NWASNEWS

Volume23, Issue 8

March 2018

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

VANITY IN SPACE

We welcome the return of Andrew Lound to our hall meeting this evening, and he, with his inimitable style will be continuing our recent Saturn series of talks, but this time concentrating on the rings and the moons that are keeping them in place about the huge gas giant.

Breaking news. China's first space station is expected to come crashing down to Earth within weeks, but scientists have not been able to predict where the 8.5-tonne module will hit.

The US-funded Aerospace Corporation estimates Tiangong-1 will re-enter the atmosphere during the first week of April, give or take a week. The European Space Agency says the module will come down between 24 March and 19 April.

Remember chicken licken.

At our last meeting we missed but were able to confirm the launch of Space 'X' heavy lift rockets. It was an amazing sight, with great land landing for reuse of the two outer rockets. It looked like something out of science fiction coming true.

The we get to see the payload. Normally they pad out the final stage with concrete blocks, but Elron Musk went one better, and was able to self advertise one of his other projects. In this instance the Teslar high performance electric car. On top of this he added another piece of humour. His own Mars spacesuit design about a dummy (hang on, we have not seen Keith since the launch), and on to the tunes of David Bowie's Starman and the sign from Dougles Adams' Hitch Hikers Guide to the Galaxy Don't Panic sign, we got some fantastic webcam images. A shame he didn't use his companies solar panels to keep the camera going.

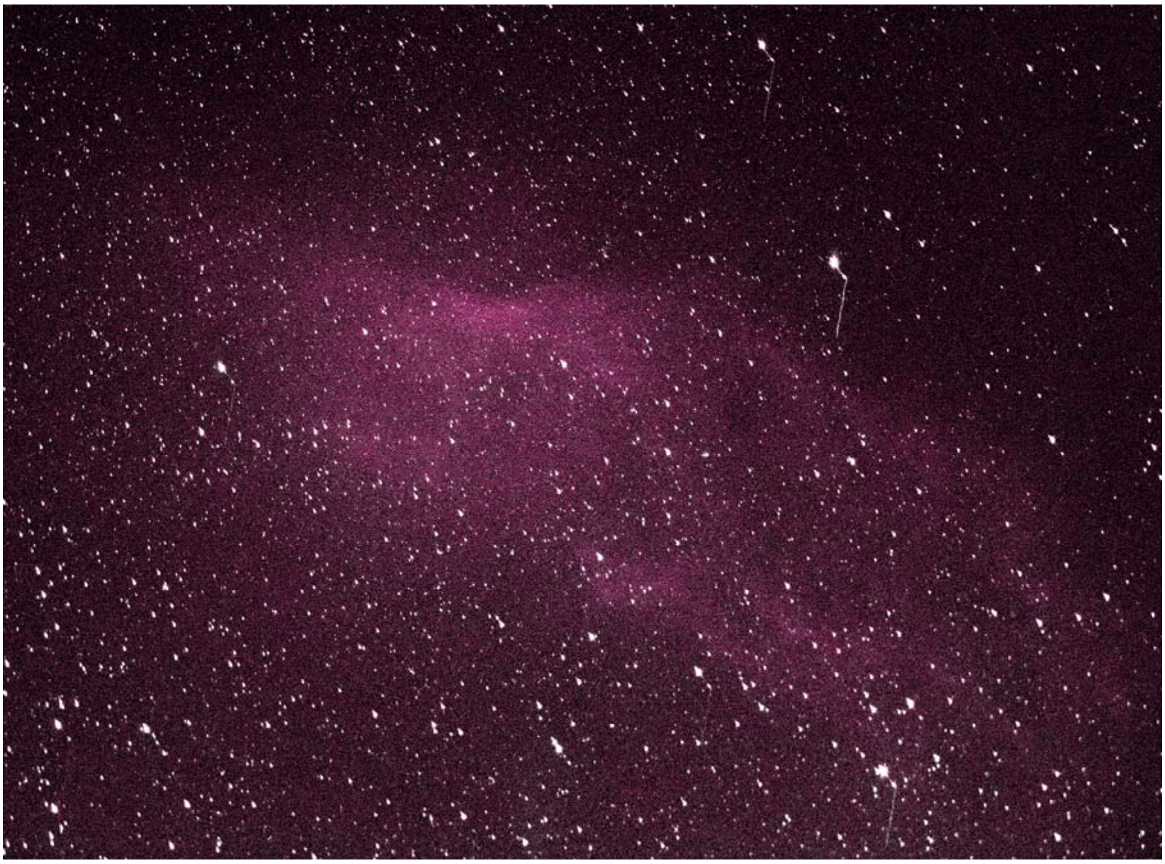
But there is a down side. It was a touch a vanity too far and the microbacterial cleaning process was not applied to all the equipment, and the joke and self advertising my pollute whatever it comes into contact with.

Another launch back in January from New Zealand (though a Californian's dream of putting something in space), a 4' disco ball has been put into polar orbit around the Earth. And it is just coming into view from Britain, see Heavens Above data for viewing in early March. While average magnitude 7 bright flashes as bright as 1.5 may be seen. It is just that. Another light put into space. This one will decay from orbit around October, but this crowd funded project want to launch brighter stars into Earth orbit. Humanity Star.

Clear Skies

Andy

High up in Perseus at the moment is the Californian nebula NGC1499.
Large but faint see needed 120 seconds on 102 TMB refractor, Nikon D810 ISO1000.
The nebula was discovered by E E Barnard in 1884/5.
This is some 1000 light years away in the Orion arm of the Milky Way galaxy.



Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

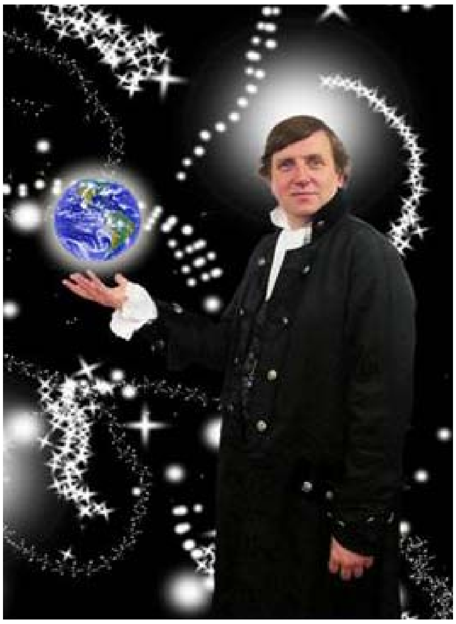
Meetings 2015/2016Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

Date	Speaker	Title
6th Mar	Andrew Lound	Guardians of the Rings.
3rd Apr	Guy Hurst	George Alcock – The Life & Achievements of this Amazing Observer.
1st May	Paul Money	Triumphs of Voyager: Journey to Jupiter/Splendours of Saturn.
5th Jun	Martin Griffiths	Understanding Stars +AGM.

Andrew Lound



Andrew Lound has been presenting public lectures and staging exhibitions for over 30 years and has participated in over 2,300 events.

He regularly tours the UK with his Odyssey Class Dramatic Lectures and is invited back time and again due to popular demand. He has also worked in USA and in 2005 became the first western science speaker to tour Libya following the removal of sanctions.

He can be heard regularly on BBC radio WM where he is known as "The Urban Space man" or "WM's Titanic Expert..." His current projects include working with the California Institute of Technology JPL on promoting the Cassini Mission to Saturn and The Antoniadi Project – a space-probe to the Hellas Region on Mars. He is also developing new computer techniques for use in public lectures. Andrew is a man of many interests who specializes in space science and astronomy from both a current and historical perspective. Another main area of interest for Andrew is the Titanic. After many years of dedicated research he is now recognized as one of the worlds leading authorities on the subject.

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)

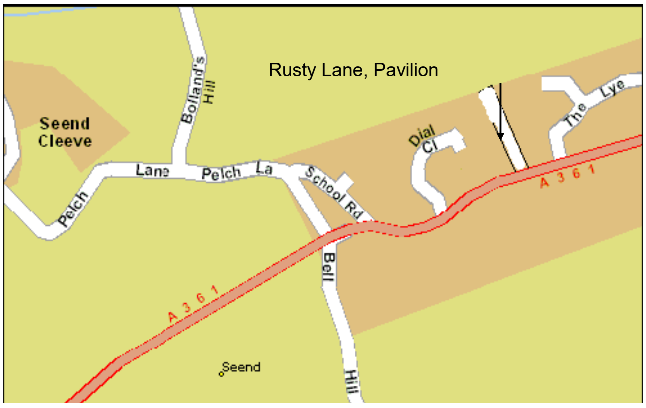
Philip Proven (Hall coordinator) Dave Buckle (Teas)

Peter Chappell (Speaker secretary)

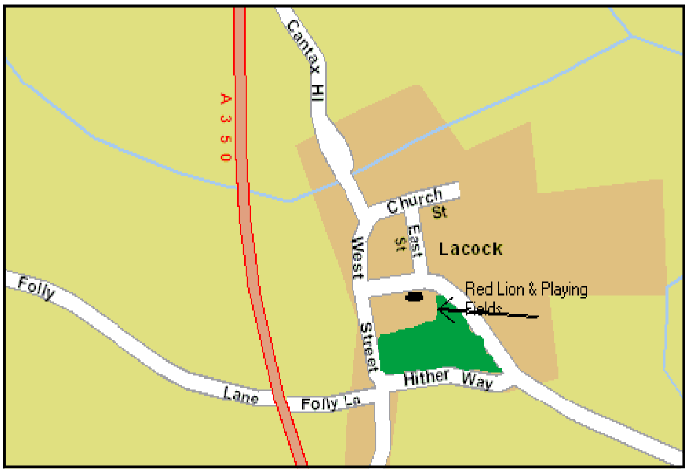
Nick Howes (Technical Guru)

Observing Sessions coordinators: Jon Gale, Tony Vale

Contact via the web site details. This is to protect individuals from unsolicited mailings.



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

Swindon's own astronomy group

The club meets once a month at Liddington Hall, Church Road, Liddington, Swindon, SN4 0HB at 7.30pm. See programme below.

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.

When we use East Kennett, we meet at the public car park just below The Red Lion pub at Avebury; we usually hang on for 10 minutes and then move on to our viewing spot at East Kennett. 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 website). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.
We are a small keen group and I would ask you to note that you DO NOT have to own a telescope to take part, just turn up and have a great evening looking through other people's scopes. We are out there to share an interest and the hobby. There's nothing better than practical astronomy in the great cold British winter! And hot drinks are often available, you can also bring your own.

Enjoy astronomy at it's best!

Members of the Wiltshire Astronomical Society always welcome!

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 2018

Friday 16 March 2018

AGM – Mark Ackland - Astrophotography For Beginners

Friday 20 April 2018
Programme: Stephen Tonkin - Age of the Universe

Friday 18 May 2018

Programme: Prof. Harrison - Space Weather
Friday 15 June 2018
Programme: Owen Brazell - Galaxy Clusters

Summer Break: No meetings in July and August

Friday 21 September 2018
Programme: Dr. Chris Pearson: Galaxy Formation and Evolution

Friday 19 October 2018
Programme: Dr. Michael McEllin - Radio Telescopes: How they work and what they can do

Friday 16 November 2018
Programme: Dr. Rhodri Evans - Astronomy from a Boeing 747

Friday 21 December 2018
Programme: Christmas Social

Website:

http://www.swindonstargazers.com

Chairman: Peter Struve

Tel No: 01793 481547
Email: peter.struve@sky.com
Address: 3 Monkton Close, Park South, Swindon, SN3 2EU

Secretary: Dr Bob Gatten (PhD)
Tel Number: 07913 335475
Email: bob.gatten@ntlworld.com
Address: 17, Euclid Street,

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

Steve Hill-----------Chairman- 01761 435663

John Ball-----------Vice Chairman- 01373 830419

………….john@abbeylands1.freeserve.co.uk

Sandy Whitton---- Secretary-07974-841239

…………………..sandy.whitton@blueyonder.co.uk

Jacky Collenette---Treasurer… collenettejacqueline@yahoo.co.uk

Mike Witt---------- Membership-……… mjwitt@blueyonder.co.uk.

John Dolton------ Committee…. member@jdolton.freeserve.co.uk

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.

16th March	*Pole Stars of other Planets*	Bob Mizon
20th April	*Building the World's Largest FM Radio Receiver to Learn about the First Galaxies*	Jonathan Pritchard
18th May	*The Dichotomy of Mars*	Mike Witt
15th June	Annual General Meeting *Member Talks*	

Dear Herschellians,

It looks like we will be compensated for the bad weather at the end of last week and the cancellation of the Annual Lecture (which is now being rescheduled) by a couple of new events coming up at Bath University. I have added the next part of our programme to show that we are undefeated by the weather!

University of Bath Founders Day Lecture 2018

Tue 6 March 2018 17:30 – 19:00 GMT
East Building Lecture Theatre 1.1, University of Bath

Gravitational Waves: turning on the soundtrack to the Universe

Professor Sheila Rowan MBE – Chief Scientific Adviser for Scotland & Director of the Institute for Gravitational Research, Glasgow

Please go the link below for further details. The event is free, but please register via the link to avoid disappointment. https://www.eventbrite.co.uk/e/founders-day-lecture-2018-registration-42986072500

Fri 16 March 2018 7.30pm : Follow this link for much more information - > The Edge, University of Bath

It takes just eight minutes for sunlight to travel 93 million miles to earth. In this unique collaboration with scientists from STFC RAL Space, choreographer Alexander Whitley takes inspiration from the breathtaking images and data from solar science research.

Dance, film and music take us on a journey through the universe, revealing the drama of the burning ball of plasma that illuminates our planet and exploring the numerous ways in which we relate to our home star. With an installation of high-definition imagery from visual artist **Tal Rosner** and a specially created score by the electroacoustic music innovator **Daniel Wohl**, *8 Minutes* captures our curiosity and wonder for this unimaginably vast subject.

TICKETS £10, £8 CONCS, £6 EAC STUDENTS from Bath Box Office 01225 386777

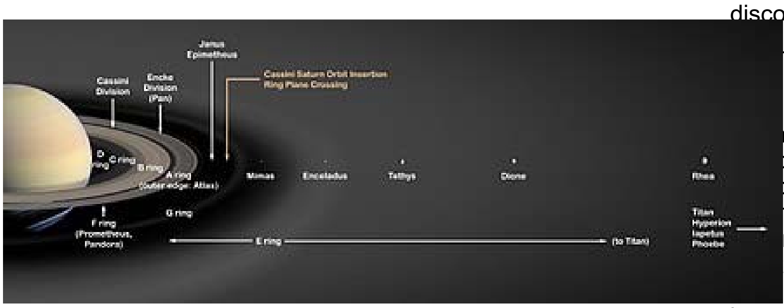
WHS lecture for April at the BRLSI
Thu 5 Apr 18 7.30 pm
Caroline Herschel and the nearly all male world of eighteenth century science
Dr Emily Winterburn, former Curator of Astronomy at Royal Observatory Greenwich
WHS lecture for May at the BRLSI
Fri 11 May 18 7.30 pm
The Apprentice (Full title to be provided later)
Dr Roger Moses, University of Bristol

Provisional date for the rescheduled WHS Annual Lecture (which was to have been given on Fri 2nd March)
Fri 18 May 18 7.30 pm at the BRLSI
The Great Quasar Debate 1963 - 1984
Prof Mike Edmunds, University of Cardiff

Extra Summer WHS lecture
Fri 13 Jul 18 7.30 pm at the BRLSI
Paler Blue Dots: Technology Developments on ISS for Finding Earth 2.0
Dr Daniel Batcheldor, Florida Institute of Technology

Kind regards,
Tony Symes

Moons of Saturn



Saturn, its rings and major icy moons—from Mimas to Rhea

Images of several moons of Saturn. From left to right: Mimas, Enceladus, Tethys, Dione, Rhea; Titan in the background; Iapetus (top right) and irregularly shaped Hyperion (bottom right). Some small moons are also shown. All to scale.

