



*Astronomy News for Bluewater Stargazers*  
*Vol 9 No.12 December 2015*

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### Hypatia (c351)

*Greek astronomer and mathematician*

Hypatia was one of the first women to study mathematics and astronomy. She rose to become the head of the Platonist school in Alexandria, but her pioneering life ended in tragedy: she was murdered by zealots during a period of religious strife. Some consider her death the end of classical scholarship.



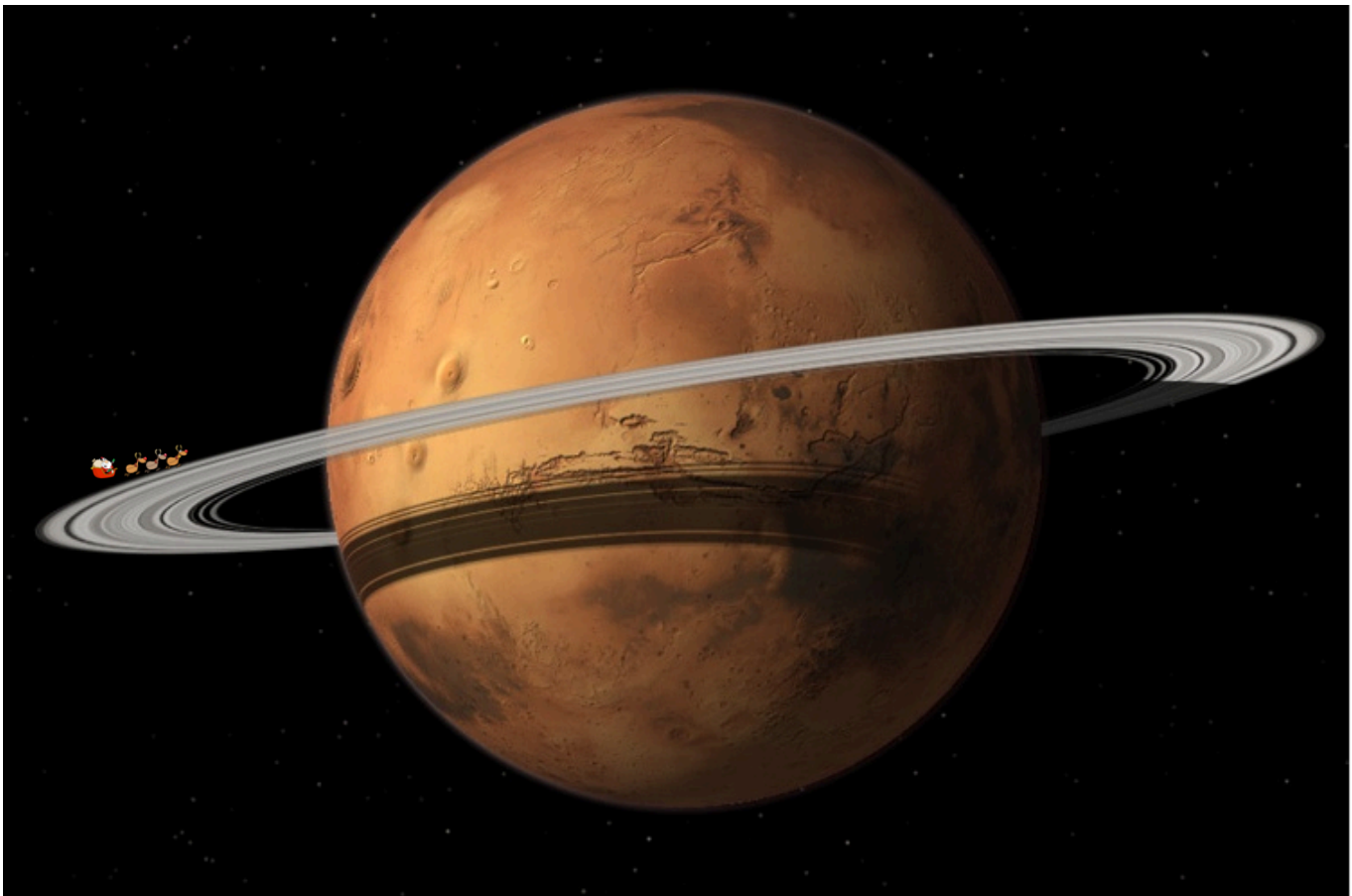
INTERNATIONAL  
YEAR OF LIGHT  
2015

Perimeter Institute in Waterloo, ON, has issued a series of posters honouring Women in Physics. SGN 2015 issues will feature women who have made major contributions to astronomy and physics.



### Ring Around Mars?

Two planetary geologists from Berkeley, postdoctoral fellow Benjamin Black and graduate student Tushar Mittal, in the University of California, Berkeley's Department of Earth and Planetary Science have been studying Phobos, Mar's inner moon. They have reached the conclusion that in 20 to 40 million years, it will probably break up and form a ring around the planet Mars. This is perhaps not a surprising result, since the four gas planets have rings formed this way and astronomers are getting a better understanding of how tidal forces from planets heat bodies up (Jupiter's moon Io is hot enough for volcanoes to erupt). If the bodies are relatively fragile, they can be broken up by these forces easily and the resulting fragments can form rings around the parent body. Our favourite ringed planet, Saturn, has an extensive ring system which is quite visible. It will be interesting if Mars gets one of these! Read all about it on page 5 of this issue.

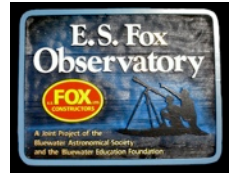


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### BAS & Astronomy Events for December

- Dec 2 Wed** BAS meeting at Grey Roots Museum Topic: Christmas recap 2015
- Dec 3 Thu** LQ
- Dec 7 Mon** **Comet Catalina** may be visible in the morning sky. Look about 4.5° left of Venus. Last Crescent Moon about 2° above Venus. Pretty dawn group!
- Dec 7 Mon** **Daytime Occultation of Venus** Disappearance on bright limb: 12:28 pm EST, duration 65 min. Reappearance at 1:32 pm EST. Moon is 3 days before New.
- Dec 11 Fri** NM
- Dec 12 Sat** BAS viewing@Fox. Watch for possible Geminids Sunday Dec 13 & Monday Dec 14 pm as well.
- Dec 14** **Geminid meteors** peak at **120/h** 1 pm daytime peak; on Dec 13 & Dec 15 the Moon is 10% so both nights should be good for meteor watching.
- Dec 18 Fri** FQ
- Dec 21 Mon** **Winter Solstice**
- Dec 25 Fri** FM **Happy Christmas Holiday!**



**Image Below:** The clouds on the evening of Nov 25 were not thick enough to hide the Moon or the bright star Aldebaran which was to be occulted 6 hours later. By the time of the event however, it was raining. This John H. image with a Canon 60Da camera on tripod with zoom lens at 170 mm, f/5, 1/12 s exp., ISO 3200 was taken at 11:01 pm EST Nov 25. This is a composite image with the 1/8000 s exposure of the full moon "pasted" in using Photoshop.



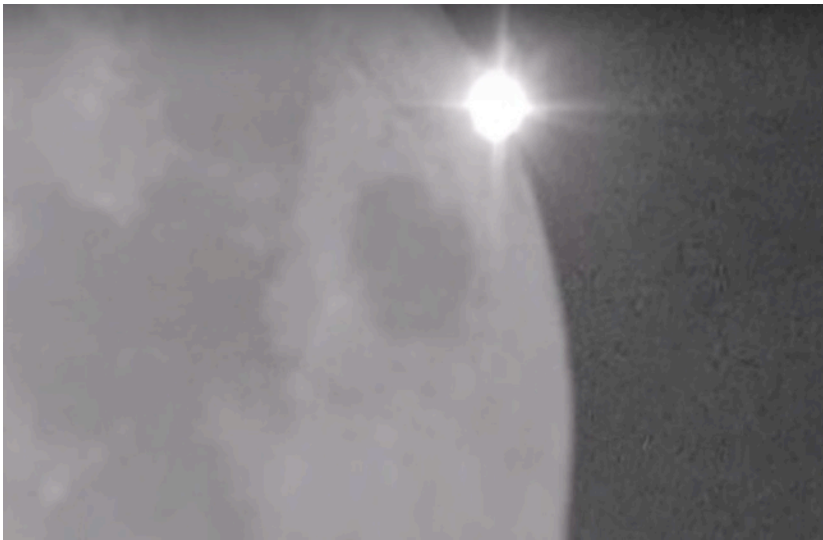
**Image Above:** Julian Delf captured the nice collection of planets and crescent Moon on the morning of Nov 7 from his home in Annan. Julian used a Sony SLT camera, 1.5 s exp. ISO 200, focal length of lens 200 mm at f/2.8. Nov 7 at 5:17 am EST. Venus and reddish Mars form a triangle with Zavijava in Virgo above the last crescent Moon. Jupiter is the brightest object near the top right corner of the image. Close inspection of the Jupiter image reveals three moons nearby.



## Mysterious Ashen Light of Venus Studied

David and Joan Dunham were at the right place at the right time with the right equipment to capture a reappearance of Venus from behind the dark limb of the moon Oct 8, 2015. The place was just north of Alice Springs, AU and Dunham, a long time occultation expert, was recording the event with a Watec 120N video camera through a 10-inch f/4 Newtonian. The image here is a screen shot from the video well after the brightest part of the disk of Venus has appeared.

The purpose of this observation was not to just record a video of the event but to determine if the "ashen light" of Venus could be confirmed. The ashen light is a faint glow (like earthshine on our Moon) reported first in 1643, and then intermittently by subsequent observers -a phenomenon that has not been confirmed by others.



The screen snap from the video above is after the bright crescent of Venus had mostly reappeared. Have a look at the video to watch the progress of the event in real time.

## Ashen Light on Venus: a history

Universe Today

by JENNY WINDER on APRIL 27, 2012

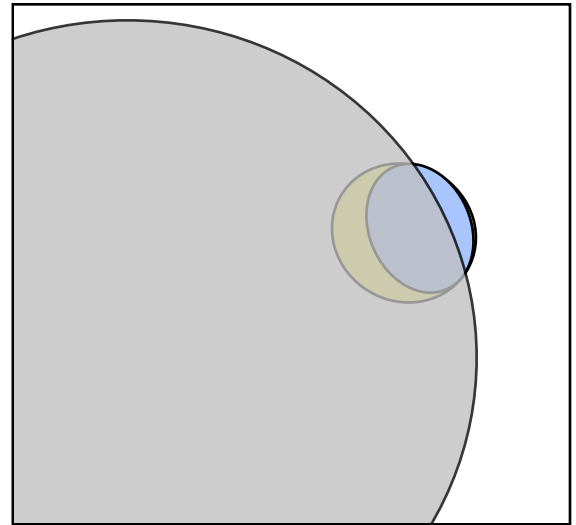
The phenomenon was first noted in 1643, by Italian astronomer Giovanni Battista Riccioli. Though many notable astronomers have reported sightings in the 369 years since, including Sir William Herschel and more recently, Sir Patrick Moore, many others have failed to see the effect, leading to claims that it is due to nothing more than observer error, an illusion, atmospheric effect or equipment malfunction. Things are not helped by the fact that nobody has managed to capture an image of Ashen Light, yet.

