NWASNEWS

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January 2016

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

2016 another potential bumper year for viewing?

2015 certainly delivered for astronomers when it had to, sometimes only just. We had some good views of comet Lovejoy in January, a fabulous partial eclipse we viewed from Silbury Hill in March, then while the noctilucent display was weaker than expected the Sun delivered plenty a energetic outbursts of plasma that reached the lower British latitudes. I thin kPeter and I recorded over 5 separate events, and we just missed out on a New Years eve display.

We also had excellent skies at the end of September for the Lunar Eclipse. We viewed from Avebury taking a group under our wing from around the world that Peter had assembled for an open stone sunset viewing and Moon rise from Stonehenge. Well done Peter Glastonbury.

We even had a glorious line up of planets that was joined by a comet by the end of December.

A full Moon an Christmas day and a final Lacock viewing session that unfortunately just got choked out by clouds.

Some personal highlight purchases in the year was the first Astronomical camera produced by Nikon. The D810A. And it can be used in normal camera daylight work.

This combined with the best portable mount to be made, the Skywatcher Star Adventurer that can not only take a camera but big lenses and even short telescopes and track with comfort with no dangling leads. At last.

In Space dramatic fly byes of Ceres and the New Horizons at Pluto were certainly highlights, then better details from Rosetta comet Churyumov-GHerasimenko mission filtering through. Water on Mars confirmed. Two reusable launch boosting systems from the private sector, and space flight costs could begin to plummet. Low cost mission from India got to Mars and remains of Beagle2 have been seen.

Some black spots include the loss of the Virgin Galactic mission, but overall a good year for space,

Cosmologists must be delighted with the advances made in the Higgs Boson field and Dark Matter beginning to be tied down a little.

So what will 2016 bring.

I have included a space preview and an astronomy 101, but the the highlight begins this weekend (Saturday morning) with a close conjunction of Venus and Saturn 5 arc minutes apart low down in the east south east. And a transit of Mercury in May… well who knows what else, it is going to be another cracking year.

Andy

A Quantarid meteor imaged on the 4th January (early morning) this year.

Pete took pictures of a few, but all got washed out by cloud during the long exposure time, and this was the only one to survive the cloud.

It was published on the Space Weather.com web site.

Pete Glastonbury

Wiltshire Society Page

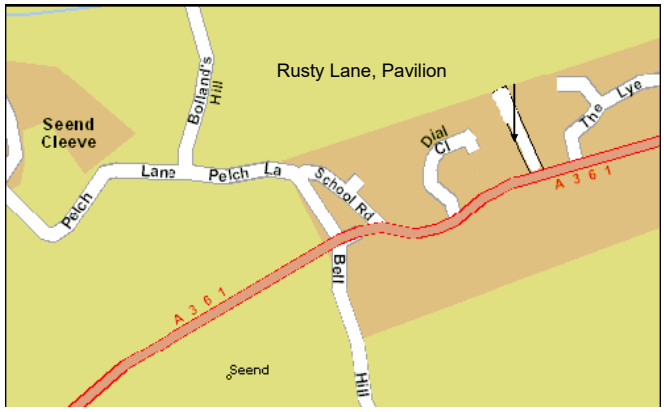
Wiltshire Astronomical Society
Web site: www.wasnet.org.uk
Meetings 2015/2016Season.
NEW VENUE the Pavilion, Rusty Lane, Seend
Meet 7.30 for 8.00pm start

2016

Jan 5th *Rosetta - An Update : Dr Andrew Morse*
Feb 2nd *10 Years at the Helm of the European Space Science: Professor David Southwood*
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 none members
Wiltshire AS Contacts

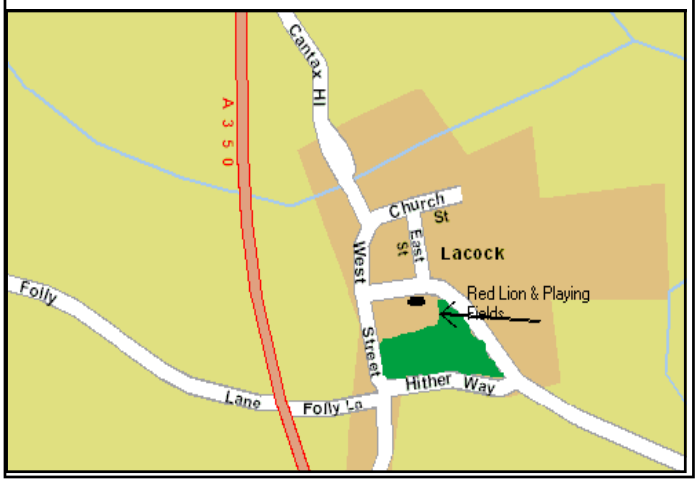
Andy Burns (Chairman, and Editor) Tel: 01249 654541, email: anglesburns@hotmail.com
Vice chair: Keith Bruton
Bob Johnston (Treasurer)
Philip Proven (Hall coordinator)
Peter Chappell (Speaker secretary)
Nick Howes (Technical Guru)
Observing Sessions coordinators: Jon Gale, Tony Vale
Contact via the web 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



Dr Andrew Morse

Andrew Morse is currently working on the Rosetta mission to study the comet 67P/ Churyumov-Gerasimenko.

In May of last year Andrew also agreed to do our little 15 questions and answers that appear on our web page. Please look them up!

Rosetta is still orbiting Comet 67P/Churyumov-Gerasimenko, and it's beamed back an impressive image showing off the comet's surface. It's rugged and beautiful.

Swindon Stargazers

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.

Stargazing Event at Blakehill Farm Nature Reserve on 14 December 2015

Originally conceived as an event to watch the Geminids Meteor Shower, the clouds closed in unfortunately and our plans changed to an indoor event for adults and children with activities and presentations by members of Wiltshire Wildlife Trust and Swindon Stargazers. Far from being a washout, it is true to say that everybody enjoyed the activities and learning about space. One presentation consisted of 'the sky at night around Blakehill Farm' (what we might have seen!), whilst another explained how meteor showers occur.
We now use Blakehill Farm Nature Reserve on a regular basis for ad-hoc stargazing and everyone is welcome. Often at short notice please see our website for more details.

More about the event here: http://www.swindonstargazers.com/noticeboard/blakehillfarm.htm

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 15 Jan 2016

Programme: Philip Perkins: Astrophotography

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

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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
15th January	*Planetary Nebulae*	Martin Griffiths
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 *Member Talks*	

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

How will we finally image the event horizon of a black hole?

By Ethan Siegel

One hundred years ago, Albert Einstein first put forth his theory of General Relativity, which laid out the relationship between spacetime and the matter and energy present within it. While it successfully recovered Newtonian gravity and predicted the additional precession of Mercury's orbit, the only exact solution that Einstein himself discovered was the trivial one: that for completely empty space. Less than two months after releasing his theory, however, the German scientist Karl Schwarzschild provided a true exact solution, that of a massive, infinitely dense object, *a black hole*.

One of the curious things that popped out of Schwarzschild's solution was the existence of an event horizon, or a region of space that was so severely curved that nothing, not even light, could escape from it. The size of this event horizon would be directly proportional to the mass of the black hole. A black hole the mass of Earth would have an event horizon less than a centimeter in radius; a black hole the mass of the sun would have an event horizon just a few kilometers in radius; and a supermassive black hole would have an event horizon the size of a planetary orbit.

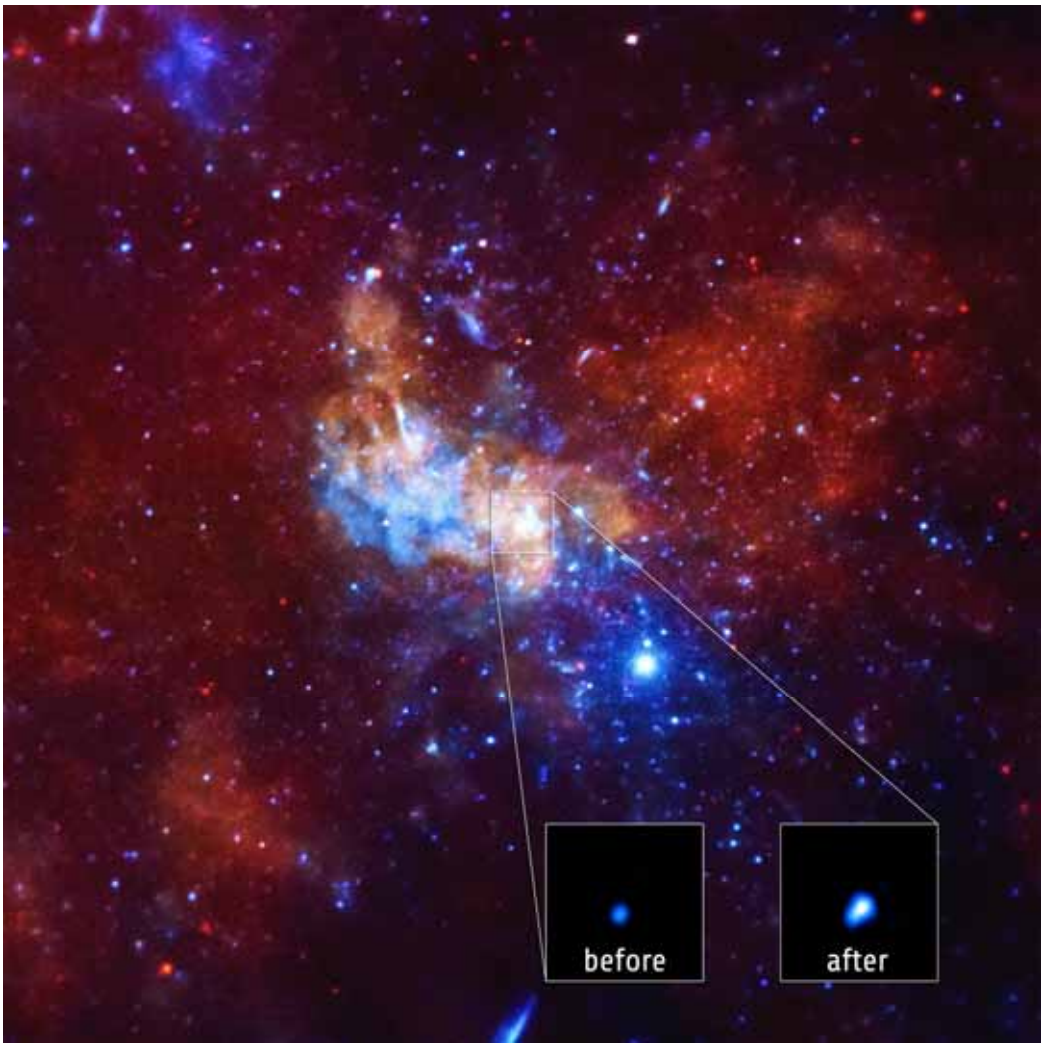


Image credit: NASA/CXC/Amherst College/D.Haggard et al., of the galactic center in X-rays. Sagittarius A is the supermassive black hole at our Milky Way's center, which normally emits X-ray light of a particular brightness. However, 2013 saw a flare increase its luminosity by a factor of many hundreds, as the black hole devoured matter. The event horizon has yet to be revealed.*

Our galaxy has since been discovered to house a black hole about four million solar masses in size, with an event horizon about 23.6 million kilometers across, or about 40 percent the size of Mercury's orbit around the sun. At a distance of 26,000 light years, it's the largest event horizon in angular size visible from Earth, but at just 19 micro-arc-seconds, it would take a telescope the size of Earth to resolve it – a practical impossibility.

But all hope isn't lost! If instead of a single telescope, we built an *array* of telescopes located all over Earth, we could simultaneously image the galactic center, and use the technique of VLBI (very long-baseline interferometry) to resolve the black hole's event horizon. The array would only have the light-gathering power of the individual telescopes, meaning the black hole (in the radio) will appear very faint, but they can obtain the resolution of a telescope that's the distance between the farthest telescopes in the array! The planned Event Horizon Telescope, spanning four different continents (including Antarctica), should be able to resolve under 10 micro-arc-seconds, imaging a black hole directly for the first time and answering the question of whether or not they truly contain an event horizon. What began as a mere mathematical solution is now just a few years away from being observed and known for certain!

Note: This month's article describes a project that is not related to NASA and does not suggest any relationship or endorsement. Its coverage is for general interest and educational purposes.

SPACE NEWS

What's Ahead for Recovered SpaceX Falcon 9 Booster?

4 Jan , 2016 by Ken Kremer

Now that SpaceX has successfully and safely demonstrated the upright recovery of their Falcon 9 booster that flew to the edge of space and back on Dec. 21 – in a historic first – the intertwined questions of how did it fare and what lies ahead for the intact first stage stands front and center.

Well the booster is apparently no worse for the wear of the grueling ascent and descent and will live to fire up again one day in the not so distant future at a former shuttle launch pad at NASA's Kennedy Space Center in Florida, following thorough inspections by SpaceX engineers.

"No damage found, ready to fire again," reports SpaceX billionaire founder and CEO Elon Musk.

"Falcon 9 back in the hangar at Cape Canaveral."

To prove his point about the recovered boosters viability, Musk has released new wide angle and up close photos of the first stage, pictured above and below.

The booster appears remarkably clean, only somewhat dishevelled and blackened by soot from rocket exhaust and hypersonic speeds after blastoff and reentry and no obvious signs of damage.

Up close view of upper portion of recovered Falcon 9 first stage inside processing hanger at pad 39A hangar at Kennedy Space Center following launch and recovery on Dec. 21, 2015. Credit: SpaceX

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."

"I think quite vital to that goal is reusability of an orbit class rocket. It's really fundamental to that goal, without which it would be unaffordable," Musk said at a post launch and landing media telecon on Dec. 21.

Furthermore, Musk indicated at the media briefing that the near term fate of the recovered booster would likely be to serve as a pathfinder stage for use in a full fledged hold down, static hot fire test at historic Launch Complex 39A at the Kennedy Space Center.

"We want to confirm that all systems are good, and that we're able to do a full thrust hold down firing of the rocket," Musk explained.

Sometime later this year, the booster will be rolled out from the hanger with a newly constructed transporter- erector and moved up the ramp to pad 39A. Technicians have already begun exercising the transporter- erector, practicing back and forth movements and raising the assembly to launch position.

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

The Falcon 9 first stage will be recycled to test out equipment, propellant loading, launch procedures and first stage ignition of the boosters upgraded Merlin 1D engines.

SpaceX is refurbishing pad 39A under a long term lease from NASA for use as a launch site starting in 2016 for the firms Falcon Heavy and Falcon 9 vehicles.

Following its spectacular blastoff from the Florida space coast on Dec. 21, the 156 foot tall booster gently touched down vertically with a rocket assisted soft landing some ten minutes later at Landing Zone-1 (LZ-1) on Cape Canaveral Air Force Station, Fla.

The entire out of this world event was webcast live by SpaceX and looked like a scene cut straight out of a science fiction movie – only it was real and thrilled on-site spectators and webcast viewers worldwide.

Soon after touchdown, Musk and his team visited LZ-1 for a preliminary assessment of the boosters fiery race to space and back. Workers used a crane to tilt the spent booster horizontally, cradle it onto a lengthy multi-wheeled trailer and tow it some ten miles north to its temporary home at a spanking new hanger just built by SpaceX at historic Launch Complex 39A at the Kennedy Space Center.

SpaceX Crew Dragon will blast off atop a Falcon 9 rocket from Launch Pad 39A at NASA's Kennedy Space Center in Florida for missions to the International Space Station. Pad 39A is undergoing modifications by SpaceX to adapt it to the needs of the company's Falcon 9 and Falcon Heavy rockets,

which are slated to lift off from the historic pad in the near future. A horizontal integration facility (right) has been constructed near the perimeter of the pad where rockets will be processed for launch prior of rolling out to the top of the pad structure for liftoff. Credit: Ken Kremer/Kenkremer.com

The video below shows the booster as its about to enter the gigantic new processing hanger that SpaceX has just constructed at the front entrance to Launch Complex 39A at the Kennedy Space Center.

Video caption: SpaceX Falcon 9 chance sighting as it was being transported to the new SpaceX Hanger located at the former LC39A Shuttle Launch Facility. Credit: Shannon Gordon

The huge new SpaceX hanger at Launch Complex 39A is intended to process both the existing medium lift Falcon 9 rocket and the new heavy lift Falcon Heavy rocket – which is essentially a tripled barred Falcon 9.