The **moons of Saturn** are numerous and diverse, ranging from tiny moonlets less than 1 kilometer across to the enormous Titan, which is larger than the planet Mercury. Saturn has 62 moons with confirmed orbits, 53 of which have names and only 13 of which have diameters larger than 50 kilometers, as well as dense rings with complex orbital motions of their own. Seven Saturnian moons are large enough to be ellipsoidal in shape, though only two of those, Titan and Rhea, are currently in hydrostatic equilibrium. Particularly notable among Saturn's moons are Titan, the second-largest moon (after Jupiter's Ganymede) in the Solar System, with a nitrogen-rich Earth-like atmosphere and a landscape featuring dry river networks and hydrocarbon lakes found nowhere else in the solar system; and Enceladus since its chemical composition is similar to that of comets. In particular, Enceladus emits jets of gas and dust which could indicate presence of liquid water under its south pole region and could potentially harbor a global ocean under its surface.

Twenty-four of Saturn's moons are *regular satellites*; they have prograde orbits not greatly inclined to Saturn's equatorial plane. They include the seven major satellites, four small moons that exist in a trojan orbit with larger moons, two mutually co-orbital moons and two moons that act as shepherds of Saturn's F Ring. Two other known regular satellites orbit within gaps in Saturn's rings. The relatively large Hyperion is locked in a resonance with Titan. The remaining regular moons orbit near the outer edge of the A Ring, within G Ring and between the major moons Mimas and Enceladus. The regular satellites are traditionally named after Titans and Titanesses or other figures associated with the mythological Saturn.

The remaining 38, all small except one, are *irregular satellites*, whose orbits are much farther from Saturn, have high inclinations, and are mixed between prograde and retrograde. These moons are probably captured minor planets, or debris from the breakup of such bodies after they were captured, creating collisional families. The irregular satellites have been classified by their orbital characteristics into the Inuit, Norse, and Gallic groups, and their names are chosen from the corresponding mythologies. The largest of the irregular moons is Phoebe, the ninth moon of Saturn, discovered at the end of the 19th century.

rings of Saturn are made up of objects ranging in size microscopic to moonlets hundreds of meters across, in its own orbit around Saturn.[9] Thus a precise number turnian moons cannot be given, because there is no tive boundary between the countless small anonymous ts that form Saturn's ring system and the larger objects ave been named as moons. Over 150 moonlets embedn the rings have been detected by the disturbance they e in the surrounding ring material, though this is thought only a small sample of the total population of such objects.

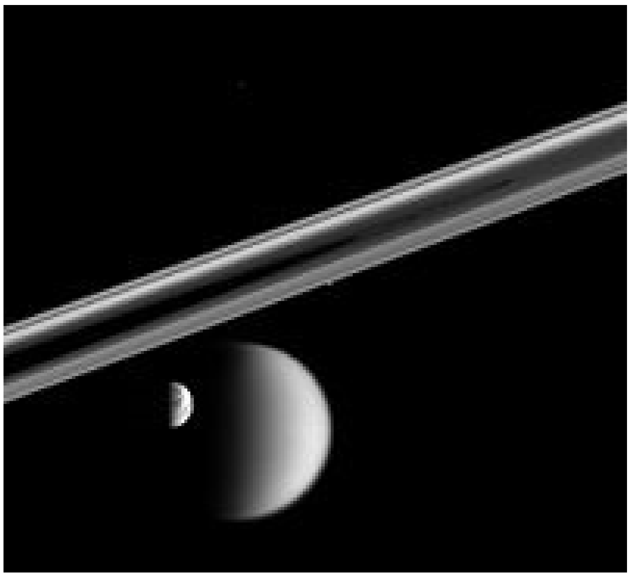
History

observations

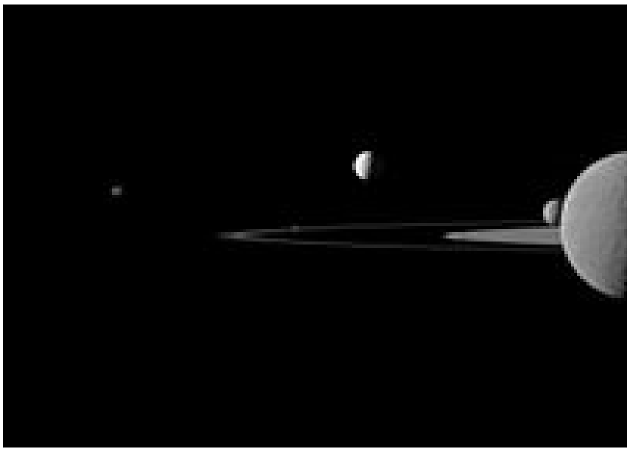
e the advent of telescopic photography, eight moons of n were discovered by direct observation using optical copes. Saturn's largest moon, Titan, was discovered in by Christiaan Huygens using a 57-millimeter (2.2 in) tive lens[on a refracting telescope of his own design. s, Dione, Rhea and Iapetus (the "Sidera Lodoicea") discovered between 1671 and 1684 by Giovanni Dome-Cassini. Mimas and Enceladus were discovered in 1789 by William Herschel. Hyperion was discovered in 1848 by W.C. Bond, G.P. Bond and William Lassell.

The use of long-exposure photographic plates made possible the discovery of additional moons. The first to be discovered in this manner, Phoebe, was found in 1899 by W.H. Pickering In 1966 the tenth satellite of Saturn was discovered by Audouin Dollfus, when the rings were observed edge-on near an equinox. It was later named Janus. A few years later it was realized that all observations of 1966 could only be explained if another satellite had been present and that it had an orbit similar to that of Janus.[17] This object is now known as Epimetheus, the eleventh moon of Saturn. It shares the same orbit with Janus—the only known example of co-orbitals in the Solar System. In 1980, three additional Saturnian moons were discovered from the ground and later confirmed by the *Voyager* probes. They are trojan moons of Dione (Helene) and Tethys (Telesto and Calypso).

Observations by spacecraft



Four moons of Saturn can be seen on this image by the Cassini spacecraft: Huge Titan and Dione at the bottom, small Prometheus (under the rings) and tiny Telesto above center.

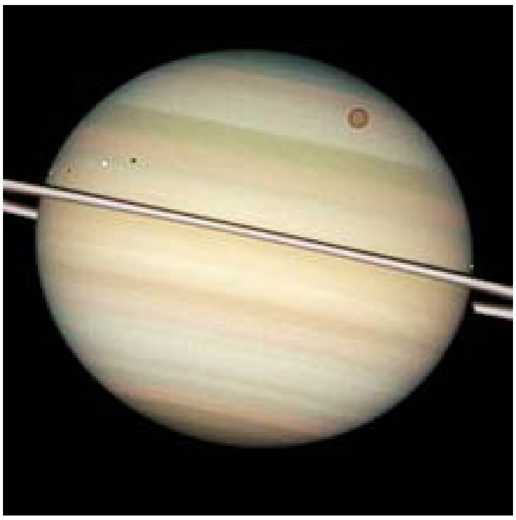


Five moons in another Cassini image: Rhea bisected in the far-right foreground, Mimas behind it, bright Enceladus above and beyond the rings, Pandora eclipsed by the F Ring, and Janus off to the left.

The study of the outer planets has since been revolutionized by the use of unmanned space probes. The arrival of the *Voyager* spacecraft at Saturn in 1980–1981 resulted in the discovery of three additional moons—Atlas, Prometheus and Pandora, bringing the total to 17.[18] In addition, Epimetheus was confirmed as distinct from Janus. In 1990, Pan was discovered in archival *Voyager* images.

The *Cassini* mission, which arrived at Saturn in the summer of 2004, initially discovered three small inner moons including Methone and Pallene between Mimas and Enceladus as well as the second trojan moon of Dione—Polydeuces. It also observed three suspected but unconfirmed moons in the F Ring. In November 2004 Cassini scientists announced that the structure of Saturn's rings indicates the presence of several more moons orbiting within the rings, although only one, Daphnis, had been visually confirmed at the time. In 2007 Anthe was announced. In 2008 it was reported that *Cassini* observations of a depletion of energetic electrons in Saturn's magnetosphere near Rhea might be the signature of a tenuous ring system around Saturn's second largest moon.In March 2009, Aegaeon, a moonlet within the G Ring, was announce. In July of the same year, S/2009 S 1, the first moonlet within the B Ring, was observed.[4] In April 2014, the possible beginning of a new moon, within the A Ring, was reported.

Outer moons



Quadruple Saturn–moon transit captured by the Hubble Space Telescope

Study of Saturn's moons has also been aided by advances in telescope instrumentation, primarily the introduction of digital charge-coupled devices which replaced photographic plates. For the entire 20th century, Phoebe stood alone among Saturn's known moons with its highly irregular orbit. Beginning in 2000, however, three dozen additional irregular moons have been discovered using ground-based telescopes. A survey starting in late 2000 and conducted using three medium-size telescopes found thirteen new moons orbiting Saturn at a great distance, in eccentric orbits, which are highly inclined to both the equator of Saturn and the ecliptic. They are probably fragments of larger bodies captured by Saturn's gravitational pull. In 2005, astronomers using the Mauna Kea Observatory announced the discovery of twelve more small outer moons, in 2006, astronomers using the Subaru 8.2 m telescope reported the discovery of nine more irregular moons, in April 2007, Tarqeq (S/2007 S 1) was announced and in May of the same year S/2007 S 2 and S/2007 S 3 were reported.

Some of the 62 known satellites of Saturn are considered lost because they have not been observed since their discovery and hence their orbits are not well-known enough to pinpoint their current locations. Work has been done to recover many of them in surveys from 2009 onwards, but seven – S/2007 S 2, S/2004 S 13, S/2006 S 1, S/2007 S 3, S/2004 S 17, S/2004 S 12, and S/2004 S 7 – still remain lost today.

Naming

Main article: Naming of moons

The modern names for Saturnian moons were suggested by John Herschel in 1847. He proposed to name them after mythological figures associated with the Roman god of agriculture and harvest, Saturn (equated to the Greek Cronus). In particular, the then known seven satellites were named after Titans, Titanesses and Giants—brothers and sisters of Cronus. In 1848, Lassell proposed that the eighth satellite of Saturn be named Hyperion after another Titan. When in the 20th century the names of Titans were exhausted, the moons were named after different characters of the Greco-Roman mythology or giants from other mythologies. All the irregular moons (except Phoebe) are named after Inuit and Gallic gods and after Norse ice giants.

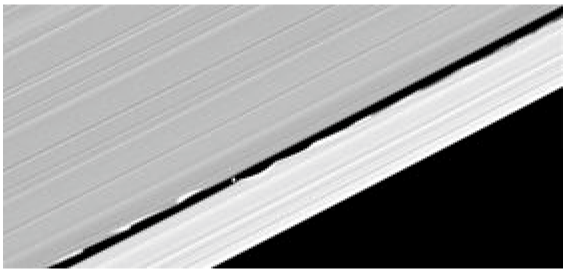
Some asteroids share the same names as moons of Saturn: 55 Pandora, 106 Dione, 577 Rhea, 1809 Prometheus, 1810 Epimetheus, and 4450 Pan. In addition, two more asteroids previously shared the names of Saturnian moons until spelling differences were made permanent by the International Astronomical Union (IAU): Calypso and asteroid 53 Kalypso; and Helene and asteroid 101 Helena.

Orbital groups

Although the boundaries may be somewhat vague, Saturn's moons can be divided into ten groups according to their orbital characteristics. Many of them, such as Pan and Daphnis, orbit within Saturn's ring system and have orbital periods only slightly longer than the planet's rotation period. The innermost moons and most regular satellites all have mean orbital inclinations ranging from less than a degree to about 1.5 degrees (except Iapetus, which has an inclination of 7.57 degrees) and small orbital eccentricities. On the other hand, irregular satellites in the outermost regions of Saturn's moon system, in particular the Norse group, have orbital radii of millions of kilometers and orbital periods lasting several years. The moons of the Norse group also orbit in the opposite direction to Saturn's rotation.

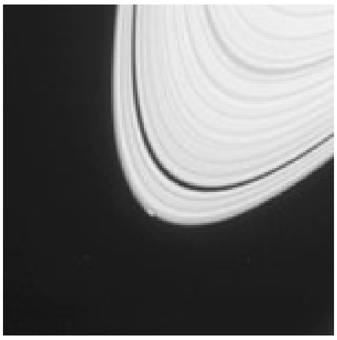
Ring moonlets

Main article: Rings of Saturn

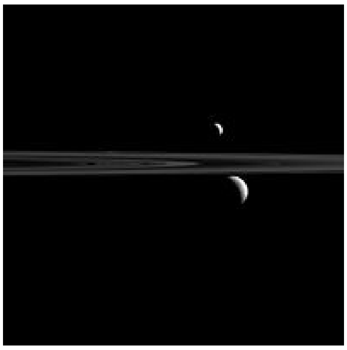


Daphnis in the Keeler gap

During late July 2009, a moonlet was discovered in the B Ring, 480 km from the outer edge of the ring, by the shadow it cast. It is estimated to be 300 m in diameter. Unlike the A Ring moonlets (see below), it does not induce a 'propeller' feature, probably due to the density of the B Ring.



Possible beginning of a new moon of Saturn imaged on 15 April 2014



Saturn's F Ring along with the moons, Enceladus and Rhea.

In 2006, four tiny moonlets were found in *Cassini* images of the A Ring. Before this discovery only two larger moons had been known within gaps in the A Ring: Pan and Daphnis. These are large enough to clear continuous gaps in the ring. In contrast, a moonlet is only massive enough to clear two small—about 10 km across—partial gaps in the immediate vicinity of the moonlet itself creating a structure shaped like an airplane propeller. The moonlets themselves are tiny, ranging from about 40 to 500 meters in diameter, and are too small to be seen directly. In 2007, the discovery of 150 more moonlets revealed that they (with the exception of two that have been seen outside the Encke gap) are confined to three narrow bands in the A Ring between 126,750 and 132,000 km from Saturn's center. Each band is about a thousand kilometers wide, which is less than 1% the width of Saturn's rings. This region is relatively free from the disturbances caused by resonances with larger satellites, although other areas of the A Ring without disturbances are apparently free of moonlets. The moonlets were probably formed from the breakup of a larger satellite.[42] It is estimated that the A Ring contains 7,000–8,000 propellers larger than 0.8 km in size and millions larger than 0.25 km.

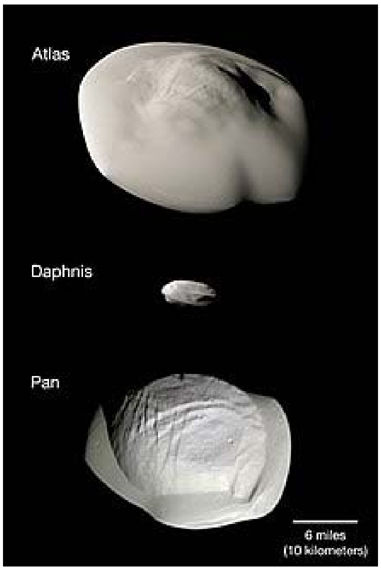
Similar moonlets may reside in the F Ring. There, "jets" of material may be due to collisions, initiated by perturbations from the nearby small moon Prometheus, of these moonlets with the core of the F Ring. One of the largest F Ring moonlets may be the as-yet unconfirmed object S/2004 S 6. The F Ring also contains transient "fans" which are thought to result from even smaller moonlets, about 1 km in diameter, orbiting near the F Ring core.

One of the recently discovered moons, Aegaeon, resides within the bright arc of G Ring and is trapped in the 7:6 mean-motion resonance with Mimas. This means that it makes exactly seven revolutions around Saturn while Mimas makes exactly six. The moon is the largest among the population of bodies that are sources of dust in this ring.

In April 2014, NASA scientists reported the possible beginning of a new moon, within the A Ring.

Ring shepherds

Main article: Rings of Saturn



Shepherd satellites – Atlas, Daphnis and Pan (color).

