Wadhurst Astronomical Society Newsletter September 2017

MEETINGS

THERE WAS NO MEETING IN AUGUST

WAS VISIT TO THE SPACE GEODESY FACILITY AT HERSTMONCEUX

There is no Society meeting in August but this year Brian Mills organised a very successful visit to the Space Geodesy Facility in the grounds of Herstmonceux Castle, East Sussex, in early August where 19 members and friends came along.

The facility is on the site of the Bader Study Centre and is a little way from the familiar domes of the Observatory Science Centre.

The Space Geodesy Facility with the now unused Isaac Newton Dome in the far distance

We were met by Dr Graham Appleby, the Head of Service for the Facility. He told us how the grounds as a whole had been vacated by the Royal Greenwich Observatory some time ago and moved first to Cambridge and then to Edinburgh. The 98-inch Isaac Newton Telescope that had been in the Isaac Newton Dome was refurbished and transferred to the observatory on Las Palma in 1979 where it is still being used although is now one of the smaller telescopes.

Herstmonceux Castle and the grounds were purchased by Dr Alfred Bader in 1993 who donated them to Queen's University of Canada, and became the Bader Study Centre, teaching mainly modern languages, English literature and the arts.

The Space Geodesy Facility remains on the site and Graham told us of the many facilities that are now carried out there.

He said the main purpose of the Facility is to carry out various extremely precise measurements of the site to help form a geodetic reference framework and support satellite missions that are used to research the dynamic Earth. This precision is needed by satellites that study the height of the oceans and the Earth's crust to an accuracy of centimetres and in some cases even millimetres. He said for example that during the last ice age, Scotland was under about 2 kilometres of ice and this depressed the surface. Today, this land is still recovering following the end of the last ice age and satellites are measuring Scotland's rise at a few millimetres each year. This is just one of the many things being taken into account when forming the geodetic frame.

Graham said he will be showing us the Satellite Laser Ranging facility, and the Absolute Gravimeter, but also pointed out that on the site is a GPS Prime receiver that, with others around the world, keeps the exact position of the GPS satellites on track. Also, there is an Ordinance Survey Reference point, one of 12 in the British Isles that link data about the sites back to the OS headquarters in Southampton.

We were divided into two groups and the first facility we were shown was the Satellite Laser Ranging equipment in the dome, which was open for our visit despite the mainly overcast sky.

The dome was opened for our visit

Although it was overcast, the laser was switched on for a demonstration

The dome houses a 50 cm Cassegrain on a computer driven alt-azimuth mount. Next to it is the laser, which we were told fires extremely short pulses lasting 10 pica-seconds with a peak power of a gigawatt at satellites of up to a distance of over 40,000 kilometres, each carrying a passive reflector. The reflected pulses are received via the Cassegrain to a detector, and then passed to a computer, which determines the distance to an accuracy of millimetres. The effects of the Moon's gravity and to a lesser effect, the Sun's, has to be taken into account together with the sea tides since the site rises and falls by as much as 15 centimetres.

To prevent the chance of the laser encountering an aircraft, there is a radar aerial in the adjacent dome. This always looks in the same direction as the laser is being fired and cuts the laser if a nearby aircraft is detected. The Civil Aviation Authority also insists that there must also be a human observer on duty at all operating times.

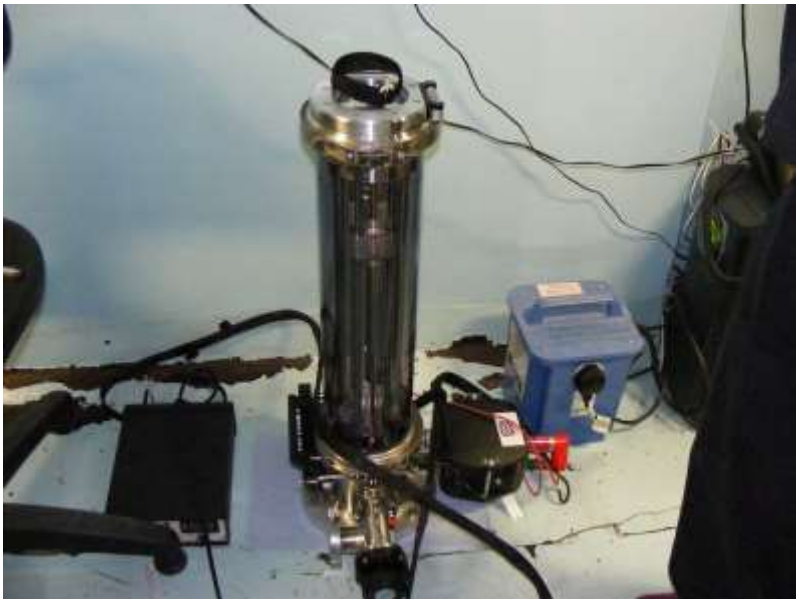
Next, we were shown the control room below where the laser is situated that fires the beam up through the central column to the dome above.

