The Monthly Newsletter of the

Bays Mountain Astronomy Club

January 2018

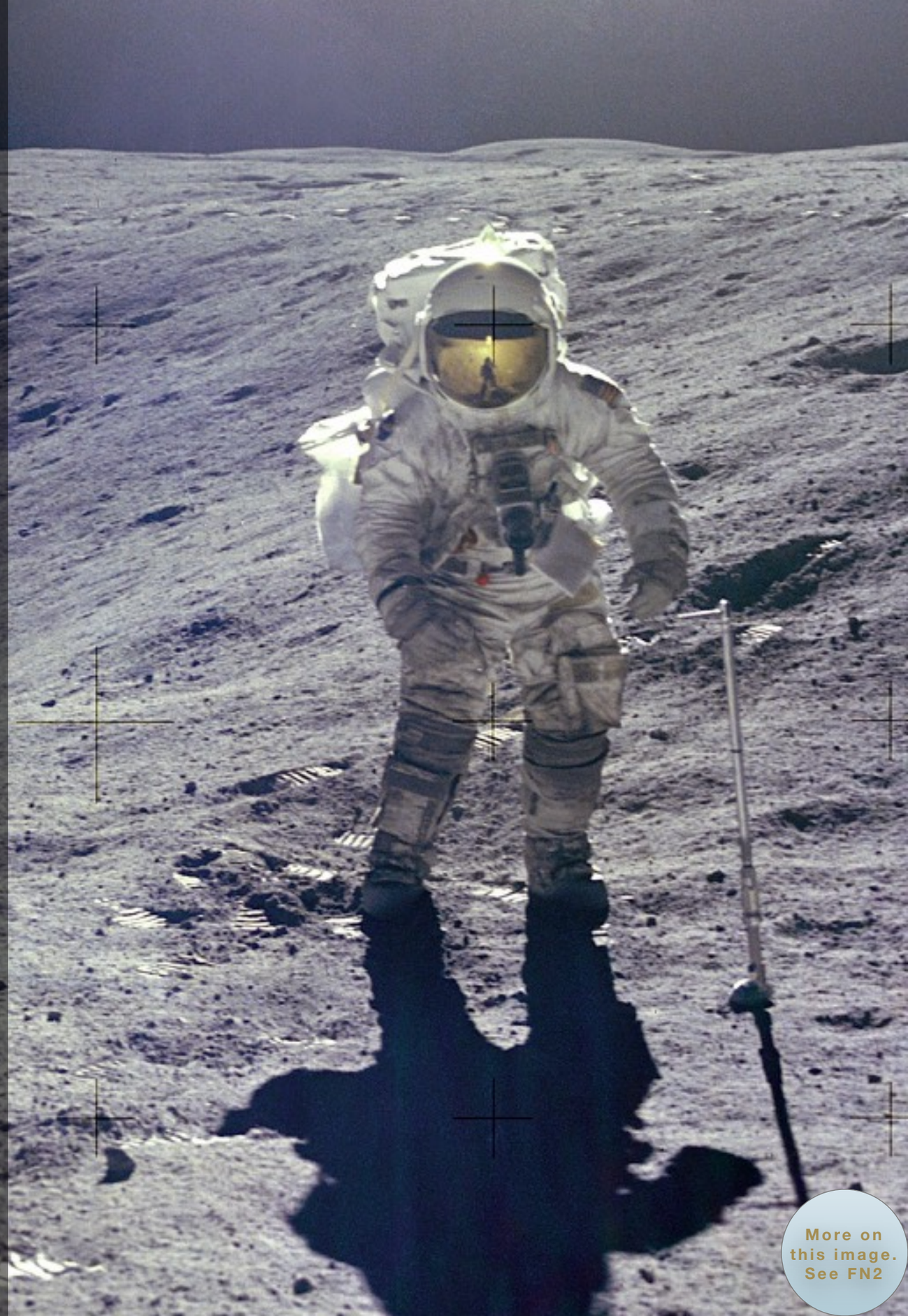
Edited by Adam Thanz

More on this image. See FN1

Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair



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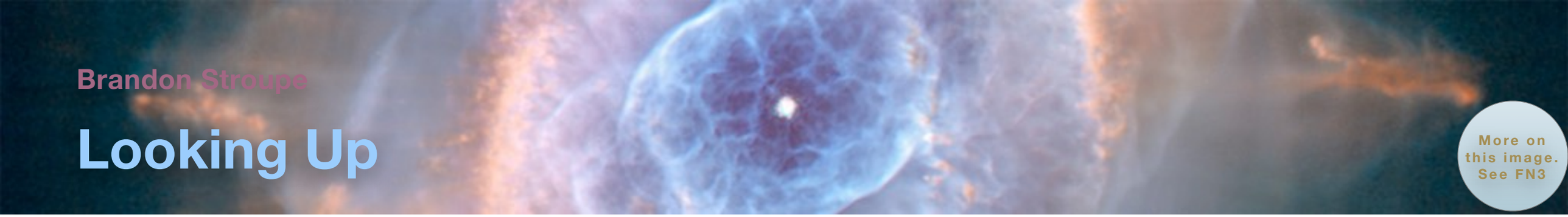


Brandon Stroupe

Looking Up

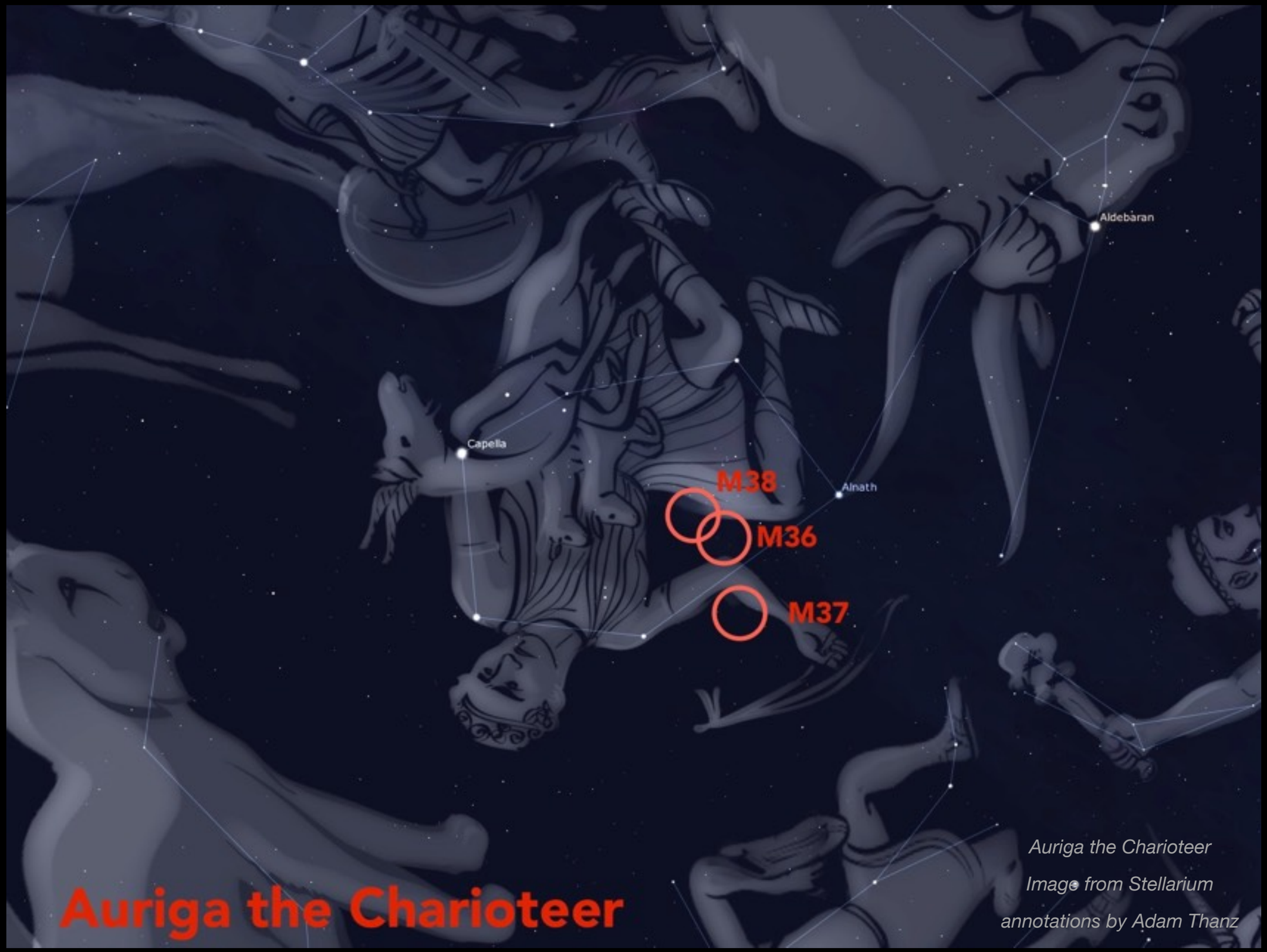
More on this image. See FN3

Hello BMACers,

Welcome to 2018! That's right, it is already 2018. Last year flew by very quickly in my opinion. I hope everyone got what they wanted for Christmas and had an awesome New Year. I also hope 2017 was a good year for everyone and I hope 2018 will be an even better year for you all. We had a lot of great events last year with Astronomy Day, StarFest, the StarWatches, SunWatches, and who could forget, the Great American Solar Eclipse. That was by-far the best event of last year to me. I do look forward to the next one. Do any of you have a memorable event from last year? I hope everyone enjoyed our monthly meetings in 2017 and I hope to make 2018 meetings even better. I wish everyone luck in this new year.