As the month progresses, Venus nears the Sun, ready for its transit on June 5th to 6th [now over -ed] and the planet's crescent phase will increase in diameter during the month, from 37 arcseconds to 56 arcseconds. The best option for amateur astronomers hoping to catch a fleeting glimpse is to use an occulting bar to block the bright crescent, making any glow present on the unlit portion of Venus, more visible.

There is much controversy and many theories as to the cause of Ashen Light. The Keck 1 telescope on Hawaii reported seeing a

The Dunhams had an opportunity to videotape ashen light if it existed on Oct 8, 2015 and travelled to Australia to do the experiment. The occultation of Venus on this occasion was such that Venus which was in crescent phase, would reappear on the dark limb of the Moon with the dark side of Venus showing first. The total re-emergence of Venus took about 40 seconds and for about half that time only the dark side of Venus would be protruding past the limb.

This was a wonderful opportunity to see ashen light with the bright side of Venus blocked out by the Moon. The video gives the answer clearly. Watch it here: <https://www.youtube.com/watch?v=r6TsRBQaMzI>

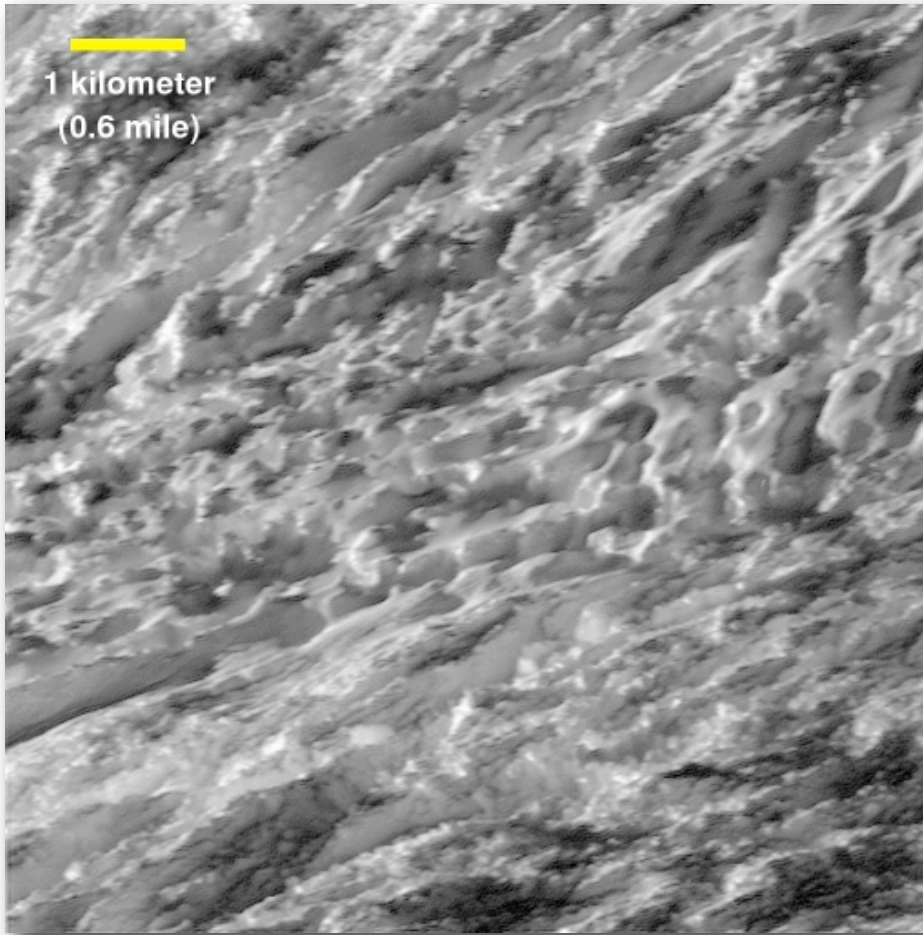


This diagram shows (with enlarged scale) the configuration of Venus as it emerged towards the upper right past the limb of the Moon. If any ashen light was going to appear, it would have been visible as a faint outline of the planet's disk against the black edge of space. Dunham's video does not show any ashen light on this occasion, thus indicating that it is even more elusive than thought or else that it does not exist.



subtle green glow and suggested it could be produced as ultraviolet light from the Sun splits molecules of carbon dioxide, known to be common in Venus' atmosphere, into carbon monoxide and oxygen, but the green light emitted as oxygen recombines to form O<sub>2</sub> is thought too faint to explain the effect. Another more likely theory is that multiple lightning strikes are illuminating Venus' skies. Though the Cassini spacecraft flew by Venus twice on its voyage to Saturn and failed to detect the high frequency radio noise we associate with thunderstorms on Earth, in 2007 Venus Express did detect low frequency 'whistler waves' that can also result from lightning. It could also be the Venusian equivalent of aurorae.

By far the most bizarre theory, and my personal favourite, was proposed in the early 19th century by the Bavarian astronomer [Franz von Gruithuisen](#), who suggested that Ashen Light was the result of fires lit to clear land for farming on Venus, or to celebrate the coronation of a new Venusian Emperor!



## Next Enceladus Flyby Dec 19

NASA's Cassini spacecraft successfully completed its close flyby of Saturn's moon Enceladus Oct 28, passing 49 km above the moon's south polar region at approximately 8:22 a.m. PDT (11:22 a.m. EDT). Mission controllers established two-way communication with the spacecraft and are receiving images (left and below). "Cassini's stunning images are providing us a quick look at Enceladus from this ultra-close flyby, but some of the most exciting science is yet to come," said Linda Spilker, the mission's project scientist at NASA's Jet Propulsion Laboratory in Pasadena, California.

Researchers will soon begin studying data from Cassini's gas analyzer and dust detector instruments, which directly sampled the moon's plume of gas and dust-sized icy particles during the flyby. Those analyses are likely to take several weeks, but should provide important insights about the composition of the global ocean beneath Enceladus' surface and any hydrothermal activity occurring on the ocean floor. The potential for such activity in this small ocean world has made Enceladus a prime target for future exploration in search of habitable environments in the solar system beyond Earth.

For more information about Cassini, visit: <http://www.nasa.gov/cassini>

## Dark Moon, Dramatic Plume

Below a darkened Enceladus, a plume of water ice is backlit in this view of one of Saturn's most dramatic moons.

Lit terrain seen here is on the leading hemisphere of Enceladus (504 kilometers across). North is up. The image was taken in visible light with the Cassini spacecraft narrow-angle camera on Feb. 20, 2012. The view was acquired at a distance of approximately 134,000 km from Enceladus and at a Sun-Enceladus-spacecraft, or phase, angle of 165 degrees. Image scale is 801 m/pixel.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the mission for NASA's Science Mission Directorate, Washington, D.C. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging operations center is based at the Space Science Institute in Boulder, Colo.

For more information about the Cassini-Huygens mission visit <http://www.nasa.gov/cassini> and <http://saturn.jpl.nasa.gov>.

Image credit: NASA/JPL-Caltech/Space Science Institute



## Mars to lose its largest moon, but gain a ring

By [Robert Sanders](#) | Nov 23, 2015 Berkeley News

Mars' largest moon, Phobos (NASA image right) is slowly falling toward the planet, but rather than smash into the surface, it likely will be shredded and the pieces strewn about the planet in a ring like the rings encircling Saturn, Jupiter, Uranus and Neptune. Though inevitable, the demise of Phobos is not imminent. It will probably happen in 20 to 40 million years, leaving a ring that will persist for anywhere from one million to 100 million years, according to two young earth scientists at the University of California, Berkeley.

In a paper appearing online this week in *Nature Geoscience*, UC Berkeley postdoctoral fellow Benjamin Black and graduate student Tushar Mittal estimate the cohesiveness of Phobos and conclude that it is insufficient to resist the tidal forces that will pull it apart when it gets closer to Mars.

Just as earth's moon pulls on our planet in different directions, raising tides in the oceans, for example, so too Mars tugs differently on different parts of Phobos. As Phobos gets closer to the planet, the tugs are enough to actually pull the moon apart, the scientists say. This is because Phobos is highly fractured, with lots of pores and rubble. Dismembering it is analogous to pulling apart a granola bar, Black said, scattering crumbs and chunks everywhere.

The resulting rubble from Phobos – rocks of various sizes and a lot of dust – would continue to orbit Mars and quickly distribute themselves around the planet in a ring.

While the largest chunks would eventually spiral into the planet and collide at a grazing angle to produce egg-shaped craters, the majority of the debris would circle the planet for millions of years until these pieces, too, drop onto the planet in 'moon' showers, like meteor showers. Only Mars' other moon, Deimos, would remain.

### Different moons, different fates

"While our moon is moving away from earth at a few cm/year, Phobos is moving toward Mars at the same rate, so it is almost inevitable that it will either crash into Mars or break apart," Black said. "One of our motivations for studying Phobos was as a test case to develop ideas of what processes a moon might undergo as it moves inward toward a planet."

Only one other moon in the solar system, Neptune's largest moon, Triton, is known to be moving closer to its planet.

Studying such moons is relevant to conditions in our early solar system, Mittal said, when it's likely there were many more moons around the planets that have since disintegrated into rings – the suspected origins of the rings of the outer planets. Some studies estimate that during planet formation, 20-30 percent of planets acquire moons moving inward and destined for destruction, though they would have long since disappeared. Some of Mars' several thousand elliptical craters may even have been formed by remnants of such moonlets crashing to the surface at a grazing angle.

### When tidal stresses overcome rock strength

To estimate the strength of Phobos, Black and Mittal looked at data from similarly fractured rocks on Earth and from meteorites that struck Earth and have a density and composition similar to Phobos.



They also constrained the strength of Phobos based on results from simulations of the 10 km diameter Stickney impact crater, which formed in the past when a rock rammed into Phobos without quite smashing the moon apart. That crater spans about one-sixth the circumference of Phobos and looks as if someone took a scoop out of the moon. (NASA image below).

