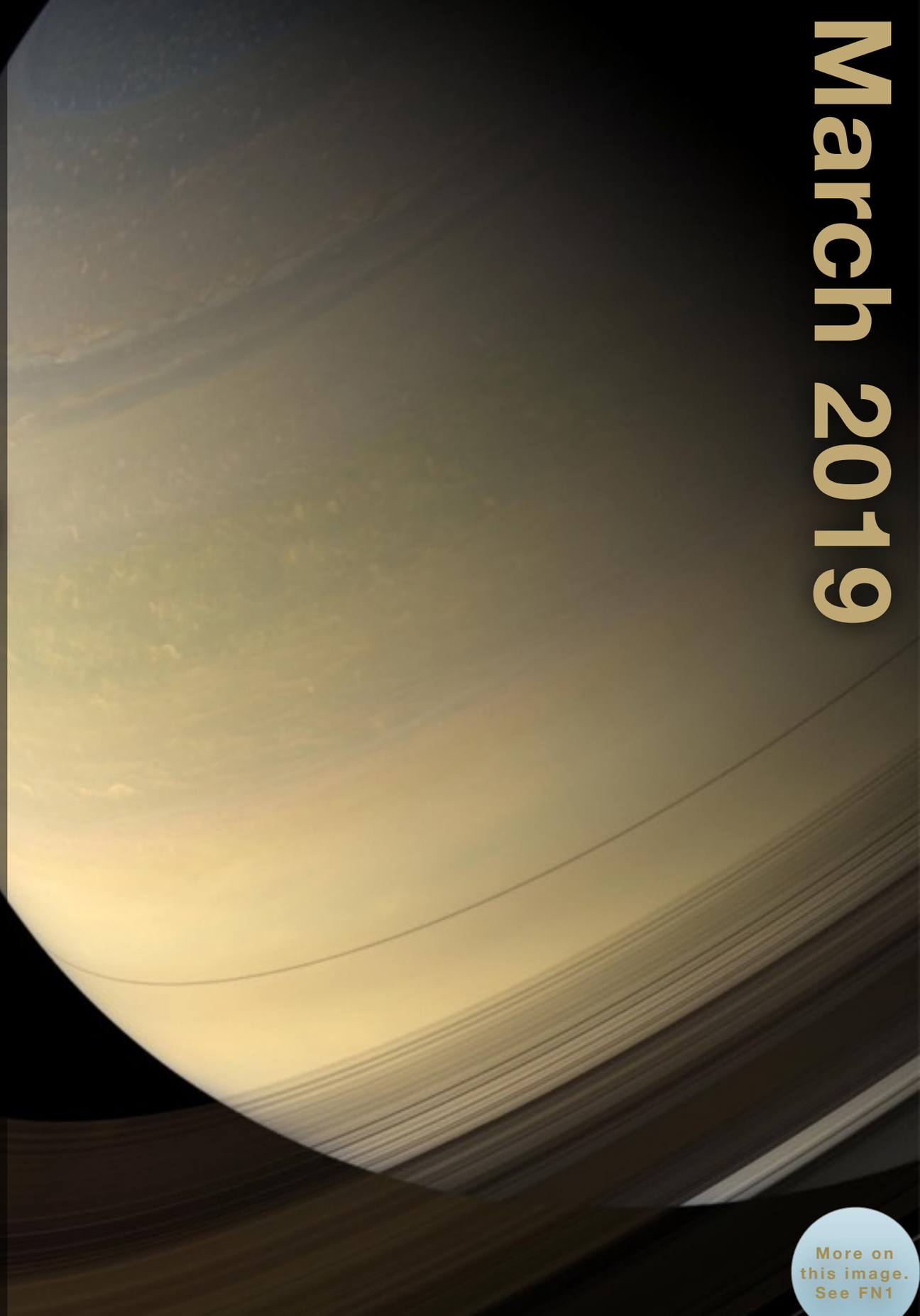
The Monthly Newsletter of the

Bays Mountain Astronomy Club

Edited by Adam Thanz

March 2019



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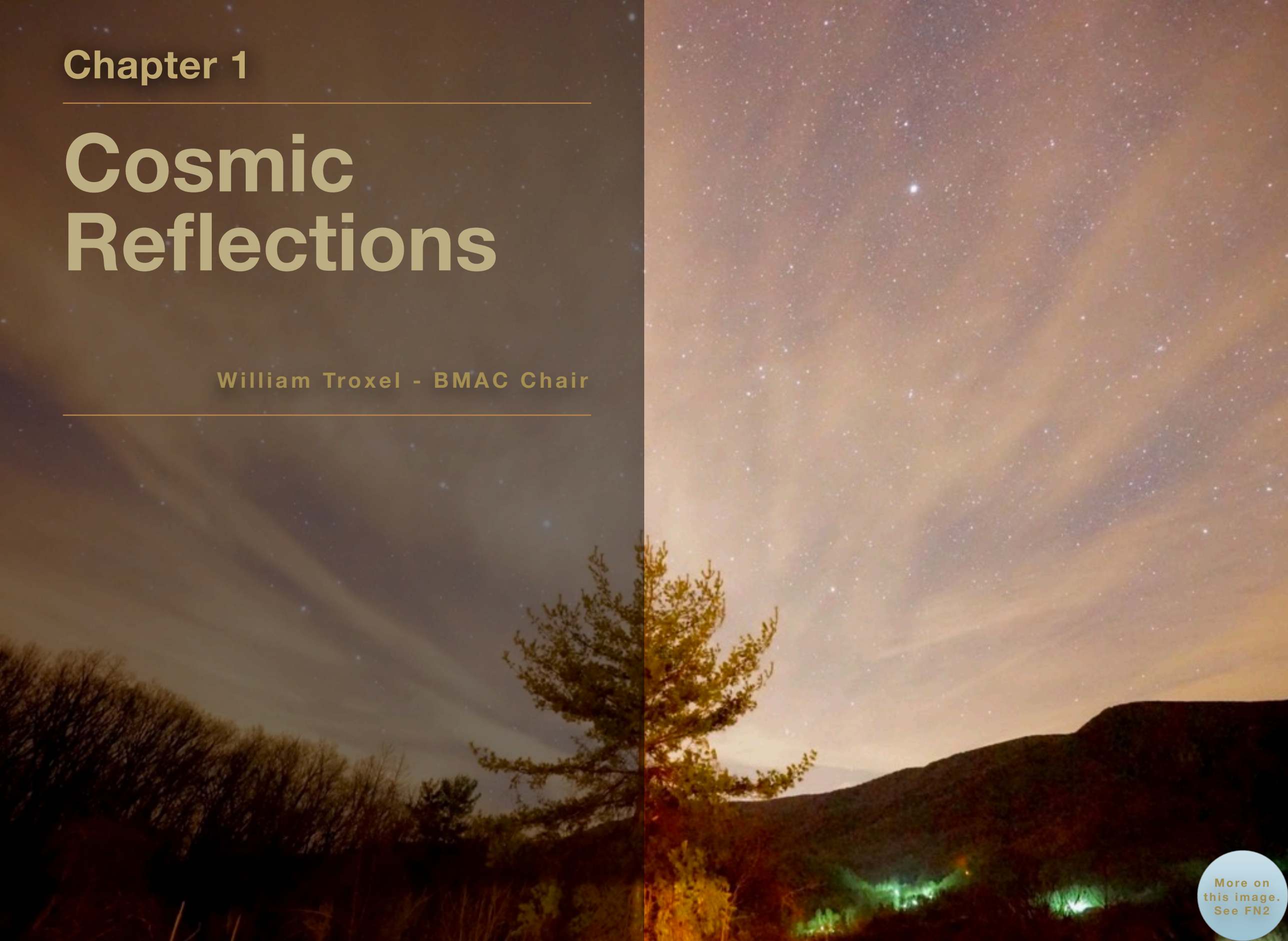
Chapter 1