The first meeting of 2018 will be, as always, our annual dinner. Our annual dinner this year will be held on January 13th at 6:30 p.m. at The Meadows Restaurant at the MeadowView Resort in Kingsport. Most of you know this resort because you may have stayed there during StarFest or if you are just familiar with the area. [Ed.: If you are not familiar, the MeadowView Marriott Resort is on the same exit (3) off of I-26 as the Park. But, you turn to the east.] The snow date for the annual dinner will be on January 20th at the same time. Hopefully we will not have any issues with the weather for our first date. We will also not be having a speaker for our annual dinner. I know we have in the past, buy new rules at the Meadows Restaurant prohibit speakers and projectors in the restaurant. I hope everyone will still come out and enjoy the food and talking amongst your fellow Astro geeks. The food there is very good too. I hope to see you all there!

At our meeting last month, we showed everyone the best way to find their way around the night sky. We had this type of meeting because we all know that it can be a difficult thing to do for people just starting out in our fun little hobby. We showed how to use a Planisphere, a finder scope, and a Telrad. We also showed how to read the different types of star charts. We had many different examples of them all. There were also many questions answered that people asked. I hope everyone enjoyed the meeting and the topic of discussion. I really enjoy when people are interested enough in the presentation to ask plenty of questions. If you didn't get to make it, we will continue to have



Auriga the Charioteer

Image from Stellarium

annotations by Adam Thanz

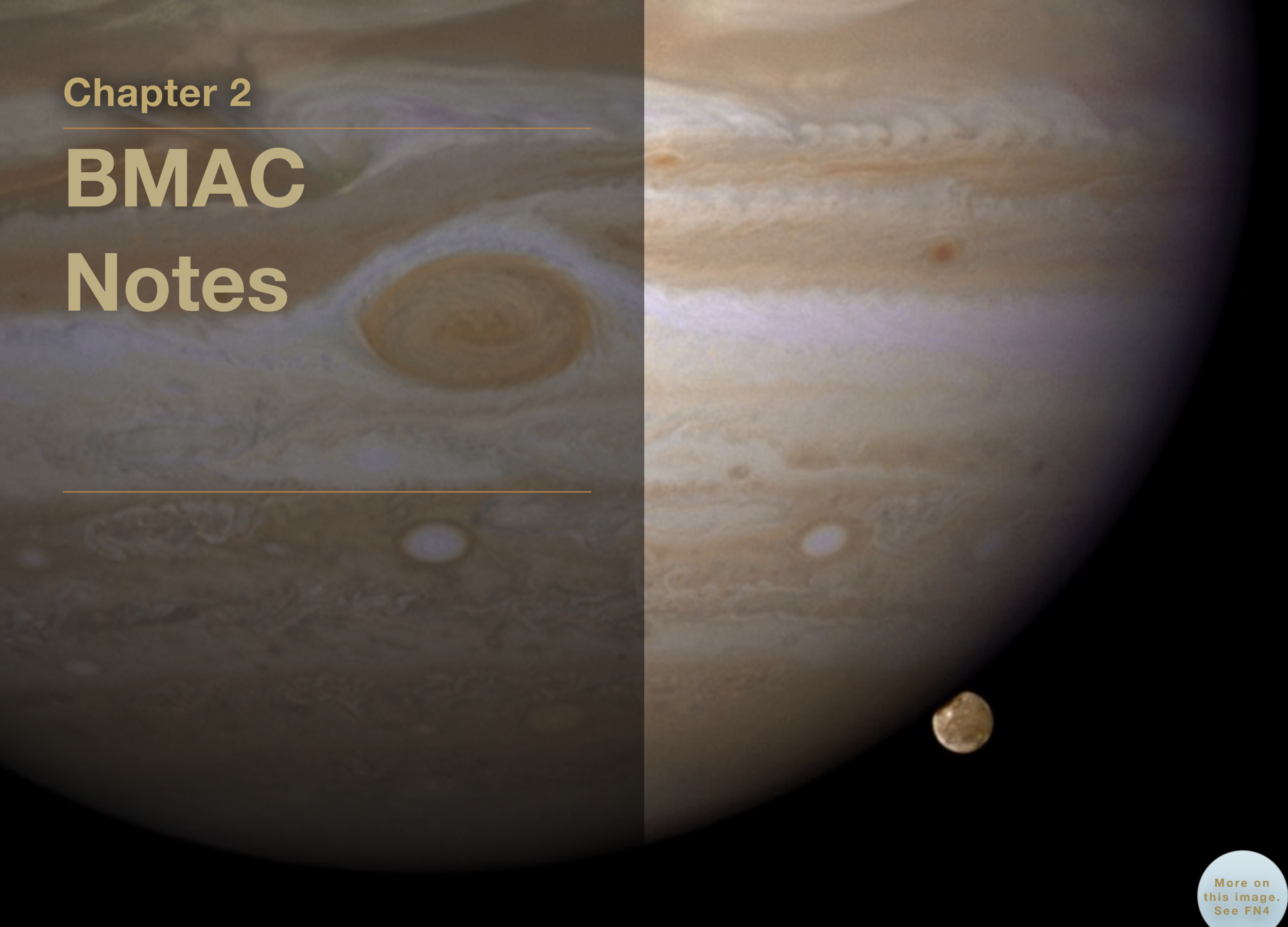
these types of presentations in the new year. I also want to thank everyone that helped with the presentation as well.

Our constellation this month will be Auriga. Auriga is translated to The Charioteer. In Greek mythology, Auriga is often identified as the mythological Greek hero Erichthonius of Athens, who was the son of Hephaestus and who was raised by the goddess Athena. Erichthonius was generally credited to be the inventor of the quadriga, which is the four-horse chariot. He used this in the battle against the Amphictyon. This was the event that made Erichthonius the King of Athens. After that, his chariot was created in the image of the Sun's chariot. The Athenian hero then dedicated himself to Athena, the one that raised him, and soon after that Zeus raised him into the night sky in honor of his ingenuity and heroic deeds. Traditionally, Auriga is depicted as a chariot and its driver, however, those depictions of Auriga have been inconsistent over the years. There are various other myths about this constellation that are worth looking into if you are interested. There are some good, notable deep-sky objects in the Auriga constellation. Three of them are Messier objects and open clusters. They are M36, M37, and M38. All three of these objects can be seen in binoculars. Auriga has a lot of other objects to look at as well. Next time you are out, give this interesting constellation a little bit of your attention. If you would like to know more, read Jason Dorfman's article Celestial Happenings for more in Auriga.

That will be it for this month. Please remember our annual dinner this month on January 13th at 6:30 p.m. at the Meadows Restaurant which is at the MeadowView Resort. Also, remember that we have a little bit of a break before the StarWatches and the SunWatches start back up in March. I hope everyone will be able to make plans to help with them when they start back. Also, if anyone got a new astro toy for Christmas and you would like to show it off at one of our meetings or even learn how to use it, please feel free to bring it and we will make time for you to show it and talk about it. Until next month… Clear Skies.