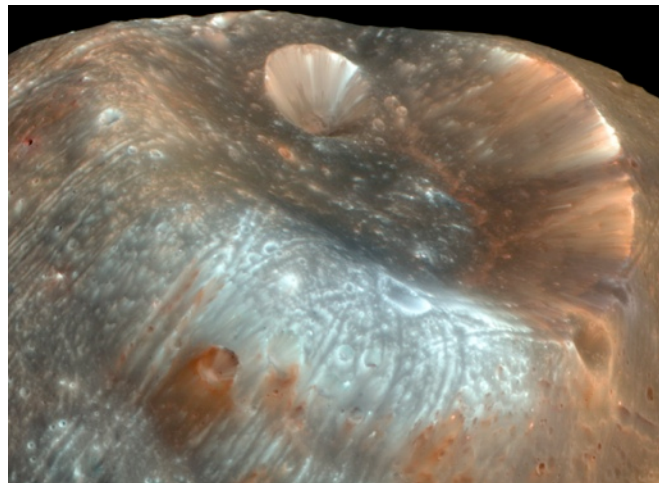
Once they determined when and how they expected tidal forces to tear Phobos apart, Mittal modeled the evolution of the ring, adapting techniques developed to understand Saturn's rings.

"If the moon broke apart at 1.2 Mars radii, about 680 km above the surface, it would form a really narrow ring comparable in density to that of one of Saturn's most massive rings," Mittal said. "Over time it would spread out and get wider, reaching the top of the Martian atmosphere in a few million years, when it would start losing material because stuff would keep raining down on Mars."

If the moon breaks up farther from Mars, the ring could persist for 100 million years before raining down on Mars, they found.

Mittal said it's not clear whether the dust and debris rings would be visible from earth, since dust does not reflect much sunlight, whereas ice in the rings of the outer planets makes them easily visible. But Mars' ring may reflect enough light to make Mars slightly brighter as seen from Earth, he said, and through a telescope the shadows of the rings might also be visible on the surface.

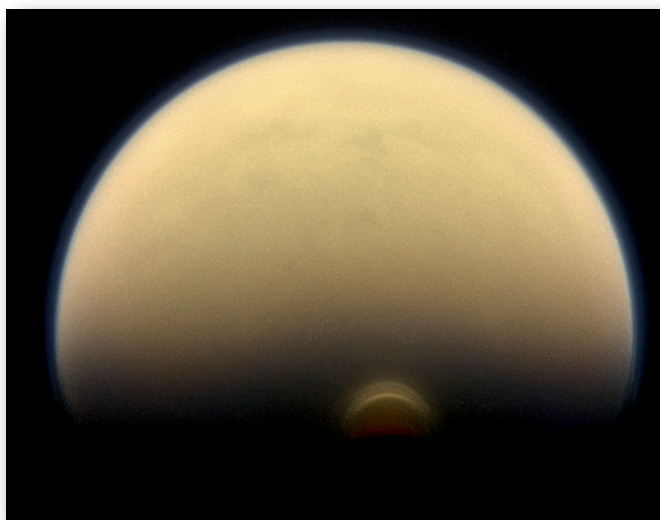
"Standing on the surface of Mars a few tens of millions of years from now, it would be pretty spectacular to watch," Black said.



### RELATED INFORMATION

- [The demise of Phobos and development of a Martian ring system](#) (*Nature Geoscience*)

New observations made near the south pole of Titan by NASA's Cassini spacecraft add to the evidence that winter comes in like a lion on this moon of Saturn. Scientists have detected a monstrous new cloud of frozen compounds in the moon's low-to mid-stratosphere – a stable atmospheric region above the troposphere, or active weather layer. Cassini's camera had already imaged an impressive cloud hovering over Titan's south pole at an altitude of about 300 km. However, that cloud, first seen in 2012, turned out to be just the tip of the iceberg. A much more massive ice cloud system has now been found lower in the stratosphere, peaking at an altitude of about 200 km.



As winter sets in at Titan's south pole, a cloud system called the south polar vortex (small, bright "button") has been forming, as seen in this 2013 image. **Credits: NASA/JPL-Caltech/Space Science Institute**

The new cloud was found in the lower stratosphere, where temperatures are even colder. The ice particles are made up of a variety of compounds containing hydrogen, carbon and nitrogen.

Anderson and her colleagues had found the same signature in CIRS data from the N pole, but the signal was much weaker. The very strong signature of the south polar cloud

supports the idea that winter's onset is much harsher than its end.

The new cloud was detected by Cassini's infrared instrument – the Composite Infrared Spectrometer, or CIRS – which obtains profiles of the atmosphere at invisible thermal wavelengths. The cloud has a low density, similar to Earth's fog but likely flat on top. For the past few years, Cassini has been catching glimpses of the transition from fall to winter at Titan's south pole – the first time any spacecraft has seen the onset of a Titan winter. Because each Titan season lasts about 7-1/2 years on Earth's calendar, the south pole will still be enveloped in winter when the Cassini mission ends in 2017. "When we looked at the infrared data, this ice cloud stood out like nothing we've ever seen before," said Carrie Anderson of NASA's Goddard Space Flight Center in Greenbelt, Maryland. "It practically smacked us in the face."

The ice clouds at Titan's pole don't form in the same way as Earth's familiar rain clouds. For rain clouds, water evaporates from the surface and encounters cooler temperatures as it rises through the troposphere. Clouds form when the water vapor reaches an altitude where the combination of temperature and air pressure is right for condensation. The methane clouds in Titan's troposphere form in a similar way.

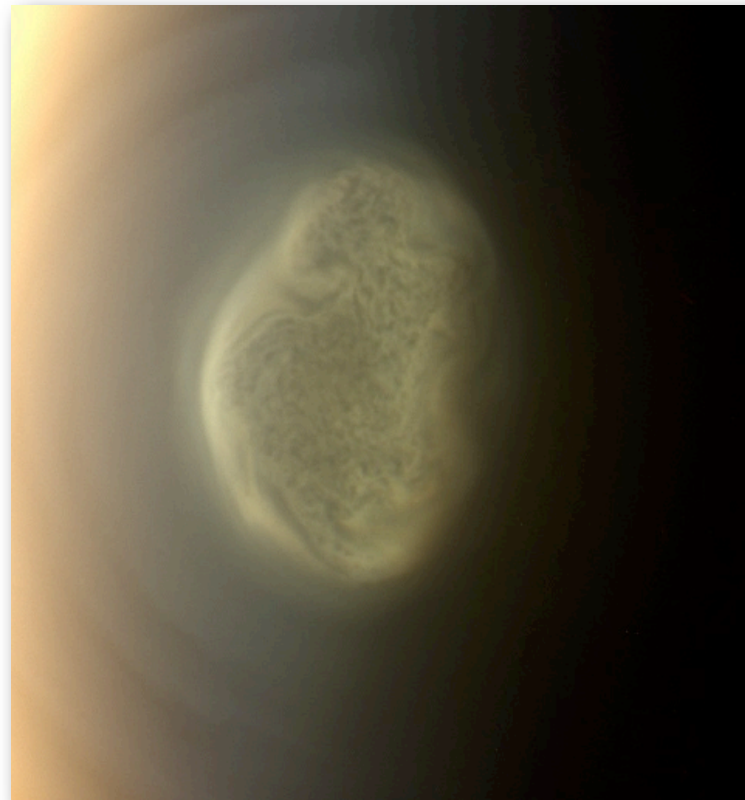
However, Titan's polar clouds form higher in the atmosphere by a different process. Circulation in the atmosphere transports gases from the pole in the warm hemisphere to the pole in the cold hemisphere. At the cold pole, the warm air sinks, almost like water draining out of a bathtub, in a process known as subsidence. The sinking gases – a mixture of smog-like hydrocarbons and nitrogen-bearing chemicals called nitriles – encounter colder and colder temperatures on the way down. Different gases will condense at different temperatures, resulting in a layering of clouds over a range of altitudes.

Cassini arrived at Saturn in 2004 – mid-winter at Titan's north pole. As the north pole has been transitioning into springtime, the ice clouds there have been disappearing. Meanwhile, new clouds have been forming at the south pole. The build-up of these southern clouds indicates that the direction of Titan's global circulation is changing.

The size, altitude and composition of the polar ice clouds help scientists understand the nature and severity of Titan's winter. From the ice cloud seen earlier, scientists determined that temperatures at the south pole must get down to at least -150 C.

"The opportunity to see the early stages of winter on Titan is very exciting," said Robert Samuelson, a Goddard researcher working with Anderson. "Everything we are finding at the south pole tells us that the onset of southern winter is much more severe than the late stages of Titan's northern winter." Anderson is presenting the findings at the annual Meeting of the Division of Planetary Sciences of the American Astronomical Society at National Harbor, Maryland, on Nov. 11. For more information about Cassini, visit:

<http://www.nasa.gov/cassini>



This 2012 close-up offers an early snapshot of the changes taking place at Titan's south pole. Cassini's camera spotted this impressive cloud hovering at an altitude of about 186 miles (300 kilometers). Cassini's thermal infrared instrument has now detected a massive ice cloud below it.

**Credits: NASA/JPL-Caltech/Space Science Institute**

## Earth Might Have Hairy Dark Matter

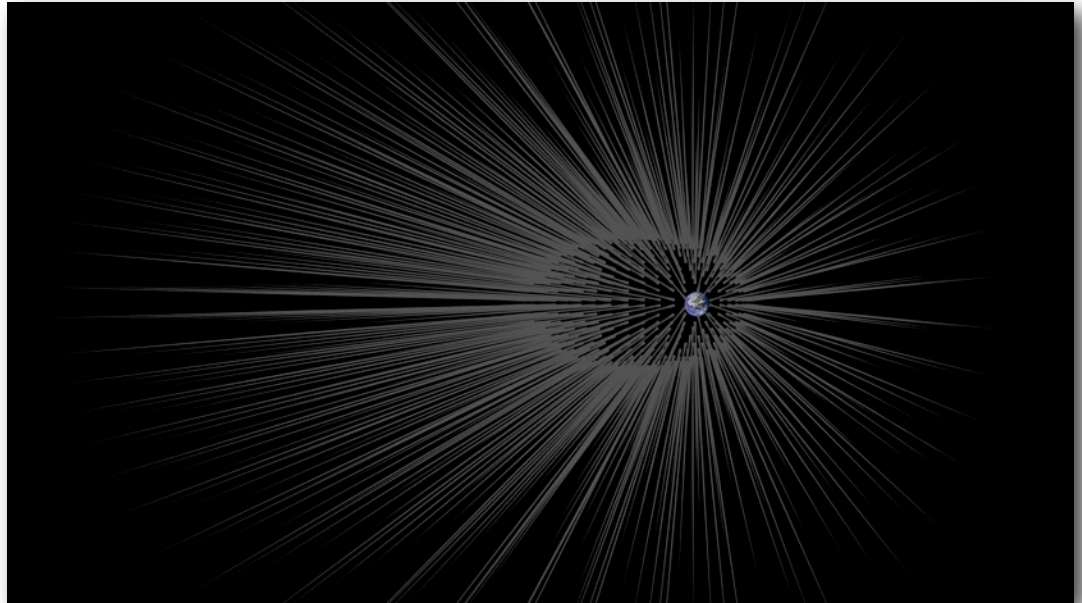
The solar system might be a lot hairier than we thought.

