Star Gazer News

Astronomy News for Bluewater Stargazers
Vol 10 No. 3 March 2016

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Jupiter Watching Season has Started

A full-disc image of Jupiter was taken on 21 April 2014 with Hubble's Wide Field Camera 3 (credit: NASA/HST)

*Victoria M. Kaspi has received the prestigious **Gerhard Herzberg Canada Gold Medal for Science and Engineering**. NSERC's highest honour recognizes research contributions characterized by both excellence and influence and is awarded annually to an individual who has demonstrated sustained excellence and influence in research for a body of work conducted in Canada that has substantially advanced the fields of natural sciences or engineering.*

Dr. Victoria M. Kaspi is one of the world's leading experts on neutron stars, the ancient remnants of the most massive stars in the Milky Way. The most massive stars end their lives as black holes. Less massive stars, however, leave behind celestial objects no bigger than the city of Montreal, yet so dense that just one teaspoon would weigh 100 million metric tonnes.

Kaspi uses the largest and most powerful radio and X-ray telescopes in the world to study the physical behaviour of neutron stars, pulsars and magnetars. Her seminal research sheds light on how stars evolve, how they die and, ultimately, the very nature of matter under extreme conditions.

Kaspi's research group has had major impacts in the field of astrophysics, including unique tests confirming Einstein's long-held theory of general relativity and discovering the fastest rotating star. Her team's 2002 landmark discovery of powerful X-ray bursts from an enigmatic class of star essentially doubled the number of known magnetars in our galaxy.

Here is an interview with Dr. Kaspi from NSERC:
https://www.youtube.com/watch?v=MgaHukkKrv4

Ever since Voyager 1 took the spectacular images of Jupiter from close up, it has been a changed world. The four bright points of light that Galileo observed shuttling back and forth around the planet have become worlds of their own with entire branches of planetary science studies devoted to them. Jupiter's fantastic extremes of weather have given earth-bound meteorologists an example of the most extreme conditions that hopefully we will never have to face here on our planet. The lightning bolts alone are thousands of times more powerful.

Since Jupiter watching is now upon us, it is time for you to bone up on the King of Planets. Brian Ventrudo's informative article is the place to start: http://cosmicpursuits.com/575/observers-guide-to-planet-jupiter/

At opposition on March 8, Jupiter rises in the east at sunset and sets by the time the Sun re-appears in the dawn sky. There is no excuse for not having a look at it and its contingent of Moons. There are 6 double shadow transits visible locally in March, -note especially the dates March 22 and 23 when two double transits occur in less than 48 hours. Specific times are given on pg. 10.

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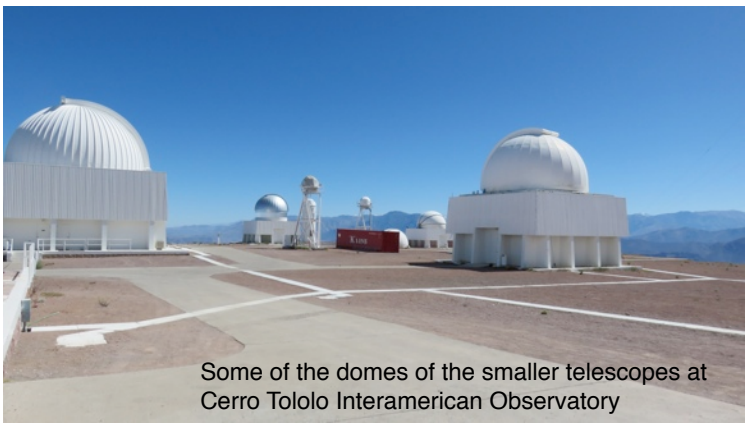
BAS is back for 2016

BAS resumes its regular monthly meetings on March 2, 2016. We meet at the Grey Roots Museum at 7 pm for a brief business meeting consisting of a treasurer's report and a short preview of 2016 events. Also, Mike T. will have a Vesta meteorite on display!

We have also arranged for a speaker for the second half of the meeting. Greg Hollinger of Wiarton will describe his visit to some observatories in Chile recently. He has images of the tour he took of two observatories at Cerro Tololo Observatory.

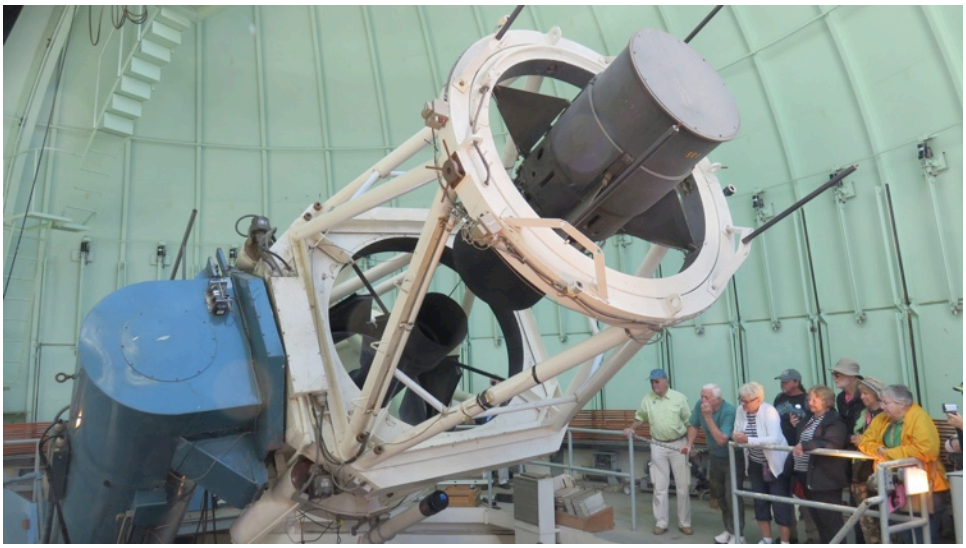


Some of the domes of the smaller telescopes at Cerro Tololo Interamerican Observatory

Note also that we have already started to make plans for the August 21, 2017 solar eclipse and you have already been given an opportunity to join in the planned trip. There is still time to sign on and we hope to have more details soon. See the February SGN issue for a description of our preliminary plans.

The list of astronomical events for 2016 has already been posted on our website and now there is a listing of BAS events as well. Check the HOME page for a link to both listings. Note that the 3-month listing continues to appear on our website as before on both the HOME page and in more detail if you click on the COMING EVENTS tab.

Please note that 2016 BAS dues are due at the March meeting or as soon as you can get them to the membership chair Dave S.



Right: One of the smaller (1.4 m?) telescopes at Cerro Tololo Interamerican Observatory. Both images supplied by Greg Hollinger

BAS & Astronomy Events for March

Mar	1	Tue	LQ
	2	Wed	**Regular Meeting** Grey Roots Museum (AGM and Greg Hollinger Chilean Observatory visit)
	5	Sat	**Fox Dark of Moon Viewing** Messier Marathon Night #1 Public Welcome
	8	**Tue**	**Jupiter at Opposition** NM **Total Solar Eclipse** (Indonesia and S. Pac.)
	13	Sun	**DST begins 2:00 am**
	15	Tue	FQ
	20	Sun	**Vernal Equinox**
	23	Wed	Penumbral Lunar Eclipse and FM
	31	Thu	LQ

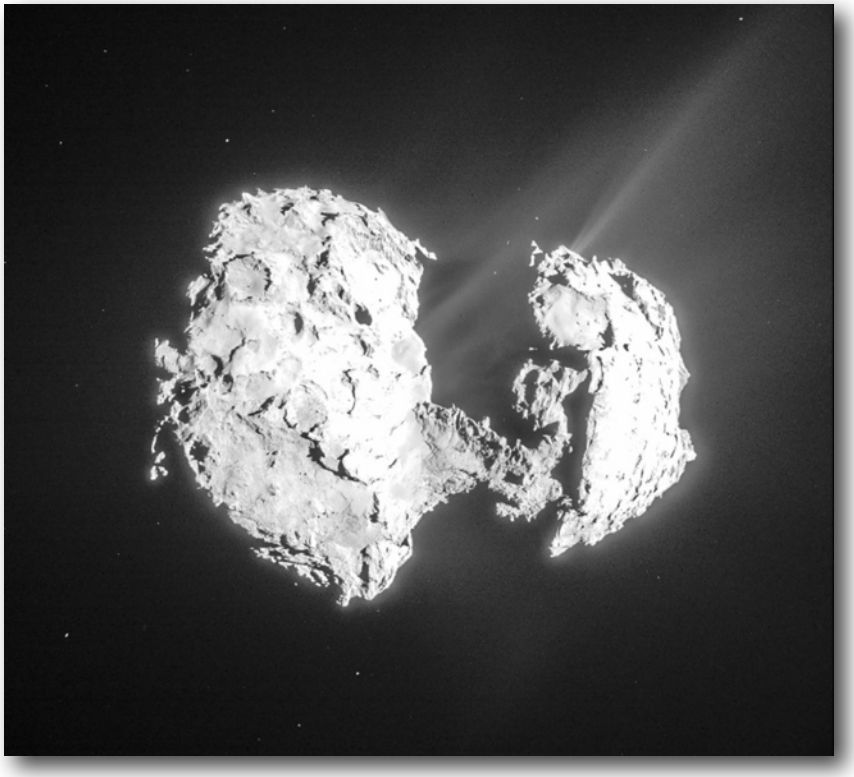
Dark of the Moon Viewing March 5

The first viewing session at the Fox Observatory is March 5 and is our annual Messier Marathon night. This can be a dusk 'til dawn event for the diehards to catch all the Messier objects, but stay as long as you wish and view as many as you wish. Come prepared for a cold night and bring a red flashlight. A coffee maker (bring Keurig K-cups of your choice) and microwave are available. If the event is clouded out, backup nights are March 12 and April 2 or 9. Please park near the Learning Centre and walk down the lane way to the observatory. Lights from vehicles are not desirable once observers eyes have dark-adapted. Note that the lane way may still be snow covered.