Shepherd satellites are small moons that orbit within, or just beyond, a planet's ring system. They have the effect of sculpting the rings: giving them sharp edges, and creating gaps between them. Saturn's shepherd moons are Pan (Encke gap), Daphnis (Keeler gap), Atlas (A Ring), Prometheus (F Ring) and Pandora (F Ring). These moons together with co-orbitals (see below) probably formed as a result of accretion of the friable ring material on preexisting denser cores. The cores with sizes from one-third to one-half the present day moons may be themselves collisional shards formed when a parental satellite of the rings disintegrated.

Co-orbitals[edit]

Main article: Co-orbital moon

Janus and Epimetheus are called co-orbital moons. They are of roughly equal size, with Janus being slightly larger than Epimetheus Janus and Epimetheus have orbits with only a few kilometers difference in semi-major axis, close enough that they would collide if they attempted to pass each other. Instead of colliding, however, their gravitational interaction causes them to swap orbits every four years.

Inner large moons[edit]

Tiger stripes on Enceladus

Saturn's rings and moons

Tethys, Hyperion and Prometheus

Tethys and Janus

T

ethys and the rings of Saturn

The innermost large moons of Saturn orbit within its tenuous E Ring, along with three smaller moons of the Alkyonides group.

- Mimas is the smallest and least massive of the inner round moons, although its mass is sufficient to alter the orbit of Methone. It is noticeably ovoid-shaped, having been made shorter at the poles and longer at the equator (by about 20 km) by the effects of Saturn's gravity Mimas has a large impact crater one-third its diameter, Herschel, situated on its leading hemisphere Mimas has no known past or present geologic activity, and its surface is dominated by impact craters. The only tectonic features known are a few arcuate and linear troughs, which probably formed when Mimas was shattered by the Herschel impact.

- Enceladus is one of the smallest of Saturn's moons that is spherical in shape—only Mimas is smaller—yet is the only small Saturnian moon that is currently endogenously active, and the smallest known body in the Solar System that is geologically active today. Its surface is morphologically diverse; it includes ancient heavily cratered terrain as well as younger smooth areas with few impact craters. Many plains on Enceladus are fractured and intersected by systems of lineaments. The area around its south pole was found by *Cassini* to be unusually warm and cut by a system of fractures about 130 km long called "tiger stripes", some of which emit jets of water vapor and dust. These jets form a large plume off its south pole, which replenishes Saturn's E ring and serves as the main source of ions in the magnetosphere of Saturn. The gas and dust are released with a rate of more than 100 kg/s. Enceladus may have liquid water underneath the south-polar surface. The source of the energy for this cryovolcanism is thought to be a 2:1 mean-motion resonance with Dione. The pure ice on the surface makes Enceladus one of the brightest known objects in the Solar System—its geometrical albedo is more than 140%.

- Tethys is the third largest of Saturn's inner moons. Its most prominent features are a large (400 km diameter) impact crater named Odysseus on its leading hemisphere and a vast canyon system named Ithaca Chasma extending at least 270° around Tethys. The Ithaca Chasma is concentric with Odysseus, and these two features may be related. Tethys appears to have no current geological activity. A heavily cratered hilly terrain occupies the majority of its surface, while a smaller and smoother plains region lies on the hemisphere opposite to that of Odysseus. The plains contain fewer craters and are apparently younger. A sharp boundary separates them from the cratered terrain. There is also a system of extensional troughs radiating away from Odysseus. The density of Tethys (0.985 g/cm^3) is less than that of water, indicating that it is made mainly of water ice with only a small fraction of rock.

- Dione is the second-largest inner moon of Saturn. It has a higher density than the geologically dead Rhea, the largest inner moon, but lower than that of active Enceladus. While the majority of Dione's surface is heavily cratered old terrain, this moon is also covered with an extensive network of troughs and lineaments, indicating that in the past it had global tectonic activity. The troughs and lineaments are especially prominent on the trailing hemisphere, where several intersecting sets of fractures form what is called "wispy terrain". The cratered plains have a few large impact craters reaching 250 km in diameter. Smooth plains with low impact-crater counts are also present on a small fraction of its surface. They were probably tectonically resurfaced relatively later in the geological history of Dione. At two locations within smooth plains strange landforms (depressions) resembling oblong impact craters have been identified, both of which lie at the centers of radiating networks of cracks and troughs; these features may be cryovolcanic in origin. Dione may be geologically active even now, although on a scale much smaller than the cryovolcanism of Enceladus. This follows from Cassini magnetic measurements that show Dione is a net source of plasma in the magnetosphere of Saturn, much like Enceladus.

What Is the Ionosphere?

By Linda Hermans-Killiam

High above Earth is a very active part of our upper atmosphere called the ionosphere. The ionosphere gets its name from ions—tiny charged particles that blow around in this layer of the atmosphere.

How did all those ions get there? They were made by energy from the Sun!

Everything in the universe that takes up space is made up of matter, and matter is made of tiny particles called atoms. At the ionosphere, atoms from the Earth's atmosphere meet up with energy from the Sun. This energy, called radiation, strips away parts of the atom. What's left is a positively or negatively charged atom, called an ion.

The ionosphere is filled with ions. These particles move about in a giant wind. However, conditions in the ionosphere change all the time. Earth's seasons and weather can cause changes in the ionosphere, as well as radiation and particles from the Sun—called space weather.

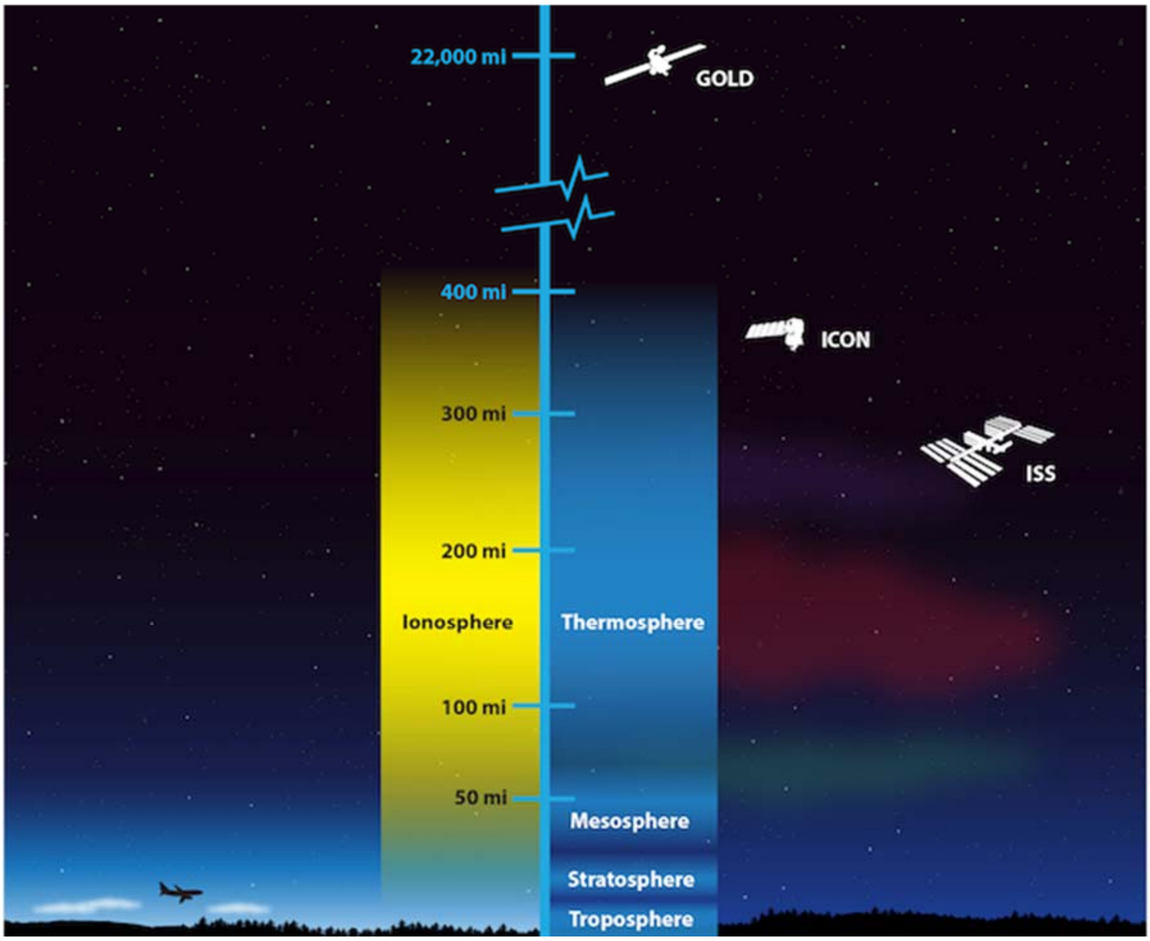
These changes in the ionosphere can cause problems for humans. For example, they can interfere with radio signals between Earth and satellites. This could make it difficult to use many of the tools we take for granted here on Earth, such as GPS. Radio signals also allow us to communicate with astronauts on board the International Space Station, which orbits Earth within the ionosphere. Learning more about this region of our atmosphere may help us improve forecasts about when these radio signals could be distorted and help keep humans safe.

In 2018, NASA has plans to launch two missions that will work together to study the ionosphere. NASA's GOLD (Global-scale Observations of the Limb and Disk) mission launched in January 2018. GOLD will orbit 22,000 miles above Earth. From way up there, it will be able to create a map of the ionosphere over the Americas every half hour. It will measure the temperature and makeup of gases in the ionosphere. GOLD will also study bubbles of charged gas that are known to cause communication problems.

A second NASA mission, called ICON, short for Ionospheric Connection Explorer, will launch later in 2018. It will be placed in an orbit just 350 miles above Earth—through the ionosphere. This means it will have a close-up view of the upper atmosphere to pair with GOLD's wider view. ICON will study the forces that shape this part of the upper atmosphere.

Both missions will study how the ionosphere is affected by Earth and space weather. Together, they will give us better observations of this part of our atmosphere than we have ever had before.

To learn more about the ionosphere, check out NASA Space Place: https://spaceplace.nasa.gov/ionosphere



This illustration shows the layers of Earth's atmosphere. NASA's GOLD and ICON missions will work together to study the ionosphere, a region of charged particles in Earth's upper atmosphere. Changes in the ionosphere can interfere with the radio waves used to communicate with satellites and astronauts in the International Space Station (ISS). Credit: NASA's Goddard Space Flight Center/Duberstein (modified)

MEMBERS VIEWING LOGS and IMAGES

Viewing Log for 23rd of February

Tony Vale had arranged the monthly viewing session at Lacock for WAS and I think it was the third one that was planned in this current season that went ahead as scheduled ☺?

Tony said he was going to get there earlier than the planned start of 20:00 as cloud was due in later in the evening? After I had finished doing everything at home I load up my car with my usual viewing equipment, namely the Meade LX 90 eight inch SCT, this time I would be using the Delos 17.3 mm eye piece, this would give me an approx. magnification of 115.6. While I was loading the car I noticed a bank of cloud out to the east and as the wind was coming from that direction it would probably hit Lacock fairly soon afterwards?

Anyway I was set up and ready to start viewing at 20:35, there was four other people already there viewing before me, namely Tony, Jon Gale, Dave Buckle and one other chap I cannot remember his name, sorry if you are reading this log later on! With it being minus one °C the conditions should be good for viewing? First thing you could not fail to notice was the Moon blazing away in the sky near Orion, it was 7.98 days old or 56 % lit. You could make out your shadow on the ground, so deep sky objects where probably out of the question, chances are they will be washed out by the brightness of the Moon? Anyway I thought I would have a look at M 42 and M 43 in Orion, I was surprised I could make out some of the dust lines coming off from the trapezium area of four stars. Going due south you come across the constellation of Lupus, the Hare and the only Messier object in this constellation in M 79. This Globular Custer is a bit of an odd ball as most Glob's are summer objects to look at? Anyway I could not make this object out at all, not sure if it was cloud or the Moon or both? So best thing I could do was to view objects a lot higher up and avoid the thick atmosphere lower down in the sky. So with this in mind I went off to M 1 in Taurus, this Supernova remnant better known as the Crab nebula, I could just make out something but no more than that? Across to Gemini and M 35, a fairly loose Open Cluster (O C), did the usual O C's in M 36 (again another loose one), M 37 and finally M 38, all in Auriga. By now it was hard to pick out anything to look at; even the Moon was getting covered in cloud! So unless the skies got better it would be the Moon and then go home? At least I did not need a Moon filter as the clouds took a lot of the brightness out of the sky. To the bottom of the terminator (day/night line on the Moon) was the crater Clavius (225 km round) with a central peak that could just be made out with the Sun raising over this crater edges. Other noticeable craters coming in to view include Plato (101 km round) which looked bigger than Clavius? I suspect we were seeing Clavius edge on a bit which might make it appear smaller (just like a full Moon raising, looks bigger than later on in the same night? Another small crater (Tycho, 86 km round) had just cleared the terminator when all of a sudden, the Moon disappeared! We waited for another 15 minutes with no change in the cloud cover, so with only three of us now left we decided to go to 'White Light' phase and pack the equipment up at 21:46. The temperature had dropped another degree but the equipment was dry to touch so I guess the Dew point was much lower and not much wetness in the air? Jon and I decided to have a committee meeting at MacDonald's in Chippenham on the way home just to finish the evening off.

Clear skies.

Peter Chappell

SPACE NEWS FOR MARCH

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

ENGINEERS DEVELOP A WHOLE NEW WAY TO USE CURIOSITY'S DRILL AFTER A RECENT HARDWARE FAILURE

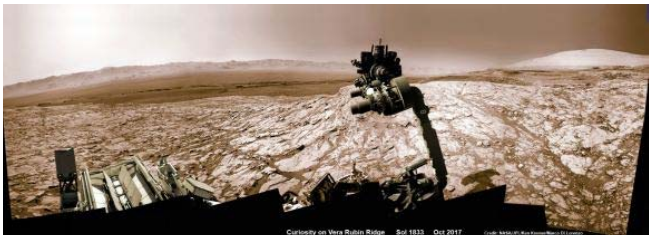
Article written: 5 Mar , 2018
Updated: 5 Mar , 2018

by Matt Williams

Since it landed on Mars in 2012, the *Curiosity* rover has used its drill to gather samples from a total of 15 sites. These samples are then deposited into two of Curiosity's laboratory instruments – the Sample Analysis at Mars (SAM) or the Chemistry and Mineralogy X-ray Diffraction (CheMin) instrument – where they are examined to tell us more about the Red Planet's history and evolution.

Unfortunately, in December of 2016, a key part of the drill stopped working when a faulty motor prevented the bit from extending and retracting between its two stabilizers. After managing to get the bit to extend after months of work, the *Curiosity* team has developed a new method for drilling that does not require stabilizers. The new method was recently tested and has been proven to be effective.

The new method involves freehand drilling, where the drill bit remains extended and the entire arm is used to push the drill forward. While this is happening, the rover's force sensor – which was originally included to stop the rover's arm if it received a high-force jolt – is used to takes measurements. This prevents the drill bit from drifting sideways and getting stuck in rock, as well as providing the rover with a sense of touch.



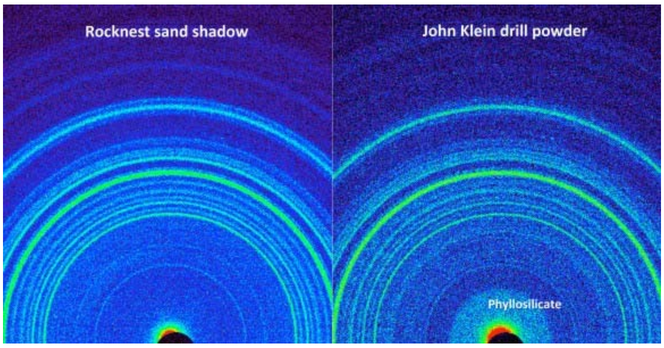
NASA's Curiosity rover raised robotic arm with drill pointed skyward while exploring Vera Rubin Ridge at the base of Mount Sharp inside Gale Crater – backdropped by distant crater rim. Credit: NASA/JPL/Ken Kremer/kenkremer.com/ Marco Di Lorenzo

The test drill took place at a site called Lake Orcadie, which is located in the upper Vera Rubin Ridge – where *Curiosity* is currently located. The resulting hole, which was about 1 cm (half an inch) deep was not enough to produce a scientific sample, but indicated that the new method worked. Compared to the previous method, which was like a drill press, the new method is far more freehand.