Furthermore SpaceX also intends to use pad 39A to launch astronauts on the commercial crew version of the firms Dragon spacecraft staring in 2017, under a Commercial Crew Program (CCP) development contract with NASA.

Musk added that he prefers to save this first recover Falcon booster for historical reasons and likely put it on display somewhere, perhaps in a museum.

“I think we’ll probably keep this one on the ground just because it’s kind of unique. It’s the first one that we brought back.”

The Falcon 9 booster landed nearly dead center at LZ-1.

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.

About 3 minutes into the flight the first stage separated from the upper stage which continued to orbit with the 11 Orbcomm satellites. Engineers then reignited a first stage Merlin 1D engine several times to successfully make the propulsive ground landing about 10 minutes later at LZ-1 at the Cape, some six miles south from the SpaceX launch pad at Space Launch Complex-40 (SLC-40).

Video caption: Mobius remote video camera positioned at launch pad showing blastoff of the SpaceX Falcon 9 Orbcomm-2 mission on December 21, 2015. Credit: Ken Kremer/kenkremer.com

“The satellites were deployed right on target,” Musk stated at the briefing. “And the Falcon 9 booster came back and landed, it looks like, almost dead center in the landing pad. And then the upper stage did a coast and then restarted to prove out the coast and restart capability.”

“So as far as we can see right now the mission was absolutely perfect. We could not have asked for a better mission or a better day.”

SpaceX transporter erector for Falcon rocket family rests atop ramp at Launch Complex 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 will 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

As for future recovered boosters, Musk definitely plans to refurbish and refly them – perhaps by the end of 2016 if all goes well.

“Over time we expect to get back over 99% of the rockets,” Musk elaborated. “So we will figure out how to make the reuse as easy as possible. So that really no work is required between reuses, apart from refilling the propellant tanks.”

“So it will take us a few years to iron all that out and make sure it all works well.”

Although some companies have expressed an interest in flying on a recovered booster, there are no announced customer contracts – yet!

Ken Kremer

Space Stories to Watch in 2016

30 Dec , 2015 by David Dickinson

2015 was an amazing year in space, as worlds such as Pluto and Ceres snapped into sharp focus. 2015 also underlined the mantra that ‘space is hard,’ as SpaceX rode the roller coaster from launch failure, to a dramatic return to flight in December, complete with a nighttime landing of its stage 1 Falcon 9 rocket back at Cape Canaveral. So, what’s in store for 2016? How about a mission to Mars, Jupiter, and – just maybe — a groundbreaking discovery in astrophysics? Here’s our drill-down of space stories to watch in 2016:

Juno Arrives at Jupiter

Juno departs Earth orbit en route to Jupiter. Artist’s conception, credit NASA/Juno

After several years of space travel, NASA’s Juno mission will enter orbit around Jupiter next year. Launched from Cape Canaveral on August 5th, 2011, Juno will only be the second spacecraft to enter orbit around Jupiter, and the first mission to the outer solar system that won’t utilize nuclear power. Instead, Juno is equipped with three enormous bus-sized solar panels. Juno will study the magnetosphere, magnetic field and gravitational environment of Jove in its wide-ranging path. Expect Juno to enter orbit around Jupiter on July 4th, 2016.

Gravitational Waves Discovered?

Looking down the arm of LIGO Hanford. Image credit: Dave Dickinson

Could astronomers directly detect gravitational waves in the coming year… just over a century after Einstein's special theory of relativity predicted them? It's a very real possibility, as the Advanced LIGO project went online in late 2015. Sporting ten times the sensitivity of the original LIGO project, Advanced LIGO 'should' detect gravitational waves generated by black hole and pulsar mergers and extra-galactic supernovae. If it *doesn't*, something is seriously wrong with our theories of cosmology. This could be the physics story of 2016 along the lines of the CERN Higgs-Boson discovery, if direct detection is accomplished.

Heavy Rockets Take Flight

Both China and SpaceX may debut their heavy lift rockets in 2016. China is set to perform its inaugural launch of its Long March 5 rocket from Wenchang Space Center sometime in the next year. Meanwhile, SpaceX is set to launch its Falcon Heavy lift rocket from the Kennedy Space Center this coming April. Yeah, I know: we've been chasing this one as a 'space story to watch' for a couple years now… but 2016 looks like the year that the Falcon Heavy will indeed break the surly bonds. And NASA's SLS heavy lifter? Expect the first uncrewed flight in the 2018 time frame, with astronauts riding atop the rocket beyond low Earth orbit three years beyond that.

Curiosity Celebrates Christmas at Red Planet Paradise at Namib Dune with 1st Mastcam Self-portrait

25 Dec , 2015 by Ken Kremer

Just in time for the holidays, NASA's Curiosity rover is celebrating Christmas 2015 at a Red Planet Paradise – spectacular "Namib Dune." And she marked the occasion by snapping her first ever color self-portrait with the mast mounted high resolution Mastcam 34 mm camera.

Heretofore Curiosity has taken color self portraits with the MAHLI camera mounted at the end of the 7-foot-long (2-meter-long) robotic arm, and black and white self portraits with the mast mounted navcam camera.

The new Mastcam color self portrait was taken just days ago on December 19, and includes the first ever color images of the rover deck. Previously, Curiosity has used the Mastcam color camera to take tens of thousands of exquisite high resolution panoramic images of the magnificent looking Martian terrain, but not the entire rover deck which includes the inlet ports for the pair of chemistry labs in the robots belly.

Curiosity arrived at the outskirts of Namib Dune in mid-December. And as the images show Namib Dune is humongous and unlike anything encountered before by Curiosity. See our exclusive photo mosaics above and below from the image processing team of Ken Kremer and Marco Di Lorenzo.

Why snap a Mastcam self portrait now? Because there's unique science to be gained from the Red Planets swirling winds whipping up dust and sand particles with the rover now at the edge of the giant dune field at the foothills of Mount Sharp, and to check for buildup of particles on the rover deck.

"The plan includes a Mastcam image of the rover deck to monitor the movement of particles," wrote MSL science team member Lauren Edgar, Research Geologist at the USGS Astrogeology Science Center, in a mission update.

Namib Dune is part of a massive field of spectacular rippled dark sand dunes, known as the "Bagnold Dunes" – located at the base of Mount Sharp and range up to two stories tall.

The six wheeled rover was dispatched to the dunes to conduct humanity's first up-close investigation of currently active sand dunes anywhere beyond Earth.

"Namib is an Aeolian paradise," wrote Edgar.

"The view at Namib Dune is pretty spectacular. We've received a lot of beautiful Mastcam and Navcam images."

Curiosity drives around the dark Namib sand dunes for first in-place study of an active sand dune anywhere beyond Earth. This colorized photo mosaic is stitched from Mastcam camera raw images taken on Sol 1192, Dec. 13, 2015. Credit: NASA/JPL/MSSS/Marco Di Lorenzo/Ken Kremer/kenkremer.com

This past week, the science and engineering team commanded the car sized rover to drive closer and around Namib to investigate the dune from various angles with her state of the art science instrument suite.

Curiosity observes dark dunes up close after arriving in the vicinity of Namib Dune at base of Mount Sharp to study sand movements over time. This photo mosaic is stitched from Mastcam camera raw images taken on Sol 1190, Dec. 11, 2015. Credit: NASA/JPL/MSSS/Marco Di Lorenzo/Ken Kremer/kenkremer.com

Curiosity arrived at the lee face of Namib Dune on December 19, or Sol 1197.

"The latest Navcam images reveal many beautiful aeolian features on the slipface and interdune deposits."

"It's hard to curb your imaging appetite when the views are so spectacular!"

Curiosity explores Namib Dunes at base of Mount Sharp, for first in-place study of an active sand dune anywhere other than Earth. See Gale Crater rim in the distance.This colorized photo mosaic is stitched from navcam camera raw images taken on Sol 1192, Dec. 13, 2015. Credit: NASA/JPL/Ken Kremer/ kenkremer.com/Marco Di Lorenzo

The dark dunes skirt the northwestern flank of Mount Sharp and lie on the alien road of Curiosity's daring trek up the lower portion of the layered Martian mountain.

Beside dunes, the local terrain is also replete with a bonanza of outcrops of bedrock and mineral veins for targeted science observations.

"Curiosity will acquire ChemCam and Mastcam observations of targets to characterize some of the local bedrock and veins," Edgar elaborated. "We'll also take a Mastcam stereo mosaic of "Namib Dune" to better understand the morphology of the ripples and grain flow."

"We'll use ChemCam to assess the composition and grain size of a ripple. Then we'll use Mastcam to image the brink of the dune and its slipface to characterize the dune morphology. We'll also use Mastcam to document an outcrop with an unusual purple hue."

Initial imaging results are already promising and much more is upcoming.

"The Mastcam images that we took earlier this week are coming down now, and they reveal a lot of great details about the dune morphology," says Edgar.

Curiosity approaches the dark Bagnold Dunes backdropped by towering Mount Sharp, for first in-place study of an active sand dune anywhere other than Earth. This colorized photo mosaic is stitched from navcam camera raw images taken on Sol 1169, Nov. 19, 2015. Credit: NASA/JPL/ Marco Di Lorenzo/ Ken Kremer/kenkremer.com

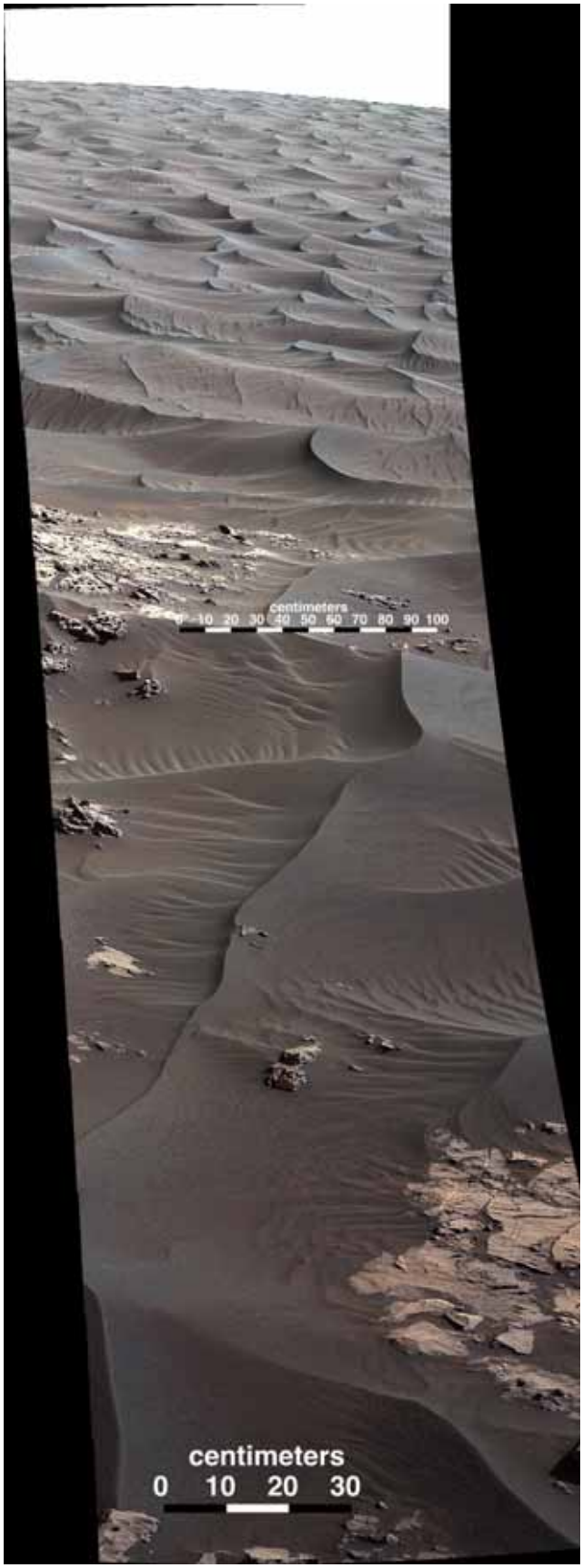
"Mastcam will do a mosaic of the slip face of Namib dune, and a stereo observation of the target "Nadas" to study the shape of the alcoves on the very crest of the dune," MSL team member Ryan Anderson added.

"Mastcam will also watch for changes in a patch of nearby sand, as well as a couple of locations on the dune slip face."

While Earthlings and their families are gathering together and engrossed in the Christmas holiday cheer, there will be little rest for 'The Martian' Curiosity. The science team has planned out and uploaded more than a week of science observations to run through the New Year's holiday.

"We're in a great location to study "Namib Dune" so there is plenty of good science to be done," says Anderson.

In addition, Curiosity is dumping the recently acquired rock drill sample from "Greenhorn" onto the surface to analyze the residue further, "before the martian wind blows it away."



The rippled surface of the first Martian sand dune ever studied up close fills this Nov. 27, 2015, view of "High Dune" from the Mast Camera on NASA's Curiosity rover. This site is part of the "Bagnold Dunes" field of active dark dunes along the northwestern flank of Mount Sharp. The raw images for this mosaic were taken on Nov. 27, 2015, Sol 1176. Credits: NASA/JPL-Caltech/MSSS

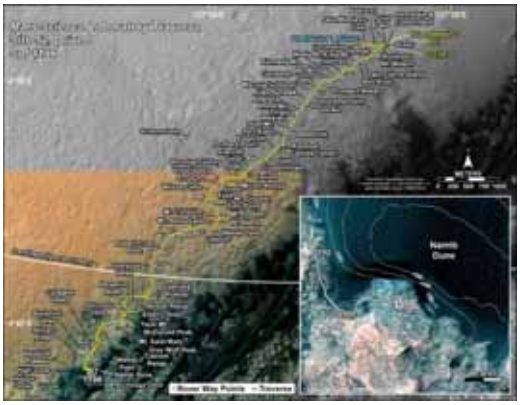
As of today, Sol 1203, December 25, 2015, Curiosity has driven over 7 miles (11.5 kilometers) and taken over 291,700 amazing images.

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

Ken Kremer

Curiosity approaches the dark Bagnold Dunes for first in-place study of an active sand dune anywhere other than Earth. This photo mosaic is stitched from navcam camera raw images taken on Sol 1168, Nov. 18, 2015. Credit: NASA/JPL/Ken Kremer/kenkremer.com/Marco Di Lorenzo

Curiosity extends robotic arm and conducts sample drilling at "Buckskin" rock target at bright toned "Lion" outcrop at the base of Mount Sharp on Mars, seen at right. Gale Crater eroded rim seen in the distant background at left, in this composite multisol mosaic of navcam raw images taken to Sol 1059, July 30, 2015. Navcam camera raw images stitched and colorized. Inset: MAHLI color camera up close image of full depth drill hole at "Buckskin" rock target on Sol 1060. Credit: NASA/JPL-Caltech/MSSS/Ken Kremer/kenkremer.com/Marco Di Lorenzo



Curiosity's Traverse Map Through Sol 1196. This map shows the route driven by NASA's Mars rover Curiosity through Sol 1196, December, 18, 2015. Numbering of the dots along the line indicate the sol number of each drive. North is up. The scale bar is 1 kilometer (~0.62 mile). From Sol 1194 to Sol 1196, Curiosity had driven a straight line distance of about 97.41 feet (29.69 meters). The base image from the map is from the High Resolution Imaging Science Experiment Camera (HiRISE) in NASA's Mars Reconnaissance Orbiter. Credit: NASA/JPL-Caltech/Univ. of Arizona

NASA Receives Significant Budget Boost for Fiscal Year 2016

18 Dec , 2015 by Ken Kremer

NASA has just received a significant boost in the agency's current budget after both chambers of Congress passed the $1.1 Trillion 2016 omnibus spending bill this morning, Friday, Dec. 18, which funds the US government through the remainder of Fiscal Year 2016.

As part of the omnibus bill, NASA's approved budget amounts to nearly $19.3 Billion – an outstandingly magnificent result and a remarkable turnaround to some long awaited good news from the decidedly negative outlook earlier this year.

This budget represents an increase of some $750 million above the Obama Administration's proposed NASA budget allocation of $18.5 Billion for Fiscal Year 2016, and an increase of more than $1.2 Billion over the enacted budget for FY 2015.

Space enthusiasts worldwide should rejoice at this tremendously positive budget news for NASA – which enables the agency to move forward with its core agenda of human spaceflight, robotic exploration, and science and technology research and development programs.