Comet 67/P: Low Density but No Caverns

ESA Press release Feb 4 2016

There are no large caverns inside Comet 67P/Churyumov-Gerasimenko. ESA's Rosetta mission has made measurements that clearly demonstrate this, solving a long-standing mystery.



Comets are the icy remnants left over from the formation of the planets 4.6 billion years ago. A total of eight comets have now been visited by spacecraft and, thanks to these missions, we have built up a picture of the basic properties of these cosmic time capsules. While some questions have been answered, others have been raised.

Comets are known to be a mixture of dust and ice, and if fully compact, they would be heavier than water. However, previous measurements have shown that some of them have extremely low densities, much lower than that of water ice. The low density implies that comets must be highly porous. But is the porosity because of huge empty caves in the comet's interior or it is a more homogeneous low-density structure?

In a new study, published in this week's issue of the journal Nature, a team led by Martin Pätzold, from Rheinische Institut für Umweltforschung an der Universität zu Köln, Germany, have shown that Comet 67P/Churyumov-Gerasimenko is also a low-density object, but they have also been able to rule out a cavernous interior. This result is consistent with earlier results from Rosetta's CONSERT radar experiment showing that the double-lobed comet's 'head' is fairly homogenous on spatial scales of a few tens of metres. The most reasonable explanation then is that the comet's porosity must be an intrinsic property of dust particles mixed with the ice that make up the interior. In fact, earlier spacecraft measurements had shown that comet dust is typically not a compacted solid, but rather a 'fluffy' aggregate, giving the dust particles high porosity and low density, and Rosetta's COSIMA and GIADA instruments have shown that the same kinds of dust grains are also found at 67P/Churyumov-Gerasimenko.

Oct 26 image from 8 km ***Credit :ESA***

Pätzold's team made their discovery by using the Radio Science Experiment (RSI) to study the way the Rosetta orbiter is pulled by the gravity of the comet, which is generated by its mass. The effect of the gravity on the movement of Rosetta is measured by changes in the frequency of the spacecraft's signals when they are received at Earth. It is a manifestation of the Doppler effect, produced whenever there is movement between a source and an observer, and is the same effect that causes emergency vehicle sirens to change pitch as they pass by. In this case, Rosetta was being pulled by the gravity of the comet, which changed the frequency of the radio link to Earth. ESA's 35-metre antenna at the New Norcia ground station in Australia is used to communicate with Rosetta during routine operations. The variations in the signals it received were analysed to give a picture of the gravity field across the comet. Large internal caverns would have been noticeable by a tell-tale drop in acceleration.

"Newton's law of gravity tells us that the Rosetta spacecraft is basically pulled by everything," says Martin Pätzold, the principal investigator of the RSI experiment. "In practical terms, this means that we had to remove the influence of the Sun, all the planets – from giant Jupiter to the dwarf planets – as well as large asteroids in the inner asteroid belt, on Rosetta's motion, to leave just the influence of the comet. Solar radiation and the comet's escaping gas tail also had to be accounted for. Thankfully, these effects are well understood and this is a standard procedure nowadays for spacecraft operations."

Whatever motion is left is due to the comet's mass. For Comet 67P/Churyumov-Gerasimenko, this gives a mass slightly less than 10 billion tonnes. Images from the OSIRIS camera have been used to develop models of the comet's shape and these give the volume as around 18.7 km^3, meaning that the density is 533 kg/m^3.

In September, Rosetta will be guided to a controlled impact on the surface of the comet. The manoeuvre will provide a unique challenge for the flight dynamics specialists at ESA's European Space Operations Centre (ESOC) in Darmstadt, Germany. As Rosetta gets nearer and nearer the complex gravity field of the comet will make navigating harder and harder. But for RSI, its measurements will increase in precision. This could allow the team to check for caverns just a few hundred metres across.

GRAVITATIONAL WAVES DETECTED 100 YEARS AFTER EINSTEIN'S PREDICTION

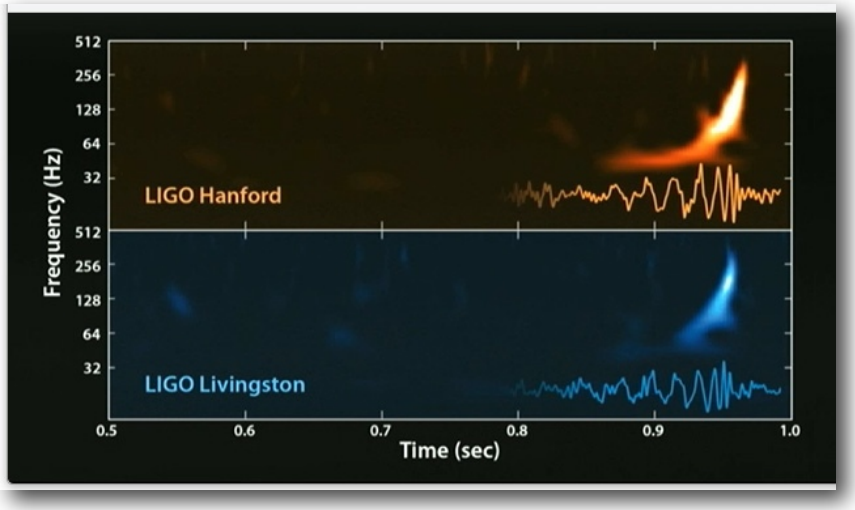
The first ever direct detection of gravitational waves has been made by researchers working on the Advanced Laser Interferometer Gravitational-wave Observatory (aLIGO) in the US. The breakthrough – announced today at a news conference in Washington, DC – ends a decades-long hunt for these ripples in space–time. This monumental observation marks the beginning of the era of gravitational-wave astronomy and provides evidence for one of the last unverified predictions of Einstein's general theory of relativity.

The waves were produced from the collision of two black holes of 36 and 29 solar masses, respectively, which merged to form a spinning, 62-solar-mass black hole, some 1.3 billion light-years away in an event dubbed GW150914. The detection was made on 14 September last year and was measured while the newly upgraded aLIGO detectors – one in Hanford, Washington, and the other in Livingston, Louisiana – were being calibrated before the first observational run began four days later.

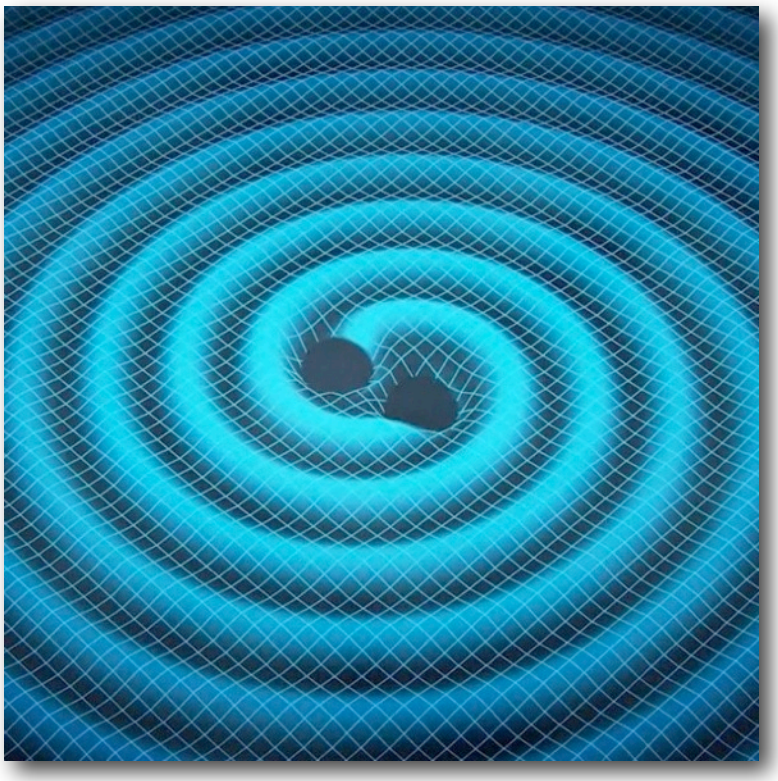
The gravitational-wave signal lasted in both of LIGO's interferometers for 0.2 seconds and has been measured to a statistical certainty above 5.1σ. In fact, the signal from the event was so strong that it could be visually "seen" in the data by eye. It was measured in both of LIGO's interferometers, arriving within seven milliseconds of each other. The observation is also the first time a stellar-mass binary black-hole system has been detected. The data also showed that gravitational waves travel at light speed and that gravity has no mass, as predicted by general relativity.

Ripples in the cosmos

Just as accelerating a charged particle produces electromagnetic radiation, so accelerating mass produces gravitational radiation – this energy is lost from the system in the form of "gravitational waves". But unlike electromagnetic waves that travel through space–time, gravitational waves actually ripple the fabric of space–time. Such waves travel away from their source in all directions at the speed of light, compressing and expanding intervening space–time as they flow.



