NWASNEWS

Volume21, Issue 7

February 2016

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

February, Astro Fest time.

Firstly can I send a thankyou to Peter Chappell for late arranging and Owen Brazell for standing in to give a talk tonight on galaxy cluster. Owen is well qualified as a deep sky observer, especially eyeball to eye piece! He has frequently come along to mass observing sessions, and is well known to several members.

One of Owen's previous visits was at a Stargazing live event 3 years ago, but we were rained of the field but the previous year we had a very full day… This year, thanks to more late coordination from the Beeb we made a low key event for the 15th, and had clear skies AND the use of the Manger Barn at very short notice. Thank you to the observing team, Nick Howes and the National Trust.

On Monday May 9th we have the transit of Mercury across the front of the Sun, starting at 12:12BST and finishing at 19:40 BST, about half an hour before sunset. I am putting this here because the English Heritage at Stonehenge have come to me and asked if we will put on an event near the stones, where we will have permission to stay until the end of the eclipse. If we can put a team together we can view and image the transit beginning to end as long as we also show the public the telescope views at the same time. We will need to work at quite high magnification, all correctly shielded, to get a chance of seeing Mercury that will be about 6 arc seconds across against 33 arc minutes for the solar surface background.

This Friday and Saturday sees the Astrofest in London at the Kensington Conference and events centre.

The talks are the key to this exhibition as the stands tend to be very cramped for space, and many suppliers can no longer afford to rent the space. Even so, they are across 3 floors and you do need to go with an idea of what you want to see and MUST prebook talks on both days.9'00am to 6pm, 8 talks each day.

Some ideas of my favourite purchases last year have been two mounts, one, the Sky Watcher Star Traveller has been the tool for astrophotography I have been chasing for years. Something that is quick to set up, gives option for small telescope use with or without camera, and no trailing leads other than your camera release. You can even plug in a computer to provide a goto facility, but I've not tried this yet. A good sturdy tripod is needed to mount it on.

The other mount was an observatory mount, but other than the astro DSLR these were my most used and successful purchases.

Good eyepieces will make a big difference to your viewing experience with any telescope, and there will be plenty on sale at the exhibition.

Enjoy...

Clear skies

Andy

The Moon and Jupiter

First one taken at 1/250 of a second, this brings Jupiter out a bit but the Moon is over exposed.

Both pictures taken with a Canon 60Da DSLR camera attached to a William Optics 80mm refractor at f6.8 on a Porta Mount II.

Rare clear sky in January!

Peter Chappell

Ed I have worked on the Jupiter zone only to bring out the planet.

I was racing home from giving talks in Wales to capture this, but thin cloud spoilt the view from Chippenham.

Andy

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

2016

Feb 2nd *Owen Brazell: Galaxy Clusters*
Mar1st *Life on Mars : Professor Mark Sims*
Apr 5th *The Story of Star Names : Mark Hurn*
May 3rd *Oddities of the Solar System : Bob Mizon*
June 7th *The Current State of SETI : Martin Griffiths*

Membership Changes in fees to be discussed. Could be lowered!

Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Andy Burns (Chairman, and Editor) Tel: 01249 654541, email: anglesburns@hotmail.com

Vice chair: Keith Bruton

Bob Johnston (Treasurer)

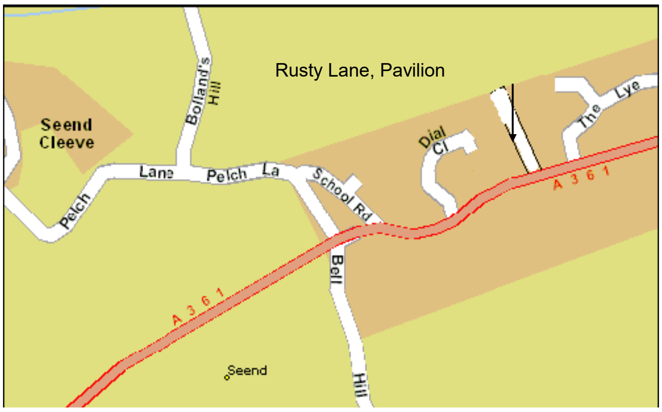
Philip Proven (Hall coordinator)

Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

Observing Sessions coordinators: Jon Gale, Tony Vale

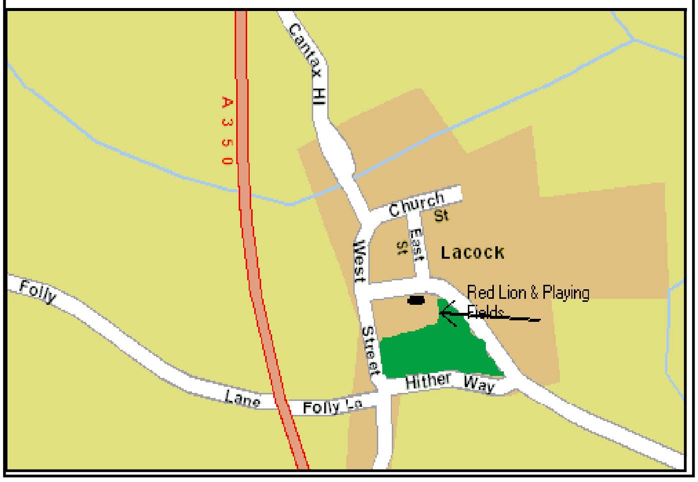
Contact via the web site details. This is to protect individuals from unsolicited mailings.



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



Speaker for February Owen Brazell. Webb society section director.

Owen Brazell, as well as previously editing the DSO, is also the assistant director of the British Astronomical Associations Deep Sky Section and regular contributor to Astronomy Now. When observing, his primary interests are in the observation of planetary and diffuse nebulae -- although since the acquisition of a 51cm telescope this has also moved to viewing galaxy clusters.

His interest in astronomy was sparked by an attempt to see a comet from his native Toronto. From early years, he kept up his interest in astronomy which culminated in a degree in astronomy from St Andrews University in Scotland and taking though not completing an MSc in Astrophysics. At that time, he also gained an interest in the northern lights. As with many astronomers, finding no living there, he moved into the oil business first in R&D and then as a computer systems designer (this explains his interest in the computer side of astronomy). Despite this he still uses Dobsonian type telescopes ranging from a 4" Genesis-sdf through a 21". The recent plethora of fuzzy objects that move has reawakened an interest in comets!

His searches for dark skies have taken him from the mountains of Canada through Texas to the Florida Keys as well as to Wales - the only good dark sky site he has found so far in the UK.

Swindon's own astronomy group

The club meets once a month at Liddington Hall, Church Road, Liddington, Swindon, SN4 0HB at 7pm. See programme below.

A Bad Month For Stargazing

It's been a bad month for stargazing in the evenings; however, the early mornings have been great for viewing the planets, some of which were on show together.

February Meeting

This month we welcome your chairman Andy Burns, who will be giving a talk on John Herschel. We look forward to this, as it has been some time since Andy has spoken to the club.

Next month is our all important AGM and we are also looking forward to this.

Ad-hoc viewing sessions near Uffcott

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

We 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!

Meetings for 2016

At Liddington Village Hall, Church Road, Liddington, SN4 0HB – 7pm 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

Friday 19 Feb 2016

Programme: Andy Burns: A presentation on John Herschel

Friday 18 Mar 2016

Programme: AGM plus a presentation

Friday 15 Apr 2016

Programme: Mark Radice: Observing the Moon

Friday 20 May 2016

Programme: Owen Brazell: Shrouds of Night - Observing Dark Nebulae

Friday 17 Jun 2016

Programme: James Fradgely: How (on Earth) Did Life Start

Friday 16 Sep 2016

Programme: Guy Hurst: Star Clusters

Friday 21 Oct 2016

Programme: Paul Roche: Robotic Astronomy

Friday 18 Nov 2016

Programme: Mike Leggett: Exploration of Mars

Friday 16 Dec 2016

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,

Swindon, SN1 2JW

BECKINGTON ASTRONOMICAL SOCIETY

We also have a new website www.beckingtonas.org where details of our programme and other useful information can be found. General enquiries about the society can be emailed to chairman@beckingtonas.org

So our committee is now:

Steve Hill, Chairman/Imaging 01761 435663
John Ball, Vice Chairman 01373 830419
Alan Aked, Treasurer 01373 830232
Rosie Wilks, Secretary 01225445814
Mike Witt, Membership 01373 303784
John Dolton, Telescope Hardware 01225335832

Meetings take place in Beckington Baptist Church Hall (see the location page for details of how to get to us) and start at 7:30pm.

Date	Title	Speaker
19th February	*Science of the Solar System – 2*	Steve Hill
18th March	*Ten ways the Universe tries to kill you*	Stephen Tonkin
15th April	*Seven Moons*	Bob Mizon
20th May	*Tales from the Dark Side of the Universe*	Mike Witt
17th June	Annual General Meeting	

The programme and details of how to contact the society are at www.beckingtonas.org

SALISBURY PLAIN OBSERVING GROUP

Where do you meet?

We meet at a variety of sites, including Pewsey Downs, Everleigh, Bratton Camp, Redhorn Hill and Whitesheet Hill. The sites are cold in winter so you will need warm clothing and a flask. We are always looking for good sites around the edge of the Plain.

Do I join?

No. We are not a club. We meet informally, so aside from contacting our friends to give a yes or no to meeting up, that's it.

I am a beginner—am I welcome?

Of course you are — whether you have a telescope, binoculars or just your eyes, there will be someone to observe with. We have a variety of equipment and are always happy for newcomers to look through.

So I just turn up?

Essentially yes, but please drop us an email as parking can be an issue at some of the meeting areas or at the pubs.

I am more experienced—what's in it for me?

If you have observing experience we prepare a monthly observing list chosen in rotation by the group. We pick some easy objects, some moderate and some tough ones. If you are experienced, why not share what you know?

SPOG OBSERVING SITES

Any ground rules for a session?

Common sense applies in the group; red light is essential to preserve night vision; we park cars so you can leave when you wish and not disturb others with your headlights.

Contact Details

Our Website

www.spogastro.co.uk

Our Email

spogastro@googlemail.com

Twitter

http://twitter.com/SPOGAstro

Facebook

http://www.facebook.com/group.php?gid=119305144780224

SOFTWARE AND APPS

Here is my first foray into this for some time. Where possible I choosing readily available and free software for PCs Macs or Apps for phones.

This first list is for YOU to check and report if it is the software you want me to review, otherwise I will run with my own software choice.

Firstly how do find what is up in the sky at any particuly day/night/time.

There are many sorts of app for the phone (Android or iPhone)

Google Sky Map

Planets

Starmap

Astronomist

Sky Safari Pro (it does have a free version and runs on Macs and iPhones plus Android… not PCs yet.)

How Aurora warnings: Aurora Watch alert works very well this year and gives audable warnings.

Satellite prediction

ProSat

SatelliteAR

ISS Detector

There is even an excellent weather predictor for viewing

Clear Outside for Android showed Fridays viewing window from days in advance.

For Deep Sky Objects, DS Browsers tells you what is up.

And the Moon, Moon HD is OK but for the sky I much prefer the bigger screen versions for the PCs and Macs.

Sky Charts:

Cartes du Ciel

Stellarium both free

Sky Safari Pro

Or the Sky are the expensiveoptions but give you so much more information.

The Moon on PCs and MACs there is one standout programme and it is free. Virtual Moon Atlas.

There are others I know, but these keep me informed and allow viewing session planning. Next month some image processing software.

Andy

The Loneliest Galaxy In The Universe

By Ethan Siegel

Our greatest, largest-scale surveys of the universe have given us an unprecedented view of cosmic structure extending for tens of billions of light years. With the combined effects of normal matter, dark matter, dark energy, neutrinos and radiation all affecting how matter clumps, collapses and separates over time, the great cosmic web we see is in tremendous agreement with our best theories: the Big Bang and General Relativity. Yet this understanding was only possible because of the pioneering work of Edwin Hubble, who identified a large number of galaxies outside of our own, correctly measured their distance (following the work of Vesto Slipher's work measuring their redshifts), and discovered the expanding universe.

But what if the Milky Way weren't located in one of the "strands" of the great cosmic web, where galaxies are plentiful and ubiquitous in many different directions? What if, instead, we were located in one of the great "voids" separating the vast majority of galaxies? It would've taken telescopes and imaging technology far more advanced than Hubble had at his disposal to even detect a single galaxy beyond our own, much less dozens, hundreds or millions, like we have today. While the nearest galaxies to us are only a few million light years distant, there are voids so large that a galaxy located at the center of one might not see another for a hundred times that distance.