The Federal spending bill first passed the House by an overwhelming vote of 316 to 113. It then moved to the Senate where it passed easily by a vote of 65 to 33, in one of the final acts of Congress this year before they adjourn for the Christmas holiday season. President Obama announced he will sign the bill.

After a contentious year of high states political brinkmanship that could easily have ended in another government shutdown this week, the US Congress and the Obama White House did the nearly unimaginable and decided to strike a compromise and pass the omnibus spending bill for the 2016 Fiscal Year that funds the government and NASA for the remainder of this year's budget season through September 2015.

Committees in both chambers passed bills earlier this year with much less funding for NASA and far different space exploration priorities compared to President Obama. The outlook for the entire Federal budget changed mightily in the past two months under the new House speaker, Republican Paul Ryan who replaced outgoing Speaker John Boehner. Ryan worked with the President and the Democratic party leadership to craft the compromise US Federal budget that passed today.

Under the newly passed Fiscal Year 2016 NASA Budget, virtually all of the agency's programs benefit with either full or added funding.

The SLS, Orion, Commercial Crew and Planetary Sciences among others are all big beneficiaries of the omnibus budget compromise.

Engineers developing Orion's thermal protection system have been improving the spacecraft's heat shield design and manufacturing process since the vehicle successfully traveled to space for the first time last year in Dec 2014. Credit: NASA

Sending humans to Mars by the 2030s is NASA's agency-wide goal as announced by NASA Administrator Charles Bolden.

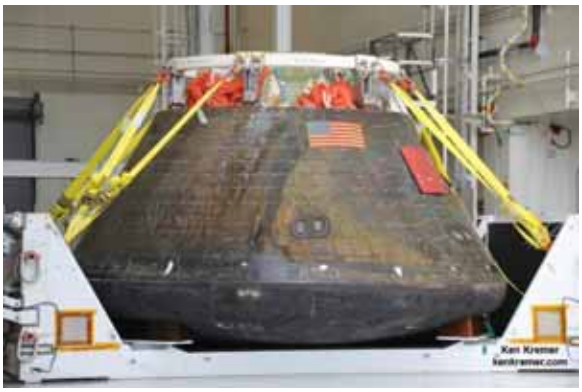
To accomplish the 'Journey to Mars' initiative, NASA is developing the mammoth Space Launch System (SLS) heavy lift rocket and the state of the art Orion deep space crew capsule.

The SLS is one of the bigggest winners. SLS will receive $2 Billion in the FY 2016 budget, compared to an Obama Administration request of only $1.36 billion that was actually a cut from the prior year. This new total represents a nearly 50% increase and is also above earlier House and Senate bills.

The Orion crew capsule receives $1.27 Billion, an increase of $70 million above the fiscal year 2015 level.

The SLS will be the most powerful rocket the world has ever seen starting with its first liftoff. It will propel our astronauts on journey's further into space than ever before.

Blastoff of the first SLS heavy lift booster (SLS-1) carrying an unmanned test version of NASA's Orion crew capsule is targeted for no later than November 2018.



Homecoming view of NASA's first Orion spacecraft after returning to NASA's Kennedy Space Center in Florida on Dec. 19, 2014 after successful blastoff on Dec. 5, 2014. Credit: Ken Kremer – kenkremer.com

The maiden SLS test flight with the uncrewed Orion is called Exploration Mission-1 (EM-1) and will launch from Launch Complex 39-B at the Kennedy Space Center (KSC).

The bill also directs NASA to use $85 million of the SLS funding to develop a new, enhanced cryogenic upper stage to replace the Interim Cryogenic Propulsion Stage (from the Delta IV rocket) that currently will be utilized on SLS-1.

NASA needs the enhanced upper stage to carry out future manned missions with Orion to deep space destinations like the Moon, Asteroids and Mars.

NASA had been marching towards an August 2021 liftoff for the maiden crewed Orion on a test flight dubbed Exploration Mission-2 (EM-2). But in August, the agency announced that EM-2 could slip two years from 2021 to 2023 due to a variety of budget and technical issues.

So the 2016 budget plus up could aid NASA significantly in trying to maintain the still officially targeted 2021 launch date.

NASA's other human spaceflight pillar, namely the Commercial Crew Program (CCP) to develop a pair of human rated 'space taxis' to transport our astronauts to the low Earth orbit and the International Space Station (ISS) is also a big beneficiary.

NASA Administrator Charles Bolden (left) announces the winners of NASA's Commercial Crew Program development effort to build America's next human spaceships launching from Florida to the International Space Station. Speaking from Kennedy's Press Site, Bolden announced the contract award to Boeing and SpaceX to complete the design of the CST-100 and Crew Dragon spacecraft. Former astronaut Bob Cabana, center, director of NASA's Kennedy Space Center in Florida, Kathy Lueders, manager of the agency's Commercial Crew Program, and former International Space Station Commander Mike Fincke also took part in the announcement. Credit: Ken Kremer- kenkremer.com

The goal of CCP is to end the US sole reliance on the Russian Soyuz manned capsule at a cost of hundreds of millions of dollars and to restore the US Human spaceflight capability to launch our astronauts on American rockets from American soil.

For the first time in its five year history, CCP will receive the full funding requested by the Obama Administration – in the amount of $1.244 Billion. Whereas earlier markups by both the House and Senate had cut CCP funding to $1 Billion or below.

Under CCP awards announced by Bolden in September 2014, NASA had contracted Boeing to develop the CST-100 Starliner and SpaceX to develop the Crew Dragon.

First view of upper half of the Boeing CST-100 'Starliner' crewed space taxi unveiled at the Sept. 4, 2015 Grand Opening ceremony held in the totally refurbished C3PF manufacturing facility at NASA's Kennedy Space Center. This will be part of the first Starliner crew module known as the Structural

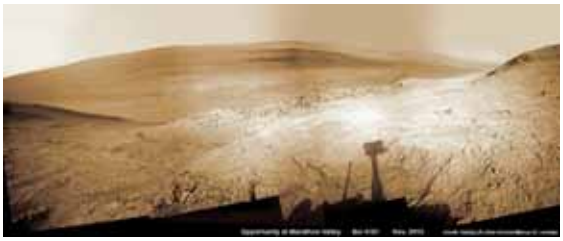
Test Article (STA) being built at Boeing's Commercial Crew and Cargo Processing Facility (C3PF) at KSC. Credit: Ken Kremer / kenkremer.com

Bolden had made it completely clear to Congress that any reduced funding would have forced NASA into slowing the program with another substantial delay in first launch now targeted for 2017, by renegotiating the CCP contracts with both Boeing and SpaceX and delaying completion of the required milestones.

"It would upend the investments we need to execute contracts with Boeing and SpaceX to return the launches of American astronauts to American soil and to do it by 2017," wrote Bolden in his NASA blog.

NASA'a Planetary Sciences Division also gets a much earned and much needed big budget boost. The omnibus bill affords $1.631 billion for Planetary exploration. This amounts to an increase of some $270 million above the Obama administration's request – which has repeatedly cut of one of NASA's crown jewels.

Congress has had the good sense to save the long lived and very scientifically productive Opportunity MER rover and Lunar Reconnaissance Orbiter (LRO) missions from certain termination – due only to a ridiculous lack of money that was "zeroed out" by the White House.



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 omnibus bill also appropriates $175 million for NASA's planned mission to Jupiter's moon Europa in the early 202os. It includes funding for both an orbiter and lander. Europa is a prime target in the search for life.

The James Webb Space Telescope (JWST) receives the Administrations full funding request of $620 million to keep it on track for launch in 2018.

View showing actual flight structure of mirror backplane unit for NASA's James Webb Space Telescope (JWST) that holds 18 segment primary mirror array and secondary mirror mount at front, in stowed-for-launch configuration. JWST is being assembled here by technicians inside the world's largest cleanroom at NASA Goddard Space Flight Center, Greenbelt, Md. Credit: Ken Kremer/kenkremer.com

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

Ken Kremer

European Mars probe arrives at launch site

Posted on December 27, 2015 by Stephen Clark

The ExoMars Trace Gas Orbiter is closed inside a shipping container before leaving Thales Alenia Space's facility in Cannes, France, on Dec. 17. Credit: ESA – B. Bethge

Three heavy-duty Antonov cargo planes flew components of Europe's ExoMars orbiter and lander from Italy to the Baikonur Cosmodrome in Kazkhastan last week, setting up for a March 14 launch toward the red planet.

The Mars mission materials will be assembled, tested, fueled and attached to a Proton rocket over the coming months on the first of two launches for the ExoMars program, to be followed by the departure of a European-made rover to the red planet in 2018.

Liftoff of the first ExoMars mission is set for March 14, at the opening of a 12-day launch period. That launch will carry the Trace Gas Orbiter instrumented with sensors to sniff out methane in the Martian atmosphere, plus the Schiaparelli lander, an entry probe that will attempt to achieve Europe's first successful landing on the red planet.

A convoy carrying the two Mars-bound components of the ExoMars 2016 mission, plus a load of ground support equipment, left the Thales Alenia Space factory in Cannes, France, on Dec. 17 en route to Turin, Italy, where three Antonov An-124 cargo flights would take the hardware to Kazakhstan.

The three Antonov transport planes departed Turin-Casselle Airport on Dec. 18, Dec. 20 and Dec. 22, carrying equipment to help prepare ExoMars for launch, the Schiaparelli lander and the Trace Gas Orbiter, respectively.

The last shipment arrived at the Baikonur Cosmodrome on Dec. 23 after a customs check in Moscow, and ground crews unloaded the spacecraft containers into a clean room to start the launch campaign.

The ExoMars Trace Gas Orbiter is loaded on an Antonov An -124 transport plane in Turin, Italy. Credit: Thales Alenia Space

One of the first tasks at the launch site will be to set up a temporary tent inside the satellite processing facility at Baikonur. The covering will ensure the Trace Gas Orbiter and Schiaparelli are free of contaminants, keeping with stringent "planetary protection" protocols aimed at safeguarding Mars from Earth microbes.

The Baikonur Cosmodrome currently does not have a facility that meets Western planetary protection requirements, according to Walter Cugno, ExoMars program director at Thales Alenia Space, the mission's prime contractor.

The European Space Agency and Roscosmos — the Russian space agency — signed a final agreement in 2013 to collaborate on the ExoMars program. Russia took over much of the work originally assigned to NASA, such as the provision of launchers and a rover descent package, before the U.S. space agency withdrew from the missions due to budget constraints.

Then teams will initially prepare the two spacecraft for launch separately.

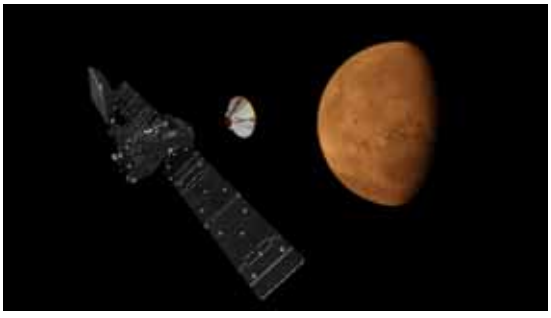
Ground crews planned to work nonstop over the holidays to keep the mission on schedule for its March 14 launch date, and perhaps gain some breathing room in the schedule in case something goes wrong closer to liftoff.

The Schiaparelli lander, covered in golden insulation and shaped like a flying saucer, will receive propellants for its descent rockets beginning around Jan. 29, according to Cugno.

With a full load of fuel, the lander will weigh about 600 kilograms, or 1,322 pounds. Schiaparelli is based on a simplified design, relying on internal batteries and not recharging solar panels for electricity, and cushioned by a "crushable" carbon-fiber structure instead of landing legs or airbags.

The lander is stationary, carrying a weather station and sensors programmed to collect data on the layers of the Martian atmosphere during its descent. Engineers expect Schiaparelli to survive between two and four days — or up to eight days if conditions are benign.

It is an introductory course to entry, descent and landing at Mars for Europe, which would become the third entity after the United States and Russia to achieve a successful touchdown on the red planet.



Artist's concept of the Schiaparelli lander separating from the Trace Gas Orbiter three days before Mars arrival in October 2016. Credit: ESA/ATG medialab

Workers will hoist the Schiaparelli lander on top of the ExoMars Trace Gas Orbiter around Feb. 12. The duo will remain attached until Oct. 16, when the lander will separate from the mothership three days before arriving at Mars.

A three-day procedure to pump 2.3 metric tons (5,070 pounds) of propellants into the Trace Gas Orbiter is scheduled for Feb. 21-24.

Combined operations between the spacecraft and launcher authorities will begin Feb. 26. In the final weeks before liftoff, Russian teams connect the ExoMars spacecraft to the Proton rocket's Breeze M upper stage, enclose it within the launcher's nose shroud, then roll out the booster for fueling with its mixture of hydrazine and nitrogen tetroxide propellants.

Launch on March 14 is currently set for approximately 0930 GMT (5:30 a.m. EST), according to Jorge Vago, ESA's ExoMars project scientist.

The ExoMars orbiter and lander will be the only Mars mission launching in 2016 after NASA's announcement last week that the InSight probe will remain on Earth until at least 2018.

The InSight lander's seismometer instrument built to search for quakes on Mars ran into problems with its vacuum enclosure, forcing a delay in the mission's launch at least until the next Mars launch opportunity in May 2018, the same month Europe's ExoMars rover is scheduled for liftoff.

ExoMars' launch was originally set for Jan. 7, but an alert from a manufacturer of pressure transducers on the Schiaparelli lander warned officials that the components may be from a faulty batch. Engineers removed the transducers from the propulsion system to eliminate the risk.

Nebulae: What Are They And Where Do They Come From?

24 Dec , 2015 by Matt Williams

A nebula is a truly wondrous thing to behold. Named after the Latin word for "cloud", nebulae are not only massive clouds of dust, hydrogen and helium gas, and plasma; they are also often "stellar nurseries" – i.e. the place where stars are born. And for centuries, distant galaxies were often mistaken for these massive clouds.

Alas, such descriptions barely scratch the surface of what nebulae are and what there significance is. Between their formation process, their role in stellar and planetary formation, and their diversity, nebulae have provided humanity with endless intrigue and discovery.

For some time now, scientists and astronomers have been aware that outer space is not really a total vacuum. In fact, it is made up of gas and dust particles known collectively as the Interstellar Medium (ISM). Approximately 99% of the ISM is composed of gas, while about 75% of its mass takes the form of hydrogen and the remaining 25% as helium.

The interstellar gas consists partly of neutral atoms and molecules, as well as charged particles (aka. plasma), such as ions and electrons. This gas is extremely dilute, with an average density of about 1 atom per cubic centimeter. In contrast, Earth's atmosphere has a density of approximately 30 quintillion molecules per cubic centimeter (3.0×10^{19} per cm^3) at sea level.

Even though the interstellar gas is very dispersed, the amount of matter adds up over the vast distances between the stars. And eventually, and with enough gravita-

tional attraction between clouds, this matter can coalesce and collapse to forms stars and planetary systems.

Nebula Formation:
In essence, a nebula is formed when portions of the interstellar medium undergo gravitational collapse. Mutual gravitational attraction causes matter to clump together, forming regions of greater and greater density. From this, stars may form in the center of the collapsing material, who's ultraviolet ionizing radiation causes the surrounding gas to become visible at optical wavelengths.

Most nebulae are vast in size, measuring up to hundreds of light years in diameter. Although denser than the space surrounding them, most nebulae are far less dense than any vacuum created in an Earthen environment. In fact, a nebular cloud that was similar in size to Earth would only so much material that its mass would be only a few kilograms.

Nebula Classification:
Stellar objects that can be called Nebula come in four major classes. Most fall into the category of **Diffuse Nebulae**, which means they have no well-defined boundaries. These can be subdivided into two further categories based on their behavior with visible light – "Emission Nebulae" and "Reflection Nebulae".

Emission Nebulae are those that emit spectral line radiation from ionized gas, and are often called HII regions because they are largely composed of ionized hydrogen. In contrast, Reflection Nebulae do not emit significant amounts of visible light, but are still luminous because they reflect the light from nearby stars.

There are also what is known as **Dark Nebulae**, opaque clouds that do not emit visible radiation and are not illuminated by stars, but block light from luminous objects behind them. Much like Emission and Reflection Nebulae, Dark Nebulae are sources of infrared emissions, chiefly due to the presence of dust within them.

Some nebulae are formed as the result of supernova explosions, and are hence classified as a **Supernova Remnant Nebulae**. In this case, short-lived stars experience implosion in their cores and blow off their external layers. This explosion leaves behind a "remnant" in the form of a compact object – i.e. a neutron star – and a cloud of gas and dust that is ionized by the energy of the explosion.