Cosmic Reflections

William Troxel - BMAC Chair



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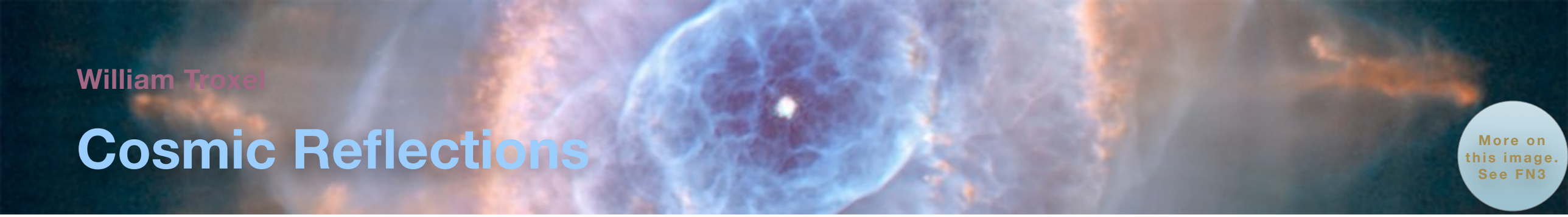


William Troxel

Cosmic Reflections

More on this image. See FN3

Greetings BMACers! Wow, it's March already! I could not believe it when I looked at the calendar. I have to send out a big thank you to our own Dr. Nathaniel Wentzel for presenting our program last month: “80’s Night.” Nate always brings a very interesting program and he was right on again for the members. The program started out with some deeper information from Jason’s program about using the planetarium projector to illustrate celestial coordinates. Nate then moved into explaining the tools that we would use in the 80’s to find the location of a star(s). We learned to use the big star maps which we had copies to use in which we had a list of stars that we needed to find. I think everyone that attended enjoyed the program, especially the several members who shared that with me during the social time afterwards. Again, I want to thank Nate for his willingness to lead the meeting.

This is a good place to say that if you are working on a project or have a program that you present to other groups and would be willing to share it with the club, please let me know. I will be happy to give you a meeting.

This month I want to add three more definitions to your list. Here they are:

Quasar - (Noun) a starlike object in space that may emit energy, light, and radio waves. Quasars are a lot like suns, though much smaller. Quasars have large redshifts, which means the light from the quasar shifts in frequency, moving to the red part of the spectrum. Quasars are powerful and usually produce a lot of radiation. Don’t mess with a quasar!

Sentence Use: Because a quasar is so bright, it overshadows the light given off by celestial objects in its vicinity.

Plasma - (noun) Plasmas are a state of matter similar to gas in which a certain portion of the particles are ionized. Heating a gas may ionize its molecules or atoms (reduce or increase the number of electrons in them), thus turning it into a plasma, which contains charged particles, i.e., positive ions and negative electrons or ions.

Sentence Use: Plasma is a state of matter that is similar to gas.

Blueshift - (noun) A blueshift is any decrease in wavelength, with a corresponding increase in frequency, of an electromagnetic wave.

Sentence Use: Blueshift is a shift toward shorter wavelengths of the spectral lines of a celestial object.

March Constellation Conversation:

This month our constellation is made of very faint stars. The name is “Monoceros.”

This constellation does not have any myths connected to it mainly because it was unknown to the ancient Greeks. I did not find any other ancient culture that had recorded it. The name, which means Unicorn, does have myths to it though, which we all know and have read throughout our education.

Monoceros first appeared on a globe by the Dutch cartographer and clergyman Petrus Plancius in 1612 as Monoceros Unicornis. The constellation was created to fill the area between two large constellations, Orion and Hydra, where there weren’t any constellations introduced in Greek times.

Plancius introduced the unicorn figure because the mythical animal appears several times in the Old Testament of the Bible. The constellation is not associated with any particular myth. The German astronomer Jakob Bartsch included the constellation in his 1624 star chart as Unicornus.

I want to encourage you to read on to Jason’s article as he will be highlighting very interesting celestial objects within this very interesting constellation.

March’s meeting will be focused on using the planetarium projector to get familiar with the spring sky and some of the cool objects to observe.