As Steven Lee, the deputy project manager of the Mars Science Laboratory at NASA's Jet Propulsion Laboratory, explained:

"We're now drilling on Mars more like the way you do at home. Humans are pretty good at re-centering the drill, almost without thinking about it. Programming Curiosity to do this by itself was challenging — especially when it wasn't designed to do that."

This new method was the result of months of hard work by JPL engineers, who practiced the technique using their testbed – a near-exact replica of *Curiosity.* But as Doug Klein of JPL, one of *Curiosity's* sampling engineers, indicated, "This is a really good sign for the new drilling method. Next, we have to drill a full-depth hole and demonstrate our new techniques for delivering the sample to Curiosity's two onboard labs."



This side-by-side comparison shows the X-ray diffraction patterns of two different samples collected from the Martian surface by NASA's Curiosity rover, as obtained by Curiosity's Chemistry and Mineralogy instrument (CheMin). Credit: NASA/JPL-Caltech/Ames

Of course, there are some drawbacks to this new method. For one, leaving the drill in its extended position means that it no longer has access to the device that sieves and portions rock powder before delivering it to the rover's Collection and Handling for In-Situ Martian Rock Analysis (CHIMRA) instrumet. To address this, the engineers at JPL had to invent a new way to deposit the powder without this device.

Here too, the engineers at JPL tested the method here on Earth. It consists of the drill shaking out the grains from its bit in order to deposit the sand directly in the CHIMRA instrument. While the tests have been successful here on Earth, it remains to be seen if this will work on Mars. Given that both atmospheric conditions and gravity are very different on the Red Planet, it remains to be seen if this will work there.

This drill test was the first of many that are planned. And while this first test didn't produce a full sample, *Curiosity's* science team is confident that this is a positive step towards the resumption of regular drilling. If the method proves effective, the team hopes to collect multiple samples from Vera Rubin Ridge, especially from the upper side. This area contains both gray and red rocks, the latter of which are rich in minerals that form in the presence of water.

Samples drilled from these rocks are expected to shed light on the origin of the ridge and its interaction with water. In the days ahead, Curiosity's engineers will evaluate the results and likely attempt another drill test nearby. If enough sample is collected, they will use the rover's Mastcam to attempt to portion the sample out and determine how much powder can be shaken from the drill bit.

AMAZING HIGH RESOLUTION IMAGE OF THE CORE OF THE MILKY WAY, A REGION WITH SURPRISINGLY LOW STAR FORMATION COMPARED TO OTHER GALAXIES

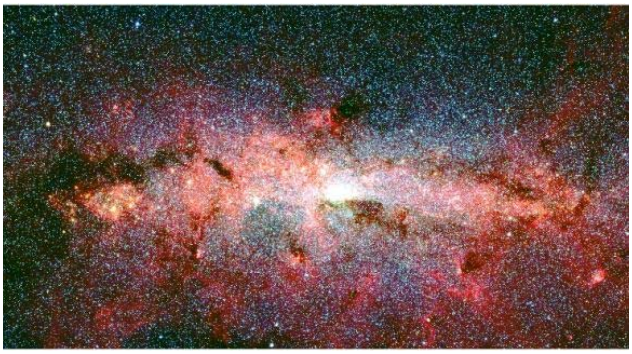
Article written: 27 Feb , 2018

by Matt Williams

Compared to some other galaxies in our Universe, the Milky Way is a rather subtle character. In fact, there are galaxies that are a thousands times as luminous as the Milky Way, owing to the presence of warm gas in the galaxy's Central Molecular Zone (CMZ). This gas is heated by massive bursts of star formation that surround the Supermassive Black Hole (SMBH) at the nucleus of the galaxy.

The core of the Milky Way also has a SMBH (Sagittarius A*) and all the gas it needs to form new stars. But for some reason, star formation in our galaxy's CMZ is less than the average. To address this ongoing mystery, an international team of astronomers conducted a large and comprehensive study of the CMZ to search for answers as to why this might be.

The study, titled "Star formation in a high-pressure environment: an SMA view of the Galactic Centre dust ridge" recently appeared in the *Monthly Notices of the Royal Astronomical Society.* The study was led by Daniel Walker of the Joint ALMA Observatory and the National Astronomical Observatory of Japan, and included members from multiple observatories, universities and research institutes.

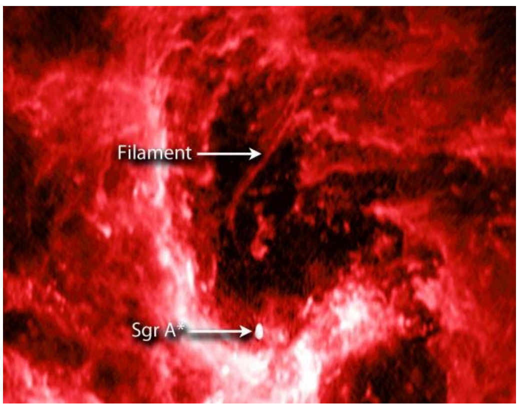


A false color Spitzer infrared image of the Milky Way's Central Molecular Zone (CMZ). Credit: Spitzer/NASA/CfA

For the sake of their study, the team relied on the Submillimeter Array (SMA) radio interferometer, which is located atop Maunakea in Hawaii. What they found was a sample of thirteen high-mass cores in the CMZ's "dust ridge" that could be young stars in the initial phase of development. These cores ranged in mass from 50 to 2150 Solar Masses and have radii of 0.1 – 0.25 parsecs (0.326 – 0.815 light-years). They also noted the presence of two objects that appeared to be previously unknown young, high-mass protostars. As they state in their study, all of this indicated that stars in CMZ had about the same rate of formation as those in the galactic disc, despite their being vast pressure differences:

"All appear to be young (pre-UCHII), meaning that they are prime candidates for representing the initial conditions of high-mass stars and sub-clusters. We compare all of the detected cores with high-mass cores and clouds in the Galactic disc and find that they are broadly similar in terms of their masses and sizes, despite being subjected to external pressures that are several orders of magnitude greater."

To determine that the external pressure in the CMZ was greater, the team observed spectral lines of the molecules formaldehyde and methyl cyanide to measure the temperature of the gas and its kinetics. These indicated that the gas environment was highly turbulent, which led them to the conclusion that the turbulent environment of the CMZ is responsible for inhibiting star formation there.



A radio image from the NSF's Karl G. Jansky Very Large Array showing the center of our galaxy. Credit: NSF/VLA/UCLA/ M. Morris et al.

As they state in their study, these results were consistent with their previous hypothesis:

"The fact that >80 percent of these cores do not show any signs of star-forming activity in such a high-pressure environment leads us to conclude that this is further evidence for an increased critical density threshold for star formation in the CMZ due to turbulence."

So in the end, the rate of star formation in a CMZ is not only dependent on their being a lot of gas and dust, but on the nature of the gas environment itself. These results could inform future studies of not only the Milky Way, but of other galaxies as well – particularly when it comes to the relationship that exists between Supermassive Black Holes (SMBHs), star formation, and the evolution of galaxies.

For decades, astronomers have studied the central regions of galaxies in the hopes of determining how this relationship works. And in recent years, astronomers have come up with conflicting results, some of which indicate that star formation is arrested by the presence of SMBHs while others show no correlation.

In addition, further examinations of SMBHs and Active Galactic Nuclei (AGNs) have shown that there may be no correlation between the mass of a galaxy and the mass of its central black hole – another theory that astronomers previously subscribed to.

As such, understanding how and why star formation appears to be different in galaxies like the Milky Way could help us to unravel these other mysteries. From that, a better understanding of how stars and galaxies evolved over the course of cosmic history is sure to emerge.

Further Reading: CfA, MNRAS

PRECISE NEW MEASUREMENTS FROM HUBBLE CONFIRM THE ACCELERATING EXPANSION OF THE UNIVERSE. STILL NO IDEA WHY IT'S HAPPENING

Article written: 27 Feb , 2018

by Matt Williams

In the 1920s, Edwin Hubble made the groundbreaking revelation that the Universe was in a state of expansion. Originally predicted as a consequence of Einstein's Theory of General Relativity, this confirmation led to what came to be known as Hubble's Constant. In the ensuring decades, and thanks to the deployment of next-generation telescopes – like the aptly-named Hubble Space Telescope (HST) – scientists have been forced to revise this law.

In short, in the past few decades, the ability to see farther into space (and deeper into time) has allowed astronomers to make more accurate measurements about how rapidly the early Universe expanded. And thanks to a new survey performed using Hubble, an international team of astronomers has been able to conduct the most precise measurements of the expansion rate of the Universe to date.

This survey was conducted by the Supernova H0 for the Equation of State (SH0ES) team, an international group of astronomers that has been on a quest to refine the accuracy of the Hubble Constant since 2005. The group is led by Adam Reiss of the Space Telescope Science Institute (STScI) and Johns Hopkins University, and includes members from the American Museum of Natural History, the Neils Bohr Institute, the National Optical Astronomy Observatory, and many prestigious universities and research institutions.

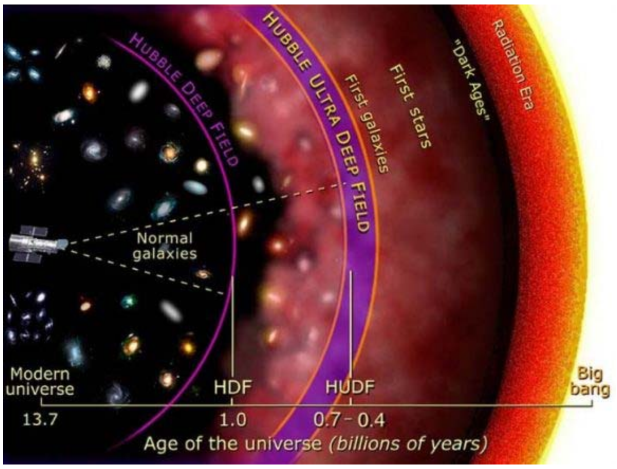


Illustration of the depth by which Hubble imaged galaxies in prior Deep Field initiatives, in units of the Age of the Universe. Credit: NASA and A. Feild (STScI)

The study which describes their findings recently appeared in *The Astrophysical Journal* under the title "Type Ia Supernova Distances at Redshift >1.5 from the *Hubble Space Telescope* Multi-cycle Treasury Programs: The Early Expansion Rate". For the sake of their study, and consistent with their long term goals, the team sought to construct a new and more accurate "distance ladder".

This tool is how astronomers have traditionally measured distances in the Universe, which consists of relying on distance markers like Cepheid variables – pulsating stars whose distances can be inferred by comparing their intrinsic brightness with their apparent brightness. These measurements are then compared to the way light from distance galaxies is redshifted to determine how fast the space between galaxies is expanding.

From this, the Hubble Constant is derived. To build their distant ladder, Riess and his team conducted parallax measurements using Hubble's Wide Field Camera 3 (WFC3) of eight newly-analyzed Cepheid variable stars in the Milky Way. These stars are about 10 times farther away than any studied previously – between 6,000 and 12,000 light-year from Earth – and pulsate at longer intervals.

To ensure accuracy that would account for the wobbles of these stars, the team also developed a new method where Hubble would measure a star's position a thousand times a minute every six months for four years. The team then compared the brightness of these eight stars with more distant Cepheids to ensure that they could calculate the distances to other galaxies with more precision.

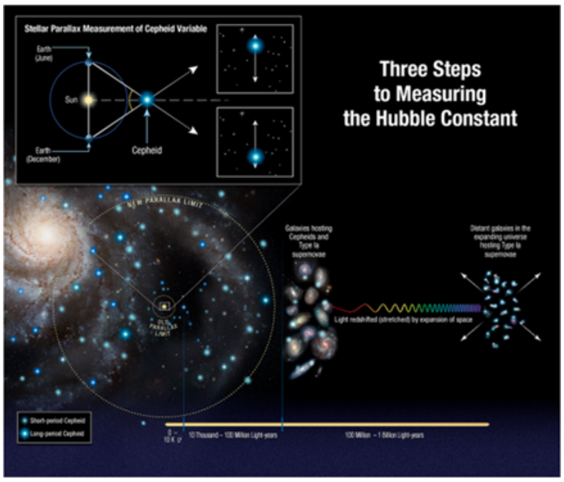


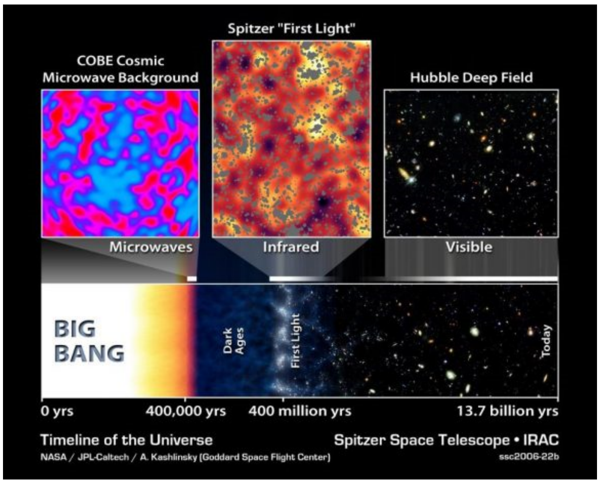
Illustration showing three steps astronomers used to measure the universe's expansion rate (Hubble constant) to an unprecedented accuracy, reducing the total uncertainty to 2.3 percent. Credits: NASA/ESA/A. Feild (STScI)/and A. Riess (STScI/JHU)

Using the new technique, Hubble was able to capture the change in position of these stars relative to others, which simplified things immensely. As Riess explained in a NASA press release:

"This method allows for repeated opportunities to measure the extremely tiny displacements due to parallax. You're measuring the separation between two stars, not just in one place on the camera, but over and over thousands of times, reducing the errors in measurement."

Compared to previous surveys, the team was able to extend the number of stars analyzed to distances up to 10 times farther. However, their results also contradicted those obtained by the European Space Agency's (ESA) Planck satellite, which has been measuring the Cosmic Microwave Background (CMB) – the leftover radiation created by the Big Bang – since it was deployed in 2009.

By mapping the CMB, Planck has been able to trace the expansion of the cosmos during the early Universe – circa. 378,000 years after the Big Bang. Planck's result predicted that the Hubble constant value should now be 67 kilometers per second per megaparsec (3.3 million light-years), and could be no higher than 69 kilometers per second per megaparsec.



The Big Bang timeline of the Universe. Cosmic neutrinos affect the CMB at the time it was emitted, and physics takes care of the rest of their evolution until today. Credit: NASA/JPL-Caltech/A. Kashlinsky (GSFC).

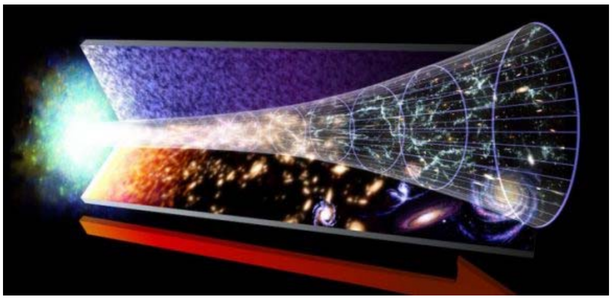
Based on their sruvey, Riess's team obtained a value of 73 kilometers per second per megaparsec, a discrepancy of 9%. Essentially, their results indicate that galaxies are moving at a faster rate than that implied by observations of the early Universe. Because the Hubble data was so precise, astronomers cannot dismiss the gap between the two results as errors in any single measurement or method. As Reiss explained:

"The community is really grappling with understanding the meaning of this discrepancy… Both results have been tested multiple ways, so barring a series of unrelated mistakes. it is increasingly likely that this is not a bug but a feature of the universe."