Chapter 2

BMAC Notes



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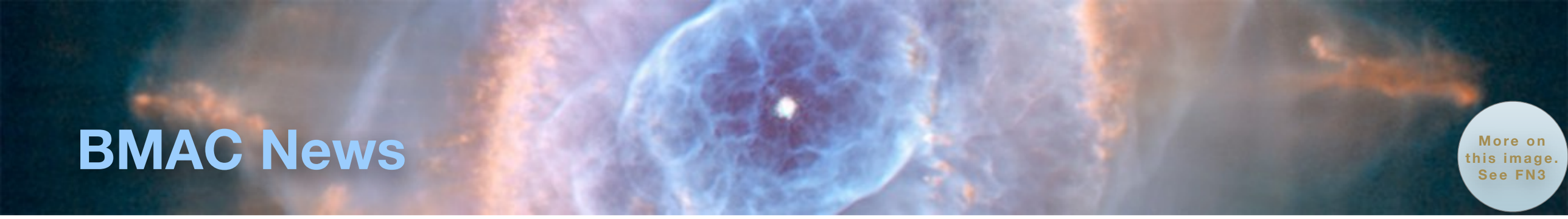

BMAC News

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2018 Texas Star Party

The great tradition of dark sky observing continues with the 40th Annual TEXAS STAR PARTY, May 6-13, 2018 near Ft Davis, Texas!

Staying on the Ranch in housing, RV, or camping? Staying off-site in other accommodations? Everyone needs to enter the TSP drawing, held in late January. You should submit a Registration/ Reservation Request Form to ENTER THE TSP DRAWING before January 19, 2018. This will provide you the highest possible chance of being selected as one of the 500 people who will be able to attend TSP this year.

Follow this link to get started!
http://texasstarparty.org/get-started/

Cool Website to Visit

I heard about this website from a planetarian colleague of mine. Upon you establishing your position on Earth, it will display when and where the International Space Station (ISS) will pass in front of the Sun or Moon! If you click the link that states to see the pass on a map, it will show a band on Google Maps. This easily shows, graphically, if you are on the right part of the Earth to see such a transit. Here's the link:

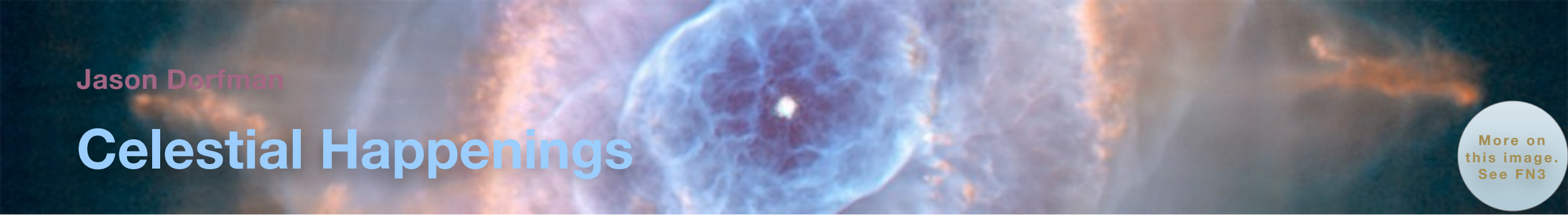
http://transit-finder.com

Chapter 3

Celestial Happenings

Jason Dorfman

More on this image. See FN5



Jason Dorfman

Celestial Happenings

More on this image. See FN3

Welcome to a new year! I hope that 2017 was a good year for everyone and that 2018 turns out to be an even better year. Personally, 2017 was a difficult year and went by quickly. I'm hoping for a much better 2018.

If you are reading this before the new year, then be sure to pay attention. New Year's Day begins with a bang, astronomically speaking. On the 1st will be the closest Full Moon of the year and Mercury reaches its greatest western elongation. This month we have our usual array of planets to observe and a normally rewarding meteor shower that unfortunately will be out done by our Moon. Also this month, Brandon and I managed to communicate early enough about this month's constellation, so I will highlight a few things to observe within it.

Constellation of the Month

As you have probably already seen in Brandon's article, the constellation this month is Auriga, the Roman charioteer. Because it lies along the band of the Milky Way, there are several good viewing targets found here. Capella is the brightest star in Auriga and shines at magnitude +0.05. To the southwest of Capella we find Almaaz, epsilon Aurigae, an eclipsing binary system that is still being studied to determine the true nature of the unique brightness variations. Almaaz is a supergiant star with a diameter of a little more than the distance of the Earth to the Sun. The eclipses occur 27.1 years apart and last for two years. The data suggests that the eclipsing object is larger than the giant star! Some of you may recall that former club member, Tom Rutherford, was involved in getting accurate brightness measurements of this star during the last eclipse in 2009-2011 and gave a terrific presentation about this research. I believe the leading hypothesis is currently that Almaaz is being eclipsed by another smaller star some 30 AU away that has a clumpy dust disk surrounding it, which would account for the long eclipse and other features seen in the light curve.

Also found within Auriga are several open clusters, three of which are Messier objects - M36, M37 and M38. About 18° to the south of Capella is the second brightest star of Auriga, a star called Elnath. Look between these two stars, about two-thirds of the way towards Elnath, and you'll find two arcs of bright stars. You can use these to help guide you to the Messier objects. From the more northeastern arc, look about a degree farther north for M38.

This is the biggest of the three open clusters. M36 is 2° southeast of M38 and M37 is just over 3° to the east-southeast of M36. Together they span a little more than 5° and can be seen together in a wide field binocular view. All three clusters are about the same distance from us, between 4300 and 4600 light-years away. This means that the differences that you see with each cluster are close to the actual differences between the clusters. M36 has the smallest diameter of the three and is the brightest and more dazzling. M37 is a much richer cluster than the others with 100's of stars compared to just dozens in the other two. There are a few other fainter clusters, as well. Check out a great article in this month's Sky & Telescope about the open clusters in Auriga and Perseus. It has some finder charts and goes into much more detail than I can provide here.

Luna

The Moon will play a more prominent role in the evening sky this month. The month, and the New Year, begins with a Full Moon and one that occurs when the Moon is at perigee. This will be the closest Full Moon of 2018. So, be prepared for lots of excessive "Super Moon" hype in the media. Look for it rising in the east at sunset.

But wait! There's more. Since the synodic period of the Moon is 29.5 days, there will be a second Full Moon this month - a Blue Moon! It will occur on the 31st. And, if that weren't spectacular enough, a total lunar eclipse will also occur that morning.

Unfortunately, from our location we will miss most of this event. The partial eclipse, when the Moon enters the Earth's darker umbral shadow, will begin at 6:48 a.m. The Moon will be just 7.5° above the western horizon at that moment and will set some 30 minutes later before reaching greatest eclipse. If you happen to find yourself farther to the west on the Earth that morning, then you'll get to see more of the eclipse.

Planets

If you are a morning person, which I am not, then you will have the opportunity this month to glimpse all the naked eye planets except for Venus. Appearing first in the early morning sky will be Mars quickly followed by Jupiter. At the start of January, Mars will rise about 3:30 a.m. with Jupiter just a few minutes later. You will see them straddling the bright star Zubenelgenubi, the alpha star of Libra. Mars is still too distant to see anything other than an orangish blob in your scope. It has a magnitude +1.5 and the disk spans about 5"(arc seconds). Mars is moving swiftly eastward this month and will cross in front of Jupiter in the first week giving us a nice conjunction on the 7th when the two will be separated by just 16'(arc minutes)! This is the closest that the two have appeared in the sky and been visible since January 1998! A few days later on the 11th, a thin waning crescent will be visible 4.6° north of the pair with 2.1° separating the two worlds. Mars will continue its eastward trek through Libra throughout the month and cross into the head of Scorpius on the 31st. Due to its eastward movement, Mars will rise just 20 minutes earlier by

month's end. A little preview of what's to come in 2018, Mars is headed towards a spectacular opposition in July.

Jupiter will remain in Libra throughout the month, moving only slightly eastward into the center of the constellation. Though it is quite distant compared to Mars, this giant world shines at a bright magnitude of -1.8. The disk spans about 34" at the beginning of the month. Your best views will be later in the predawn hours when Jupiter has risen a bit higher above the horizon. The "King of the Planets" will rise about an hour and half earlier by month's end.

As the New Year begins and your celebrations are winding down, stay up to see the Sun rise (or set an early alarm) and catch a glimpse of the smallest planet, Mercury. It will reach its greatest western elongation on the 1st putting it about 23° west of the Sun. A half hour before sunrise it will be about 11° above the southeastern horizon and roughly 11° to the left of Antares in Scorpius. The magnitude will be -0.3 and through a scope you will see the planet about 62% illuminated with a 6.7" disk. Though this swift and small world will begin an eastward trek back towards the Sun after this day, putting it more into the early twilight glow, be sure to take a look again on the 12th and 13th for a conjunction with Saturn. On the 13th, the two will be just 0.6° apart. Saturn will be at magnitude +0.5, so you'll probably need binoculars to pull it out from the bright morning twilight. But, don't expect any spectacular views of the ringed planet this month. Even by month's end, the planet will still be a bit low to the horizon as the Sun's bright glow begins to extinguish the light of the stars.