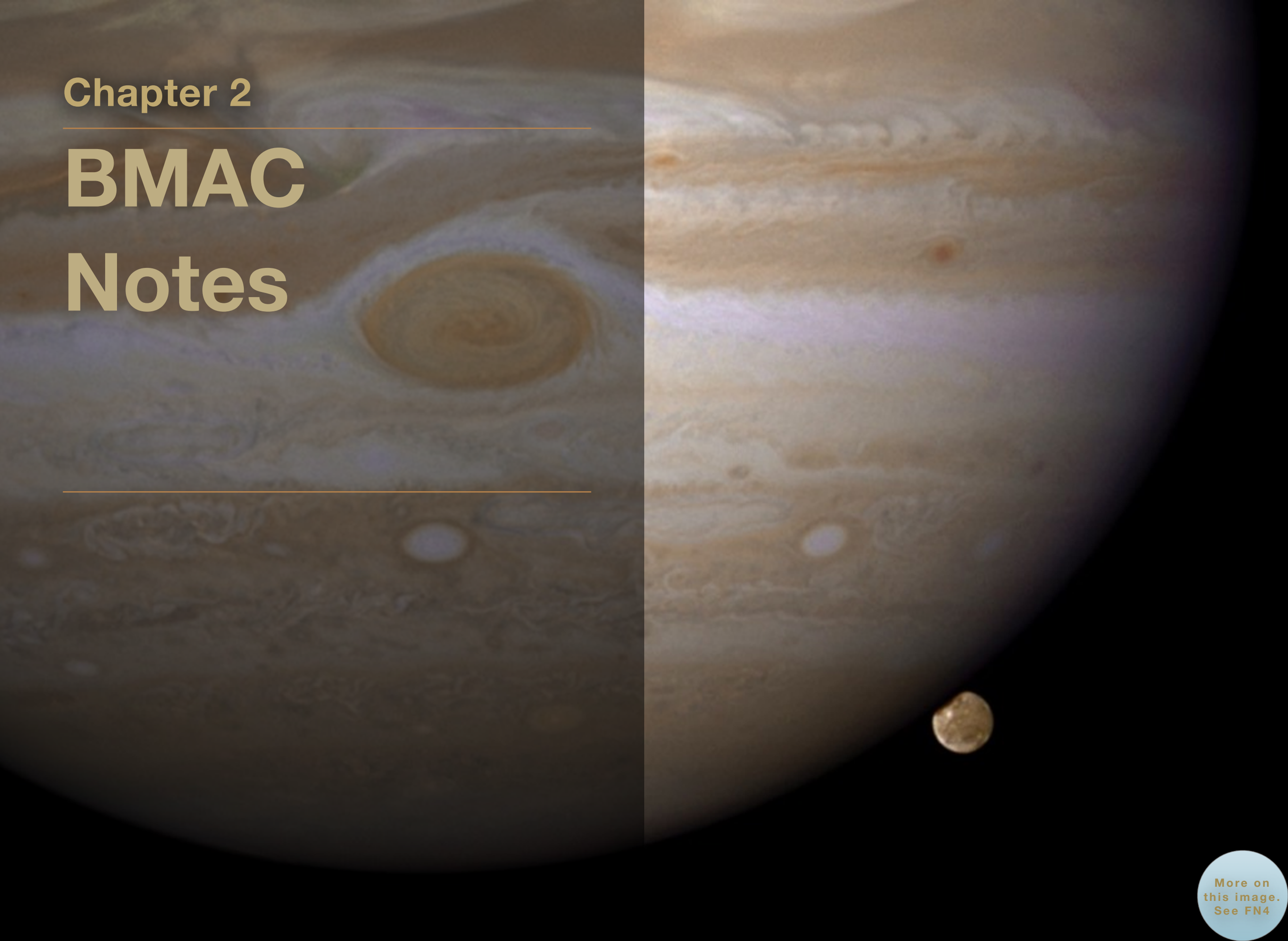
[Ed.: A special note, there has been construction going on for the last two months to add more parking to the Park. Unfortunately, and fortunately, it is near the observatory area. So, until it is complete and safe to drive and walk on, we will have to move our StarWatches to the dam. It is the only other place in the Park that has a clear view of the sky. Remember, you need to have passed the volunteer orientation through the Park to engage with the public during the StarWatches.]

Remember, the upcoming spring StarWatches will start Saturday night, March 2, 2019. What a great way to open the 2019 star gazing. Hope to see you on the mountain.

Until next time… Clear skies.

Chapter 2

BMAC Notes



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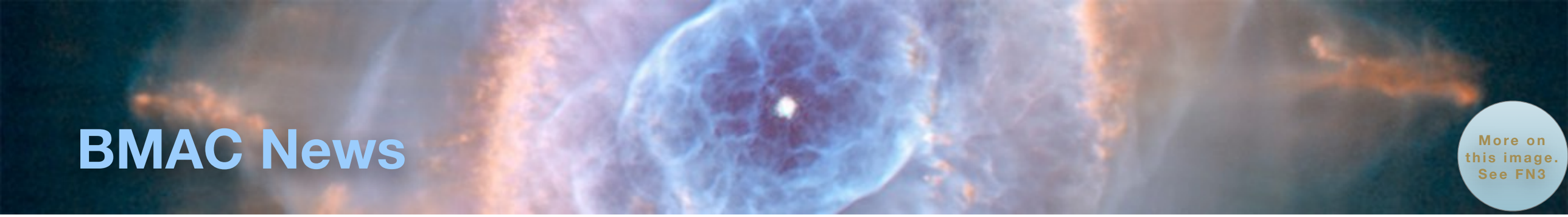


BMAC News

More on this image. See FN3

StarWatches Temporarily Moved to Dam

There has been construction going on for the last two months to add more parking to the Park. Unfortunately, and fortunately, it is near the observatory area. So, until it is complete and safe to drive and walk on, we will have to move our StarWatches to the dam. It is the only other place in the Park that has a clear view of the sky. Remember, you need to have passed the volunteer orientation through the Park to engage with the public during the SunWatches and StarWatches.

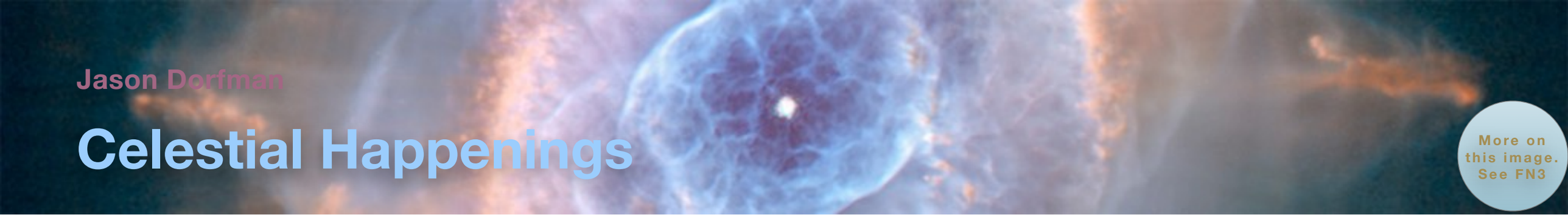
Another note about the Park. You might notice the dam looking a lot nicer. You've seen all the scaffolding on the dam over the past year. A crew has been fixing leaks and old mortar. The walkway has also been worked on. It should be good for the next 100 years.