A new study publishing this week in the *Astrophysical Journal* by Gary Prézeau of NASA's Jet Propulsion Laboratory, Pasadena, California, proposes the existence of long filaments of dark matter, or "hairs." Dark matter is an invisible, mysterious substance that makes up about 27 percent of all matter and energy in the universe. The regular matter, which makes up everything we can see around us, is only 5 percent of the universe. The rest is dark energy, a strange phenomenon associated with the acceleration of our expanding universe. Neither dark matter nor dark energy has ever been directly detected, although many experiments are trying to unlock the mysteries of dark matter, whether from deep underground or in space.

Based on many observations of its gravitational pull in action, scientists are certain that dark matter exists, and have measured how much of it there is in the universe to an accuracy of better than one percent. The leading theory is that dark matter is "cold," meaning it doesn't move around much, and it is "dark" insofar as it doesn't produce or interact with light. Galaxies, which contain stars made of ordinary matter, form because of fluctuations in the density of dark matter. Gravity acts as the glue that holds both the ordinary and dark matter together in galaxies.

According to calculations done in the 1990s and simulations performed in the last decade, dark matter forms "fine-grained streams" of particles that move at the same velocity and orbit galaxies such as ours. "A stream can be much larger than the solar system itself, and there are many different streams crisscrossing our galactic neighborhood," Prézeau said. Prézeau likens the formation of fine-grained streams of dark matter to mixing chocolate and vanilla ice cream. Swirl a scoop of each together a few times and you get a mixed pattern, but you can still see the individual colors. "When gravity interacts with the cold dark matter gas during galaxy formation, all particles within a stream continue traveling at the same velocity," Prézeau said.

But what happens when one of these streams approaches a planet such as



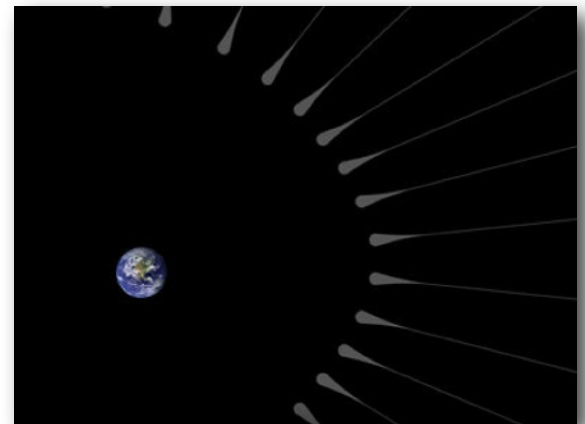
Earth? Prézeau used computer simulations to find out.

His analysis finds that when a dark matter stream goes through a planet, the stream particles focus into an ultra-dense filament, or "hair," of dark matter. In fact, there should be many such hairs sprouting from Earth. A stream of ordinary matter would not go through Earth and out the other side. But from the point of view of dark matter, Earth is no obstacle. According to Prézeau's simulations, Earth's gravity would focus and bend the stream of dark matter particles into a narrow, dense hair. Hairs emerging from planets have both "roots," the densest concentration of dark matter particles in the hair, and "tips," where the hair ends. When particles of a dark matter stream pass through Earth's core, they focus at the "root" of a hair, where the density of the particles is about a billion times more than average. The root of such a hair should be around 600,000 miles (1 million kilometers) away from the surface, or twice as far as the moon. The stream particles that graze Earth's surface will form the tip of the hair, about twice as far from Earth as the hair's root. "If we could pinpoint the location of the root of these hairs, we could potentially send a probe there and get a bonanza of data about dark matter," Prézeau said.

A stream passing through Jupiter's core would produce even denser roots: almost 1 trillion times denser than the original stream, according to Prézeau's simulations. "Dark matter has eluded all attempts at direct detection for over 30 years. The roots of dark matter hairs

would be an attractive place to look, given how dense they are thought to be," said Charles Lawrence, chief scientist for JPL's astronomy, physics and technology directorate.

Another fascinating finding from these computer simulations is that the changes in density found inside our planet - from



the inner core, to the outer core, to the mantle to the crust - would be reflected in the hairs. The hairs would have "kinks" in them that correspond to the transitions between the different layers of Earth. Theoretically, if it were possible to obtain this information, scientists could use hairs of cold dark matter to map out the layers of any planetary body, and even infer the depths of oceans on icy moons. Further study is needed to support these findings and unlock the mysteries of the nature of dark matter.

The California Institute of Technology manages JPL for NASA.

**Credit:** NASA News Release

## A Christmas Gift Worth Buying!

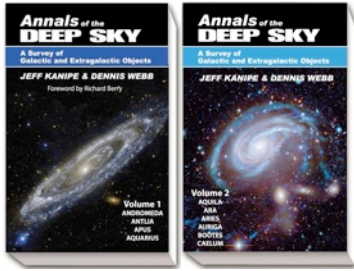
*“Our goal is to provide, in one place, a broad synthesis of astronomical knowledge that cannot be gleaned except by sifting through hundreds of other sources!”*

Jeff Kanipe & Dennis Webb

### Annals of the Deep Sky Vol. 1 & 2

by Jeff Kanipe and Dennis Webb

published by Willmann-Bell, 2015



On Friday, November 20th, an early Christmas present came for me from Willmann-Bell. It was the first two volumes of a new observer’s guide, written by Jeff Kanipe, an astrophysics-cosmologist journalist, and Dennis Webb, a retired NASA engineer and astronomy-artist.

I said to my wife, Paula, after I had perused the first Volume, that this wonderful series will add a new and enriching dimension to my observing experience of the deep sky. Like the 3 Volumes of Burnham’s Celestial Handbook before it, this series belongs in every astronomer’s library. I learned about it after I read a review written by Sky & Telescope’s senior editor, Alan McRobert, which was published in the recent December, 2015 issue. The goal of the authors is to present in-depth profiles of the notable stars and deep sky objects, within each of the 88 constellations, organized alphabetically. Volume 1 is 358 pages (6 x 9 inch), and contains 158 illustrations, maps, and photos, and covers the constellations of Andromeda, Antlia, Apus, and Aquarius. Volume 2 is 344 pages and contains 244 illustrations, maps, and photos which cover the constellations Aquila, Ara, Aries, Auriga, Bootes, and Caelum. Volume 3 is due out in January and, during the next year or so, other Volumes will be published that collectively will cover all the 88 constellations from Andromeda to Vulpecula.

There are many things I really liked about the first two volumes of “Annals of the Deep Sky” series. Space permits me only to mention just 3 of them.

Firstly, astronomers experience astronomy with both the mind and the eye and Kanipe and Webb have captured this interplay beautifully. They have focused on providing an in-depth and up-to-date scientific background for each notable object within a constellation. This fascinating background information is difficult to easily obtain without consulting many sources. In many cases, the authors recount some of the fascinating historical stories of the famous astronomers who studied those deep sky objects and stars.

To mention just one example, consider the constellation Andromeda, which is covered in Volume 1. Notable stars and deep-sky objects of this constellation are allotted 92 pages of the 358 pages of this volume. I turned randomly to page 154 where a fascinating story is told about the 19<sup>th</sup> century woman astronomer, Williamina Flemming. She was employed by the director of the Harvard Observatory, Edward Pickering, in a project to classify stars based on their spectra.

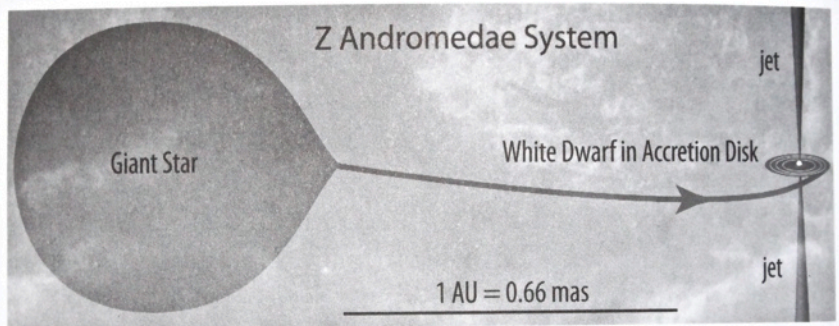
She started out her life in Boston, was abandoned by her husband,

pregnant and ended up working as a maid. She eventually came to work for Edward Pickering at the Harvard College Observatory, ended up cataloging more than 10,000 stars, and provided the first photographic classification of stellar spectra for the Henry Draper catalogue.

It was during this work that she discovered a variable star in Andromeda, designated as Z Andromeda, which displayed a very peculiar spectrum. It had the spectral characteristics suggesting a physical interaction between two closely spaced stars. The spectrum

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### ANNALS OF THE DEEP SKY



**Figure 19: Artist’s depiction of Z Andromedae as a symbiotic pair of stars.** The white dwarf pulls material off the giant star, forming an accretion disk around itself and producing jets perpendicular to the disk. The two stars are enveloped in a nebulosity thought to be material thrown off by the jets.

was so unusual that during her career she compiled a separate list of variable stars displaying that same peculiar spectrum. Kanipe and Webb devote 7 pages to tell both the story of Williamina Flemming and the science behind Z Andromeda. They even provide finder maps, with comparison star magnitudes, so you can observe this star for yourself, and follow its fascinating variations in brightness.

