

The Prairie Astronomer

December 2015 Volume 56, Issue #12

The Mountainous Shoreline of Sputnik Planum

**December
Program**



**Mark Dahmke:
Adventures in
Astrophotography**



Night Sky Network



The Newsletter of the Prairie Astronomy Club

The Prairie Astronomer

NEXT PAC MEETING: December 29, 6:30pm Holiday Gathering at Mueller Planetarium

PROGRAM

“Adventures in Astrophotography” by Mark Dahmke. Google Earth and other software tools and websites make it relatively easy to plan and execute photo shoots of terrestrial subjects with the Moon or other celestial objects. Mark will show how to go find targets of opportunity and will also offer some tips on equipment and proper exposure to help you shoot great astro photos.

We will have refreshments, popcorn, cookies, cake.



FUTURE PROGRAMS

January: “How to Use Your Telescope”

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The Prairie Astronomy Club:
Fifty Years of Amateur Astronomy



COMPILED AND EDITED BY MARK DAHMKE

Buy the book! The Prairie Astronomy Club: Fifty Years of Amateur Astronomy.

Order online from [Amazon](https://www.amazon.com) or [lulu.com](https://www.lulu.com).

EVENTS



PAC Holiday Gathering (members only)
Tuesday December 29th, 2015, 6:30pm
Mueller Planetarium

Newsletter submission deadline January 16

PAC Meeting
"How to Use Your Telescope"
Tuesday January 26th, 2016, 7:30pm
Hyde Observatory

PAC Meeting
Tuesday February 23rd, 2016, 7:30pm
Hyde Observatory

2015 STAR PARTY DATES



Photo by Brian Sivill

Dates in underlined are closest to the new moon

Jan 16,23, Feb 13,20
Mar 13,20, Apr 10,17
May 8,15, Jun 12,19
Jul 10,17
NSP Jul 12-17
Aug 7,14, Sep 4,11
Oct 9,16, Nov 6,13
Dec 4,11

Lunar Party Dates

Mar 27, Apr 24, Jul 24, Aug 21

(Lunar party dates are tentative, sites to be determined.)



PAC E-MAIL:

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PAC-LIST:

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Panhandleastronomyclub.com
www.universetoday.com/
www.planetary.org/home/
<http://www.darksky.org/>



Night Sky Network

PAC Meeting Minutes

Minutes for the meeting of November 24, 2015

President Jim Kvasnicka called the meeting to order. 15 members, 2 guests: Dan, Denira(?)

Upcoming events:

Hyde is open every Saturday 7-10 PM

The next star parties are Dec 4 & 11 at the farm.

The December PAC meeting will be Dec 29, our holiday gathering. We are discussing

having this at Mueller Planetarium.

Jim reviewed dues and benefits of club membership.

Jim provided the December observing report, with a focus on the constellation Perseus.

Club business:

Jim introduced our current club officers:

President and observing chair, Jim Kvasnicka

Vice President, Brett Boller

2nd VP (Program chair) Beth Jenckes

Secretary, Lee Taylor

Treasurer, John Reinert

Newsletter editor, Mark Dahmke
eclipse coordinator (new position) Dave Churilla

Adjourn to program, How to Buy a Telescope.

Respectfully submitted by,
Lee Taylor

PAC Board Meeting Minutes

Prairie Astronomy Club

Minutes for the Board of Directors meeting Oct. 29, 2015

Members present:

Jim Kvasnicka, President
Brett Boller, Vice President
John Reinert, Treasurer
Lee Taylor, Secretary

Others present:

Dan Delzell, Outreach coordinator

November meeting:

Our November meeting will be 'How to buy a telescope'. Our

idea this year is to have stations with the different designs of telescopes available, a station on accessories, and examples of what to avoid. We'll have a refractor, reflector, and an SCT for people to look over and try. We would also like to have the telescope on Hyde's deck available. We will have a short presentation to start things off.

We will try to get publicity for this, using the usual outlets.

December gathering

Jim will try to contact Zach for a holiday gathering at Mueller. Larry Stepp will NOT be available, but others may have other things to present. We will

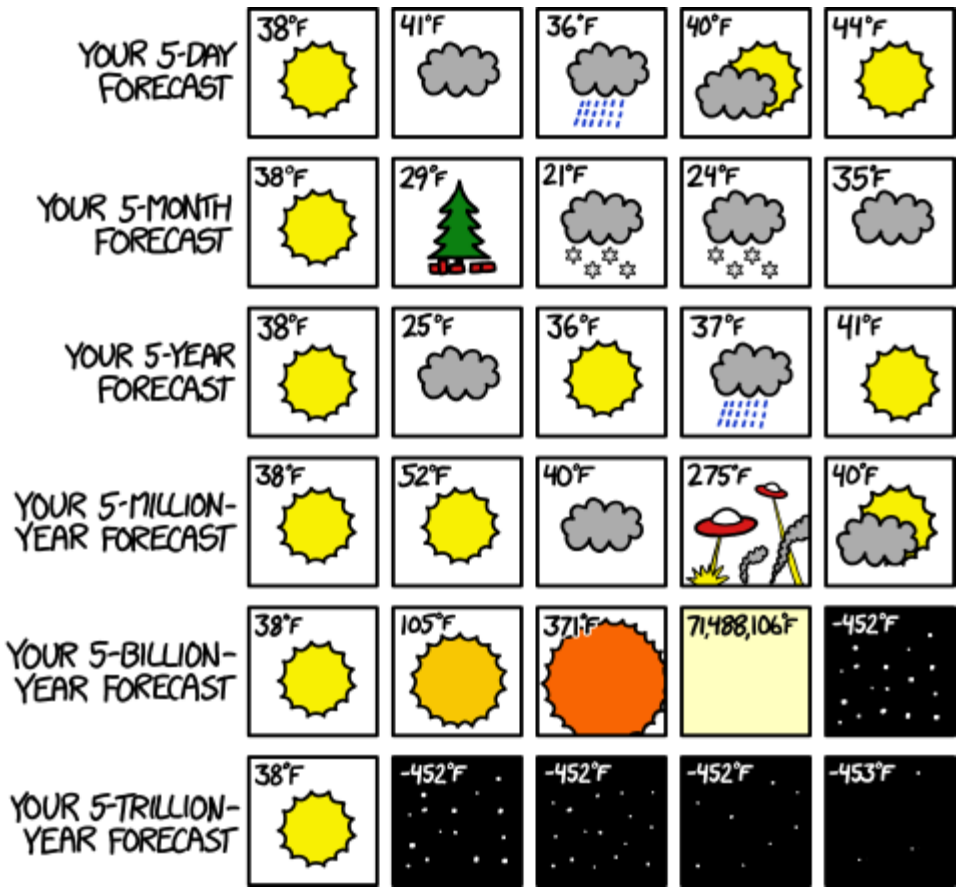
have snacks available, like last year.

Club equipment

The club 13-inch has been checked out by Rick Brown. However, there is no secondary. We will do what we can to get that fixed. The 100mm refractor is on Hyde's deck, available for checkout, as are the 10-inch and the new dob without a base. We discussed ways to get the base for this.