These latest results therefore suggest that some previously unknown force or some new physics might be at work in the Universe. In terms of explanations, Reiss and his team have offered three possibilities, all of which have to do with the 95% of the Universe that we cannot see (i.e. dark matter and dark energy). In 2011, Reiss and two other scientists were awarded the Nobel Prize in Physics for their

1998 discovery that the Universe was in an accelerated rate of expansion.

Consistent with that, they suggest that Dark Energy could be pushing galaxies apart with increasing strength. Another possibility is that there is an undiscovered subatomic particle out there that is similar to a neutrino, but interacts with normal matter by gravity instead of subatomic forces. These "sterile neutrinos" would travel at close to the speed of light and could collectively be known as "dark radiation".



This illustration shows the evolution of the Universe, from the Big Bang on the left, to modern times on the right. Credit: NASA

Any of these possibilities would mean that the contents of the early Universe were different, thus forcing a rethink of our cosmological models. At present, Riess and colleagues don't have any answers, but plan to continue fine-tuning their measurements. So far, the SHoES team has decreased the uncertainty of the Hubble Constant to 2.3%.

This is in keeping with one of the central goals of the Hubble Space Telescope, which was to help reduce the uncertainty value in Hubble's Constant, for which estimates once varied by a factor of 2.

So while this discrepancy opens the door to new and challenging questions, it also reduces our uncertainty substantially when it comes to measuring the Universe. Ultimately, this will improve our understanding of how the Universe evolved after it was created in a fiery cataclysm 13.8 billion years ago.

Further Reading: NASA, *The Astrophysical Journal*

22 YEARS OF THE SUN FROM SOHO

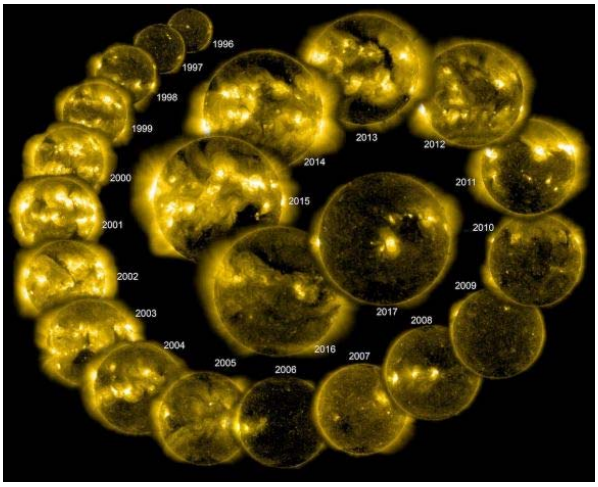
Article written: 26 Feb , 2018

by Evan Gough

The Solar and Heliospheric Observatory (SOHO) is celebrating 22 years of observing the Sun, marking one complete solar magnetic cycle in the life of our star. SOHO is a joint project between NASA and the ESA and its mission is to study the internal structure of the sun, its extensive outer atmosphere, and the origin of the solar wind.

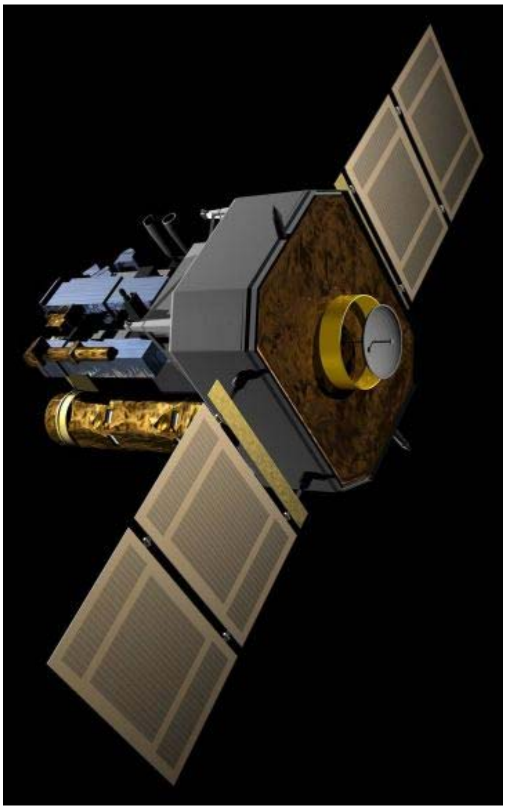
The activity cycle in the life of the Sun is based on the increase and decrease of sunspots. We've been watching this activity for about 250 years, but SOHO has taken that observing to a whole new level.

Though sunspot cycles work on an 11-year period, they're caused by deeper magnetic changes in the Sun. Over the course of 22 years, the Sun's polarity gradually shifts. At the 11 year mark, the orientation of the Sun's magnetic field flips between the northern and southern hemispheres. At the end of the 22 year cycle, the field has shifted back to its original orientation. SOHO has now watched that cycle in its entirety.



The magnetic field of the Sun operates on a 22 year cycle. It takes 11 years for the orientation of the field to flip between the northern and southern hemisphere, and another 11 years to flip back to its original orientation. This composite image is made up of snapshots of the Sun taken with the Extreme ultraviolet Imaging Telescope on SOHO. Image: SOHO (ESA & NASA)

SOHO is a real success story. It was launched in 1995 and was designed to operate until 1998. But it's been so successful that its mission has been prolonged and extended several times.

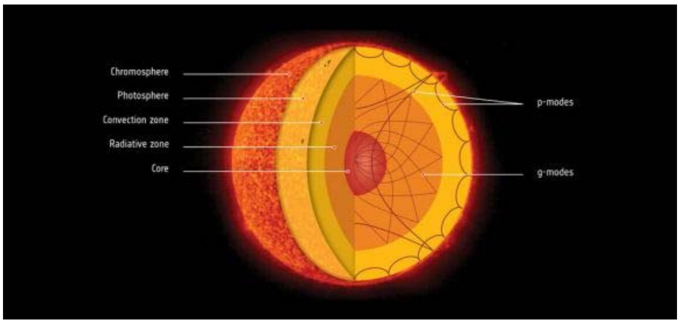


An artist's illustration of the SOHO spacecraft. Image: NASA

SOHO's 22 years of observation has turbo-charged our space weather forecasting ability. Space weather is heavily influenced by solar activity, mostly in the form of Coronal Mass Ejections (CMEs). SOHO has observed well over 20,000 of these CMEs.

Space weather affects key aspects of our modern technological world. Space-based telecommunications, broadcasting, weather services and navigation are all affected by space weather. So are things like power distribution and terrestrial communications, especially at northern latitudes. Solar weather can also degrade not only the performance, but the lifespan, of communication satellites.

Besides improving our ability to forecast space weather, SOHO has made other important discoveries. After 40 years of searching, it was SOHO that finally found evidence of seismic waves in the Sun. Called g-modes, these waves revealed that the core of the Sun is rotating 4 times faster than the surface. When this discovery came to light, Bernhard Fleck, ESA SOHO project scientist said, “This is certainly the biggest result of SOHO in the last decade, and one of SOHO’s all-time top discoveries.”



Data from SOHO revealed that the core of the Sun rotates 4 times faster than the surface. Image: ESA

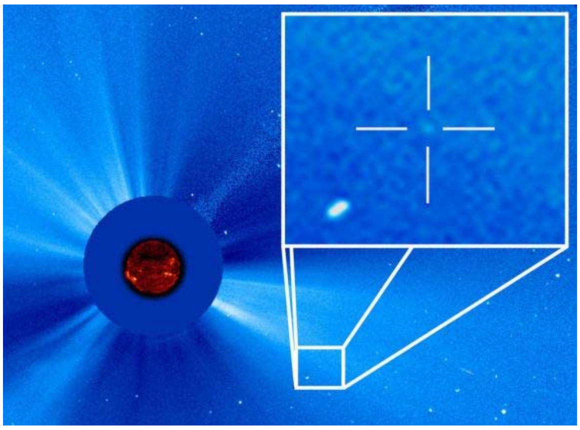
SOHO also has a front row seat for comet viewing. The observatory has witnessed over 3,000 comets as they’ve sped past the Sun. Though this was never part of SOHO’s mandate, its exceptional view of the Sun and its surroundings allows it to excel at comet-finding. It’s especially good at finding sun-grazer comets because it’s so close to the Sun.

“But nobody dreamed we’d approach 200 (comets) a year.” – Joe Gurman, mission scientist for SOHO.

“SOHO has a view of about 12-and-a-half million miles beyond the sun,” said Joe Gurman in 2015, mission scientist for SOHO at NASA’s Goddard Space Flight Center in Greenbelt, Maryland. “So we expected it might from time to time see a bright comet near the sun. But nobody dreamed we’d approach 200 a year.”

A front-row seat for sun-grazing comets allows SOHO to observe other aspects of the Sun’s surface. Comets are primitive relics of the early Solar System, and observing them with SOHO can tell scientists quite a bit about where they formed. If a comet has made other trips around the Sun, then scientists can learn something about the far-flung regions of the Solar System that they’ve traveled through.

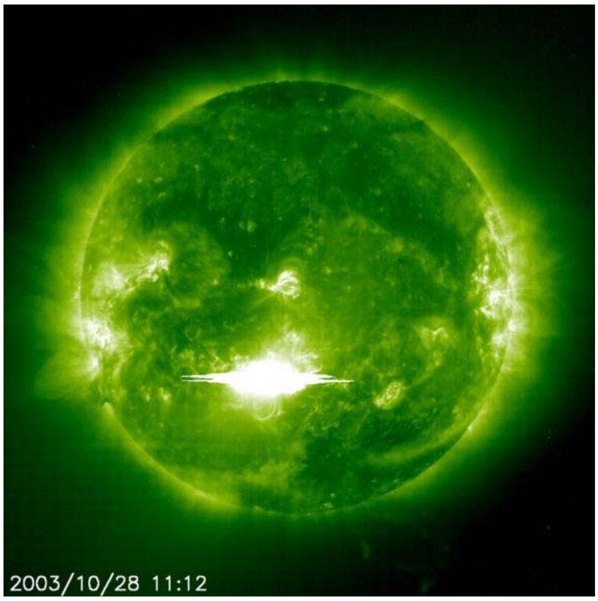
Watching these sun-grazers as they pass close to the Sun also teaches scientists about the Sun. The ionized gas in their tails can illuminate the magnetic fields around the Sun. They’re like tracers that help observers watch these invisible magnetic fields. Sometimes, the magnetic fields have torn off these tails of ionized gas, and scientists have been able to watch these tails get blown around in the solar wind. This gives them an unprecedented view of the details in the movement of the wind itself.



It’s hard to make out, but the dot in the cross-hairs is a comet streaming toward the Sun. This image is from 2015, and the comet is the 3,000th one discovered by SOHO since it was launched. Image: SOHO/ESA/NASA

SOHO is still going strong, and keeping an eye on the Sun from its location about 1.5 million km from Earth. There, it travels in a halo orbit around LaGrange point 1. (It’s orbit is adjusted so that it can communicate clearly with Earth without interference from the Sun.)

Beyond the important science that SOHO provides, it’s also a source of amazing images. There’s a whole gallery of images here, and a selection of videos here.



In 2003, SOHO captured this image of a massive solar flare, the third most powerful ever observed in X-ray wavelengths. Very spooky. Image: NASA/ESA/SOHO

THERE IS A CAR, IN SPACE. LAUNCHED BY A ROCKET WITH REUSED PARTS THAT LANDED BACK ON EARTH BY A BILLIONAIRE WHO WANTS TO COLONIZE MARS.

Article written: 6 Feb , 2018
Updated: 6 Feb , 2018

by Fraser Cain

Update: It looks like the center booster didn’t make the landing. It couldn’t light all its engines back up and it hit the droneship hard.

In the last hour or so, SpaceX successfully completed the first liftoff of the Falcon Heavy rocket. This is a beefed up version of its successful Falcon-9 rocket, where three boosters are strapped together, firing 27 Merlin engines simultaneously with the capability of launching 54 tonnes of cargo into space.

And Liftoff for Falcon Heavy. Credit: SpaceX

The Falcon Heavy is now the most powerful rocket currently operating on Earth, by a factor of two.

On board the Falcon Heavy was Elon Musk's choice for a test mass. An appropriate amount of weight that will demonstrate the Falcon Heavy's ability to carry cargo into space: his car. Specifically, his Midnight Red Tesla Roadster. At the driver's seat is a dummy named StarMan wearing a prototype of the SpaceX spacesuit that astronauts will wear when the Dragon capsule starts delivering crew to the International Space Station.

The launch was delayed by high winds in the upper atmosphere, but when things settled down, they did the launch.

And the launch itself seemed to go perfectly. The Falcon leaped off the launch pad, blasted off into space with its twin reused rocket boosters firing. After a couple of minutes, the boosters detached and returned to Earth, followed by the central stage.

We watched the twin boosters return to Cape Canaveral and land almost simultaneously. The fate of the central third core is still unknown, the video feed cut off as the rocket was returning to the autonomous drone ship in the Atlantic. This happens from time to time, apparently, as the blast of the rocket's landing engines can throw the drone's communications antennae out of alignment.

The payload fairing detached and fell away, revealing the Tesla to the Universe, and the second stage continued on, carrying the car to orbit. As David Bowie's "Space Oddity" began its endless looping background music, we could see the car floating free above the Earth.

According to Musk, the car's going to spend the next 5 hours or so enjoying the radiation of the Van Allen Belts before its final burn to carry it out onto a Marslike orbit.

In completing this launch, SpaceX demonstrated several things. The Falcon Heavy is a reality. If you've got $90 million burning a hole in your pocket, and you want to send 54 tonnes of cargo into low Earth orbit, they'll be glad to take your order.

They tested using previously flown Falcon-9 first stages as components in the Falcon Heavy. They tested landing three boosters simultaneously.

They also got a chance to test out their new spacesuit in actual space. And I guess, they'll know if Tesla Roadsters are ready for the harsh environment of interplanetary space.

Don't Panic StarMan, Don't Panic. Credit: SpaceX

I'm not sure how long this'll last, but you can watch a live view from over the shoulder of StarMan as he sits behind the wheel, with the reassuring "Don't Panic" sign on the Roadster's dashboard.

Interesting side note, Musk announced that they wouldn't be making the Falcon Heavy human rated, they'll be saving that trick for the BFR which should start launching in the next few years, or decades, or however long things take. In other words, we'll need to go through this whole process all over again of anticipation, and excitement.

Clearly this story is still unfolding. Will the car make its transfer burn? Did the third booster land? Does anyone want to buy 54 tonnes of cargo launched to orbit for $90 million? Will the BFR ever launch? Will Jeff Bezos and Blue Origin catch up?

Stay tuned.

BACTERIA SURVIVING ON MUSK'S TESLA ARE EITHER A BIO-THREAT OR A BACKUP COPY OF LIFE ON EARTH

Article written: 28 Feb , 2018

by Evan Gough

A great celebratory eruption accompanied the successful launch of SpaceX's Falcon Heavy rocket in early February. That launch was a big moment for people who are thoughtful about the long arc of humanity's future. But the Tesla Roadster that was sent on a long voyage in space aboard that rocket is likely carrying some bacterial hitch-hikers.

The Falcon Heavy's first flight. Image: SpaceX

A report from Purdue University suggests that, though unlikely, the Roadster may be carrying an unwelcome cargo of Earthly bacteria to any destination it reaches. But we're talking science here, and science doesn't necessarily shy away from the unlikely.

“The load of bacteria on the Tesla could be considered a bio-threat, or a backup copy of life on Earth.” – Alina Alexeenko, Professor of Aeronautics and Astronautics at Purdue University.

NASA takes spacecraft microbial contamination very seriously. The Office of Planetary Protection monitors and enforces spacecraft sterilization. Spreading Terran bacteria to other worlds is a no-no, for obvious reasons, so spacecraft are routinely sterilized to prevent any bacterial hitch-hikers. NASA uses the term “biological burden” to quantify how rigorously a spacecraft needs to be sterilized. Depending on a spacecraft’s mission and destination, the craft is subjected to increasingly stringent sterilization procedures.

