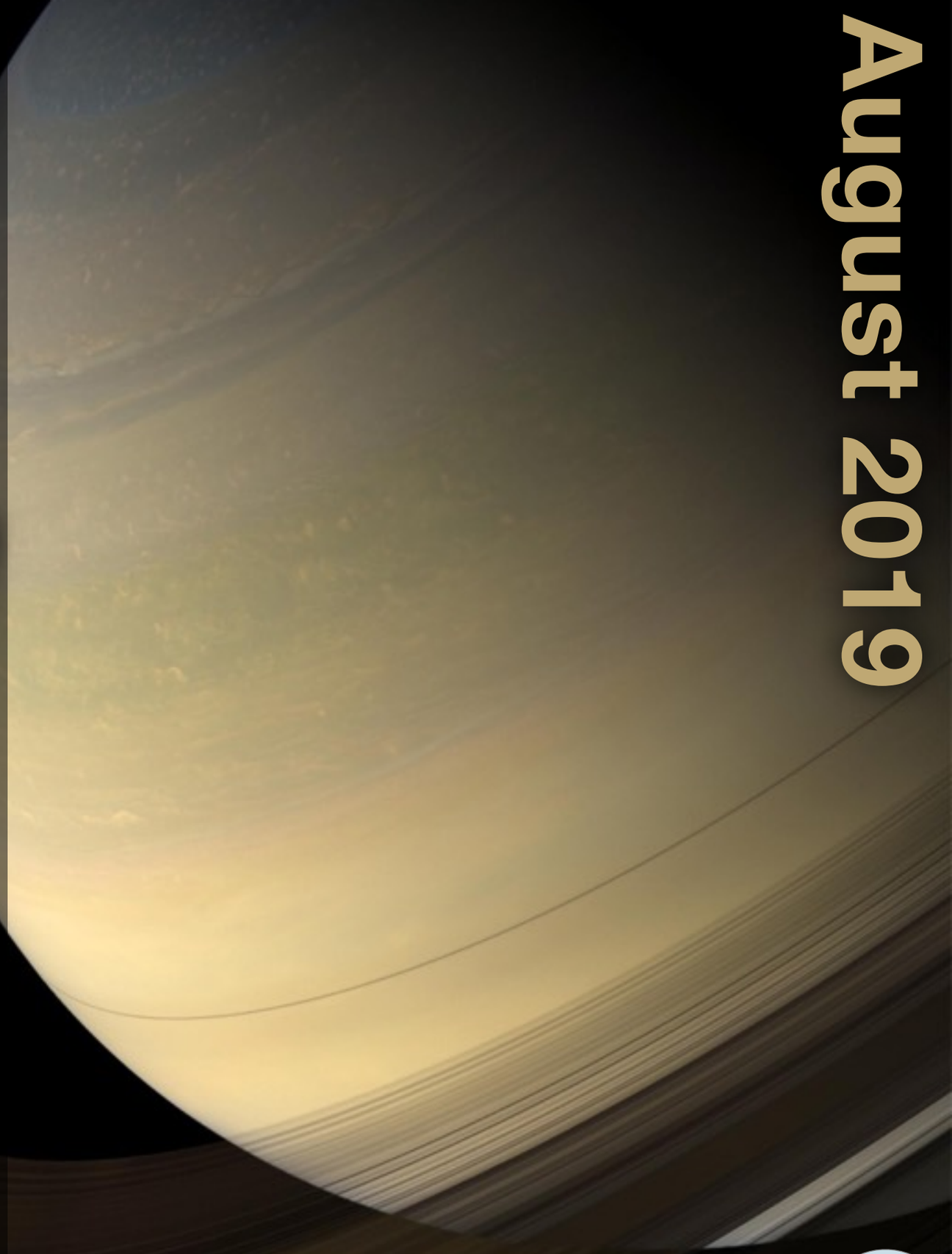
The Monthly Newsletter of the

Bays Mountain Astronomy Club

August 2019



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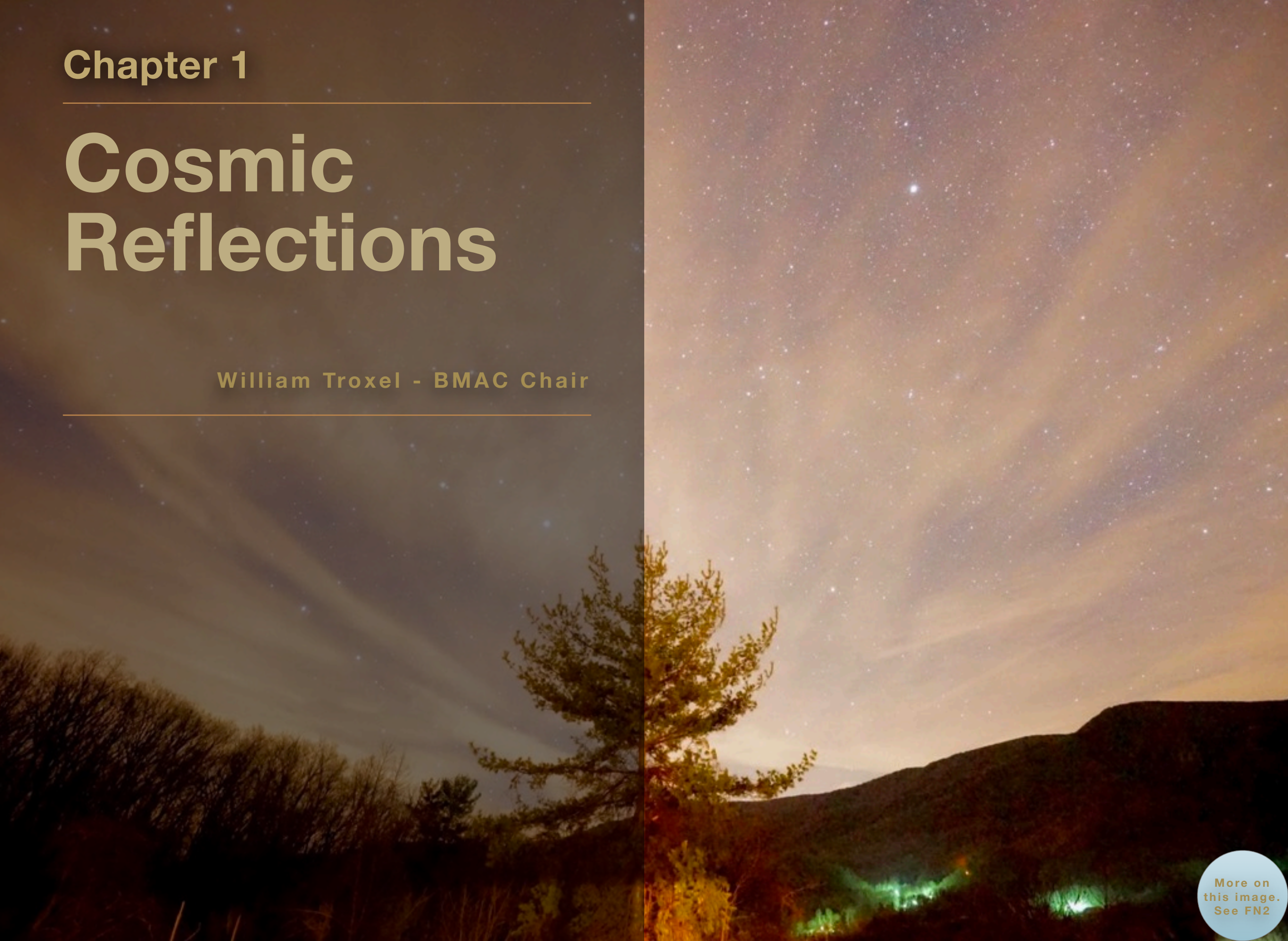
Edited by Adam Thanz