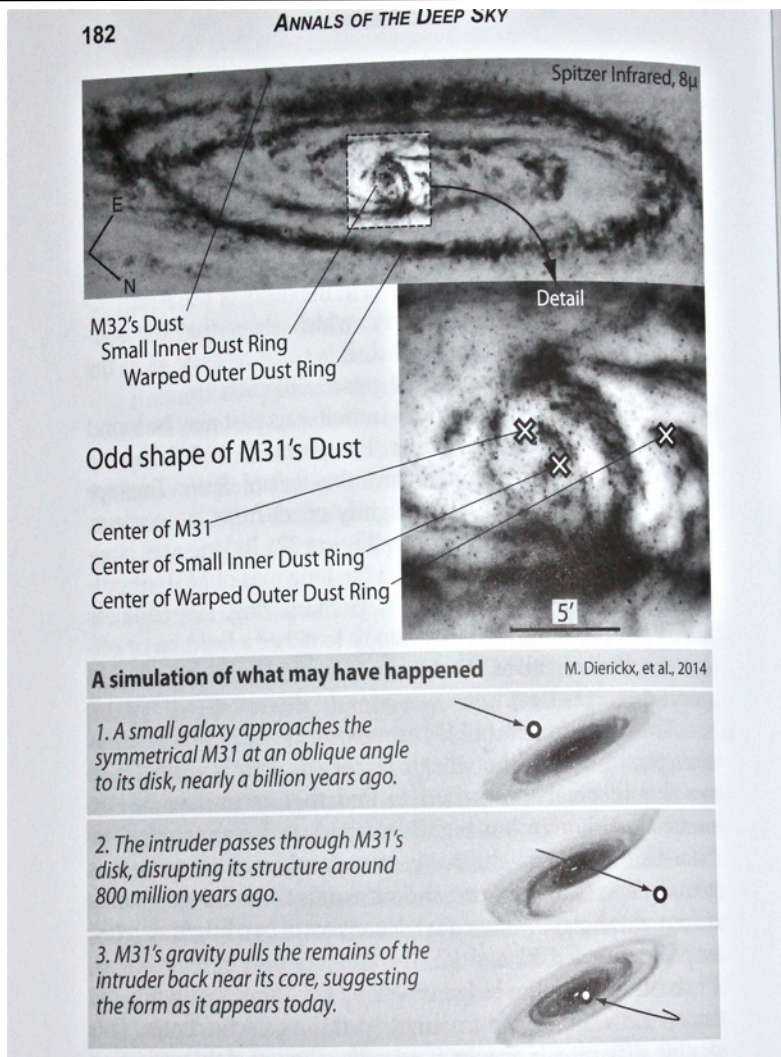
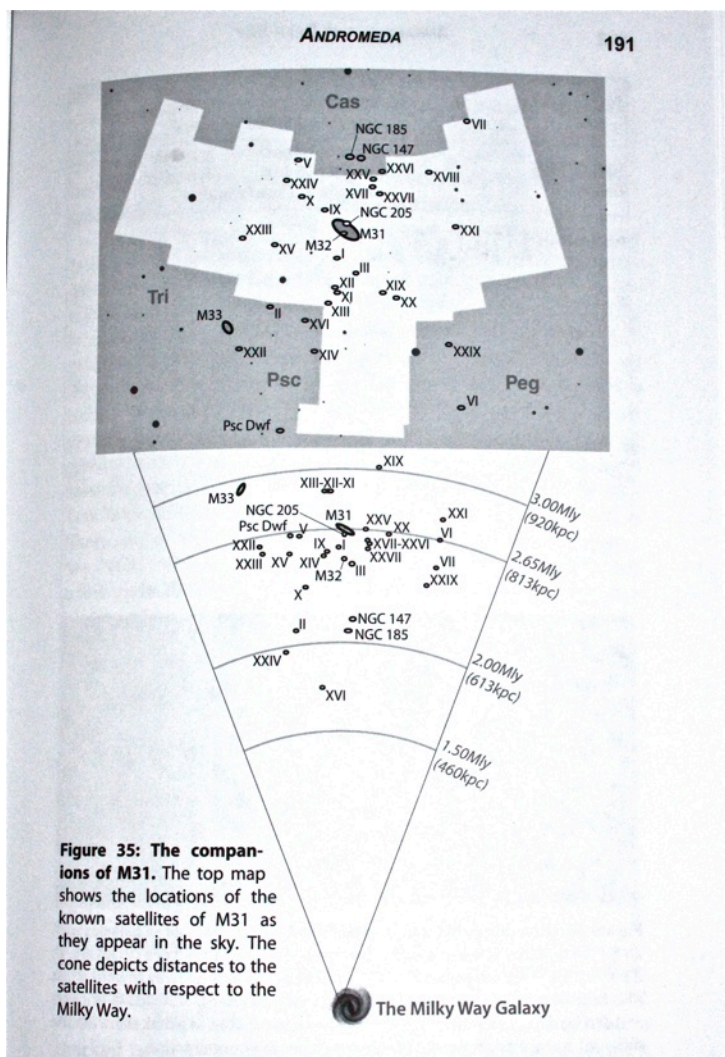
Astronomers now consider Z Andromeda to be a close interacting binary system containing a white dwarf, a red giant, and a hot accretion disk. They belong to a class of variable stars called symbiotic stars. Fascinating celestial beasts! Kanipe and Webb finder chart plus a comparison field stars allow you to locate Z Andromeda and follow its fluctuations yourself.

Secondly, the authors have created an innovative illustrative technique which they call “The Third Dimension”. This visual technique employs a cone-shaped diagram that shows the 3-D location of deep sky objects as a function of distance from the observer. To provide a familiar frame of reference they provide the

standard astronomy map's 2-D depiction of that area of the sky.

To show you how they do this I have chosen their depiction of an observer's 3-D view in the direction of M31, the Andromeda Galaxy. See image below.

I knew that M31 had many companion galaxies but I never had a table listing 37 of them, complete with their coordinates, galactic classification, sizes, position angles, and distances. On page 190, Kanipe and Webb present such a table, and on the facing page, p. 191, they present their innovative 3-D view of this star field. Notice that the 3-D distance dimension is given on the right of the diagrammatic cone. I will never look at M31 the same way again .. especially in my TAK FSQ 106 wide field refractor.



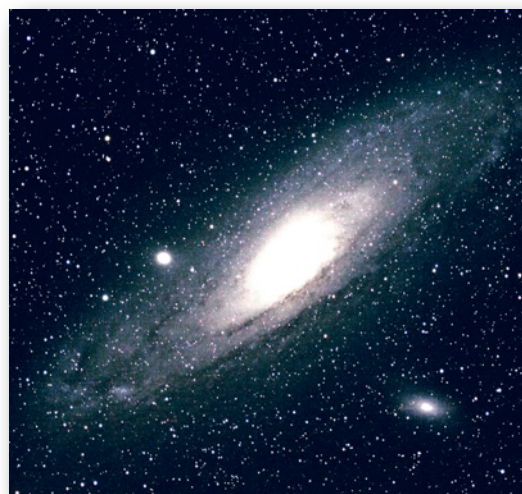
Alan McRobert, in his own review of this series, calls "Annals of the Deep Sky" the "Next Great Handbook"; and I heartily agree. My own review, limited by space, has touched on just a few of the wonderful astronomical topics covered within each Volume.

This series was in the planning stages for at least 7 years and is now being published by Willmann-Bell. By the time all 88 constellations have been covered, the series will have produced about 10 Volumes, and Volume #3 (Camelopardalis through Canis Minor) is due out in January. Currently each Volume sells for US \$24.95 and in my mind it is well worth the cost! My own involvement in the hobby, which is extensive now, will be enriched considerably by this series. I highly recommend it ... what a wonderful Christmas present!

Thirdly, the authors provide many examples of the dynamic changes that have affected the evolution of Deep Sky Objects. Readers might know that M31 has odd shaped dust rings which highly suggests that, sometime in the past, its companion galaxy, M32, passed through M31's core to create this structure.

Page 182 (partly shown above) from Volume #1 of Annals of the Deep Sky shows what might have happened. The top image is a reproduction of the NASA's Spitzer Infrared image of the Dust Rings of M31, with an enlargement of the central sections of the dust rings. At the bottom of the images the authors provide an explanation of how the passage of M32 through M31 could have disrupted its symmetrical central regions.

During the International Year of Astronomy, Doug contributed this image of M31, the Andromeda Galaxy which travelled to various display locations around Bruce and Grey counties. A classic image.





The Nov 14 BAS “Dark-of-the-Moon” viewing session was high-lighted by a wonderful Taurid fireball which was eye-witnessed by two of us and captured on camera by yours truly. I have no trouble stating that this is the best meteor image I have in my collection and matches the best images I have ever recorded. (A Perseid in 2012 is still my favourite as it left a persistent trail for several minutes).

This fireball was recorded by the Fox meteor camera as well as the one near Kincardine (c/o Paul Z.). Peter Brown of the Meteor Group at UWO provided the data for this fireball from both stations and supplied it within a few hours of the event. It is amazing what we know about the event so quickly.

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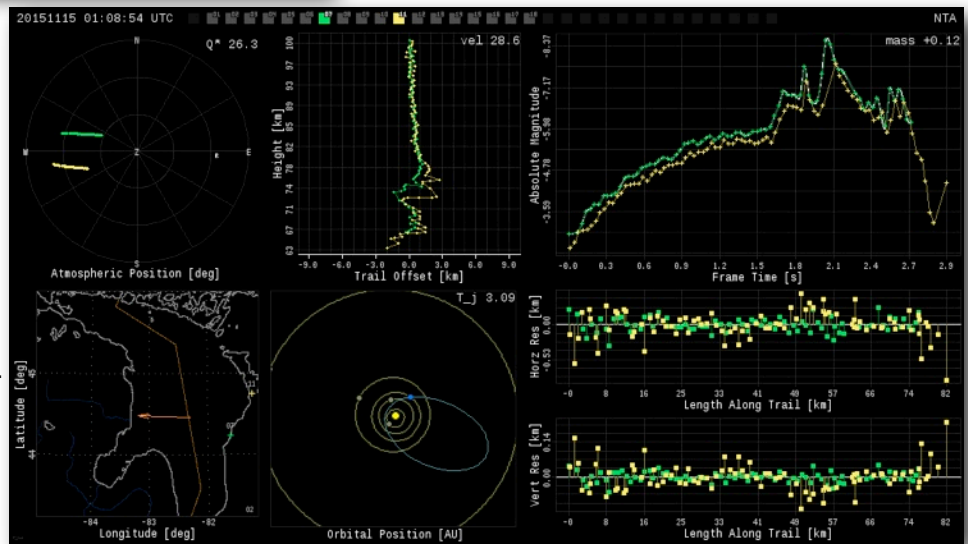
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**Fireball Details:**  
**Time of Event:** 8:08:54 pm Nov 14, 2015  
**Maximum Magnitude:** -8.4 at peak, main trail about -6  
**Length of track:** 22 degrees + faint pre-trail, perhaps 4°  
**Entry altitude:** 100 km  
**Entry location:** mid Lake Huron over USA/Canada border about latitude of Port Elgin, ON  
**Entry Velocity:** 26.8 km/s (typical N.Taurid velocity)  
**Burnout altitude:** 63 km  
**Burnout location:** over Lk Huron approx. 10 km E of Tawas City, MI  
**Direction of motion:** azimuth very close to due West  
**Origin:** probably asteroid belt, orbit perihelion about 3 AU.