Once again, the only observable planets during the few hours after sunset are Uranus and Neptune. Look for Neptune first in the constellation of Aquarius. It will be about 30° above the southwest horizon after sunset. It has a magnitude of +7.9. Look near the star Lambda Aquarii. Then head eastward into Pisces for Uranus. Being a bit closer to the Sun than Neptune, it's a bit brighter at magnitude +5.8. Both will appear star-like in binoculars. You'll definitely want a finder chart for Uranus since its among the fainter stars of Pisces. Sky & Telescope has a nice one available here: http://wwwcdn.skyandtelescope.com/wp-content/uploads/WEB_Uranus_Neptune17.pdf

Quadrantids Meteor Shower

Normally a good shower to observe with an hourly rate that often exceeds 100, the Quadrantids this year will be impacted by a bright, gibbous Moon. The peak night occurs on the night of the 3rd, just two days after Full Moon. Though much of the possible meteors will not be visible, the Quadrantids are known to produce some bright fireballs, which would definitely be visible despite the Moon's presence.

Miscellany

This has turned into a slightly longer article than planned, but I do have some final tidbits for you. Our planet will reach perihelion on

the 3rd of the month. It will then be 91.4 million miles from the Sun. Also, the largest asteroid, Ceres, reaches opposition on the 31st. However, as mentioned earlier, there is a Full Moon that evening. Your best views will be closer to midnight and when the Moon is not as prominent.

Thanks for reading! Wishing you all great views of the skies above for 2018!

Chapter 4

The Queen Speaks

Robin Byrne

Robin Byrne

Book Review: Margaret and the Moon

More on this image. See FN3

For this book review, I'm doing something different and reviewing a children's book. Margaret and the Moon: How Margaret Hamilton Saved the First Lunar Landing by Dean Robbins and illustrated by Lucy Knisley is targeted to children ages 4 - 8, though this 53 year old also enjoyed reading it.

This is the true story of Margaret Hamilton. It begins with her childhood and love of solving problems, from insects to music and all points in between. The book also shows how, despite growing up in the 1930's and 40's, she was willing to break gender stereotypes, even playing on the all-boys baseball team.

Mathematics was her true love, though. From simple arithmetic to algebra to calculus, she always enjoyed the challenge of solving problems. Then she discovered the world of computers and transferred her love of problem solving to writing computer code. She even coined the new title for the work she did: Software Engineer. Some of her earliest programs began with basic arithmetic, but built up to tracking airplanes through clouds, and using computer software to predict the weather.

In 1964, Margaret joined NASA to write computer code to help land men on the Moon. Her code not only dealt with the expected events of the lunar trip, but she also built into the software contingency plans for when things didn't go as planned. Moving up through the ranks, Margaret became Director of Software Programming for Project Apollo. Her code was first used for Apollo 8, but it was Apollo 11 that really put her software to the test. During the Apollo 11 landing, there was a problem with the computer - it became overloaded with too much happening at once. However, Margaret had a simple fix already written into the code that allowed the computer to ignore everything but the landing. The rest, as they say, is history.

This book tells a great story and should be particularly inspirational for young girls. Some of the vocabulary may be above the level of the youngest children being targeted, but that can provide an opportunity for conversations between the child and parent. The illustrations by Lucy Knisley are enchanting. At the end of the book are actual photographs of Margaret Hamilton, some of which were clearly used as the source for the drawings.

The cover to Margaret and the Moon

Margaret Hamilton and the code for the Apollo Project. Image from Draper Laboratory; restored by Adam Cuerden

Margaret Hamilton in the Apollo Command Module. Image NASA.

Presidential Medal of Freedom recipient Margaret Hamilton with President Barack Obama. November 2016. Official White House Photo by Lawrence Jackson

Whether you are a big kid who enjoys reading about the unsung heroes of the space program, or you have a young person in your life who you want to help inspire, Margaret and the Moon is the book for you.

References:

Margaret and the Moon: How Margaret Hamilton Saved the First Lunar Landing by Dean Robbins, illustrated by Lucy Knisley; Alfred A. Knopf 2017.

Chapter 5

Space Place

More on this image. See FN6

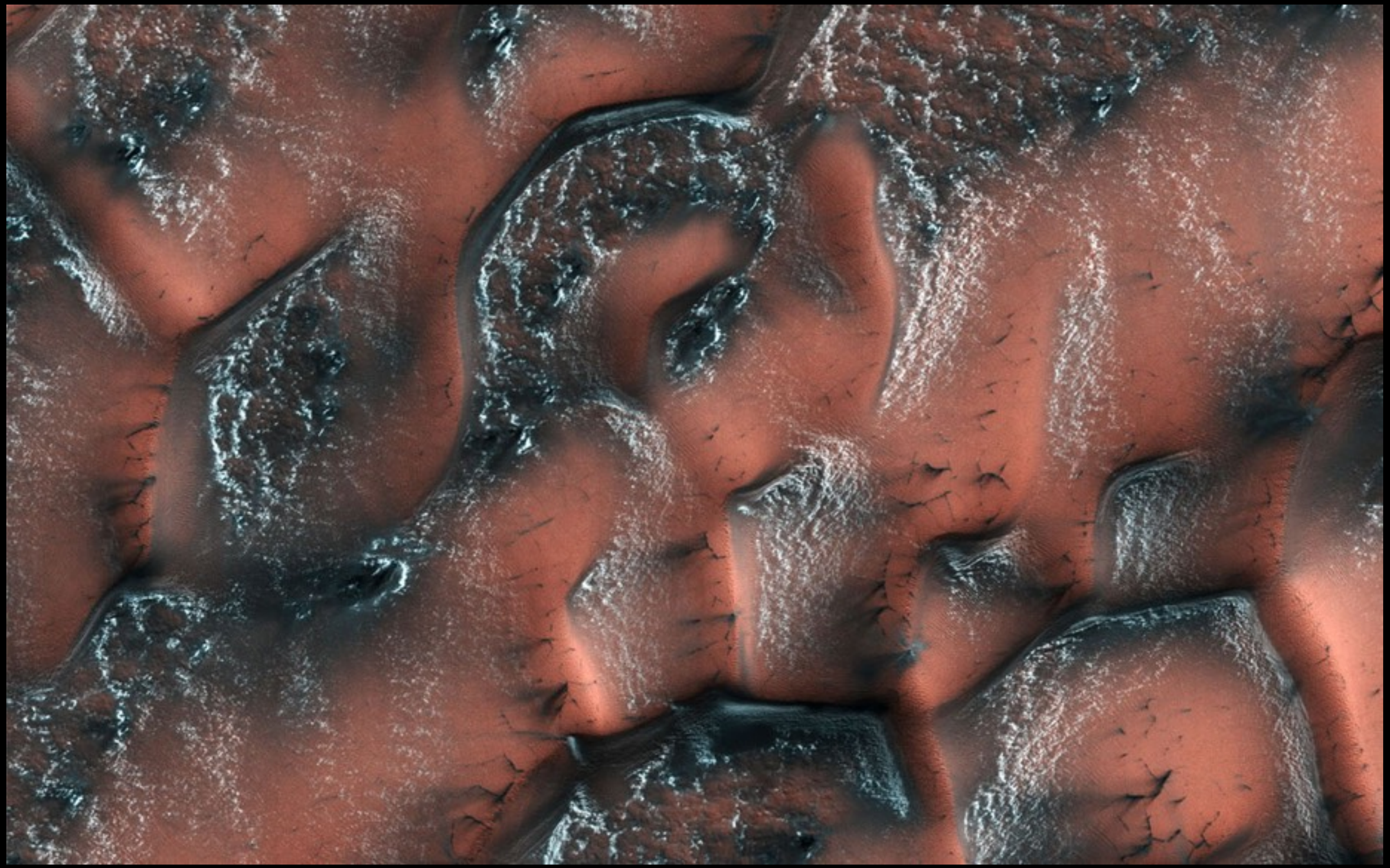
Linda Hermans-Killiam
Snowy Worlds Beyond Earth

MORE ABOUT THIS IMAGE

There are many places on Earth where it snows, but did you know it snows on other worlds, too? Here are just a few of the places where you might find snow beyond Earth:

Mars

The north pole and south pole of Mars have ice caps that grow and shrink with the seasons. These ice caps are made mainly of water ice—the same kind of ice you'd find on Earth. However, the snow that falls there is made of carbon dioxide—the same ingredient used to make dry ice here on Earth. Carbon dioxide is in the Martian atmosphere and it freezes and falls to the surface of the planet as snow. In 2017, NASA's Mars Reconnaissance Orbiter took photos of the sand dunes around Mars' north pole. The slopes of these dunes were covered with carbon dioxide snow and ice.



