s more, according to studies, Beta Virginis could host two or three Jupiter-sized planets – either brown dwarf stars in wide orbits or true planetary objects.

Ready for Gamma Virginis? That’s the “Y” symbol. Best known as Porrima, this binary star of nearly matched magnitudes was an easy object for amateur astronomers, but now



the smaller apparent distance between the stars requires a larger telescope. Because of its relatively quick orbital period of 168.93 years, you'll sometimes hear Porrima referred to as the "Shrinking Star". At the time of this writing (early 2009), the pair is only separated by about .04″ and it will be another 11 years before they have moved apart enough again to be easily split with a small telescope!

Because there are massive amounts of deep sky objects in Virgo, annotating a map would be so cluttered it would be difficult to read. Let us begin first with the chart we have above which highlights the brighter objects in Virgo – ones easily seen with binoculars and small telescopes. Ready to dance?

Our first target will be Messier 104 (RA 12 : 40.0 Dec -11 : 37). Now, shake your fist at Spica… Because that's all it

takes to find the awesome M104, eleven degrees due west. (If you still have trouble finding M104, don't worry. Try this trick! Look for the upper left hand star in the rectangle of Corvus – Delta. Between Spica and Delta is a diamond-shaped pattern of 5th magnitude stars. Aim your scope or binoculars just above the one furthest south.) Also known as the "Sombrero Galaxy" this gorgeous 8th magnitude spiral galaxy was discovered by Pierre Mechain in 1781, added by hand to Messier's catalog and observed independently by William Herschel as H I.43 – who was probably the first to note its dark inclusion. The Sombrero's rich central bulge is comprised of several hundred globular clusters and can be hinted at in just large binoculars and small telescopes. Large aperture telescopes will revel in this galaxy's "see through" qualities and bold, dark dustlane – making it a seasonal favorite!

Now, let's take a look at one of the brightest members of the Virgo Cluster – Messier 49. Located about eight degrees northwest of Delta Virginis almost directly between a pair of 6th magnitude stars (RA 12 29 46 Dec +07 59 59), the giant elliptical galaxy M49 holds the distinction of being the first galaxy in the Virgo cluster to be discovered – and only the second beyond our local group. At magnitude 8.5, this type E4 galaxy will appear as an evenly illuminated egg shape in almost all scopes, and as a faint patch in binoculars. While a possible supernova event occurred in 1969, don't confuse the foreground star noted by Herschel with something new! Although most telescopes won't be able to pick this region apart, there are also many fainter companions near M49, including NGC 4470. But a sharp-eyed observer named Halton Arp noticed them and listed them as Peculiar Galaxy 134 – one with "fragments!"

Next up, Messier 87 (RA 12 : 30.8 Dec +12 : 24). It's a radio-source galaxy so bright it can be seen in binoculars – 8.6

magnitude M87, about two fingerwidths northwest of Rho Virginis. This giant elliptical galaxy was discovered by Charles Messier in 1781 and cataloged as M87. Spanning 120,000 light-years, it's an incredibly luminous galaxy containing far more mass and stars than the Milky Way Galaxy – gravitationally distorting its four dwarf satellites galaxies. M87 is known to contain in excess of several thousand globular clusters – up to 150,000 – and far more than our own 200.

In 1918, H. D. Curtis of Lick Observatory discovered something else – M87 has a jet of gaseous material extending from its core and pushing out several thousand light-years into space. This highly perturbed jet exhibits the same polarization as synchrotron radiation – a property of neutron stars. Containing a series of small knots and clouds as observed by Halton Arp at Palomar in 1977, he also discovered a second galaxy jet in 1966 erupting in the opposite direction. Thanks to these two properties, M87 made Arp's "Catalog of Peculiar Galaxies" as number 152. In 1954 Walter Baade and R. Minkowski identified M87 with radio source Virgo A, discovering a weaker galactic halo in 1956. Its position over an x-ray cloud extending through the Virgo cluster make M87 a source of an incredible amount of x-rays. Because of its many strange properties, M87 remains a target of scientific investigation. The Hubble Space Telescope has shown a violent nucleus surrounded by a fast rotating accretion disc, whose gaseous make-up may be part of a huge system of interstellar matter. As of today, only one supernova event has been recorded – yet M87 remains one of the most active and highly prized study galaxies of all. Capture it tonight!