Chapter 3

Celestial Happenings

Jason Dorfman

More on this image. See FN5



Jason Dorfman

Celestial Happenings

More on this image. See FN3

Welcome to the month of March. This month we transition from winter to spring. The Vernal Equinox is on March 20, which coincides with the Full Moon. We also experience a time-shift this month on Sunday, March 10 at 2 a.m., as we change to Daylight Saving Time. Over the winter months, we haven't had a lot of cooperation from Mother Nature with respect to observing - lots of cloudy and rainy nights. We'll have to see what March has in store. Hopefully, we'll see a few beautifully clear and somewhat warm evenings to get out and observe.

I thought I would include the sunrise and sunset times for the month. Not sure if this is helpful for everyone, but I always look these up when writing my article and figured that someone may find it useful. However, I'm not going to list these times for every day of the month - that would be a little overkill. On the first, the Sun rises at 7:01 a.m. EST and sets at 6:24 p.m. EST. By the end of the month, it will rise only slightly later at 7:18 a.m. EDT due to the time change, but will set a bit later at 7:51 p.m. EDT.

Planets

We begin the month of March with a look at the smallest planet, Mercury. Mercury reached its greatest eastern elongation at the end of last month, so this small, rocky world still appears far enough from the Sun making it easily observable in the early evening hours at the start of March. Look for it about 8° high in west 45 minutes after sunset. Mercury's magnitude will be 0.0 and should be easy to spot as twilight fades. A telescope or binoculars will show an 8” diameter disk with 33% illumination. As the week progresses, Mercury will be moving back towards the Sun and thus the bright twilight. After the 7th, the low altitude and competing twilight glow will make observations difficult.

Next up is Uranus, an ice giant that is currently showing a large, white cloud encircling around its north pole. Uranus can be found in the southwest corner of Aries. Look about 35° above the western horizon an hour after sunset. With a telescope, search about 2.1° northeast of Omicron Piscium for this magnitude +5.9 world. Look for a blue-green disk spanning about 3.4” in diameter. Over the month, Uranus will be lower and lower each night, just beginning to get lost in the glowing twilight of the setting Sun by month's end.

Mars is also in Aries, but moving eastward much more swiftly than Uranus. An hour after sundown, you'll find Mars about 45°

above the western horizon. Due to its swift easterly motion, it will remain roughly at this altitude all month as twilight is ending. Mars will cross into Taurus on the 23rd, creating a nice pairing with the Pleiades star cluster on the 29th and 30th as it passes roughly 3° south of the cluster. The pair will fit into a binocular field from March 23 into early April. Though easily visible at magnitude +1, its location on the opposite side of the Sun means disappointing telescopic views.

You'll have to wait a few hours for more planetary observations. Jupiter rises in the southeast at about 2:30 a.m. EST at the start of the month. It will be 25° above the horizon just before twilight begins, which is about 5:30 a.m. for the Tri-Cities area. By the end of the month, it will be rising around 1:30 a.m. EDT. Jupiter is currently in the constellation of Ophiuchus and moving slightly eastward over the month. Its magnitude on the 1st will be -2.0 and will brighten slightly to -2.2 by month's end. Views of Jupiter through a telescope are always a wonderful sight. Over the month, the diameter of Jupiter's disk will grow from 36” to 40”.

Saturn rises next in the early morning hours, about 15 min. after the thin, waning crescent Moon on the 1st. Both will be high enough above the horizon to see by 4:30 a.m. EST. Saturn is currently shining at magnitude +0.6 in Sagittarius moving slowly eastward away from the Teapot asterism. As twilight begins, it will be about 10° high in the southeast. The disk of the planet spans about 16” with the ring plane extending out to 36” and a 24° tilt.

Last to rise and the most brilliant is Venus. It will rise about 5 a.m. on 1st in the ESE and will reach about 10° high an hour before sunup. Venus begins the month at magnitude -4.1. Telescopic views will reveal a 16” disk which is 72% lit. By month's end, it will dim slightly to magnitude -3.9 and will be rising about 12° farther north. Venus is moving away from Earth and heading towards the far side of the Sun, so we'll then see a slightly smaller world, a 13" disk, but we'll see a bit more of the Sun facing side of the planet at 81% illumination.

Be sure to look on the 13th just before sunrise to see Venus, Saturn and Jupiter equally spaced apart in the pre-dawn sky.

Constellation of the Month

For the month of March, William and I have chosen the constellation Monoceros, which is Latin for unicorn. This is one of the newer constellations having been assigned to the sky in 1612 by Petrus Plancius. With its brightest star at magnitude 3.9, Monoceros is not one of the easiest to identify. However, being next to Orion, it's fairly simple to locate the right area of the sky and the Milky Way passes right through the middle of the constellation, so it's rich with open clusters, double and variable stars.

In early March, look for it just west of due south between 40 and 50° high. Orion borders it to the west, Hydra to the east, Canis Minor to the northeast and Gemini to the North. It's broadest border is to the south with Canis Major, Puppis, and a little bit of