Any accelerating mass will produce gravitational waves so long as it is not spherically or cylindrically symmetric, which means that a perfectly spherical spinning star will not create the ripples. Since Einstein published his general theory of relativity 100 years ago, scientists have predicted that binary-star or black-hole systems would be prolific sources of gravitational waves in our universe, but



such waves had never been directly detected, until aLIGO's measurement last September. If two black holes are stably orbiting each other, they produce a continuous stream of gravitational waves at twice the orbital frequency, carrying away the system's rotational energy and angular momentum. Such ripples are thought to have wavelengths that are tens of light-years and are relatively weak. But if the initial separation between the two black holes is not too large then – at some point – the orbit will get smaller as the system loses rotational energy and the two holes will eventually "inspiral".

Chirp and ring

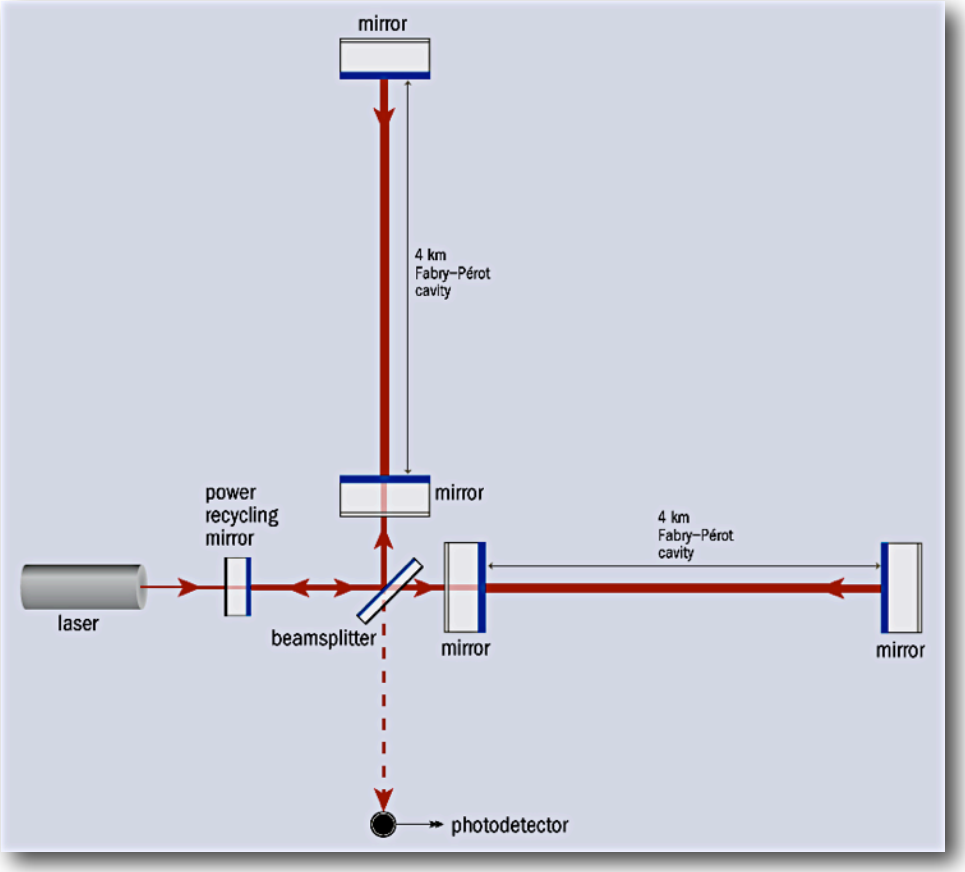
The closer a binary pair is initially, the more radiation is emitted as the two black holes plunge into one another, which accelerates the inspiral. This process produces a characteristic "chirp" waveform in which both the amplitude and frequency of the gravitational waves increases – sometimes for less than a second – until it peaks at the merger. Given off during the last few seconds of the merger, these gravitational waves are characteristic of the mass and spin of the final black hole. (Data record shown at left)

The single black hole created by such a cataclysmic merger is initially highly distorted. However, the nascent hole loses its deformity almost instantly by ringing like a bell and producing further gravitational radiation. The system quickly loses energy and the strength of the waves decays exponentially to form a "ringdown" signal. For event GW150914, aLIGO detected the chirp and the ringdown note at the end.

As the final black hole was 62 solar masses, this means that 3 solar masses' worth of gravitational radiation was emitted during the event. The signal also revealed that the new-born black hole is a rotating Kerr black hole (with a spin parameter of 0.67). Cosmologists have modelled such a gravitational-wave signal as audible sounds, based on the frequencies of the waves as they would arrive at LIGO's detectors. (You can listen to a chirp and ringdown here.)

The length of time that a signal remains in LIGO's interferometers – and hence the quality of a potential detection of gravitational waves – depends inversely on the frequency that LIGO is set up to measure and the masses of the binary objects involved. It is therefore easier to detect gravitational waves at lower frequencies and from lighter objects. Before its upgrade, LIGO was able to detect gravitational waves from 40 to 10,000 Hz, but since aLIGO came online, the interferometers have been able to detect waves down to a frequency of just 10 Hz, thereby greatly extending LIGO's reach.

B S Sathyaprakash – a physicist at Cardiff University in the UK and a member of the LIGO collaboration – says the facility is currently functioning at 30 Hz, which was still sufficient to pick up the signal at 1.3 billion LY. Although he admits that a heavier object will last for a shorter time, the signal itself is really strong. "Big objects have a larger amplitude, so a [gravitational wave] signal from a binary black-hole system can be detected from a much greater distance than a similar signal from a neutron-star system," he explains.



Long arm of LIGO

LIGO's successful detection of gravitational waves is thanks to its simple but ingenious design. The two observatories are essentially Fabry–Pérot interferometers consisting of two 4 km-long arms at right angles to each other, with "test masses" in the form of pure silicon primary mirrors – each weighing 40 kg and suspended as a pendulum – at both ends of the arms. Both interferometer arms are housed in an ultrahigh vacuum.

During a run, laser light with a wavelength of 1064 nm and a power of 200 W is sent to a beamsplitter, which transmits one half of the light into one of the arms and reflects the rest down the other arm. As each arm itself is a Fabry–Pérot cavity, the light is allowed to bounce back and forth some 400 times in each arm before returning to the beamsplitter. This effectively increases the arm length to nearly 1600 km, boosting aLIGO's sensitivity.

After the bounces, light from each arm returns to the beamsplitter, where the two beams combine. Some of this light is again transmitted through the beamsplitter and is detected at the photodetector (see diagram below).

Riding the wave

If the light travels exactly the same distance down both arms, the two combining light waves interfere destructively, cancelling each other so that no light is observed at the photodetector. But if a gravitational wave slightly stretches one arm and compresses the other, the two beams would no longer completely subtract each other, producing an interference pattern at the detector. This pattern contains information about how much the two arms have lengthened or shortened, which in turn tells us about what produced the gravitational waves.

The aLIGO facility does not, however, measure the change in path-length because the gravitational wave compresses or expands the light's wavelength too. Instead, what the device reveals are tiny shifts in the period of the two light beams. If the crests or troughs of the wave arrive out of synch, they produce an interference pattern, meaning that the light acts as a clock and not a ruler.

Apart from using a Fabry–Pérot cavity to increase their sensitivity, the interferometers also have a "power-recycling mirror" placed just behind the beamsplitter. This mirror, which is partly reflective, slowly boosts the laser power from 200 W to 750 kW by reflecting nearly all of the laser light back to the beamsplitter and into the arms. Despite all of these upgrades and modifications, even a strong gravitational wave from colliding black holes displaces the mirrors by barely 10^{-19} m, making LIGO's successful detection even more triumphant.

Testing Einstein

With the gravitational-wave data from the GW150914 event, the LIGO researchers were also able to check a key prediction made by general relativity, which is that gravitational waves travel at the speed of light and that the currently unknown carriers of the force – often dubbed "gravitions" – are massless. If gravitons did have mass, some physicists have reasoned, it could explain the accelerating expansion of the universe without resorting to the concept of "dark energy". However, the aLIGO data show no evidence that the gravitational waves were anomalously dispersed, as they would if gravity had some small mass.

1. The research is published in *Physical Review Letters* and is freely accessible: "Observation of gravitational waves from a binary black-hole merger"
2. A supplementary paper is published in *Astrophysical Journal Letters*, and is also free to access: "Astrophysical implications of the binary black-hole merger GW150914"

About the author

Tushna Commissariat is a reporter for *physicsworld.com* With additional reporting from Margaret Harris in Washington, DC

A Wolf-Rayet Monster in Canis Major

"Pretty, isn't it? But the beauty belies a true monster."
Phil Plait's Bad Astronomy Blog

Imagine, on a cold winter's night, taking your binoculars, and directing your gaze near the Canis Majoris star, Omicron-1, and seeing, just beside it, the naked, nuclear furnace of a 20 solar mass, pre-supernova Wolf-Rayet star called EZ Canis Majoris. (EZ CMa).