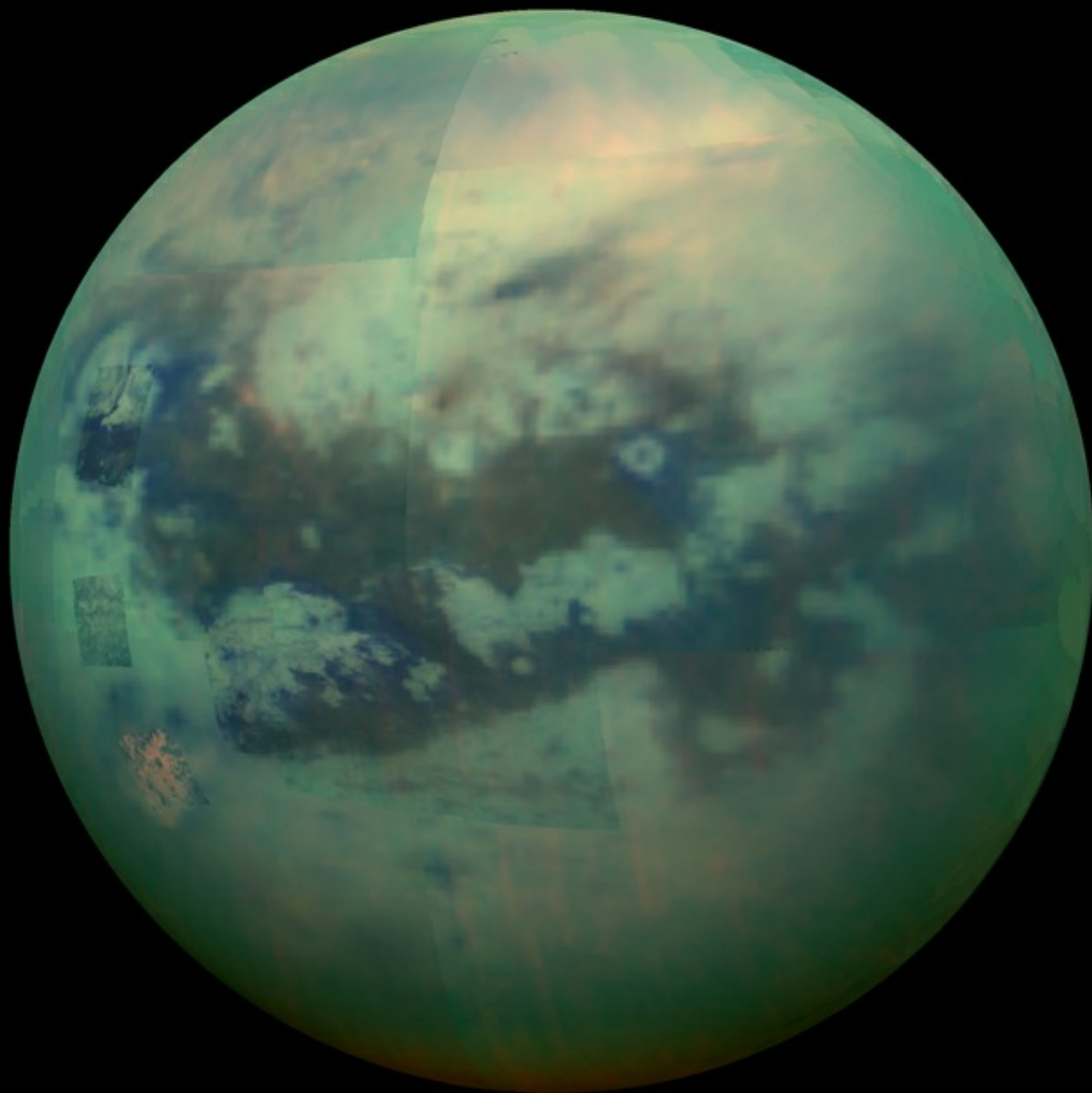
2016 Star Party Dates

	Star Party Date	Star Party Date	Lunar Party Date
January	Jan 1st	Jan 8th	
February	Jan 29th	Feb 5th	
March	Mar 4th	Mar 11th	
April	Apr 1st	Apr 8th	Apr 15th
May	Apr 29th	May 6th	May 13th
June	May 27th	Jun 3rd	
July	Jul 1st	Jul 8th	
NSP	July 31st - August 5th		
August	Jul 29th	Aug 5th	Aug 12th
August	Aug 26th	Sep 2nd	Sep 9th
September	Sep 23rd	Sep 30th	
October	Oct 21st	Oct 28th	
November	Nov 25th	Dec 2nd	
December	Dec 23rd	Dec 30th	



xkcd.com

Peering Through Titan's Haze



Peering Through Titan's Haze

This view from NASA's Cassini spacecraft, acquired during the mission's 'T-114' flyby on Nov. 13, 2015, looks toward terrain that is mostly on the Saturn-facing hemisphere of Titan.

This composite image shows an infrared view of Saturn's moon Titan from NASA's Cassini spacecraft, acquired during the mission's "T-114" flyby on Nov. 13, 2015. The spacecraft's visual and infrared mapping spectrometer (VIMS) instrument made these observations, in which blue represents wavelengths centered at 1.3 microns, green represents 2.0 microns, and red represents 5.0 microns. A view at visible wavelengths (centered around 0.5 microns) would show only Titan's hazy atmosphere (as in PIA14909). The near-infrared wavelengths in this image allow Cassini's vision to penetrate the haze and reveal the moon's surface.

During this Titan flyby, the spacecraft's closest-approach altitude was 6,200 miles (10,000 kilometers), which is considerably higher than those of typical flybys, which are around 750 miles (1,200 kilometers). The high flyby allowed VIMS to gather moderate-resolution views over wide areas (typically at a few kilometers per pixel).

The view looks toward terrain that is mostly on the Saturn-facing hemisphere of Titan. The scene features the parallel, dark,

dune-filled regions named Fensal (to the north) and Aztlan (to the south), which form the shape of a sideways letter "H."

Several places on the image show the surface at higher resolution than elsewhere. These areas, called subframes, show more detail because they were acquired near closest approach. They have finer resolution, but cover smaller areas than data obtained when Cassini was farther away from Titan.

Near the limb at left, above center, is the best VIMS view so far of Titan's largest confirmed impact crater, Menrva (first seen by the RADAR instrument in PIA07365). Similarly detailed subframes show eastern Xanadu, the basin Hotei Regio, and channels within bright terrains east of Xanadu. (For Titan maps with named features see <http://planetarynames.wr.usgs.gov/Page/TITAN/target>.)

Due to the changing Saturnian seasons, in this late northern spring view, the illumination is significantly changed from that seen by VIMS during the "T-9" flyby on December 26, 2005 (PIA02145). The sun has moved higher in the sky in Titan's northern hemisphere, and lower in the sky in the south, as northern summer approaches. This change in the sun's angle with respect to Titan's surface has made high southern latitudes appear darker, while

northern latitudes appear brighter.

The Cassini mission is a cooperative project of NASA, ESA (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. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The visual and infrared mapping spectrometer team is based at the University of Arizona.

For more information about the Cassini-Huygens mission <http://saturn.jpl.nasa.gov/home/index.cfm>. The visual and infrared mapping spectrometer team homepage is at <http://www.vims.lpl.arizona.edu>.

Astrophotography

Photos by Beth Jenckes. Canon EOS REBEL T2i,, ISO 800, f/5.6, 30 seconds



Taurus and Pleiades



Orion at Sunset



Pleiades



Orion and Taurus

The Moon by Mark Dahmke.

Panasonic Lumix DMC-G7 capturing video at 4K (3840x2160) resolution, ISO6400, 30fps. The video was then split into 16-bit TIFs. 60 of the frames were stacked using Registax.

Celstron Onyx 80EDF 80mm refractor at prime focus.



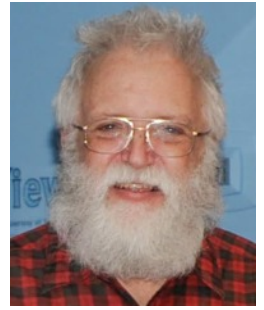
Gyulbudaghian's Nebula

Rick Johnson

I've always updated my image of Gyulbudaghian's Nebula, a variable nebula, about once a year. I took this year's version in July earlier than usual hoping to try again in a few months. It didn't get processed until earlier this month (See update #15-156 for 11-04-15) which reminded me I was going to try again. Unfortunately conditions so far this month have been very bad. Fog and haze moved in even as the first frame was starting. I ended up taking 8 luminance frames none of which were very good but combining all 8 I sort of

got something useful. There were nasty fog halos around bright stars I sort of dealt with. Removing them but not the nebula behind them was quite a challenge. Color data was very poor due to the fog. I about gave up on processing this but finally managed to get something useful by using the color data from last July so if it changed color this image won't show that. I could try again once the moon is out of the way. If so that would give a very short term view of how it changes. Looking at the

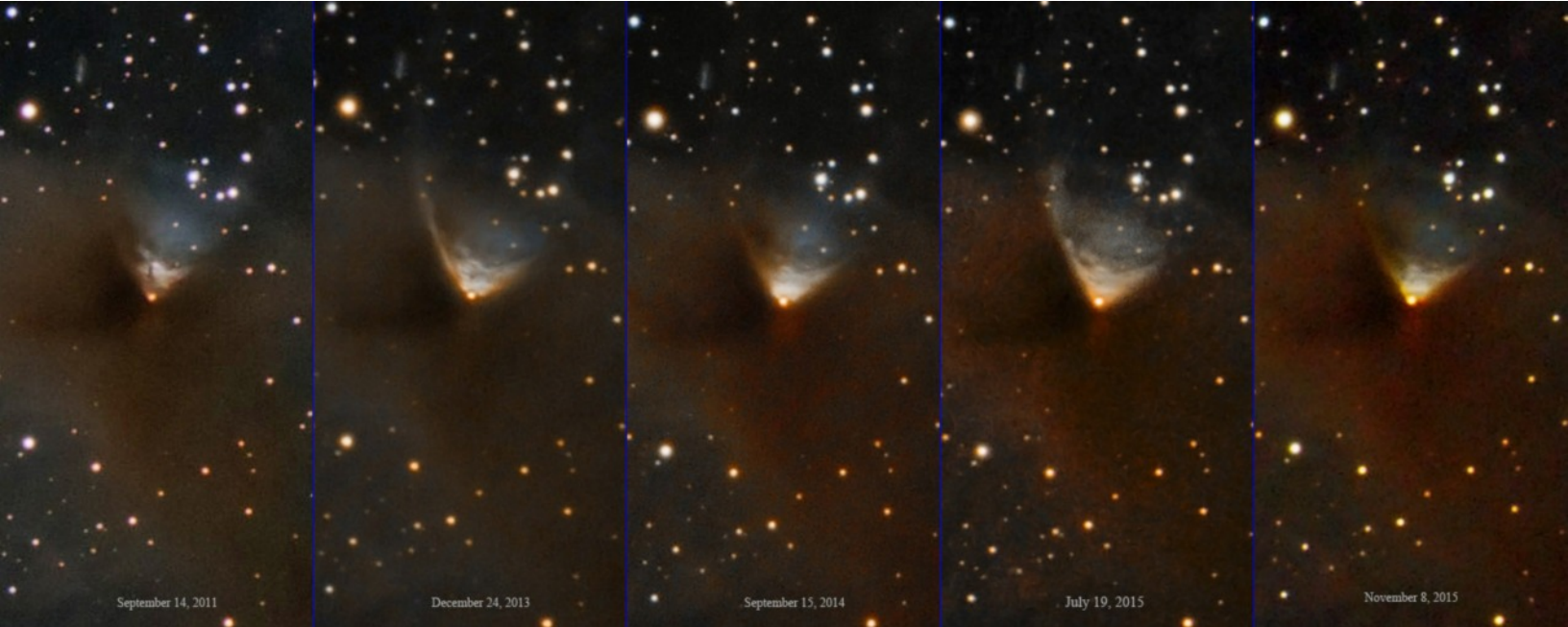
November 8 image it looks much like it did a year ago rather than as it did in July. So it may very well show variations in only two or three weeks time. If the weather ever cooperates maybe I can find out. But it's biggest change appears to be in PV Cephei itself. Being a protostar it is an irregular variable commonly running about magnitude 16.5 but with