The solid-state laser that fires its beam up through the central column to the dome above

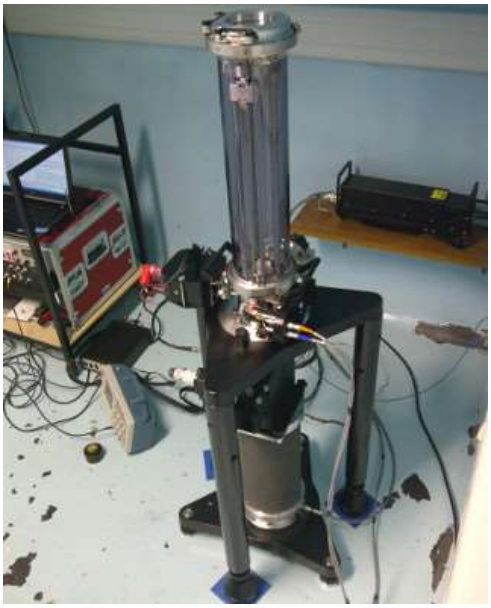
The air-radar control panel that cuts the laser if an aircraft is detected

The control room also contains the control panel for the air-radar in the smaller dome above.

By now it was dark outside as we made our way to the basement where we were shown the Absolute Gravimeter. It had recently been taken to Cornwall to carry out measurements at a site close to Newlyn where the OS Sea Level Reference point is located. But this did enable us to see the dropping chamber close-up.



Dropping chamber



The complete Absolute Gravimeter in place

The dropping chamber contains a cube prism that is forced to fall by gravity in a vacuum, the fall being time-measured at various points by a lasers interferometer. The timing is done using a hydrogen-maser that is also located in the basement. The gravimeter must be perfectly vertical and this is checked several times during operation by using laser reflections from the surface of an alcohol pool. This instrument enables local gravity to be measured to an accuracy of an incredible 10^{-8} G. The effects of the ocean and the tidal effects on the solid Earth are taken into account when calculating the final result.

We were told that some work is being carried out to assess the effect of the wind on nearby trees where the movement of their roots may flex and affect the accuracy of some measurements.

Graham said that next week, Birmingham University are bringing an even more accurate prototype atom gravimeter to the site so that they have a known gravity to work with.

At the far end of the basement, we were shown the hydrogen-maser. Although relatively small it is kept in a temperature controlled enclosure with a bank of batteries alongside in case there is a loss of power. The maser is accurate to 1 second in 10 million years.

The temperature controlled cabinet that contains the hydrogen maser

The reference from the maser is used not only by the gravimeter but also by the Laser Ranger and by the prime GPS receiver, so the length of each cable feed has to be very carefully calculated and known.

In the corner beside the maser was a seismometer in the ground, which is part of the Geological Survey. It had been placed in the basement as it was thought to be a stable enough environment, although Graham said our presence may well have given the impression of a massive earthquake!

Graham had given up his evening to show us in great detail, how the facility works and is being used, which is regarded as a very important prime reference site.

FUTURE MEETINGS

20th September - Barry Soden recalls "NASA Disasters (and Some Causes)".

18th October - David Pulley asks the question "So, How Do We Know They Are Planets?"

15th November – Jan Drozd regales us with stories about "Astronomical Blunders in Science Fiction"

13th December – (This is the second Wednesday in the month) Brian Mills FRAS tells the story of "The Great Telescope at Birr Castle"

SKY NOTES FOR SEPTEMBER 2017

Planets

Mercury is a morning object, reaching greatest western elongation of 18° on September 12th. On that date the planet is 10° high, due east at a few minutes before 06.00 with the Sun 6° below the horizon. Mercury is magnitude -0.2, and is just 11° south of the much brighter Venus as shown in fig 1. Following elongation it moves back towards the Sun to reach superior conjunction in early October.