Chapter 1

Cosmic Reflections

William Troxel - BMAC Chair



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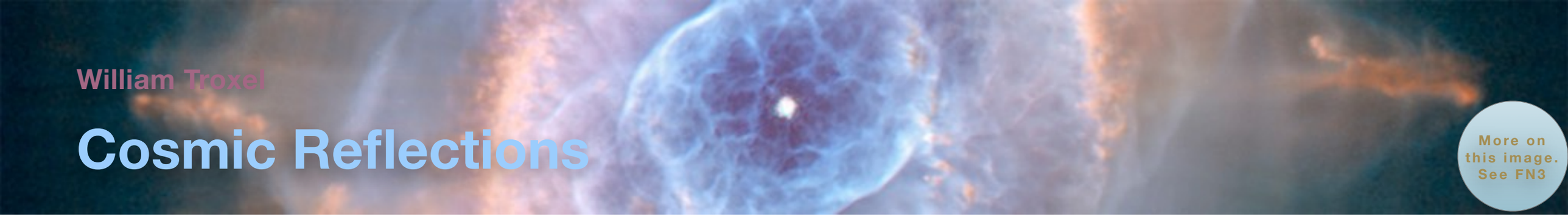

William Troxel

Cosmic Reflections

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Greetings fellow BMAC'ers. Wow it's August all ready. I wanted to thank a everyone for coming out for the club's annual picnic. A very special thank you to BMACer Dan Merrick for allowing the club to come to his home again. I tried something a little different this year by adding games/activities to the event. Thanks to BMACer Robin Byrne, for coming up with a game based on the monthly Astro vocabulary section of my article. The game had three parts and I think everyone enjoyed it. The game required recalling the words and more important the definition and details about the terms.

I came up with an activity that I called "The Planet Walk." Dan and I set it up where 100 yards = 1 billion miles and the object was to walk (or travel) to each planet and answer three questions. Then, after you completed the planet walk, you had to try your luck "landing on a planet," this required that you toss a landing craft, (rubber balls connected with a rope) at one of three landing sites on Mars and the Moon. This game was adapted from the yard game "Ladder Toss." I have to admit that I was using the club as a test to gauge your reaction to these games to possibly use them as part of Astronomy Day 2020. I hope you will write down your ideas and share them with me at the August meeting. I wanted to thank Dan again for helping me set up both games. Watching and listening to your conversations, it seemed that you enjoyed the concept(s). Unfortunately, the weather did not allow us to get some viewing during the picnic. We had a lot of awesome food to which I wanted to thank everyone that fixed something to share. Overall, I think it was a good event. I hope those of you that were able to come out felt the same.

This month, I wanted to talk about the constellation Serpens. In Greek mythology, Serpens represents a giant snake held by the healer Asclepius, represented by the Ophiuchus constellation. Asclepius is usually depicted holding the top half of the snake in his left hand and the tail in his right hand.

Asclepius was the son of the god Apollo who was said to be able to bring people back from the dead with his healing powers. In one of the stories, he killed a snake and saw it be brought back to life by a herb that another snake placed on it. It was said that Asclepius later used the same technique.

Serpens the snake.

Image from Stellarium

The brightest star in the constellation, Unukalhai (Alpha Serpentis), represents the serpent's neck, and Alya (Theta Serpentis) marks the tip of the snake's tail.

Serpens dates back to Babylonian times. The Babylonians had two snake constellations. One represented a hybrid of a dragon, lion and bird and roughly corresponded to the constellation we know as Hydra, the water snake.

The other Babylonian constellation, called Bašmu, was depicted as a horned serpent, and loosely corresponded to the constellation ″Οφις, created by the Greek astronomer Eudoxus of Cnidus in the 4th century BC, on which Ptolemy's Serpens constellation was based.

This will be my last month of sharing constellations with you. This feature of the chairman's article has been running a long time and I think we have covered most if not all the constellations. I hope that you have been able to learn some interesting things about the constellations over the course of the chairman's articles. I also hope that you have been able to add some of them to your observing lists. Thank you again for continuing to read my article.

This month our vocabulary words are:

Apogee: Noun; the point in the orbit of the Moon or a satellite at which it is furthest from the Earth.

Nova: noun; a star showing a sudden large increase in brightness and then slowly returning to its original state over a few months.

Satellite: Noun; a celestial body orbiting the Earth or another planet.

I am very excited about the upcoming months for the club. You all know that we have a very big event called "StarFest" in October, which Adam will talk about in his section for the newsletter, also keep watching the web site for updates.

Thanks to BMACer' Brandon Stroupe for contacting Steve Conard, who is the speaker for the August Meeting.

The New Horizons spacecraft collected data on Kuiper Belt Object 2014MU69, nicknamed Ultima Thule (pronounced tu-li), during a flyby encounter in December and January. Steve Conard will discuss the efforts to find Ultima Thule, to characterize it prior to the encounter, the preparations for the encounter, and the data collected by the LORRI instrument.