If a craft is not likely to ever contact another body, then sterilization isn’t as strict. If the target is a place like Mars, where the presence of Martian life is undetermined, then the craft is prepared differently. When required, spacecraft and spacecraft components are treated in clean rooms like the one at Goddard Space Flight Center.

The clean room at Goddard Space Flight Center where spacecraft are sterilized. Image: NASA

The clean rooms are strictly controlled environments, where staff wear protective suits, boots, hoodies, and surgical gloves. The air is filtered and the spacecraft are exposed to various types of sterilization. After sterilization, the spacecraft is handled carefully before launch to ensure it remains sterile. But the Tesla Roadster never visited such a place, since it’s destination is not another body.

The Tesla Roadster in space was certainly manufactured in a clean place, but there’s a big difference between clean and sterile. To use NASA’s terminology, the bacterial load of the Roadster is probably very high. But would those bacteria survive?

The atmosphere in space is most definitely hostile to life. The temperature extremes, the low pressure, and the radiation are all hazardous. But, some bacteria could survive by going dormant, and there are nooks and crannies in the Tesla where life could cling.

This images shows the Orion capsule wrapped in plastic after sterilization, and being moved to a workstand. These types of precautions are mandated by NASA’s Office of Planetary Protection. Image: NASA.

The Tesla is not predicted to come into contact with any other body, and certainly not Mars, which is definitely a destination in our Solar System that we want to protect from contamination. In fact, a more likely eventual destination for the Roadster is Earth, albeit millions of years from now. And in that case, according to Alina Alexeenko, a Professor of Aeronautics and Astronautics at Purdue University, any bacteria on the red Roadster is more like a back-up for life on Earth, in case we do something stupid before the car returns. “The load of bacteria on the Tesla could be considered a biothreat, or a backup copy of life on Earth,” she said.

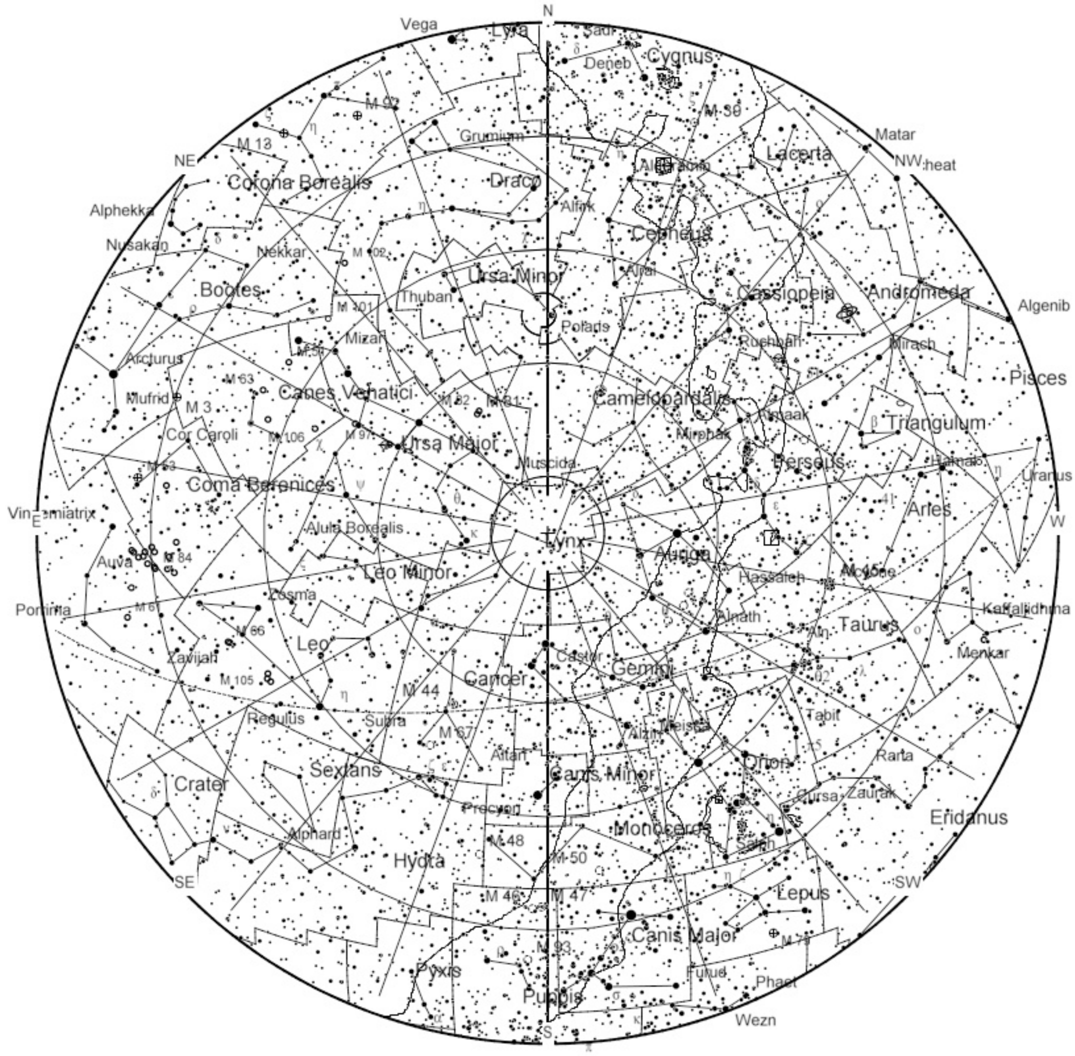
But even if some bacteria survived for a while in some hidden recess somewhere on the Tesla Roadster, could it realistically survive for millions of years in space?

As far as NASA is concerned, length of time in space is one component of sterilization. Some missions are designed with the craft placed in a long-term orbit at the end of its mission, so that the space environment can eventually destroy any lingering bacterial life secreted away somewhere. Surely, if the Roadster does ever collide with Earth, and if it takes millions of years for that to happen, and if it’s not destroyed on re-entry, the car would be sterilized by its long-duration journey?

That seems to be the far more likely outcome. You never know for sure, but the space-faring Roadster is probably not a hazardous bio-threat, nor a back-up for life on Earth; those are pretty fanciful ideas.

Musk’s pretty red car is likely just a harmless, attention-grabbing bauble.

WHATS UP, MARCH 2018



March 2 - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 00:51 UTC. This full moon was known by early Native American tribes as the Full Worm Moon because this was the time of year when the ground would begin to soften and the earthworms would reappear. This moon has also been known as the Full Crow Moon, the Full Crust Moon, the Full Sap Moon, and the Lenten Moon.

March 15 - **Mercury at Greatest Eastern Elongation.** The planet Mercury reaches greatest eastern elongation of 18.4 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the evening sky. Look for the planet low in the western sky just after sunset.

March 17 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 13:12 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

March 20 - **March Equinox.** The March equinox occurs at 16:15 UTC. The Sun will shine directly on the equator and there will be nearly equal amounts of day and night throughout the world. This is also the first day of spring (vernal equinox) in the Northern Hemisphere and the first day of fall (autumnal equinox) in the Southern Hemisphere.

March 31 - **Full Moon, Blue Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 12:37 UTC. Since this is the second full moon in the same month, it is sometimes referred to as a blue moon. This year is particularly unique in that January and March both contain two full moons while February has no full moon.

Planetary Venus and Mercury in the evening skies after Sunset may be the easiest pick of the month, but so below and following pages for more.

This is also the best month to attempt the Messier Marathon. If you can see 102 0f 110 in a FULL night you have done very well indeed. Remember the Messier catalogue objects were seen from an observatory nearly 10 degrees further south than we are here in Wiltshire.

We have a pdf booklet that allows you to plan and mark up your views. Goto telescopes should not be used. Email the newsletter editor and I will send you the 12Mb PDF we have used in the past. The best weekend is the moonless weekend of the 16th and 17th.

This is also the ideal weekend to look for the mysterious zodiacal light I photographed for the first time last March.

Plus the Auror season increases around equinox, so who knows, we may get a triple display.

Clear Skies

Andy

THE MESSIER MARATHON

Messier Marathon is a term describing the attempt to find as many Messier objects as possible in one night. Depending on the location of the observer, and season, there is a different number of them visible, as they are not evenly distributed in the celestial sphere. There are heavily crowded regions in the sky, especially the Virgo Cluster and the region around the Galactic Center, while other regions are virtually empty of them. In particular, there are no Messier objects at all at Right Ascensions 21:40 to 23:20, and only the very northern M52 is between RA 21:40 and 0:40. This chance effect leads, at considerably low northern latitudes on Earth (best around 25 degrees North), to the chance to observe all 110 Messier objects in one night! This opportunity occurs once every year, around mid- to end-March; the best time to try is of course when the Moon is near its new phase. For the upcoming years until 2050, we give best Messier Marathon dates here.

Note: Most Messier Marathoners accept NGC 5866 as M102, either in account of historical evidence, or at least as substitute accepted for the Messier Marathon, and thus arrive at actually 110 different objects. We recommend to do so, but you decide what you want to do.

Messier Marathon was invented independently by several North American (including **Tom Hoffelder**, **Tom Reiland** and **Don Machholz**) and perhaps one Spanish amateur astronomers and groups, in the 1970s. It was probably first in the night of March 23/24, 1985 that **Gerry Rattley** from Dugas, Arizona, completed the list and hunted down all 110 Messier Objects in one night; while he was the first to achieve this goal, it was only about one hour later that **Rick Hull** duplicated this success from Anza, California. This is however possible only under exceptionally good observing conditions, and at a preferred location. Anyway, some Messier Marathon tips may help to be [even] more successful with this endeavor, i.e., see one or a few objects more.

Meanwhile, a number of clubs started to hold more considerable Messier Marathon events, notably in Arizona. In 1981, the **Saguaro Astronomy Club (SAC)** held their first Messier Marathon with about 40 participants, the first in a row of meanwhile 21 events (as of 2009) sponsored by this club; Gerry Rattley's first 110 objects success of 1985 happened on their fourth event. Since 1993, SAC sponsors the famous **All Arizona Messier Marathons** held annually near Arizona City and organized by **A.J. Crayon**. Other clubs throughout the world are also holding their Messier Marathon events semi-annually.

The more complete Messier Marathon history can be found in **Don Machholz**'s booklet, *The Messier Marathon Observer's Guide* (Machholz 1994), or its newer edition or successor, *The Observing Guide to the Messier Marathon* (Machholz 2002), which moreover gives a most useful proposition for the search sequence. It also points out that less complete Messier Marathons may be run at every time in the year, the percentage depending on location and time.

Southerners may prefer other marathons. For the time around September each year, there is another 110-object marathon for mid-northern observers, the Messier Plus Marathon (compiled by Wally Brown and Bob Buckner). Experienced observers have compiled more massive lists for marathoning up to over 500 objects a night; Don Machholz reports that he hunted down 599 deep-sky splendors in one night !

Tom Polakis has investigated the observing window for finding all 110, depending on geographic latitude (Polakis 2006).

Since their invention, Messier Marathons had to face some opposition. As Don Machholz points out, the major complaint is that "rushing through a Messier [or other] list does not allow to study each" object seriously. However, as nothing prevents you from returning to them, and studying them with more time, in other nights, "such criticism can be ignored, since the Messier Marathon is not designed for everyone. The critic can spend the night looking at a shorter list of wonders. A counterpoint to this resistance is that the Marathoner will see nearly all the Messier Catalogue in one night -- many amateur astronomers [and even more professionals, believe me - hf :-)] never see the whole catalogue in their whole lifetime. Additionally, one's searching and locating skills, necessary in most aspects of astronomy, are sharpened during the Marathon. The benefit of seeing, in one night, the major building blocks of our Galaxy: open and globular clusters, diffuse and planetary nebulae, along with other galaxies, cannot be ignored. Finally, there is a satisfaction of working with others toward a common goal, and then finally achieving it [hopefully !]." Rumors say that there are some hardliners who feel the same satisfaction when they do it alone...

Marathons are of course enriched if other appealing celestial events can fill in the pauses which normally occur if you have hunted down everything you can at a time, and wait for the morning objects to rise. In 1997, the outstanding naked-eye comet Hale-Bopp (C/1995O1) gave an extraordinary spectacle exactly at Messier Marathon time in March and April, to celebrate the Messier Marathon's 20th birthday, similar to 1996's Hyakutake (C/1996B2). In 1998, there was no such bright comet, but a considerable supernova, SN 1998S in NGC 3877 (in Ursa Major), had timely occured and brightened up to 12th magnitude to enrich the Messier Marathon. In 2002, there occured two remarkable add-ons just in time: the most remarkable supernova 2002ap occurred in M74 in late January, and comet C/2002 C1 (Ikeya-Zhang) was discovered, and brightened to naked-eye visibility in March and April! In 2006, supernova 2006X flashed up in M100 in early February, as for 2009 did SN 2008in in M61, giving an interesting addition of the marathon. We don't know in advance what extras will give future Messier Marathons additional value, but intend to provide the relevant information here as soon as it is available. Check for more info on upcoming or current Messier Marathons: **Messier Marathon 2010**.

Another common extension of the Messier Marathon is to add a solar system marathon, i.e. to try to observe as many of the 8 planets besides Earth during the Messier Marathon night (e.g., 1999 to 2004 offered the opportunity to find all 8). 2006 to 2008 may have been the last opportunities to achieve the Nine-Planet goal; then Uranus and later Neptune will be too close to the Sun during Messier Marathon time for a considerable number of years, until about the 2040s, but there always remain some of them.

There have been several propositions to make the Messier Marathon more challenging for those who do it repeated times. An interesting proposition was brought to my attention by **Tom Hoffelder** one of the Messier Marathon inventors. He points out that he and his friend **Greg Zentz**, who has also completed a number of Marathons, came up with the idea of doing it completely from memory. This would mean no star charts or notes of any kind, only a list of the objects in order of search. They are thinking of trying it and calling it "M cubed" (Messier Memory Marathon). On March 29-30, 2003, **Don Machholz** was the first marathoner to achieve a more notable success in a "M cubed" marathon, as he hunted down as many as 108 Messier objects from memory without any further help. On March 25/26, 2004, it was again **Don Machholz** who successfully did the first full 110-object score in a "M cubed." Marathoner and A.L. Master Observer **Stephen Saber** has also been running the M-Cubed for several years. His method adds the memorization of the entire search sequence.

ZODIACAL LIGHT

Zodiacal light is a faint, diffuse, and roughly triangular white glow visible in the night sky that appears to extend from the vicinity of the Sun along the ecliptic or zodiac.[1] Sunlight scattered by interplanetary dust in the zodiacal cloud causes this phenomenon. Zodiacal light is best seen during twilight after sunset in spring and before sunrise in autumn, when the zodiac is at a steep angle to the horizon. However, the glow is so faint that moonlight and/or light pollution outshine it, rendering it invisible.

The zodiacal light decreases in intensity with distance from the Sun, but in naturally dark skies, it is visible as a band completely around the ecliptic. In fact, the zodiacal light covers the entire sky and is largely responsible for the total natural skylight on a moonless, clear night. Another phenomenon—a faint, but slightly brighter, oval glow—directly opposite of the Sun is the gegenschein.

The dust in the Solar System forms a thick, pancake-shaped cloud collectively known as the zodiacal cloud, which straddles the ecliptic plane. The dust particles are between 10 and 300 micrometres in diameter, most with a mass around 150 micrograms

Viewing

In the mid-latitudes, the zodiacal light is best observed in the western sky in the spring after the evening twilight has completely disappeared, or in the eastern sky in the autumn just before the morning twilight appears. The zodiacal light appears as a column, brighter at the horizon, tilted at the angle of the ecliptic. The light scattered from extremely small dust particles is strongly forward scattering, although the zodiacal light actually extends all the way around the sky, hence it is brightest when observing at a small angle with the Sun. This is why it is most clearly visible near sunrise or sunset, when the sun is blocked, but the dust particles nearest the line of sight to the sun are not. The dust band that causes the zodiacal light is uniform across the whole ecliptic.