Now we're heading for our more detailed map and the galaxy fields of Virgo about four fingerwidths east-southeast of Beta

Leonis. As part of Markarian's Chain, this set of galaxies can all be fitted within the same field of view with a 32mm eyepiece and a 12.5″ scope, but not everyone has the same equipment. Set your sights toward M84 and M86 and let's discover!

Good binoculars and small telescopes reveal this pair with ease as a matched set of elliptical galaxies. Mid-sized telescopes will note the western member of the pair – M84 – is seen as slightly brighter and visibly smaller. To the east and slightly north is larger

M86 – whose nucleus is broader, and less intensely brilliant. In a larger scope, we see the galaxies literally "leap" out of the eyepiece at even the most modest magnifications. Strangely though, additional structure fails to be seen. As aperture increases, one of the most fascinating features of this area becomes apparent. While studying the bright galactic forms of M84/86 with direct vision, aversion begins to welcome many other mysterious strangers into view. Forming an easy triangle with the two Messiers and located about 20 arc-minutes south lies NGC 4388. At magnitude 11.0, this edge-on spiral galaxy has a dim star-like core to mid-sized scopes, but a classic edge-on structure in larger ones.

At magnitude 12, NGC 4387 is located in the center of a triangle formed by the two Messiers and NGC 4388. NGC 4387 is a dim galaxy – hinting at a stellar nucleus to smaller telescopes, while the larger ones will see a very small face-on spiral galaxy with a brighter nucleus. Just a breath north of M86 is an even dimmer patch of nebulosity – NGC 4402 – which needs higher magnifications to be detected in smaller scopes. Large apertures at high power reveal a noticeable dust lane. The central structure forms a curved "bar" of light. Luminosity appears evenly distributed end to end, while the dust lane cleanly separates the central bulge of the core. East of M86 are two brighter NGC galaxies – 4435 and 4438. Through average scopes, NGC 4435 is easily picked out at low power with a simple star-like core and wispy round body structure. NGC 4438 is dim, but even large apertures make elliptical galaxies a bit boring. The beauty of NGC 4435 and NGC 4438 is simply their proximity to each other. 4435 shows true elliptical structure, evenly illuminated, with a sense of fading toward the edges… But 4438 is quite a different story! This elliptical galaxy is much more elongated. A highly conspicuous wisp of galactic material can be seen stretching back toward the brighter, nearby galaxy pair M84/86.

Ready for bright galaxy Messier 58 (RA 12 : 37.7 Dec +11 : 49)? It's a spiral galaxy actually discovered by Messier in 1779! As one of the brightest galaxies in the Virgo cluster, M58 is one of only four that have barred structure. It was cataloged by Lord Rosse as a spiral in 1850. In binoculars, it will look much like our previously studied ellipticals, but a small telescope under good conditions will pick up the bright nucleus and a faint halo of spiral galaxy structure – while larger ones will see the central concentration of the bar across the core. Chalk up another Messier study for both binoculars and telescopes and let's get on to something really cool!

Around a half degree southwest are NGC 4567 and NGC 4569. L. S. Copeland dubbed them the "Siamese Twins," but this galaxy

pair is also considered part of the Virgo cluster. While seen from our viewpoint as touching galaxies, no evidence exists of tidal filaments or distortions in structure, making them a line of sight phenomenon and not interacting members. While that might take little of the excitement away from the "Twins," a supernova event has been spotted in NGC 4569 as recently as 2004. While the duo is visible in smaller scopes as two, with soft twin nuclei, intermediate and large telescopes will see an almost V-shaped or heart-shaped pattern where the structures overlap. If you're doing double galaxy studies, this is a fine, bright one! If you see a faint galaxy in the field as well, be sure to add NGC 4564 to your notes. Moving about a degree north will call up face-on spiral galaxy M89, which will show a nice core region in most telescopes. One half degree northeast is where you will find the delightful 9.5 magnitude M90 – whose dark dust lanes will show to larger telescopes.

Virgo contains many, many more fine objects – so be sure to get a detailed star chart and spend some time with this great constellation!