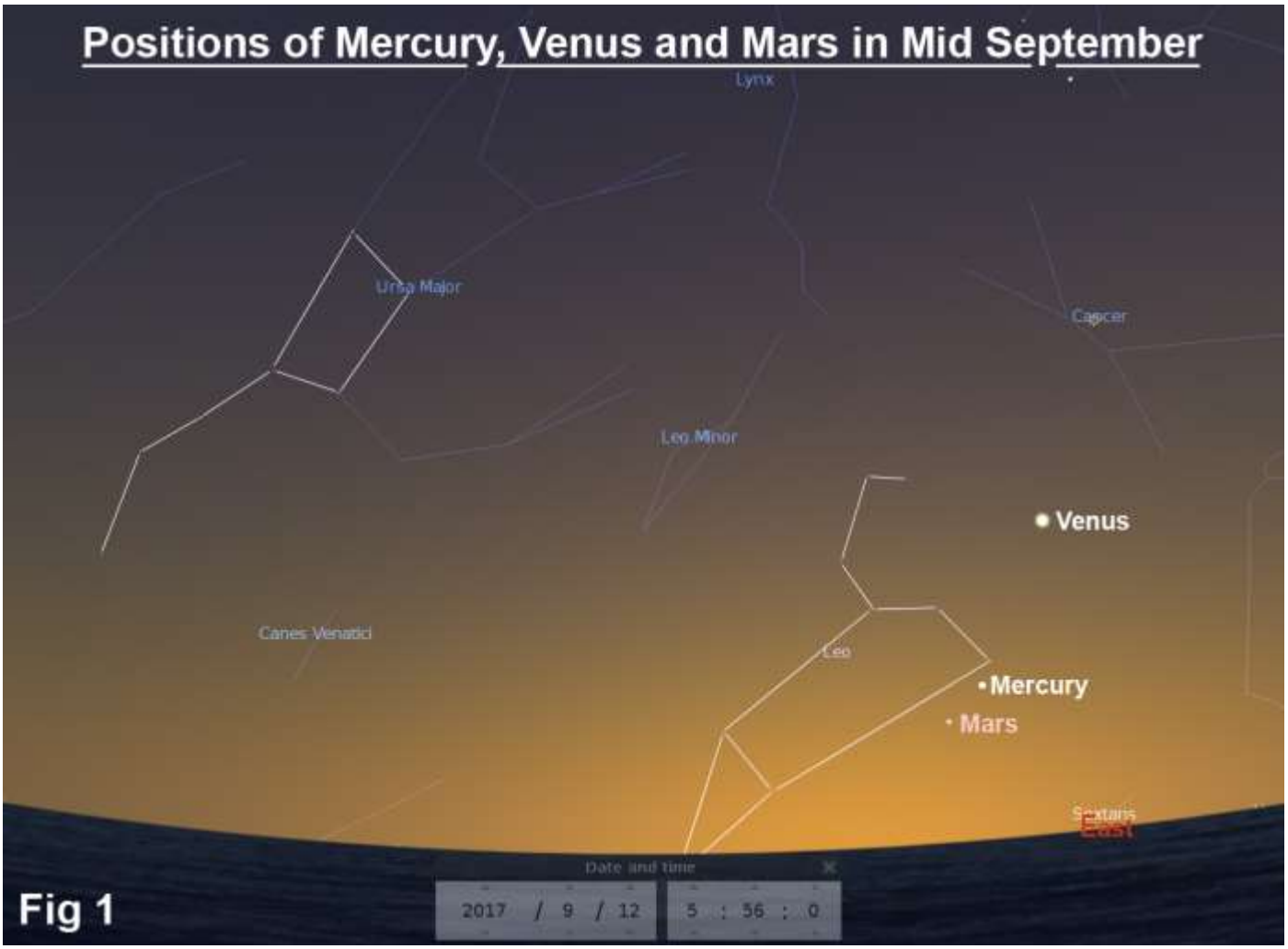


Fig 1

Venus is a brilliant morning object rising almost three hours before the Sun at the start of the month although by the end this has slipped to a little over two hours. Around mid September, as shown in fig 1, the planet is 20° in altitude at the beginning of civil twilight. At magnitude -4.0 it is impossible to mistake the brilliant Venus for anything else in that region of the sky. It continues to move back towards the Sun but will remain a morning object until early to mid November as it approaches a solar conjunction in January next year.

Earth reaches the Autumnal Equinox on September 22nd at 21.03 BST. This means that the Sun has arrived at that point on its passage around the sky where it crosses the celestial equator to give us progressively shorter days and longer nights.

The Sun's yearly path across the sky is known as the ecliptic, though this is an apparent motion rather than a real one and is caused not by the Sun but in fact by the Earth. We are simply viewing the Sun against a gradually changing backdrop as we move in orbit around our parent star over the course of a year. The ecliptic is constantly changing its position throughout the day and throughout the year whereas the celestial equator always appears the same from a given location regardless of date or time. Where these two lines intersect are the points where the equinoxes occur. At the spring equinox the Sun moves from below the celestial equator to above it passing through what is referred to as the *ascending* node. This is also known as the "First Point of Aries" or was previously before the Earth's precession moved it gradually westwards into Pisces. At the autumnal equinox the opposite is true with the Sun moving from north of the celestial equator to south of it, passing through the *descending* node. This is also referred to as the "First Point of Libra" although for the reason mentioned above the point where the celestial equator and ecliptic now cross lies in neighbouring Virgo.

Fig 2 shows the situation for the autumnal equinox on September 22nd with the direction of the Sun's travel indicated by the arrow.