sudden peaks to 15 and slow dips to 18th magnitude. Except for this image all the others appear rather constant at mid 16th magnitude. Due to it being embedded in nebulosity I can't

get a good measurement but it appears about 14.8 in my images which would put it near a typical maximum. Something none of my other images have caught before.

For more on this nebula see my [November 4th post](#).



New Clues to Ceres' Bright Spots and Origins

Ceres reveals some of its well-kept secrets in two new studies in the journal *Nature*, thanks to data from NASA's Dawn spacecraft. They include highly anticipated insights about mysterious bright features found all over the dwarf planet's surface.

In one study, scientists identify this bright material as a kind of salt. The second study suggests the detection of ammonia-rich clays, raising questions about how Ceres formed.

About the Bright Spots

Ceres has more than 130 bright areas, and most of them are associated with impact craters. Study authors, led by Andreas Nathues at Max Planck Institute for Solar System Research, Göttingen, Germany, write that the bright material is consistent with a type of magnesium sulfate called hexahydrite. A different type of magnesium sulfate is familiar on Earth as Epsom salt.

Nathues and colleagues, using images from Dawn's framing camera, suggest that these salt-rich areas were left behind when water-ice sublimated in the past. Impacts from asteroids would have unearthed the mixture of ice and salt, they say.

"The global nature of Ceres' bright spots suggests that this world has a subsurface layer

that contains briny water-ice," Nathues said.

A New Look at Occator

The surface of Ceres, whose average diameter is 584 miles (940 kilometers), is generally dark -- similar in brightness to fresh asphalt -- study authors wrote. The bright patches that pepper the surface represent a large range of brightness, with the brightest areas reflecting about 50 percent of sunlight shining on the area. But there has not been unambiguous detection of water ice on Ceres; higher-resolution data are needed to settle this question.

The inner portion of a crater called Occator contains the brightest material on Ceres. Occator itself is 60 miles (90 kilometers) in diameter, and its central pit, covered by this bright material, measures about 6 miles (10 kilometers) wide and 0.3 miles (0.5 kilometers) deep. Dark streaks, possibly fractures, traverse the pit. Remnants of a central peak, which was up to 0.3 miles (0.5 kilometers) high, can also be seen.

With its sharp rim and walls, and abundant terraces and landslide deposits, Occator appears to be among the youngest features on Ceres. Dawn mission scientists estimate its age to be about 78 million years old.

Study authors write that some views of Occator appear to show

a diffuse haze near the surface that fills the floor of the crater. This may be associated with observations of water vapor at Ceres by the Herschel space observatory that were reported in 2014. The haze seems to be present in views during noon, local time, and absent at dawn and dusk, study authors write. This suggests that the phenomenon resembles the activity at the surface of a comet, with water vapor lifting tiny particles of dust and residual ice. Future data and analysis may test this hypothesis and reveal clues about the process causing this activity.

"The Dawn science team is still discussing these results and analyzing data to better understand what is happening at Occator," said Chris Russell, principal investigator of the Dawn mission, based at the University of California, Los Angeles.

The Importance of Ammonia

In the second *Nature* study, members of the Dawn science team examined the composition of Ceres and found evidence for ammonia-rich clays. They used data from the visible and infrared mapping spectrometer, a device that looks at how various wavelengths of light are reflected by the surface, allowing minerals to be identified.

Ammonia ice by itself would evaporate on Ceres today, because the dwarf planet is too warm. However, ammonia molecules could be stable if present in combination with (i.e. chemically bonded to) other minerals.

The presence of ammoniated compounds raises the possibility that Ceres did not originate in the main asteroid belt between Mars and Jupiter, where it currently resides, but instead might have formed in the outer solar system. Another idea is that Ceres formed close to its present position, incorporating materials that drifted in from the outer solar system - near the orbit of Neptune, where nitrogen ices are thermally stable.

"The presence of ammonia-bearing species suggests that Ceres is composed of material accreted in an environment where ammonia and nitrogen were abundant. Consequently, we think that this material originated in the outer cold solar system," said Maria Cristina De Sanctis, lead author of the study, based at the National Institute of Astrophysics, Rome.

In comparing the spectrum of reflected light from Ceres to meteorites, scientists found some similarities. Specifically, they focused on the spectra, or chemical fingerprints, of carbonaceous chondrites, a type of carbon-rich meteorite thought to be relevant analogues for the dwarf planet. But these are not good matches for all wavelengths that the instrument sampled, the team found. In particular, there were distinctive

absorption bands, matching mixtures containing ammoniated minerals, associated with wavelengths that can't be observed from Earth-based telescopes.

The scientists note another difference is that these carbonaceous chondrites have bulk water contents of 15 to 20 percent, while Ceres' content is as much as 30 percent.

"Ceres may have retained more volatiles than these meteorites, or it could have accreted the water from volatile-rich material," De Sanctis said.

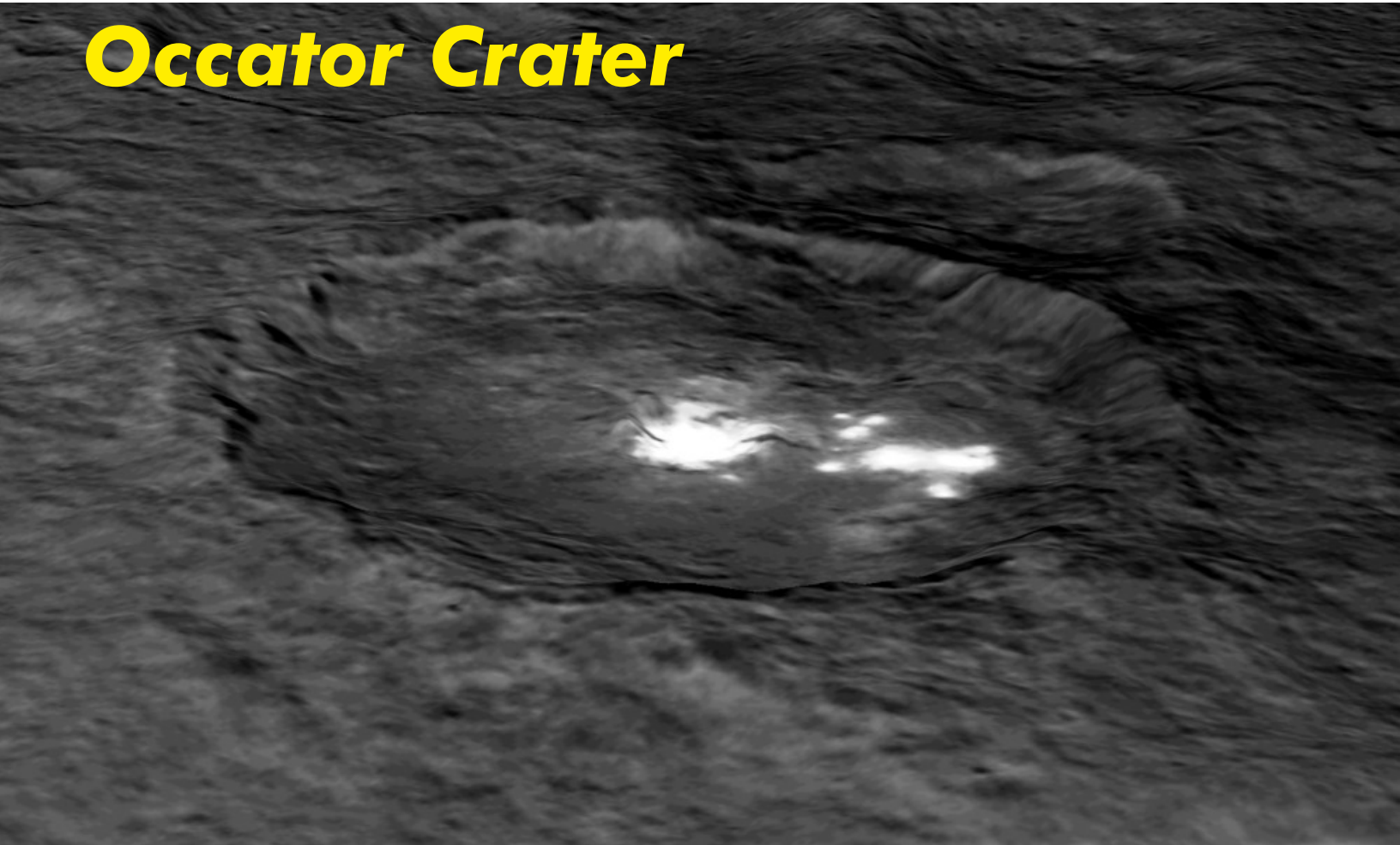
The study also shows that daytime surface temperatures on Ceres span from minus 136 degrees to minus 28 degrees Fahrenheit (180 to 240 Kelvin). The maximum temperatures were measured in the equatorial region. The temperatures at and near the equator are generally too high to support ice at the surface for a long time, study authors say, but data from Dawn's next orbit will reveal more details.