Enlargement left shows the track as it arced downwards starting under Sagitta, crossing Aquila and ending up in the NE corner of Ophiuchus. There is a faint pre-trail extension at the start of the track that may add another 3 to 4° to the length and a few 10ths of a second to the duration. The last little burst at the end came at 2.9 s so the total duration was 3 s or a bit longer.

The Nov 14 viewing night started off being hazy with clouds covering much of the sky to the south and a layer about 10\* up around the entire horizon. Only the view straight up showed a relatively clear sky. Frank W. tried some imaging but the haze added fuzz around objects that shouldn't be fuzzy so he and the rest of the group (Brett T., Lorraine R., and I) decided to pack it in around 9:30 pm. However, during the 45 minutes or so we chatted in the warm room, the skies cleared up and by the time we left about 10:30 pm had cleared pretty much from horizon to horizon. Typical Nov weather.

Peter Brown of the UWO Meteor Physics Group kindly provided the data graphs at right from which the information for this article was derived. Any errors in interpretation are my own.



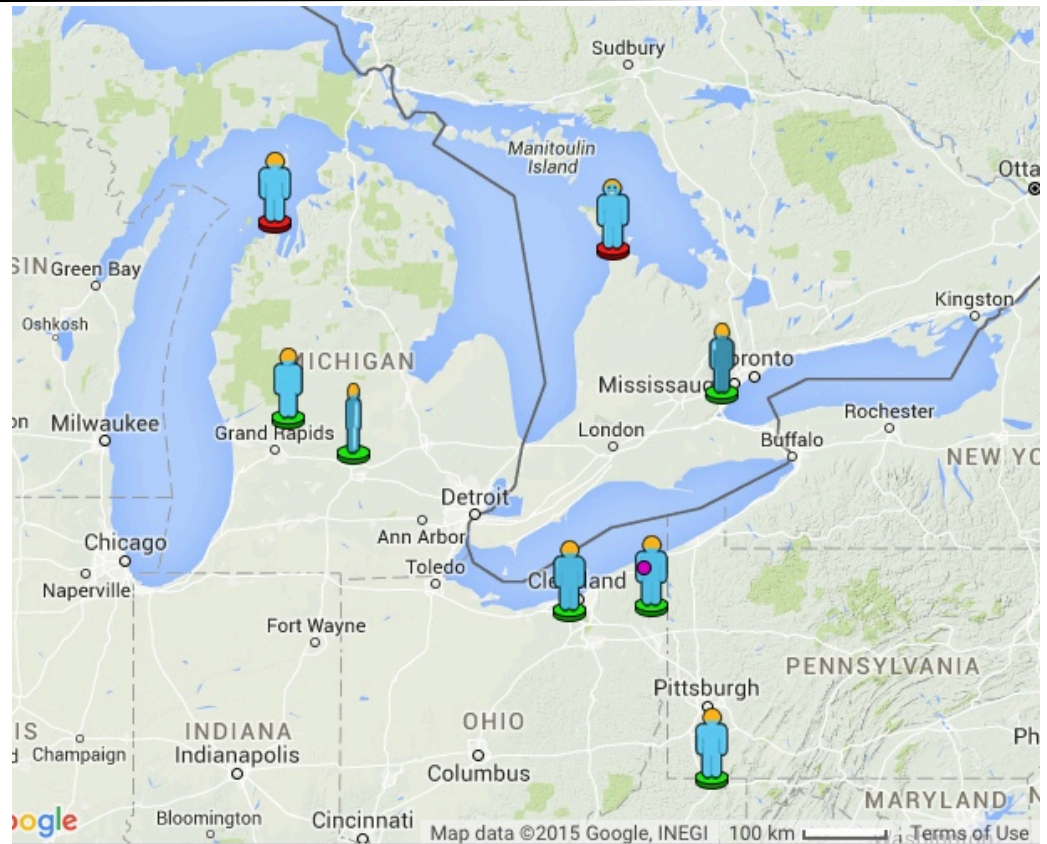
## Nine Observations of Nov 14 Fireball

The American Meteor Society plotted the locations of the observers that sent in reports but only showed one at the Fox Observatory. The Kincardine camera (Paul Z.) was omitted for no apparent reason. Including Kincardine puts the number of observations at 9 with the two highest quality ones being the two cameras of UWO's network followed by the image taken by the DSLR on the previous page. None of the US reports had images of this fireball.

Both the American Meteor Society (AMS) and the International Meteor Organization (IMO) have fireball reporting forms at their respective websites if you see something similar. You are encouraged to send in reports.

AMS here: <http://www.amsmeteors.org/>

IMO here: <http://www.imo.net/>



The camera caught a faint "pre-trail" at the start of the fireball which adds about 4" to the length of the trail or a total of 26". This fireball was unusual in that the more visible trail seemed to start rather abruptly with no gradual increase in brightness as is more normal.

Note that the trail runs parallel to Sagitta and that the Coathanger Cluster, also known as Brocchi's Cluster or Collinder 399, is easy to pick out in both images. Limiting magnitude of both images is about 7.6 or so. Both were taken with Canon 60Da, with a 10 mm Sigma lens at f/2.8, ISO 3200, 30 second exposure.

The very next frame caught the persistent trail left by the fireball and shows how quickly they get twisted by the upper altitude winds. Oddly enough the brighter portion of the trail beyond Altair did not leave a persistent train even where it crossed the darker background of one of the dark clouds in this region of the Milky Way.

Images were cropped and processed in Photoshop to reduce noise and bring out detail.



# Comet Catalina Grows Two Tails

Comet C/2013 US10 (Catalina) has finally been seen and caught on camera by several photographers. Images show the standard twin tails of a typical comet after perihelion. Comet Catalina will get higher and higher in the pre-dawn sky and will become brighter and easier to see. Current magnitude estimates ranges between 7.6 to 6 (the limit of viewing with the unaided eye). The brightness is expected to increase although original estimates had it getting brighter than it actually has.

Most comets do show two tails: a dust tail and a plasma tail of ionized gas. These tails point away from the sun and are usually not related to the direction of travel. Instead, the tails are related to how the gases and dust react to the solar wind blowing, sometimes gustily, outwards from the Sun.

Comet Catalina reached perihelion (closest to the Sun) on Nov 15, so it is still difficult to observe because of its nearness to the horizon just before sunrise. The hope is that the comet will brighten enough to become visible with the naked eye from a dark site, by the end of November, as it moves higher in the predawn sky. By the end of November, Comet Catalina might be visible in binos at magn. 5 or 6.

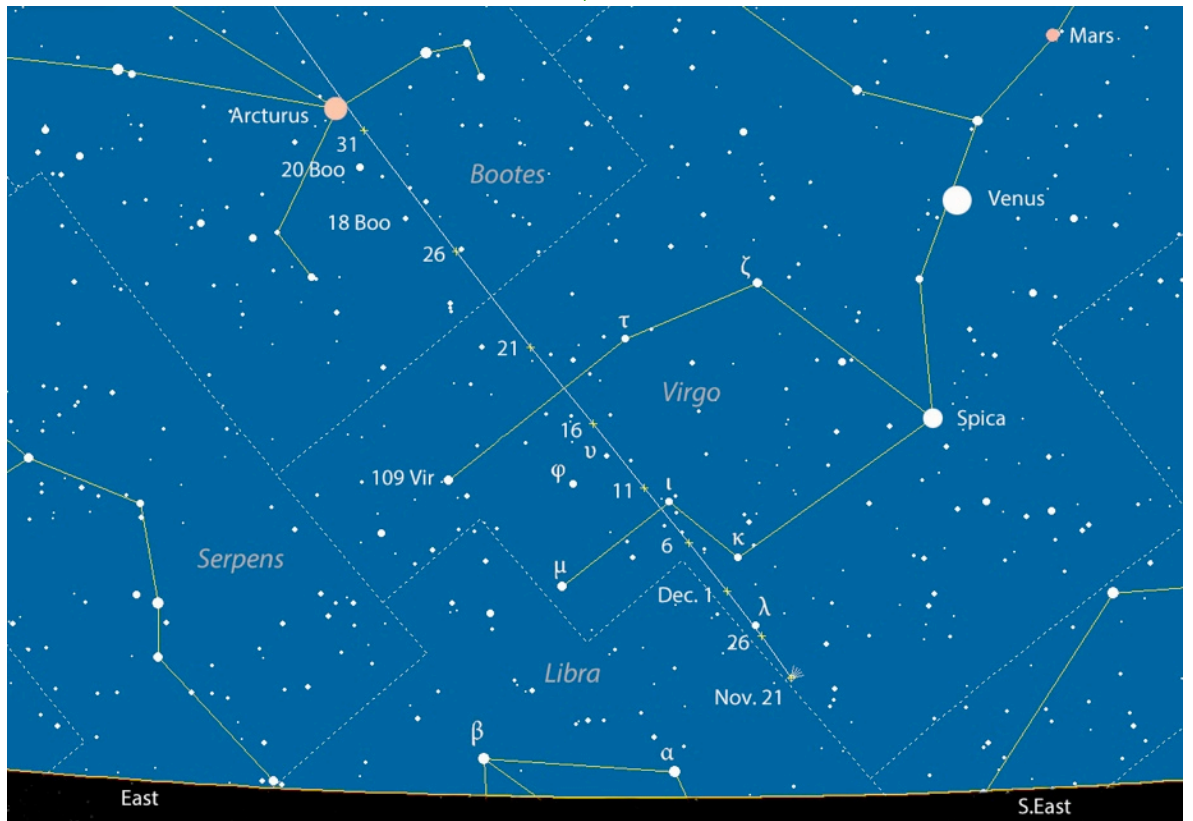
But make sure to go out Dec 7. It'll be sitting 4 degrees or so to the left of Venus with the last crescent Moon nearby as well as Mars above the Moon. This will be a very photogenic grouping!

From then on it just gets higher and higher and on Jan 1, 2016 is a scant 30 minutes of arc from Arcturus! Then it continues towards Polaris but first has to pass the tail star of the Big Dipper, Alkaid. On Jan 15, the comet is slipping past Alkaid, or η-UMa (eta) with about 1.5° of space between them. It misses Polaris by about 8.5° on Jan 31 and by then it will have lost in brightness as it starts its long trek back out beyond the Oort Cloud. This comet will only be making one trip to the inner solar system so catch it this time around.