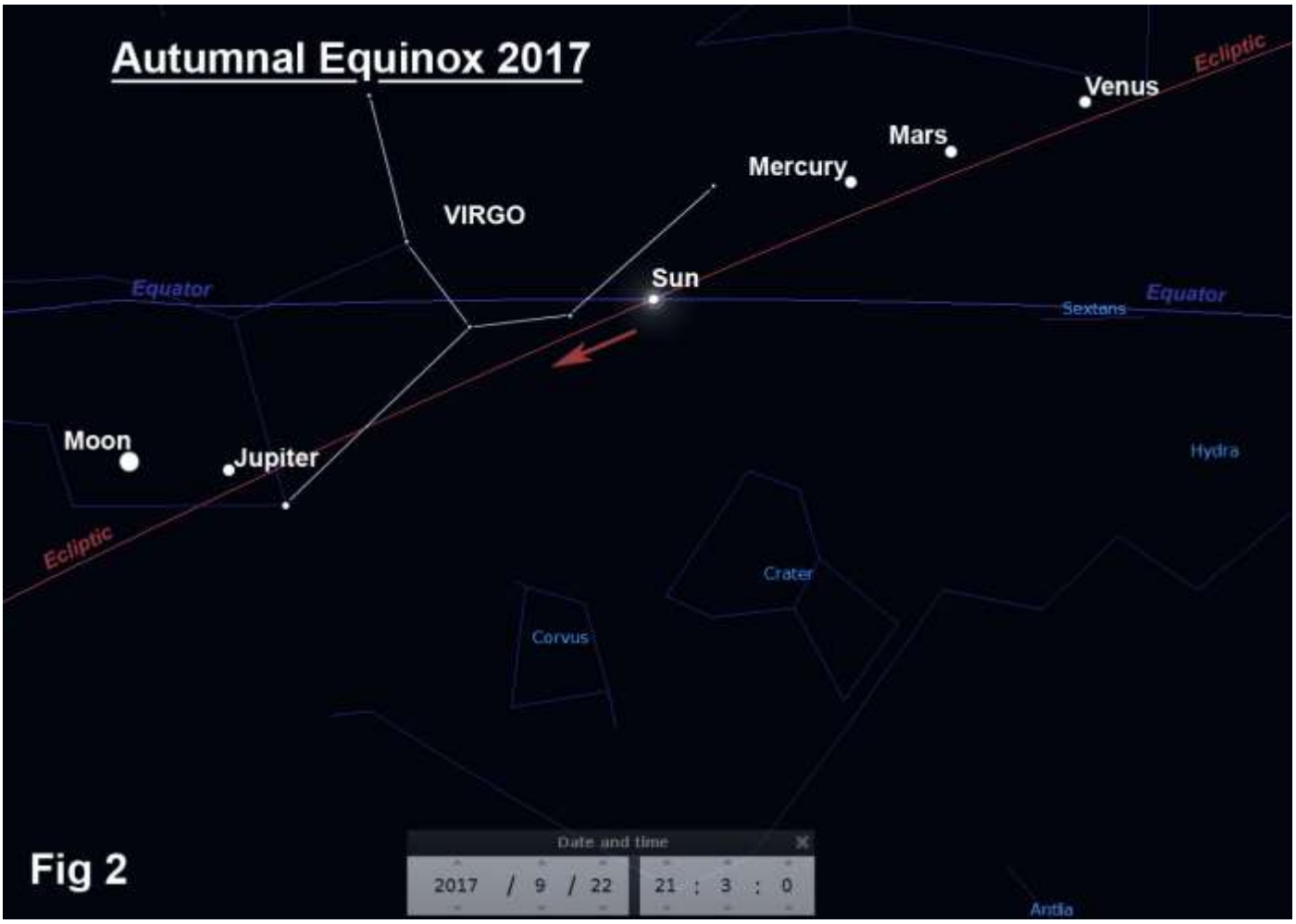
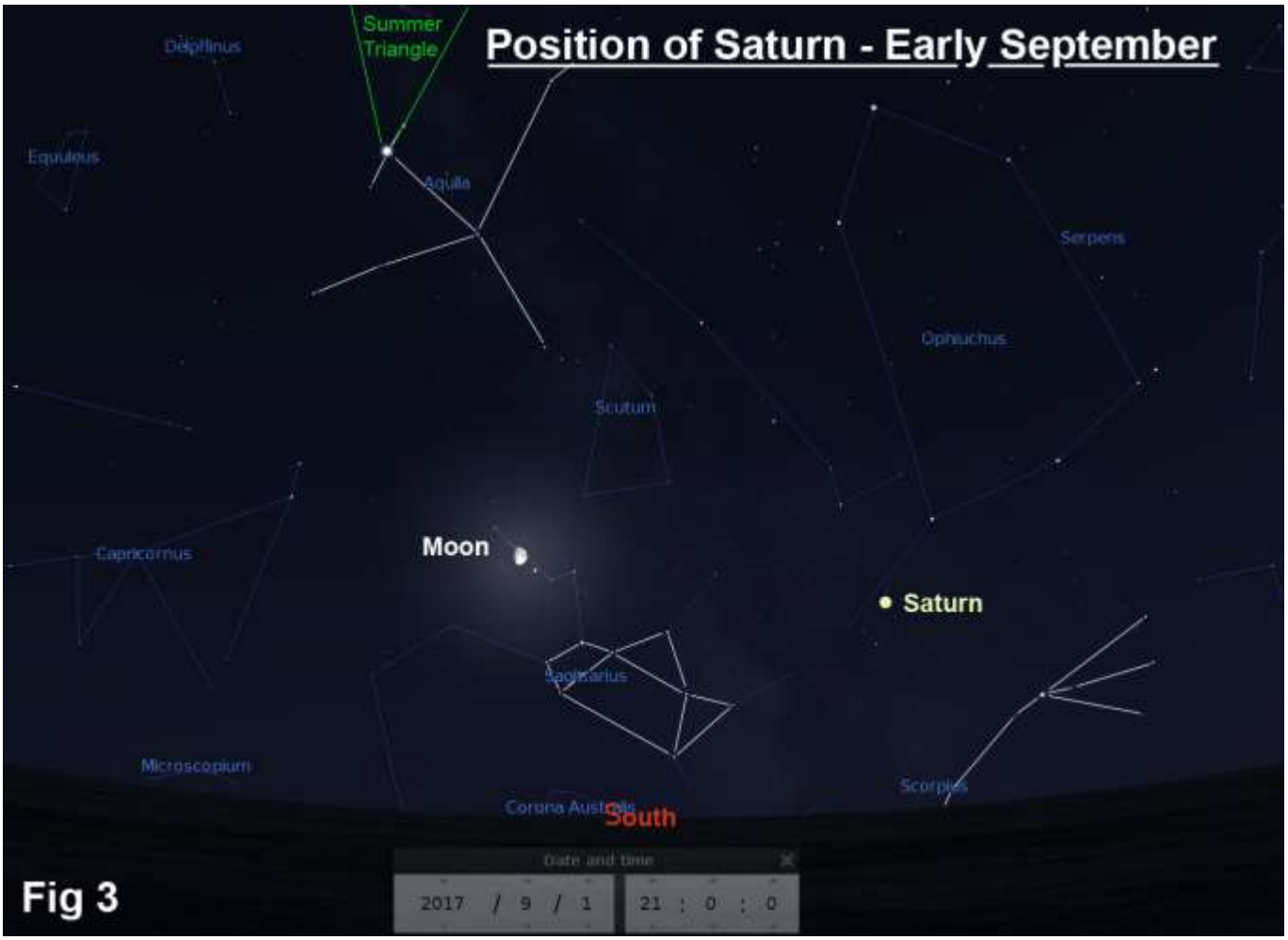