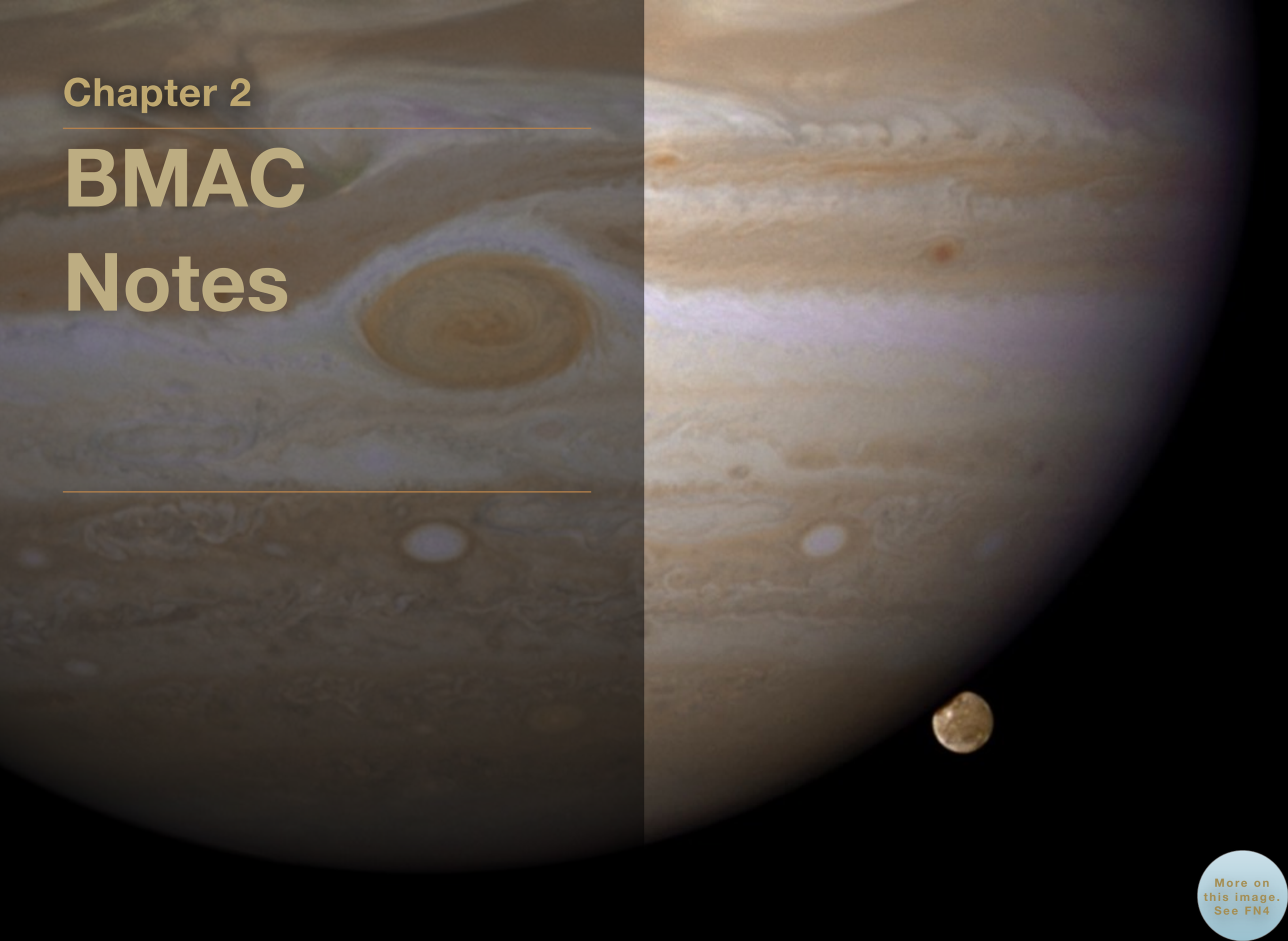
Steven J. Conard is a member of the Principal Professional Staff at the Johns Hopkins University Applied Physics Laboratory. He has over 35 years' experience building, testing, and operating optical instrumentation for astrophysics and planetary space missions. He has been lead engineer for the Long Range Reconnaissance Imager on the New Horizons mission since 2003. He has been an amateur astronomer since age 12, and grinding his own telescope mirrors as a teenager led him to a

career in optics. His current interests in amateur astronomy are occultation timing and spectroscopy.

Please mark this on your calendar. I hope we can fill the Discovery Theater classroom for this meeting. Steve is a wonderful speaker and many of you have asked when he could come back and share some of the updates with us. Please invite your friends, neighbors and anyone you can to hear Steve. Our next meeting is August 2nd at 7 p.m. Hope to see you then. Until next time, clear skies.

Chapter 2

BMAC Notes



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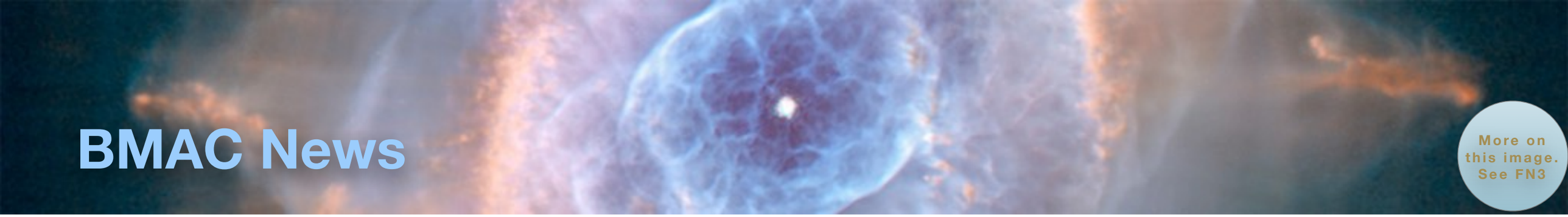
BMAC News



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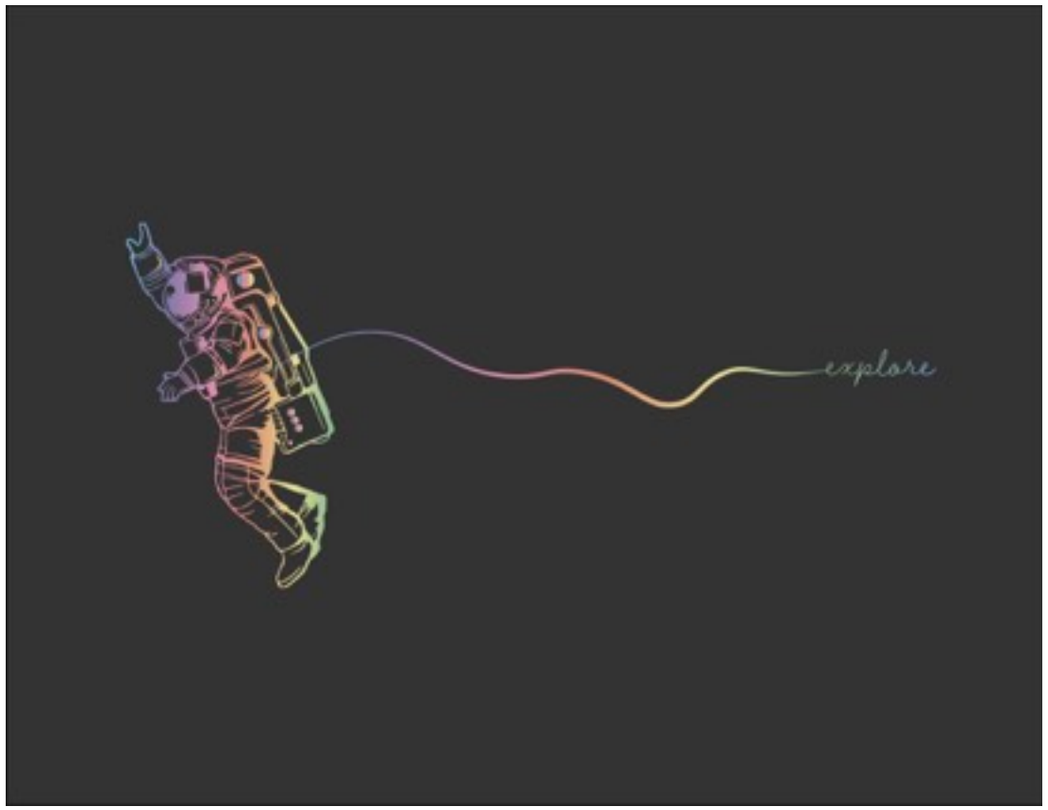
StarFest 2019

Greetings! StarFest is soon upon us! If you not aware of this annual event, it will be our 36th! It is three days of astronomical fun and learning and will be held on October 18-20. There is a fee, but it covers the four keynote speakers, five full meals, a T-shirt with unique art (see image), all activities, and the option to sleep on Park grounds.



This year's theme is "Exploring the Spectrum." That means that our four speakers each do astronomical research in different parts of the electromagnetic spectrum. The speakers and their topics are:

Dr. Chuck Higgins - "The Radio Universe"

Dr. Erin Smith - (title not yet received, but it will be in the IR and the James Webb Space Telescope)

Dr. Tyson Littenberg - "Tuning in to Einstein's Universe" (gravity waves!)