The dust further from the ecliptic is almost undetectable except when viewed at a small angle with the sun. Thus it is possible to see more of the width at small angles toward the sun, and it appears wider near the horizon, closer to the sun under the horizon.

Origin

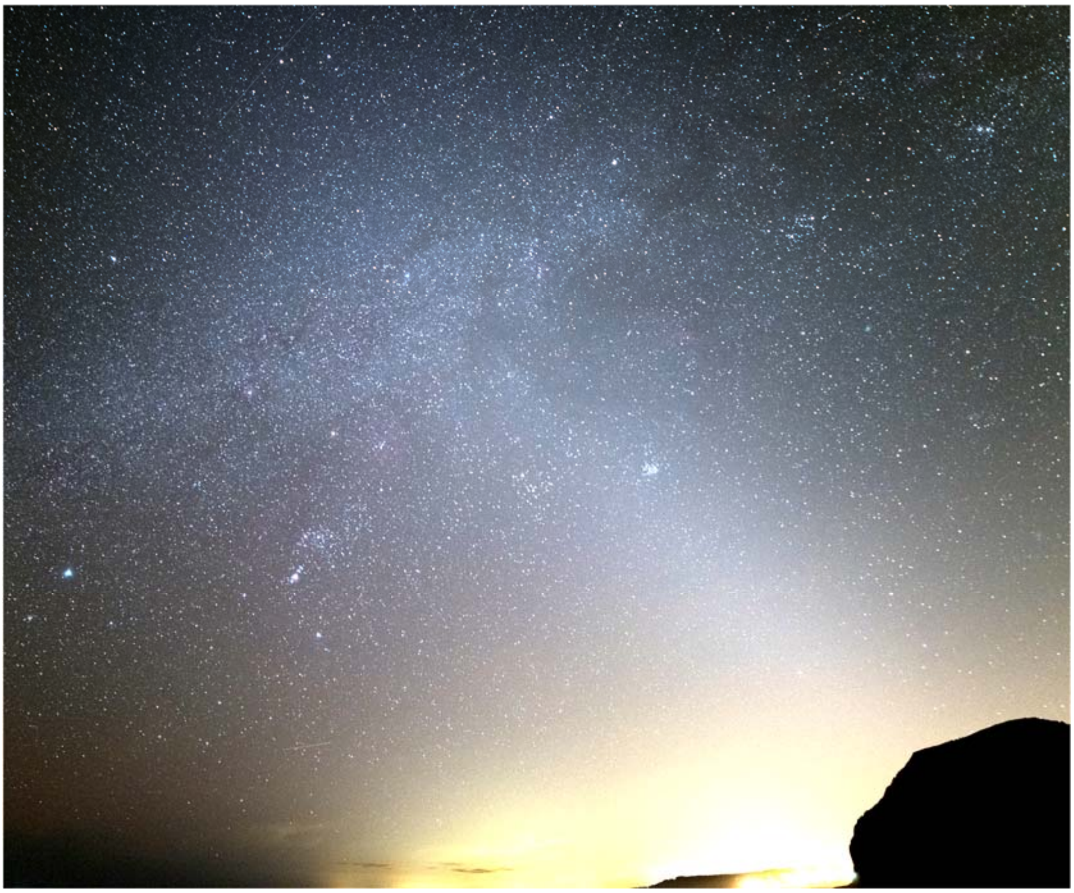
The source of the dust has been long debated. Until recently, it was thought that the dust originated from the tails of active comets and from collisions between asteroids in the asteroid belt.[5] Many of our meteor showers have no known active comet parent bodies. Over 85 percent of the dust is attributed to occasional fragmentations of Jupiter-family comets that are nearly dormant.[6] Jupiter-family comets have orbital periods of less than 20 years and are considered dormant when not actively outgassing, but may do so in the future. The first fully dynamical model of the zodiacal cloud demonstrated that only if the dust was released in orbits that approach Jupiter, is it stirred up enough to explain the thickness of the zodiacal dust cloud. The dust in meteoroid streams is much larger, 300 to 10,000 micrometres in diameter, and falls apart into smaller zodiacal dust grains over time.

The Poynting–Robertson effect forces the dust into more circular (but still elongated) orbits, while spiralling slowly into the Sun. Hence a continuous source of new particles is needed to maintain the zodiacal cloud. Cometary dust and dust generated by collisions among the asteroids are believed to be mostly responsible for the maintenance of the dust cloud producing the zodiacal light and the gegenschein.

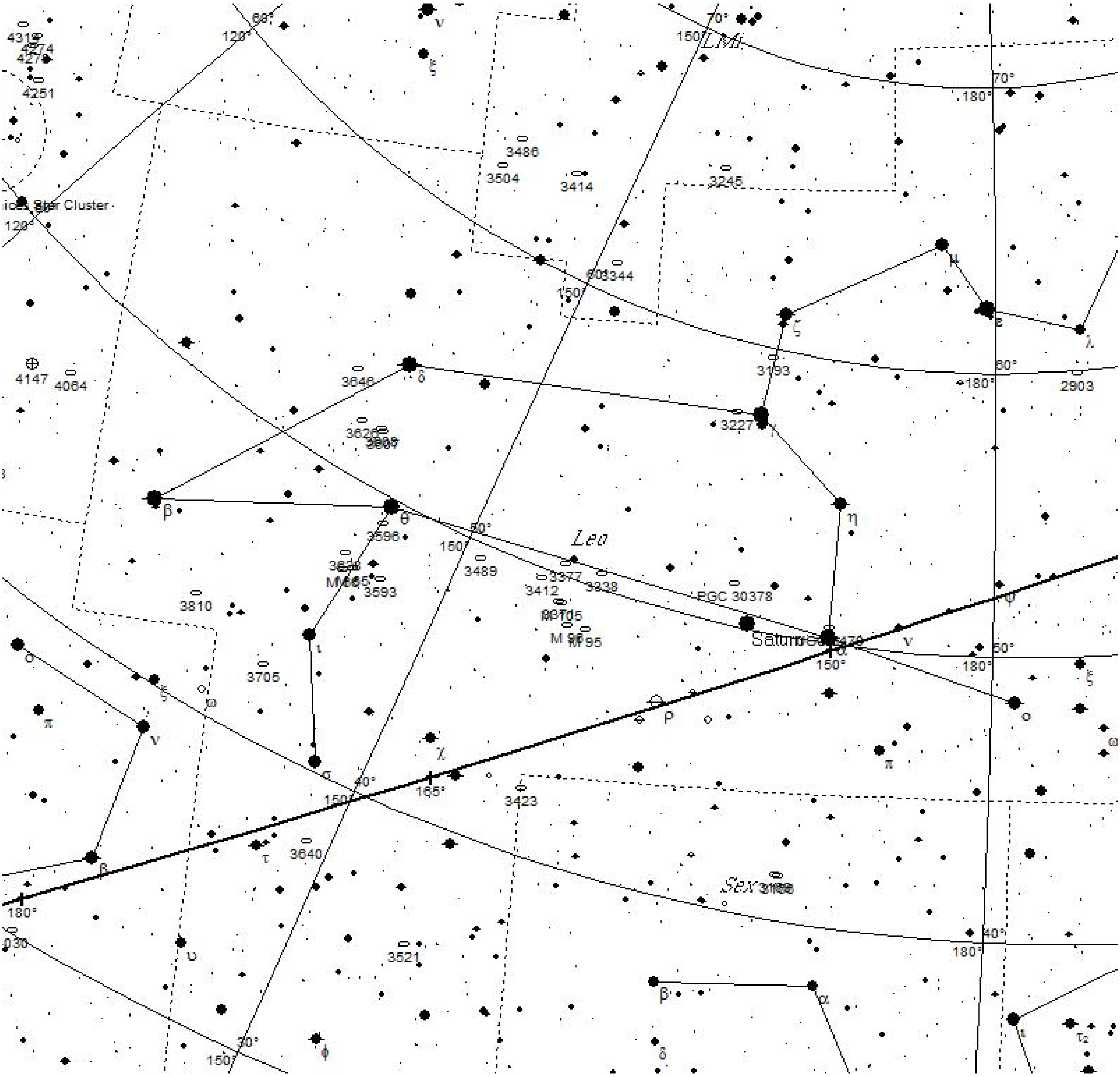
Particles can be reduced in size by collisions or by space weathering. When ground down to sizes less than 10 micrometres, the grains are removed from the inner Solar System by solar radiation pressure. The dust is then replenished by the infall from comets. Zodiacal dust around nearby stars is called exozodiacal dust; it is a potentially important source of noise for directly imaging extrasolar planets. It has been pointed out that this exozodiacal dust, or hot debris disks, can be an indicator of planets, as planets tend to scatter the comets to the inner Solar System.

In 2015, new results from the secondary ion dust spectrometer COSIMA on board the *ESA/Rosetta* orbiter confirmed that the parent bodies of interplanetary dust are most probably Jupiter-family comets such as comet 67P/Churyumov-Gerasimenko.

The image of the zodiacal light below I took using a 20mm lens from the beach below Golden Cap. The lights from Lyme Regis are yellowish, and the Milky Way runs left to right at a slight incline, but the triangle of light sretching right to left from the cliff top through the Pleiades is the zodiacal light.



CONSTELLATIONS OF THE MONTH: LEO



The first on the list of Heracles' labours was the task of killing the Nemean Lion, a giant beast that roamed the hills and the streets of the Peloponnesian villages, devouring whomever it met.

The animal's skin was impervious to iron, bronze, and stone. Heracles' arrows harmlessly bounced off the lion; his sword bent in two; his wooden club smashed to pieces. So Heracles wrestled with the beast, finally choking it to death. He then wrapped the lion's pelt about him; it would protect him from the next labour: killing the poisonous Hydra.

As the story goes, the lion found its way to the heavens to commemorate the great battle with Heracles. Yet this isn't all there is to the story. For even in antiquity, long before the Greeks began telling stories, the lion was an ancient symbol of power.

Approximately three thousand years before the Christian era carvings and sculptures showed kings flanked with rampant lions. Indeed, the archaeological evidence suggests that at about this time the lion had already replaced an even earlier "sacred" symbol, the bull.

It has been suggested that this transfer of power from a horned animal to the lion was a change-over from a lunar-based to a solar-based religion. That is, instead of drawing their inspiration from a night-time symbol with a monthly cycle --a symbol which dealt with the fecundity of the earth and of its animals--the new rulers identified with an animal of strength and power, and with a heavenly body that ruled the day. Thus, as the bull had been identified with the moon, the lion was now associated with the sun. To assert this new religion, or new political structure, the lion was made to kill the bull. Its place in the heavens was therefore critical.

An intriguing theory, put forth thirty years ago by Professor Willy Hartner, eloquently describes the result. Briefly put, at about 4000 BC, the Lion is seen chasing the Bull over the horizon, announcing the end of winter and the beginning of spring. I shall quote Professor Hartner's descriptive words:

"The constellation Leo would have been directly overhead, standing at zenith and displaying thereby its maximum power [as it] kills and destroys the Bull trying to escape below the horizon, which during the subsequent days disappears in the Sun's rays to remain invisible for a period of forty days, after

which it is reborn, rising again for the first time (March 21) to announce Spring equinox." [See W. Hartner, "The Earliest History of the Constellations in the Near East and the Motif of the Lion-Bull Combat" *JNES* 24(1965)1-16.]

Thus Leo, slayer of Taurus, dominated the summer skies, the time that the sun passed through this constellation. Due to precession, the sun currently passes through Leo at the end of summer, from mid-August through mid-September.

Leo is a fairly compact constellation and, unlike so many other constellations, it is readily recognisable. *Alpha Leonis* is named "Regulus" because it was seen as the Heaven's Guardian, one who regulated all things in the heavens. While the name Regulus was given us by Copernicus, the star was better known in antiquity as *Cor Leonis*, the Lion's Heart.

Regulus is a multiple binary, discussed below. Also, because Regulus lies so close to the ecliptic, the moon often passes close by, and even occults the star on very rare occasions.

Like other ancient constellations, many of the stars in Leo are named.

Beta Leonis is called "Denebola": the Lion's Tail.

Gamma Leonis is "Algeiba", Arabic for forehead, but more correctly named *Juba*, meaning mane.

Zeta Leonis is "Aldhafera", the meaning is uncertain;

Epsilon Leonis and *mu Leonis* go under the name of "Al Ashfar", the eyebrows.

Delta Leonis is "Zosma", a Greek word meaning girdle.

Lambda Leonis is Alterf, apparently meaning "extremity". It's located right at the tip of the lion's mouth.

Double stars in Leo:

Alpha Leonis (Regulus) is a multiple system. Component B is very wide: (8.1m, PA 307 degrees, 177"), and this star has its own companion ("C"), a very faint 13m dwarf, with a period of about 2000 years, now approximately 2.6" and a PA of about 86 degrees.

A fourth companion, D, is only optical. That is, there is no gravitational bond with the others, but before that was established, it too became a part of the group. It is found at 274 degrees, and 217".

Gamma Leonis is a notable binary with a slow orbit. While Burnham lists three possible periods (407y, 701.4, and 618.6) we have settled on the latter as the most probable, and based its orbit on this period.

Presently the companion is very gradually drawing away from the primary. The current values are: PA 124 degrees and separation 4.4".

Iota Leonis is a more rapid binary, with a period of 192 years. Its orbit shows that the 6.7m companion is slowly increasing its distance (now at PA 122 degrees and separation 1.62").

Variable stars in Leo:

R Leonis is the only variable of note in Leo. This isn't your typical Mira-type long-period variable. First of all, it's usually a very faint 11.3m star, which grows to an extremely bright 4.4m every 309.95 days. In 2000 the maximum should arrive in the last week of February.

Secondly, its colour is an unusually deep red, approaching purple. Surrounded by a number of white stars (18, 19, 21 Leo.) its own colour is even more pronounced. Thus *R Leonis* has become a favourite subject for many variable star observers.

Deep Sky Objects in Leo:

Leo has five Messier objects: *M65*, *M66*, *M95*, *M96*, and *M105*.

M65 (NGC 3623) and *M66* (NGC 3627) make a splendid pair of spiral galaxies in the same field, between theta Leonis and iota Leonis.

This is a fine binocular duo, or use a small telescope. M66 is the one to the east. Both galaxies are elongated north-south; M65 has a tighter spiral and is perhaps the more noticeable.

About a degree north, hovering just between M65 and M66, is NGC 3628, a galaxy seen edge-on. Actually this is larger than either Messier object, but much dimmer because it is seen edge-on.

M95 (NGC 3351) and *M96* (NGC 3368) form another nice pair, although farther apart. The two are found is a group of galaxies midway between alpha Leonis and theta Leonis, and just slightly to the south.

Of the two, M95 is to the west. This is a curious round object, with a very faint circular bar. M96 is a tight spiral galaxy, much brighter than its neighbour. Both this pair and M65/M66 are considered to be about 30 million light years away.

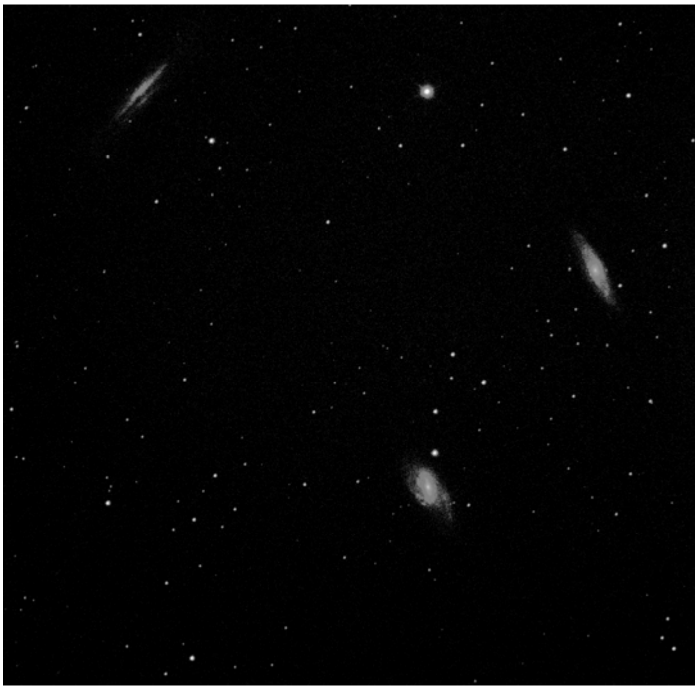
M105 (NGC 3379) is a much dimmer galaxy to the north-north-east of M96. Along with NGC 3384 and NGC 3389, which lie just to the east, this object forms a small triangle of galaxies.