Fig 2

Mars was in conjunction with the Sun at the end of July so the planet is still hidden in the solar glare for the first half of the month. On the 15th it rises 1½ hours ahead of the Sun and is just 10° in altitude at the beginning of civil twilight. By month's end Mars rises over 2 hours before the Sun. Its brightness remains steady at +1.8 so it will not be easy to locate in the dawn skies. Fig 1 shows the red planet's position on September 12th, particularly with respect to the brighter Mercury and the much brighter Venus. On the morning of the 16th Mercury and Mars are less than half a degree apart.

Jupiter may just be glimpsed in the first few days of the month low down in the west-south-west as soon as the Sun has set. However, its visibility is extremely limited as it moves towards solar conjunction in late October. Following that it will become a morning object and will not be seen in the evening skies again until late March 2018.

Saturn is currently an evening object in the southern part of Ophiuchus, where it will stay until late November. It lies equidistant from Scorpio, to the west, and the "Teapot" asterism in Sagittarius to the east. The whole of the area is rich with nebulae, open clusters and globulars. The planet is well past opposition, which means that thanks to its increasing distance from us, both Saturn's apparent size and brightness are slowly falling. By the middle of the month it shines at magnitude +0.5 and has an apparent equatorial diameter (ignoring the rings) of 16.5 arc seconds. If we include the rings then this becomes 38 arc seconds. Fig 3 shows the position of Saturn on the first if the month at 21.00 BST. Unfortunately its declination is -22° so it will never appear very high in the sky with all the associated issues of air pollution and turbulence that that brings.



Lunar Occultations

In the table below I've listed events for stars down to magnitude 7.0 that mostly occur before midnight although there are many others that are either of fainter stars or occur at more unsociable hours. DD = **d**isappearance at the **d**ark limb. RD = **r**eappearance at the **d**ark limb. The column headed "mm" (millimetres) shows the minimum aperture telescope required for each event. The Moon once again visits the Hyades in the early hours of September 12th but on this occasion only one event will occur before sunrise. **Times are in BST.**

Sept	Time	Star	Mag	Ph	Alt °	% illum.	mm
2nd	21.35	ZC 2935	7.0	DD	19	88	110
7th	21.54	ZC 49	6.1	RD	13	97	90
24th	19.55	ZC 2223	3.9	DD	9	20	40
28th	21.56	ZC 2760	6.9	DD	11	57	80
29th	20.02	ZC 2886	4.9	DD	19	66	40

Phases of the Moon for September

Full	Last ¼	New	First ¼
6th	13th	20th	28th

ISS

Below are details for passes of the International Space Station (ISS) during evening hours of September that are brighter than magnitude 0.0. The details of other passes, including those visible between midnight and dawn, can be found at www.heavens-above.com. Please remember that the times and directions shown below are for when the ISS is at it's ***maximum*** elevation, so you should go out and look at least five minutes beforehand.