NASA's Mars Reconnaissance Orbiter captured this image of carbon dioxide snow covering dunes on Mars. Credit: NASA/JPL/University of Arizona

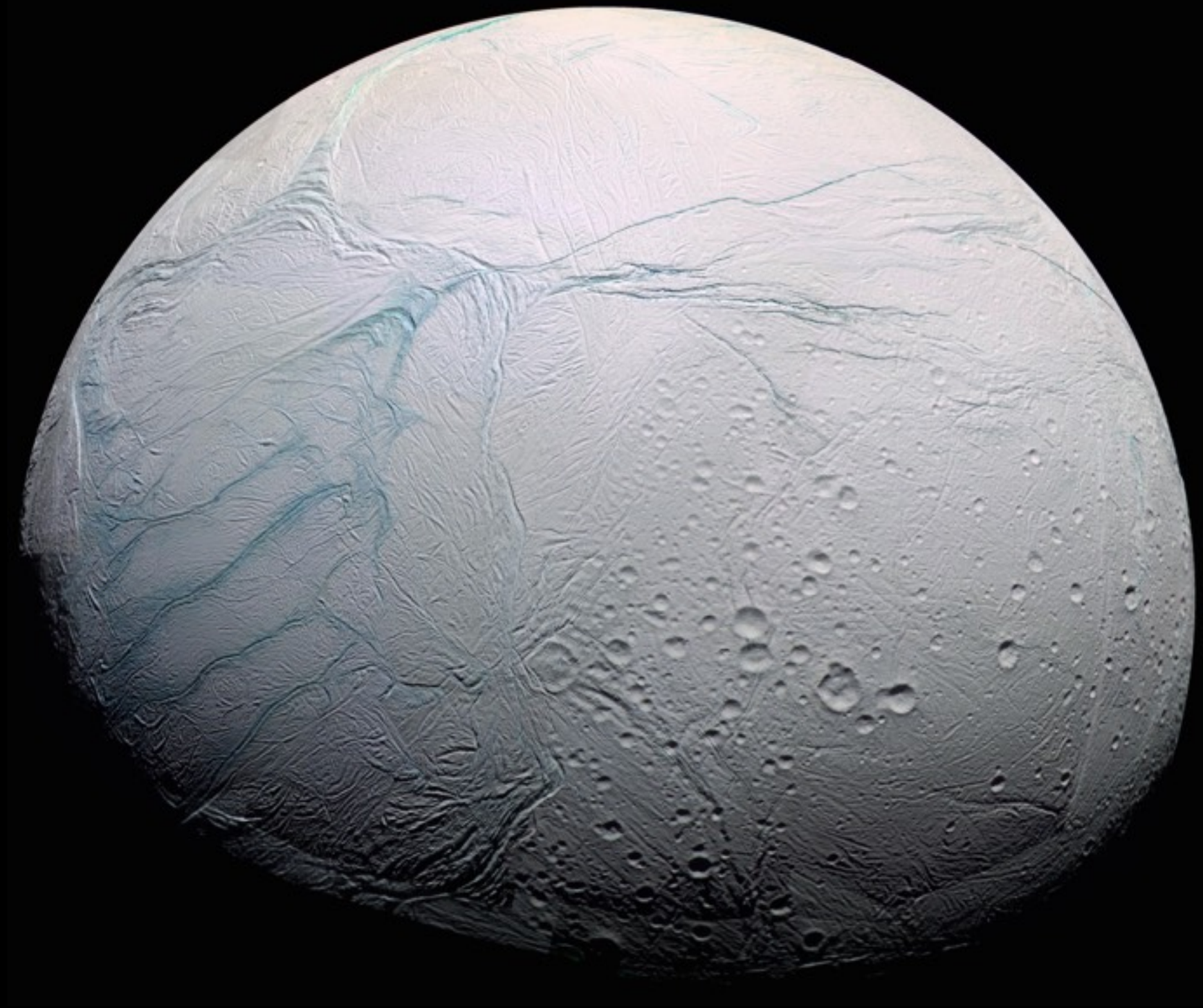
A Moon of Jupiter: Io

There are dozens of moons that orbit Jupiter and one of them, called Io, has snowflakes made out of sulfur. In 2001, NASA's Galileo spacecraft detected these sulfur snowflakes just above Io's south pole. The sulfur shoots into space from a volcano on Io's surface. In space, the sulfur quickly freezes to form snowflakes that fall back down to the surface.

A volcano shooting molten sulfur out from the surface of Io. Credit: NASA/JPL-Caltech

A Moon of Saturn: Enceladus

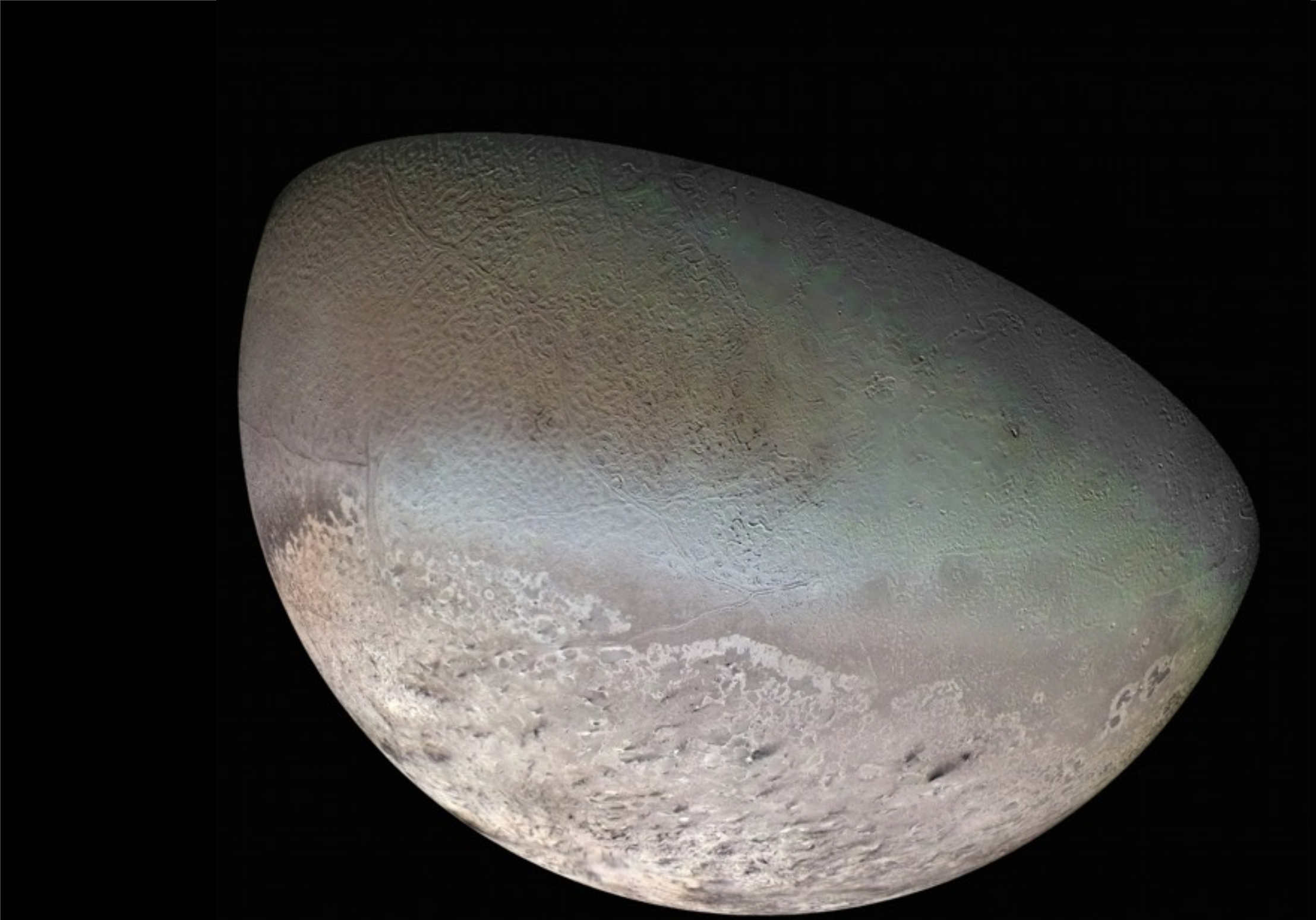
Saturn's moon, Enceladus, has geysers that shoot water vapor out into space. There it freezes and falls back to the surface as snow. Some of the ice also escapes Enceladus to become part of Saturn's rings. The water vapor comes from a heated ocean which lies beneath the moon's icy surface. (Jupiter's moon Europa is also an icy world with a liquid ocean below the frozen surface.) All of this ice and snow make Enceladus one of the brightest objects in our Solar System.