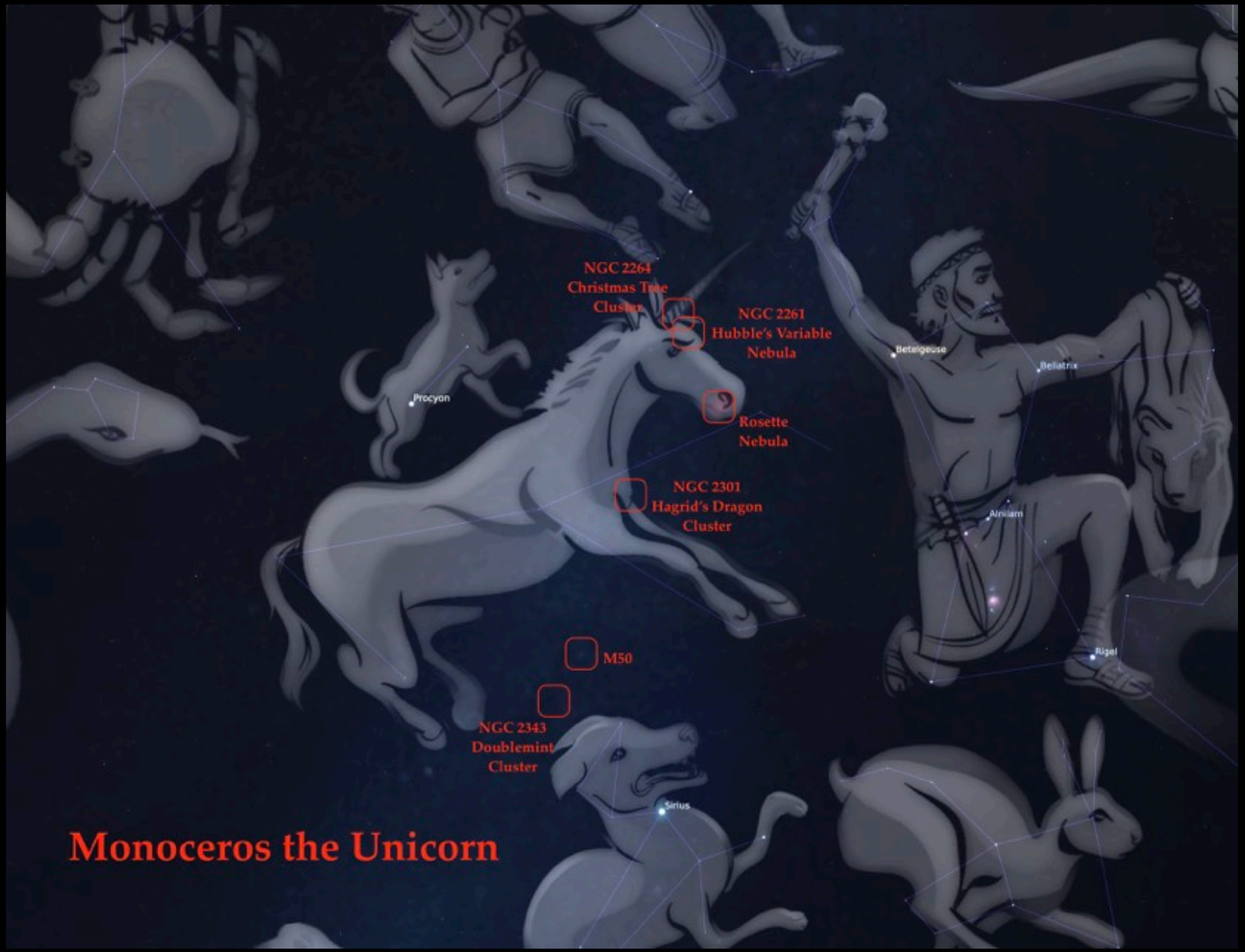


Image from Stellarium.

Annotation by Adam Thanz.

Lepus to the southwest. If you make a triangle using Betelgeuse, Sirius and Procyon, Monoceros lies mostly within that triangle with its hindquarters extending out to the east.

Monoceros contains one Messier object - M50, also known as the Heart-Shaped Cluster. It is a 6th-magnitude open cluster located a little more than a third of the way along a line drawn between Sirius and Procyon in the southern part of the constellation. The cluster consists of roughly 100-200 stars and is about 10' in diameter with many outliers increasing the apparent size to about 20' x 15'.

One of the more beautiful and notable deep-sky objects found in Monoceros is the Rosette Nebula. The nebulosity forms a large wreath-like shape with a pinkish-red color that extends to about 80' in diameter. Four of the brightest portions of the nebula were given individual designations in the NGC (New General Catalogue) of 2237, 2238, 2239 and 2246, though it is often referenced as simply NGC 2237. The Rosette Nebula is located at a distance of about 2600 light years, making the actual diameter roughly 55 light years. In the heart of the nebula we find a bright galactic star cluster, NGC 2244, which appears to have cleared away the surrounding gas and dust of the nebula. It is a large rectangular collection of about 20 brighter stars spanning about 40' in diameter.

There are many other open clusters of note with some rather clever names. The Christmas Tree Cluster (NGC 2264), Hagrid's Dragon Cluster (NGC 2301) and the Doublemint Cluster (NGC 2343) are just a few. There's also Hubble's Variable Nebula (NGC 2261) located about 4° northeast of the Rosette Nebula. This is a peculiar gaseous region surrounding the variable star R Mononcerotis. Early observations by Edwin Hubble showed the shape of the nebula to be changing. It turned out that the nebula itself was not changing that quickly, which would defy the laws of physics, and that the variability of the enveloped star also did not correlate with the changes seen in the nebula. Instead, it was deduced that observed changes are due to dark masses drifting near the star creating a play of light and shadow on the nebula.

Luna

March begins with a thin waning crescent just 3° to the west of Saturn on the 1st and just over 3° to the southwest of Venus on the next morning. We'll see it shift into our evening sky as we begin the second week of March. On the 11th, a waxing crescent will be about 6° to the southeast of Mars.

Bracketing the third quarter Moon on the 28th, we find a waning gibbous Moon about 5° to the east of Jupiter on the 27th and then, 2 nights later, a similar arrangement with a waning crescent about 3° to the east of Saturn.

Full Moon occurs on the night of the Vernal Equinox, the 20th. With the Moon having reached perigee the previous day, it should be another brilliant sight and you're bound to hear the media throwing around the term "SuperMoon" once again.

Wishing you all a Happy Spring and clear skies!