Times are in BST.

Sept	Time	Mag.	Alt°	Az.		Sept	Time	Mag.	Alt°	Az.
25th	20:10:11	-1.4	11°	SSE		28th	20:44:50	-3.3	47°	SSW
26th	20:52:48	-1.8	19°	SSW		29th	19:52:43	-3.2	38°	SSE
27th	20:02:01	-2.5	22°	SE		29th	21:26:56	-1.4	21°	W
27th	21:35:14	-0.9	13°	WSW		30th	20:36:13	-4.0	81°	SSE

Iridium Flares

The flares that I've listed are the *only* evening ones visible this month. There are a lot more that occur after midnight, so if you wish to see a complete list, or obtain timings for somewhere other than Wadhurst, go to www.heavens-above.com . When one of these events is due, it is sometimes possible to see the satellite before and after the "flare" although, of course, it will be much fainter then.

Times are in BST.

Sept	Time	Mag	Alt°	Az.°		Sept	Time	Mag.	Alt°	Az.°
6th	21.38	-2.2	13°	357° (N)		29th	21.21	-2.2	8°	2° (N)
9th	21.09	-1.9	21°	358° (N)		30th	21.16	-0.1	9°	2° (N)
10th	21.03	-6.5	23°	358° (N)						

The Night Sky in September (Written for 22.00hrs BST mid month)

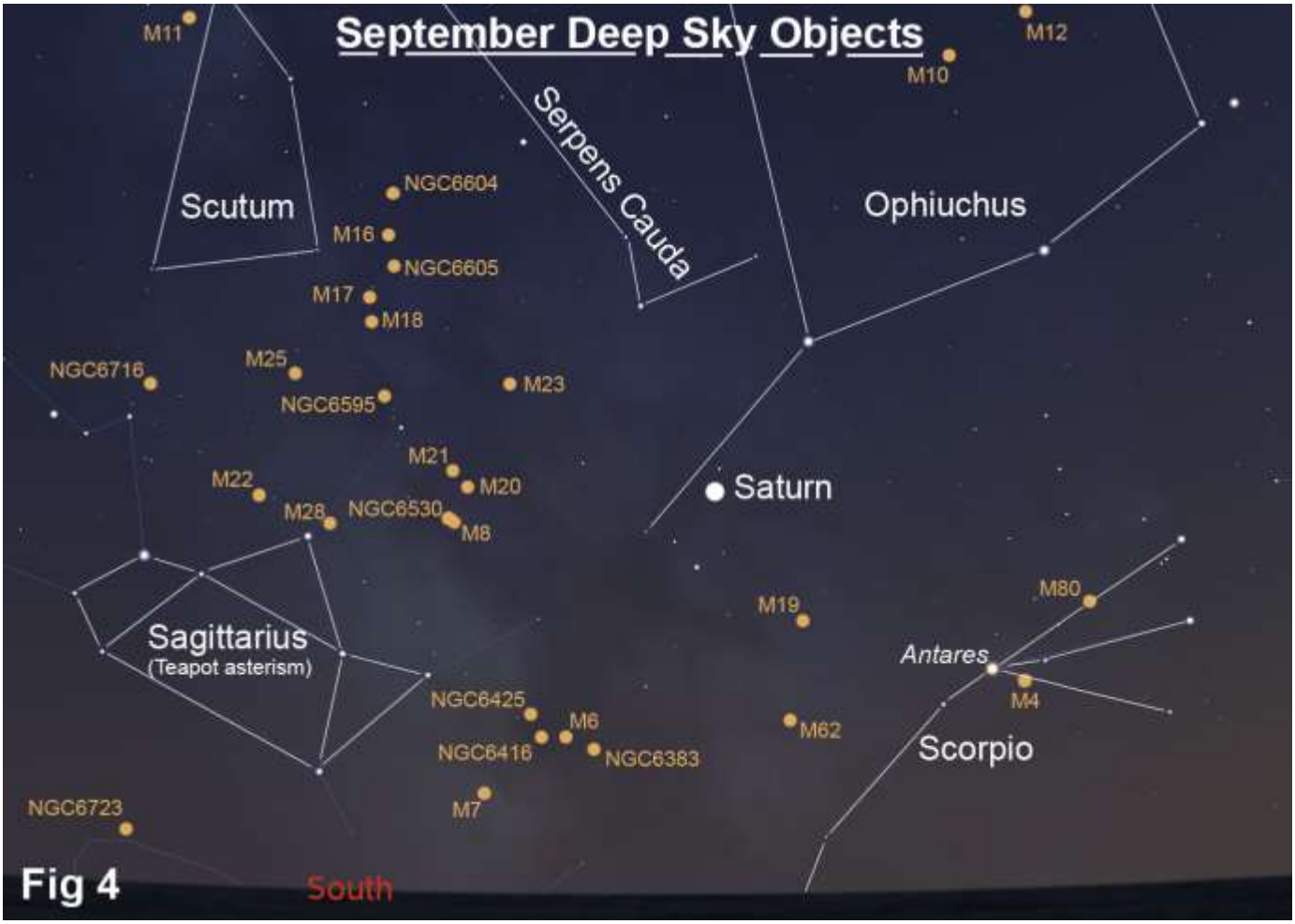
Looking towards the north Ursa Major is about to make its closest approach to the horizon as the head of the bear nears the meridian. Despite this M81 and M82 lie at a modest altitude of just over 30°. Ursa Minor points towards the west and in the general direction of alpha Draconis, otherwise known as Thuban, which 5,000 years ago, was a previous incumbent in the position of "Pole Star". Approaching the meridian to the north of the North Celestial Pole (NCP) is Cepheus with a number of clusters to its name, some of which are associated with nebulosity. NGC 7160 is the brightest of the open clusters at magnitude 6.1 and was first identified in 1787 by William Herschel.