Dr. Stephen Reynolds - "Exploring the Spectrum of the Remnants of Stellar Explosions" (high energy gamma and x-rays)

Registrations should go out in early August. There is also a special rate for the MeadowView Marriott if you want to be close and have a shower and nice bed! All the details will be posted on the website:

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

Thanks,

Adam Thanz - StarFest 2019 Chairman

Images taken by Robin Byrne using a phone adapter on a telescope.

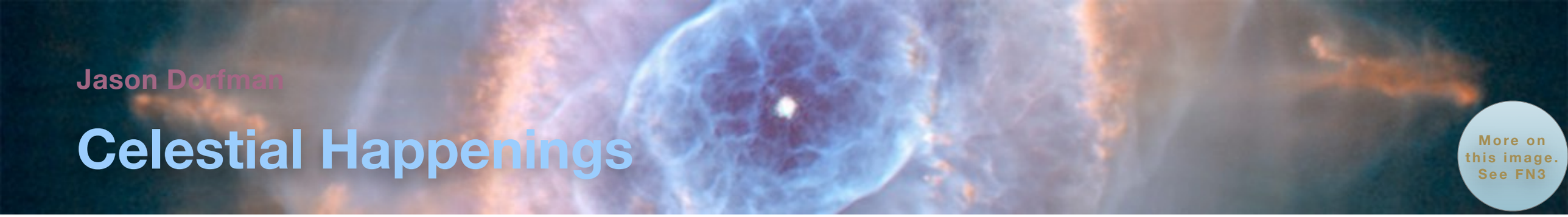
A drone image of the club picnic by Shawn Beamish.

Chapter 3

Celestial Happenings

Jason Dorfman

More on this image. See FN5



Jason Dorfman

Celestial Happenings

More on this image. See FN3

This month marks my third anniversary of writing this article. As I begin my fourth year, I've decided to take a slightly different direction with the focus of the article. In the past, I've written about what was up and observable in the night sky with the occasional tidbit about some current astronomical event. Often, in writing this article or answering questions in the planetarium, I come across a topic that I need or would like to understand better. It occurred to me that many of our newsletter readers would benefit and perhaps enjoy gaining some additional knowledge about various astronomical topics, as well. Therefore, I'll be writing each month about various astronomical topics with the goal of providing a slightly deeper understanding beyond the basic facts.

For those still wanting to know what's up in the sky for the month, I recommend taking a look at Astronomy or Sky & Telescope magazine, both provide a wonderful overview of the highlights for the current month (I prefer the writeup by Martin Ratcliffe and Alister Ling in Astronomy).

Over the last couple of months, I've come across a few articles exclaiming that the Great Red Spot was shrinking. This really piqued my curiosity — was this long-lasting storm going to disappear in my lifetime? As I read on, I began to realize that this was not a new revelation, but more of an update on something that has been going on for some time. Along the way, I also realized that I have been communicating incorrectly about how long we've known about the Red Spot. Let's take a look at when we first observed Jupiter's Red Spot, how storms like this develop and persist, and if this storm is about to break apart.

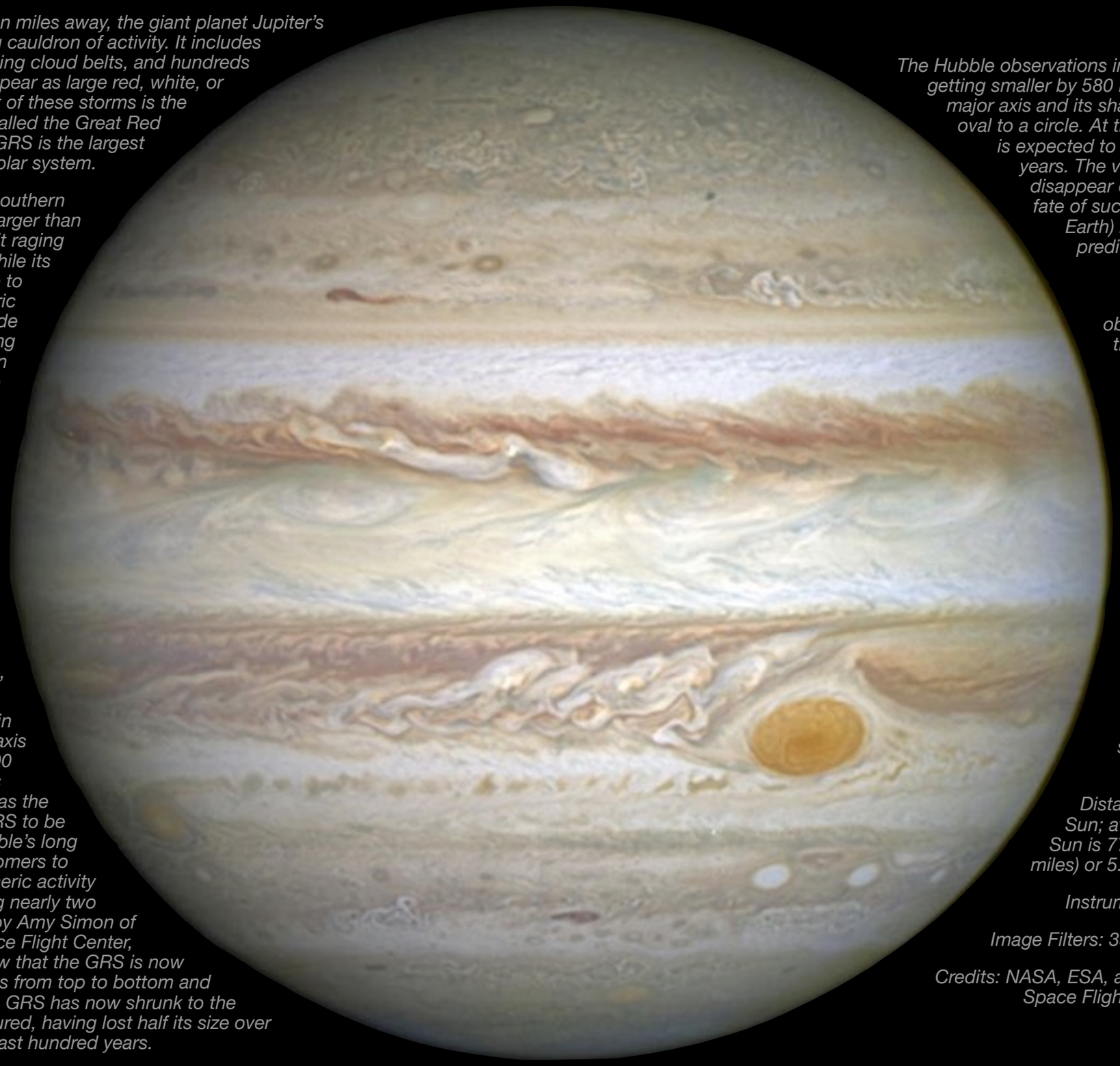
How Long Has the Red Spot Persisted?