Chapter 4

The Queen Speaks

Robin Byrne

Robin Byrne

Book Review: Curiosity: The Story of a Mars Rover

More on this image. See FN3

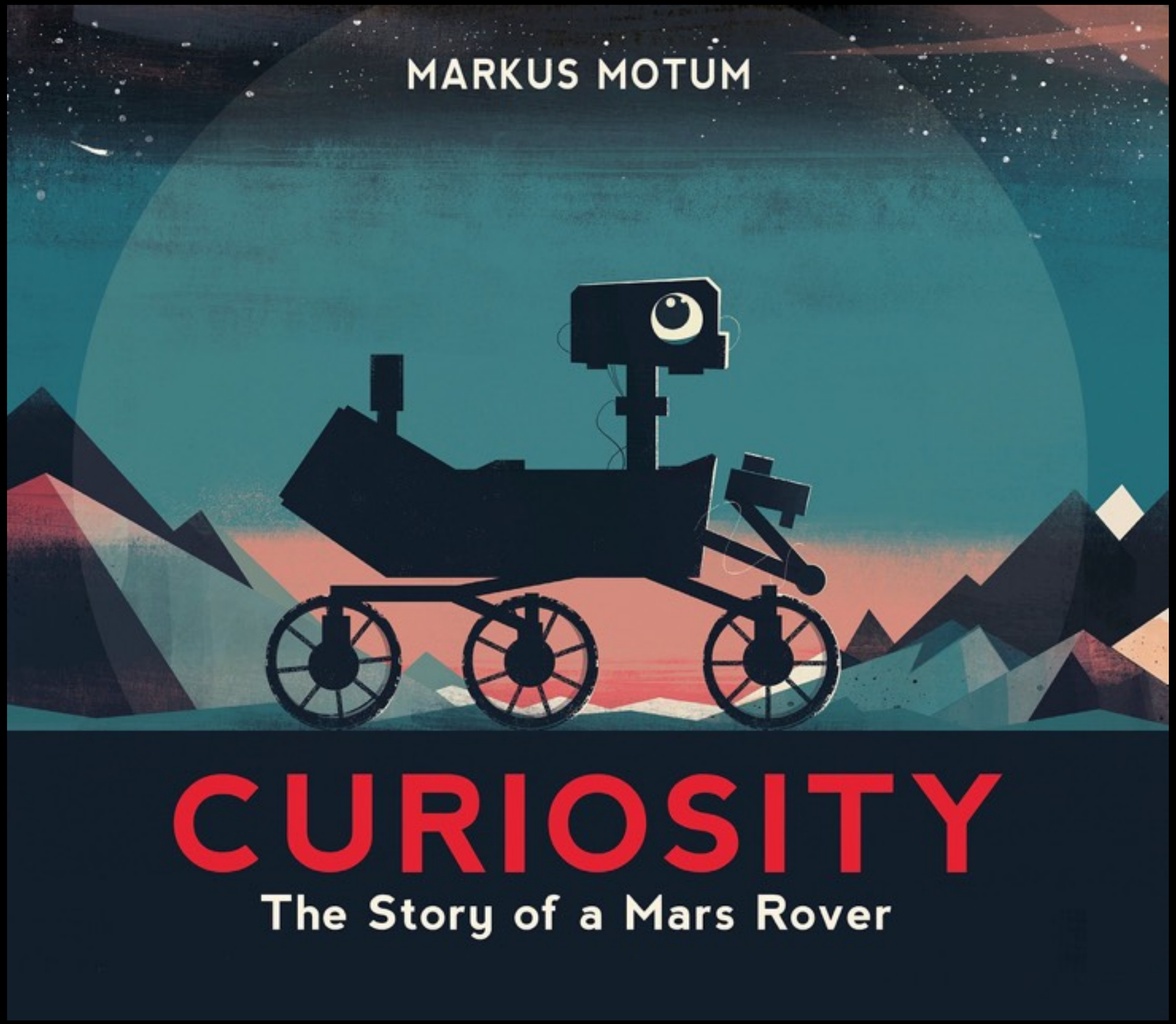
Continuing in my theme of reviewing children's books, this time it is Curiosity: The Story of a Mars Rover written and illustrated by Markus Motum. Motum's training is in illustration, with no real science or engineering background. That imbalance is, unfortunately, apparent in the book.

The story begins with why we travel and explore space. It then goes into human exploration and the Apollo moon landing. That leads to the difficulties of sending people as far as Mars, and why we use robotic spacecraft, instead. Next we see how the rover was designed and built. The launch and trip to Mars are shown, and then the incredible landing. It ends with how Curiosity does science on Mars, and what the future holds.

Geared for children ages seven to eleven, the illustrations are gorgeous. Motum's style has an angular feel that is well-suited for depicting spacecraft and the technical components involved with sending a rover to Mars. The launch illustration is designed for you to turn the book and view vertically, which works very well. There's a definite retro feel to the images that I truly enjoy. Very "Space Age."

However, Motum's lack of science background comes across in the writing. He was very conscientious to getting the information correct, which I appreciate. But his lack of background means that he didn't do a very good job of simplifying it for his target audience. The upper end of his target group (ten or eleven year olds) will be fine, but younger kids will get lost in the terminology and phrasing. They'll still appreciate the pictures while being read to, but Mom and Dad may want to just read snippets from each page rather than all of the text. I also have a problem with the Solar System illustration that depicts all of the planets on one side of the Sun, and very close to one another, while the text talks about how the planets move at different speeds and only rarely line up. That page sends very mixed signals to the kids reading it, and I can guarantee they'll remember the incorrect picture rather than the correct words.

So, I'm left in a quandary. Beautiful pictures versus technical writing. What age group should be targeted? My inclination is to say that this is not going to be appropriate for younger kids, but upper elementary school would be a good audience for it. And, honestly, adults who appreciate picture books and just want a



The cover to Curiosity: The Story of a Mars Rover.

brief overview of the mission will also enjoy it. So, not an overwhelming endorsement, but a qualified recommendation for Curiosity: The Story of a Mars Rover.

References:

Curiosity: The Story of a Mars Rover by Markus Motum, Candlewick Press, 2017

Chapter 5

Space Place

More on this image. See FN6

David Prosper

Springtime Planet Party

More on this image. See FN3

March brings longer days for Northern Hemisphere observers, especially by the time of the equinox. Early risers are treated to the majority of the bright planets dancing in the morning skies, with the Moon passing between them at the beginning and end of the month.