While we've readily learned about our place in the universe from observing what's around us, not everyone is as fortunate. In particular, the galaxy MCG+01-02-015 has not a single known galaxy around it for a hundred million light years in all directions. Were you to draw a sphere around the Milky Way with a radius of 100 million light years, we'd find hundreds of thousands of galaxies. But not MCG+01-02-015; it's the loneliest galaxy ever discovered. Our Milky Way, like most galaxies, has been built up by mergers and accretions of many other galaxies over billions of years, having acquired stars and gas from a slew of our former neighbors. But an isolated galaxy like this one has only the matter it was born with to call its own.

Edwin Hubble made his universe-changing discovery using telescope technology from 1917, yet he would have found absolutely zero other galaxies at all were we situated at MCG+01-02-015's location. The first visible galaxy wouldn't have shown up until we had 1960s-level technology, and who knows if we'd have continued looking? If we were such a lonely galaxy, would we have given up the search, and concluded that our galaxy encompassed all of existence? Or would we have continued peering deeper into the void, eventually discovering our unusual location in a vast, expanding universe? For the inhabitants of the loneliest galaxy, we can only hope that they didn't give up the search, and discovered the entire universe.

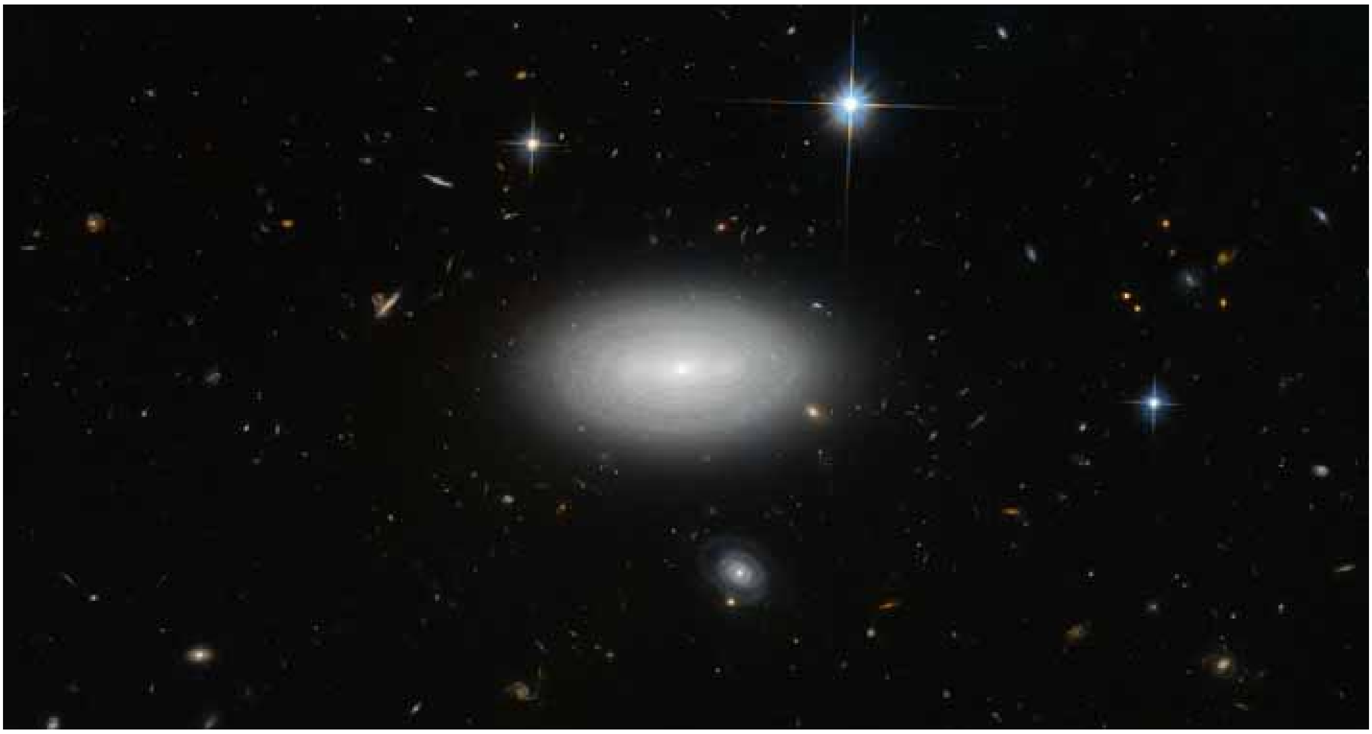


Image credit: ESA/Hubble & NASA and N. Gorin (STScI); Acknowledgement: Judy Schmidt, of the loneliest void galaxy in the known: MCG+01-02-015.

SPACE NEWS

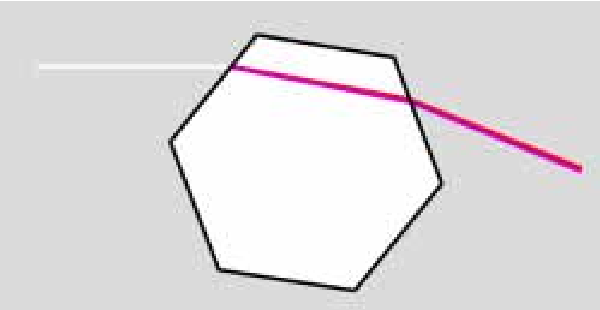
Why Do We Sometimes See a Ring Around the Moon?

26 Jan , 2016 by Fraser Cain

Have you ever looked up on a clear night and noticed there's a complete ring around the Moon? In fact, if you look closely, the ring can have a rainbow appearance, with bright spots on either side, or above and below. What's going on with the Moon and the atmosphere to cause this effect?

This ring surrounding the Moon is caused by the refraction of Moonlight (which is really reflected sunlight, of course) through ice crystals suspended in the upper atmosphere between 5-10 km in altitude. It doesn't have to be winter, since the cold temperatures at high altitudes are below freezing any time of the year. Generally they're seen with cirrus clouds; the thin, wispy clouds at high altitude.

The ice crystals themselves have a very consistent hexagonal shape, which means that any light passing through them will always refract light – or bend – at the same angle.



Path of rays in a hexagonal prism" by donalbein – Own work. Licensed under CC BY-SA 2.5 via Commons.

Moonlight passes through one facet of the ice crystal, and is then refracted back out at exactly the angle of 22-degrees.

Of course, the atmosphere is filled with an incomprehensible number of crystals, all refracting moonlight off in different directions. But at any moment, a huge number happen to be in just the right position to be refracting light towards your eyes. You just aren't in a position to see all the other refracted light. In fact, everyone sees their own private halo, because you're only seeing the crystals that happen to be aligning the light for your specific location. Someone a few meters beside you is seeing their own private version of the halo – just like a rainbow.

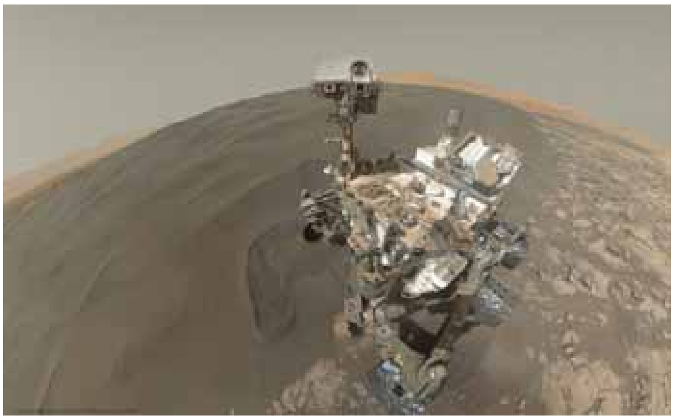
A halo rings the bright moon and planet Jupiter (left of moon)
Credit: Bob King

The size of the ring is most commonly **22-degrees**. This is about the same size as your open hand on your outstretched arm. The Moon itself, for comparison, is the size of your smallest nail when you hold out your hand.

The 22-degree size corresponds to the refraction angle of moonlight.

Curiosity Sticks Her Toes in a Martian Sand Dune, Takes a Selfie

26 Jan , 2016 by Nancy Atkinson



While some of us might only be dreaming of sticking our toes in the sand right about now, the Curiosity rover is actually doing so. But it's no vacation for the rover, as she makes her way through some very unusual and striking sand dunes on Mars. The Bagnold Dune Field lies along the northwestern flank of Mt. Sharp — Curiosity's main target for its mission — and this is the first time ever we've had the opportunity to do close-up studies of active sand dunes anywhere besides Earth.

Thanks to Andrew Bodrov for sharing his compilation of this 57-image mosaic 'selfie,' and you can play around with an interactive version below to see some great views of the dunes. The images were taken by the rover's Mars Hand Lens Imager (MAHLI) on Sol 1228 (January 19, 2016).

Mars Panorama – Curiosity rover: Martian solar day 1228

Sampling the Dunes with SAM

While the rover stopped to take these images to create this 57-image mosaic 'selfie,' Curiosity has also been quite busy, both navigating through the dunes and stopping to do some sampling. Excitingly, the rover scooped up some of the sand and sent it to the on-board chemistry lab, the Sample Analysis at Mars (SAM). This is only the second time the scoop has been used to deliver small portions – usually about the size of a half of a baby aspirin –to be analyzed; the rover's drill has been used several times to get samples.

Curiosity scooped its first dune sample on Jan. 14, but the rover stuck in its wheel briefly, scuffing it with a wheel. "The scuff helped give us confidence we have enough sand where we're scooping that the path of the scoop won't hit the ground under the sand," said Michael McHenry, who is the rover planner for collecting these samples.

I had the chance to visit with John Michael Morookian, the rover planning team lead for Curiosity at JPL about two weeks ago, and he said the plan was to drive into the dune a short distance, get samples with the scoop and deliver them to the experiments on board.

Morookian explained that from orbital images from the HiRISE camera on the Mars Reconnaissance Orbiter, the team knows there is a good path among the dunes for the rover to navigate, and there should be no danger of the rover getting stuck or trapped.

“We’ll be circumnavigating them, there is plenty of path available,” he said. “This is not impassible area. The rover will be at this particular site doing the sampling for approximately the month of January, and the current plan is to take a long path about a kilometer circumnavigating the dunes to get to less active dunes that are part of the same field of dunes.”

Getting the samples from the scoop to SAM involves a set of complex moves of a multi-chambered device on the rover’s arm passing the material through a sieve that screened out particles bigger than 150 microns (0.006 inch); some of the material that passed the sieve was dropped into laboratory inlet ports from a “portioner” on the device.

“We start the vibration and gradually tilt the scoop,” Morookian explained. “The material flows off the end of the scoop, in more of a stream than all at once.”

The material blocked by the sieve is dumped onto the ground.

According to Ryan Anderson from the Curiosity team, the rover Mastcam and MAHLI cameras are both thoroughly documenting the scooping process, and the Mastcam also is doing observations of the dump piles left over from the scooping, and the ChemCam will take passive spectra of the piles. The Mastcam will also be imaging a dune names “Hebron” several times to observe any changes in the dune while the rover is nearby.

Find out more about Curiosity’s recent activities at the Martian Chronicles blog, and at this article from JPL.

And if you’re wondering why the rover’s arm doesn’t show up on the self image mosaics, read our previous article which explains it here.

Our blue marble. Credit: NASA

Astronomy, Earth, Guide to Space

How Does The Earth Rotate?

30 Jan , 2016 by Matt Williams

Beginning in the 16th century, humanity’s understanding of our world and the cosmos was revolutionized as we became aware of a simple fact. The Earth moved! Not only did it move about the Sun, but it also rotates. And while it would take several centuries before this became universally accepted (aka. a few people had to endure persecution and house arrest) the fact that the Earth rotates about our Sun and on its axis soon became accepted fact.

In fact, the rotation of our planet on its axis and around the Sun are the cause of just about every stellar phenomenon we humans have come to take for granted. It is the reason the Sun rises in the East and sets in the West, the reason why the Moon goes through phases, and the reason the stars appear to rotate around the Earth once every day. So let’s address this whole “Eppur Si Mouve” business, shall we?

