The Monthly Newsletter of the

Bays Mountain Astronomy Club

September 2016

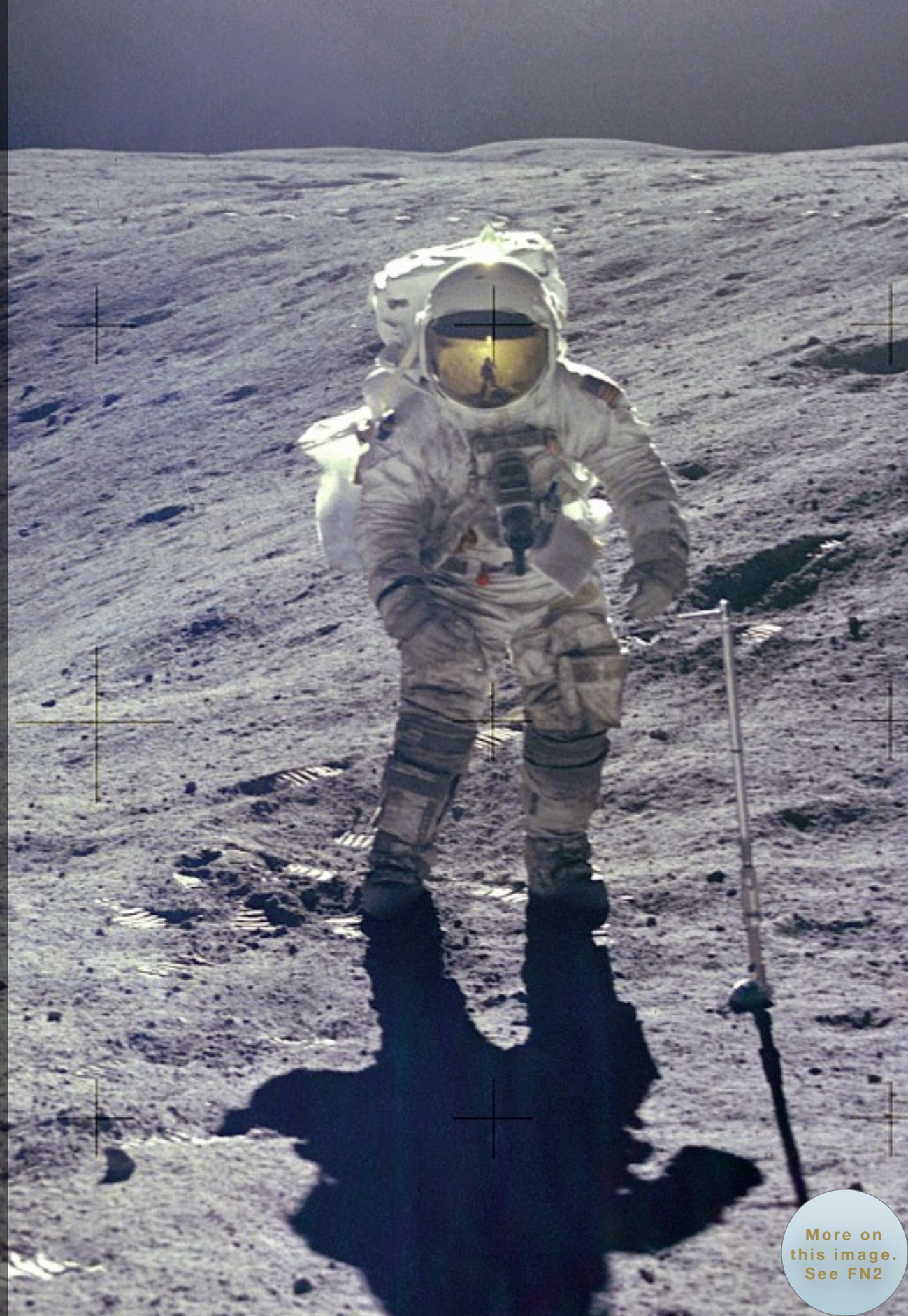
Edited by Adam Thanz

More on this image. See FN1

Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair



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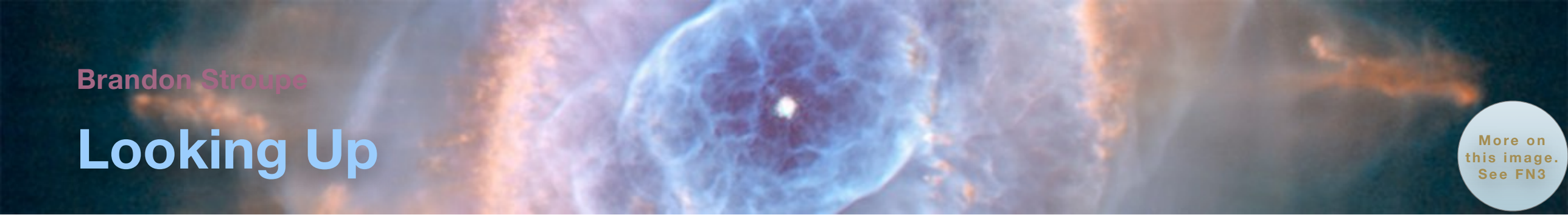