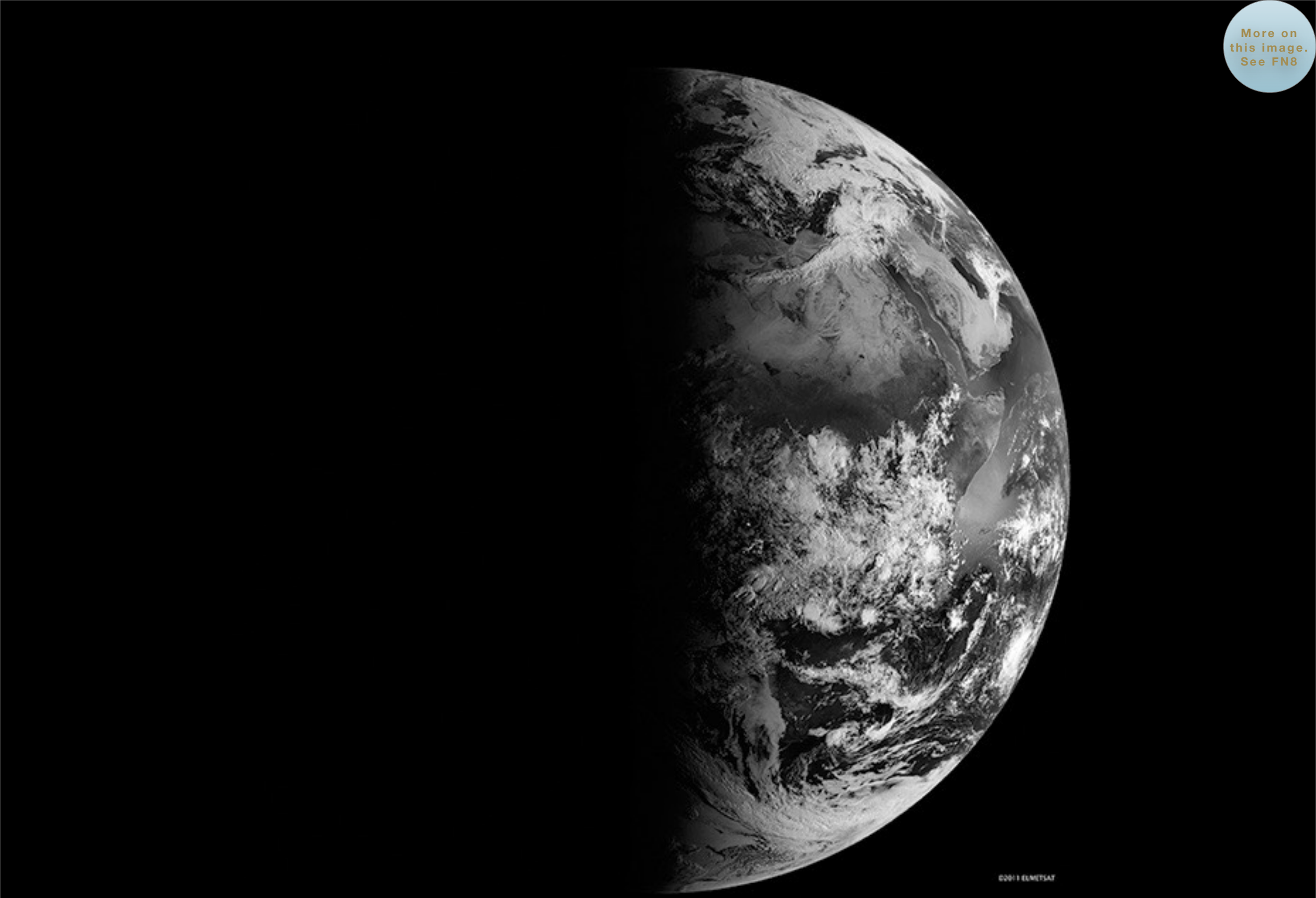
The vernal equinox occurs on March 20, marking the official beginning of spring for the Northern Hemisphere. Our Sun shines equally on the Northern and Southern Hemispheres during the moment of equinox, which is why the March and September equinoxes are the only times of the year when the Earth's north and south poles are simultaneously lit by sunlight. Exacting astronomers will note that the length of day and night on the equinox are not precisely equal; the date when they are closest to equal depends on your latitude, and may occur a few days earlier or later than the equinox itself. One complicating factor is that the Sun isn't a point light source, but a disk. Its edge is refracted by our atmosphere as it rises and sets, which adds several minutes of light to every day. The Sun doesn't neatly wink on and off at sunrise and sunset like a light bulb, and so there isn't a perfect split of day and night on the equinox - but it's very close!

Ruddy Mars still shines in the west after sunset. Mars scoots across the early evening skies from Aries towards Taurus and meets the sparkling Pleiades star cluster by month's end.

March opens with the morning planets of Jupiter, Saturn, and Venus spread out over the southeastern horizon before sunrise. A crescent Moon comes very close to Saturn on the 1st and occults the ringed planet during the daytime. Lucky observers may be able to spot Mercury by the end of the month. March 31 opens with a beautiful set of planets and a crescent Moon strung diagonally across the early morning sky. Start with bright Jupiter, almost due south shortly before dawn. Then slide down and east towards Saturn, prominent but not nearly as bright as Jupiter. Continue east to the Moon, and then towards the beacon that is Venus, its gleam piercing through the early morning light. End with a challenge: can you find elusive Mercury above the eastern horizon? Binoculars may be needed to spot the closest planet to the Sun as it will be low and obscured by dawn's encroaching glow. What a way to close out March!

Discover all of NASA's current and future missions at nasa.gov.