As of this week, Dawn has reached its final orbital altitude at Ceres, about 240 miles (385 kilometers) from the surface of the dwarf planet. In mid-December, Dawn will begin taking observations from this orbit, including images at a resolution of 120 feet (35 meters) per pixel, infrared, gamma ray and neutron spectra, and high-resolution gravity data.

Dawn's mission is managed by the Jet Propulsion Laboratory for NASA. Dawn is a project of the

directorates Discovery Program, managed by NASA's Marshall Space Flight Center in Huntsville, Alabama. UCLA is responsible for overall Dawn mission science. Orbital ATK Inc., in Dulles, Virginia, designed and built the spacecraft. The German Aerospace Center, Max Planck Institute for Solar System Research, Italian Space Agency and Italian National Astrophysical Institute are international partners on the mission team.

Occator Crater



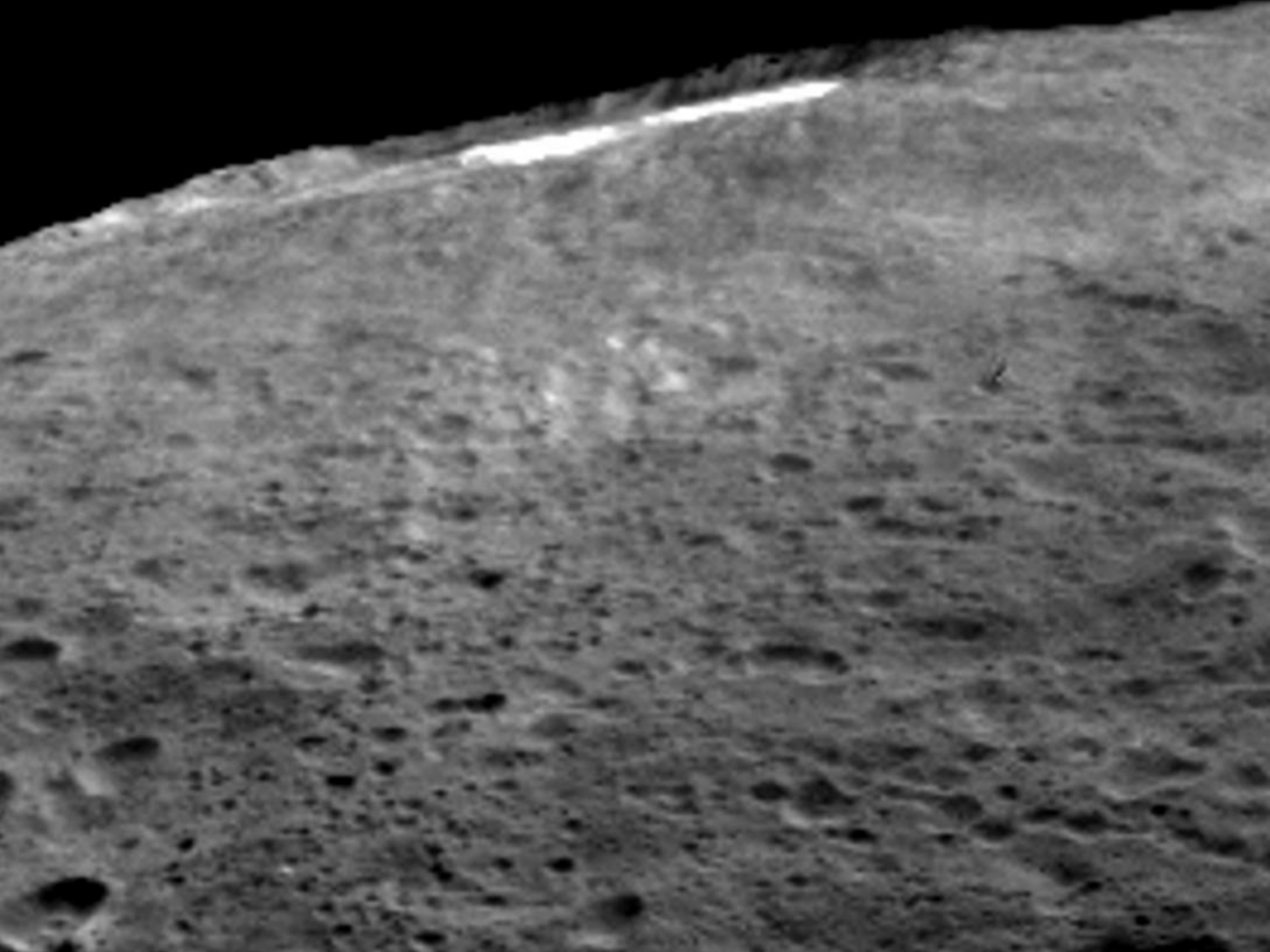
An image of Occator Crater draped over a digital terrain model provides a 3-D-like perspective view of the impact structure. Several bright areas can be seen in this crater. The inner part of the crater forms a type of "crater within a crater" measuring about 6 miles (10 kilometers) in diameter and 0.3 miles (0.5 miles) in depth, and contains the brightest material on all of Ceres. Occator measures about 60 miles (90 kilometers) wide.

With its sharp rim and walls, and abundant terraces and landslide deposits, Occator appears to be among the youngest features on Ceres. Dawn mission scientists estimate its age to be about 78 million years old.

Dawn's mission is managed by JPL for NASA's Science Mission Directorate in Washington. Dawn is a project of the directorate's Discovery Program, managed by NASA's Marshall Space Flight Center in Huntsville, Alabama. UCLA is responsible for overall Dawn mission science. Orbital ATK, Inc., in Dulles, Virginia, designed and built the spacecraft. The German Aerospace Center, the Max Planck Institute for Solar System Research, the Italian Space Agency and the Italian National Astrophysical Institute are international partners on the mission team. For a complete list of acknowledgments, see <http://dawn.jpl.nasa.gov/mission>.

For more information about the Dawn mission, visit <http://dawn.jpl.nasa.gov>.

Lateral View of Occator



A group of scientists from NASA's Dawn mission suggests that when sunlight reaches Ceres' Occator Crater, a kind of thin haze of dust and evaporating water forms there. This haze only becomes dense enough to be seen by looking at it laterally, as in this image, the scientists wrote in the journal Nature in December 2015.

Occator measures about 60 miles (90 kilometers) wide, and contains the brightest material seen on Ceres.

Dawn's mission is managed by JPL for NASA's Science Mission Directorate in Washington. Dawn is a project of the directorate's Discovery Program, managed by NASA's Marshall Space Flight Center in Huntsville, Alabama. UCLA is responsible for overall Dawn mission science. Orbital ATK, Inc., in Dulles, Virginia, designed and built the spacecraft. The German Aerospace Center, the Max Planck Institute for Solar System Research, the Italian Space Agency and the Italian National Astrophysical Institute are international partners on the mission team. For a complete list of acknowledgments, see <http://dawn.jpl.nasa.gov/mission>.