Our Milky Way has 500 known Wolf-Rayet stars and EZ CMa is the closest one to our solar system. This star is rapidly burning through its nuclear fuel and our models of stellar evolution predict that, in a few thousand years, it will detonate in a massive supernova explosion. Phil Plait, of Bad Astronomy fame, suggests

Above: EZ CMa and Sharpless 2-308 Don Goldman image, Apr 23, 2009

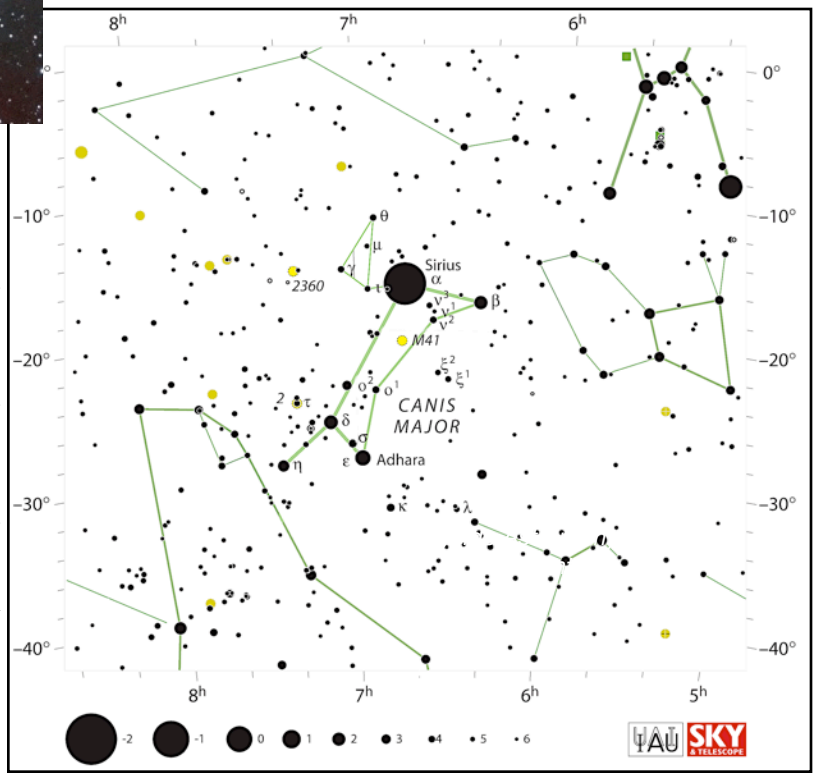
that the explosion will blast out, in a few weeks, as much energy as our Sun does in its entire 10 billion year history! From our vantage point on Earth we are safe, but, the explosion's debris is predicted to shine brighter than Venus! That should be quite a spectacle! Canis Major is already the host constellation for Sirius, the brightest apparent star in the sky, but now, add a luminous supernova remnant to the mix, with a brightness rivaling Venus, and the visible constellation will be dramatically transformed.

This fascinating class of variable stars are called Wolf-Rayet stars after their discoverers, two French astronomers, Charles Wolf and Georges Rayet. In 1867, using only a 16 inch telescope at the Paris Observatory, they discovered three unusual stars in the constellation Cygnus that exhibited broad emission lines superimposed on a continuous spectrum. They had expected to see absorption lines. By 1929 the broad emission line widths seen in the spectra were explained by Doppler shifting. This phenomenon results when the elements responsible for the broad emission lines, like H, He, N, C, and O are expelled from the outer star layers with varying speeds.

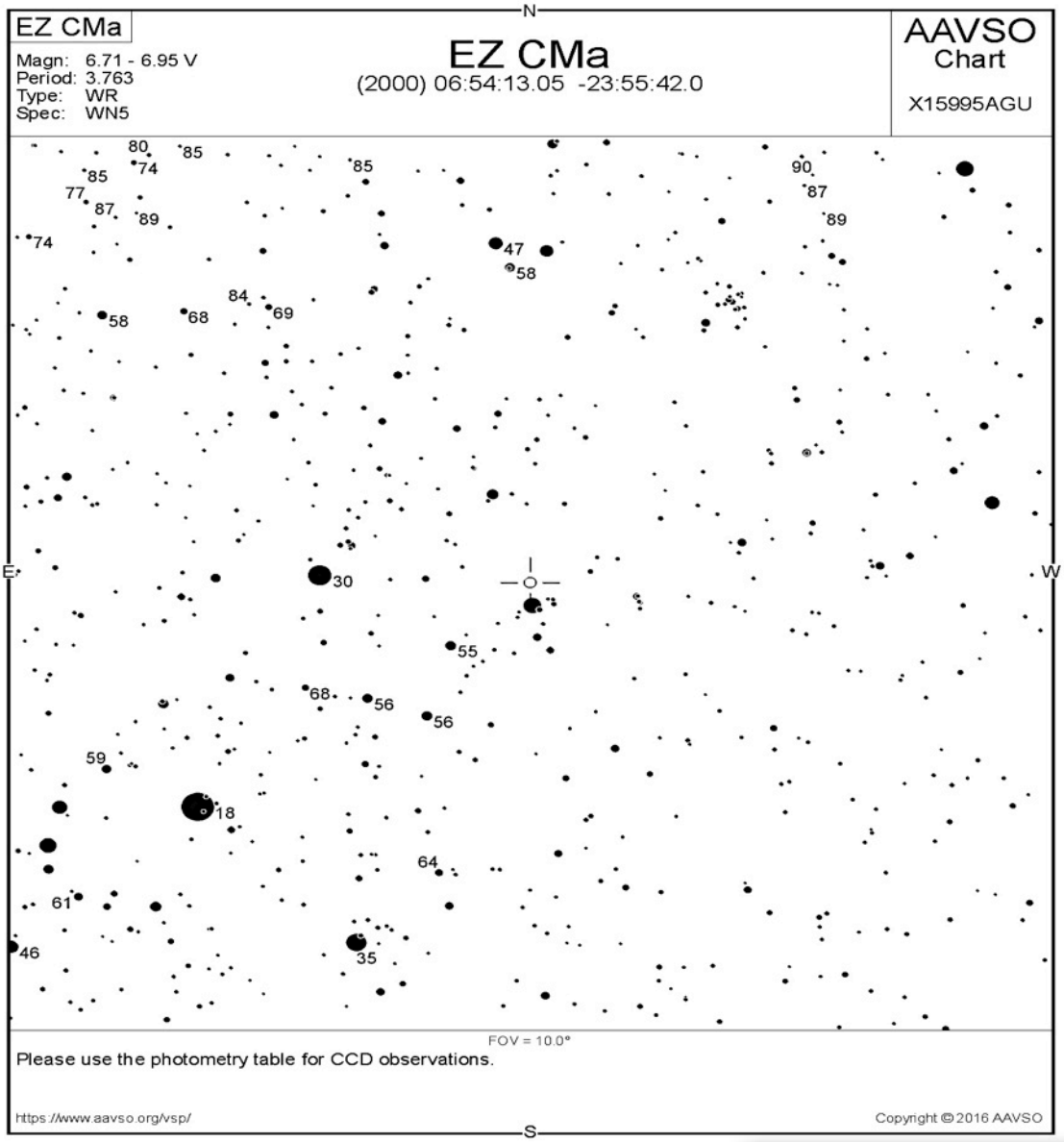
In Don Goldman's photo, shown left, the yellow star to the right is Canis Major's Omicron-1, and the blue star in the middle is the Wolf-Rayet star in question, EZ Canis Majoris. Notice that it is located slightly off-centre within the expanding asymmetric, bubble of nebulosity. EZ CMa is the 20 solar mass remainder of an original, 20 to 40 solar mass, Type O supergiant star. It is a variable star and changes its brightness between 6.95 and 6.71 visual magnitude, in a time period of 3.76 days. There is some speculation that the light variations of this Wolf-Rayet star are caused by a neutron star companion but no firm evidence for this has surfaced.

EZ CMa and its nebula are about 5,000 ly distant, and the surrounding nebulosity, called Sharpless 2-308, is 60 ly across and occupies an apparent diameter on the sky of one degree, or the width of two Full Moons! In comparison, the Helix nebula in Aquarius, is about 0.5 degree in diameter. In response to the pressure from the high stellar winds, the gaseous nebula is expanding outward at an incredible, 1700 km per second!

***Below**: Chart of Canis Major from Sky&Telescope. Note: the Wolf-Rayet Star, EZ Canis Major, is found just above O1 (left of the "C" in Canis Major). Use the detailed AAVSO chart on the next page to locate it.*



You won't see the nebulosity in your binoculars, but amateur astronomer, Ronald Stoyan, has seen it as a large, faint sickle from dark sky sites, using 8 inch and larger telescopes. My wife, Paula, brought her Celestron CPC 9.25 with her to Arizona, (the largest telescope we brought with us) and we hope to observe this nebula once the Moon is out of our sky.



(NOTE: The star numbered 30 on the AAVSO Chart above is really Omicron 2 (O-2) on the Sky & Tel map and has a visual magnitude of 3.0. The star numbered 18 on the AAVSO Chart is really Delta Canis Majoris on the Sky & Tel map and has a visual magnitude of 1.80)

There are only about 500 known Wolf-Rayet stars in our Milky Way galaxy. Initially, these stars were broadly classified as WN, WC, or WO, depending on whether nitrogen emission lines, carbon emission line, or oxygen emission lines were dominant. Now, with improved spectra, our classification scheme for Wolf-Rayet stars has acquired many subdivisions. We now understand that these stars start out as highly luminous, giant, O-type stars with masses between 20 and 40 times the mass of our Sun. Near the end of its lifetime, a Wolf-Rayet star loses a substantial fraction of its mass in the form of an energetic stellar wind which, in the process, creates a beautiful nebula, as captured in Don Goldman's image.