As already noted, Earth experiences two kinds of rotation. On the one hand, there is the rotation of Earth on its axis, which is known as sidereal rotation. This is what allows for the diurnal cycle and makes it appear as if the heavens are revolving around us. On the other hand, the Earth orbits about the Sun, which is known as its orbital period. This revolution (among other things) is responsible for the seasons, the length of the year, and variations in our diurnal cycle. Let’s break these rotational habits down by the numbers…

Sidereal Rotation:

Earth rotates once on its axis every 23 hours, 56 minutes and 4.1 seconds. Also known as a sidereal day, this period of rotation is measured relative to the stars. Meanwhile, Earth’s solar day (i.e. the amount of time it takes for the Sun to reappear in the same place in the sky) is an even 24 hours. Naturally, we use this latter value when it comes time to measure calendar days.

The night sky, showing 6 hours of rotation captured by long-exposure. Credit: Chris Schur

Earth’s sidereal rotation is responsible for the pattern of sunrises and sunsets that we are so familiar with. Using celestial objects as a reference point (i.e. the Moon, the stars, etc) the Earth rotates at a rate of 15°/h (or 15’/min) in a western direction. If viewed from space above the North Pole, Earth would appear to be rotating counter-clockwise. Hence why the Sun rises in the East and sets in the West.

The speed of the rotation of Earth has had various effects over time, including the Earth’s shape (an oblate spheroid with flattening at the poles), Earth’s climate, the depth and currents of its oceans, as well as tectonic forces. This should come as no surprise, considering that it’s rotational velociy is 1,674.4 km/h.

However, the planet is slowing slightly with the passage of time, due to the tidal effects the Moon has on Earth’s rotation. Atomic clocks show that a modern day is longer by about 1.7 milliseconds than a century ago, slowly increasing the rate at which UTC is adjusted by leap seconds. The Earth’s rotation also goes from the west towards east, which is why the Sun rises in the east and sets in the west.

Orbital Period:

Earth orbits the Sun at an average distance (aka. semi-major axis) of 149,598,023 km or 92,955,902 mi (about 1 AU), and completes a single rotation every 365.2564 mean solar days.

This is what is known as a sidereal year, or Earth's orbital period. This creates the appearance of the Sun moving eastward through the sky at a rate of about 1° per day.

At this rate, it takes the Sun the equivalent of 24 hours – i.e. one solar day – to complete a full rotation about the Earth's axis and return to the meridian (a point on the globe that runs from north to south through the poles). Viewed from the vantage point above the north poles of both the Sun and Earth, Earth orbits in a counterclockwise direction about the Sun.

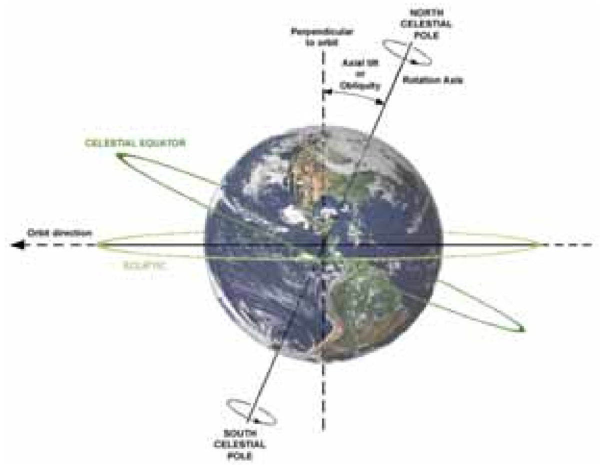
This Earth's rotation around the Sun, or the precession of the Sun through the equinoxes, is the reason a year lasts approximately 365.2 days. It is also for this reason that every four years, an extra day is required (a February 29th during every Leap Year). Also, Earth's rotation about the Sun is sujbect to a slight eccentricity of (0.0167°), which means that it is periodically closer or farther from the Sun at certain times of the year.

Earth's perihelion (147,098,074 km) occurs around January 3rd, and the aphelion around July 4th (152,097,701 km). The changing Earth-Sun distance results in an increase of about 6.9% in solar energy reaching the Earth at perihelion as related to aphelion. The southern hemisphere is tilted toward the Sun at about the same time that the Earth reaches the closest approach to the Sun, so the southern hemisphere receives slightly more energy from the Sun than does the northern over the course of a year.

It is also the reason for the Moon's apparent phases, and the occasional lunar and solar eclipse. A lunar eclipse occurs where the Moon passes into the shadow of the Earth (umbra) relative to the Sun, which causes it to darken and take on a reddish appearance (aka. a "Blood Moon" or "Sanguine Moon".)

A solar eclipse occurs during a new Moon, when the Moon is between the Sun and Earth. Since they are the same apparent size in the sky, the moon can either partially block the Sun (annular eclipse) or fully block it (total eclipse). In the case of a total eclipse, the Moon completely covers the disc of the Sun and the solar corona becomes visible to the naked eye.

Were it not for Earth's axial tilt (which is inclined 24.3° to the ecliptic), there would be an eclipse every two weeks, alternating between lunar eclipses and solar eclipses. It is also because of it's axial tilt that the amount of sunlight reaching the Earth's surface varies over the course of the year. This is what causes seasonal changes, changes in the diurnal cycle, and changes in the Sun's position in the sky relative to equator. When one hemisphere is tilted towards the Sun, it experiences summer, characterized by warmer temperatures and longer days. Every six months, this situation is reversed.



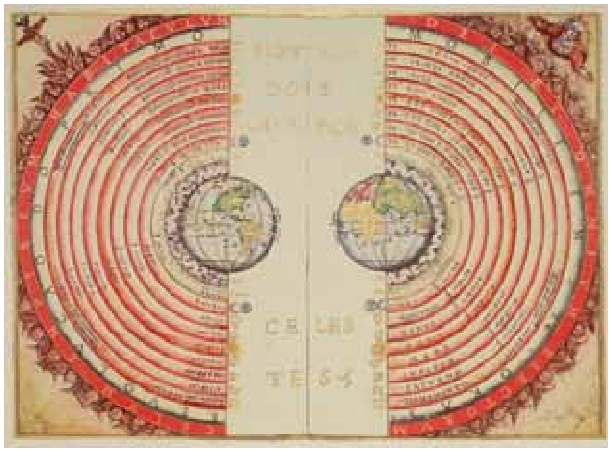
Earth's axial tilt (or obliquity) and its relation to the rotation axis and plane of orbit. Credit: Wikipedia Commons

History of Study:

In ancient times, astronomers naturally believed that the Earth was a fixed body in the cosmos, and that the Sun, the Moon, the planets and stars all rotating around it. By classical antiquity, this became formalized into cosmological systems by philosophers and astronomers like Aristotle and Ptolemy – which later came to be known as the Ptolemaic Model (or Geocentric Model) of the universe.

However, there were those during Antiquity that questioned this convention. One point of contention was the fact that the Earth was not only fixed in place, but that it did not rotate. For instance, Aristarchus of Samos (ca. 310 – 230 BCE) published writings on the subject that were cited by his contemporaries (such as Archimedes). According to Archimedes, Aristarchus espoused that the Earth revolved around the Sun and that the universe was many times greater than previously thought.

And then there was Seleucis of Seleucia (ca. 190 – 150 BCE), a Hellenistic astronomer who lived in the Near-Eastern Seleucid empire. Seleucus was a proponent of the heliocentric system of Aristarchus, and may have even proven it to be true by accurately computing planetary positions and the revolution of the Earth around the Earth-Moon 'center of mass'.

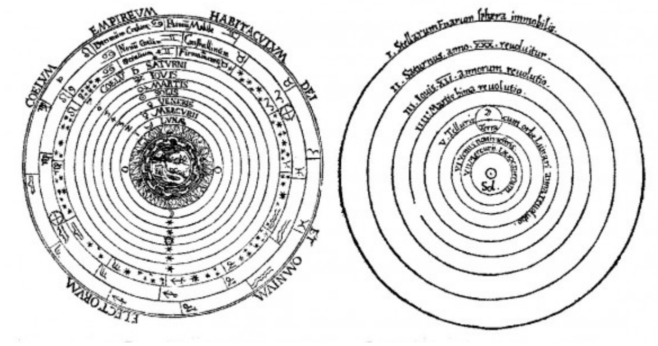


An illustration of the Ptolemaic geocentric system by Portuguese cosmographer and cartographer Bartolomeu Velho, 1568. Credit: Bibliothèque Nationale, Paris

The geocentric model of the universe would also be challenged by medieval Islamic and Indian scholars. For instance, In 499 CE, Indian astronomer Aaryabhata published his magnum opus *Aryabhatiya*, in which he proposed a model where the Earth was spinning on its axis and the periods of the planets were given with respect to the Sun.

The 10th-century Iranian astronomer Abu Sa'id al-Sijzi contradicted the Ptolemaic model by asserting that the Earth revolved on its axis, thus explaining the apparent diurnal cycle and the rotation of the stars relative to Earth. At about the same time, Abu Rayhan Biruni 973 – 1048) discussed the possibility of Earth rotating about its own axis and around the Sun – though he considered this a philosophical issue and not a mathematical one.

At the Maragha and the Ulugh Beg (aka. Samarkand) Observatory, the Earth's rotation was discussed by several generations of astronomers between the 13th and 15th centuries, and many of the arguments and evidence put forward resembled those used by Copernicus. It was also at this time that Nilakantha Somayaji published the *Aryabhatiyabhasya* (a commentary on the *Aryabhatiya*) in which he advocated a partially heliocentric planetary model. This was followed in 1500 by the *Tantrasangraha,* in which Somayaji incorporated the Earth's rotation on its axis.



A comparison of the geocentric and heliocentric models of the universe. Credit: history.ucsb.edu

In the 14th century, aspects of heliocentricism and a moving Earth began to emerge in Europe. For example, French philosopher Bishop Nicole Oresme (ca. 1320-1325 to 1382 CE) discussed the possibility that the Earth rotated on its axis. However, it was Polish astronomer Nicolaus Copernicus who had the greatest impact on modern astronomy when, in 1514, he published his ideas about a heliocentric universe in a short treatise titled *Commentariolus* ("Little Commentary").

Like others before him, Copernicus built on the work of Greek astronomer Atistarchus, as well as paying homage to the Maragha school and several notable philosophers from the Islamic world (see below). Intrinsic to his model was the fact that the Earth, and all the other planets, rolved around the Sun, but also that the Earth revolved on its axis and was orbited by the Moon.

In time, and thanks to scientists sch as Galileo and Sir Isaac Newton, the motion and revolution of our planet would become an accepted scientific convention. With the advent of the Space Age, the deployment of satellites and atomic clocks, we have not only confirmed that it is in constant motion, but have been able to measure the its orbit and rotation with incredibly accuracy.

We have written many interesting articles about the motions of the Earth here at Universe Today. Here's How Fast Does The Earth Rotate?, Earth's Orbit Around The Sun, How Fast Does The Earth Rotate?, Why Does The Earth Spin?, What Would Happen If The Earth Stopped Spinning?, and What Is The Difference Between the Heliocentric and Geocentric Models Of The Solar System?

Astronomy Cast also has a relevant episode on the subject – Episode 171: Solar System Movements and Positions

For more information, be sure to check out NASA: Why Do We Study the Sun? NASA Eclipse, and all about Earth.

Blue Origin Reaches Another Milestone: Reusable Rocket Launches and Lands Safely

27 Jan , 2016 by Evan Gough

On Friday, January 22nd, commercial space company Blue Origin successfully launched and landed its reusable rocket, New Shepard, at their launch facility in Texas. This is the second flight for New Shepard, showing that reusable rockets are on their way to becoming the launch system of choice. New Shepard launched, travelled to apogee at 101.7 kilometres, (63.19 miles) and then descended to land safely at their site in West Texas. This is the first successful reuse of a rocket in history.

Reusable rockets are an important development for space travel. Rockets are enormously expensive, and having to trash each rocket after a single use makes commercial space flight a real challenge. Blue Origin—and other companies like SpaceX—are blazing a trail to cheaper space flight with their reusable designs. This is great, not only for all the good sciencey reasons that we love so much, but because eventually civilian space enthusiasts may be able to travel past the Karman Line without having to sell all their possessions to do so. (Reserve your ticket here.)