Enceladus as viewed from NASA's Cassini spacecraft. Credit: NASA

A Moon of Neptune: Triton

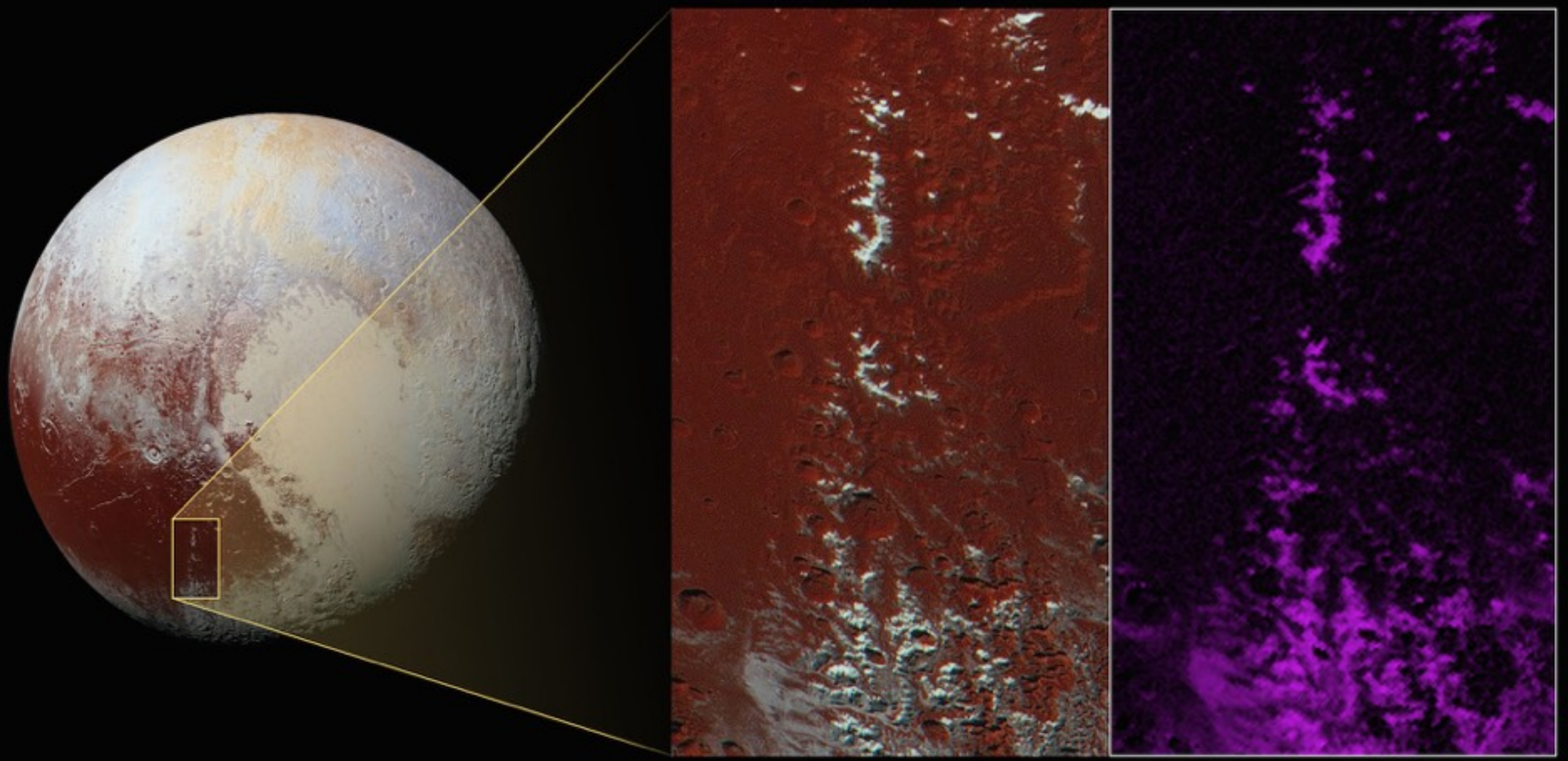
Neptune’s largest moon is Triton. It has the coldest surface known in our Solar System. Triton’s atmosphere is made up mainly of nitrogen. This nitrogen freezes onto its surface covering Triton with ice made of frozen nitrogen. Triton also has geysers like Enceladus, though they are smaller and made of nitrogen rather than water.



The Voyager 2 mission captured this image of Triton. The black streaks are created by nitrogen geysers. Credit: NASA/JPL/USGS

Pluto

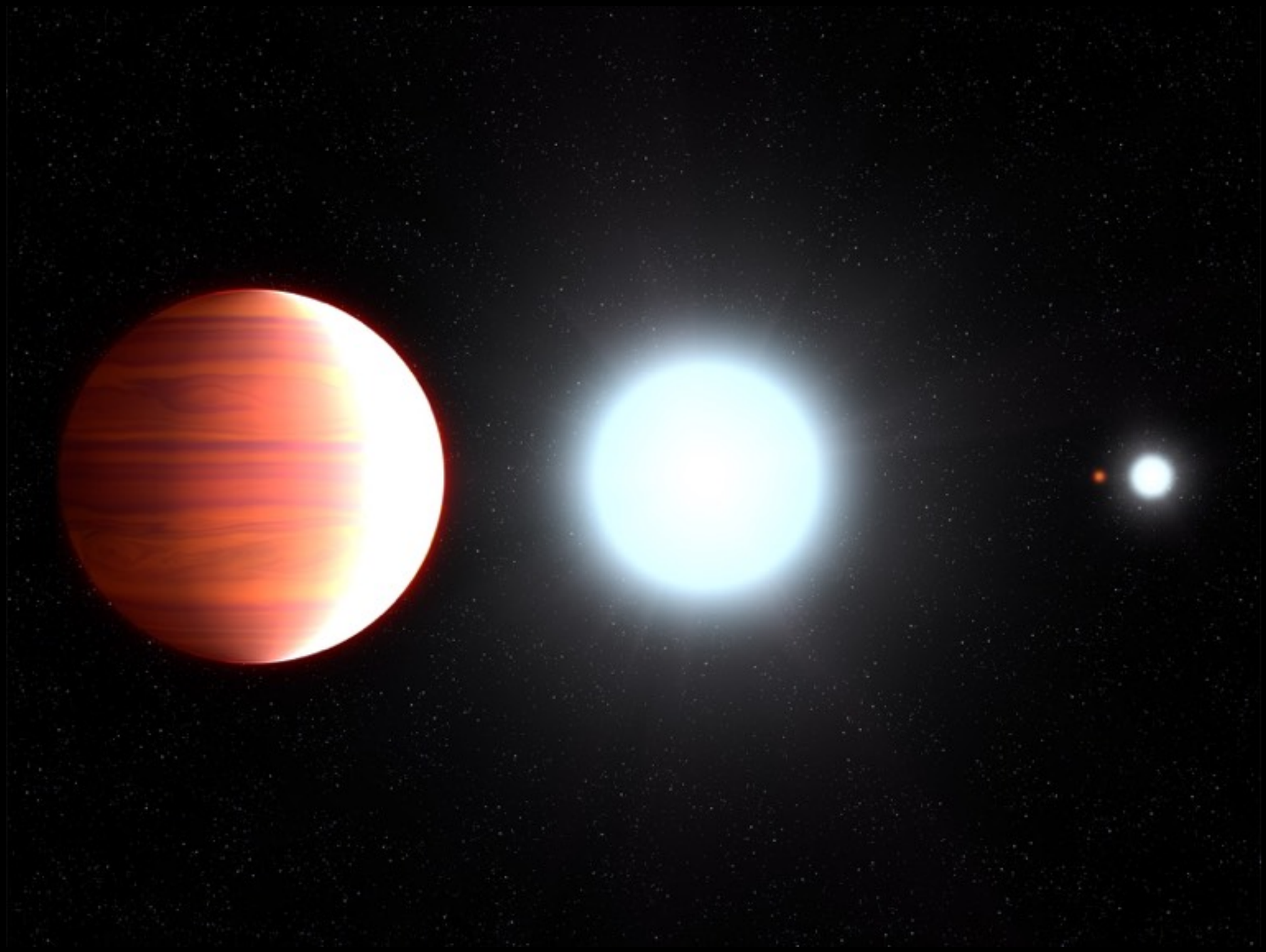
Farther out in our Solar System lies the dwarf planet Pluto. In 2016, scientists on the New Horizons mission discovered a mountain chain on Pluto where the mountains were capped with methane snow and ice.