The evolution of Wolf-Rayet stars are a current topic of research and a full understanding of their nature still eludes astronomers. For example, the evolution of a Wolf-Rayet star can be complicated by its rotation, composition (metallicity), and by the presence of a companion. During their lifespan Wolf-Rayet stars can change dramatically and are a fascinating stellar group for amateurs and professionals to monitor. EZ CMa is a convenient and bright binocular example of a Wolf-Rayet star .. a precursor to a supernova.

I used to belong to the American Association of Variable Star Observers (AAVSO) and I greatly enjoyed following the brightness variations of many classes of variable stars – from eclipsing binaries, and cataclysmic variables, to supernovae explosions. As a member, I received my variable star comparison charts through the mail. I still keep them in my files. Now, I create my own charts using AAVSO's on-line Variable Star Plotter (https://www.aavso.org/apps/vsp/). Its quite a convenience!

I believe that seeing with the mind and the eye is what professional and amateur astronomy is all about. I enjoy reading the professional astronomer's theoretical interpretations of a published variable star's light curve. During my early years as an amateur I had a lot of fun following the brightness variations of many mysterious variable stars and, in the process, I learned the night sky!

From the Editor:

After viewing EZ CMa, have a look at the nice open cluster M41 just below Sirius (see chart on previous page).

It contains only about one hundred stars, including several bright red giants (orange, in image). The blue star in lower left corner is a foreground star but provides a nice contrast.

Credit: NAOA/AURA/NSF

OSCEOLA METEORITE RECOVERY

by Mike Hankey www.mikesastrophotos.com

On Sunday January 24th, 2016 at 10:30 AM, a bright fireball streaked over the Florida skies. Having been a bit worn down from the east coast snow storm, I got excited when I heard the news from my friend Marc Fries. His message was short and sweet, "Your pending AMS reports contain a meteorite fall!" I immediately checked and approved over 80 reports from eye witnesses of the fall. After computing and publishing the trajectory, I sent the map to Marc. He responded, 'SPOT-ON BULLSEYE!' The AMS's fireball trajectory intersected with the meteorite cloud Marc had found.

While fireballs fall every day, it is rare for large groups of people to see them. It is rarer still for them to show up on doppler weather radar. When this does happen, its an almost certain sign that meteorites are on the ground under the return. This was one of those times. A radar return like this takes out all the guess work and you know exactly where to search.

News of the fall spread in the meteorite community quickly. I got a call from my friend Larry Atkins the next day. He exclaimed after I answered the phone, "I'm in the car, just two hours away from the strewnfield!" Larry had been visiting his dad in Florida the weekend of the fall. When he heard the news, he jumped in his car and and started driving toward the field.

While the radar returns looked rich, the terrain and prospects for making a find were bleak. The meteorites fell over swamp land and pine forests. Hunting for meteorites in the woods is doable but not easy, hunting in a swamp is beyond possible. Larry spent the next few days driving around the area and getting a lay of the land. He figured out who the land owners were, contacted them and hunted what he could, even in the rain. We talked daily and by Wednesday I was ready to roll. I hadn't been meteorite hunting since 2012 and I was ready to try my luck again. Besides, with the cold and snow, I could use a long weekend in Florida, even if it was walking around a swamp.

I drove down with my friend Brendan Fallon Thursday night. We were in the field hunting with Larry and his Aunt Laura by Friday morning. I'm glad Larry had done all the ground work before I got there, or else I'd have been driving around lost for days. As we approached the ground near the radar returns, Larry got a call from a local number. A local land owner told us he heard a crackling noise and saw two smoke rings in the sky above his head, one inside the other. He was into the fall and liked the idea of finding a meteorite from it, but at the same time, he didn't think we had a chance. He gave us permission to hunt, a key to the gates and a map of his 15,000 acre ranch and then went on his way.

Largest meteorite found was 800 grams! Image used with permission of Mike Hankey www.mikesastrophotos.com

As we walked into the property, we knew this was the zone, and we all knew we were going to find meteorites. It's a super exciting feeling

First Osceola meteorite find was a small 8.5 gram piece. Image used with permission of Mike Hankey www.mikesastrophotos.com

you get when you are walking around in a place where meteorites just fell. Every step and every glance matters, one step leads to the next and there could be a meteorite around you at any time.

We spent most of the first day at the ranch and left in the afternoon to scout out alternate areas. There is only one road into and through the search area, and calling it a road is a bit of a stretch. It's made out of what looks like beach sand and is even called Sand Hill Road. We spent the rest of the afternoon scouting for 'low hanging fruit'. Thats what we call clear spots along the side of the road or hunt-able areas that are easy to access. Exhausted, we left the strewnfield and went straight to dinner. We celebrated at a nice steak house like we had already found a meteorite. We were all filled with energy and so optimistic and grateful to be at that place in that moment.

The next day, we went out to the state park and started hunting the paths and dirt roads that went through the swamp. We were all walking north on a road about 10 feet wide. We got to a fork and Larry and Brendan turned around to search the other side of the road. Laura and I stayed behind to search the remaining roads. We didn't get far as the water from the swamp overflowed onto the road making it impassible. We turned around and headed back to the car to regroup. (cont'd pg 6.)

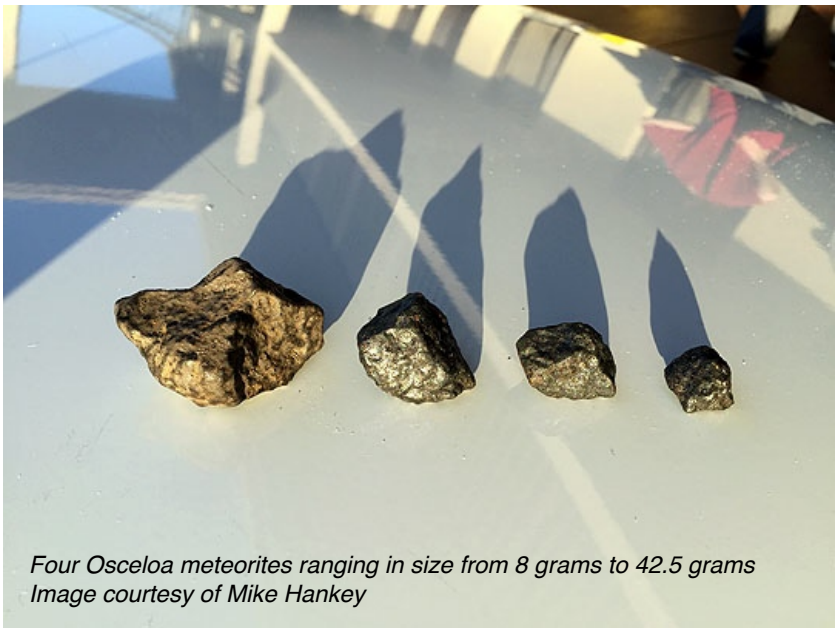
On our walk back, I paused for a second to stretch, looked down and there it was. The first meteorite from the fall. It was small, about 8 grams and I knew right away, but was cautious to get too excited at first. I got on the ground with my face just inches from the rock. Examining it from all sides I stated, "this is a meteorite." Laura excitedly inspected and agreed. After a quick meteorite dance, Laura ran down the path to get the other guys while I stayed behind.

Second Osceola Meteorite Find – 28.5 Grams – Photo Credit Larry Atkins

They returned, we celebrated, took some pictures and continued on. I felt so relieved and at peace. Any other finds from this trip would be a bonus. I'd accomplished what I'd set out to do and was totally satisfied. We had a meteorite from this fall. I thought about all the mechanics involved to get to this place and time. For over 4 billion years this rock traveled 100's of millions of miles. Just 6 days ago, it ended its journey in a brilliant explosion 10-20 miles above the Earth's surface. And then, was found by me in a swamp. It was an amazing thought cycle filling me with euphoria.

I hunted around the next two hours close to my find. I wanted to find the fragments related to it. Meteorites often fall in clusters and are found close to each other. Surrounded by water and a swampy mess, I couldn't grid the area, so I just did the best I could.

A little later, I heard screaming from the group. Sure enough, Larry had just found the second stone. A 28.5 gram stone about a half-mile south of where I found mine. We all celebrated and were so excited. Now that we had found two stones and just hours apart, we all knew there were more meteorites all around us. We hunted until dark that night and then went out to dinner to celebrate. We were all walking on air.



Four Osceloa meteorites ranging in size from 8 grams to 42.5 grams
Image courtesy of Mike Hankey

My friend Josh Adkins drove down from Baltimore Saturday night and arrived in Lake City before we headed out to the field. Having not slept, and just driven 13 hours, he was ready to spend the day hunting. Its amazing the energy people can get from meteorites.

We went back to the place where we had made the finds. "You don't run from meteorites.", Larry repeated a few times that day. When you find one meteorite there are others close by, so stay in that place and keep searching. Larry, his aunt Laura and I started near my find. We were walking down a sand road just about an hour after we started, when Laura exclaimed, "Here's one." Sure enough, one side of a small meteorite was poking through the sand in the road. I don't know how Laura even spotted it, as it was flat against the road and looked like a leaf. After taking some pictures she pulled it out of the dirt. It left an impression the size of a sugar cube in the sand road.

After Laura's find, I started paying extra attention to all the dark objects on the ground. Leaves, burnt wood chips and tree bark all look like meteorites from 6 feet up. The only way to know for sure is to touch them as you go by. I spent the rest of the day, crouching down every other minute and checking dark objects in the sand. I felt like the guy who combs the fringe on his rug.