Then there is *NGC 2903*, which somehow escaped Messier's telescope. This deep sky object is judged to be a visual magnitude of 8.9, which makes it brighter than any of the above Messier objects, and covering a larger area as well. It is an elongated multiple-armed spiral located directly south of lambda Leonis, one and a half degrees.

Indeed, there are many more galaxies in Leo to explore. Most of them lie between alpha and beta Leonis, with a smaller group scattered around gamma Leonis. Most of them are 10-12m, so the larger the telescope the more favourable the viewing.

If you wish a real deep sky challenge, try *Wolf 359*. This is an extremely faint red dwarf, and the third closest star, at 7.65 light years. It has a visual magnitude of only 13.53, which renders it all but lost among the millions of other stars. Only as large as Jupiter, it has a luminosity about 1/65,000 of the Sun's; its absolute magnitude is calculated at 16.7m.

Its Epoch 2000 values are: right ascension 10h 56m, declination 07 degrees, one second. If using Tirion's *SkyAtlas 2000.0*, while this chart doesn't show the star, you can easily find the region. Locate 56 Leo (west of sigma Leonis) then place a mark on the ecliptic just above this star. (The ecliptic is the dotted line running north of this star). This is where you'll find *Wolf 359*. Now you'll need Burnham's finder (on his page 1072), a nice dark sky, and plenty of patience.



HUMANITY STAR

A STAR FOR HUMANITY

Visible with the naked eye, the Humanity Star is a highly reflective satellite that blinks brightly across the night sky to create a shared experience for everyone on the planet.

Created by Rocket Lab founder and CEO Peter Beck, the Humanity Star is a geodesic sphere made from carbon fibre with 76 highly reflective panels. It spins rapidly, reflecting the sun's rays back to Earth, creating a flashing light that can be seen against a backdrop of stars.

Orbiting the Earth every 90 minutes and visible from anywhere on the globe, the Humanity Star is designed to be a bright symbol and reminder to all on Earth about our fragile place in the universe.

Launch and orbit

Humanity Star was launched on 21 January 2018 at 01:43 UTC from Rocket Lab Launch Complex 1, located on the Māhia Peninsula of New Zealand

It orbits the Earth every 92 minutes in a polar orbit of approximately 290 by 520 km (180 by 320 mi) in altitude. The satellite's orbit is expected to decay after about nine months, eventually burning up completely in Earth's atmosphere.

Visibility

Because of its highly reflective surface, Rocket Lab claims *Humanity Star* can be seen by the naked eye from the surface of the Earth. Its apparent brightness is estimated to be magnitude 7.0 when half illuminated and viewed from a distance of 1,000 kilometres (620 mi), while its maximum brightness is estimated to be magnitude 1.6.

The satellite is likely to be visible in the night sky at dawn or dusk. Its orbit can be tracked at Heavens-Above and at the satellite's website.

Criticism

Initial reactions by astronomers were negative, since reflective objects in orbit can interfere with astronomical observations. It has been described as an act of vandalism of the night sky, space graffiti, a "publicity stunt" and "glittery space garbage". Others argue that flares by existing satellites and the ISS are much brighter than *Humanity Star*.

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
07 Mar	8.5	05:40:17	10°	ENE	05:40:46	10°	ENE	05:41:15	10°	ENE
08 Mar	7.5	05:59:08	10°	NNE	06:01:17	22°	ENE	06:03:30	10°	SE
09 Mar	4.1	19:39:57	10°	S	19:42:17	83°	W	19:44:39	10°	N
10 Mar	6.5	19:58:17	10°	SW	20:00:22	28°	WNW	20:02:30	10°	NNW
11 Mar	7.9	05:23:25	10°	NNE	05:25:13	16°	ENE	05:27:03	10°	ESE
11 Mar	5.7	18:44:10	10°	SE	18:45:57	20°	E	18:47:48	10°	NE
11 Mar	8.0	20:16:26	10°	WSW	20:17:41	13°	WNW	20:18:57	10°	NW
12 Mar	6.6	05:39:42	10°	N	05:42:10	33°	ENE	05:44:42	10°	SE
12 Mar	4.4	18:59:55	10°	S	19:02:11	48°	E	19:04:31	10°	NNE
13 Mar	4.8	19:15:18	10°	SSW	19:17:36	59°	W	19:20:00	10°	N
14 Mar	6.9	19:30:12	10°	SW	19:32:14	25°	WNW	19:34:19	10°	NNW
15 Mar	7.9	04:53:53	10°	NNE	04:55:48	18°	ENE	04:57:45	10°	ESE
15 Mar	8.0	19:44:47	10°	WSW	19:46:03	13°	WNW	19:47:20	10°	NW

ISS PASSES For March/April 2018 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
07 Mar	-1.6	04:01:38	24°	ESE	04:01:38	24°	ESE	04:03:18	10°	E
07 Mar	-3.9	05:34:17	18°	W	05:36:33	88°	S	05:39:51	10°	E
08 Mar	-3.9	04:43:57	67°	SW	04:44:15	75°	SSE	04:47:31	10°	E
09 Mar	-1.7	03:53:36	25°	E	03:53:36	25°	E	03:55:11	10°	E
09 Mar	-3.9	05:26:14	20°	W	05:28:23	84°	N	05:31:41	10°	E
10 Mar	-4.0	04:35:51	79°	W	04:36:02	88°	N	04:39:19	10°	E
11 Mar	-1.6	03:45:28	25°	E	03:45:28	25°	E	03:46:58	10°	E
11 Mar	-3.9	05:18:06	21°	W	05:20:11	89°	S	05:23:28	10°	E
12 Mar	-4.0	04:27:43	83°	NW	04:27:47	85°	N	04:31:04	10°	E
13 Mar	-1.4	03:37:21	22°	E	03:37:21	22°	E	03:38:40	10°	E
13 Mar	-3.8	05:10:00	23°	W	05:11:52	70°	SSW	05:15:08	10°	ESE
14 Mar	-3.9	04:19:38	79°	SE	04:19:38	79°	SE	04:22:46	10°	ESE
15 Mar	-1.2	03:29:21	18°	E	03:29:21	18°	E	03:30:21	10°	E
15 Mar	-3.4	05:01:59	26°	W	05:03:27	46°	SSW	05:06:36	10°	SE
16 Mar	-3.2	04:11:45	48°	SE	04:11:45	48°	SE	04:14:20	10°	ESE
16 Mar	-2.1	05:44:45	10°	W	05:47:08	19°	SW	05:49:31	10°	S
17 Mar	-0.8	03:21:38	12°	ESE	03:21:38	12°	ESE	03:21:58	10°	ESE
17 Mar	-2.8	04:54:17	26°	SW	04:54:53	28°	SSW	04:57:44	10°	SSE
18 Mar	-1.9	04:04:16	22°	SSE	04:04:16	22°	SSE	04:05:41	10°	SE
18 Mar	-1.5	05:38:01	10°	SW	05:38:21	10°	SW	05:38:42	10°	SW
19 Mar	-1.8	04:47:06	15°	SSW	04:47:06	15°	SSW	04:48:18	10°	S
24 Mar	-1.4	20:16:32	10°	SSW	20:17:02	13°	S	20:17:02	13°	S
25 Mar	-1.9	20:25:01	10°	S	20:26:46	14°	SE	20:27:30	13°	SE
25 Mar	-1.3	21:59:29	10°	SW	22:00:11	15°	SW	22:00:11	15°	SW
26 Mar	-3.2	21:07:11	10°	SW	21:10:13	35°	SSE	21:10:24	35°	SE
27 Mar	-2.5	20:15:05	10°	SSW	20:17:48	24°	SSE	20:20:25	11°	E
27 Mar	-3.0	21:50:40	10°	WSW	21:53:05	45°	WSW	21:53:05	45°	WSW
28 Mar	-3.7	20:58:10	10°	WSW	21:01:24	57°	SSE	21:02:54	27°	E
28 Mar	-1.3	22:34:32	10°	W	22:35:34	19°	W	22:35:34	19°	W
29 Mar	-4.0	21:41:55	10°	W	21:45:13	89°	N	21:45:16	86°	ENE
30 Mar	-3.9	20:49:19	10°	WSW	20:52:36	80°	SSE	20:54:53	18°	E
30 Mar	-2.0	22:25:47	10°	W	22:27:31	29°	W	22:27:31	29°	W
31 Mar	-3.9	21:33:09	10°	W	21:36:27	85°	N	21:37:03	56°	E
31 Mar	-0.5	23:09:38	10°	W	23:09:41	10°	W	23:09:41	10°	W
01 Apr	-3.8	20:40:30	10°	W	20:43:48	86°	N	20:46:32	14°	E
01 Apr	-2.5	22:16:59	10°	W	22:19:10	38°	W	22:19:10	38°	W
02 Apr	-3.9	21:24:20	10°	W	21:27:38	86°	S	21:28:36	43°	ESE
02 Apr	-0.8	23:00:53	10°	W	23:01:14	12°	W	23:01:14	12°	W
03 Apr	-3.8	20:31:40	10°	W	20:34:58	86°	NNE	20:38:01	12°	E
03 Apr	-2.8	22:08:09	10°	W	22:10:39	39°	WSW	22:10:39	39°	WSW
04 Apr	-3.7	21:15:27	10°	W	21:18:43	65°	SSW	21:20:03	32°	SE
04 Apr	-0.9	22:52:19	10°	W	22:52:41	12°	W	22:52:41	12°	W
05 Apr	-3.8	20:22:46	10°	W	20:26:03	82°	S	20:29:20	10°	ESE
05 Apr	-2.5	21:59:22	10°	W	22:02:05	29°	SW	22:02:05	29°	SW
06 Apr	-3.1	21:06:33	10°	W	21:09:41	42°	SSW	21:11:29	21°	SE
07 Apr	-1.7	21:50:49	10°	W	21:53:02	17°	SW	21:53:34	16°	SSW
08 Apr	-2.2	20:57:44	10°	W	21:00:31	26°	SSW	21:03:02	12°	SSE
10 Apr	-1.3	20:49:15	10°	WSW	20:51:12	15°	SW	20:53:08	10°	S

END IMAGES, OBSERVING AND OUTREACH

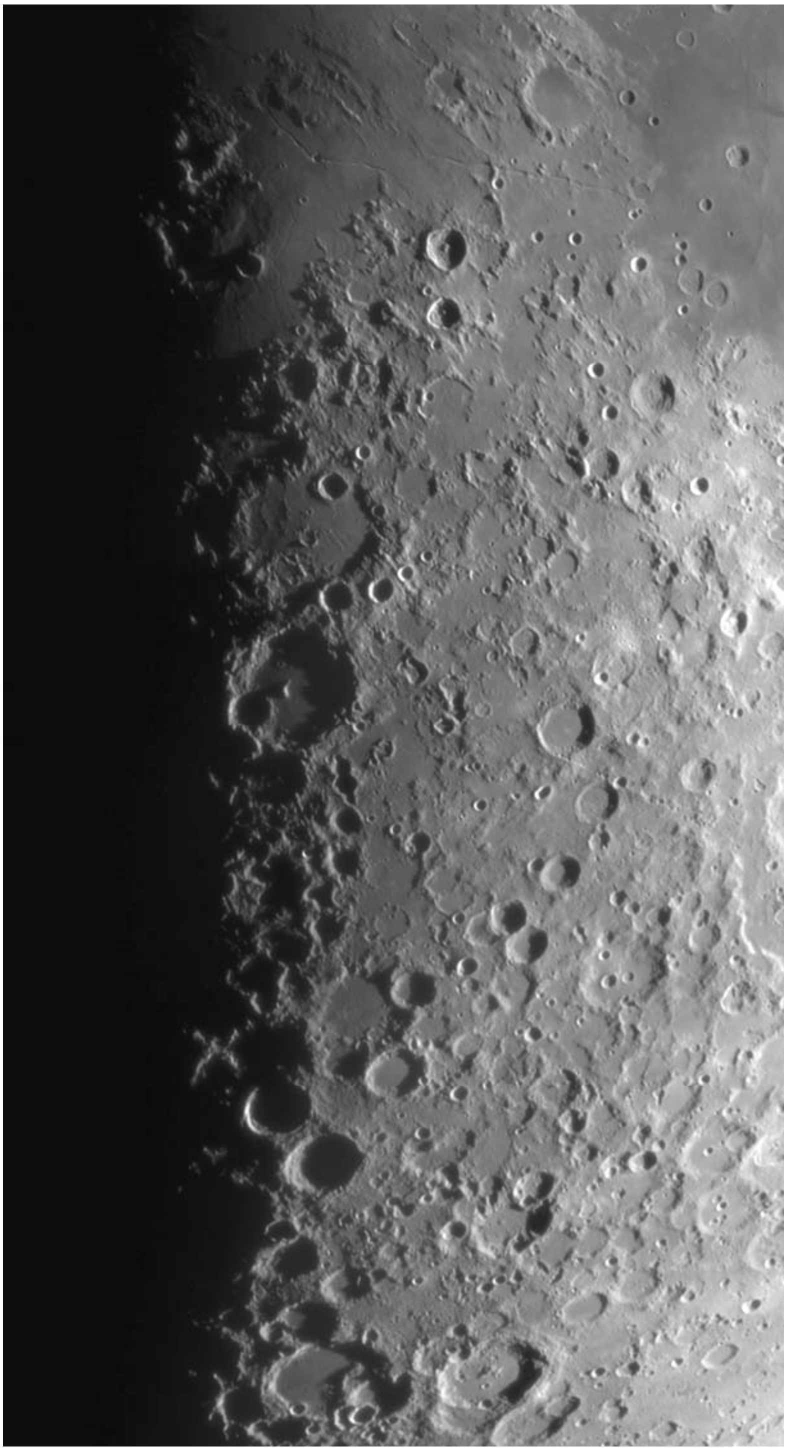
The Lunar 'V' and Lunar 'X'

I set up the web cam and barlow lens to my short 102TMB refractor to capture the 6 day phase of the Moon on the 18th of February and was delighted that it coincided with the 3 hour window per lunar cycle when Werner's X appears in the southern half of the terminator.

Werner's X. The event is dependent on sunlight illuminating the features at 25.2S/0.9E, so it is really the sun angle at that position which matters. Aside from differences in foreshortening, the view will be essentially the same whenever the Sun is at a particular angle above the local horizontal (the "sun angle"). For example, according to Chapman, in an observtion of January 25, 2007 the "first pinprick" of light was observed at 2130 UT. This corresponds to a sun angle of -1.97°. At this particular position, and under the circumstances where the "X" is observed, the local sun angle is increasing by about 0.1 degrees every 13 minutes. According to Chapman, the "X" can be seen for a total of about 4.5 hours, during which time the Sun would rise by about 2° (or to a roughly horizontal position). The illusion of a bright "X" on a dark background is most striking for about an hour near the end of that interval.

The ***Lunar V*** north-northeast of **Ukert M** (this is a rather large clair-obscur effect, observable through small telescopes, during local sunrise). This effect is observable at about the same moment of the Lunar X 's appearance.

About 6000 frames of DMK52 images included in the whole terminator view.



Wiltshire Astronomical Society Observing Sessions 2017 – 2018		
Date	**Moon Phase**	**Observing Topic**
2018		
23rd March	Half moon	Lunar targets and brighter deep sky objects
20th April	Waxing Crescent	Deep sky objects in the Great Bear and Leo
18th May	Slim Crescent	Jupiter low in the south east, and the return of the Summer Triangle

OUTREACH ACTIVITIES

Arrangements being made with several schools, but dates tbc.