Sources:
Wikipedia
SEDS
Chandra Observatory

ISS PASSES For March/Early April 2019 From Heavens Above website maintained by Chris Peat

Date	Brightness (mag)	Start			Highest point			End		
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
06 May	-3.0	04:00:09	21°	SSW	04:01:53	38°	SSE	04:05:00	10°	E
07 May	-2.6	03:10:47	27°	SSE	03:10:55	27°	SSE	03:13:46	10°	E
07 May	-3.8	04:43:53	10°	WSW	04:47:12	79°	SSE	04:50:31	10°	E
08 May	-1.4	02:21:23	14°	ESE	02:21:23	14°	ESE	02:22:21	10°	E
08 May	-3.7	03:54:05	21°	WSW	03:56:07	62°	SSE	03:59:23	10°	E
09 May	-3.5	03:04:39	43°	S	03:05:03	45°	SSE	03:08:15	10°	E
09 May	-3.8	04:38:12	10°	W	04:41:31	86°	N	04:44:51	10°	E
10 May	-2.2	02:15:10	25°	ESE	02:15:10	25°	ESE	02:17:02	10°	E
10 May	-3.9	03:47:52	16°	WSW	03:50:22	85°	S	03:53:41	10°	E
11 May	-1.0	01:25:39	10°	E	01:25:39	10°	E	01:25:41	10°	E
11 May	-3.9	02:58:20	43°	SW	02:59:14	71°	SSE	03:02:32	10°	E
11 May	-3.8	04:32:29	10°	W	04:35:48	86°	N	04:39:07	10°	E
12 May	-3.5	02:14:26	51°	SE	02:14:26	51°	SE	02:17:17	10°	E
12 May	-3.8	03:47:13	10°	W	03:50:33	85°	N	03:53:52	10°	E
13 May	-1.8	01:25:05	20°	E	01:25:05	20°	E	01:26:20	10°	E
13 May	-3.9	02:57:47	24°	W	02:59:38	88°	N	03:02:57	10°	E
13 May	-3.8	04:32:55	10°	W	04:36:13	75°	SSW	04:39:32	10°	ESE
14 May	-4.0	02:08:23	70°	SW	02:08:42	81°	S	02:12:02	10°	E
14 May	-3.9	03:41:59	10°	W	03:45:18	88°	S	03:48:37	10°	E
15 May	-2.8	01:18:55	37°	E	01:18:55	37°	E	01:21:05	10°	E
15 May	-3.8	02:51:37	14°	W	02:54:22	85°	N	02:57:41	10°	E
15 May	-3.6	04:27:39	10°	W	04:30:52	50°	SSW	04:34:05	10°	SE
16 May	-1.6	00:29:20	16°	E	00:29:20	16°	E	00:30:08	10°	E
16 May	-3.9	02:02:01	32°	W	02:03:24	85°	N	02:06:44	10°	E
16 May	-3.9	03:36:41	10°	W	03:39:59	67°	SSW	03:43:16	10°	ESE
17 May	-3.9	01:12:10	73°	WSW	01:12:27	88°	S	01:15:46	10°	E
17 May	-3.9	02:45:43	10°	W	02:49:03	82°	S	02:52:22	10°	ESE
17 May	-2.9	04:22:26	10°	W	04:25:22	29°	SSW	04:28:18	10°	SSE
17 May	-2.6	22:42:31	10°	SSW	22:48:06	9°	E	22:44:47	23°	SSE
18 May	-4.0	00:18:11	10°	WSW	00:21:29	74°	SSE	00:24:48	10°	E
18 May	-3.9	01:54:45	10°	W	01:58:04	88°	N	02:01:23	10°	E
18 May	-3.5	03:31:23	10°	W	03:34:32	42°	SSW	03:37:40	10°	SE
18 May	-2.2	21:52:20	10°	S	21:54:28	16°	SE	21:56:37	10°	E
18 May	-3.8	23:27:18	10°	WSW	23:30:32	57°	SSE	23:33:48	10°	E
19 May	-3.9	01:03:46	10°	W	01:07:05	85°	N	01:10:24	10°	E
19 May	-3.8	02:40:21	10°	W	02:43:37	58°	SSW	02:46:53	10°	ESE
19 May	-2.2	04:17:32	10°	W	04:19:43	16°	SW	04:21:53	10°	S
19 May	-3.4	22:36:30	10°	SW	22:39:38	41°	SSE	22:42:47	10°	E
20 May	-3.9	00:12:46	10°	W	00:16:05	88°	NNW	00:19:24	10°	E
20 May	-4.0	01:49:21	10°	W	01:52:40	75°	SSW	01:55:59	10°	ESE
20 May	-2.7	03:26:11	10°	W	03:28:55	24°	SSW	03:31:40	10°	SSE
20 May	-2.9	21:45:50	10°	SSW	21:48:45	29°	SSE	21:51:40	10°	E
20 May	-3.9	23:21:46	10°	WSW	23:25:04	82°	S	23:28:24	10°	E
21 May	-3.9	00:58:21	10°	W	01:01:40	88°	S	01:03:45	21°	E
21 May	-2.1	02:35:01	10°	W	02:36:21	20°	W	02:36:21	20°	W
21 May	-3.9	22:30:48	10°	WSW	22:34:05	66°	SSE	22:37:23	10°	E
22 May	-3.8	00:07:20	10°	W	00:10:39	85°	N	00:13:24	14°	E
22 May	-2.9	01:43:56	10°	W	01:46:05	33°	WSW	01:46:05	33°	WSW