Comet Catalina (after the Catalina Sky Survey operated by the University of Arizona Lunar and Planet Laboratory) was discovered over 2 years ago, on Halloween, 2013 at a distance of over a billion km in the Oort Cloud. Its orbit does not appear to be one that brings it back to the sun anytime



Stack of 12x30 sec images of Comet Catalina C/2013 US10 taken with a 12 inch f/2.6 SCT and 765x510 CCD. FOV is about 20x30 arc min. Gas tail (to the right) shows three streamers and dust tail (lower left) goes off frame. Credit: Image by Dr. D. T. Durig Cordell-Lorenz Observatory, Sewanee, TN



Star chart for Comet Catalina C/2013 US10 shows Venus on Nov 21 the date of the start of the track for Catalina. On Dec 7, Venus and Catalina will be beside each other about 4 degrees apart near the star labelled κ (kappa-Virginis). The Moon, 3 days before new, will be a few degrees to the right of Venus that night as well. Credit: Chris Marriott SkyMaps.

soon. In fact, after a close pass around the Sun on Nov 15, it will continue on an ejection trajectory (escaping the gravitational pull of the Sun) and will end up wandering in interstellar space.

# Taurus (Tau)

α-Tauri - Aldebaran    γ-Tauri - Hyadum Primus  
 η-Tauri - Alcyone    β-Tauri - Nath    ε-Tauri - Ain

Taurus is a zodiacal constellation and is one of the oldest of the star groups, being recognized by the ancient Babylonians, Persians, Egyptians and Greeks. A V-shaped group of stars, the well-known Hyades Cluster, forms the bull's face; Aldebaran, a great red star, is the bull's right eye; it ranks 13th in brightness, having a magnitude of 1.0. Nath, at the tip of the bull's left horn, would seem to properly belong to the constellation Auriga; it is shared by both constellations. The best known feature of Taurus is the beautiful cluster of stars known as the Pleiades, M45, a compact group located in the bull's shoulder. Six of these stars are visible to the naked eye; an observer with keen eyesight can sometimes see seven. The Pleiades are a beautiful sight in fieldglasses, 30 to 40 stars being visible. This cluster is most impressive at low power. The Pleiades are named (see chart) after the daughters of Atlas, the giant who supported the world. All the stars named on the chart in this group are not visible to the naked eye, but are easily observable in binoculars. θ1 and θ2 Tauri are a pretty pair visible to the naked eye and an attractive pair in fieldglasses.

## DOUBLE STARS

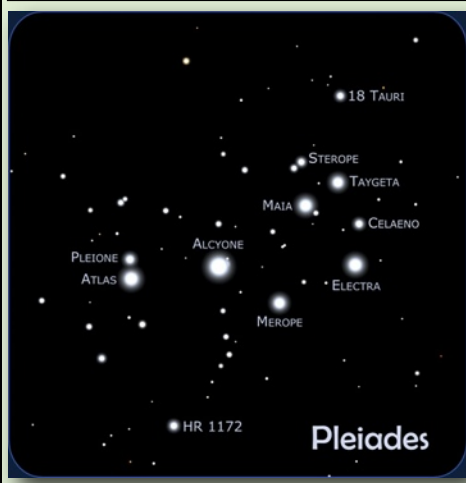
Mag.	Sep (s)	Location	Remarks
α	1.0-11.2	31 043316	Gold-Pale Red.
τ	5.0-8.5	63 043923	White-Blue.
θ	5.1-8.5	52 041727	Red-Blue.
χ	5.4-7.5	19 041925	
30	5.0-10.0	9 034611	Green-Purple.
62	6.2-8.0	29 042124	Many stars here
88	4.4-8.0	69 043310	
Σ422	6.0-8.2	7 033400	Gold-Blue.
Σ430	6.0-9.0-9.8	26-37 033805	Triple.
Σ495	6.0-8.8	4 040515	
Σ548	6.0-8.0-10.3	15-121 042630	Triple.
Σ645	6.2-8.2	12 050728	White-Ashen.
Σ674	6.5-9.5	10 051620	
Σ716	5.8-6.6	5 052725	A striking pair.
Σ730	6.5-7.0	10 053017	

## MESSIER OBJECTS

Mag	Location	Remarks
<b>M 1</b> 8.4	053222	Planetary Nebula. The famous "Crab Nebula," a still-expanding cloud from a SN explosion in 1054 A.D. Visible as a faint misty patch in a small scope.
<b>M45</b> 1.6	134524	Open cluster. The Pleiades.

## Other Objects of Interest in Taurus

λ Tauri - Eclipsing variable, magnitude range 3.8-4.1, period 3 d 22 h 52 min. Location 035812.



Star	Magnitude
18 Tau	5.65
Sterope	5.75
Taygeta	4.28
Maia	3.84
Celaeno	5.83
Electra	3.71
Merope	4.12
Alcyone	2.84
Pleione	5.03
Atlas	3.59
HR 1172	5.43

# Auriga (Aur)

α Aurigae - Capella    β Aurigae - Menkalinan    ζ Aurigae - Sadatoni

The outstanding feature of this beautiful and prominent constellation is the star Capella, magnitude 0.2, the third brightest star visible in the northern latitudes. Capella means "She-Goat"; the three stars ε, ζ and η-Aurigae were called the "Kids" by the ancient Arabs. Nath (β-Tauri) properly belongs to the constellation Taurus, but is shared by both constellations. β, ε and ζ-Aurigae are all eclipsing variables; ε-Aurigae is one of the largest stars in the sky. The area within the pentagonal figure of Auriga is rich in stars and clusters and well worth sweeping with binoculars; Auriga lies directly in the Milky Way plane.

## DOUBLE STARS

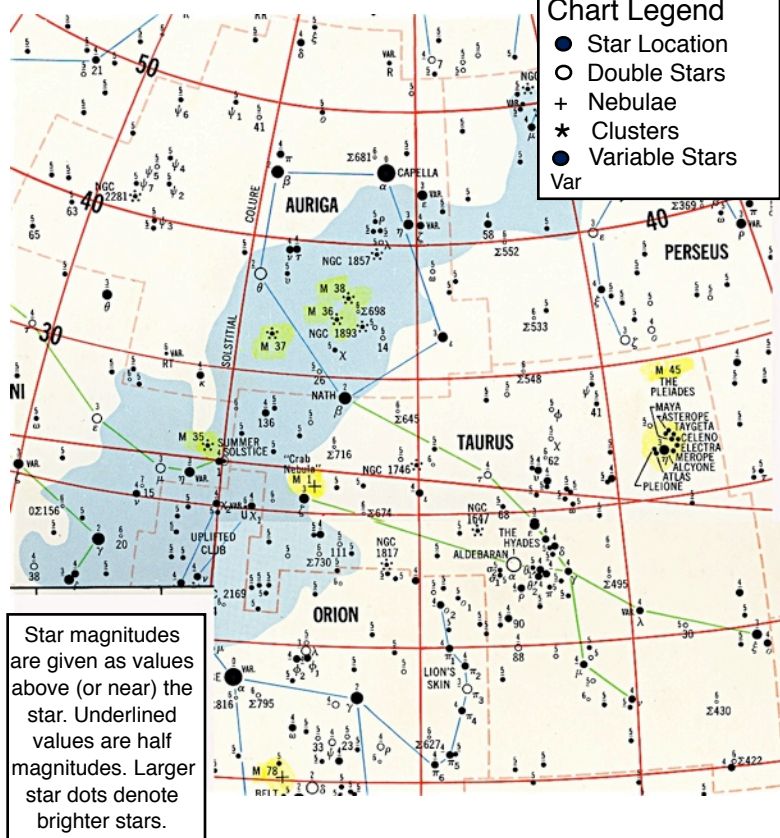
Mag.	Sep (s)	Location	Remarks
θ	2.7-7.1	1 055737	
λ	5.2-8.7	104 051640	
ψ5	5.3-9.0	41 064344	
ω	5.0-8.0	6 045638	Pale Green-Bluish White.
14	5.0-7.2-11	15 051233	Yellow-Blue; triple.
26	6.1-6.4-8.0	12 053631	Yellow-Blue; triple.
41	6.1-6.8	8 060849	White-Violet.
Σ681	6.3-8.3	23 051747	
Σ698	6.2-7.7	31 052235	Yellow-Pale Blue; beautiful.

## MESSIER OBJECTS

Mag	Location	Remarks
<b>M 36</b> 6.3	053334	Open Cluster.
<b>M 37</b> 6.2	054933	Open Cluster. Beautiful.
<b>M 38</b> 7.4	052536	Open Cluster. Unusual shape.

## Other Objects of Interest in Auriga

**R Aurigae** - Long period (459 days) variable, max. mag. is 7.7  
 Location 051354.



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

- Dec 03** 02:40 **LQ Moon** rises locally at 11:53 pm EST Dec 2
- 04** 01:21 Jupiter 1.8° N of Moon
- 05** 09:56 Moon at Apogee: 404 800 km  
21:40 Mars 0.1° N of Moon: Occ'n not vis. in N. Amer.
- 07 11:55 Venus 0.7° S of Moon: Occ'n see Spec. Events**
- 10** 07:00 Saturn 2.6° S of Moon (both are about 10° from Sun)
- 11** 05:29 **NM** rises locally at 7:39 am EST
- 14** 13:00 **Geminid Meteors 120/h! Moon only 11%**
- 18** 01:01 Saturn-Antares: 6.1° N
- 18** 10:14 **FQ Moon** rises locally at 12:32 pm EST
- 19** 20:00 Uranus 1.2° N of Moon: Occ'n in Antarctic region
- 21** 03:53 Moon at Perigee: 368 418 km
- 21** 23:48 **Winter Solstice**
- 23** 09:18 Mars-Spica: 3.3° N  
**15:00 Aldebaran 0.6° S of Moon: Daytime Occ'n:**  
reapp. visible only on eastern coast of N.America
- 25** 06:11 **FM** rises locally at 4:27 pm EST Dec 24
- 28** 22:00 **Mercury at Greatest Elong: 19.7° E**
- 31** 12:55 Jupiter 1.5° N of Moon

## BAS Astronomy Events

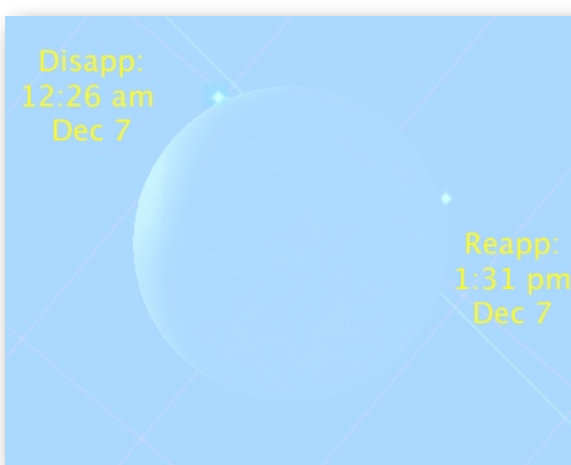
- Dec 2** Wed BAS meeting at Grey Roots Museum Topic: Christmas recap 2015
- Dec 3** Thu LQ
- Dec 7** Mon **Comet Catalina** may be visible in the morning sky. Look about 4.5° left of Venus. Last Crescent Moon about 2° above Venus. Pretty dawn group!
- Dec 7** Mon **Daytime Occultation of Venus** Disappearance on bright limb: 12:28 pm EST, duration 65 min. Reappearance at 1:32 pm EST. Moon is 3 days before New.
- Dec 11** Fri NM
- Dec 12** Sat BAS viewing@Fox. Watch for possible Geminids Sunday Dec 13 & Monday Dec 14 pm as well.
- Dec 14** **Geminid meteors** peak at **120/h** 1 pm daylight peak; on Dec 13 and Dec 15 Moon is 10% so both nights should be good for meteor watching.
- Dec 18** Fri FQ
- Dec 21** Mon **Winter Solstice**
- Dec 25** Fri FM Happy Christmas Holiday!