By 5 o'clock Sunday evening, Larry and Laura were worn out and wanted to quit early. It was my last day there and I didn't want to stop early. While remote, I still hand a chance to find another meteorite. I suggested we drive toward the center of the radar return, and hunt for another hour until dark. Larry dropped us off on the main sand road and continued down a quarter mile with his aunt. We planned to have him pick us up at the same spot an hour later.

The three of us hunted around the road, finding nothing and then worked our way back to where Larry dropped us off. I felt tired but satisfied. It was a great trip and I had accomplished what I set out to. As I reflected and thought about my find accepting it would be my one and only, I looked down into a mud puddle. The mud was dry on top and cracked like the ground in a dry lake bed. One of the cracks looked odd to me, so I poked it with my finger. Expecting it to be soft to the touch, when I realized it was hard, I got excited. There was a rock here.

I pulled it out and immediately felt the weight. It was much heavier than a normal rock its size. I wiped away the mud and started to see smooth divots throughout the stone. I shouted out to Brendan and Josh, "I think I got another one." They ran over and inspected themselves, agreeing. I still wasn't sure, the color was off, but it was hard to tell with all the mud. I borrowed a loupe from Brendan and once I looked at it through the magnifying glass I knew it was a meteorite. The rock had a fantastic crust that was oozing rust. (cont'd pg 7)

I worked my way down the road to show Larry and confirm the find. I still had a little bit of doubt, it might not be a meteorite. Before I gave it to him to inspect, I said firmly, "Don't throw it away! Its covered with mud and hard to tell. You need to use the loupe". Suspicious at first, Larry inspected it with the magnifying glass and agreed. This was another meteorite, the 4th and biggest so far at 42 grams. What a great way to end the day and the trip.

The next morning, Larry mailed his stone to Alan Ruben at UCLA. Alan will cut the stone, analyze it and determine its classification. We should get a report in another week.

I started my drive back home alone. Brendan didn't want to leave without a meteorite. He stayed behind with Larry, Laura, Josh and several of Larry's family members. I wished the luck but knew they would have a hard time in the days to come.

The day after I got home I got a text from Brendan. Josh's truck got stuck in the mud on Sand Hill Road.

It took them two days two get the truck out of the mud. The rest of the week for them was tough. I kept wondering when Brendan would give it up and come home. The Sunday morning after I got home, I got a text from Brendan and Josh. They had found a stone, a big one.

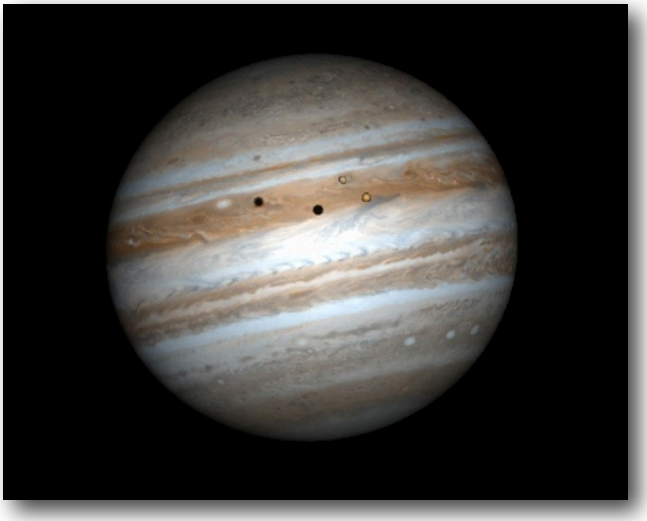
Wow. Over three miles away from my 42 gram find, they found a 800 gram stone almost completely buried in the sand. Amazing. They continued to hunt for another four days with no finds. I would have called it quits after my first trip if not for the new big find. Larry was still at it with a friend and his aunt and uncle. I had to give it one more shot over a long weekend. I was in the field by Friday morning and we spent two days hunting with five people total. About mid day today, Larry made another find in the woods. An almost 80 gram stone.

I've got one more day in this strewnfield and then back home tonight. No matter what happens on my last day of hunting, this was a miraculous discovery with 6 stones and almost 1,000 grams recovered.

Transits of Jupiter's Moons

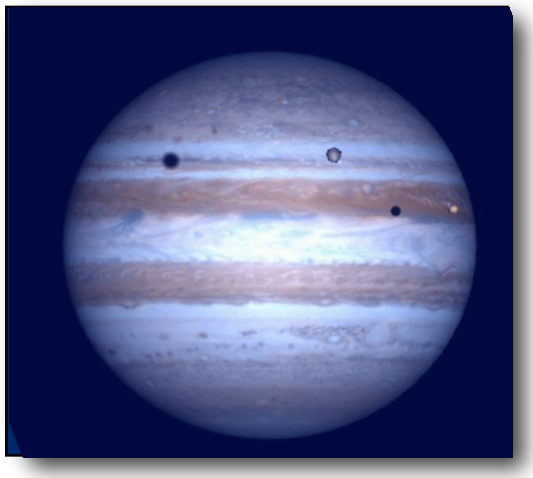
Transits of Jupiter's Moons are always interesting to watch and in March alone there are 11 listed in the Observer's Handbook including two on consecutive dates March 22 and March 23. February has 3 (only one visible locally), April has 4 more (2 visible here) and there is one in May as well for a total of 19 shadow passages across Jupiter's disk. Not all are visible locally when Jupiter is above the horizon and daytime events are also not listed in this table. Those below occur when Jupiter is above our horizon and it is generally dark.

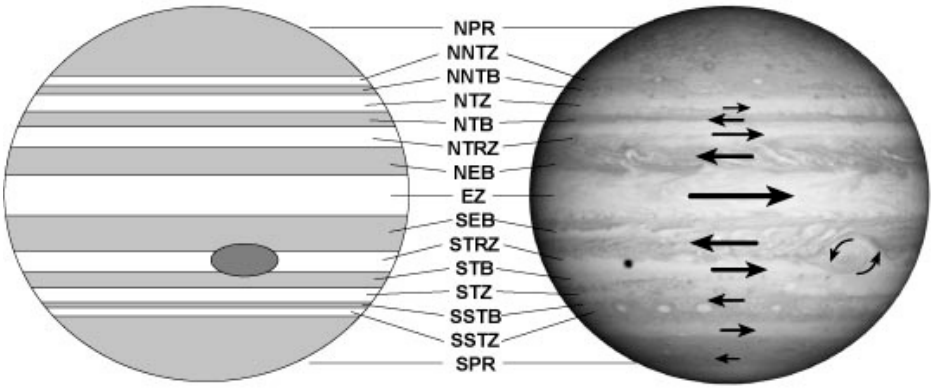
Date	Start Time	End Time	Moons involved
Feb 26	5:37 pm EST	6:02 pm EST	Europa, Io
Mar 4	6:31 am EST	7:19 am EST (Jupiter sets)	Europa, Io
Mar 7	7:26 pm EST	8:56 pm EST	Europa, Io
Mar 14	10:21 pm DST	11:33 pm DST	Europa, Io
Mar 22	12:20 am DST	2:30 am DST	Io, Europa
Mar 23	7:43 pm DST	8:58 pm DST	Io, Ganymede
Mar 29	2:58 am DST	4:53 am DST	Io, Europa
Apr 5	5:35 am DST	6:05 am DST (Jupiter sets)	Io, Europa
Apr 8	6:52 pm DST	7:14 pm DST (sunset 8 pm)	Io, Europa
May 7	12:48 am DST	1:42 am DST	Callisto, Io



Above: Shadows of Io and Europa shown for March 22 in his Starry Night graphic at mid point of transit around 1:30 am DST. Io and Europa may be detectable on disc as well.

Graphic right shows Io and Ganymede shadows crossing Jupiter's disk on March 23 about 8:15 pm DST. The moons themselves are more difficult to spot unless they are in front of a light-coloured zone on the planet's disk.





Note: the Red Spot is usually found in the South Tropical Zone between the South Equatorial Belt and South Temperate Belt. Times of Red Spot visibility are available in the Observer's Handbook for 2016 or on here: http://www.projectpluto.com/jeve_grs.htm

Graphic left abbreviations:
N = North; S = South
B = Belt (dark cloud belts)
Z = Zone (bright cloud zones)
TB,TZ = Temperate (mid-latitudes) Belts or Zones
TRZ = Tropical Zone
EB, EZ = Equatorial Belt or Zone
PR = Polar Region

Monoceros (Mon)

Monoceros (the Unicorn) is an inconspicuous and relatively modern constellation, having probably been invented about the 16th century. This constellation is interesting in that it is diametrically opposite the center of our galaxy, the Milky Way; in looking at this area of the sky, you are looking toward the rim and outside edge of our galaxy. It is for this reason that the density of the stars in this region is so low. The open cluster NGC 2244 is visible to the naked eye and is a beautiful sight in fieldglasses. Near this cluster, around ε Monocerotis, is a fine field of stars observable in powerful binoculars or low power telescopes. [NGC 2244 is imbedded in the Rosette Nebula -ed]

DOUBLE STARS

	Mag.	Sep (s)	Location	Remarks
β	4.7-5.2-5.6	7-10	062607	White-Pearl Grey; beautiful
ε	4.5-6.5	14	062105	Gold-Blue
4	6.5-10.5 -11.5	3-9	060011	
Σ921	6.0-8.2	16	062811	
Σ1183	5.5-7.8	31	080409	

MESSIER OBJECTS

	Mag	Location	Remarks
M 50	6.3	070108	Open Cluster. Beautiful, red star in field.