Venus Climate Orbiter "AKATSUKI" Inserted Into Venus' Orbit

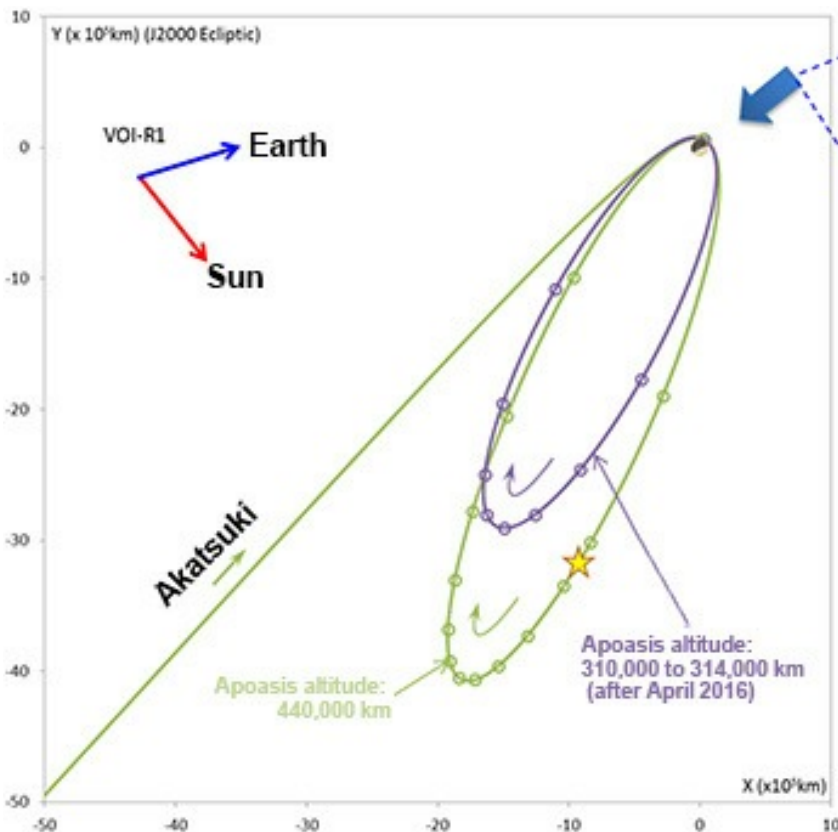
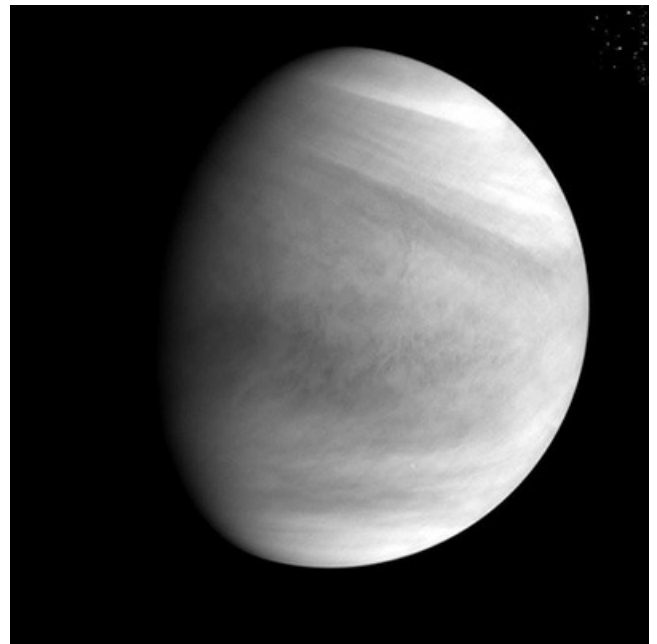
The Japan Aerospace Exploration Agency (JAXA) successfully inserted the Venus Climate Orbiter "AKATSUKI" into the orbit circling around Venus.

As a result of measuring and calculating the AKATSUKI's orbit after its thrust ejection, the orbiter is now flying on the elliptical orbit at the apoapsis altitude of about 400 km and periapsis altitude of about 440,000 km from Venus. The orbit period is 13 days and 14 hours. We also found that the orbiter is flying in the same direction as that of Venus's rotation.

The AKATSUKI is in good health.

We will deploy the three scientific mission instruments namely the 2 μ m camera (IR2), the Lightning and Airglow Camera (LAC) and the Ultra-Stable oscillator (USO) and check their functions. JAXA will then perform initial observations with the above three instruments along with the three other instruments whose function has already been confirmed, the Ultraviolet Imager (UVI), the Longwave IR camera (LIR), and the 1 μ m camera (IR1) for about three months. At the same time,

JAXA will also gradually adjust the orbit for shifting its elliptical orbit to the period of about nine days. The regular operation is scheduled to start in April, 2016.



The AKATSUKI is now flying on Venus orbit

Period: about 13 days and 14 hours

Inclination: about 3 degrees

(It will shift to about 25 degrees in two years)

Periapsis altitude: 400 km

Apoapsis altitude: 440,000 km

The AKATSUKI is in good health after Venus orbit insertion.

January Observing: What to View

Jim Kvasnicka

This is a partial list of objects visible for the upcoming month.

Planets

Neptune and Uranus: In Aquarius and Pisces.

Mercury: Shines at -0.4 magnitude on January 1st 10° above the SW horizon. It quickly dims to 1.8 magnitude and reaches inferior conjunction on January 14th.

Jupiter: Rises around 10:30 pm to start the month and by 8:30 at the end.

Mars: Rises around 1:30 am to start the month in Virgo.

Venus: Rises 3 hours before the Sun to start January and 2 hours at the end of the month.

Saturn: On January 9th Saturn is just ½° to the upper right of Venus. Soon after this conjunction Saturn opens a wide gap with Venus. On January 24th it passes close to M20 the Trifid Nebula in Sagittarius.

Meteor Showers

Quadrantids: Peaks on January 4th at 2:00 am Central Time. The moon will be a waning crescent rising about an hour after the peak. Peak rates have varied from 60-200.

Messier List

M33: The Triangulum Galaxy.

M34: Open cluster in Perseus.

M52: Open cluster in Cassiopeia.

M74: Galaxy in Pisces.

M76: The Little Dumbbell in Perseus.

M77: Galaxy in Cetus.

M103: Open cluster in Cassiopeia.

Last Month: M2, M15, M29, M31, M32, M110

Next Month: M35, M36, M37, M38, M42, M43, M45, M78, M79

NGC and other Deep Sky Objects

Collinder 69: Open cluster in Orion.

NGC 1980: Emission nebula and open cluster in Orion.

NGC 2169: The 37 Cluster in Orion.



Double Star Program List

Beta Orionis: Rigel, white and dim blue stars.

Delta Orionis: Mintaka, Bright white and pale blue pair.

Struve 747: Equal pair of white stars in Orion.

Lambda Orionis: Pair of white stars.

Theta 1 Orionis: The Trapezium in the Orion Nebula.

Iota Orionis: White and blue stars.

Theta 2 Orionis: Three white stars.

Sigma Orionis: White star with 3 pale blue stars.

Zeta Orionis: Alnitak, white star with two white secondary stars.

Challenge Object

B33: The Horsehead Nebula. A dark nebula silhouetted against IC 434 in Orion.

Focus on Constellations: Orion

Jim Kvasnicka

Orion

Orion the Hunter is perhaps second only to the Big Dipper in Ursa Major as the most recognizable star pattern in the sky. It covers 1,231 square degrees. Orion is accompanied by his faithful dogs, Canis Major and Canis Minor. Together they hunt various celestial animals including Lepus the rabbit and Taurus, the Bull. The three bright stars Alnitak, Alnilam, and Mintaka make up Orion's belt. Betelgeuse forms Orion's left shoulder. Hanging down from Orion's belt is his sword. The central star of his sword is not really a star, but the Great Orion Nebula, M42, one of the most famous and observed objects in the sky. Besides M42 Orion has two additional Messier objects in bright nebulae M43 and M78. The constellation Orion is best observed in January.

Showpiece Objects

Open Clusters: NGC 1981, NGC 2169 (The 37 Cluster)

Bright Nebulae: M42 (The Orion Nebula), M43, M78, NGC 1977, NGC 1980

Multiple Stars: Beta Orionis (Rigel), Delta Orionis (Mintaka), Theta 1 Orionis (The Trapezium), Sigma Orionis

Dark Nebulae: B33 (The Horsehead Nebula)

Mythology

Orion, the son of Neptune, boasted that so great was his might and skill as a hunter that he could kill all the animals on Earth. Gaea, Goddess of Earth, was alarmed by such a boastful statement. Gaea was afraid that Orion might try to carry out

his boast. Gaea sent a giant scorpion and ordered the beast to sting Orion. After a brief battle the scorpion stung Orion in the heel (the star Rigel) and he died. Both Orion and the scorpion were given honored places in the sky, but they were placed at opposite ends of the sky dome so they would never engage in battle again.

Number of Objects Magnitude 12.0 and Brighter

Galaxies: 0

Open Clusters: 11

Planetary Nebulae: 0

Bright Nebulae: 9

Dark Nebulae: 6



"Orion 3008 huge" by Mouser - Own work.
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How Will We Finally Image the Event Horizon of a Black Hole?

This article is provided by NASA Space Place.

With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology. Visit spaceplace.nasa.gov to explore space and Earth science!

Ethan Siegel



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

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

few kilometers in radius; and a supermassive black hole would have an event horizon the size of a planetary orbit.