This article is distributed by NASA Night Sky Network. The Night Sky Network program supports astronomy clubs across the USA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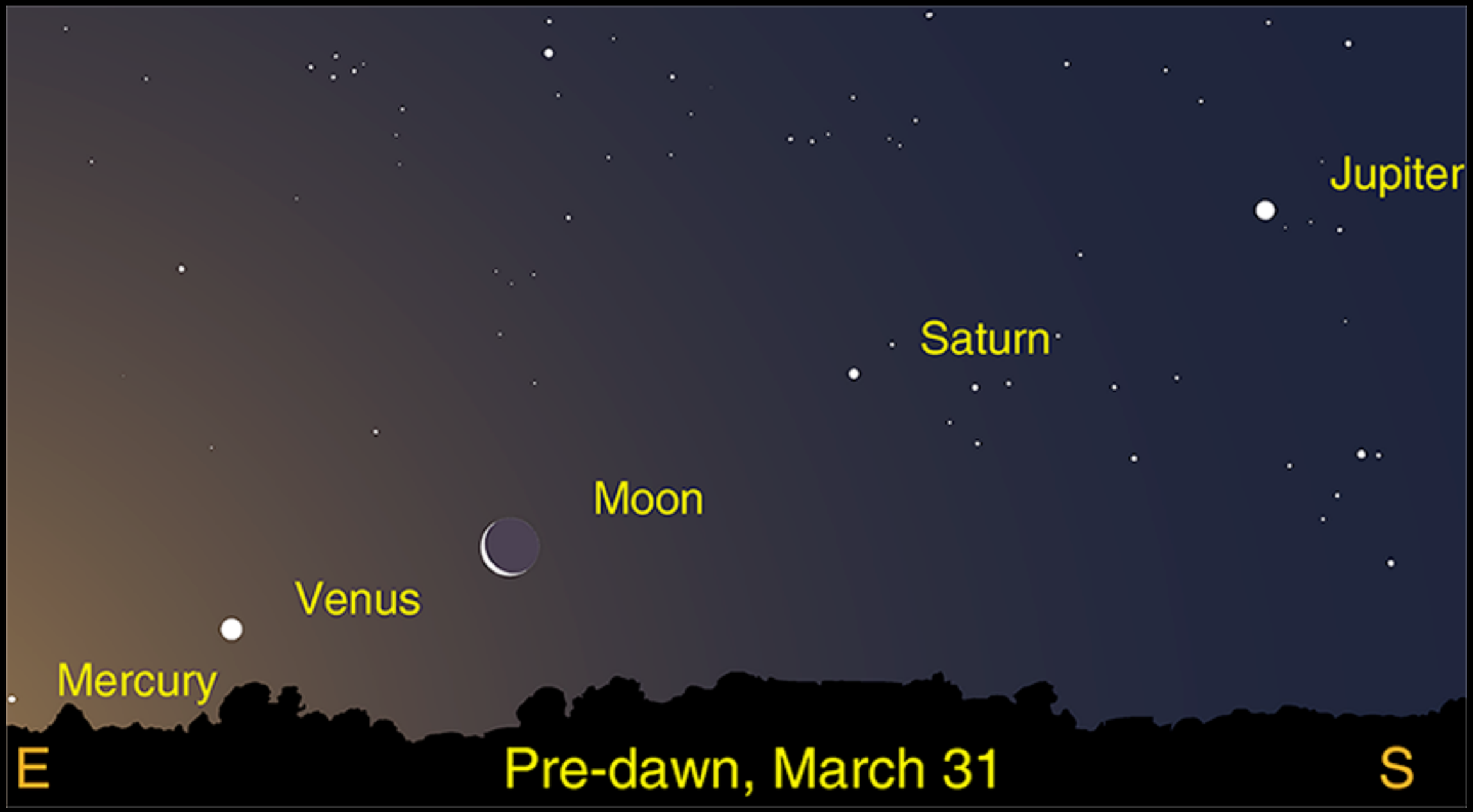

dedicated to astronomy outreach. Visit nightsky.jpl.nasa.org to find local clubs, events, and more!

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, March 1, 2019	7 p.m.	Nature Center Planetarium	Program: We'll focus on using the planetarium projector to get familiar with the spring sky and some of the cool objects to observe.; Free.
Friday, April 5, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program TBA; Free.
Friday, May 3, 2019	7 p.m.	Nature Center Discovery Theater	Program: Students from Sullivan South High School will present papers on their current scientific research. Lead educator, Thomas Rutherford. Titles: 1) Using Gaia Data to Determine the Distance and Size of the Open Cluster NGC 2420. 2) A Search for Exoplanets in the Galactic Open Cluster NGC 2355. 3) The Effects of Red Light on the Germination of Lettuce. 4) The Effect of pH on Lead Toxicity in Brine Shrimp (Artemia). 5) Microplastics in Bottled Water. 6) Terra-forming Mars.; Free.
Friday, June 14, 2019	7 p.m.	Nature Center Discovery Theater	Notice the date change to the 14th! Program: Program 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. 2, 9, 2019	7 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. 16, 23, 30, 2019	8 p.m.		
Apr. 6, 13, 20, 27, 2019	8:30 p.m.		
Special Events			
Saturday, May 11, 2019	1-4:30 p.m. 8:30-9:30 p.m.	Nature Center & Observatory	Annual Astronomy Day - Displays et al. on the walkway leading to the Nature Center, 1-4:30 p.m.; Solar viewing 3-3:30 p.m. at the dam; Night viewing 8:30-9:30 p.m. at the observatory. All non-planetarium astronomy activities are free.

Bays Mountain Astronomy Club

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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:

https://www.baysmountain.com/astronomy/astronomy-club/#newsletters

Regular Contributors:

William Troxel

William is the current chair of the club. He enjoys everything to do with astronomy, including sharing this exciting and interesting hobby with anyone that will listen! He has been a member since 2010.

Robin Byrne

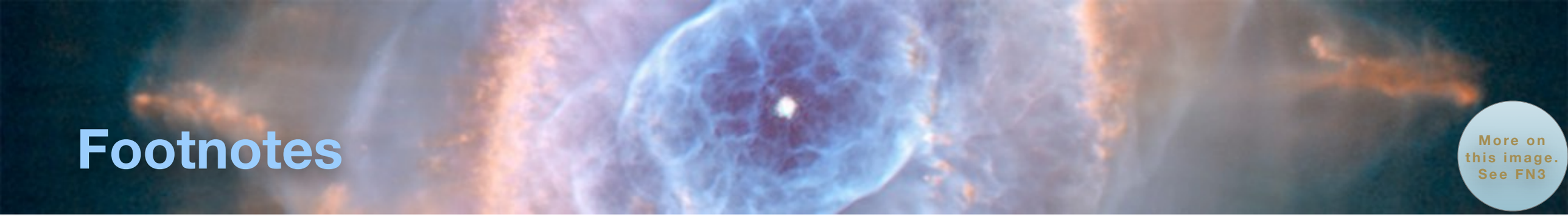
Robin has been writing the science history column since 1992 and was chair in 1997. She is an Associate Professor of Astronomy & Physics at Northeast State Community College (NSCC).

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

More on this image. See FN3

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. Leo Rising

A sky filled with stars and a thin veil of clouds.

Image by Adam Thanz

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 March 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)

8. Earth from orbit on the March equinox, as viewed by EUMETSAT. Notice how the terminator – the line between day and night - touches both the north and south poles. Additional information can be found at http://bit.ly/earthequinox

Image credit: NASA/Robert Simmon

9. The morning planets on March 31.

Image created with assistance from Stellarium.