Brandon Stroupe

Looking Up

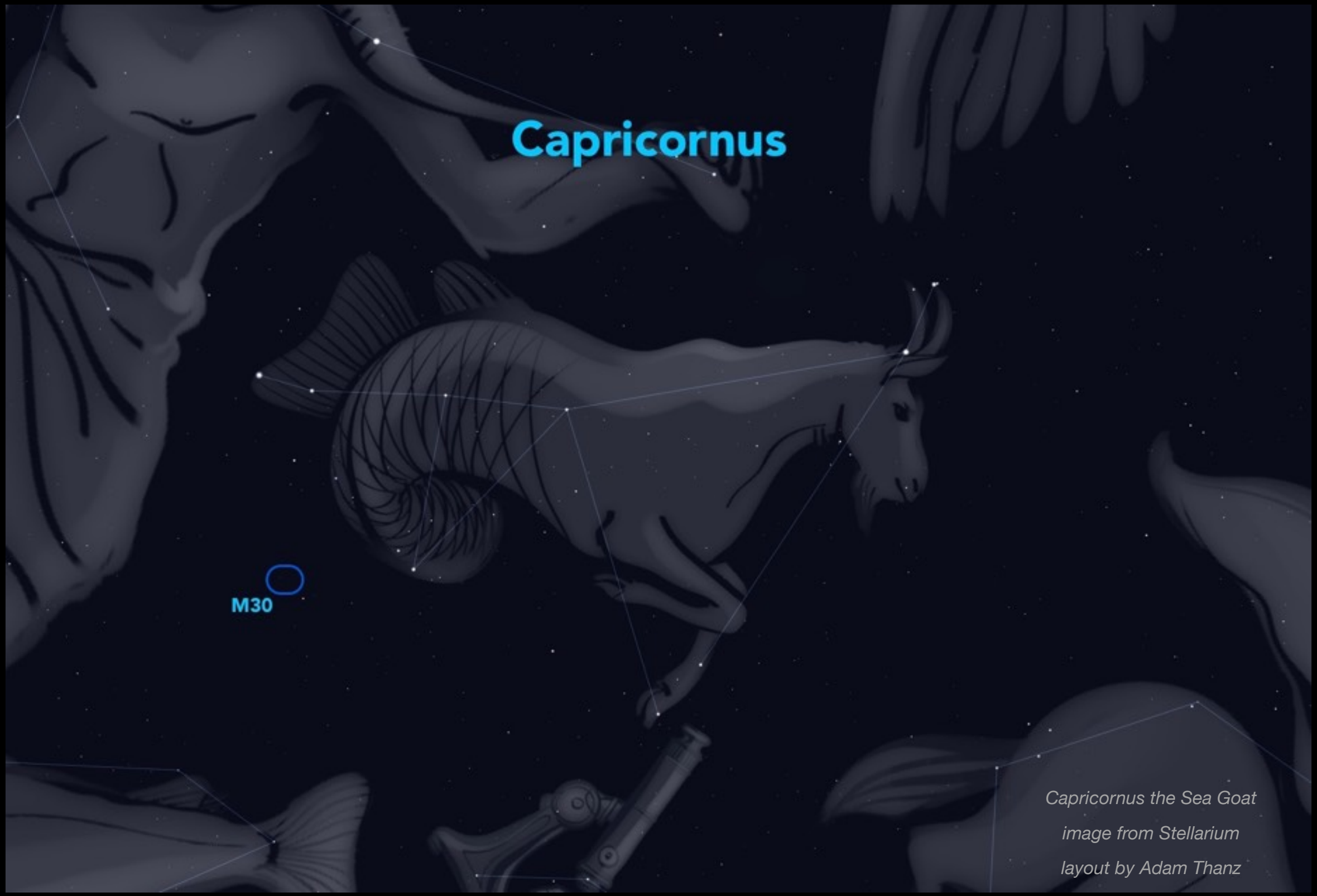
More on this image. See FN3

Hello BMACers,

September is upon us. This year seems to be going by pretty fast. It seemed like just yesterday we were going into summer and now we are fixing to be done with it. I for one am very happy for that fact. As most of you all know from my numerous rants in previous articles, I do not like hot, humid weather. I am an autumn/winter type of guy. Mostly because that is when the skies are the best for imaging and observing. I only wish that the beautiful, distant objects in our spring/summer sky was in our fall/winter sky. I especially mean the summer Milky Way. It is far brighter and denser than the winter Milky Way. Well, anyway, I welcome the cooler, more tranquil nights ahead of us and I hope you do too.

For our meeting this month, we welcome Judy Beck. Judy is a lecturer in the Department of Physics at UNC Asheville, where she teaches physics for majors and non-majors, astronomy, and special topics courses. She is active in science outreach for schools, teachers, and the general public, and she co-directs the Science Olympiad tournament hosted by UNC Asheville each year. In 2008, she spent the year living and working in La Serena, Chile, where she taught classes in the physics department at the university and collaborated with colleagues on astronomy outreach, teacher professional development workshops, and inquiry-based science curriculum development for schools. Judy is an active member of the Astronomy Club of Asheville, and is on the advisory group of Lookout Observatory, a collaboration between the club and the university which opened in the fall of 2014. Judy's