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

But all hope isn't lost! If instead of a single telescope, we built an *array* of telescopes located all over Earth, we could simultaneously image the galactic center, and use the technique of VLBI (very long-baseline interferometry) to resolve the black hole's event horizon. The array would only have the light-gathering power of the individual telescopes, meaning the black hole (in the radio) will appear very faint, but they can obtain the resolution of

a telescope that's the distance between the farthest telescopes in the array! The planned Event Horizon Telescope, spanning four different continents (including Antarctica), should be able to resolve under 10 micro-arc-seconds, imaging a black hole directly for the first time and answering the question of whether or not they truly contain an event horizon. What began as a mere mathematical solution is now just a few years away from being observed and known for certain!

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

Galactic Center in X-rays

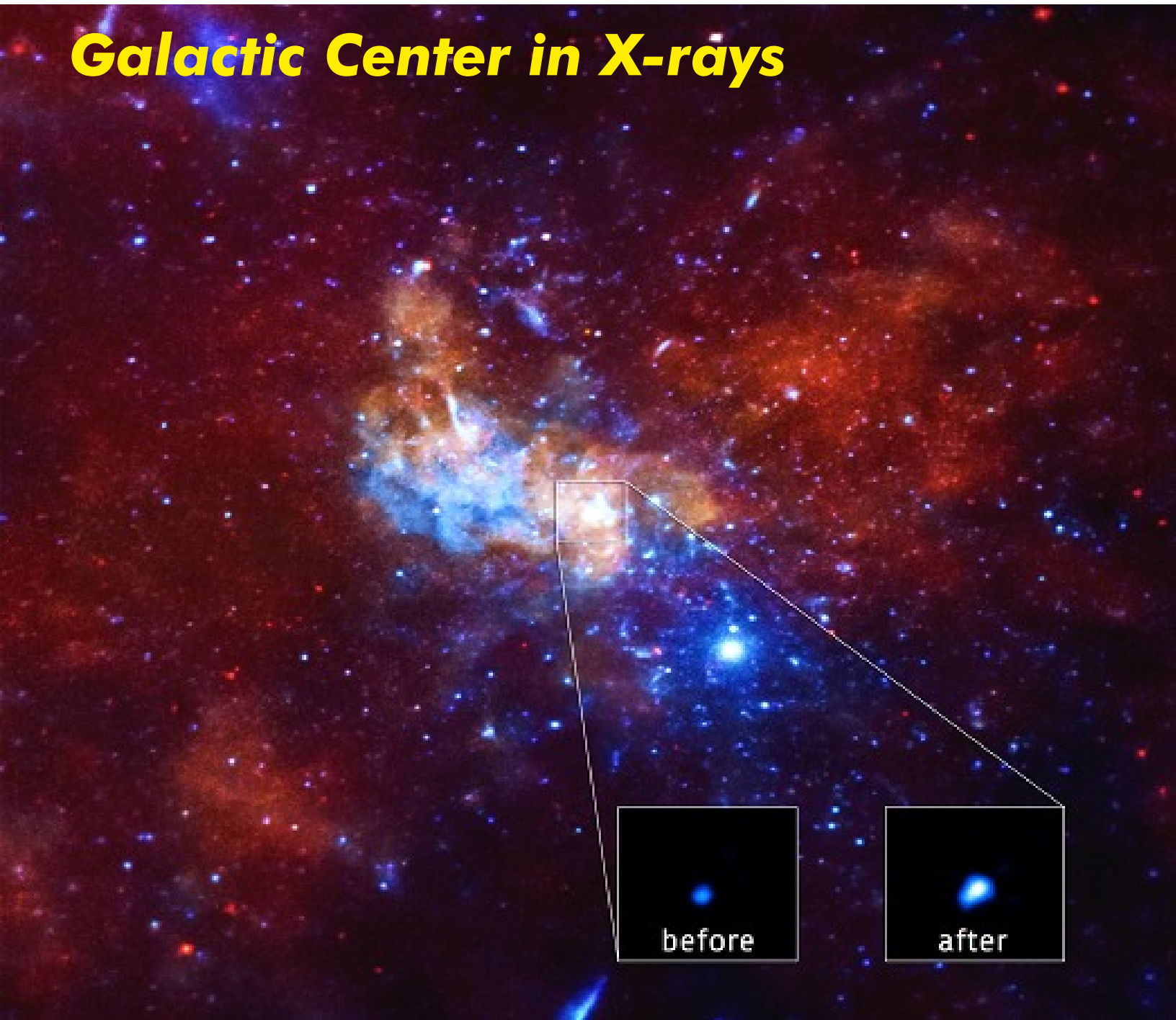


Image credit: NASA/CXC/Amherst College/D.Haggard et al., of the galactic center in X-rays. Sagittarius A is the supermassive black hole at our Milky Way's center, which normally emits X-ray light of a particular brightness. However, 2013 saw a flare increase its luminosity by a factor of many hundreds,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

Zooming in on Pluto's Pattern of Pits

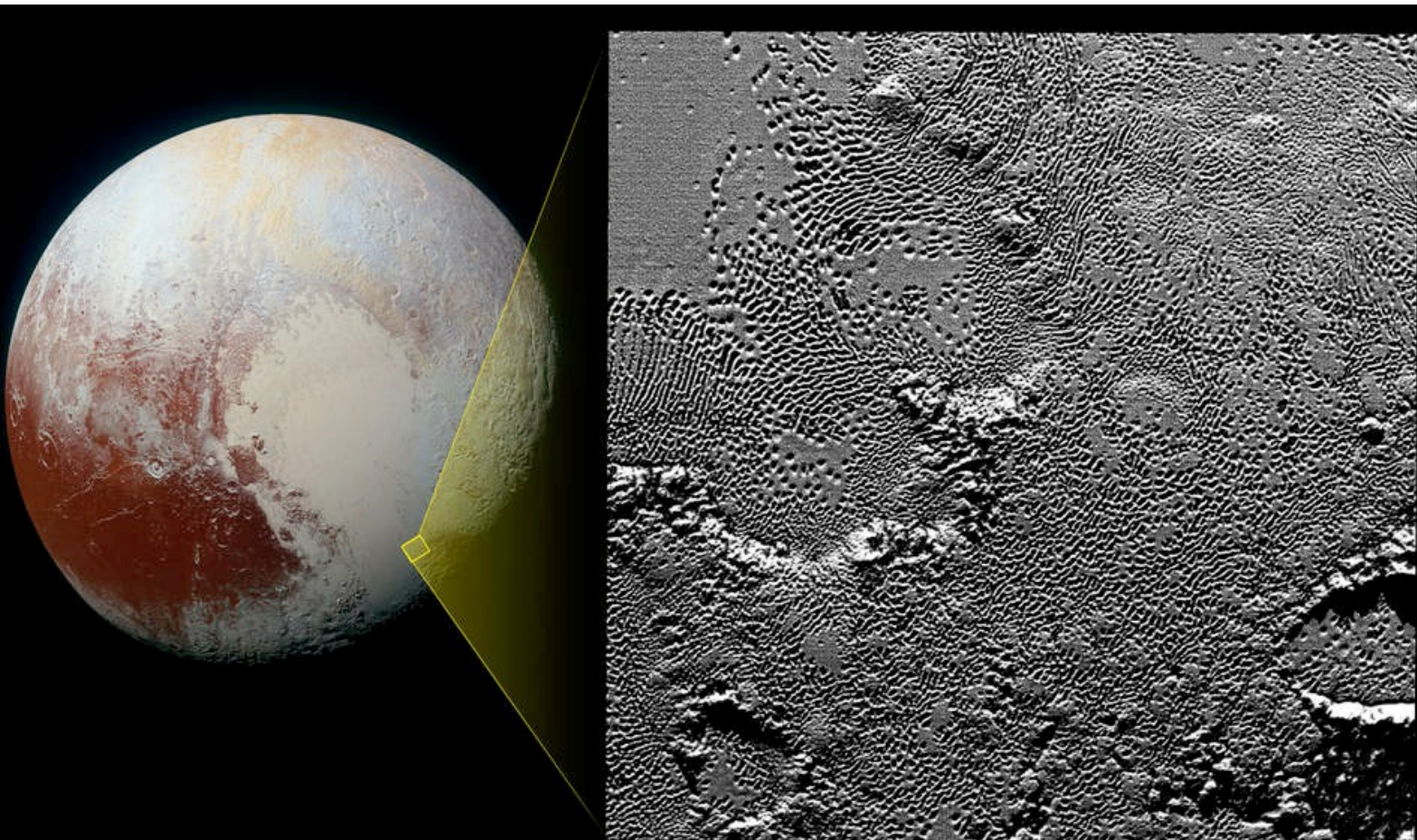
On July 14 the telescopic camera on NASA's New Horizons spacecraft took the highest resolution images ever obtained of the intricate pattern of "pits" across a section of Pluto's prominent heart-shaped region, informally named Tombaugh Regio. Mission scientists believe these mysterious indentations may form through a combination of ice fracturing and evaporation. The scarcity of overlying impact craters in this area also leads scientists to conclude that these pits – typically hundreds of yards across and tens of yards deep – formed relatively recently. Their alignment

provides clues about the ice flow and the exchange of nitrogen and other volatile materials between the surface and the atmosphere.