The snowy Cthulhu (pronounced kuh-THU-lu) mountain range on Pluto. Credits: NASA/JHUAPL/SwRI

Beyond Our Solar System

There might even be snow far outside our Solar System! Kepler-13Ab is a hot, giant planet 1,730 light years from Earth. It's nine times more massive than Jupiter and it orbits very close to its star. The Hubble Space Telescope detected evidence of titanium oxide—the mineral used in sunscreen—in this planet's upper atmosphere. On the cooler side of Kepler-13Ab that faces away from its host star, the planet's strong gravity might cause the titanium oxide to fall down as "snow."



This is an artist's illustration of what Kepler-13Ab might look like. Credit: NASA/ESA/G. Bacon (STScI)

Want to learn more about weather on other planets? Check out NASA Space Place: https://spaceplace.nasa.gov/planet-weather

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!

Chapter 6

BMAC Calendar and more

More on this image. See FN7

BMAC Calendar and more

More on this image. See FN3

Date	Time	Location	Notes
BMAC Meetings			
Friday, February 2, 2018	7 p.m.	Nature Center Discovery Theater	Program: Topic TBA; Free.
Friday, March 2, 2018	7 p.m.	Nature Center Discovery Theater	Program: Topic TBA; Free.
Friday, April 6, 2018	7 p.m.	Nature Center Discovery Theater	Program: Topic TBA; Free.
SunWatch			
Every Saturday & Sunday March - October	3-3:30 p.m. if clear	At the dam	View the Sun safely with a white-light view if clear.; Free.
StarWatch			
Mar. 3, 10, 2018	7:00 p.m.	Observatory	View the night sky with large telescopes. If poor weather, an alternate live tour of the night sky will be held in the planetarium theater.; Free.
Mar. 17, 24, 2018	8:00 p.m.		
Apr. 7, 14, 21, 28, 2018	8:30 p.m.		
Special Events			
Saturday, January 13, 2018	6:30 p.m.	Meadows Restaurant, MeadowView Marriott Resort	Annual BMAC Dinner. Jan. 20 is the snow date.

Bays Mountain Astronomy Club

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1 (423) 229-9447

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Annual Dues:

Dues are supplemented by the Bays Mountain Park Association and volunteerism by the club. As such, our dues can be kept at a very low cost.

$16 /person/year

$6 /additional family member

Note: if you are a Park Association member (which incurs an additional fee), then a 50% reduction in BMAC dues are applied.

The club's website can be found here:

www.baysmountain.com/astronomy/astronomy-club/

Regular Contributors:

Brandon Stroupe

Brandon is the current chair of the club. He is a photographer for his home business, Broader Horizons Photography and an avid astrophotographer. He has been a member since 2007.

Robin Byrne

Robin has been writing the science history column since 1992 and was chair in 1997. She is an Associate Professor of Astronomy & Physics at Northeast State Community College (NSCC).

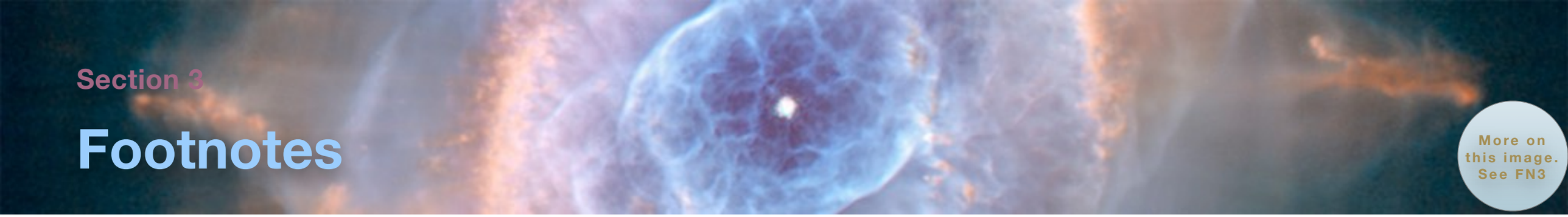
Jason Dorfman

Jason works as a planetarium creative and technical genius at Bays Mountain Park. He has been a member since 2006.

Adam Thanz

Adam has been the Editor for all but a number of months since 1992. He is the Planetarium Director at Bays Mountain Park as well as an astronomy adjunct for NSCC.

Footnotes



Footnotes:

1. The Rite of Spring

Of the countless equinoxes Saturn has seen since the birth of the solar system, this one, captured here in a mosaic of light and dark, is the first witnessed up close by an emissary from Earth … none other than our faithful robotic explorer, Cassini.

Seen from our planet, the view of Saturn's rings during equinox is extremely foreshortened and limited. But in orbit around Saturn, Cassini had no such problems. From 20 degrees above the ring plane, Cassini's wide angle camera shot 75 exposures in succession for this mosaic showing Saturn, its rings, and a few of its moons a day and a half after exact Saturn equinox, when the sun's disk was exactly overhead at the planet's equator.

The novel illumination geometry that accompanies equinox lowers the sun's angle to the ring plane, significantly darkens the rings, and causes out-of-plane structures to look anomalously bright and to cast shadows across the rings. These scenes are possible only during the few months before and after Saturn's equinox which occurs only once in about 15 Earth years. Before and after equinox, Cassini's cameras have spotted not only the predictable shadows of some of Saturn's moons (see PIA11657), but also the shadows of newly revealed vertical structures in the rings themselves (see PIA11665).

Also at equinox, the shadows of the planet's expansive rings are compressed into a single, narrow band cast onto the planet as seen in this mosaic. (For an earlier view of the rings' wide shadows draped high on the northern hemisphere, see PIA09793.)

The images comprising the mosaic, taken over about eight hours, were extensively processed before being joined together. First, each was re-projected into the same viewing geometry and then digitally processed to make the image "joints" seamless and to remove lens flares, radially extended bright artifacts resulting from light being scattered within the camera optics.

At this time so close to equinox, illumination of the rings by sunlight reflected off the planet vastly dominates any meager sunlight falling on the rings. Hence, the half of the rings on the left illuminated by planetshine is, before processing, much brighter than the half of the rings on the right. On the right, it is only the vertically extended parts of the rings that catch any substantial sunlight.

With no enhancement, the rings would be essentially invisible in this mosaic. To improve their visibility, the dark (right) half of the rings has been brightened relative to the brighter (left) half by a factor of three, and then the whole ring system has been brightened by a factor of 20 relative to the planet. So the dark half of the rings is 60 times brighter, and the bright half 20 times brighter, than they would have appeared if the entire system, planet included, could have been captured in a single image.

The moon Janus (179 kilometers, 111 miles across) is on the lower left of this image. Epimetheus (113 kilometers, 70 miles across) appears near the middle bottom. Pandora (81 kilometers, 50 miles across) orbits outside the rings on the right of the image. The small moon Atlas (30 kilometers, 19 miles across) orbits inside the thin F ring on the right of the image. The brightnesses of all the moons, relative to the planet, have been enhanced between 30 and 60 times to make them more easily visible. Other bright specks are background stars. Spokes -- ghostly radial markings on the B ring -- are visible on the right of the image.

This view looks toward the northern side of the rings from about 20 degrees above the ring plane.

The images were taken on Aug. 12, 2009, beginning about 1.25 days after exact equinox, using the red, green and blue spectral filters of the wide angle camera and were combined to create this natural color view. The images were obtained at a distance of approximately 847,000 kilometers (526,000 miles) from Saturn and at a Sun-Saturn-spacecraft, or phase, angle of 74 degrees. Image scale is 50 kilometers (31 miles) per 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://saturn.jpl.nasa.gov/. The Cassini imaging team homepage is at http://ciclops.org.

Image Credit: NASA/JPL/Space Science Institute

2. Duke on the Craters Edge

Astronaut Charles M. Duke Jr., Lunar Module pilot of the Apollo 16 mission, is photographed collecting lunar samples at Station no. 1 during the first Apollo 16 extravehicular activity at the Descartes landing site. This picture, looking eastward, was taken by Astronaut John W. Young, commander. Duke is standing at the rim of Plum crater, which is 40 meters in diameter and 10 meters deep. The parked Lunar Roving Vehicle can be seen in the left background.

Image AS16-114-18423

Creator/Photographer: NASA John W. Young

3. The Cat's Eye Nebula, one of the first planetary nebulae discovered, also has one of the most complex forms known to this kind of nebula. Eleven rings, or shells, of gas make up the Cat's Eye.