Other nebulae may form as **Planetary Nebulae**, which involves a low-mass star entering the final stage of its life. In this scenario, stars enter their Red Giant phase, slowly losing their outer layers due to helium flashes in their interior. When the star has lost enough material, its temperature increases and the UV radiation it emits ionizes the surrounding material it has thrown off.

This class also contains the subclass known as Protoplanetary Nebulae (PPN), which applies to astronomical objects that are experiencing a short-lived episode in a star's evolution. This is the rapid phase that takes place between the Late Asymptotic Giant Branch (LAGB) and the following Planetary Nebula (PN) phase.

Four different planetary nebulae. Credit: NASA/Chandra Observatory

During the Asymptotic Giant Branch (AGB) phase, the star undergoes mass loss, emitting a circumstellar shell of hydrogen gas. When this phase comes to an end, the star enters the PPN phase, where it is energized by a central star, causing it to emit strong infrared radiation and become a reflection nebula. The PPN phase continues until the central star reaches a temperature of 30,000 K, after which it is hot enough to ionize the surrounding gas.

History of Nebula Observation:
Many nebulous objects were noticed in the night sky by astronomers during Classical Antiquity and the Middle Ages. The first recorded observation took place in 150 CE, when Ptolemy noted the presence of five stars in *Almagast* that appeared nebulous in his book. He also noted a region of luminosity between the constellations Ursa Major and Leo that was not associated with any observable star.

In his *Book of Fixed Stars*, written in 964 CE, Persian astronomer Abd al-Rahman al-Sufi made the first observation of an actual nebula. According to al-Sufi's observations, "a little cloud" was apparent in a portion of the night sky where the Andromeda Galaxy is now known to be located. He also cataloged other nebulous objects, such as the Omicron Velorum and Brocchi's Cluster.

On July 4th, 1054, the supernova that created the Crab Nebula (SN 1054,) was visible to astronomers on Earth, and recorded observations that were made by both Arabic and Chinese astronomers have been identified. While anecdotal evidence exists that other civilizations viewed the supernova, no records have been uncovered.

By the 17th century, improvements in telescopes led to the first confirmed observations of nebulae. This began in 1610, when French astronomer Nicolas-Claude Fabri de Peiresc made the first recorded observation of the Orion Nebula. In 1618, Swiss astronomer Johann Baptist Cysat also observed the nebula; and by 1659, Christiaan Huygens made the first detailed study of it.

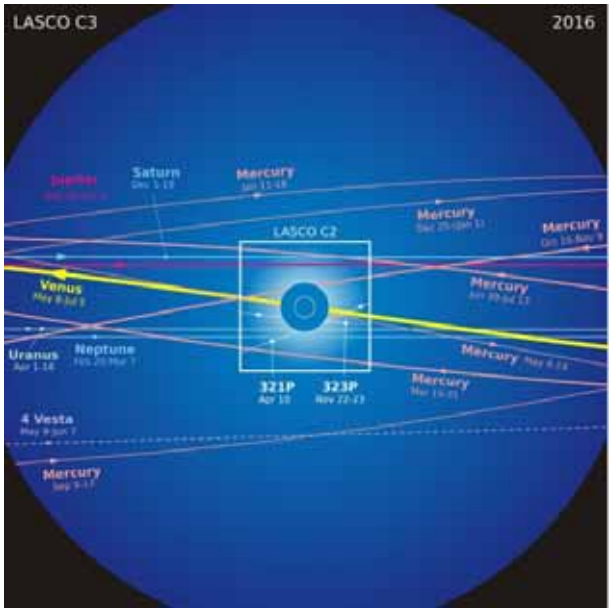
By the 18th century, the number of observed nebulae began to increase and astronomers began to compile lists. In 1715, Edmund Halley published a list of six nebulae – M11, M13, M22, M31, M42, and the Omega Centauri globular cluster (NGC 5139) – in his "An account of several nebulae or lucid spots like clouds, lately discovered among the fixt stars by help of the telescope."

The Top 101 Astronomical Events for 2016

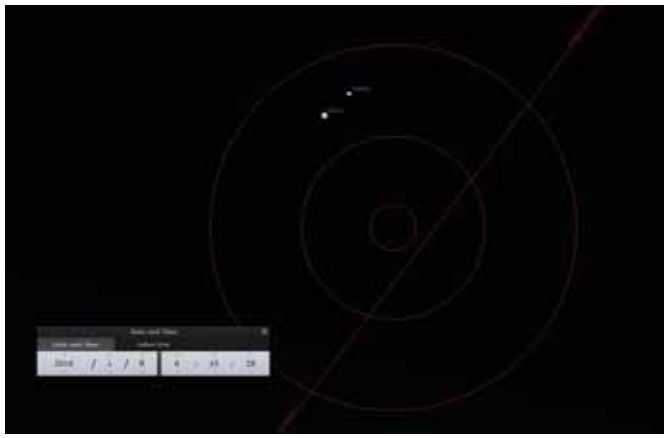
28 Dec , 2015 by David Dickinson

Here it is… our year end look at upcoming events in a sky near you. We've been doing this "blog post that takes four months to write" now on one platform or another every year since 2009, and every year, it gets bigger and more diverse, thanks to reader input. This is not a top 10 listicle, and not a full-fledged almanac, but hopefully, something special and unique in between. And as always, some of the events listed will be seen by a large swath of humanity, while others grace the hinterlands and may well go unrecorded by human eyes. We'll explain our reasoning for drilling down each category, and give a handy list of resources at the end.

Here's our quick picks for the very best astronomical events for 2016:
– Comet C/2013 US10 Catalina continues to perform as a binocular comet through January.
– Mars reaches opposition on May 22nd.
-Mercury transits the Sun on May 9th, the first time it has done so since 2006.
-A close grouping of Venus and Jupiter on August 27th.
-A total solar eclipse of the Sun crossing southeast Asia on March 9th.
-A fine series of occultations of the bright star Aldebaran by the Moon continues, including a fine nighttime event on January 20th for North America.
-An annular solar eclipse across central Africa on September 1st.
And check out this nifty simulation of lunar phases for 2016 courtesy of the NASA Lunar Reconnaissance Orbiter:
No dawn or dusk elongations of the planet Venus occur in 2016. The last time Venus experienced an 'elongationless year' was 2008, and the next is 2024, right in step with the 8-year cycle of Venus. 2016 also sees the Sun coming off of the maximum for solar cycle #24, and its anyone's guess as to whether we'll slide into another profound minimum, or if cycle #25 will occur at all. This will also impact the appearance of sunspots and aurorae for the year to come.
And speaking of the Sun, here's what the joint NASA/ESA Solar Heliospheric Observatory will see crossing its 15 degree-wide LASCO C3 camera in 2016:



Solar system objects transiting the field of view of SOHO's LASCO C2 and C3 cameras. Note that you can not only see the 2016 transit of Mercury, but the Sun will also occult Venus. Image credit: Worachate Boonplod
Update: Christopher Becke (@BeckePhysics) was kind enough to compile the events in a handy iCal download and Html link format… thanks!
The Rules
Here's what we looked for this year in each category to 'make the cut:'
-Asteroid occultations: events with a 99% probability of occulting of stars brighter than +8th magnitude.
-Double shadow transits: events involving the Jovian moons farther than 10 degrees from the Sun.
-Known comets expected to break +10 magnitude brightness and visible in binoculars. Remember though, the next 'great comet' could still show up at any time!
-Conjunctions of naked eye planets passing closer than one degree apart.
-Occultations involving the Moon and naked eye planets, or the 'bright four' stars along the Moon's path (Aldebaran, Spica, Regulus or Antares).
-There are 4 eclipses in 2016 – two lunar and two solar — the minimum that can occur in a calendar year. There are no total lunar eclipses in 2016, just two faint penumbrals.
-Weirdness: Yes, Moons super, mini, black & blue are more are included. These are more of a modern cultural phenomenon than a true astronomical event, sure, but the public loves 'em, and we continue to include 'em.
-Meteor showers: annual showers with an expected zenithal hourly rate of 10 or higher.
-Times are quoted in Universal Time (UT being approximately equal to UTC/Zulu and GMT) with a 24 hour clock, and we've occasionally quoted EST-centric Eastern Standard/Daylight Time as needed.
Ready? Here we go…



Venus and Saturn paired together on January 9th. Image credit: Stellarium

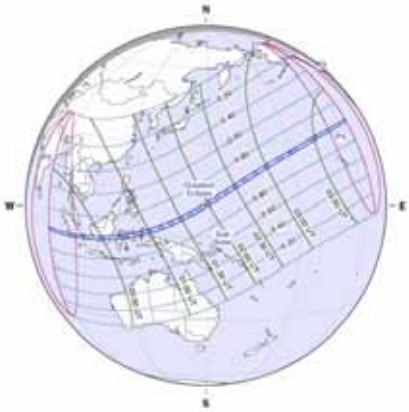
January

1- Comet C/2013 X1 PanSTARRS may break binocular brightness at +10th magnitude.
4- The Quadrantid meteors peak at ~8:00UT/3:00 AM EST, with an estimated ZHR of 120 favoring North America.
9- Venus passes 5' from Saturn at 4:00 UT/11:00 PM EST (on the 8th).
20- The 81% illuminated Moon occults Aldebaran at ~2:40UT/9:40 PM EST (on the 19th) for North America.

A triple play: Mercury, Venus and the waning crescent Moon on the morning of February 6th. Image credit: Stellarium

February

7- Mercury reaches 25.6 degrees western elongation at 5:00 UT/0:00 AM EST.
16- The 59% illuminated Moon occults Aldebaran at 8:05 UT/3:05 AM EST for the northern Pacific.
22- Double shadow transit (Io-Europa) occurs from 20:43-20:46 UT.
26- Double shadow transit (Io-Europa) occurs from 9:39-10:01 UT.
29- Double shadow transit (Io-Europa) occurs from 22:34-23:20 UT.



The total solar eclipse of March 9th. Image credit: NASA/ Fred Espenak/GSFC

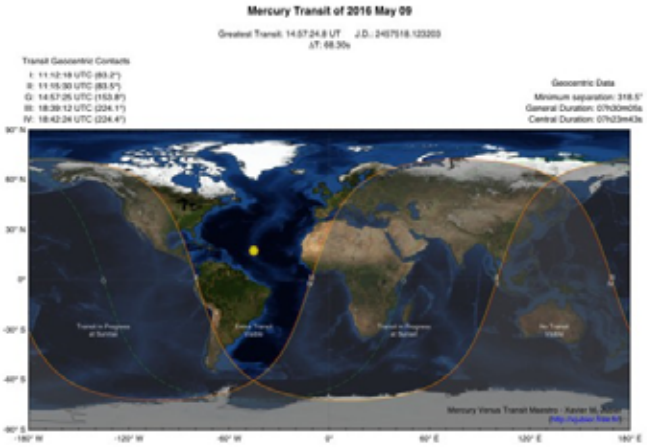
March

04- Double shadow transit (Io-Europa) occurs from 11:32-12:38 UT.
08- Double shadow transit (Io-Europa) occurs from 00:28-01:56 UT.
08- Jupiter reaches opposition at 10:00 UT/5:00 AM EST.
09- A total solar eclipse spans the Pacific and SE Asia centered on 1:58 UT. **The only total solar eclipse of 2016, and the final one until the 2017 total solar eclipse spanning the United States.**
09- Double shadow transit (Io-Ganymede) occurs from 18:56-19:11 UT.
11- Double shadow transit (Io-Europa) occurs from 13:24-15:15 UT.
14- The 37% illuminated Moon occults Aldebaran at 14:07 UT/10:07 AM EDT for Central Asia.
15- Double shadow transit (Io-Europa) occurs from 2:21-4:34 UT.
16- Double shadow transit (Io-Ganymede) occurs from 20:51-23:05 UT.
18- Double shadow transit (Io-Europa) occurs from 15:19-17:50 UT.
20- The March northward equinox occurs at 4:30 UT, marking GEO satellite flare and eclipse season.
22- Double shadow transit (Io-Europa) occurs from 4:23-7:10 UT.
23- Double shadow transit (Io-Ganymede) occurs from 23:47-0:58 UT (on the 24th).
23- A penumbral lunar eclipse occurs, centered on the central Pacific around 11:48 UT.
25- Double shadow transit (Io-Europa) occurs from 17:41-19:26 UT.
29- Double shadow transit (Io-Europa) occurs from 7:00-8:24 UT.

The double shadow transit of April 3rd. Image credit: Stellarium

April

01- Double shadow transit (Io-Europa) occurs from 20:16-21:19 UT.
03- Double shadow transit (Io-Callisto) occurs from 15:09-15:49 UT.
05- Double shadow transit (Io-Europa) occurs from 9:36-10:17 UT.
06- The 1% illuminated Moon occults Venus for Europe in the daytime at ~8:31 UT.
08- Double shadow transit (Io-Europa) occurs from 22:54-23:14 UT.
10- The 17% illuminated Moon occults Aldebaran at 22:27 UT/6:27 PM EDT for eastern North America.
12- Double shadow transit (Io-Europa) occurs from 12:11-12:14 UT.
18- Mercury reaches 19.9 degrees eastern elongation at 12:00 UT/8:00 AM EDT.
21- Minimoon: the most distant Full Moon of the year occurs, reaching apogee 406,350 kilometers from Earth 13 hours after Full.

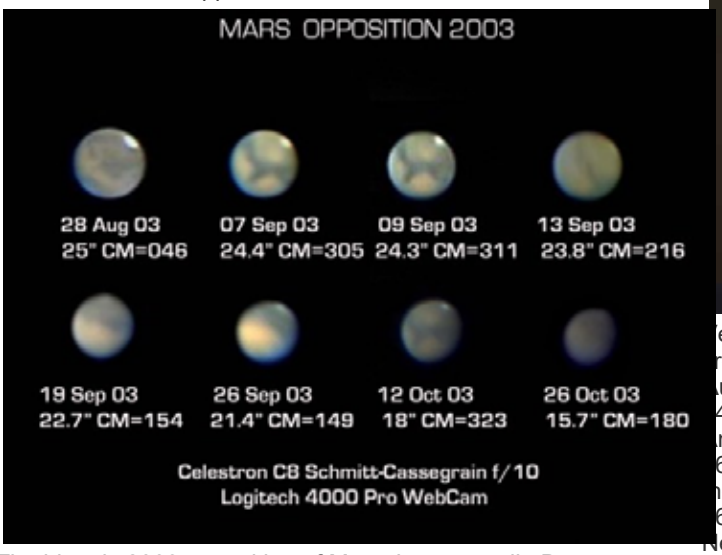


Mercury transits the Sun: visibility prospects worldwide. Image credit: Xavier Jubier

May

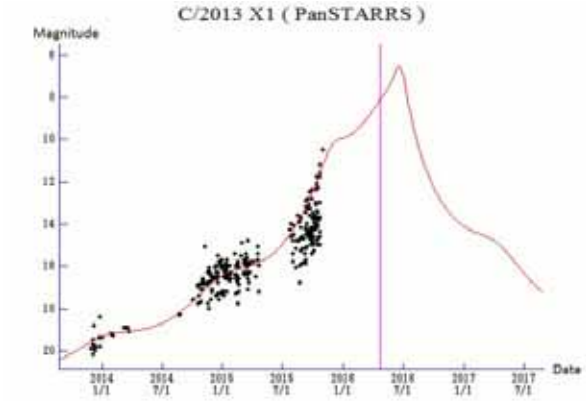
05- The Eta Aquariid meteors peak at ~20:00 UT/4:00 PM EDT with an estimated ZHR of 40 favoring SE Asia.

07- Double shadow transit (Io-Callisto) occurs from 4:38-5:44 UT.
08- The 6% illuminated Moon occults Aldebaran at 8:43 UT/4:43 AM EDT for NE Asia.
09- A **transit of Mercury** across the face of the Sun occurs, 7 hours and 23 minutes in central duration centered on ~14:57 UT for viewers around the Atlantic Ocean region. **The only transit of the planet Mercury for this decade.**
21- A Blue Moon occurs, in the sense of the 3rd in an astronomical season with four Full Moons.
22- Mars reaches opposition at 11:00 UT/7:00 AM EDT.