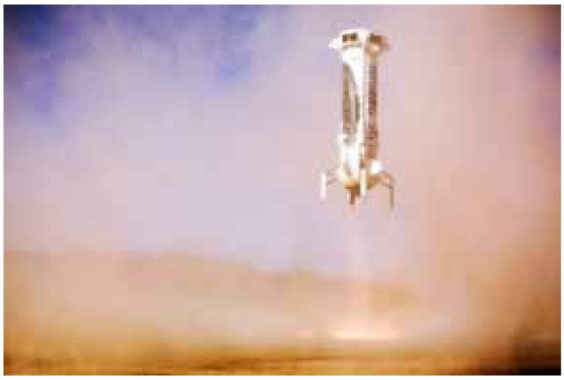
This video shows New Shepard launching, travelling and sticking its landing.

At the heart of New Shepard is its dynamically gimballed engine, which aims itself as it approaches the ground. This system allows the rocket to land precisely and safely, and is at the heart of its reusability. It's also a system that scales well: rather than New Shepard just showing that reusable rockets are a feasible concept, but will require significant advancements before being scalable to larger payloads, the gimballed engine system will actually perform better with larger mass. This is because of the inverted pendulum problem.

The Blue Origin website explains it well:

"Try balancing a pencil on the tip of your finger. Now try it with a broomstick. The broomstick is simpler because its greater moment of inertia makes it easier to balance. We solved the inverted pendulum problem on *New Shepard* with an engine that dynamically gimbals to balance the vehicle as it descends."

The Space Shuttle was the first system to come close to being a Reusable Launch System (RLS), although it was only partially reusable. It reused its main engines, as well as two solid rocket boosters, though they took months of refitting. Other components of the shuttle were discarded after a single use. New Shepard reuses its whole system, other than some components like pyro igniters, and of course the parachutes from the crew capsule.



New Shepard comes in for a landing with drag brakes and landing gear deployed. Image: Blue Origin.

Blue Origin is on a roll, and they'll be continuing to develop New Shepard. They plan to keep launching and landing New Shepard, and refining the system. They are also developing their next engine, the BE4, which will increase the system's thrust by 500%.

Opportunity Robustly in Action on 12th Anniversary of Red Planet Touchdown

26 Jan , 2016 by Ken Kremer

Composite hazcam camera image (left) shows the robotic arm in motion as NASA's Mars Exploration Rover Opportunity places the tool turret on the target named "Private John Potts" on Sol 4234 to brush away obscuring dust. Rover is actively working on the southern side of "Marathon Valley" which slices through western rim of Endeavour Crater. On Sol 4259 (Jan. 16, 2016), Opportunity completed grinds with the Rock Abrasion Tool (RAT) to exposure rock interior for elemental analysis, as seen in mosaic (right) of four up close images taken by Microscopic Imager (MI). Credit: NASA/JPL/Cornell/Ken Kremer/kenkremer.com/Marco Di Lorenzo

NASA's world famous Mars Exploration Rover Opportunity continues blazing a daily trail of unprecedented science first's, still swinging her robotic arm robustly into action at a Martian "Mining Zone" on the 12th anniversary of her hair-raising Red Planet touchdown this week, a top rover scientist told Universe Today.

"Looks like a mining zone!" Opportunity Deputy Principal Investigator Ray Arvidson, of Washington University in St. Louis, explained to Universe Today. On Jan. 24 the rover marked 4267 Sols and a dozen years and counting exploring Mars.

Significantly, Opportunity also just passed through winter solstice on Sol 4246 (Jan. 3, 2016), corresponding to the lowest-solar-energy days of the mission's seventh Martian winter – 12 years into a 3 month mission.

At this very moment and despite the "low energy" season Opportunity is actively at work, having just completed grinding into a high value rock surface target called "Private John Potts" at her current location inside steep walled Marathon Valley – where she is conducting breakthrough science on smectite clay mineral bearing rocks yielding clues to Mars watery past.

"Just finished multiple grinds on Private John Potts to establish baseline compositions for rocks," Arvidon told me. "Marathon Valley is unlike anything we have ever seen."

This is especially exciting to researchers because the phyllosilicate clay mineral rocks formed under water wet, non-acidic conditions that are more conducive to the formation of Martian life forms – billions of years ago when the planet was far warmer and wetter.

"We have been in the smectite [phyllosilicate clay mineral] zone for months, ever since we entered Marathon Valley," Arvidson confirmed.

See our exclusive mosaic views (above and below) of the Martian worksite at Marathon Valley showing the robotic arm in motion and rock grinding results – created by the imaging team of Ken Kremer and Marco Di Lorenzo.

NASA's Opportunity rover images current worksite at Knudsen Ridge on Sol 4228 where the robot is grinding into rock targets inside Marathon Valley during 12th Anniversary of touchdown on Mars in Jan. 2016. Credit: NASA/JPL/Cornell/Marco Di Lorenzo/Ken Kremer/kenkremer.com

Jan. 24 marks the 12th anniversary since Opportunity's safe landing on the plains of Meridiani Planum on Jan. 24, 2004, after plummeting through the Martian atmosphere, and surviving the harrowing descent and scorching temperatures dubbed the "Six Minutes of Terror!"

Spirit landed inside 100 mile wide Gusev crater three weeks earlier on Jan. 3, 2004.

Just like her twin sister Spirit, the robotic dynamic duo have experienced an unending series of unimaginable science adventures that ended up revolutionizing our understanding of Mars due to their totally unexpected longevity.

This six wheeled emissary from Earth has survived more than 12 years and 7 frigidly harsh winters on the Red Planet – nearly twice the lifetime of Spirit.

Opportunity has now functioned an unfathomable 47 times beyond her "warrantied" lifetime of merely 90 Martian days, or Sols.

Indeed, after a dozen years sleuthing on Mars, Opportunity ranks as the longest living "Martian."

On Sol 4259 (Jan. 16, 2016), Opportunity completed grinds with the Rock Abrasion Tool (RAT) to exposure rock interior for elemental analysis, as seen in mosaic (right) of four up close images taken by Microscopic Imager (MI). Credit: NASA/JPL/Cornell/Marco Di Lorenzo/Ken Kremer/kenkremer.com

Both rovers were equipped with a rock grinder named the Rock Abrasion Tool (RAT) built by Honeybee Robotics, located on the tool turret at the terminus of the robotic arm. Opportunity's RAT still functions very well today.

Over the past few weeks, engineers commanded the rovers RAT to first brush and then grind away surface crust from the "Private John Potts" target located on "Knudsen Ridge" inside Marathon Valley.

NASA's Opportunity rover peers outwards across to the vast expense of Endeavour Crater from current location descending along steep walled Marathon Valley in early November

2015. Marathon Valley holds significant deposits of water altered clay minerals holding clues to the planets watery past. Shadow of Pancam Mast assembly and robots deck visible at right. This navcam camera photo mosaic was assembled from images taken on Sol 4181 (Oct. 29, 2015) and colorized. Credit: NASA/JPL/ Cornell/Ken Kremer/kenkremer.com/Marco Di Lorenzo

The team is naming targets in Marathon Valley after members of the Lewis and Clark Expedition's Corps of Discovery. They are also moving the rover from spot to spot to collected as much data as possible to place the region in geologic context and better elucidate Mars history.

Marathon Valley measures about 300 yards or meters long and cuts downhill through the west rim of Endeavour crater from west to east the same direction in which Opportunity is driving. Endeavour crater spans some 22 kilometers (14 miles) in diameter. Opportunity has been exploring Endeavour since arriving in 2011.

On Sol 4257 (Jan. 14, 2016), the golf cart sized robot successfully finished a series of successive RAT grinds on the target, totaling over 2 millimeters of grind depth to expose the rocks interior. Two days later on Sol 4259, the rover brushed away the grind tailings to enable an in-situ (contact) science campaign to examine the composition and texture of the target.

Opportunity then collected a Microscopic Imager (MI) mosaic and placed the Alpha Particle X-ray Spectrometer (APXS) inside the ground target to gather the measurements for determining the elemental composition of the rock.

The brush, MI and APXS are all housed on the tool turret with the RAT.

With the data gathering done on Sol 4262 (Jan. 19, 2016), the rover was commanded to bump barely 2 inches (5 centimeters) to examine the next target.

"Now finished MI and APXS on John Collin, a small sand splay and today we will button up the IDD [robotic arm] and head east along Knudsen Ridge in search of red outcrops," Arvidson elaborated.

I asked Arvidson to assess the condition of the RAT's diamond encrusted bits after 12 years of rock grinds.

"RAT bits still ok because the rocks in Marathon Valley are relatively soft."

The ancient, weathered slopes around Marathon Valley became a top priority science destination after they were found to hold a motherlode of 'smectite' clay minerals, based on data obtained from specially targeted and extensive Mars orbital measurements gathered by the CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) spectrometer on NASA's Mars Reconnaissance Orbiter (MRO) – accomplished earlier at the direction of Arvidson.

"Opportunity is driving east and southeast down Marathon Valley, bisecting the region in which we detect smectites using CRISM [spectrometer] data," Arvidson told Universe Today.

Asked to describe what are the key science accomplishments of the past year, Arvidson mentioned the up close inspection of the Marathon Valley smectites, which amounts to a payoff for CRISM's orbital measurements.

"Discovery of red rocks and complex structures in Marathon Valley," Arvidson explained. "They are unlike anything we have ever seen. Corresponds to what from CRISM spectra we mapped as smectite bearing."

"Likely the [smectite] signature is carried by these red rocks in that they have spectral evidence from Pancam for hematite and APXS shows low Fe, Mn and enrichments in Al and Si. Still working on it."

How did the smectites form?

"Leading hypothesis is hydrothermal alteration just after Endeavour formed. First ground examination of the altered rim of a Noachian crater and many, many Noachian crater rims show evidence of this alteration mineralogy."

Panoramic view from NASA's Opportunity rover looking down the floor of Marathon Valley and out to the vast expense of Endeavour Crater. Marathon Valley holds significant deposits of water altered clay minerals. This composite photo mosaic shows the rover's robotic arm reaching out at left to investigate Martian rocks holding clues to the planets watery past, and robot shadow and wheel tracks visible at right. The mosaic combines a flattened fisheye hazcam image at left with a trio of navcam camera images taken on Sol 4144 (Sept. 20, 2015) and colorized. Credit: NASA/JPL/ Cornell/Ken Kremer/kenkremer.com/Marco Di Lorenzo

Overall Opportunity remains healthy with sufficient power to continue operations. Indeed the solar arrays output is increasing, producing 454 watt-hours of energy as of Jan. 19, 2016, partly due to more sunshine being available after winter solstice.

In recent weeks, fortuitous wind gusts have blown away some dust obscuring the solar panels and engineers are also maneuvering the rover to north facing slopes to catch more of the sun's rays on the southern side of Marathon Valley.

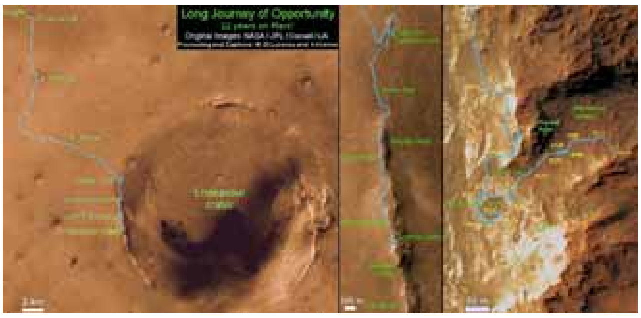
"Yes, power has been increasing since we passed aphelion and the winter solstice," explained Arvidson. "Active but not super active. Batteries do not charge well at cold temperatures so solar power is only one measure of energy available."

As of today, Sol 4269, Jan. 26, 2016, Opportunity has taken over 207,600 images and traversed over 26.50 miles (42.65 kilometers) – more than a marathon.

Meanwhile Opportunity's younger sister rover Curiosity traverses and drills into the basal layers at the base of Mount Sharp.

Stay tuned here for Ken's continuing Earth and planetary science and human spaceflight news.