Other Objects of Interest in Monoceros

NGC 2244 - Open Cluster; very beautiful; observer with low power. [This cluster is surrounded by the **Rosette Nebula**. -ed]
NGC 2261 - A diffuse nebula, Hubble's Variable Nebula; see R Monocerotis. First 200-inch image by E. Hubble.
NGC 2264 - Open Cluster; Location 063810 [aka **Christmas Tree Cluster** see Dec 2012 SGN for more. -ed]
R Monocerotis - An irregular variable, maximum magnitude 9.5. This star is the center of an unusual nebula called a "Variable Nebula." It varies in brightness very rapidly . Barely visible in small scopes. Location 063709.
T Monocerotis - Cepheid var. per= 27 d, range 6.4-8.0 Location 062207.

Canis Minor (CMi)

α Canis Minoris - Procyon β Canis Minoris - Gomeisa

Canis Minor is easily located; its brightest star, Procyon, forms an equilateral triangle with Sirius in Canis Major and Betelgeuse in Orion. Procyon is a star similar to our sun, golden-yellow in color and having a magnitude of 0.37, making it the 8th brightest star in the sky. Procyon means "before the dog," so called because it rises about half an hour before Sirius, the Dog Star.

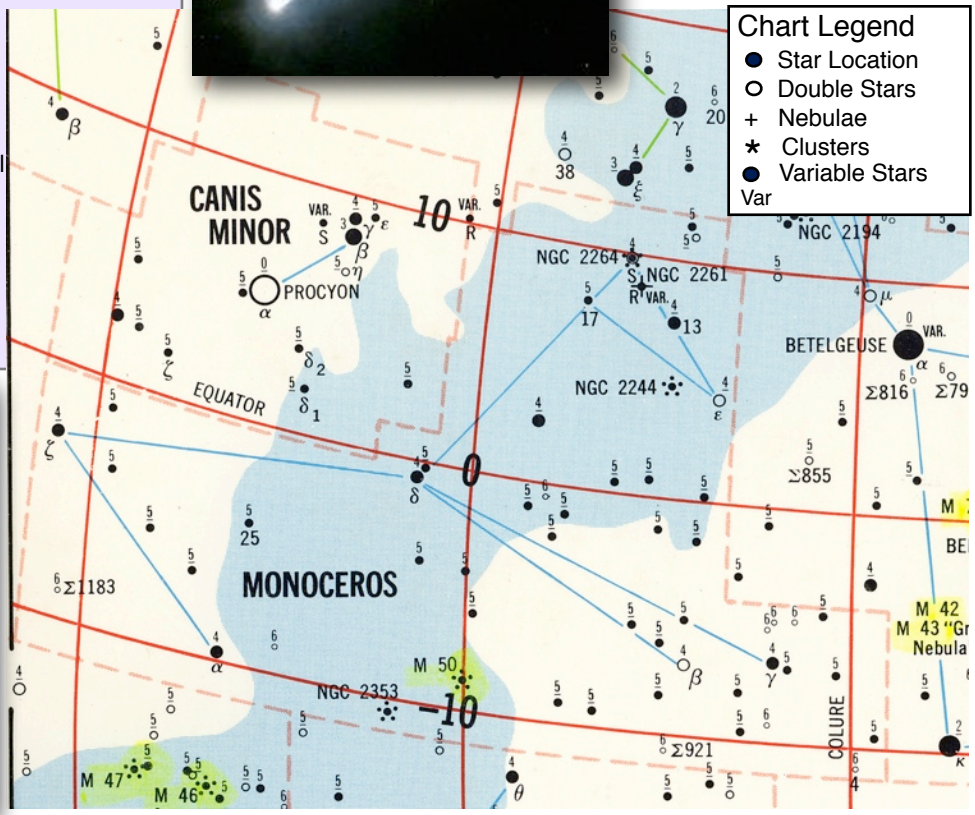
DOUBLE STARS

	Mag.	Sep (s)	Location	Remarks
α	0.5-13.5	5	073705	Visible only in large telescope.

Other Objects of Interest in Canis Minor

R Canis Minoris - Long period (338 d) variable, max mag = 8.0. Location 070610.
S Canis Minoris - Long period (332 d) variable, max mag = 7.5. Location 073008.

NGC 2261 (**Hubble's Variable Nebula** or **Caldwell 46**) is a variable nebula illuminated by the star R Monocerotis, which is not directly visible itself. Dense clouds of dust near R Mon may periodically block the illumination from the star. In 1949, Hubble himself imaged this object-the first photo taken by the 200-inch Hale Telescope on Mt. Palomar. [Wikipedia]



Rosette Nebula imaged by Stuart Heggie of the Flesherton area, who kindly allowed this image to be used in the Cosmic Images photo show for IYA 2009. The Rosette Nebula is a vast cloud of dust and gas, extending over an area of more than 1° across. Its parts have been assigned different NGC numbers: 2237, 2238, 2239, and 2246. The open star cluster NGC 2244 is situated within the nebula, consisting of the young stars which recently formed from the nebula's material. The brightest make the nebula shine by exciting its atoms to emit radiation. Star formation is still in progress in this vast cloud of interstellar matter. Distance to the Rosette Nebula is about 5 500 light years. Stuart's image was a multiple exposure totally 280 minutes with H-alpha and RGB filters. Telescope used was a Takahashi FSQ 106 mm refractor.

Date: (Time given on 24 h clock EST unless otherwise noted).

Mar 01	18:11	**LQ Moon** rises locally at 12:59 am DST
02	01:53	Saturn 3.6°S of Moon
07	05:54	Venus 3.5°S of Moon -nice view in dawn twilight
08	**05:00**	**Jupiter at Opposition**
	20:54	**NM** rises locally at 6:30 am DST
	20:57	Total Solar Eclipse; Indonesia, S. Pacific
10	02:02	Moon at Perigee: 359 509 km
13	**02:00**	**Daylight Saving Time begins 2:00 am**
14	09:44	Aldebaran 0.3°S of Moon Occultation not vis. here
15	13:03	**FQ Moon** rises locally 11:24 pm DST Mar 14
20	00:31	Vernal Equinox -spring has sprung!
	14:05	Regulus 2.5°N of Moon
21	23:57	Jupiter 2.1°N of Moon
23	07:47	Pen. Lunar Eclipse; mag=0.775 Eastern N.Amer. sees first half; Moon is half its diameter from umbra
	08:01	**FM** rises locally at 7:03 pm DST Mar 22
	16:00	Mercury at superior conjunction (behind Sun)
24	21:50	Spica 5.1°S of Moon
25	10:16	Moon at Apogee: 406 125 km
28	14:45	Mars 4.2°S of Moon
29	10:58	Saturn 3.5°S of Moon
31	11:17	**LQ Moon** rises locally at 2:32 am DST

BAS/Astronomy Events

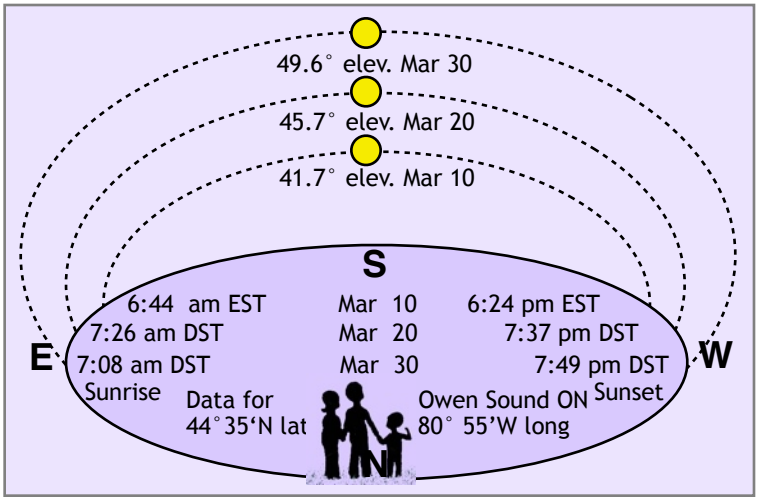
Mar	1	Tue	LQ
	2	Wed	**Regular Meeting** Grey Roots Museum (AGM and Greg Hollinger Chilean Observatory visit
	5	Sat	**Fox Dark of Moon Viewing** Messier Marathon Night #1 Public Welcome
	8	**Tue**	**Jupiter at Opposition** NM **Total Solar Eclipse** (Indonesia and S. Pac.)
	13	Sun	DST begins 2:00 am
	15	Tue	FQ
	20	Sun	Vernal Equinox
	23	Wed	Penumbral Lunar Eclipse and FM
	31	Thu	LQ

Planets

MERCURY is not visible in the morning sky since it is very close to the Sun in March. There is better viewing in the western sky in April.

VENUS, (-3.8) is now closer to the Sun but still shines brightly in the morning sky before dawn. It continues to drop towards the Sun however. **MARS,** (mag. 0.0) rises after midnight and is high above the southern horizon by dawn. It passes less than 10 minutes from 2.5 mag. Graffias (β-Sco) on March 16. **JUPITER**, (-2.5) rises by sunset (opposition March 8) and is well placed for viewing in the evening sky. Several double shadow transits occur this month. **SATURN,** (mag. 0.5) rises an hour after Mars and gets closer to Mars all month. Only one of the gas giants, **URANUS,** (5.8) is still visible in the west for an hour before it sets. **NEPTUNE,** (7.9) is a morning planet now and is close to Venus (0.5° away) March 20. **Dwarf planet**, **Ceres (8.3)** is not observable in dark sky being too close to the Sun this spring. **Asteroid, Vesta (6.7)** is near Uranus and has the same viewing conditions until both set. **PLUTO** (mag. 14) rises about 3 am and will be better viewing in the summer. Charts for these planets and asteroids for the 2016 viewing season will soon be on the BAS website.