The historic 2003 opposition of Mars. Image credit: Dave Dickinson

June
03- The 4% illuminated Moon occults Mercury ~9:47 UT for the Falkland Islands.
03- Saturn reaches opposition at 6:00 UT/2:00 AM EDT.
05- Mercury reaches 24.2 degrees western elongation at 10:00 UT/5:00 AM EDT.
20- The June northward solstice occurs at 22:34 UT. The International Space Station generally reaches a period of full illumination favoring the northern hemisphere around this time.

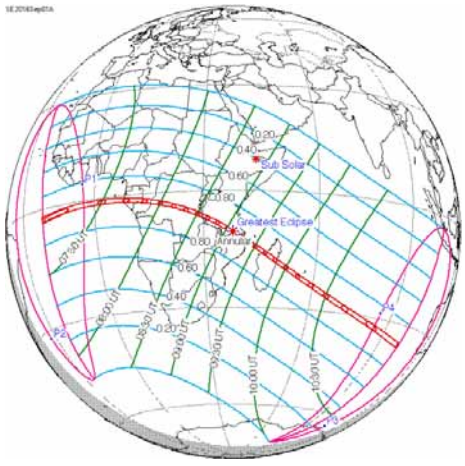


The light curve of comet X1 PanSTARRS. Image credit: Seichii Yoshida.

July
01- Comet C/2013 X1 PanSTARRS may reach a maximum brightness of +6th magnitude.
02- The 5% illuminated Moon occults Aldebaran for north Africa at 4:20 UT.
09- The 27% illuminated Moon occults the planet Jupiter for the southern Indian Ocean at ~10:11 UT.
16- Mercury passes 30' from Venus at 23:00 UT/7:00 PM EDT.
27- The farthest lunar perigee of 2016 occurs 11:26 UT/7:26 AM EDT, at 369,658 km distant.
29- The 22% illuminated Moon occults Aldebaran for Central America at ~11:16 UT.
30- Mercury passes 17' from Regulus at 19:00 UT/3:00 PM EDT.

enus in a close pairing with Jupiter on August 27th. Image redit: Stellarium

ugust
4- The 3% illuminated Moon occults Mercury for South merica at ~22:11 UT.
6- The 14% illuminated Moon occults the planet Jupiter for he southern Pacific at ~3:30 UT.
6- Asteroid 120 Lachesis occults a +7.1 magnitude star for New Guiana and Eastern Australia at ~14:23 UT.
07- Double shadow transit (Io-Ganymede) occurs from 5:31 -6:31 UT.
10- Closest lunar apogee of 2016 occurs at 00:06 UT, at 404,265 km distant.
12- The Perseid meteors peak at 15:30 UT/11:30 AM EST, with an estimated ZHR of 150, favoring the central Pacific.
14- Double shadow transit (Io-Ganymede) occurs from 7:30 -9:38 UT.
16- Mercury reaches 27.4 degrees eastern elongation at 18:00 UT/2:00 PM EDT.
20- Asteroid 164 Eva occults a +5.3 magnitude star for northeastern Brazil at 22:41 UT.
21- Double shadow transit (Io-Ganymede) occurs from 11:29-11:34 UT.
25- The 45% illuminated Moon occults Aldebaran for the western Pacific at ~16:44 UT.
27- Asteroid 85 Io occults a +7.5 magnitude star for North America at 4:38 UT.
27- Venus passes 4' from Jupiter at 22:00 UT/6:00 PM EDT. **The closest conjunction of two naked eye planets for 2016.**

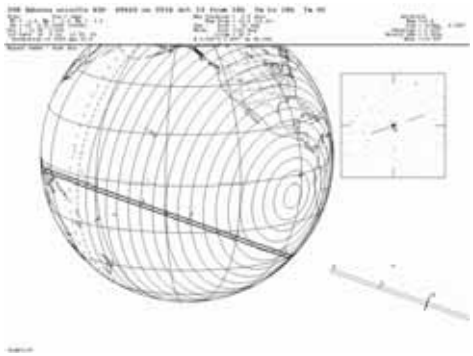


The annular eclipse of September 1st. Image credit: NASA/

Fred Espenak/GSFC

September

01- An annular solar eclipse spans southern Africa and the Indian Ocean, centered on ~9:08 UT.
01- The final Callisto shadow transit of the current cycle occurs at ~10:30 UT.
02- The 1% illuminated Moon occults Jupiter for Central America at ~21:55 UT.
02- Neptune reaches opposition at 16:00 UT/2:00 PM EDT.
03- Asteroid 51 Nemausa occults a +7.6 magnitude star for western United States at ~10:02 UT.
03- The 5% illuminated Moon occults the planet Venus for the Arctic at ~10:31 UT.
16- A penumbral lunar eclipse occurs, centered on the Indian Ocean around ~18:55 UT.
21- The 70% illuminated Moon occults the star Aldebaran for southwestern Asia at ~22:37 UT.
22- The September equinox occurs at 14:21 UT, also marking GEO satellite flare and eclipse season.
29- Mercury reaches 17.9 degrees western elongation at ~1:00 UT/9:00 PM EDT (on the 28th).
29- The 2% illuminated Moon occults the planet Mercury at ~10:41 UT for South America.
30- The 1% illuminated Moon occults the planet Jupiter for Canada at 16:11 UT.



The October 13th occultation path of Regulus. Image credit: Steve Preston's best asteroid occultations for 2016

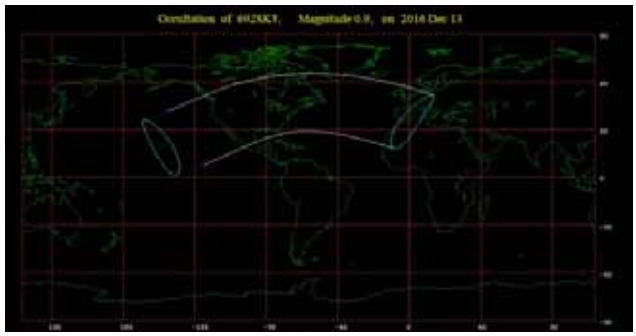
October

11- Mercury passes 51' from Jupiter at ~9:00 UT/5:00 AM EDT.
12- Asteroid 9 Metis occults a +7.4 magnitude star for Europe at ~1:37 UT.
13- Asteroid 268 Adorea occults the bright +1.4 magnitude naked eye star Regulus for New Guiana at ~18:04 UT. **The brightest star occulted by an asteroid in 2016.**
15- Uranus reaches opposition at 10:00 UT/5:00 AM EDT.
16- Asteroid 7 Iris occults a +6.3 magnitude star for southern South America at 00:24 UT.
16- Supermoon 1 of 3 occurs at 23:37 UT, reaching perigee 19 hours after Full.
17- Double shadow transit (Ganymede-Europa) occurs at 20:59-22:11 UT.
19- The 83% illuminated Moon occults the star Aldebaran for North America at ~6:40 UT.
22- The Orionid meteors peak at 2:00 UT (10:00 PM EDT on the night of the 21st) with an estimated ZHR = 25 favoring Europe and Africa.
24- Double shadow transit (Ganymede-Europa) occurs at 23:34-2:06 UT (on the 25th).
30- A 'Black Moon' occurs, in sense of the second New Moon in a calendar month.
31- The most distant lunar apogee of the year, at 19:30 UT and 406,659 km distant.

A 2014 'Supermoon'. Image credit: Andrew Symes/ @failedprotostar

November

01- Double shadow transit (Ganymede-Europa) occurs at 3:20-4:39 UT.
08- Double shadow transit (Ganymede-Europa) occurs at 7:11-7:19 UT.
14- Supermoon 2 of 3 (Closest Full Moon of the Year) occurs, also the closest lunar perigee of 2016 at 356,511 km distant at 11:24 UT, occurring 2 hours before Full. **The closest lunar perigee spanning a period from 1990-2020.**
15- The 98% illuminated Moon occults the star Aldebaran for central Asia at ~17:12 UT.



The December 13th occultation of Aldebaran by the Moon. Image credit: IOTA/Occult 4.2

December

11- Mercury reaches 20.8 degrees eastern elongation at 4:00 UT (11:00 PM EST on the 10th).
12- Supermoon 3 of 3 occurs at 23:28 UT, with perigee occurring 24 hours prior to Full phase.
13- The 99% illuminated Moon occults Aldebaran for North America at ~4:37 UT.
13-The Geminid meteors peak at 24:00 UT/7:00 PM EDT with an estimated ZHR of 120 favoring central Asia.
14- Asteroid 11 Parthenope occults a +7.4 magnitude star for South America at ~1:05 UT.
14- The Moon reaches its farthest northern declination for 2016 at 18.9 degrees around 21:00 UT.
18- The Moon occults the bright star Regulus ~18:38 UT for southern Australia, marking the first occultation of Regulus in a new cycle running through early 2018.
21- The December southward Solstice occurs at 10:44 UT. The International Space Station reaches a span of full illumination favoring the southern hemisphere around this time.
29- The Moon reaches its farthest southern declination for 2016, at -19.0 degrees around 02:00 UT.

Here's some of the references we used researching this compendium:

The International Meteor Organization's annual calendar
The United States Naval Observatory

Steve Preston's best picks for asteroid occultation events

Fourmilab's calculations for the Moon, Mercury and Venus

Fred Espenak's NASA eclipse page

Programs, such as Starry Night Pro 7, Stellarium and Occult 4.2

Guy Ottewell's 2016 Astronomical Calendar

Introductory image courtesy and copyright of Michelle Nixon Photography (MNixonPhoto), used with permission.

Missing your favorite? See an error? Let us know! And as this gets bigger every year, we're seriously thinking of making this a 101 page e-book in 2017… any takers?

We'll be expounding on each of these events and more on the pages of *Universe Today* in the year to come… don't miss the astronomical action in 2016!

Now lets look at a highlight for this weekend. A Close conjunction.

Watch Venus Brush Past Saturn This Weekend

4 Jan , 2016 by David Dickinson

Welcome to 2016! The early morning sky is where the action is this first week of the year. We were out early this Monday morning as skies cleared over Central Florida on our yearly vigil for the Quadrantid meteors. Though only a handful of meteors graced the dawn skies, we were treated to a splendid line-up, including Jupiter, Mars, Spica, Antares, Saturn, Venus, the waning crescent Moon AND a fine binocular view of Comet C/2013 US10 Catalina.

We're always a bit skeptical of the Quadrantids. Its slim peak, coupled with a relative dearth of bright meteors makes it the elusive 'unicorn' of annual major meteor showers. Occurring in the dead of northern hemisphere winter certainly doesn't help the 'Quads in the PR department.

But there's another reason to brave the cold this week, as two naked eye planets close in for one of the tightest conjunctions of 2016.

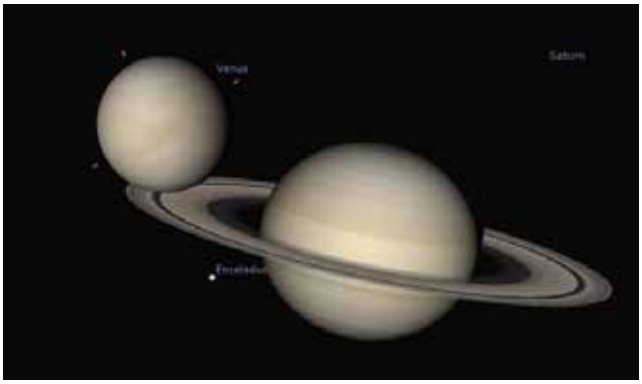
Venus and Saturn on January 9th. Image credit: Stellarium

Venus and Saturn pass just 5′ (that's 1/6th the diameter of the Full Moon!) apart on the morning of Saturday, January 9th. The conjunction (sometimes called an *appulse*) occurs at around 4:00 Universal Time (UT). This is the second closest conjuction of two naked eye planets for 2016: only the 4′ pairing of Jupiter and Venus on August 27th narrowly beats it out for top billing.

The January 9th conjunction occurs 36 degrees west of the Sun in the morning sky: expect the pair to be visible in the dawn low to the east, about two hours prior to sunrise. Venus shines at magnitude -4.0 with a 80% illuminated disk 14" across, while Saturn is nearly a hundred times fainter at magnitude +0.6 with a 15" diameter disk, 36" across if you count the span of its rings.

You'll be able to spy both Saturn and Venus in the same telescopic field of view — ironically, on a Saturday morning — a rare catch. Can you split the two with the unaided eye? We once showed off a similar conjunction of Saturn and Venus to an astrology-minded friend on the morning of August 26th, 2006… we can only hope they came over to the 'light side' of astronomy.

To the unaided eye, Saturn will look like the 'moon' Venus never had Saturday morning. The pair closes the gap by nearly a degree a day this week. Curiously, the Earth-Moon system would look very nearly the same in terms of separation and brightness from the cloud tops of Venus.



The spectacular transit of Venus across the rings of Saturn on August 12th, 2243. Image credit: Stellarium

This is also the closest passage of the two planets for some time. We ran a simulation using Occult 4.2, and found this won't be topped until July 22nd , 2037. Do the two *ever* meet? Stick around until August 12th, 2243 AD and you can actually watch Venus graze the rings of Saturn. Though no one alive today will live to see this event, we might just make it to November 22nd, 2065 to witness the transit of Venus across the face of Jupiter.

Venus meets Jupiter on November 22nd, 2065. Image credit: Stellarium

Venus is headed towards in superior conjunction on the far side of the Sun on June 6th, when it will actually pass behind the Sun as seen from the Earth for 46 hours. Venus will then slowly return to dusk skies for the remainder of 2016. Meanwhile, Saturn will grow more prominent in the dusk sky, as it heads towards opposition on June 3rd. Saturn's rings are currently very prominent, and reach the maximum opening as seen from our Earthly vantage point on October 7th, 2017.

Looking east about an hour before sunrise on January 6th… Image credit: Starry Night

As a teaser leading up to the conjunction, the Moon joins the pair on the morning of Thursday, January 7th. We call such a multiple meet-up a lunar-planetary *grouping*, as opposed to a conjunction pairing. The Moon, Saturn and Venus will fit inside a circle less than four degrees wide—a fine view for binoculars—with the Moon just three days from New and the start of lunation 1151. Follow that Moon into the daytime, and you should be able to see Venus sitting off of its limb against the daytime sky several lunar diameters away on Wednesday and Thursday.

And a closeup view of the lunar planetary action on the morning of January 7th. Image credit: Starry Night

Let's dive into the third dimension of what we're seeing. The Moon is 1 1/4 light seconds away, representing the farthest humans have traveled in person. Venus is currently slightly more distant than the Sun, at 1.2 AU or 10 light minutes away. Comet US10 Catalina is 0.8 AU away in the constellation Boötes, and approaches closest to Earth at 0.7 AU distant on January 17th. Saturn lies 10.8 AU (1.5 light hours) away. The Huygens lander on the surface of Saturn's moon Titan represents the most distant landing of a human-made object to date. Now, see the brilliant orange-red star Antares to the right of the pair? It's 554 light years distant, and yet to receive our radio signals from our fledgling civilization by a factor of five.

Feeling puny yet? Hey, astronomy can do that to you. Don't miss this weekend's conjunction of Saturn and Venus as a fine way to kick off astronomy in 2016.

VIEWING LOGS and IMAGES

Viewing Log for 8th December

A rare night when I was free and the sky was clear, as I was in the process of decorating the hall, stairs and landing and this had to be finished before Christmas and the annual visit of the Mother in Law!

So I packed my telescope gear up and travelled to my usual viewing position near the village of Uffcott just to the south of Swindon. For a change instead of taking my Meade LX 90 I took my 80 mm William Optic's doublet refractor on a Skywatcher EQ3-2 Pro mount. While setting up the equipment I noticed the last time this equipment had seen light was back in April! Some people might know I have an EQ6 mount for my 127 mm triplet refractor and this has not seen light in several years, one day I will have to take it out and see how long it has been out of action maybe that will be my New Year's promise to astronomy? I had the kit set up and ready to view by 20:30 and tonight I would be using a Pentax 14 mm eye piece, this would give me a magnification of 38.9. To find the magnification of the equipment you are using you divide the focal length of the telescope (mine was 545 mm long) by the mm of the eye piece (14 in this case), so 545/14 = 38.9. As this was an unplanned viewing session I would let the 'Best of Tonight' tour on the hand controller be my guide, I was surprised where it went around the sky that evening! Before I started the tour I had a look at the planets of Uranus and Neptune with such low magnification I could only make out the colouring of the planets and nothing elseL I noticed the stars that make up the Summer Triangle still up low in the west and looking to the east I could make out two of the three stars that make up the Winter Triangle. Set a challenge to myself, it is possible to see both sets of triangles up at the same time from my location?