Ken Kremer



12 Year Traverse Map for NASA's Opportunity rover from 2004 to 2016. This map shows the entire path the rover has driven during almost 12 years and more than a marathon runners distance on Mars for over 4267 Sols, or Martian days, since landing inside Eagle Crater on Jan 24, 2004 – to current location at the western rim of Endeavour Crater and descending into Marathon Valley. Rover surpassed Marathon distance on Sol 3968 and marked 11th Martian anniversary on Sol 3911. Opportunity discovered clay minerals at Esperance – indicative of a habitable zone – and is currently searching for more at Marathon Valley. Credit: NASA/JPL/ Cornell/ASU/Marco Di Lorenzo/Ken Kremer/kenkremer.com

SpaceX Test Fires Recovered Falcon 9 Booster in Major Step To Reusable Rockets

16 Jan , 2016 by Ken Kremer

Recovered Falcon 9 first stage standing on LZ-1 at Cape Canaveral after intact landing on Dec. 21, 2015. Credit: SpaceX

In a major advance towards the dream of rocket reusability, SpaceX successfully test fired the first stage engines of the Falcon 9 booster they successfully recovered last month – following its launch to the edge of space and back that ended with a history making upright landing at Cape Canaveral.

The re-firing of the engines from history's first recovered rocket took place Friday evening, Jan. 15.

And the test results were initially confirmed by Hans Koenigsmann, SpaceX vice president for mission assurance during a media briefing, moments after it occurred.

"Apparently it went very well," said Koenigsmann, at the prelaunch briefing for NASA's Jason-3 mission set for blastoff on a Falcon 9 on Sunday, Jan. 17, at Vandenberg Air Force Base in California.

Long exposure of launch, re-entry, and landing burns of SpaceX Falcon 9 on Dec. 21, 2015. Credit: SpaceX

The static fire test of the 156-foot-tall first stage involved ignition of all nine Merlin engines and was carried out at the same pad from which it launched on Dec. 21, 2015 from Cape Canaveral Air Force Station, Fla and soft landed about 10 minutes later.

Proving that the recovered rocket can be refurbished with minimal maintenance and eventually reflown is critical to demonstrating the rocket reuse is economically viable.

The successful outcome of the test was announced by SpaceX billionaire founder and CEO Elon Musk.

"Conducted hold-down firing of returned Falcon rocket," Musk tweeted overnight after an initial data review.

"Data looks good overall."

During the static fire test, the Falcon 9 was held down in place at the launch pad at Space Launch Complex-40, as is customary, as the engines fire for several seconds.

However the duration of this particular test firing is not known at this time.

Musk noted that although the "data looks ok" there was an issue with one of the nine Merlin 1D engines, which are attached at the boosters base in an octoweb arrangement.

"Engine 9 showed thrust fluctuations," Musk stated.

"Maybe some debris ingestion. Engine data looks ok.

Engineers are now inspecting the engine to precisely determine its condition.

"Will borescope tonight. This is one of the outer engines."

Falcon 9 first stage in pad 39A hangar at Kennedy Space Center following upright landing recovery from launch on Dec. 21, 2015. Credit: SpaceX

Conducting the test at pad 40, amounted to a change in plans from what Musk had announced last month.

During a post launch briefing on Dec. 21, Musk stated that SpaceX would conduct the test firing of the recovered first stage at the Kennedy Space Center on historic Launch Complex 39A.

In fact the Falcon 9 booster was towed some 10 miles north from LZ-1 to pad 39A and brought inside a newly built SpaceX hangar for initial inspections. The rocket was then transported back to pad 40 and erected for the hot fire engine test.

SpaceX transporter erector for Falcon rocket family rests atop ramp at Launch Complex Pad 39A at NASA's Kennedy Space Center in Florida. It will transport and erect SpaceX Falcon 9 and Falcon Heavy rockets between processing hanger and launch pad. It was to be used for upcoming hold down static fire test of recently recovered Falcon 9 booster. Formerly served as NASA space shuttle launch pad 39A. Credit: Ken Kremer/Kenkremer.com

Musk's space vision is to radically slash the costs of launching people and payloads to space by recovering and reflying rockets – built individually at great expense – rather than completely discarding them after a single use.

Musk's long term dream is to enable "A City on Mars" – as I reported earlier here.

The Dec. 21 upright landing recovery of the intact Falcon 9 first stage counts as a game changing achievement in the history spaceflight on the once fantastical road to rocket reusability and "A City on Mars."

The primary goal of the Dec. 21 'Return to Flight' launch was carrying a constellation of 11 ORBCOMM OG2 commercial communications satellites to low Earth orbit.

The next time SpaceX will actually try to recover a Falcon 9 first stage is less than 1 day way.

SpaceX is on course to try a 2nd rocket recovery landing of their Falcon 9 booster this Sunday, Jan. 17, following blast-off of the Jason-3 ocean monitoring satellite for NASA from Vandenberg AFB.

Stay tuned here for Ken's continuing Earth and planetary science and human spaceflight news.

Ken Kremer

Phase of the Moon affects amount of rainfall

Posted on 30 January 2016 by Astronomy Now

The waxing gibbous Moon of 11 January 2014. Image credit: Ade Ashford.

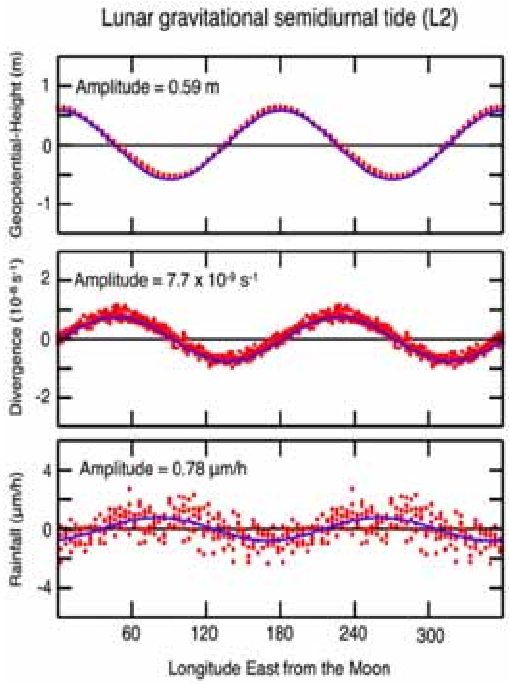
When the Moon is high in the sky, it creates bulges in the planet's atmosphere that creates barely perceptible changes in the amount of rain that falls below.

New University of Washington research to be published in Geophysical Research Letters shows that the lunar forces affect the amount of rain — though very slightly.

"As far as I know, this is the first study to convincingly connect the tidal force of the Moon with rainfall," said corresponding author Tsubasa Kohyama, a UW doctoral student in atmospheric sciences.

Kohyama was studying atmospheric waves when he noticed a slight oscillation in the air pressure. He and co-author John (Michael) Wallace, a UW professor of atmospheric sciences, spent two years tracking down the phenomenon.

Air pressure changes linked to the phases of the Moon were first detected in 1847, and temperature in 1932, in ground-based observations. An earlier paper by the UW researchers used a global grid of data to confirm that air pressure on the surface definitely varies with the phases of the Moon.



Satellite data over the tropics, between 10° S and 10° N, shows a slight dip in rainfall when the Moon is directly overhead or underfoot. The top panel shows the air pressure, the middle shows the rate of change in air pressure, and the bottom shows the rainfall difference from the average. The change is 0.78 micrometres, or less than $^{1}/_{10,000}$ of an inch, per hour. Illustration credit: Tsubasa Kohyama/University of Washington.

"When the Moon is overhead or underfoot, the air pressure is higher," Kohyama said.

Their new paper is the first to show that the Moon's gravitational tug also puts a slight damper on the rain.

When the Moon is overhead, its gravity causes Earth's atmosphere to bulge toward it, so the pressure or weight of the atmosphere on that side of the planet goes up. Higher pressure increases the temperature of air parcels below. Since warmer air can hold more moisture, the same air parcels are now farther from their moisture capacity.

"It's like the container becomes larger at higher pressure," Kohyama said. The relative humidity affects rain, he said, because "lower humidity is less favourable for precipitation."

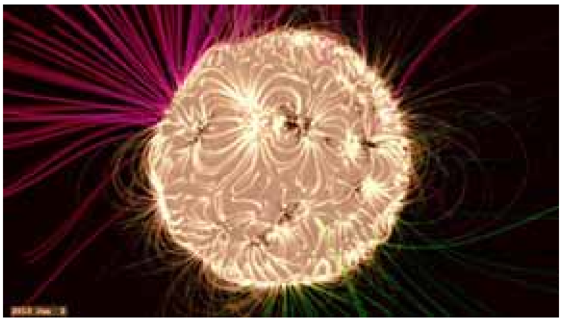
Kohyama and Wallace used 15 years of data collected by NASA and the Japan Aerospace Exploration Agency's Tropical Rainfall Measuring Mission satellite from 1998 to 2012 to show that the rain is indeed slightly lighter when the Moon is high. The change is only about 1 percent of the total rainfall variation, though, so not enough to affect other aspects of the weather or for people to notice the difference.

"No-one should carry an umbrella just because the Moon is rising," Kohyama said. Instead, this effect could be used to test climate models, he said, to check if their physics is good enough to reproduce how the pull of the Moon eventually leads to less rain.

Wallace plans to continue exploring the topic to see whether certain categories of rain, like heavy downpours, are more susceptible to the phases of the Moon, and whether the frequency of rainstorms shows any lunar connection.

Understanding the magnetic Sun

Posted on 30 January 2016 by Astronomy Now



A frame from movie (see below) where NASA Goddard solar scientist Holly Gilbert explains a computer model of the Sun's magnetic field. Grasping what drives that magnetic system is crucial for understanding the nature of space throughout the solar system. The Sun's invisible magnetic field is responsible for everything from the solar explosions that cause space weather on Earth — such as aurorae — to the interplanetary magnetic field and radiation through which our spacecraft journeying around the solar system must travel. Image credit: NASA's Goddard Space Flight Center/Duberstein.

The surface of the Sun writhes and dances. Far from the still, whitish-yellow disc it appears to be from the ground, the Sun sports twisting, towering loops and swirling cyclones that reach into the solar upper atmosphere, the million-degree corona — but these cannot be seen in visible light. Then, in the 1950s, we got our first glimpse of this balletic solar material, which emits light only in wavelengths invisible to our eyes.

Once this dynamic system was spotted, the next step was to understand what caused it. For this, scientists have turned to a combination of real time observations and computer simulations to best analyse how material courses through the corona. We know that the answers lie in the fact that the Sun is a giant magnetic star, made of material that moves in concert with the laws of electromagnetism.

"We're not sure exactly where in the Sun the magnetic field is created," said Dean Pesnell, a space scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "It could be close to the solar surface or deep inside the Sun — or over a wide range of depths."

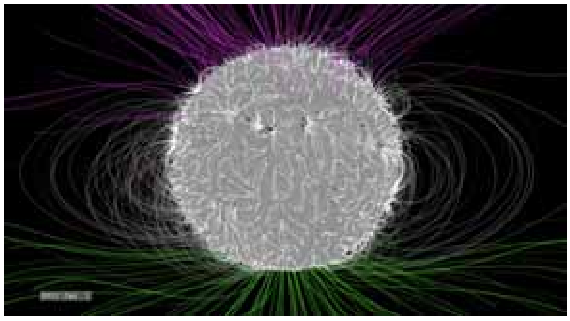
Getting a handle on what drives that magnetic system is crucial for understanding the nature of space throughout the solar system: The Sun's magnetic field is responsible for everything from the solar explosions that cause space weather on Earth — such as aurorae — to the interplanetary magnetic field and radiation through which our spacecraft journeying around the solar system must travel.

So how do we even see these invisible fields? First, we observe the material on the Sun. The Sun is made of plasma, a gas-like state of matter in which electrons and ions have separated, creating a super-hot mix of charged particles. When charged particles move, they naturally create magnetic fields, which in turn have an additional effect on how the particles move. The plasma in the Sun, therefore, sets up a complicated system of cause and effect in which plasma flows inside the Sun — churned up by the enormous heat produced by nuclear fusion at the centre of the Sun — create the Sun's magnetic fields. This system is known as the solar dynamo.

We can observe the shape of the magnetic fields above the Sun's surface because they guide the motion of that plasma — the loops and towers of material in the corona glow brightly in EUV images. Additionally, the footpoints on the Sun's surface, or photosphere, of these magnetic loops can be more precisely measured using an instrument called a magnetograph, which measures the strength and direction of magnetic fields.