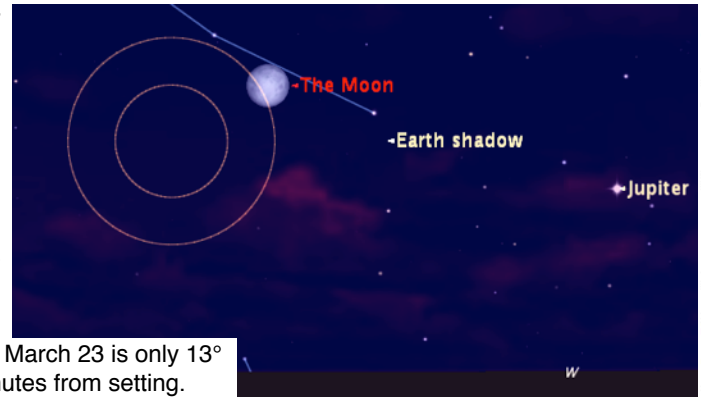
The diagram below gives the sunrise/sunset times and the Sun's altitude for March. The Sun is at Vernal Equinox March 20. The moon phase graphic at the bottom of this page shows the lunar phase for each night of March. Times of moonrise for NM, FQ, FM and LQ for Owen Sound are in the Sky Calendar listing at left. The March 14 Aldebaran occultation is not visible locally. Our next Aldebaran occultation takes place Apr 10 but it is a daylight event.



Special Events

Penumbral Lunar Eclipse March 23, 2016

The March 23 early morning penumbral lunar eclipse will be one that only true die-hard eclipse lovers will make an effort to observe. For Grey-Bruce, it will be a difficult observation since the Moon sets halfway through the event. The mid-point would be the best time to catch any hint of umbral darkening but dawn is quickly approaching by this time and washing out any potential shading. The Moon's edge will be at least 12 minutes of arc from the umbral circle and only 77% immersed inside the penumbral circle. During past eclipses, this has been sufficient for observers under ideal conditions (Moon altitude high, dark and cloudless skies) to see some penumbral shading and it may be possible this time. Viewers in western North America are better placed in this regard. For us on Grey-Bruce, the fact that the Moon is setting at the worst time and the sky is brightening does not bode well for seeing anything. But, give it a go and let SGN know how you made out.



Right: Moon at 6:15 am March 23 is only 13° from horizon and 75 minutes from setting.

March 2016

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8 NM	9	10	11	12
13	14	15 FQ	16	17	18	19
20	21	22	23 FM	24	25	26
27	28	29	30	31 LQ		

By permission Univ. of Texas McDonald Obs.

BAS Member Loaner Scopes

Solar H-alpha scope now available.

Our Lunt solar scope can be borrowed by BAS members and it is waiting at the Fox! Contact John to get your hands on it. We now have a suitable mount for it as well. A short training session will be provided on pickup.

Several Dobs available.

One 12-inch dobsonian loaner telescope is available for free loan by members. Smaller 8-inchers are also available. Contact John H. or Brett T. for availability. Scopes come in and out so keep checking with John or Brett if you are interested in a loaner.

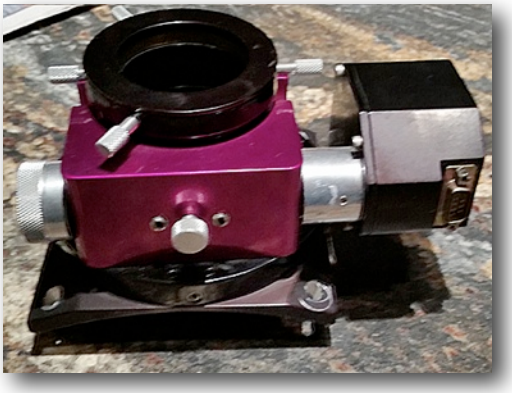
S G N Classified Ads Section

(Now also on our website)

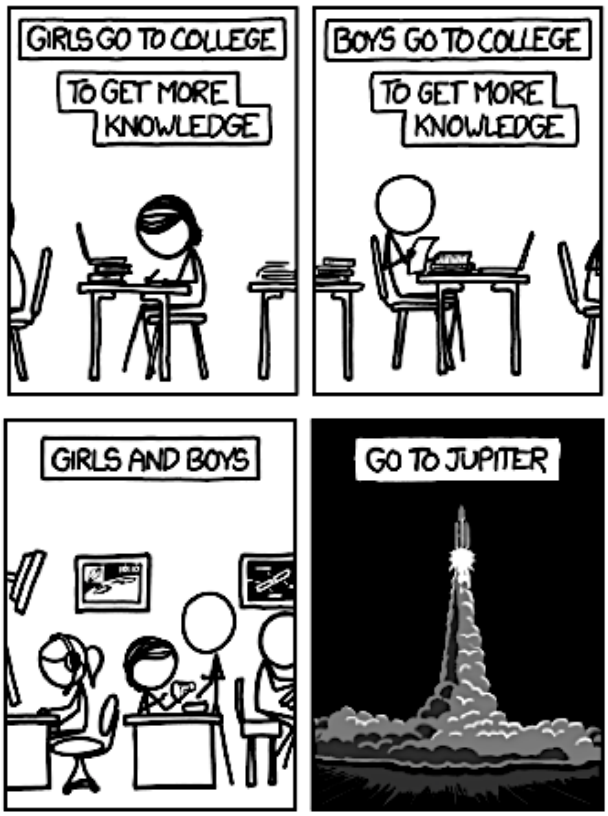
FOR SALE: Zambuto 18" f/4 mirror only 12 months old, performs beautifully. Original price $5260 US. Asking $4500 US. Contact Jack at 520-558-1143 (Arizona) or by email: jackjacknewton@gmail.com. Available only until new mirror is ready in 3 weeks or so.

FOR SALE:

Moonlite CRL 2.5 inch Large Format **Crayford Newtonian Focuser** ($592.10 new -see https://focuser.com/products.php) with Hi-Res Stepper Motor ($252.81 new). Flange for 14" tube, accepts 2" accessories (EP/camera). This is a **true Crayford focuser**, not the cheap "Crayford-style" knock-off. Not set up for manual focusing, requires hand paddle ($330 not included) for manual operation and computer control for remote focusing. This is meant for a remote imaging setup and comes from an abandoned project (12" scope). Over $850 plus taxes and shipping new. Asking $600.00. Contact **Paul** at ski@bmts.com



Cartoon Corner c/o www.xkcd.com



From the Editor: I was a bit puzzled by this one at first and here is the gist of the author's explanation. This comic is a play on the popular school-yard taunt: "Girls go to college, to get more knowledge; Boys got to Jupiter, to get more stupider." Another version is "Boys go to Mars to get more candy bars, Girls go to Jupiter, to get more stupider." The gender of the chanter determines the version. This comic subverts the original rhyme by having both girls and boys get smart and go to Jupiter together! Maybe not a side-splitter but I like it.

FOR SALE:

Celestron AVX mount. Includes GOTO hand controller, tripod and two 10 pound counterweights. OTA capacity 30 pounds. Reviews at http://joebergeron.com/avx.htm New $880, asking $650.00.

Contact **John H.** at stargazerjohn@rogers.com

The Triangulum Galaxy - M33 by Stuart Heggie Nov 2007
Scope: Astro-Physics AP155EDF **Mount:** Paramount ME
Camera: Apogee U16M w Astrodon Gen II Filters
21x10min Red, 24x10min Green and Blue
Acquired in CCDSoft5
Dark and Flat application, Alignment and Sigma Reject combine in Maxim
Post processing in PS CS4

Description From SEDS.ORG:

Probably discovered by Hodierna before 1654. Independently discovered by Charles Messier 1764.

The Triangulum galaxy M33 is another prominent member of the Local Group of galaxies but smaller than its neighbor, the Andromeda Galaxy M31, and our Milky Way, but this is more of an average size for spiral galaxies in the universe. M33 may be a remote but gravitationally bound companion of the Andromeda Galaxy. M33 is approaching us at a relative velocity of 24 km/sec.

The results of the Hipparcos satellite have lead to a revision of the cosmic distance scale, as well as our distance to M33: The current value is about 3.0 million light-years. With this value, its major axis corresponds to about 50,000 light-years, however with faint outliers perhaps 60,000 light-years, roughly half as big as the Milky Way. The mass of the Triangulum Galaxy has been estimated between 10 and 40 billion solar masses.

For the observer, this galaxy can be seen with the naked eye under exceptionally good conditions; for most people, it is the most distant object visible to the naked eye. It is outstanding in good binoculars, but as its total brightness is distributed quite evenly over an area of nearly four times that covered by the full Moon, its surface brightness is extremely low. Therefore, it is difficult or impossible to view this galaxy in telescopes which do not allow low magnification - lowest is best for this object! M33 is also a most rewarding target for the astrophotographer, who can track down its spiral arms and brighter nebulae with inexpensive equipment. [But it does “shine” in more sensitive cameras/telescopes! -ed]