One of the reasons I chose to write about Jupiter's Red Spot was because, in my readings about it, I became painfully aware that I had been incorrectly stating how long we think this massive storm system has persisted. Somehow I had gotten the idea that Galileo Galilei had observed the Red Spot back in 1610 when he first made observations of Jupiter. From this I'd been stating that this storm has persisted for at least 400 years. But, Galileo did not observe the Red Spot. Thinking about it now, it seems quite obvious — given the low power, small field of view and the low quality of the optics, Galileo apparently had trouble even seeing the colorful bands of Jupiter's atmosphere.

Located nearly 500 million miles away, the giant planet Jupiter's atmosphere is a roiling cauldron of activity. It includes lightning, oppositely moving cloud belts, and hundreds of rotating storms that appear as large red, white, or brown ovals. The largest of these storms is the legendary anticyclone called the Great Red Spot (GRS). In fact, the GRS is the largest known storm in the solar system.

Located in Jupiter's southern hemisphere, the GRS is larger than Earth, with winds inside it raging at 500 miles per hour. While its longitude drifts relative to surrounding atmospheric bands, the storm's latitude has been stable for as long as records of it have been kept. The GRS may have been seen as early as 1632 by Leander Bandtius, Abbot of Dunisburgh. In 1664, the philosopher, architect, and polymath Robert Hooke reported observing a spot that moved from east to west on the planet. The next year, astronomer, mathematician, and engineer Giovanni Cassini was the first to note a "permanent spot."

The Voyager spacecraft in 1979 measured the long axis of the GRS to be 14,500 miles across; historic observations as far back as the late 1800s gauged the GRS to be 25,500 miles across. Hubble's long life has allowed astronomers to follow Jupiter's atmospheric activity over a period spanning nearly two decades. In a study led by Amy Simon of NASA's Goddard Space Flight Center, Hubble observations show that the GRS is now approximately 8,000 miles from top to bottom and 10,250 miles across: the GRS has now shrunk to the smallest size ever measured, having lost half its size over the past hundred years.



The Hubble observations indicate that the GRS is getting smaller by 580 miles per year along its major axis and its shape is changing from an oval to a circle. At the current rate, the storm is expected to become circular in four years. The vortex could completely disappear or grow larger, since the fate of such storms (even storms on Earth) is difficult to model and predict precisely due to their complexity.

In the new Hubble observations, it is apparent that very small eddies are feeding into the storm. Simon and her team hypothesize that these eddies may be responsible for the sudden change by altering the internal dynamics and energy of the GRS. They plan to study the future motions of the small eddies, along with the internal motions of the GRS, to determine whether such eddies can feed or sap momentum entering the upwelling vortex and contribute to changes in the size and shape of the Great Red Spot.

Distance: 5th planet from the Sun; average distance from the Sun is 778 million km (484 million miles) or 5.2 astronomical units (AU)

Instrument: WFC3/UVIS

Image Filters: 395nm, 502nm, 631nm

Credits: NASA, ESA, and A. Simon (Goddard Space Flight Center)

So, when was this storm first observed? One of the first accredited sightings of a large storm in Jupiter's atmosphere was in May of 1664 by Robert Hooke, but this was likely a different storm in the North Equatorial Belt instead of the spot's current location in the South Equatorial Belt. The following year, Giovanni Cassini described a permanent spot in his observations. This spot was observed from 1665 to 1713 and showed fluctuations in its visibility during that period. Could these be the earliest views of the present spot?

It is difficult to say with a strong degree of certainty. The current Red Spot has been observed only after 1830 and well-studied only since 1879. The storm observed by Cassini had a slower motion than the current spot and, with a 118 year gap in observations (1713 to 1830), Cassini's storm may have dissipated and the current storm formed in that time period. Therefore, with regular observations since 1879, we can only say that the Red Spot has existed for at least 140 years and more likely closer to 200 years with observations in the 1830's. Due to the observations of Cassini, you'll often see it stated that the spot has existed for more than 300 years, though this may be true, the supporting evidence for this is not as strong.

Understanding the Dynamics of Jupiter's Atmosphere.

Part of the problem in knowing how long the Red Spot has existed is that scientists don't have a complete understanding of the internal dynamics within Jupiter's atmosphere. What we do know: Jupiter is what we call a gas-giant planet and, like our Sun, is made mostly of hydrogen and helium. In fact, the quantities by mass are the same: 70% hydrogen and 27% helium. Deeper into the atmosphere, the increased pressure compresses the hydrogen gas into a liquid. It is thought that about half way to the center of the planet, the higher pressures result in electrons being stripped away from the hydrogen atoms, creating an electrically conducting liquid that, with Jupiter's fast rotation, drives electrical currents and creates Jupiter's powerful magnetic field.

What we see when we view the colorful bands of Jupiter are clouds in its upper atmosphere which are thought to exist in three layers — a top layer of ammonia ice, a middle layer of ammonium hydrosulfide crystals, and a bottom layer of water ice and vapor. All three layers together span about 44 miles. The dark bands are called belts and the lighter ones are called zones. Neighboring bands rotate in opposite directions resulting in strong winds at the boundary called zonal jets, which are similar to the jet stream in our atmosphere. Due to its turbulent and gaseous nature, the appearance of Jupiter is constantly changing. Smaller storms come and go and the colors of the bands and storms vary somewhat over time. The latitude of the belts and zones has remained consistent, however. The Red Spot is an anticyclonic storm similar to hurricanes seen on Earth. Part of the reason that storms like the red spot last so long is that, unlike Earth's

hurricanes, there are no land masses to dissipate the energy of the storm.

Is the Red Spot Going to Disappear?

The Great Red Spot has consistently been located in the southern belt at a latitude of 22°S. It is confined by an eastward moving jet to its north and a westward moving jet to its south. This massive storm rotates counterclockwise and has wind speeds up to 300 mph. It moves in a westward direction and there is evidence that its rate of movement is increasing.

The Red Spot IS shrinking, but it has been doing so since 1878. It has been decreasing in length, getting rounder and taller. It used to be large enough to hold three Earths, but now could just hold a little more than one. At its current rate of reduction, it would become circular by 2040. More recent observations have revealed changes in the Red Spot that have not been seen before. Streamers, also described as "hooks," "blades" and "flakes," have been observed peeling off of the main spot as often as every week. This has caused many to ask if the storm is beginning to unravel. At this point, it is difficult to say what may happen with the Red Spot in the very near future. Will it continue to shrink and eventually disappear entirely or is this just another type of fluctuation in what will continue to be a long-lasting storm system. Whatever the outcome, the Great Red Spot continues to be one of the most intriguing features of Jupiter.