Anyway on with the tour, my first target was M44 (Beehive Cluster) in Cancer, this was not far above the horizon and being an Open Cluster (O C) did not give much of a problem for viewing close to the horizon, in fact this O C is most suitable to be viewed at low magnification as it covers a reasonably large area of the sky and cannot be seen wholly with my LX90! M31 (Andromeda Galaxy) was the next target, I could make out M32 nearby as well, got a good view of this galaxy as it was directly overhead. Off to another famous winter object and M42 (Great Orion Nebula) with M43 right next door. This object never bores me as it is one of the few deep sky objects I can see with my own eyes. NGC 2264 was labelled as the Christmas Tree nebula on the hand controller and it looked like a Christmas Tree to me, this object is in the constellation of Monoceros to the east of Orion. Back to another Messier object and M33 (Triangulum Galaxy), this galaxy is similar to M31 but fainter, I have trouble finding this object without GOTO equipment. The Double Cluster was brilliant to view getting both sections in my eye piece with room to spare on the edges. Decided to have a small break from viewing, while on the break I noticed the Milky Way going from Cygnus to Cassiopeia, normally I only see this during the summer months and to the south, this time I saw it to the north western horizon, another first for me. I also noticed some cloud on the horizon which was coming my way so I knew I had limited time before getting clouded out! Anyway back to the tour and the next object was M39 in Cygnus, this O C was okay to look at. I thought the next object might be M29 also in Cygnus how wrong I was, the telescope went to M34 in Perseus another O C to look at. Next object was my first star to look at (not including the set up stars at the begin-

ning of the viewing session), the star Almach was a tight double to view in Andromeda. Off to M35 in Gemini followed by M45 (Seven Sisters or Pleiades) in Taurus two nice O C's to view, after these O C's it was back to the star, Albireo in Cygnus probably the most colourful double star in the whole sky? Yet another O C was viewed in M37 in Auriga would have thought M36 and M38 would follow, these would turn up soon but not yet, strange? M67 in Cancer was behind trees and close to the horizon so I could not look at this object. Went to M13 (Hercules Cluster) but could not make it out as cloud and nearly covered half of the sky by now! Finally back to M38 and I could make out the propeller in this O C. M81 in Ursa Major was in cloud so it took me back to M36 in Auriga. I could just make out M15 in Pegasus before I cancelled the tour for the evening. By now Procyon was well clear the eastern horizon but my attention had turned to noise on the car. This noise turned out to be rain drops so I had to put my equipment into the car the best I could as telescopes/ electrics/glass lens do not do very well with the wet stuff! It is normal for me to put everything back into their correct positions as I pack up but this time I did not have the time as the heavens soon opened up at 21:23.

Time to go home and strip all the equipment and let it dry overnight in the lounge before putting it away correctly. This was only my second time I have been rained out while doing a viewing session in about 16 years?

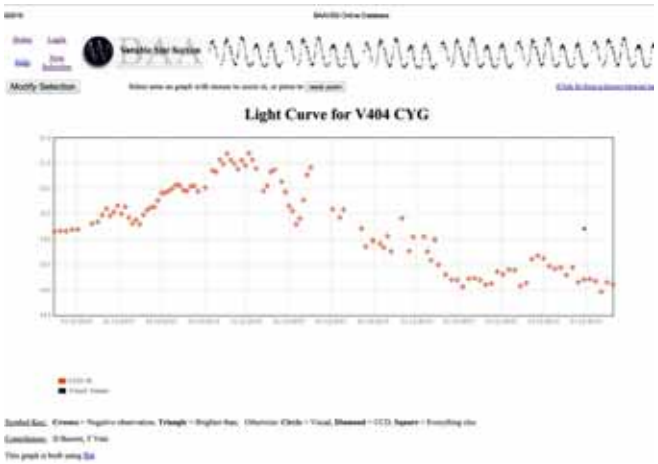
Doing this tour seem to be very mixed, the telescope went all over the sky and not follow a logical tour around the sky, the number of times it went from the west to the east and then back again to view an object, at least the gears and motors got a work out after not being used for around eight months.

Let's hope 2016 is a bit better for viewing than 2015, as I write this log the sky outside has clouded out but at the moment there is no rain coming down!

Peter Chappell

From Tony Vale:

Log December 2015
Only 21 observations of variable stars this month, a large proportion of which were made on 31st (sad, I know). On that evening there was an alert from a BAA observer that V404 Cyg had re-brightened in infra red (I Band) so I thought it might be worth a look to see if I could catch it visually. Unfortunately it was another negative observation at < 12.8. An IR sequence taken at the same time showed it fading from about 11.3 80 mins before my observation to 13.8 at the time of my observation, so perhaps if I could have observed it a bit earlier I might have seen it. Nevertheless, it is a very interesting object and caused quite a stir this summer when it was observed by NASA's Swift satellite in outburst for the first time in 26 years.
V404 Cyg is an X-Ray binary with a black hole primary and a sun like star (G-K spectral class) secondary. Material is being drawn off the secondary and onto an accretion disc surrounding the black hole. My understanding is that when the disc goes into outburst, increased viscosity in the disc causes an increase in the rate of material falling into the black hole and an increase in X-ray emission from the black hole and its jets, as well as an increase in visual emission from the hot disc so I'm unclear why CCD observers use I Band filters to observe it.
Another negative observation was U Gem at <13.1. This was no surprise as its not long since it was in outburst. Its quiescent magnitude is below 14 which is a bit too faint for me to see. What was interesting was a bright magnitude 10 object in the field. I later read an alert from another BAA observer which said that there was "vermin infestation" of the U Gem field by the asteroid 30 Urania. I was able to confirm its position corresponded with the object I had seen from my Guide 9 software. Vermin or not, I was glad to have seen it.

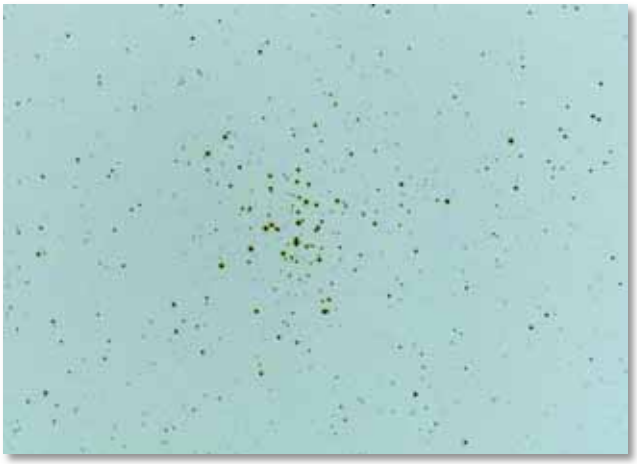


Tony.

I managed to get a few observing sessions in with a main focus on the morning (pre dawn) line ups of the planets beginning to spread out from Jupiter, Mars, Venus and Mercury and Saturn swapping round. But keep an eye on the eastern sky for the next weekend—Venus passing Saturn. However the best was trying to image comet Catalina with its split Ion and dust tails.
These pictures are elsewhere in the newsletter and even a meteor on the last page.
I did have a chance to image the Moon using the DMK video camera on the 9th December. With multiple zones using the 8" Maksutov telescope.

The bulk of the other images were tracking down galaxies using the Nikon D810A camera on the Televue 127.
Here I have tried to limit the size of file (originals in excess of 35Mb each), and having had problems in past issues I am using these images to test the PDF making AND up-graded to Windows10…
Hope this is successful…
I have also inverted the colours to produce the stars and galaxies as black on cream to help highlight the dim features on the printers you (and I) use and preserve some ink supplies!
M37

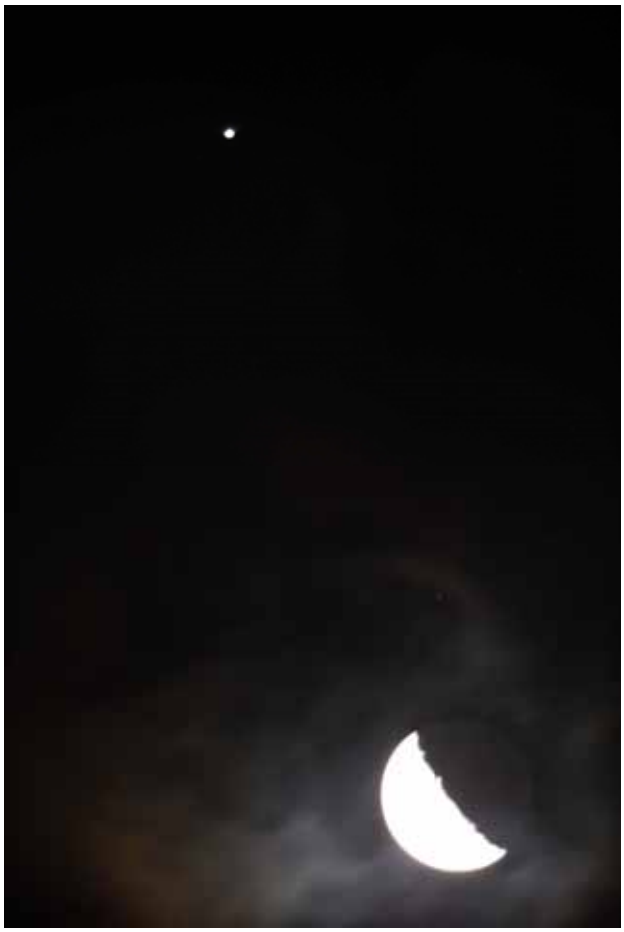
M36



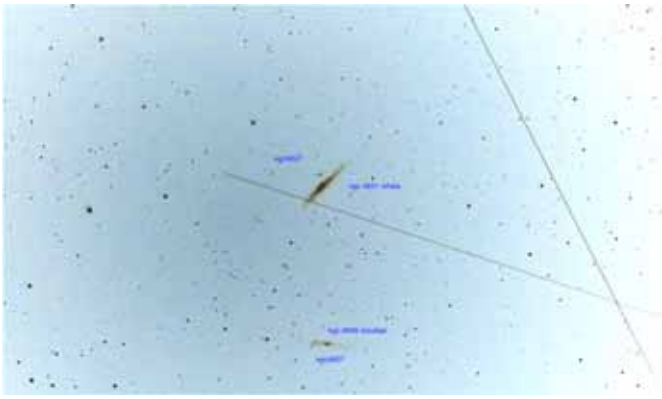
M38

Morning planet line up 2nd December
And lunar halos21st December.

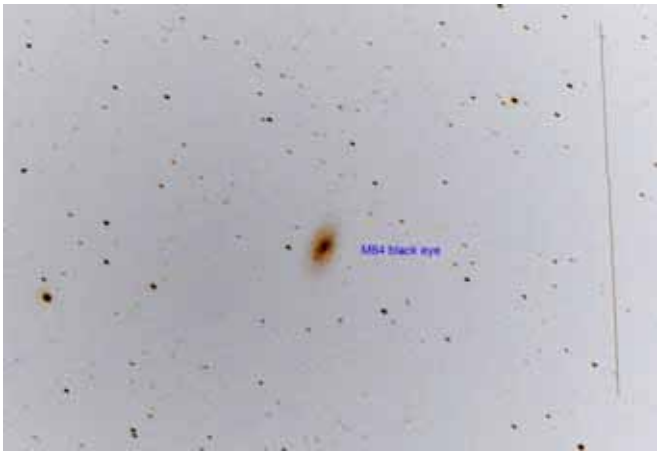
The Moon and Jupiter4th December.



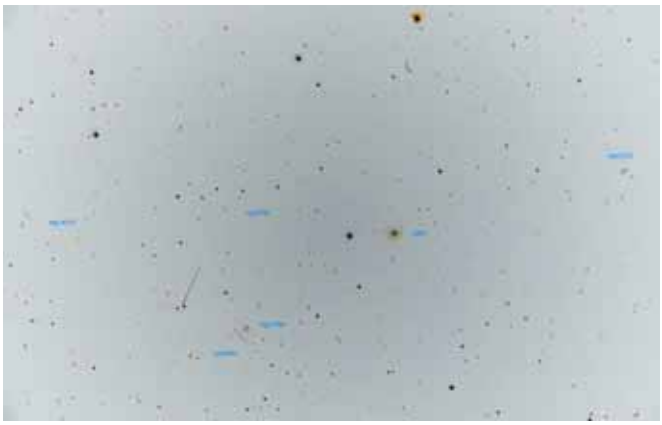
NGC 4631 the Whale and the crowbar with crossing satellites.



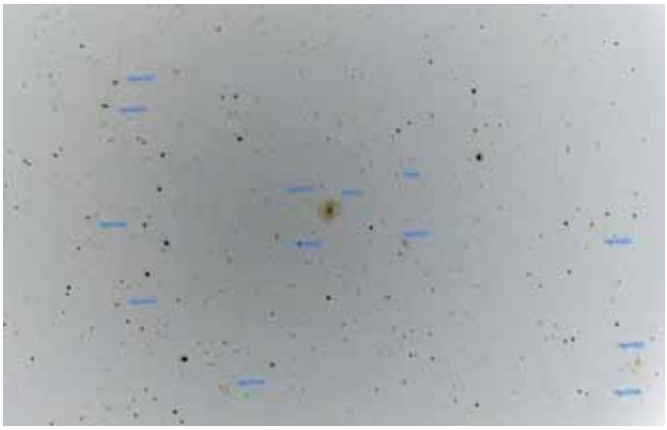
M64 The Blackeye galaxy. And satellite!



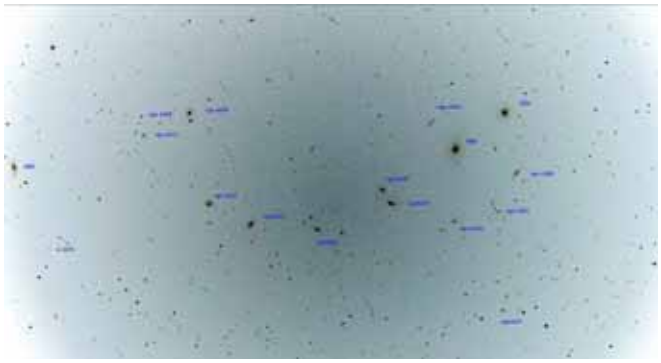
M99 Virgo cluster



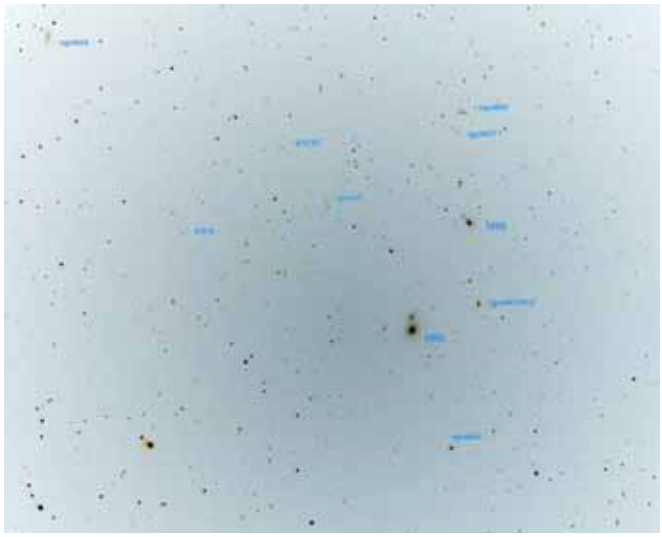
M100 Virgo cluster



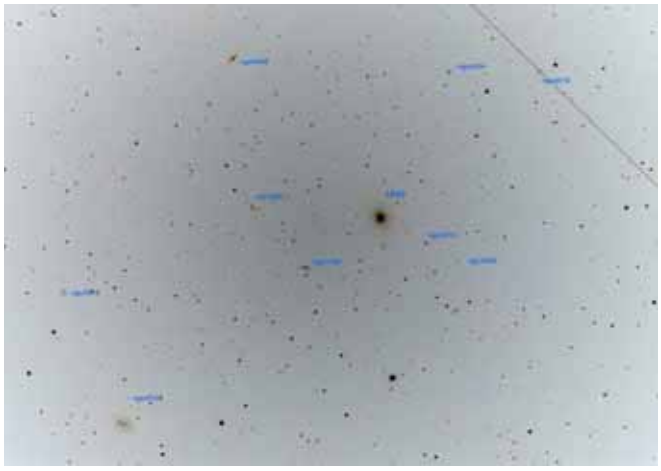
M84, M86 and the Makarian Chain. Virgo cluster.