Credit: NASA, ESA, HEIC, and The Hubble Heritage Team (STScI/AURA)

Acknowledgment: R. Corradi (Isaac Newton Group of Telescopes, Spain) and Z. Tsvetanov (NASA)

4. Jupiter & Ganymede

NASA's Hubble Space Telescope has caught Jupiter's moon Ganymede playing a game of "peek-a-boo." In this crisp Hubble image, Ganymede is shown just before it ducks behind the giant planet.

Ganymede completes an orbit around Jupiter every seven days. Because Ganymede's orbit is tilted nearly edge-on to Earth, it routinely can be seen passing in front of and disappearing behind its giant host, only to reemerge later.

Composed of rock and ice, Ganymede is the largest moon in our solar system. It is even larger than the planet Mercury. But Ganymede looks like a dirty snowball next to Jupiter, the largest planet in our solar system. Jupiter is so big that only part of its Southern Hemisphere can be seen in this image.

Hubble's view is so sharp that astronomers can see features on Ganymede's surface, most notably the white impact crater, Tros, and its system of rays, bright streaks of material blasted from the crater. Tros and its ray system are roughly the width of Arizona.

The image also shows Jupiter's Great Red Spot, the large eye-shaped feature at upper left. A storm the size of two Earths, the Great Red Spot has been raging for more than 300 years. Hubble's sharp view of the gas giant planet also reveals the texture of the clouds in the Jovian atmosphere as well as various other storms and vortices.

Astronomers use these images to study Jupiter's upper atmosphere. As Ganymede passes behind the giant planet, it reflects sunlight, which then passes through Jupiter's atmosphere. Imprinted on that light is information about the gas giant's atmosphere, which yields clues about the properties of Jupiter's high-altitude haze above the cloud tops.

This color image was made from three images taken on April 9, 2007, with the Wide Field Planetary Camera 2 in red, green, and blue filters. The image shows Jupiter and Ganymede in close to natural colors.

Credit: NASA, ESA, and E. Karkoschka (University of Arizona)

5. 47 Tucanae

In the first attempt to systematically search for "extrasolar" planets far beyond our local stellar neighborhood, astronomers probed the heart of a distant globular star cluster and were surprised to come up with a score of "zero".

To the fascination and puzzlement of planet-searching astronomers, the results offer a sobering counterpoint to the flurry of planet discoveries announced over the previous months.

"This could be the first tantalizing evidence that conditions for planet formation and evolution may be fundamentally different elsewhere in the galaxy," says Mario Livio of the Space Telescope Science Institute (STScI) in Baltimore, MD.

The bold and innovative observation pushed NASA Hubble Space Telescope's capabilities to its limits, simultaneously scanning for small changes in the light from 35,000 stars in the globular star cluster 47 Tucanae, located 15,000 light-years (4 kiloparsecs) away in the southern constellation Tucana.

Hubble researchers caution that the finding must be tempered by the fact that some astronomers always considered the ancient globular cluster an unlikely abode for planets for a variety of reasons. Specifically, the cluster has a deficiency of heavier elements that may be needed for building planets. If this is the case, then planets may have formed later in the universe's evolution, when stars were richer in heavier elements. Correspondingly, life as we know it may have appeared later rather than sooner in the universe.

Another caveat is that Hubble searched for a specific type of planet called a "hot Jupiter," which is considered an oddball among some planet experts. The results do not rule out the possibility that 47 Tucanae could contain normal solar systems like ours, which Hubble could not have detected.

But even if that's the case, the "null" result implies there is still something fundamentally different between the way planets are made in our own neighborhood and how they are made in the cluster.

Hubble couldn't directly view the planets, but instead employed a powerful search technique where the telescope measures the slight dimming of a star due to the passage of a planet in front of it, an event called a transit. The planet would have to be a bit larger than Jupiter to block enough light — about one percent — to be measurable by Hubble; Earth-like planets are too small.

However, an outside observer would have to watch our Sun for as long as 12 years before ever having a chance of seeing Jupiter briefly transit the Sun's face. The Hubble observation was capable of only catching those planetary transits that happen every few days. This would happen if the planet were in an orbit less than 1/20 Earth's distance from the Sun, placing it even closer to the star than the scorched planet Mercury — hence the name "hot Jupiter."

Why expect to find such a weird planet in the first place?

Based on radial-velocity surveys from ground-based telescopes, which measure the slight wobble in a star due to the small tug of an unseen companion, astronomers have found nine hot Jupiters in our local stellar neighborhood. Statistically this means one percent of all stars should have such planets. It's estimated that the orbits of 10 percent of these planets are tilted edge-on to Earth and so transit the face of their star.

In 1999, the first observation of a transiting planet was made by ground-based telescopes. The planet, with a 3.5-day period, had previously been detected by radial-velocity surveys, but this was a unique, independent confirmation. In a separate program to study a planet in these revealing circumstances, Ron Gilliland (STScI) and lead investigator Tim Brown (National Center for Atmospheric Research, Boulder, CO) demonstrated Hubble's exquisite ability to do precise photometry — the measurement of brightness and brightness changes in a star's light — by also looking at the planet. The Hubble data were so good they could look for evidence of rings or Earth-sized moons, if they existed.

But to discover new planets by transits, Gilliland had to crowd a lot of stars into Hubble's narrow field of view. The ideal target was the magnificent southern globular star cluster 47 Tucanae, one of the closest clusters to Earth. Within a single Hubble picture Gilliland could observe 35,000 stars at once. Like making a time-lapse movie, he had to take sequential snapshots of the cluster, looking for a telltale dimming of a star and recording any light curve that would be the true signature of a planet.

Based on statistics from a sampling of planets in our local stellar neighborhood, Gilliland and his co-investigators reasoned that 1 out of 1,000 stars in the globular cluster should have planets that transit once every few days. They predicted that Hubble should discover 17 hot Jupiter-class planets.

To catch a planet in a several-day orbit, Gilliland had Hubble's "eagle eye" trained on the cluster for eight consecutive days. The result was the most data-intensive observation ever done by Hubble. STScI archived over 1,300 exposures during the observation. Gilliland and Brown sifted through the results and came up with 100 variable stars, some of them eclipsing binaries where the companion is a star and not a planet. But none of them had the characteristic light curve that would be the signature of an extrasolar planet.

There are a variety of reasons the globular cluster environment may inhibit planet formation. 47 Tucanae is old and so is deficient in the heavier elements, which were formed later in the universe through the nucleosynthesis of heavier elements in the cores of first-generation stars. Planet surveys show that within 100 light-years of the Sun, heavy-element-rich stars are far more likely to harbor a hot Jupiter than heavy-element-poor stars. However, this is a chicken and egg puzzle because some theoreticians say that the heavy-element composition of a star may be enhanced after if it makes Jupiter-like planets and then swallows them as the planet orbit spirals into the star.

The stars are so tightly compacted in the core of the cluster – being separated by 1/100th the distance between our Sun and the next nearest star — that gravitational tidal effects may strip nascent planets from their parent stars. Also, the high stellar density could disturb the subsequent migration of the planet inward, which parks the hot Jupiters close to the star.

Another possibility is that a torrent of ultraviolet light from the earliest and biggest stars, which formed in the cluster billions of years ago may have boiled away fragile embryonic dust disks out of which planets would have formed.

These results will be published in The Astrophysical Journal Letters in December. Follow-up observations are needed to determine whether it is the initial conditions associated with planet birth or subsequent influences on evolution in this heavy-element-poor, crowded environment that led to an absence of planets.

Credits for Hubble image: NASA and Ron Gilliland (Space Telescope Science Institute)

6. Space Place is a fantastic source of scientific educational materials for children of all ages. Visit them at:

http://spaceplace.nasa.gov

7. NGC 3982

Though the universe is chock full of spiral-shaped galaxies, no two look exactly the same. This face-on spiral galaxy, called NGC 3982, is striking for its rich tapestry of star birth, along with its winding arms. The arms are lined with pink star-forming regions of glowing hydrogen, newborn blue star clusters, and obscuring dust lanes that provide the raw material for future generations of stars. The bright nucleus is home to an older population of stars, which grow ever more densely packed toward the center.

NGC 3982 is located about 68 million light-years away in the constellation Ursa Major. The galaxy spans about 30,000 light-years, one-third of the size of our Milky Way galaxy. This color image is composed of exposures taken by the Hubble Space Telescope's Wide Field Planetary Camera 2 (WFPC2), the Advanced Camera for Surveys (ACS), and the Wide Field Camera 3 (WFC3). The observations were taken between March 2000 and August 2009. The rich color range comes from the fact that the galaxy was photographed invisible and near-infrared light. Also used was a filter that isolates hydrogen emission that emanates from bright star-forming regions dotting the spiral arms.

Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)

Acknowledgment: A. Riess (STScI)