References:

Pierce, Donna; "What's Going On with Jupiter's Red Spot?"; March 19, 2019; https://theconversation.com/jupiters-great-red-spot-a-300-year-old-cyclone-persists-but-is-shrinking-112934

Zubritsky, Elizabeth; "Jupiter's Great Red Spot Getting Taller as it Shrinks, NASA Team Finds"; March 13, 2018; https://www.nasa.gov/feature/goddard/2018/jupiters-great-red-spot-getting-taller-as-it-shrinks

Quinn, Jim; "Stargazing with Early Astronomer Galileo Galilei"; July 31, 2008; https://www.skyandtelescope.com/astronomy-resources/stargazing-with-galileo/

Candanosa, Robert Molar; "Jupiter's Great Red Spot: A Swirling Mystery"; August 4, 2015; https://www.nasa.gov/feature/goddard/jupiter-s-great-red-spot-a-swirling-mystery

Anderson, John Scott; "Is Jupiter's Great Red Spot Disintegrating?"; June 10, 2019; https://earthsky.org/space/is-jupiters-great-red-spot-disintegrating

https://solarsystem.nasa.gov/planets/jupiter/in-depth/

Wikipedia: Great Red Spot

Chapter 4

The Queen Speaks

Robin Byrne

Robin Byrne

Book Review: The Girls of Atomic City

More on this image. See FN3

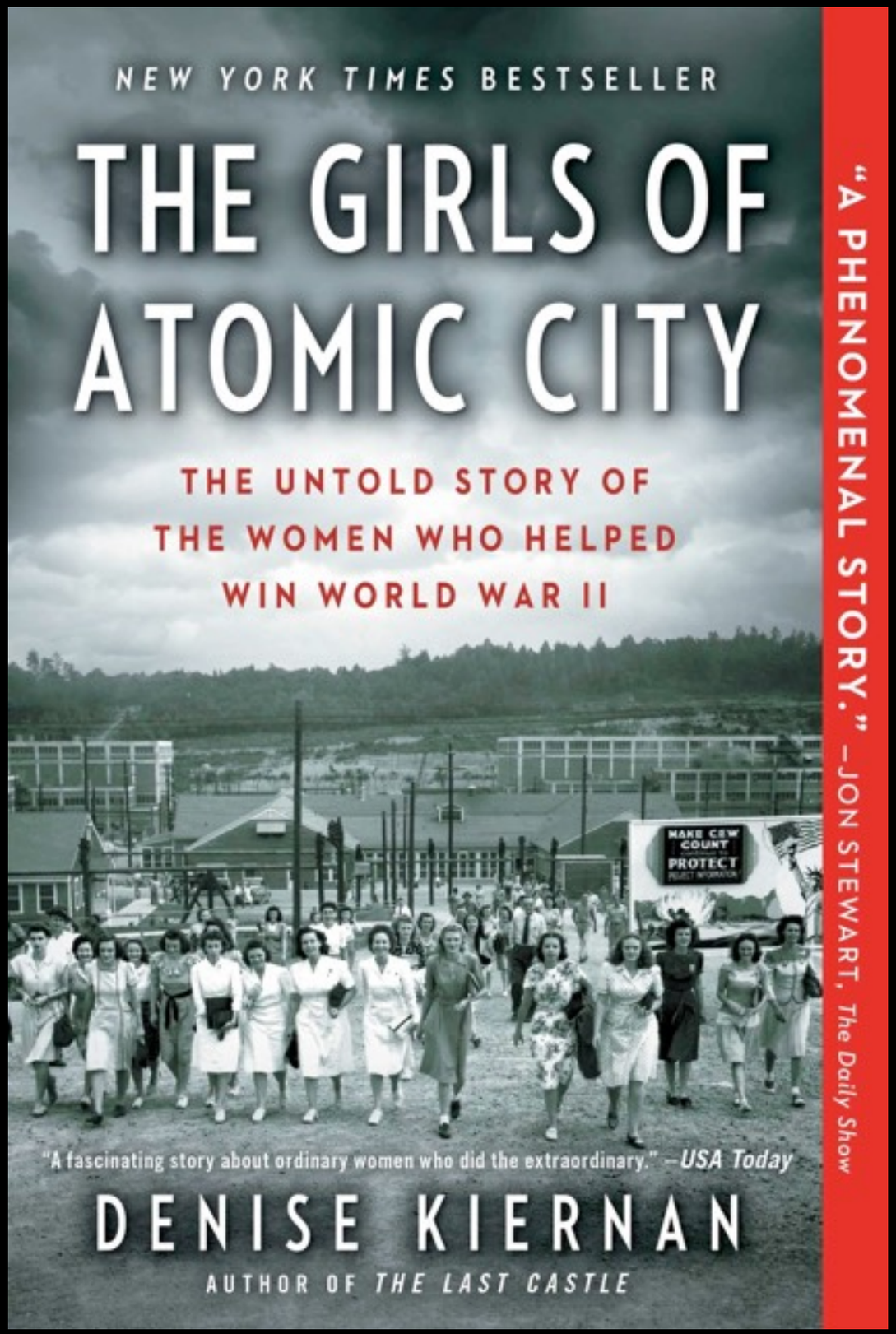
A little over a year ago, Adam and I went on a tour of the Oak Ridge National Laboratory in Oak Ridge, Tennessee. When looking around the gift shop, I saw the title, The Girls of Atomic City: The Untold Story of the Women Who Helped Win World War II by Denise Kiernen, and knew it was a book I should read.

The Girls of Atomic City follows the story of the Manhattan Project and the development of the first atomic bomb, but focuses on the lives of several women who would work at Oak Ridge during this time. The women chosen covered a wide range of roles for women at the facility: janitorial service, secretary, nurse, wife, leak pipe maintenance, calutron cubical operator, statistician, and chemist. We also get a glimpse at the differences between how white and black employees were housed and treated.

The story begins in Germany with Lise Meitner, an Austrian physicist who was one member of the team that first discovered fission. Because she fled Germany for her safety after the rise of the Nazis, she missed out on being recognized for her contributions to the discovery. The story then moves to the United States, the beginning of the Manhattan Project, and the choosing of sites to develop the bomb.

It was obvious from the start that a lot of manpower was going to be needed. Initial estimates suggested needing 10 - 20 thousand employees. By the end of the war, that was closer to 40,000 people working at Oak Ridge. The majority of people recruited to work there, male and female, had no idea what they were working on, with each job being highly compartmentalized. All they knew was that it was part of the war effort, and it was a paying job. The isolation of each component would continue until the bomb was dropped on Hiroshima.

As the new employees arrived by train in Knoxville from all over the country, they were usually met at the train station and driven to the new site. Their first jolt of reality involved the excessive security measures, with multiple warnings about not talking to others about anything they were doing or saw, and to never engage in idle speculation about what was really being done at the site. Some employees were recruited to spy on their coworkers and report anything suspicious. Anyone accused of discussing a taboo topic quickly disappeared from the facility.



The cover to "The Girls of Atomic City."

The next strong impression made on the new arrivals was the ever-present mud and the primitive housing conditions. Roads were not paved, and most people either accepted mud covered shoes, or walked barefoot, carrying their shoes to and from work. Housing ranged from literal huts with holes in the wall for windows (for the black employees only), to separate dormitories for single white men and women, to houses for white married couples and their children. A very elite few found housing in Knoxville and commuted each day. Black husbands and wives could not live together. No housing had been constructed for black employees beyond the huts, which were designed to be single-sex, multiple occupancy residences, with the men and women residing in separate areas of the facility. Because of the housing situation, black employees couldn't bring their children, so they sent money home to family members caring for the kids.

Because so many people worked and lived on site, it quickly became a town, despite its isolation. Grocery stores, churches, movies, dances, and a variety of clubs for different interests, such as hiking, cropped up to help the residents feel at home and fill their leisure time. What began as a facility geared toward only one purpose, quickly turned into a community. Love also blossomed for many of the women working there. Since the vast majority of people at Oak Ridge were single, romance was inevitable. More than half of the single women highlighted in the book ended up marrying someone they met while at Oak Ridge.