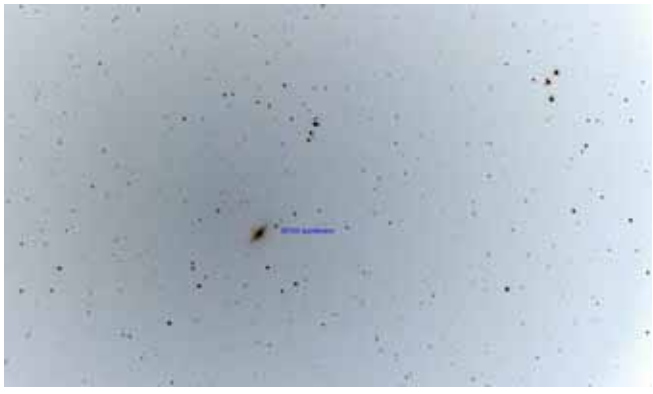
M59 and M60 region of Virgo cluster.



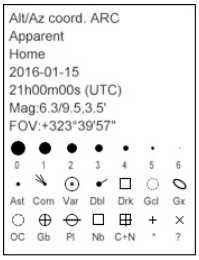
M49 in Virgo cluster and satellite

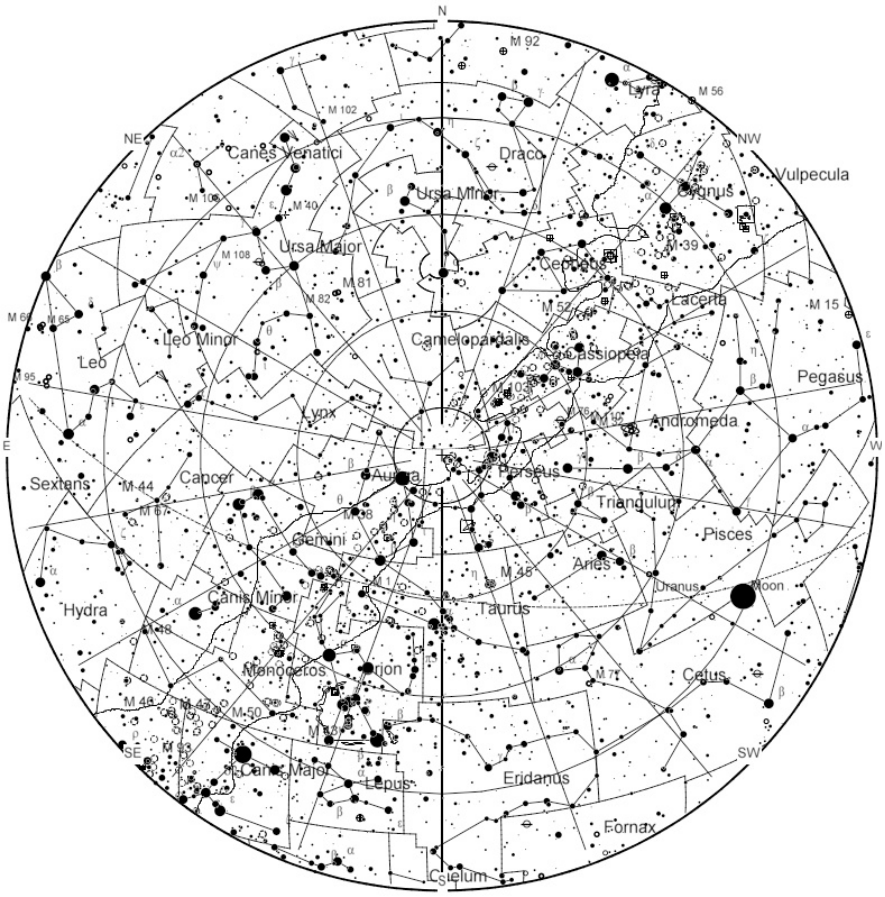


M104. Sombreroand the 2 guiding asterisms I use with bins.



WHATS UP, January 2016





1- Comet C/2013 X1 PanSTARRS may break binocular brightness at +10th magnitude.

January 3, 4 - Quadrantids Meteor Shower. The Quadrantids is an above average shower, with up to 40 meteors per hour at its peak. It is thought to be produced by dust grains left behind by an extinct comet known as 2003 EH1, which was discovered in 2003. The shower runs annually from January 1-5. It peaks this year on the night of the 3rd and morning of the 4th. The second quarter moon will block out all but the brightest meteors this year, but it could still be a good show if you are patient. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Bootes, but can appear anywhere in the sky.

9- Venus passes 5' from Saturn at 4:00 UT/11:00 PM EST (on the 8th).

January 10 - 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 01:30 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.

20- The 81% illuminated Moon occults Aldebaran at ~2:40UT/

January 24 - 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 01:46 UTC. This full moon was known by early Native American tribes as the Full Wolf Moon because this was the time of year when hungry wolf packs howled outside their camps. This moon has also been know as the Old Moon and the Moon After Yule.

The chart above is for 9pm on the 15th January, when we hope to be holding our star gazing live observing session at Lacock Playing Field starting at 7pm.

Stargazing Live want to tie in on the following, see my comments in italic.

Some of the topics in the upcoming series are:

- the ISS and other visible satellites *(so only morning ISS passes in January)*

- the largest things (stars / systems / structures) in the universe *(not ideal for small telescopes)*

- parts of the UK with geology and landscapes that resemble different planets (*Nothing in our reqion as it is mainly sedimentary rock which only occurs on Earth)*

- New Horizons / Pluto (*not visible from UK until summer and very high powers with clear skies needed, plus it has the backdrop of the Milky Way)*

- Orion *(Hurray. One we can do)*

Low mass star life-cycle (*Low mass stars too faint for telescope eye vision)*

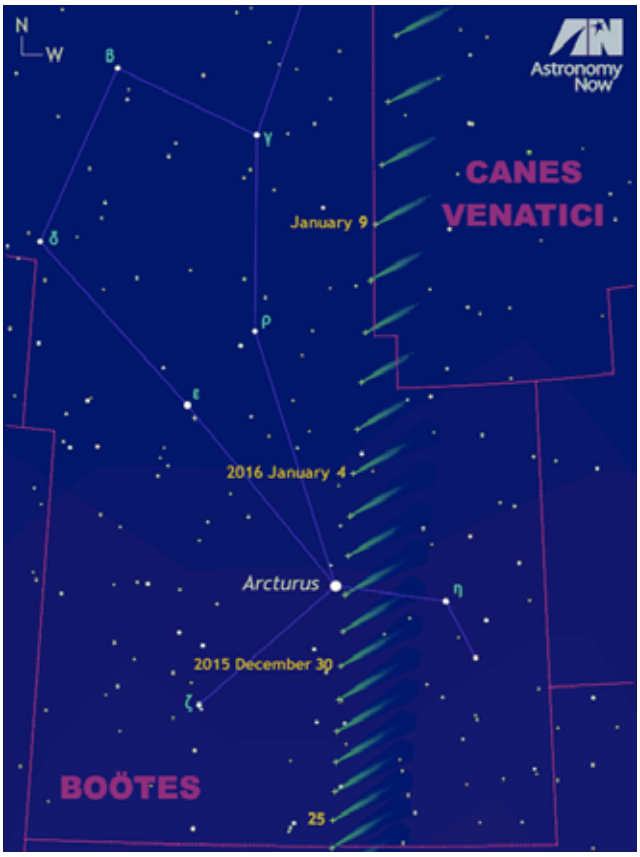
One out of six visible to show linked in to BBC programme. I really do despair.

Clear Skies. Andy

Comet Catalina US10

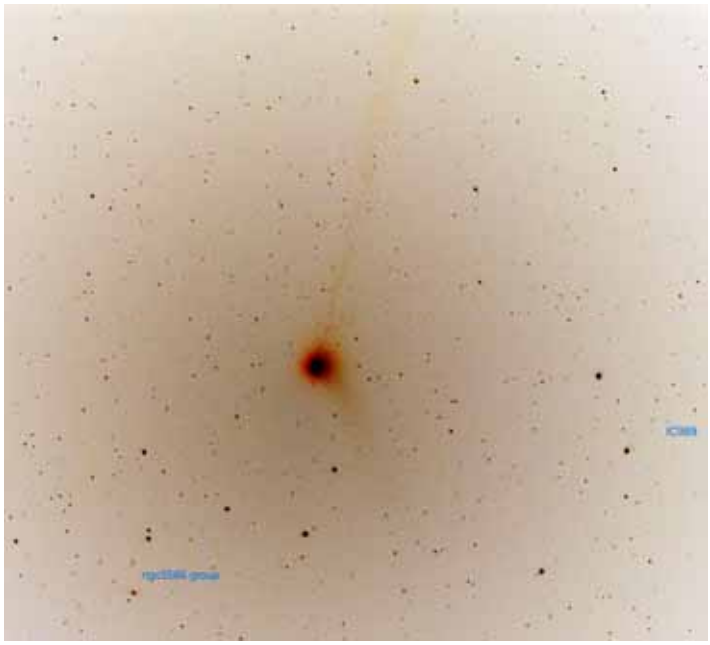
Perhaps the brightest comet through Chritstmas and the New Year it has been running up through Virgo and is now in Bootes (the radiant for the Quantrid Meteor shower.

While boasting brightness of 4.5 to 4.9 magnitude, it is a large size object, so the surface brightness (what we can see) is around 7, apart from the brighter core. It can be seen in binoculars, though most of my shots were taken with a bright Moon within 60 degrees of the comet.



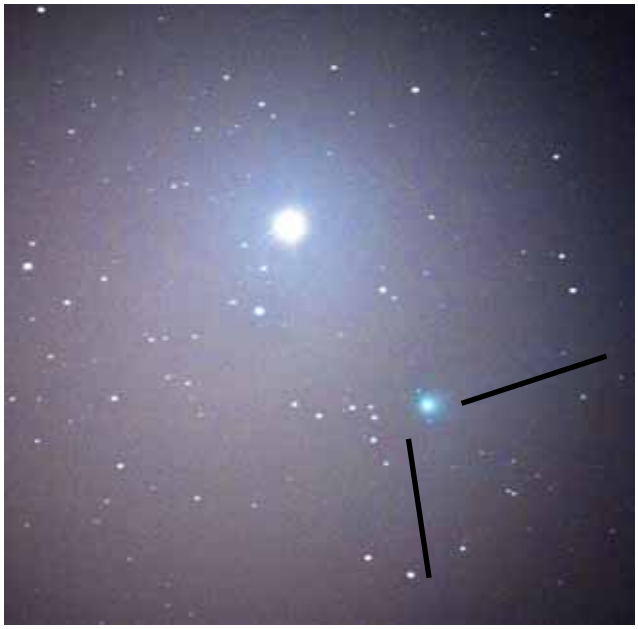
The most distinguishing feature is the very large angle between its twin tails.

The comet with some galaxy groups from December.

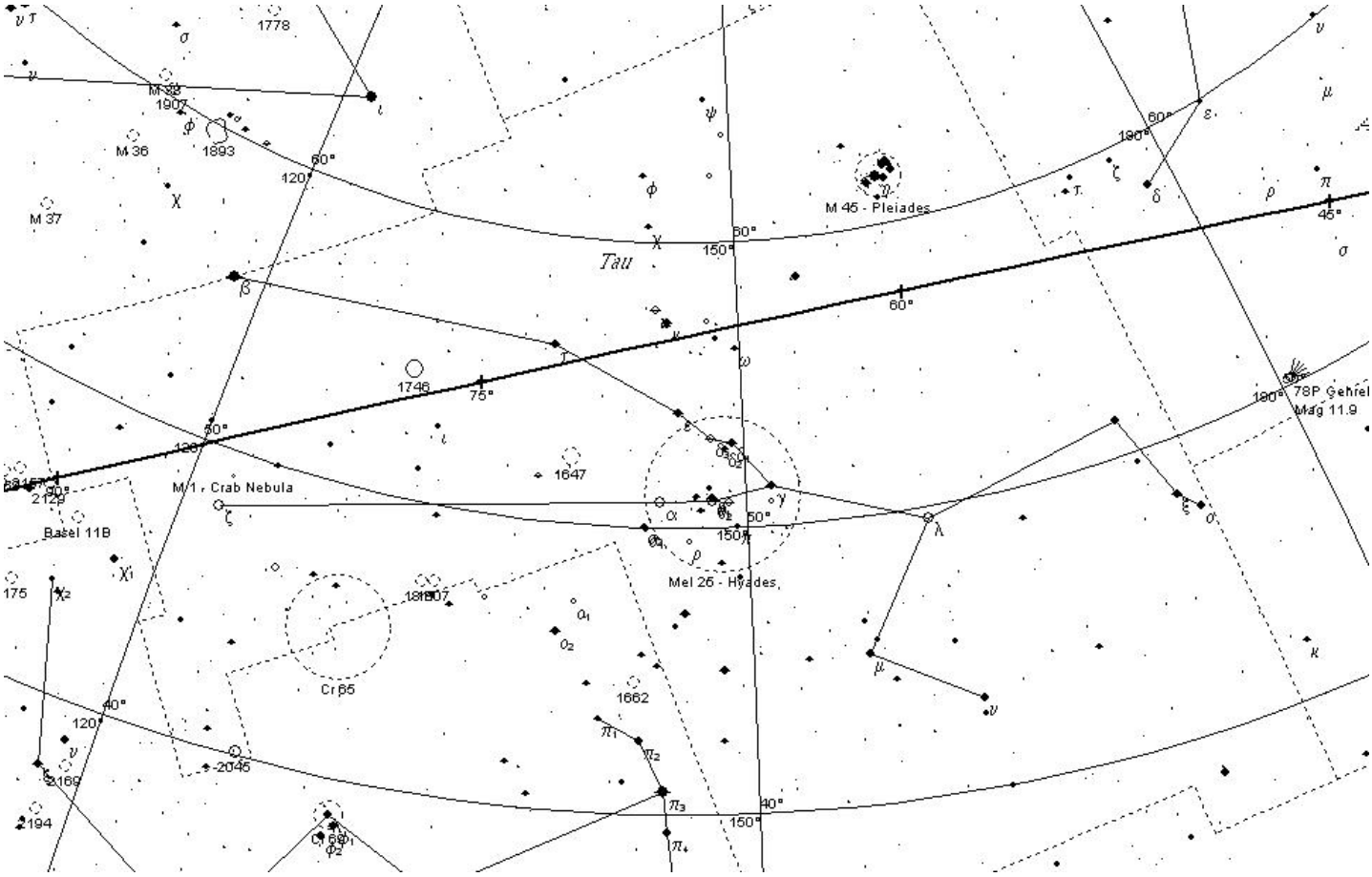


Comet Catalina again (C/2013 Catalina US10 to give it its full name). The 2013 tells us the year it was discovered and US10 tells us when in the year. Catalina is the deep sky wide-field imaging survey that picked the comet up when it was 10,000 times more dim. The hugely divergent tails are unusual, the dust tail or coma below in this picture points along the orbital track of the comet, but the Ion tail is associated with solar winds and vigorous gas release from the comet is pushed out along the magnetic flow from the Sun. This shows some signs of waves and fluxing as the magnitude stream and wind from the Sun varies. It is currently in Virgo heading back out of the inner solar system, just visible in binoculars and the finder scope of my televue finder scope.
Nikon D810, 60seconds, ISO640, inverted to show better tail detail.

Below. The comet imaged through thin cloud on January 1st as it was just below the very bright Arcturus. Note as the comet swings away from prehelion and the Earth to comet angle changes the angle between the Ion tail and the dust tail is decreasing. All images Andy Burns. Sky Map, Astronomy Now.



CONSTELLATIONS OF THE MONTH: TAURUS



Is Taurus attacking Orion, the Hunter, or are the Horns of the Bull the real story?

The horn was a symbol of fertility and bountiful riches in many cultures for thousands of years, and it is probably the case here, for the constellation would have announced the Vernal Equinox at around 4000 BC.

The constellation Taurus may also allude to the Greek story of Europa and the Bull. Europa was daughter of King Agenor. One fine spring day, accompanied by her hand maidens, Princess Europa went to the seashore to gather flowers. Zeus, who had fallen in love with Europa, seized the opportunity.