A little to the east of the meridian, Auriga, with the brilliant Capella, is just rising. The brightest star in the charioteer can be easily identified by using Megrez and Dubhe in the plough and extending a line forwards in the opposite direction to the bear's tail, until it passes close to alpha Aurigae. The constellation contains a number of open clusters including M36 and M37 at magnitudes 6.0 and 5.6 respectively.

Turning to the east, that first indicator of the approaching colder weather, the Pleiades, have just cleared the horizon. Due east, the autumn groups of Pisces, Pegasus and Andromeda are becoming more prominent with M31 almost 50° above the horizon. Tiny Lacerta, another of the small constellations added by Hevelius, fills the gap between the winged horse and the zenith with its northern portion being crossed by the Milky Way. There are a few open clusters, NGC7209 and NGC7243 being the brightest, and a number of faint planetary nebulae.

In the south, Cygnus, sometimes referred to as the "Northern Cross," commands the zenith. The area contains numerous open clusters and nebulae of which the Cocoon nebula and the Veil nebula, a supernova remnant, are perhaps the best known. One of the most imaged segments of the Veil nebula is the "Witches Broom" where the most exquisite and subtle detail can be revealed. The Milky Way runs through Cygnus, more or less along the spine of the mythological swan, and contains the dark dust lane known as the "Cygnus Rift".

The other members of the "Summer Triangle" lie to the west and south of Deneb which itself is just 6° from the zenith. The line of the Milky Way continues towards the horizon passing through the small groups of Vulpecula, Sagitta, Aquila and Scutum before reaching Sagittarius where the galactic core is located. The area is rich with globular and open clusters as well as nebulae. You will be well rewarded if you sweep the area with good binoculars or a rich field telescope. Fig 4 shows a selection of the myriad objects that can be seen, although some should be sought out early in the month as they lie well south of the celestial equator. The table below tells you what type each object is and its brightness.



Object	Type	Mag.		Object	Type	Mag.
M4	Globular	5.9		M23	Open	5.5
M6	Open	4.2		M25	Open	4.6
M7	Open	3.3		M28	Globular	6.9
M8	Nebula	5.8		M62	Globular	6.6
M10	Globular	6.6		M80	Globular	7.2
M11	Open	5.8		NGC 6383	Cluster/nebula	5.5
M12	Globular	6.6		NGC 6416	Open	5.7
M16	Open/nebula	6.0		NGC 6425	Open	7.2
M17	Open/nebula	6.0		NGC 6530	Open	4.6
M18	Open	6.9		NGC 6595	Open	7.0
M19	Globular	7.2		NGC 6604	Open/nebula	6.5
M20	Open/nebula	6.3		NGC 6605	Open	6.0
M21	Open	5.9		NGC 6716	Open	6.9
M22	Globular	5.1		NGC 6723	Globular	7.3

In the west Arcturus is just 10° above the horizon and will soon be lost along with the large and rather shapeless forms of Ophiuchus and Serpens. Corona Borealis and Hercules are still reasonably well presented with the superb globular cluster M13 still 45° in altitude.

Advance warning for September

September 15th – Cassini mission is due to end as the craft plunges into Saturn's atmosphere.

Brian Mills

SPACEPLACE - NASA

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The 2017 Solar Eclipse Across America
By Teagan Wall

On August 21st, the sky will darken, the temperature will drop and all fifty United States will be able to see the Moon pass—at least partially—in front of the Sun. It's a solar eclipse!

A solar eclipse happens when the Moon passes between the Sun and Earth, casting its shadow on Earth. Sometimes the Moon only covers up part of the Sun. That is called a partial solar eclipse. When the Moon covers up the Sun completely, it's called a total solar eclipse. As our planet rotates, the Moon's shadow moves across Earth's surface. The path of the inner part of this shadow, where the Moon totally covers the Sun, is called the path of totality.