22 May	-3.8	23:16:17	10°	W	23:19:37	85°	N	23:22:56	10°	E
23 May	-3.9	00:52:53	10°	W	00:56:11	66°	SSW	00:56:19	65°	S
23 May	-3.8	22:25:15	10°	W	22:28:33	88°	S	22:31:53	10°	E
24 May	-3.9	00:01:50	10°	W	00:05:10	82°	S	00:06:43	29°	ESE
24 May	-1.6	01:38:33	10°	W	01:39:24	16°	W	01:39:24	16°	W
24 May	-3.8	23:10:47	10°	W	23:14:07	88°	NNE	23:17:11	12°	E
25 May	-3.0	00:47:24	10°	W	00:49:53	36°	WSW	00:49:53	36°	WSW
25 May	-3.8	22:19:42	10°	W	22:23:02	85°	N	22:26:21	10°	E
25 May	-3.8	23:56:18	10°	W	23:59:34	58°	SSW	00:00:23	42°	SE
26 May	-3.9	23:05:13	10°	W	23:08:32	75°	SSW	23:10:54	17°	ESE
27 May	-2.0	00:42:01	10°	W	00:43:36	20°	WSW	00:43:36	20°	WSW
27 May	-3.8	22:14:08	10°	W	22:17:27	88°	S	22:20:46	10°	E
27 May	-3.1	23:50:46	10°	W	23:53:51	35°	SSW	23:54:09	34°	SSW
28 May	-3.5	22:59:36	10°	W	23:02:50	49°	SSW	23:04:44	21°	SE
29 May	-1.2	00:37:09	10°	WSW	00:37:26	11°	WSW	00:37:26	11°	WSW
29 May	-3.8	22:08:29	10°	W	22:11:47	66°	SSW	22:15:04	10°	ESE
29 May	-2.2	23:45:26	10°	W	23:47:57	20°	SW	23:48:01	20°	SW
30 May	-2.7	22:54:04	10°	W	22:57:00	29°	SSW	22:58:38	19°	SSE
31 May	-3.2	22:02:50	10°	W	22:05:59	42°	SSW	22:09:08	10°	SE
31 May	-1.3	23:41:09	10°	SW	23:41:53	11°	SW	23:41:58	11°	SW
01 Jun	-1.8	22:48:49	10°	W	22:51:00	16°	SW	22:52:38	12°	S
02 Jun	-2.2	21:57:17	10°	W	22:00:02	24°	SSW	22:02:47	10°	SSE

Amazingly so many opportunities to see the ISS through May to the2nd of June…
But in June no more sightings, until July 4th!

END IMAGES, OBSERVING AND OUTREACH

How low can you go? From the Griffon educational observatory I was always aware that getting down into Centaur constellation would be possible in the late Spring. When I went this time, I was able to set up and see too the south from the terrace pier mounted telescope just before into went into a very fast growing false pepper tree. Then the alignment issues of the main dome mounting where resolved using the very affective Pole-Master mounted camera and software (not the current of access finder that put the pole star in the trees that were cut back in October.

Using one star alignment to cure a problem with the software (easily updated on next visit) I was able to pick up the radio source lenticular galaxy Centaurus 'A' at –43º declination this is never visible from the UK. It is an Arp peculiar galaxy disturbed with high dust absorption.

Even lower at –47º30' is Omega Centauri. Long been observed this bright globular cluster of stars is a bright luminous patch the cluster is a close 17,000 light years away. One of the nearest globular clusters, it is also huge, containing several million stars it is a failed galaxy that was stripped of star forming matter by the main Milky Way galaxy, leaving this large core of stars behind.

Wiltshire Astronomical Society	Observing Sessions 2018 – 2019	
Date	**Moon Phase (%)**	**Moonrise**
2019		
24th May	Waning gibbous (75%)	After midnight

OUTREACH

Evenings now too light for school link ins.

July 4th-5th Nibley Music Festival