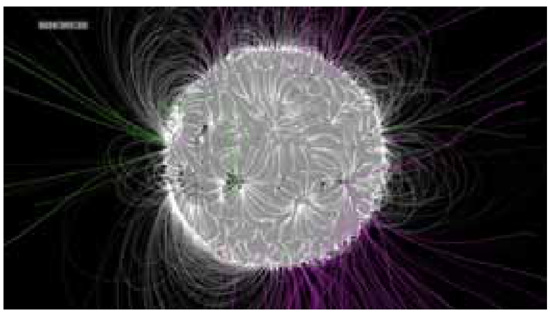
Next, scientists turn to models. They combine their observations — measurements of the magnetic field strength and direction on the solar surface — with an understanding of how solar material moves and magnetism to fill in the gaps. Simulations such as the Potential Field Source Surface, or PFSS, model — shown in the video below — can help illustrate exactly how magnetic fields undulate around the Sun. Models like PFSS can give us a good idea of what the solar magnetic field looks like in the Sun's corona and even on the Sun's far side.

A complete understanding of the Sun's magnetic field — including knowing exactly how it's generated and its structure deep inside the Sun — is not yet mapped out, but scientists do know quite a bit. For one thing, the solar magnetic system is known to drive the approximately-11-year activity cycle on the Sun. With every eruption, the Sun's magnetic field smooths out slightly until it reaches its simplest state. At that point the Sun experiences what's known as solar minimum, when solar explosions are least frequent. From that point, the Sun's magnetic field grows more complicated over time until it peaks at solar maximum, some 11 years after the previous solar maximum.



In January 2011, three years after solar minimum, the solar magnetic field is still relatively simple, with open field lines concentrated near the poles. Image credit: NASA/SVS.

"At solar maximum, the magnetic field has a very complicated shape with lots of small structures throughout — these are the active regions we see," said Pesnell. "At solar minimum, the field is weaker and concentrated at the poles. It's a very smooth structure that doesn't form sunspots."



At solar maximum, in July 2014, the structure is much more complex, with closed and open magnetic field lines poking out all over — ideal conditions for solar explosions. Image credit: NASA/SVS.

VIEWING LOGS AND IMAGES

Hi Andy,

Could you put these pictures in the magazine of the close encounter between Jupiter and the Moon on the 28th of January.

Tech details of the pictures:

First one taken at 1/250 of a second, this brings Jupiter

out a bit but the Moon is over exposed.

This one taken at 1/640 of a second, this kills the over expose of the Moon but makes Jupiter harder to see.

Both pictures taken with a Canon 60Da DSLR camera attached to a William Optics 80mm refractor at f6.8 on a Porta Mount II.

Rare clear sky in January!

Peter

(The cover picture is one of these shots… I did a little zone work to hold back the Moon and bring out Jupiter. Ed)

Stargazing Live.

We managed to put together an indoor show, and miracle of miracles, some clear skies so we could have another team in the field with telescopes and binoculars.

In the Barn (we were generously allowed to hire at very late notice and public toilets were left open for us by the National Trust Estate Office) we had an exhibition of meteorites and bits of Apollo and Gemini space mission parts under Nick Howes guidance, and I put up a range of telescope types, attempted a lunar video and displayed meteors and a short slide show of astro images taken in the last year to describe what we see, from satellites, planets, stars (birth to death), cluster and galaxies.

Out in the field Tony and Jonathan were organising views of the Moon, the Orion nebula and various cluster of stars, and (I am told) some galaxies. Thanks to the others who turned up to help, in particular Martin who ended up being a bit of a go between as I got stuck in the barn more than I had anticipated.

Despite our low key advertising of this event the National Trust observer put the numbers visiting between 70 and 80.

Thank you again to all involved.

Andy.

The Sun from January 14th. The beginning of a week of many aurora, but just stopped north of Wiltshire for viewing.

DMK51au video camera, televue 127 telescope with Solarscope 70mm Hydrogen alpha filter.

The Moon in all its glory climbed high in the sky after the new Moon of the 11th. Here is an image of the Moon when it was 1.5days old. You can just see the shine from the far side of the Moon illuminating the edge. But as you can see this is disappearing into the trees very quickly.The Moon pictures

here were taken using compact camera, hand held at near full zoom. Nikon S9900.

The Moon on the 16th January is one of my favourite phases of the Moon. I call it the Herschel Moon, because all three major craters named after family members William, Caroline and John are all visible.

It also is the ideal illumination for Sinus Iridium, the bay of showers on the terminator.

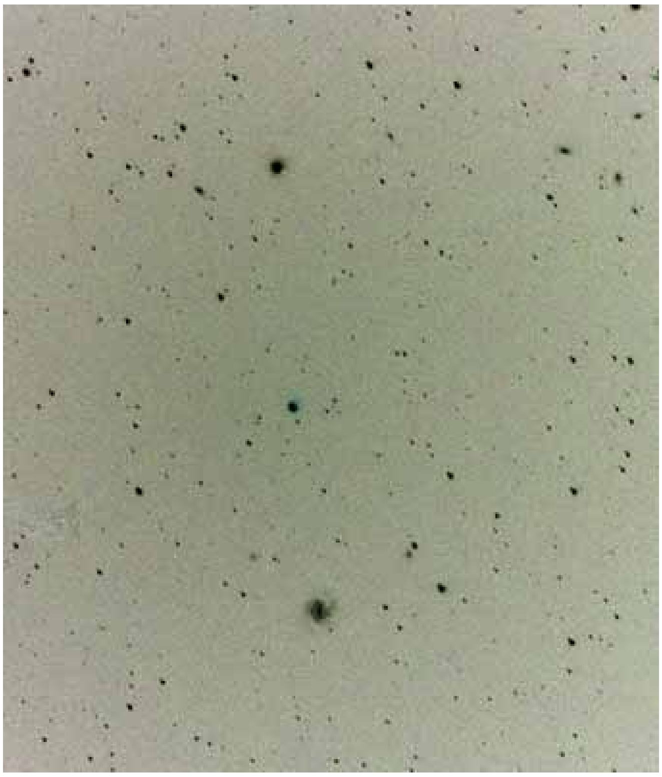
Going down the Moon we have the lower Oceanus Procularum and Thebit region. Here we can just see rupes recta or the straight wall.

On the lower picture the libration has pushed the southern most visible part of the Moon around from view, but it leaves the Clavius crater region perfectly lit to show the inner craters.

M3 in Canes Venetici.

M13 and a much more distant galaxy ngc 6207 in Hercules.

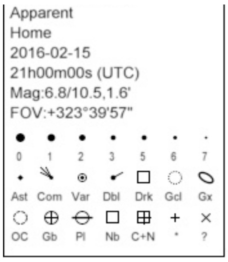
M51 whirlpool galaxy with its companion galaxy ngc 5195

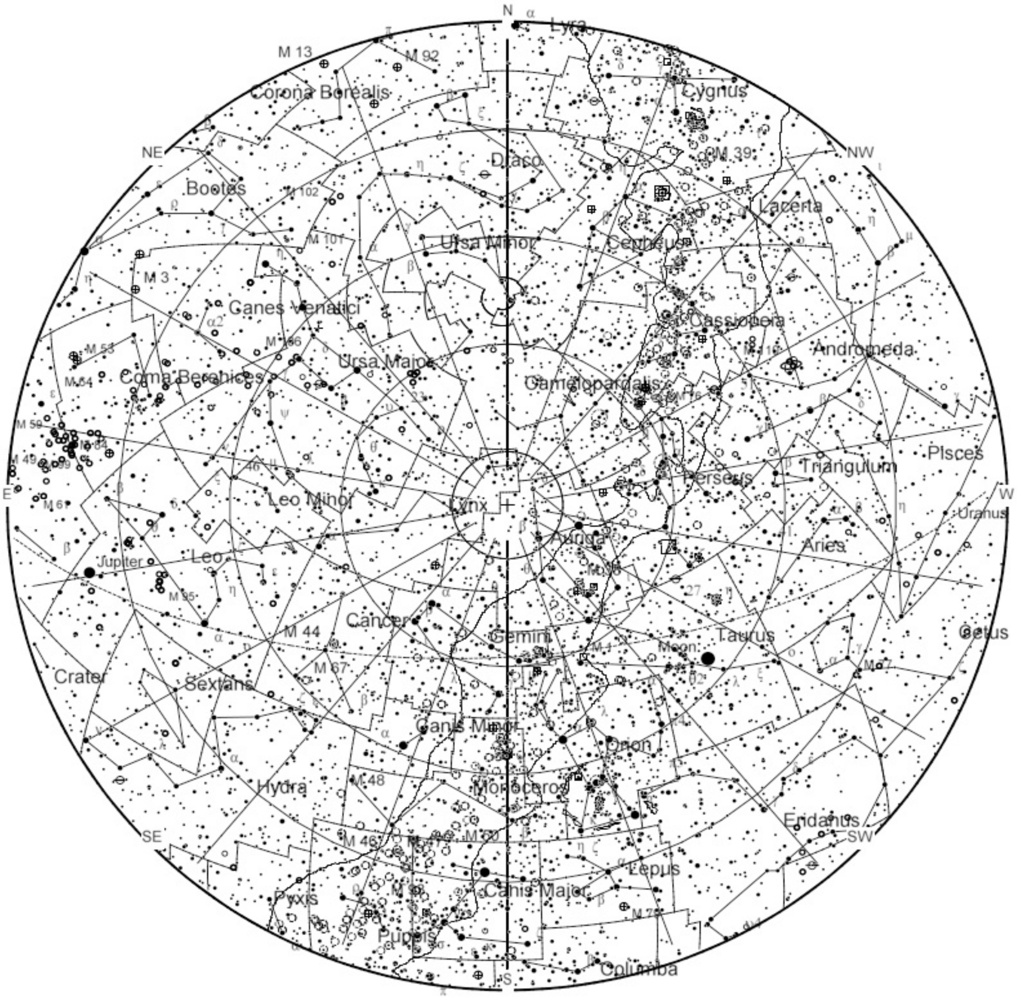


M61 a beautiful spiral in the Virgo cluster. Many more galaxies visible.

M81, M82 and Codringtons galaxy above and the edge on needle galaxy ngc 4565.

WHATS UP, February 2016





•**February 7** - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 25.6 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

●

•**February 8** - **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 14:39 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

●

•**February 22** - **Full Moon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 18:20 UTC. This full moon was known by early Native American tribes as the Full Snow Moon because the heaviest snows usually fell during this time of the year. Since hunting is difficult, this moon has also been known by some tribes as the Full Hunger Moon, since the harsh weather made hunting difficult.

03 19:05 Saturn 3.5°S of Moon
06 07:32 Venus 4.3°S of Moon
06 16:47 Mercury 3.8°S of Moon
07 01 Mercury at Greatest Elong: 25.6°W
08 14:39 NEW MOON
10 20:46 Moon at Descending Node
11 02:42 Moon at Perigee: 364358 km
13 03 Mercury 4.0° of Venus
15 07:46 FIRST QUARTER MOON
16 07:41 Aldebaran 0.3°S of Moon
21 17 Mercury at Aphelion
22 12:48 Regulus 2.5°N of Moon
22 18:20 FULL MOON
24 03:58 Jupiter 1.7°N of Moon
24 06:10 Moon at Ascending Node
26 19:05 Spica 5.1°S of Moon
27 03:28 Moon at Apogee: 405383 km
28 15 Neptune in Conjunction with Sun
29 18:16 Mars 3.6°S of Moon