The image is part of a sequence taken by New Horizons' Long Range Reconnaissance Imager (LORRI) as the spacecraft passed within 9,550 miles (15,400 kilometers) of Pluto's surface, just 13 minutes before the time of closest approach. The small box on the global view shows the section of the region imaged in the southeast corner of the giant ice sheet informally named Sputnik Planum. The magnified view is

50-by-50 miles (80-by-80 kilometers) across. The large ring-like structure near the bottom right of the magnified view -- and the smaller one near the bottom left -- may be remnant craters. The upper-left quadrant of the image shows the border between the relatively smooth Sputnik Planum ice sheet and the pitted area, with a series of hills forming slightly inside this unusual "shoreline."

Credit: NASA/JHUAPL/SwRI



From the Archives: December, 1966

The President's Report

December, 1966

A grazing occultation occurred on Dec 18th at 6:45pm local time. This was one of the best planned and attended occultations observed that our club has participated in. About ten or so members gathered at my place on the afternoon of the event. After locating our viewing spot on the survey map we had lunch and then departed for the site about 24 miles south of Firth. We had all the equipment necessary. Rick Johnson brought his new 10 inch f/8, a tape record and shortwave radio to pick up time signals and I had my 8in and the 2.4in refractor. But the best laid plans of mice and men, etc. Wouldn't you know after a week of clear warm dry weather that those clouds would have to move in. We could see the Moon through the clouds but not the star, not even in the 10 inch.

Well, we plan another one on Dec 31st at 3 am. This will be a third mag that failed to show through the clouds on Dec. 18. This graze will be a little closer to home. About one half mile south of my place. I will be out there. Hope to see some of you there also.

—Earl Moser, President.

* * * * *

Our next meeting will be Dec 27th, Tuesday night, 7:30pm at the Nebr. Wesleyan Science Building.

The program will be a good one. Monte Cole will give a report on Astronomical Facts, from a 1919 Copyrighted Encyclopedia. A film if possible. We are going to sell those lenses that Felix Cavosie gave to the club. There's a lot of them so come prepared to take some of them home. The selling price will be low, and the money will go into our treasury.

Have a good Christmas and I hope everyone finds two or more Good Eyepieces, or whatever you been needin, in your sock.

A group of us got together a week or so ago, and demonstrated our scopes to some of Prof. Carroll Moore' students. It was very nice of you boys to turn out. Next year we should do it earlier in the month, or sooner still, so that anyone wishing to order a telescope would get ahead of the Christmas rush.

So, meeting Dec 27. You know where and the time. Refreshments. —Happy Holidays, Jess Williams.



Triple Crescents

A single crescent moon is a familiar sight in Earth's sky, but with Saturn's many moons, you can see three or even more.

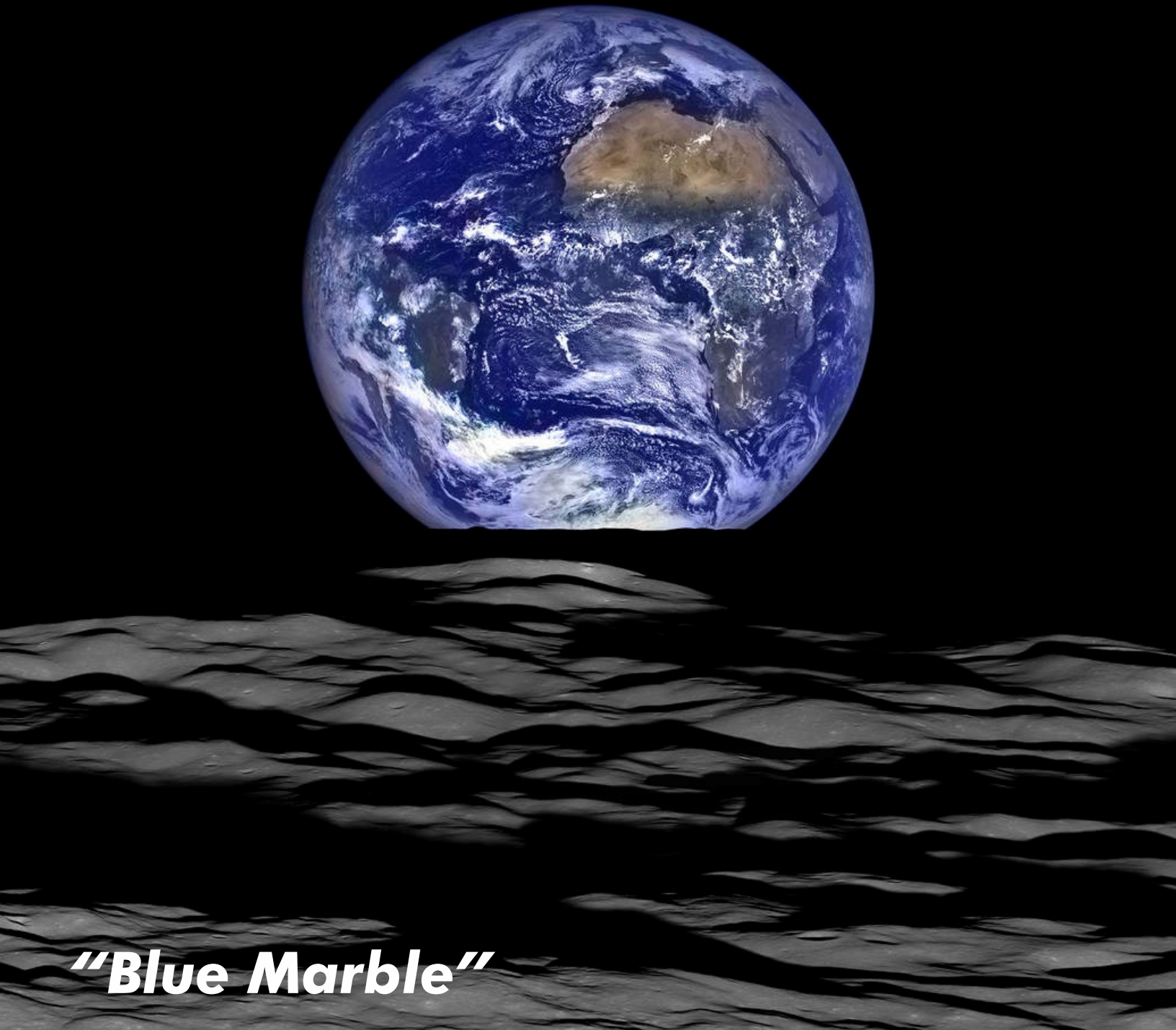
The three moons shown here -- Titan (3,200 miles or 5,150 kilometers across), Mimas (246 miles or 396 kilometers across), and Rhea (949 miles or 1,527 kilometers across) -- show marked contrasts. Titan, the largest moon in this image, appears fuzzy because we only see its cloud layers. And because Titan's atmosphere refracts light around the moon, its crescent "wraps" just a little further around the moon than it would on an airless body. Rhea (upper left) appears rough because its icy surface is heavily cratered. And a close inspection of Mimas (center bottom), though difficult to see at this scale, shows surface irregularities due to its own violent history.

This view looks toward the anti-Saturn hemisphere of Titan. North on Titan is to the right. The image was taken in visible light with the Cassini spacecraft narrow-angle camera on March 25, 2015.

The view was obtained at a distance of approximately 2.7 million miles (4.3 million kilometers) from Titan. Image scale at Titan is 16 miles (26 kilometers) per pixel. Mimas was 1.9 million miles (3.0 million kilometers) away with an image scale of 11 miles (18 kilometers) per pixel. Rhea was 1.6 million miles (2.6 million kilometers) away with an image scale of 9.8 miles (15.7 kilometers) per pixel.

The Cassini mission is a cooperative project of NASA, ESA (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. 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, Colorado.

For more information about the Cassini-Huygens mission visit <http://saturn.jpl.nasa.gov> and <http://www.nasa.gov/cassini>. The Cassini imaging team homepage is at <http://ciclops.org>.