The path of totality on August 21 stretches from Oregon to South Carolina. If you happen to be in that path, you will be able to experience a total solar eclipse! If you're in any of the 50 United States during this time, you can see a partial solar eclipse.

No matter where you'll be for the eclipse, remember that SAFETY is very important. Never look at the Sun when any part of it is exposed, like during a partial eclipse! It can hurt your eyes very badly. If you want to view the eclipse, you can buy special eclipse glasses. Go the NASA 2017 Eclipse Safety website to learn more about what glasses to buy.

If you are in the path of the total eclipse, you may look directly at the eclipse only when the Moon has completely covered the Sun. This is called totality, and it lasts a very short time. You must be sure to put your eclipse glasses back on before the Sun peeks out from behind the Moon.

You won't be the only one watching this event! NASA scientists will use this eclipse to study our Sun. During a total solar eclipse, we can see the Sun's atmosphere, called the corona. Usually the Sun is so bright that we can't see the corona. However, when the Moon blocks out most of the Sun's light, we can get a glimpse of the corona.

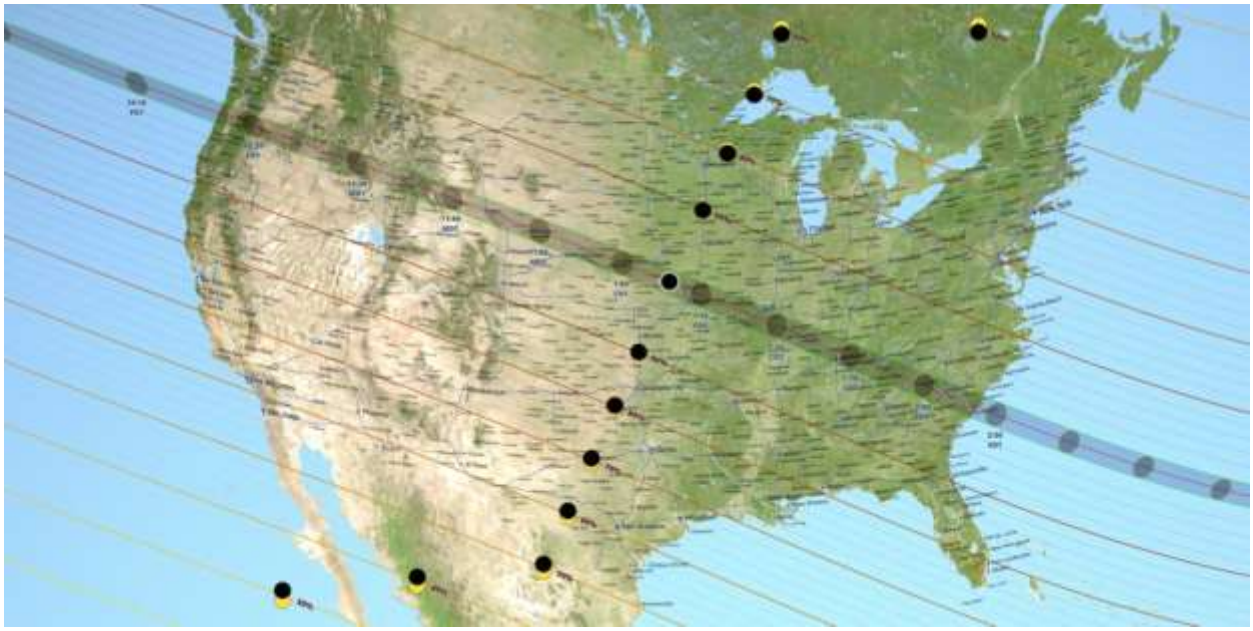
The surface of the Sun is about 10,000 degrees Fahrenheit, but the corona is much hotter. It's about 2 million degrees Fahrenheit! The eclipse gives NASA researchers the chance to learn more about why the corona is so hot. In fact, while the eclipse will only last about two to three minutes in one place, scientists have found a way to have more time to study it.

NASA will use two research jets to chase the eclipse as it crosses the country. The jets will fly very high, and spend seven minutes in the shadow of the Moon. Researchers are using jets to help look for small explosions on the Sun, called nanoflares. These nanoflares may help to explain the corona's extreme heat.

Whether you're watching with eclipse glasses from the ground, or in a NASA jet from the sky, the 2017 eclipse should be quite a show! It's a fun reminder of our place in the solar system, and how much we still have to learn.

To learn about what eclipse glasses to buy and other eclipse safety guidelines, visit: https://eclipse2017.nasa.gov/safety

To learn more about solar eclipses, check out this NASA Space Place video: https://spaceplace.nasa.gov/eclipse-snap



Caption: A map of the United States showing the path of totality for the August 21, 2017 total solar eclipse. Image credit: NASA's Scientific Visualization Studio

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Any material for inclusion in the October 2017 Newsletter should be with the Editor by September 28th 2017