I found the stories interesting and entertaining. My one complaint would be that the stories were told chronologically and intertwined with milestones in the development of the bomb. All the while the author would present snippets from the lives of each of the women, but I would lose track of who's who. It made it difficult to follow the complete story arc of any one individual, so they blended together. If you are better at following multiple story lines than I am, it shouldn't present as much of a challenge. Overall, I recommend The Girls of Atomic City as a glimpse into the story of the atomic bomb told from a very different point-of-view.

References:

The Girls of Atomic City: The Untold Story of the Women Who Helped Win World War II by Denise Kiernen; Touchstone/Simon & Schuster, 2013

Chapter 5

Space Place

More on this image. See FN6

David Prosper

Chill Out: Spot an Ice Giant in August

More on this image. See FN3

Is the summer heat getting to you? Cool off overnight while spotting one of the Solar System's ice giants: Neptune! It's the perfect way to commemorate the 30th anniversary of Voyager 2's flyby.

Neptune is too dim to see with your unaided eye so you'll need a telescope to find it. Neptune is at opposition in September, but its brightness and apparent size won't change dramatically as it's so distant; the planet is usually just under 8th magnitude and 4.5 billion kilometers away. You can see Neptune with binoculars but a telescope is recommended if you want to discern its disk; the distant world reveals a very small but discernible disk at high magnification. Neptune currently appears in Aquarius, a constellation lacking in bright stars, which adds difficulty to pinpointing its exact location. Fortunately, the Moon travels past Neptune the night of August 16th, passing less than six degrees apart (or about 12 Moon widths) at their closest. If the Moon's glare overwhelms Neptune's dim light, you can still use its location that evening to mark the general area to search on a darker night. Another Neptune-spotting tip: Draw an imaginary line from bright southern star Fomalhaut up to the Great Square of Pegasus, then mark a point roughly in the middle and search there, in the eastern edge of Aquarius. If you spot a blue-ish star, swap your telescope's eyepiece to zoom in as much as possible. Is the suspect blue "star" now a tiny disc, while the surrounding stars remain to be points of white light? You've found Neptune!

Neptune and Uranus are ice giant planets. These worlds are larger than terrestrial worlds like Earth but smaller than gas giants like Jupiter. Neptune's atmosphere contains hydrogen and helium like a gas giant, but also methane, which gives it a striking blue color. The "ice" in "ice giant" refers to the mix of ammonia, methane, and water that makes up most of Neptune's mass, located in the planet's large, dense, hot mantle. This mantle surrounds an Earth-size rocky core. Neptune possesses a faint ring system and 13 confirmed moons. NASA's Voyager 2 mission made a very close flyby on August 25, 1989. It revealed a dynamic, stormy world streaked by the fastest winds in the Solar System, with their ferocity fueled by the planet's surprisingly strong internal heating. Triton, Neptune's largest moon, was discovered to be geologically active, with cryovolcanoes erupting nitrogen gas and dust dotting its surface, and a mottled "cantaloupe" terrain made up of hard water ice. Triton is similar to Pluto in size and composition, and orbits Neptune in the opposite direction of the planet's rotation, unlike every other large moon in the Solar System. These clues lead

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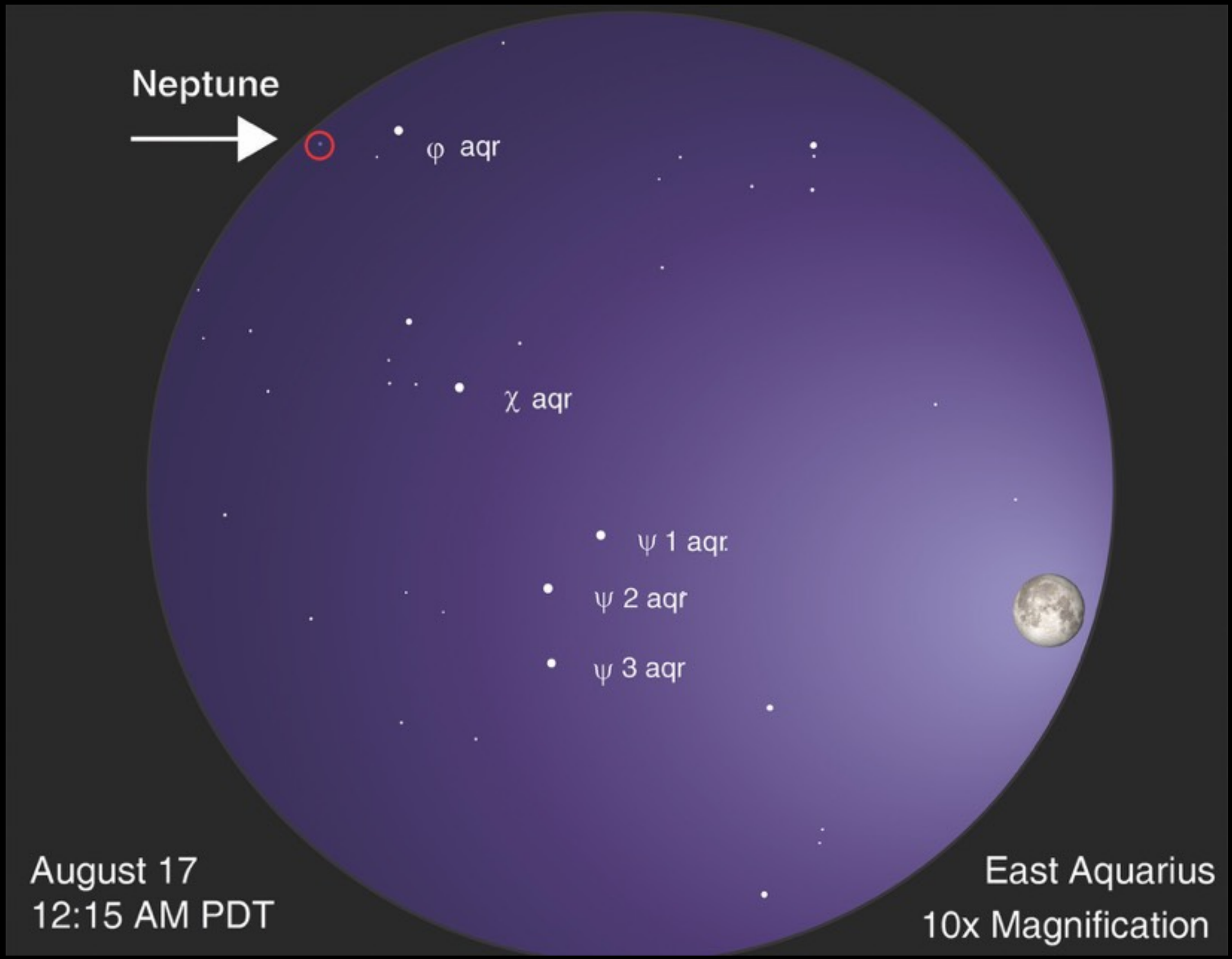