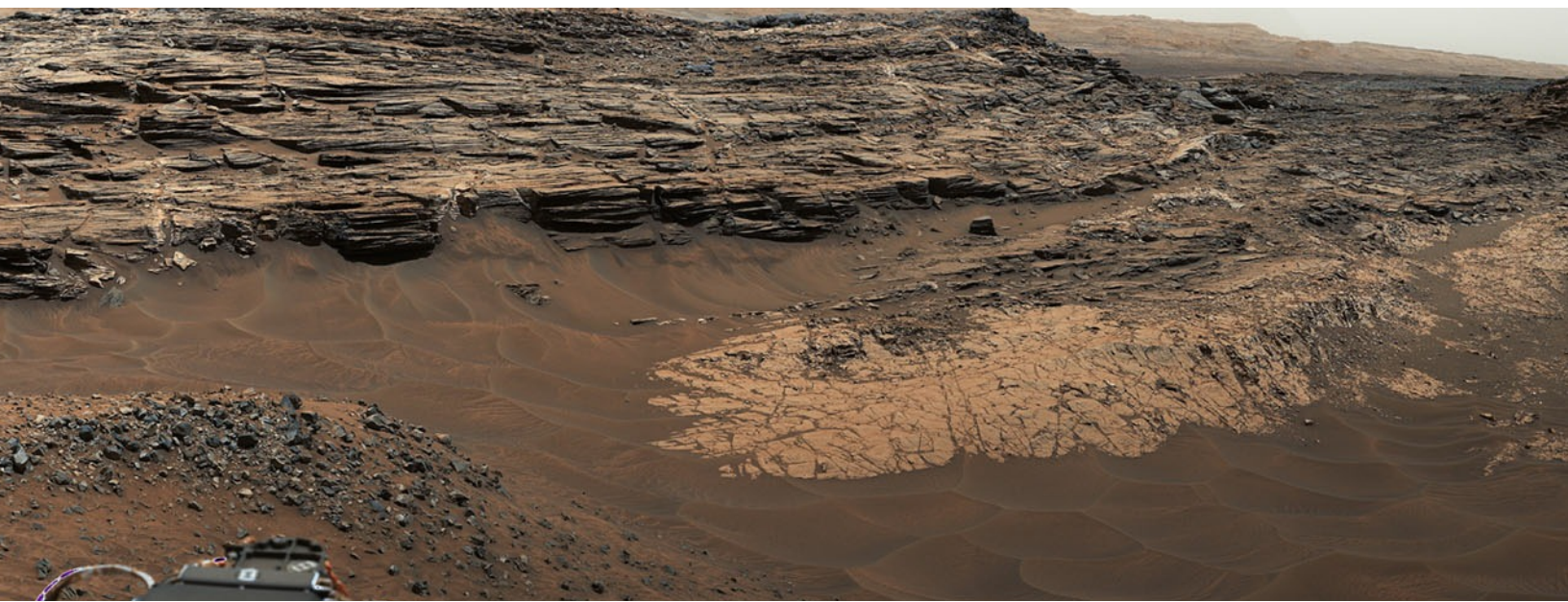
“Blue Marble”

NASA's Lunar Reconnaissance Orbiter (LRO) recently captured a unique view of Earth from the spacecraft's vantage point in orbit around the moon.

"The image is simply stunning," said Noah Petro, Deputy Project Scientist for LRO at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "The image of the Earth evokes the famous 'Blue Marble' image taken by Astronaut Harrison Schmitt during Apollo 17, 43 years ago, which also showed Africa prominently in the picture."

In this composite image we see Earth appear to rise over the lunar horizon from the viewpoint of the spacecraft, with the center of the Earth just off the coast of Liberia (at 4.04 degrees North, 12.44 degrees West). The large tan area in the upper right is the Sahara Desert, and just beyond is Saudi Arabia. The Atlantic and Pacific coasts of South America are visible to the left. On the moon, we get a glimpse of the crater Compton, which is located just beyond the eastern limb of the moon, on the lunar farside.

Rocks Rich in Silica Present Puzzles for Mars Rover Team



This May 22, 2015, view from the Mast Camera (Mastcam) in NASA's Curiosity Mars rover shows the "Marias Pass" area where a lower and older geological unit of mudstone -- the pale zone in the center of the image -- lies in contact with an overlying geological unit of sandstone. Credit: NASA/JPL-Caltech/MSSS

In detective stories, as the plot thickens, an unexpected clue often delivers more questions than answers. In this case, the scene is a mountain on Mars. The clue: the chemical compound silica. Lots of silica. The sleuths: a savvy band of Earthbound researchers whose agent on Mars is NASA's laser-flashing, one-armed mobile laboratory, Curiosity.

NASA's Curiosity rover has found much higher concentrations of silica at some sites it has investigated in the past seven months than anywhere else it has visited since landing on Mars 40 months ago. Silica makes up nine-tenths of the composition of some of the rocks. It is a rock-forming chemical combining the elements silicon and oxygen, commonly seen on Earth as

quartz, but also in many other minerals.

"These high-silica compositions are a puzzle. You can boost the concentration of silica either by leaching away other ingredients while leaving the silica behind, or by bringing in silica from somewhere else," said Albert Yen, a Curiosity science team member at NASA's Jet Propulsion Laboratory, Pasadena, California. "Either of those processes involve water. If we can determine which happened, we'll learn more about other conditions in those ancient wet environments."

Water that is acidic would tend to carry other ingredients away and leave silica behind. Alkaline or neutral water could bring in dissolved silica that would be deposited from the solution.

Apart from presenting a puzzle about the history of the region where Curiosity is working, the recent findings on Mount Sharp have intriguing threads linked to what an earlier NASA rover, Spirit, found halfway around Mars. There, signs of sulfuric acidity were observed, but Curiosity's science team is still considering both scenarios -- and others -- to explain the findings on Mount Sharp.

Adding to the puzzle, some silica at one rock Curiosity drilled, called "Buckskin," is in a mineral named tridymite, rare on Earth and never seen before on Mars. The usual origin of tridymite on Earth involves high temperatures in igneous or metamorphic rocks, but the finely layered

sedimentary rocks examined by Curiosity have been interpreted as lakebed deposits.

Furthermore, tridymite is found in volcanic deposits with high silica content. Rocks on Mars' surface generally have less silica, like basalts in Hawaii, though some silica-rich (silicic) rocks have been found by Mars rovers and orbiters. Magma, the molten source material of volcanoes, can evolve on Earth to become silicic. Tridymite found at Buckskin may be evidence for magmatic evolution on Mars.

Curiosity has been studying geological layers of Mount Sharp, going uphill, since 2014, after two years of productive work on the plains surrounding the mountain. The mission delivered evidence in its first year that lakes in the area billions of years ago offered favorable conditions for life, if microbes ever lived on Mars. As Curiosity reaches successively younger layers up Mount Sharp's slopes, the mission is investigating how ancient environmental conditions evolved from lakes, rivers and deltas to the harsh aridity of today's Mars.

Seven months ago, Curiosity approached "Marias Pass," where two geological layers are exposed in contact with each other. The rover's laser-firing instrument for examining compositions from a distance, Chemistry and Camera (ChemCam), detected bountiful silica in some targets the rover passed on its way to the contact

zone. The rover's Dynamic Albedo of Neutrons instrument simultaneously detected that the rock composition was unique in this area.

"The high silica was a surprise -- so interesting that we backtracked to investigate it with more of Curiosity's instruments," said Jens Frydenvang of Los Alamos National Laboratory in New Mexico and the University of Copenhagen, Denmark.

Gathering clues about silica was a major emphasis in rover operations over a span of four months and a distance of about one-third of a mile (half a kilometer).

The investigations included many more readings from ChemCam, plus elemental composition measurements by the Alpha Particle X-ray Spectrometer (APXS) on the rover's arm and mineral identification of rock-powder samples by the Chemistry and Mineralogy (CheMin) instrument inside the rover.

Buckskin was the first of three rocks where drilled samples were collected during that period. The CheMin identification of tridymite prompted the team to look at possible explanations: "We could solve this by determining whether tridymite in the sediment comes from a volcanic source or has another origin," said Liz Rampe, of Aerodyne Industries at NASA's Johnson Space Center, Houston. "A lot of us are in our labs trying to

see if there's a way to make tridymite without such a high temperature."

Beyond Marias Pass, ChemCam and APXS found a pattern of high silica in pale zones along fractures in the bedrock, linking the silica enrichment there to alteration by fluids that flowed through the fractures and permeated into bedrock. CheMin analyzed drilled material from a target called "Big Sky" in bedrock away from a fracture and from a fracture-zone target called "Greenhorn." Greenhorn indeed has much more silica, but not any in the form of tridymite. Much of it is in the form of noncrystalline opal, which can form in many types of environments, including soils, sediments, hot spring deposits and acid-leached rocks.

"What we're seeing on Mount Sharp is dramatically different from what we saw in the first two years of the mission," said Curiosity Project Scientist Ashwin Vasavada of JPL. "There's so much variability within relatively short distances. The silica is one indicator of how the chemistry changed. It's such a multifaceted and curious discovery, we're going to take a while figuring it out."

For more about Curiosity, which is examining sand dunes this month, visit:

<http://mars.jpl.nasa.gov/msl/>

CLUB MEMBERSHIP INFO

REGULAR MEMBER - \$30.00 per year. Includes club newsletter, and 1 vote at club meetings, plus all other standard club privileges.

FAMILY MEMBER - \$35.00 per year. Same as regular member except gets 2 votes at club meetings.

STUDENT MEMBER - \$10.00 per year with volunteer requirement.

If you renew your membership prior to your annual renewal date, you will receive a 10% discount.

Club members are also eligible for special subscription discounts on Sky & Telescope Magazine.

CLUB TELESCOPES

To check out one of the club telescopes, contact Beth Jenckes. If you keep a scope for more than a week, please check in once a week, to verify the location of the telescope and how long you plan to use it. The checkout time limit will be two weeks, but can be extended if no one else has requested use of a club scope.

100mm Orion refractor: Available

10 inch Meade Dobsonian: Available

13 inch Truss Dobsonian: Available

CLUB APPAREL



Order club apparel from cafepress.com:



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