## Special Events

### Venus and Aldebaran Occultation

This month you get a chance to test out your GoTo systems for at least one daytime event in Bruce-Grey, the occultation of Venus by a waning crescent Moon Dec 7. If you happen to be in St. John's Nfld on Dec 23, you can also try for the reappearance of Aldebaran as well. The disappearance is over the mid-Atlantic.

The Venus events should be relatively easy as the planet is easily seen in daylight. Note that since Venus has a large disk, this is not like a stellar occultation. Starry Night gives more than a minute for the full disk to disappear/reappear. Make sure you leave the scope tracking while Venus is obscured, it may be tricky to have to reacquire the target if you go in for a coffee and shut the system down. As for a good dark sky occultation of Aldebaran, that happens for us on Jan 19, 2016.



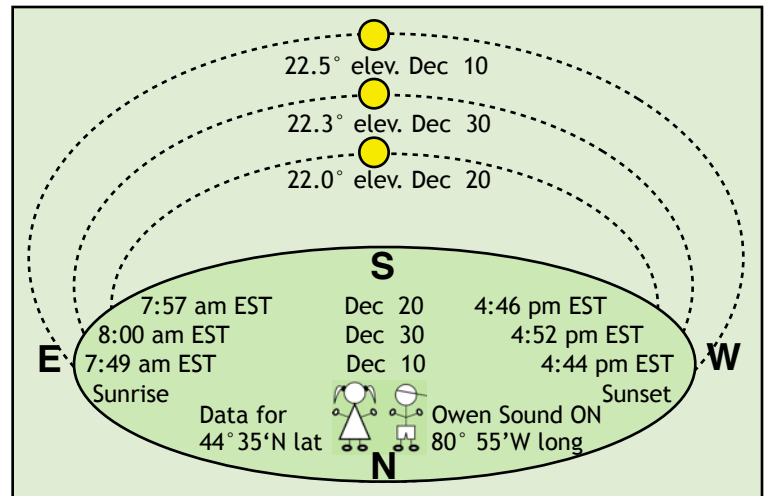
## Planets

**MERCURY** spends early December near the Sun enroute to an evening sky appearance at the end of the month and in January.

**VENUS**, (-4.2) is a beautiful Morning Star and is occulted in daylight by the Moon on Dec 7. Earlier that morning it is near Comet Catalina. **MARS**, (mag. 1.5) is also well placed in the morning sky and is closest to Spica around Dec 27. **JUPITER**, (-2.0) rising around midnight by month end is well up in the east at dawn. **SATURN**, (mag. 0.5) will rise about 6 am by month end just below Venus in the east at dawn. **URANUS**, (5.8) and **NEPTUNE**, (7.8) are well-placed in the evening sky all month. Neptune sets before midnight and Uranus about two hours later. **Dwarf planet, Ceres (8.3)** sets by 8 pm in late Dec. **Asteroid, Vesta (6.7)** follows Ceres in the sky and sets a few hours later. Both are generally in the same part of the sky as Uranus and Neptune. **PLUTO** (mag. 14) is not visible in December since it is too close to the Sun. Charts for these planets and asteroids are on the BAS website.

The diagram below gives the sunrise/sunset times and the Sun's altitude for December. The Sun sinks lower in elevation until iDec 21 when it is at winter solstice and winter officially starts.

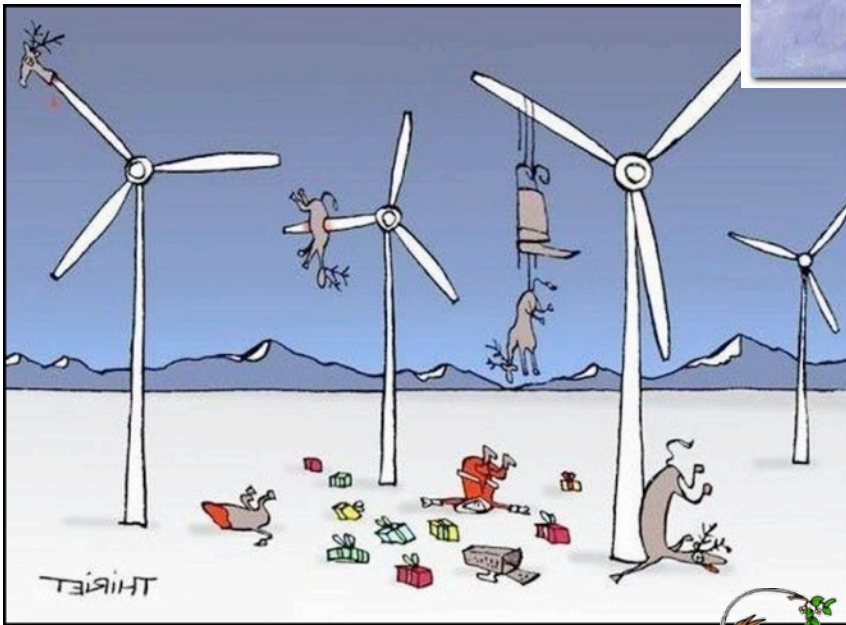
The moon phase graphic at the bottom of this page shows the lunar phase for each night of the month. Times of moonrise for NM, FQ, FM and LQ for Owen Sound are in the Sky Calendar listing at left. The Moon occults Venus in the daytime Dec 7 and Aldebaran on Dec 23, an event not visible from the local area..



### Dec 2015

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

By permission Univ. of Texas McDonald Obs.



"The Poke" by Robert Atkinson (BAS poet laureate)

As I lay in slumber, deep asleep.  
 A gentle poke, I feel, me thinks.  
 As I continue to sleep and lay.  
 The gentle poke returns, to my dismay!  
 I respond with a yes, what could it be?  
 All that is said, go out back and to your right, you'll see!  
 So out I go, and through the trees,  
 Shining brightly, the moon, and planets three.  
 I must obtain a further, better view,  
 So I trudge to the front yard on crunchy, frozen, dew.  
 Awe, the crescent moon, then Venus, Mars, and Jupiter too  
 All in a row, awesome, very cool!  
 I stand in wonder of this celestial alignment.  
 Not feeling the cold, just standing silent!  
 No camera picture, just naked eye,  
 The image of this splendour, burnt forever to my mind's eye!  
 Back in bed, to warmth, she lays beside me,  
 Yes, it was that gentle poke from a loving women, that allowed me to see!  
 Oh Kelee.....

FROM the BAS EXECUTIVE:

**Merry Christmas**

And a HAPPY NEW YEAR!

## Rosette Nebula -by Paul Zelichowski



Paul Zelichowski continues to amaze us with his astro images! The latest is this multi-channel shot of the Rosette Nebula in Monoceros. Paul is now imaging using several filters including Hydrogen- $\alpha$ , Oxygen and Sulfur. This shot was a total 9.5 hour exposure involving 1h15 min through H- $\alpha$ , 2h20 min through O3 and 2h20 min through S2 along with 3 hours of RGB data (1h in each colour). So this is a hybrid shot which uses both narrowband filters and the regular wideband colour filters. The telescope used was a 12" Hyperbolic Newtonian Astrograph f/4.27 and SBIG STL11000M CCD camera w/Baader filters. Image taken at Starbase Six which Paul refers to now as the "Kinhuron Imaging Complex Kincardine One" or KICK-1 !

### From Wikipedia:

*The Rosette Nebula (also known as Caldwell 49) is a large, circular H II region located near one end of a giant molecular cloud in the Monoceros region of the Milky Way Galaxy. The open cluster NGC 2244 (Caldwell 50) is closely associated with the nebulosity, the stars of the cluster having been formed from the nebula's matter.*

*The complex has the following NGC designations: NGC 2237, NGC 2238, NGC 2239, NGC 2244 – the open cluster within the nebula (Discovered by John Flamsteed in 1690) and NGC 2246.*

*The cluster and nebula lie at a distance of some 5,000 light-years from Earth and measure roughly 50 light years in diameter. The radiation from the young stars excites the atoms in the nebula, causing them to emit radiation themselves producing the emission nebula we see. The mass of the nebula is estimated to be around 10,000 solar masses.*

*A survey of the nebula with the Chandra X-ray Observatory has revealed the presence of numerous new-born stars inside the optical Rosette Nebula and studded within a dense molecular*

*cloud. Altogether, approximately 2500 young stars lie in this star-forming complex, including the massive O-type stars HD 46223 and HD 46150, which are primarily responsible for blowing the ionized bubble. Most of the ongoing star-formation activity is occurring in the dense molecular cloud to the south east of the bubble.*

*A diffuse X-ray glow is also seen between the stars in the bubble, which has been attributed to a super-hot plasma with temperatures ranging from 1 to 10 million K. This is significantly hotter than the 10,000 K plasmas seen in HII regions, and is likely attributed to the shock-heated winds from the massive O-type stars.*

### Observing the Rosette:

*The cluster of stars is visible in binoculars and quite well seen in small telescopes while the nebula itself is more difficult to spot visually and requires a telescope with a low magnification. A dark site is a must to see it. Photographically the Rosette Nebula is easier to record and it is the only way to record the red color which is not seen visually. [maybe a 28-inch will do it, though...-ed]*