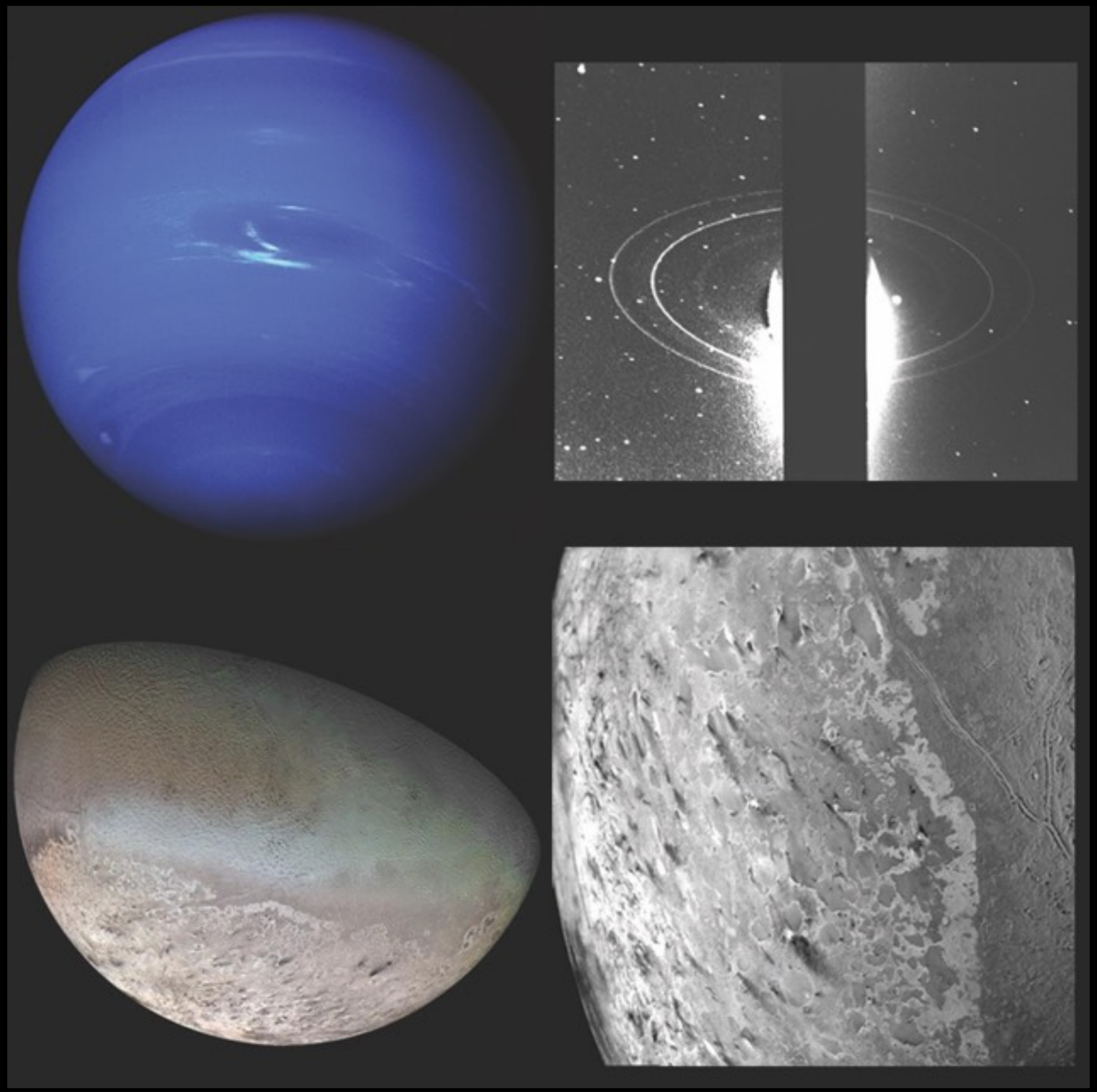

scientists to conclude that this unusual moon is likely a captured Kuiper Belt object.

Discover more about Voyager 2, along with all of NASA's past, present, 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 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, August 2, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program Steven J. Conard from the Johns Hopkins University Applied Physics Lab will present: "New Horizons Spacecraft Efforts to Find Ultima Thule." The New Horizons spacecraft collected data on Kuiper Belt Object 2014MU69, nicknamed Ultima Thule, during a flyby encounter in December and January. Steve Conard will discuss the efforts to find Ultima Thule, to characterize it prior to the encounter, the preparations for the encounter, and the data collected by the LORRI instrument. Steven J. Conard is a member of the Principal Professional Staff at the The Johns Hopkins University Applied Physics Laboratory. He has over 35 years experience building, testing, and operating optical instrumentation for astrophysics and planetary space missions. He has been lead engineer for the Long Range Reconnaissance Imager (LORRI) on the New Horizons mission since 2003. He has been an amateur astronomer since age 12, and grinding his own telescope mirrors as a teenager led him to a career in optics. His current interests in amateur astronomy are occultation timing and spectroscopy.; Free.
Friday, September 6, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program TBA; Free.
Friday, October 4, 2019	7 p.m.	Nature Center Discovery Theater	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			
Oct. 5, 12, 2019	7:30 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.
Oct. 19, 26, Nov. 2, 2019	7 p.m.		
Nov. 9, 16, 23, 30, 2019	6 p.m.		
Special Events			
Oct. 18-20, 2019	-	Bays Mountain Park	StarFest 2019. Our 36th annual astronomy convention/star gathering for the Southeast United States. Three days of astronomy fun, 5 meals, 4 keynote speakers, unique T-shirt, and more. ***Pre-registration by Sept. 27, 2019 with full payment is mandatory for attendance. Sorry, no walk-ins nor "visits."*** Registration will open in August.

Bays Mountain Astronomy Club

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Kingsport, TN 37650

1 (423) 229-9447

www.BaysMountain.com

AdamThanz@KingsportTN.gov

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:

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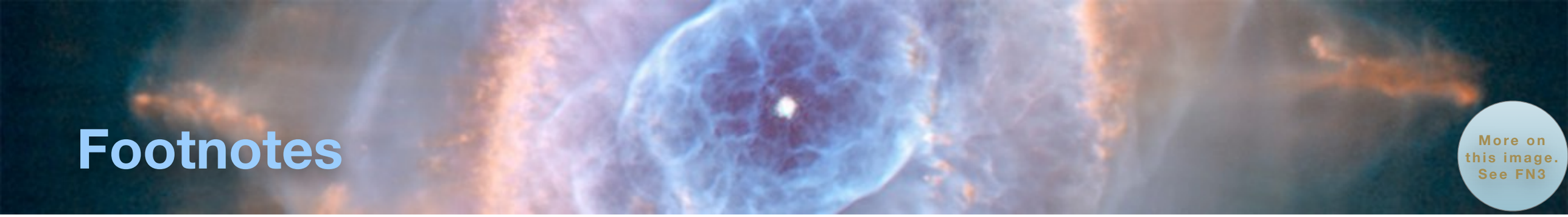

Footnotes

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 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)

8. Finder chart for Neptune. This is a simulated view through 10x50 binoculars (10x magnification). Please note that the sizes of stars in this chart indicate their brightness, not their actual size. Moon image courtesy NASA Scientific Visualization Studio; chart created with assistance from Stellarium.

9. Clockwise from top left: Neptune and the Great Dark Spot traced by white clouds; Neptune’s rings; Triton and its famed icy cantaloupe surface; close up of Triton’s surface, with dark streaks indicating possible cyrovolcano activity. Find more images and science from Voyager 2’s flyby at bit.ly/NeptuneVoyager2 Image Credit: NASA/JPL