> Zeus transformed himself into a magnificent white bull, and as such he joined King Agenor's grazing herd. Europa noticed the wonderful white beast, who gazed at them all with such a mild manner that they were not frightened.
>
> Europa wove wreathes of flowers for the beast, and wrapped them around his horns. She led him around the meadow, and he was as docile as a lamb. Then, as he trotted down to the seashore, she jumped onto his shoulders. Suddenly, to her surprise and fright, he plunged into the sea and carried the princess to Crete.
>
> As they reached the Cretan shore, Zeus then turned into an eagle and ravaged Europa. She bore three sons, the first of which was Minos.

Minos is said to have introduced the bull cult to the Cretans. He had Daedalus build a labyrinth in the depths of his palace at Knossus, which became the home of the Minotaur (offspring of Mino's wife Pasiphae, and a bull). Seven young men and seven maidens were ritually sacrificed to the Minotaur until Theseus killed it.

Minos, in fact, was the title of the ancient rulers of Crete, and the story probably tells of their mythic origin.

The constellation shows mainly the horns, and exceedingly long horns they are. The left (southern) horn starts from the group of stars known as The Hyades, of which Aldebaran seems (erroneously) to be a member. It extends from Aldebaran to zeta Tauri, near the eastern edge of the constellation.

The right horn lifts up just west of the Hyades, from delta Tauri through tau Tauri and finally to its tip at beta Tauri (El Nath: remember this star as part of Auriga?)

The rest of the bull is rather disappointing; a slight body and two spindly legs. It may be that the bull is half-emerged in water, as it carries Europa across to Crete.

The stars of Taurus:

Taurus' eye is bright and piercing. This is *Aldebaran (alpha Tauri)*, an orange giant about 40 times the size of the Sun. Aldebaran is an old star. For billions of years it has burned its supply of hydrogen until there is little left. Its future won't be as a spectacular explosion of a supernova but rather a gradual dimming into a white dwarf.

Following the lower horn out to its tip we find *zeta Tauri*. This is a shell star. Shell stars are main-sequence stars which rotate rapidly, causing a loss of matter to an ever-expanding shell.

Most of the interesting features of Taurus are found in the centre of the constellation and toward the west. Around Aldebaran are a number of stars which go by the collective name of *The Hyades* (see below).

Aldebaran is not a member of this group. Not only is it closer to us, but its proper motion is at a different angle. Aldebaran is moving at an angle of 161 degrees, the stars of the Hyades at around 102-109 degrees.

Double stars in Taurus

Taurus has an abundant selection of binary stars, including many Struve binaries that we haven't mentioned. Below is a very small selection of some of the easier doubles to resolve.

Theta^2 and *theta*^{1} form a fixed binary of wide separation, *theta*^{2} just below and to the east. Note that *theta*^{2} is the primary: 3.4, 3.8; PA 346º and separation 337".

Kappa^1 and *kappa*^{1} form an easily resolved binary: 4.2, 5.3; PA 328º, separation 5.3".

Sigma^2 and *sigma*^{1} is another wide fixed binary. And again, *sigma*^{2} is the primary: 4.8, 5.2; PA 193º and separation 431".

80 Tauri is a difficult visual binary with an orbit of 189.5 years: 5.5, 8.0; current PA 17º and separation of 1.8" (very nearly its maximum separation).

Struve 422 is a wide visual binary with an orbit of over 2000 years: 5.9, 8.8; PA 269º, 6.7". It's located at 9º SW of *nu Tauri*, just north of the brighter *10 Tauri*.

Variable stars in Taurus

Many of the more notable variable stars in Taurus are of a type not noticed by casual observation, such as *alpha Taurus*, which is classified as an Lb type variable. These are irregular giants whose variation can only be detected by means of photoelectric photometry. *Alpha Taurus* only changes in visual magnitude by 0.2, from 0.75 to 0.95, and the period is irregular.

BU Tauri (Pleione) is a gammaCas type variable, from 4.77 to 5.50. GammaCas variables are also characterised by an irregular period, which may sometimes be very rapid. These are B stars, quite young, and rotate very rapidly. This rotation results in the throwing off of material, which then forms a shell around the star. The cause of its variation is still not understood.

Zeta Tauri is also a gammaCas type variable, with a variation from 2.88 down to 3.17 roughly every 133 days.

Lambda Tauri, in the Hyades cluster, is a good example of an eclipsing variable. The variability is caused by the partial eclipse of the primary by its companion, dimming the 3.3 visual magnitude down to 3.8 every 3.95 days.

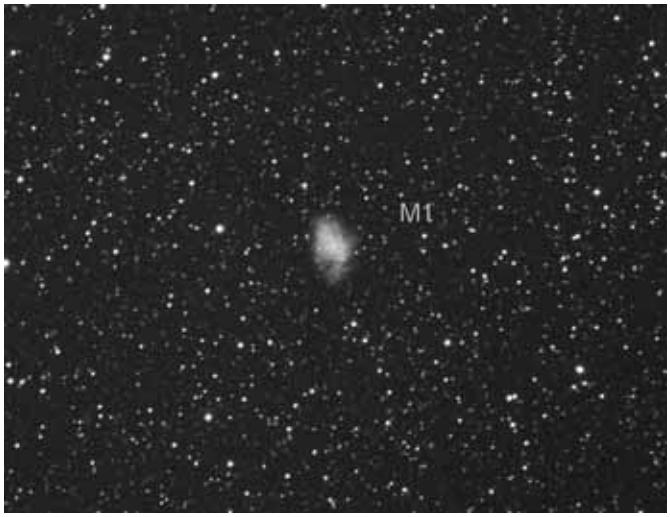
R Tauri is a Mira-type variable with a 320.9 day period. Usually at 7.6, it drops to a very dim 15.8 once a year. In 2000 the maximum should occur in the first week of May.

Deep Sky Objects in Taurus:

Taurus contains two well known Messier objects: the Crab Nebula and the Pleiades. Besides these two there is the `other' cluster, known as The Hyades, and the curious "Hind's Variable Nebula".

Just northwest of zeta Tauri is the first of Messier's objects: M1, the *Crab Nebula*. Early observers thought the object to be a star cluster, something like a dimmer version of the Great Orion Nebula. Messier was so intrigued by it, on the night of 12 September, 1758, that he began his catalogue - the purpose of which was to keep observers from mistaking such objects for comets.

It takes a rather large telescope to see any of the filamentary features of the nebula; most viewers come away disappointed.



The Crab Nebula is a remnant of a supernova, whose explosion occurred (or rather, was visibly recorded) in July of 1054. Chinese and Japanese astronomers witnessed the event. In fact, it would have been difficult not to notice, for the night sky would have been lit up by a star with the visual magnitude of about -5, bright enough to be seen even in the daytime for nearly a month.

The star that exploded, producing the nebula, is now an optical pulsar. Even now, nearly a thousand years later, the nebula is hurtling through space at roughly a thousand kilometers per second. And it continues to grow; the nebula is now over thirteen light years in diameter (four parsecs) according to the *Facts On File Dictionary of Astronomy*.

M45, The Pleiades.

This open cluster contains as many as three thousand stars. The brightest seven go under the name The Seven Sisters" (from brighter to dimmer): Alcyone (eta Tauri), Electra, Maia, Merope, Taygeta, Celaeno, and Asterope. Added to the list are also Pleione (BU Tauri = 28 Tauri), just east of Alcyone, and Atlas (27 Tauri) who are actually Mum and Dad for the seven sisters. (The two are often seen as one star; it takes a clear night to see them as two separate stars.)

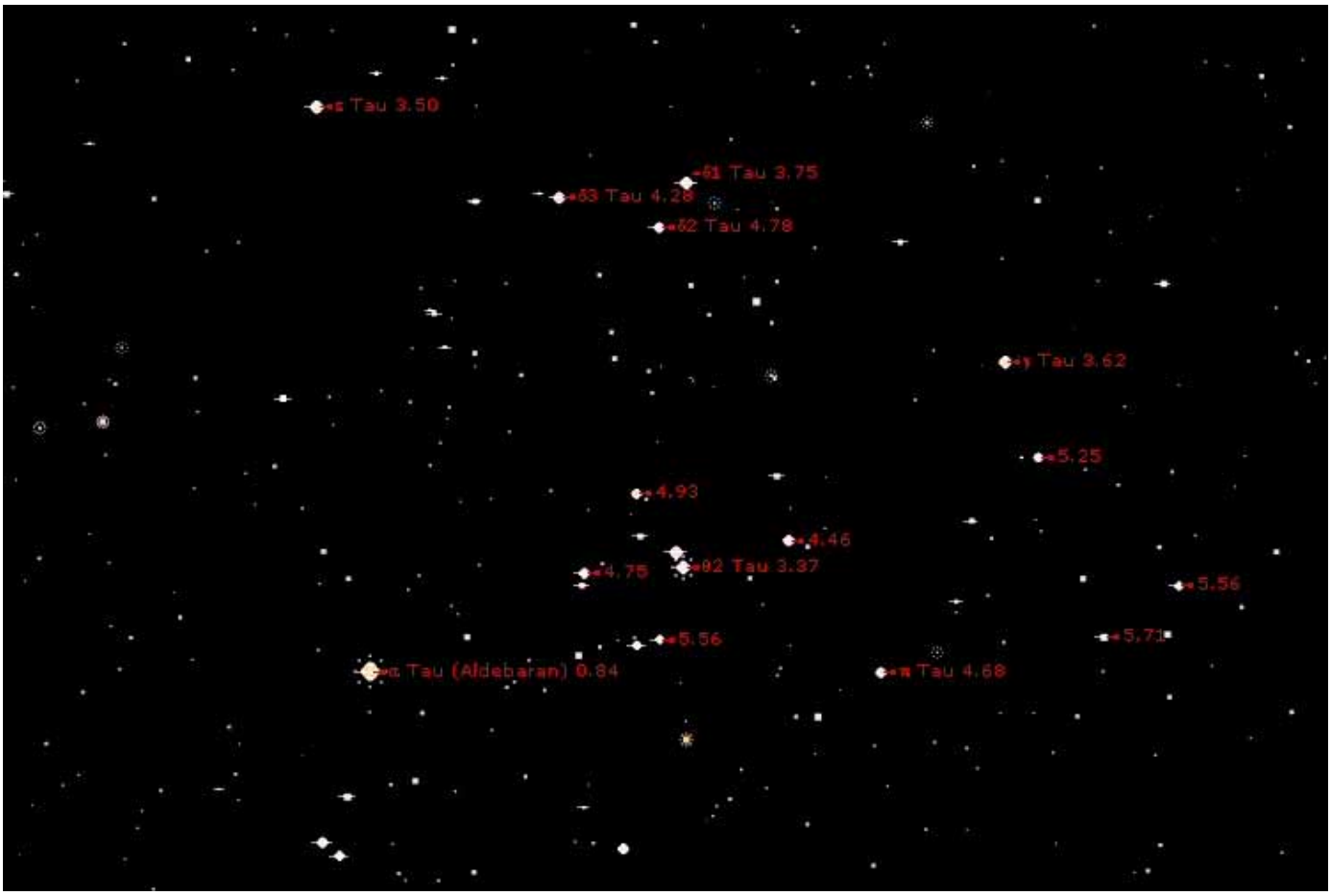
The Hyades

This open cluster of about two hundred stars is only 150 light years away, and considered to be about 600 million years old. It is shaped like a "V", just to the west of Aldebaran.

Just as the Pleiades have individual names, so did the Hyades at one time. In fact, these stars were supposed to be the half-sisters of the Pleiades, and Robert Burnham (*Celestial Handbook*) gives their names - and a great deal more on this group. Theta^2 is the brightest star of the group, which forms a binary with theta^1 (see below). The group is thought to be about 400 million years old.

These nine stars, then, constitute the minimum count, easily seen with the naked eye, while there are actually as many as 250 stars which belong to the group. The cluster is estimated to be 415 light years away. Even a small telescope brings this famous star cluster alive.

Hind's Variable Nebula



(NGC 1555)

This curious deep sky object is located two degrees west of epsilon Tauri, and two degrees north of delta Tauri. First look for the rather dim variable T Tauri. Burnham (*Celestial Handbook*) has a finder's chart, on page 1833. The star has an irregular variability, from 9 to 13.

Very close to T Tauri, just off to the west, is a cloud-like object. This is Hind's Variable Nebula. Its variability is long-lasting; from 1869 to 1890 it couldn't be found at all. Presently, it seems to be gaining slightly in visual magnitude, although its actual visual magnitude hasn't been determined

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

Date	Brightness	Start			Highest			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
05 Jan	-0.9	06:40:11	10°	SSW	06:42:48	23°	SSE	06:45:27	10°	E
06 Jan	-0.4	05:47:51	10°	S	05:49:43	15°	SE	05:51:40	10°	ESE
06 Jan	-2.6	07:22:28	10°	WSW	07:25:38	54°	SSE	07:28:50	10°	E
07 Jan	-2.0	06:29:31	11°	SW	06:32:25	37°	SSE	06:35:28	10°	E
08 Jan	-1.5	05:38:50	24°	SSE	05:39:13	25°	SSE	05:41:58	10°	E
08 Jan	-3.2	07:12:06	10°	WSW	07:15:20	77°	SSE	07:18:36	10°	E
09 Jan	0.2	04:47:58	11°	ESE	04:47:58	11°	ESE	04:48:14	10°	E
09 Jan	-2.9	06:20:34	28°	SW	06:22:01	58°	SSE	06:25:14	10°	E
10 Jan	-1.7	05:29:32	34°	ESE	05:29:32	34°	ESE	05:31:49	10°	E
10 Jan	-3.4	07:02:08	13°	W	07:05:02	88°	N	07:08:17	10°	E
11 Jan	-3.4	06:11:00	54°	WSW	06:11:38	80°	SSE	06:14:53	10°	E
12 Jan	-1.2	05:19:47	27°	E	05:19:47	27°	E	05:21:29	10°	E
12 Jan	-3.4	06:52:22	18°	W	06:54:38	85°	N	06:57:54	10°	E
13 Jan	-3.5	06:01:05	82°	WNW	06:01:12	86°	N	06:04:28	10°	E
14 Jan	-0.8	05:09:45	21°	E	05:09:45	21°	E	05:11:01	10°	E
14 Jan	-3.4	06:42:20	23°	W	06:44:11	86°	SSW	06:47:27	10°	E
15 Jan	-3.2	05:50:58	74°	ENE	05:50:58	74°	ENE	05:53:58	10°	E
15 Jan	-2.7	07:23:53	10°	W	07:27:02	48°	SSW	07:30:11	10°	SE
16 Jan	-0.4	04:59:35	17°	E	04:59:35	17°	E	05:00:29	10°	E
16 Jan	-3.2	06:32:10	29°	W	06:33:37	66°	SSW	06:36:50	10°	ESE
17 Jan	-2.7	05:40:46	54°	ESE	05:40:46	54°	ESE	05:43:23	10°	ESE
17 Jan	-2.0	07:13:25	10°	W	07:16:19	30°	SSW	07:19:11	10°	SSE
18 Jan	0.0	04:49:23	14°	E	04:49:23	14°	E	04:49:52	10°	E
18 Jan	-2.7	06:21:58	33°	WSW	06:22:55	44°	SSW	06:26:01	10°	SE
19 Jan	-1.9	05:30:35	35°	SE	05:30:35	35°	SE	05:32:39	10°	ESE
19 Jan	-1.4	07:03:10	10°	W	07:05:25	18°	SW	07:07:42	10°	S
20 Jan	-2.1	06:11:49	27°	SW	06:12:03	27°	SSW	06:14:52	10°	SSE
21 Jan	-1.0	05:20:30	19°	SE	05:20:30	19°	SE	05:21:41	10°	SE
22 Jan	-1.1	06:01:50	15°	SSW	06:01:50	15°	SSW	06:03:08	10°	S
02 Feb	-0.9	19:14:51	10°	SSW	19:15:40	15°	S	19:15:40	15°	S
03 Feb	-1.2	18:22:03	10°	S	18:23:48	14°	SE	18:24:20	14°	SE
03 Feb	-0.3	19:56:31	10°	SW	19:56:54	13°	SW	19:56:54	13°	SW

END IMAGES

COMET and a Meteor

Sometimes you get lucky. On the morning of 21st December caught an Ursiid Meteor while imaging comet Catalina.

Nikon D810, 640ISO, 60seconds. Televue 127mm telescope.

Date	Moon Phase	Observing Topic
2016		
Friday 29th January	Waning gibbous	Lunar targets
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

8th January East Witchell School, daytime.

15th January 7pm BBC Stargazing live tie in.