Clear Skies. Andy

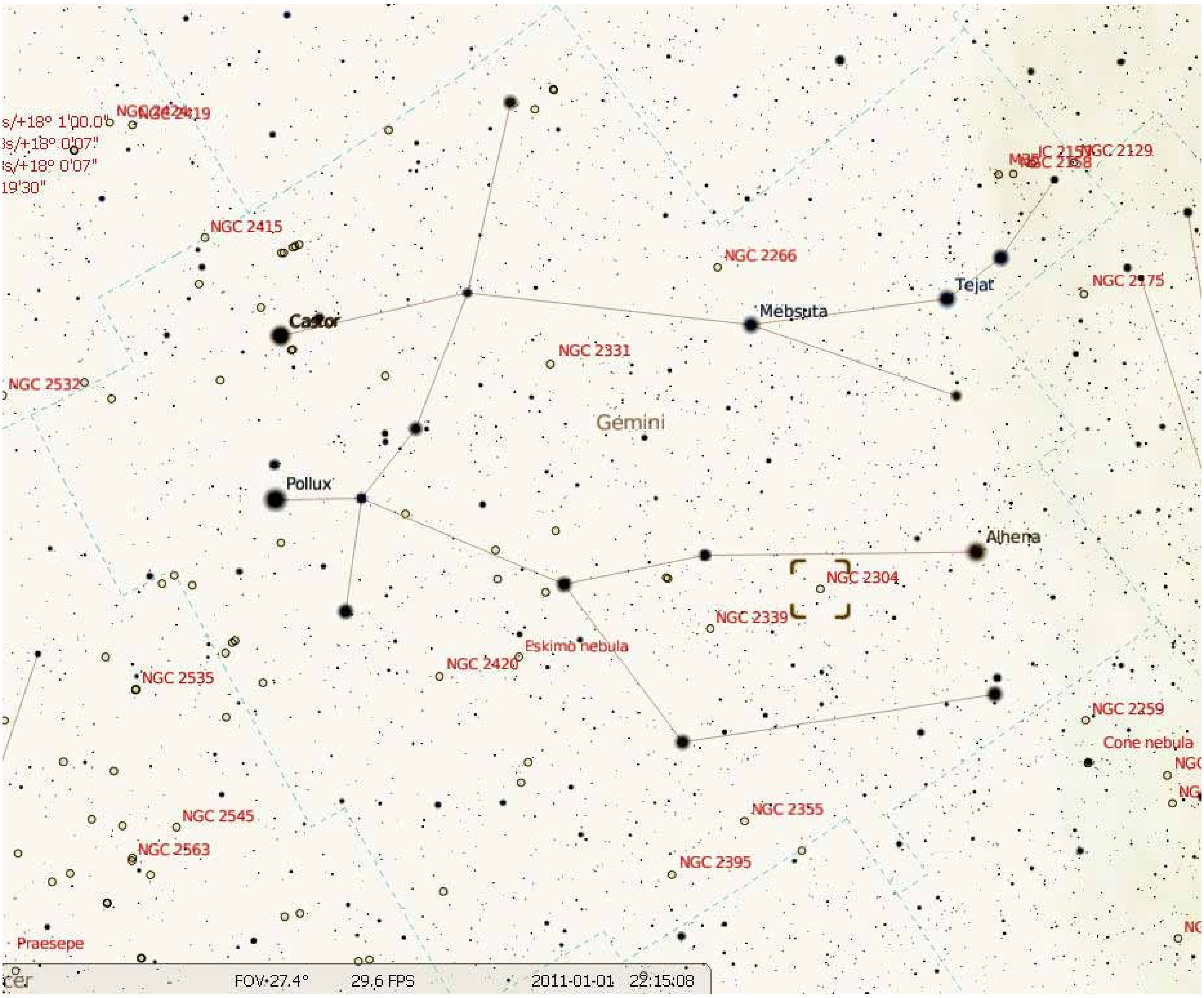
M42 and M43 in Orion will be a favourite site through February.

Comet Catalina in January

Firstly 14th January

By the 19th much dimmer and a shortened tail, here with the handle of the plough and Messier 101. It has been getting dimmer since and has passed polaris now.

CONSTELLATIONS OF THE MONTH: GEMINI



Mythological Background:

The names of the two brightest stars of this constellation, Castor and Pollux, can be found in the greek mythology:
One day Zeus seduced Leda, the wife of the King of Sparta, Tyndareos. To get Leda Zeus changed himself to a swan. Leda became pregant and gave birth to the twins Pollux and Castor and to a girl named Helena. This was the same Helena who was robbed by Paris and brought to Troja; this was the reason for the start of the trojanian war.

Stars and other objects

The two brightest stars *alpha Gem*, ***Castor***, and *beta Gem*, ***Pollux***, are worth for observations: Castor has a brightness of 1.6 mag. Viewed with good amateur telescopes this star can be split into three components: Castor A and Castor B revolve each other with a period of 420 years (less good telescopes may only split Castor into two blue-white stars of 2nd and 3rd mag). The third component, Castor C (also known as *YY Gem*) circulates this pair with a period of several thousand years. Each of the three components is a spectroscopic binary.
Pollux is a red giant of 1.1 mag.
The semiregular variable star *eta Gem* is a red giant. Its brightness varies from 3rd to 4th magnitude with a period of 230 days. In larger telescopes (apertur at least 150mm) *eta Gem* reveals a companion of 8.8 mag
Zeta Gem is a 4th mag Cepheid variable that varies 0.4 mag in brightness every 10.2 days.
The two double stars *epsilon Gem* and *38 Gem* are best viewed in small scopes. The first consists of a 3rd mag yellow supergiant with a wide 9th mag companion. The second splits into a pair of withe and yellow 5th and 8th mag stars.
With the help of small telescopes the planetary nebula *NGC 2392* reveals an 8th mag blue-green disk about the size of Jupiter. When viewed with larger telescopes it shows a funny shape why it is named ***Eskimo** or **Clown Face Nebula***.
The open cluster *M35* (NGC 2168) is an outstanding cluster with about 200 stars. In binoculars or small telescopes it is visible as a hazy patch. More detailed information about M35 can be found in the Messier database.
One of the most prominent meteor showers radiates from this constellation (from the region around Castor), the *geminids*. They peak on december 13th and 14th.
The meteor shower rho geminids are visible from end of december to the end of january. They have their peak on 8th of january (there is a second maximum on the 21st of january).

The history of Gemini Constellation is a unique one. The symbol of twins depicts a love bond between them as stated in Greek myth. A majority of the Greek constellations came from Babylonian astronomy. However, the legends surrounding the origin of the constellations were mostly taken from Greek mythology.

The Gemini Constellation is one of the 88 constellations defined by the Astronomical Union. The constellation is an image of a two spurs with stars Castor and Pollux at one end and four short spurs in the other end. This history of Gemini constellation dates back to prehistoric times. Gemini is in fact the Latin word for “twins”. It is associated with the twins, Castor and Pollux as depicted in Greek mythology. Besides Castor and Pollux, the other two visible stars in the constellation are Alhena and Wasat. Pollux is the brightest star in the Gemini constellation. It is known in astronomical terms as beta Geminorum. It was discovered that Pollux is approximately 33 light years from our solar system and has a planet that is believed to be 2.3 times the size of Jupiter.

The mythology explains that Castor and Pollux were both mothered by a same person called Leda, but had different fathers. The myth elaborates that Leda was seduced and made pregnant in the same night by Zeus (who disguised himself as a Swan) and her husband, King Tyndareus. Leda then birthed Pollux and Helen of Troy, followed by Castor the Twin of Pollux. Castor did well in managing horses while Pollux had extraordinary skills in boxing. It was also noted that Pollux was immortal, whereas Castor was mortal. They both journeyed together in search of the Golden Fleece (similar to the Holy Grail). They fought alongside in the Trojan War to return Helen to her husband. When Castor died, Pollux was in despair. Pollux then requested Zeus to allow Castor share his immortality. Zeus with the power given agreed, and they were reunited as the Gemini Constellation image in the night sky, never parted.

The rich history of Gemini Constellation depicts a beautiful love story between two twins, who in the end chose to be together despite death.

The stars of Gemini include two of the most recognisable in the heavens: the twins Castor and Pollux.

Castor (alpha Geminorum) is the slightly dimmer star. It has a visual magnitude of 1.93 and is 52 light years distant. It isn't a particularly large star, at about twice the Sun's diameter. The star is a noted binary, discussed below.

Pollux is the brighter of the two stars with a visual magnitude of 1.16 and a distance of 33.7 light years. It is also considerably larger, with an estimated diameter of about ten Suns.

Castor and Pollux are 4.5 degrees apart, which helps observers estimate separation distances between other stars.

Epsilon Geminorum is a supergiant at about 30 Sun diameters. This star may be as far away as 950 light years, but the combination of visual and absolute magnitudes suggests a much closer star, at only 190 light years.

Zeta Geminorum is the most distant of the bright stars in this constellation, at over 1200 light years. This is a cepheid variable (see below).

Eta Geminorum is a red giant, about 50 times the size of the Sun, at a distance of 280 light years. It is a visual binary and a variable (details below).

Double stars in Gemini

Alpha Geminorum is a well-known binary with the companion currently (2000.0) at a PA of 65º and separation 3.9". The visual magnitudes are 1.9 and 3.0. There is some disagreement over the precise period of the companion; one observer has it at 420 years, another at 511. More recent measurements put the orbit at 467 years and the orbit we've prepared uses this revised value.

This was the first binary system that was so recognised, in 1802 (or 1803, accounts vary) by William Herschel. However there is considerable speculation that the star was a known double long before that, perhaps even a century before Herschel made his announcement.

The companion, Castor B, is also a spectroscopic binary, with its companion revolving around Castor B every three days.

In fact, the entire system is comprised of six stars, including a red dwarf, Castor C, which slowly revolves around both Castor A and Castor B. This star is also a variable (and therefore catalogued as YY Gem).

Delta Geminorum: visual magnitudes 3.5, 8.2, PA 225º, separation 5.8". The period is estimated at 1200 years; the companion is an orange dwarf which may be difficult to resolve in smaller telescopes.

Eta Geminorum is a visual binary that takes some work to resolve; the companion is only 8.8 (primary is 3.3), the PA is 266º and separation 1.4". This is nearly a fixed binary, with very little movement.

Variable stars in Gemini

Zeta Geminorum is a cepheid variable, from 3.62 to 4.18 every 10.15 days.

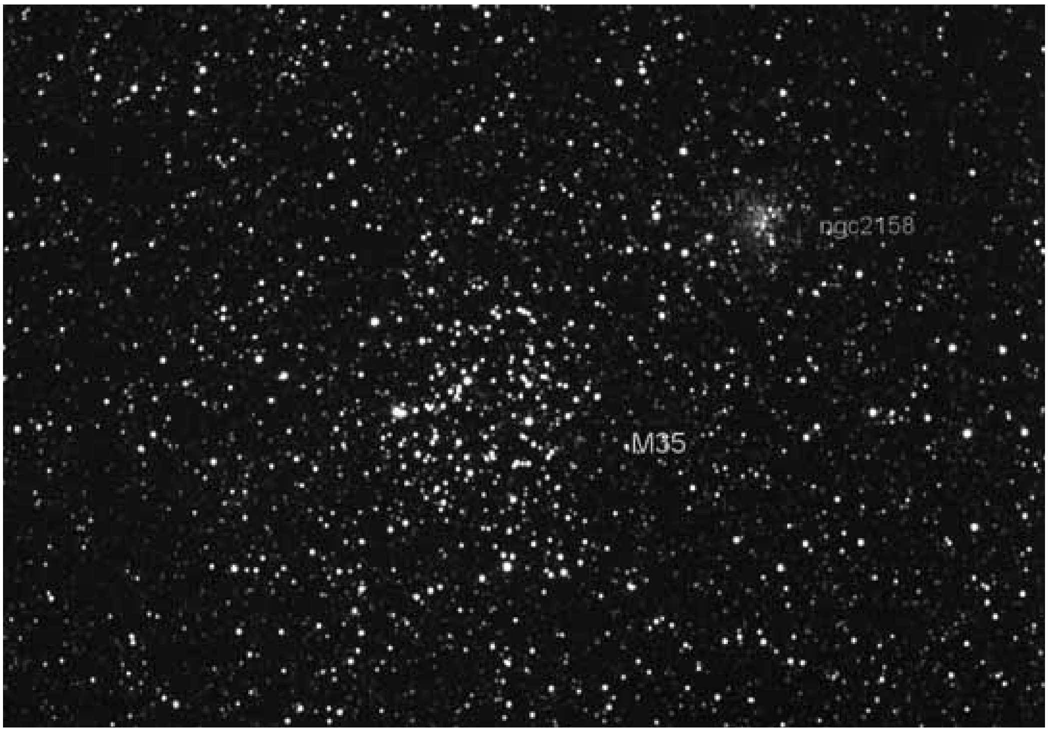
Eta Geminorum is a semi-regular variable with an average period of 232.9 days. It ranges from 3.2 to 3.9.

R Geminorum is a Mira-type long-period variable, with large variation from 6.0 to 14.0 every 370 days. The 2000 maximum should arrive in mid October.

Deep Sky Objects in Gemini:

The only Messier object in Gemini is *M35 (NGC 2168)*. This is an open cluster easily enjoyed in small scopes. It lies just 2.5 degrees northwest of eta Geminorum.

This cluster is extremely attractive, with gently curving rows of glittering stars. Several hundred stars make up the group, which is perhaps 2500 light years away.



The Eskimo Nebula (NGC 2392) is one of the more distant nebulae at an estimated distance of 10,000 light years. There

is a tenth-magnitude central star. If you do have a large enough scope, be prepared for anything: Burnham thought the Eskimo Nebula suggested "the classic and unforgettable features of W. C. Fields."

While you can locate this blue-green object in small scopes, it takes a very large telescope to see the "face" of this nebula, the eyes, nose, and mouth and the "fur collar" that gave it its name.

To find this rather small planetary nebula draw an imaginary line between kappa Geminorum and lambda Geminorum. Now draw a perpendicular line from delta Geminorum, and just about where this line meets the other one is where you'll find the Eskimo Nebula.

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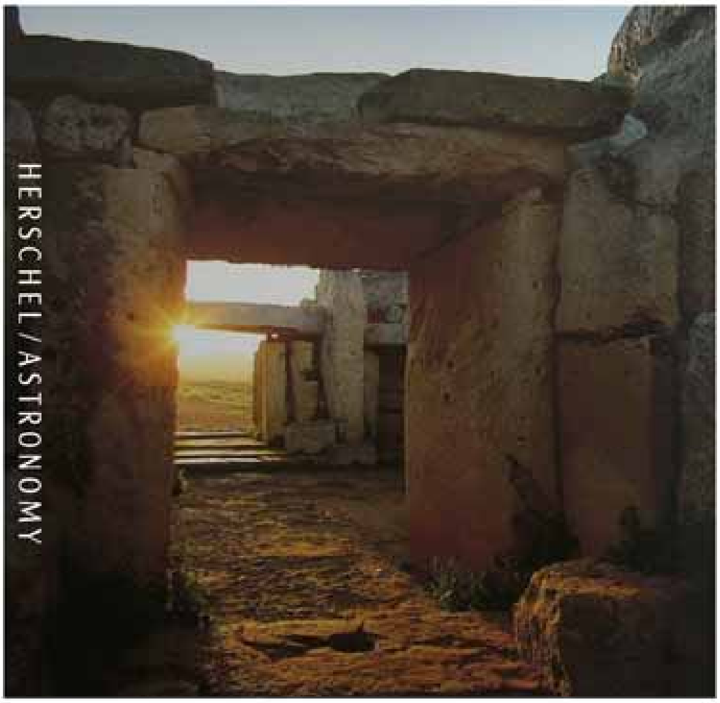
THE DICK PHILLIPS MEMORIAL LECTURE

Archaeoastronomy

A BRIEF HISTORY



Professor Clive Ruggles
University of Leicester

Archaeoastronomy (the study of beliefs and practices concerning the sky in the past) grew out of interpretations of Stonehenge and other British prehistoric monuments in the 1960s, pitting archaeologists against astronomers as they reached fundamentally different conclusions on the basis of the same evidence.

Archaeoastronomy is now universally recognised by historians and archaeologists. It can provide valuable insights into ancient people's perceptions of space, time and the cosmos, and help us to understand aspects of myth, ritual, religion, and calendars.

Professor Ruggles will trace the history of this intriguing subject, drawing upon case studies from around the world as well as his own fieldwork in pre-historic Europe, Peru and Hawaii.

BRLSI

Friday 5 February 2016 • 7.30 pm

VISITORS £4 • MEMBERS / STUDENTS £2

ISS PASSES For February 2016 From Heavens Above website maintained by Chris Peat

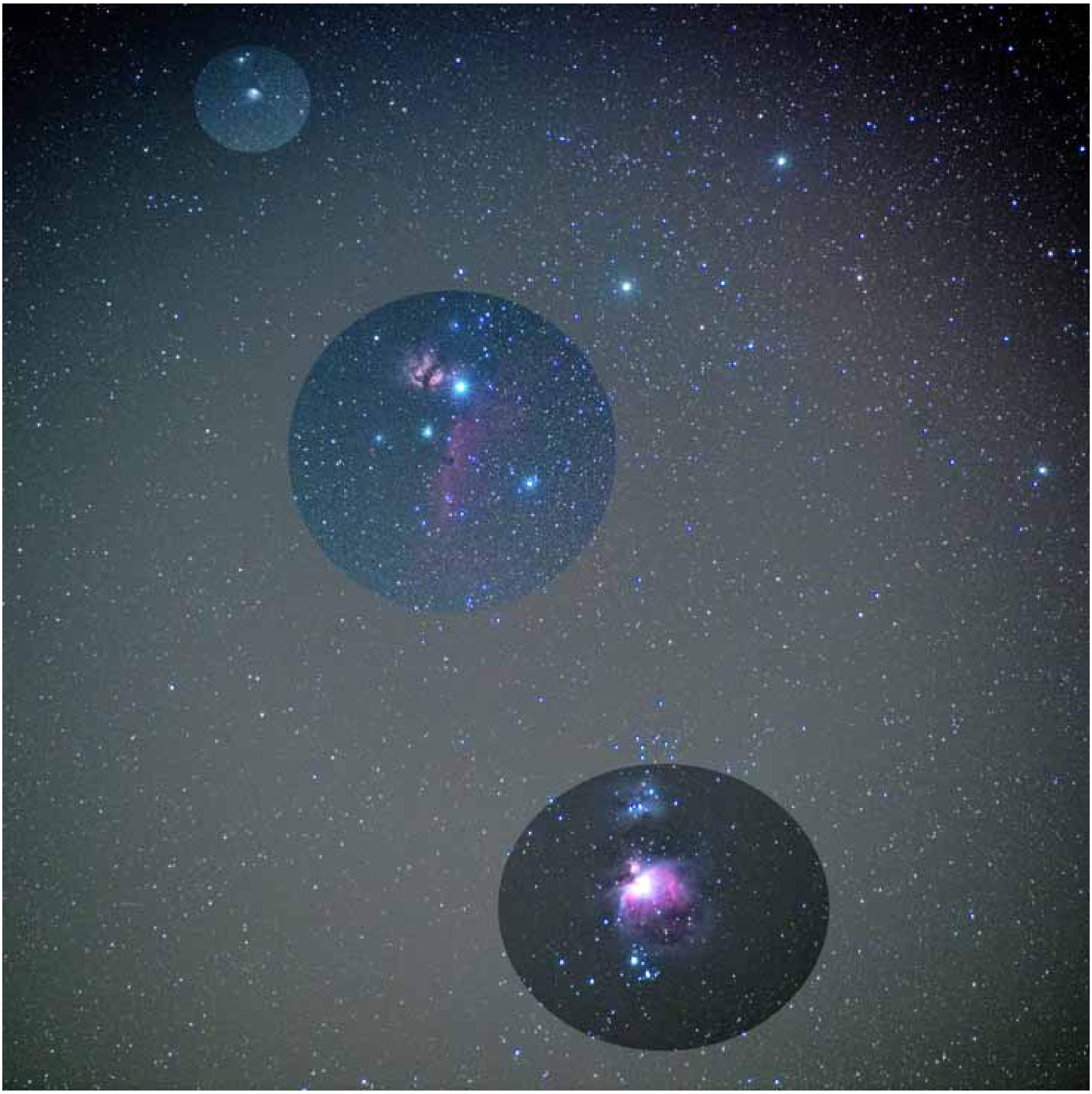
Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
02 Feb	-0.4	19:38:47	10°	SSW	19:39:06	12°	SSW	19:39:06	12°	SSW
03 Feb	-1.6	18:46:54	10°	SSW	18:49:04	20°	SSE	18:49:04	20°	SSE
04 Feb	-1.1	17:55:31	10°	S	17:57:09	13°	SE	17:58:48	10°	ESE
04 Feb	-1.5	19:29:54	10°	SW	19:31:37	27°	SW	19:31:37	27°	SW
05 Feb	-2.4	18:37:40	10°	SW	18:40:40	34°	SSE	18:41:25	30°	ESE
05 Feb	0.0	20:13:41	10°	W	20:14:04	13°	W	20:14:04	13°	W
06 Feb	-1.7	17:45:39	10°	SSW	17:48:19	23°	SSE	17:50:58	10°	E
06 Feb	-2.7	19:21:12	10°	WSW	19:23:48	52°	SW	19:23:48	52°	SW
07 Feb	-3.1	18:28:47	10°	WSW	18:31:58	55°	SSE	18:33:29	27°	E
07 Feb	-0.5	20:05:08	10°	W	20:06:08	18°	W	20:06:08	18°	W
08 Feb	-3.4	19:12:35	10°	W	19:15:46	85°	W	19:15:46	85°	W
09 Feb	-3.4	18:20:04	10°	WSW	18:23:18	79°	SSE	18:25:23	21°	E
09 Feb	-1.0	19:56:31	10°	W	19:58:01	25°	W	19:58:01	25°	W
10 Feb	-3.5	19:03:57	10°	W	19:07:13	85°	N	19:07:37	66°	E
11 Feb	-3.4	18:11:22	10°	W	18:14:39	87°	N	18:17:12	15°	E
11 Feb	-1.6	19:47:52	10°	W	19:49:50	33°	W	19:49:50	33°	W
12 Feb	-3.4	18:55:17	10°	W	18:58:33	86°	S	18:59:26	45°	ESE
12 Feb	0.1	20:31:50	10°	W	20:32:05	12°	W	20:32:05	12°	W
13 Feb	-3.4	18:02:40	10°	W	18:05:57	86°	N	18:09:04	11°	E
13 Feb	-2.2	19:39:10	10°	W	19:41:42	41°	WSW	19:41:42	41°	WSW
14 Feb	-3.1	18:46:32	10°	W	18:49:47	65°	SSW	18:51:22	27°	ESE
14 Feb	-0.2	20:23:24	10°	W	20:24:01	13°	WSW	20:24:01	13°	WSW
15 Feb	-3.3	17:53:55	10°	W	17:57:11	82°	S	18:00:26	10°	ESE
15 Feb	-1.8	19:30:31	10°	W	19:33:24	29°	SSW	19:33:44	28°	SSW
16 Feb	-2.3	18:37:46	10°	W	18:40:53	42°	SSW	18:43:32	13°	SE
16 Feb	-0.2	20:15:54	10°	WSW	20:16:11	10°	SW	20:16:11	10°	SW
17 Feb	-0.8	19:22:07	10°	W	19:24:19	17°	SW	19:26:06	12°	S
18 Feb	-1.3	18:29:06	10°	W	18:31:52	26°	SSW	18:34:37	10°	SSE
20 Feb	-0.4	18:20:45	10°	WSW	18:22:41	15°	SW	18:24:36	10°	S
05 Mar	-0.3	06:03:48	10°	SSE	06:05:09	12°	SE	06:06:30	10°	ESE
07 Mar	-1.0	05:52:58	10°	SSW	05:55:32	21°	SE	05:58:07	10°	E
08 Mar	-0.6	05:01:07	10°	S	05:02:53	14°	SE	05:04:40	10°	ESE
09 Mar	-2.0	05:42:56	10°	SW	05:45:59	35°	SSE	05:49:01	10°	E
10 Mar	-1.4	04:51:39	17°	S	04:53:14	24°	SSE	04:55:57	10°	E
11 Mar	-0.8	04:00:56	15°	SE	04:00:56	15°	SE	04:02:36	10°	ESE
11 Mar	-2.9	05:33:33	12°	WSW	05:36:28	56°	SSE	05:39:42	10°	E

END IMAGES

Picture taken of Orion belt and sword zone. Taken from deepest Welsh Valleys in Cwmcarn Forest.

Single exposure of 60seconds f3.8 180mm Nikkor, Nikon D810A.

Mount:: Sky Watcher 'Star Adventurer. The zones processed from the single picture showing advantage of zone selection in Photoshop.



Date	Moon Phase	Observing Topic
2016		
Friday 26th February	Waning gibbous	Lunar targets
Friday 25th March	Full	Lunar targets
Friday 29th April	Last quarter	Lunar targets
Monday 9th May		*Transit of Mercury*
Friday 27th May	Waning gibbous	

Wiltshire Astronomical Society Observing Sessions 2015 – 2016

OUTREACH ACTIVITIES

Some evening sessions are being arranged.