presentation is entitled, "Gravity in Astronomy: Developments from Galileo to Gravitational Waves." Gravity, one of the four fundamental forces in the Universe, is intricately threaded throughout the study of astronomy. Her talk will explore some of "gravity's greatest hits," from the insights of Galileo and Newton, to the prediction and discovery of black holes, to the recent observational evidence for gravitational waves. We all experience gravity every day, and yet it can still amaze and intrigue us! I am really excited for Judy's presentation. I hope everyone will be able to come out to the Park and enjoy it with me.

At our August meeting, I was the presenter and my presentation was entitled, "Astrophotography: Budget Friendly Ways to Image



Capricornus the Sea Goat
image from Stellarium
layout by Adam Thanz

the Night Sky.” I spoke briefly about the basics of astrophotography. I spent a great deal of time showing the different types of equipment that can be used and I also covered the cost of most of the equipment. I talked briefly about how easy it would be for a beginner to image the night sky on a budget and still produce breath-taking images. At the end of the presentation, I gave a quick demonstration of two different types of software that is used to control your imaging setup. One of the options was a budget friendly option and the other was a more expensive option. Both accomplished the same thing and they both had their pros and cons. If you did not get to see the presentation, I do plan to give it again in the future. I can also make the PowerPoint presentation available if anyone would like it. Thank you for letting me speak and I hope everyone enjoyed the presentation.

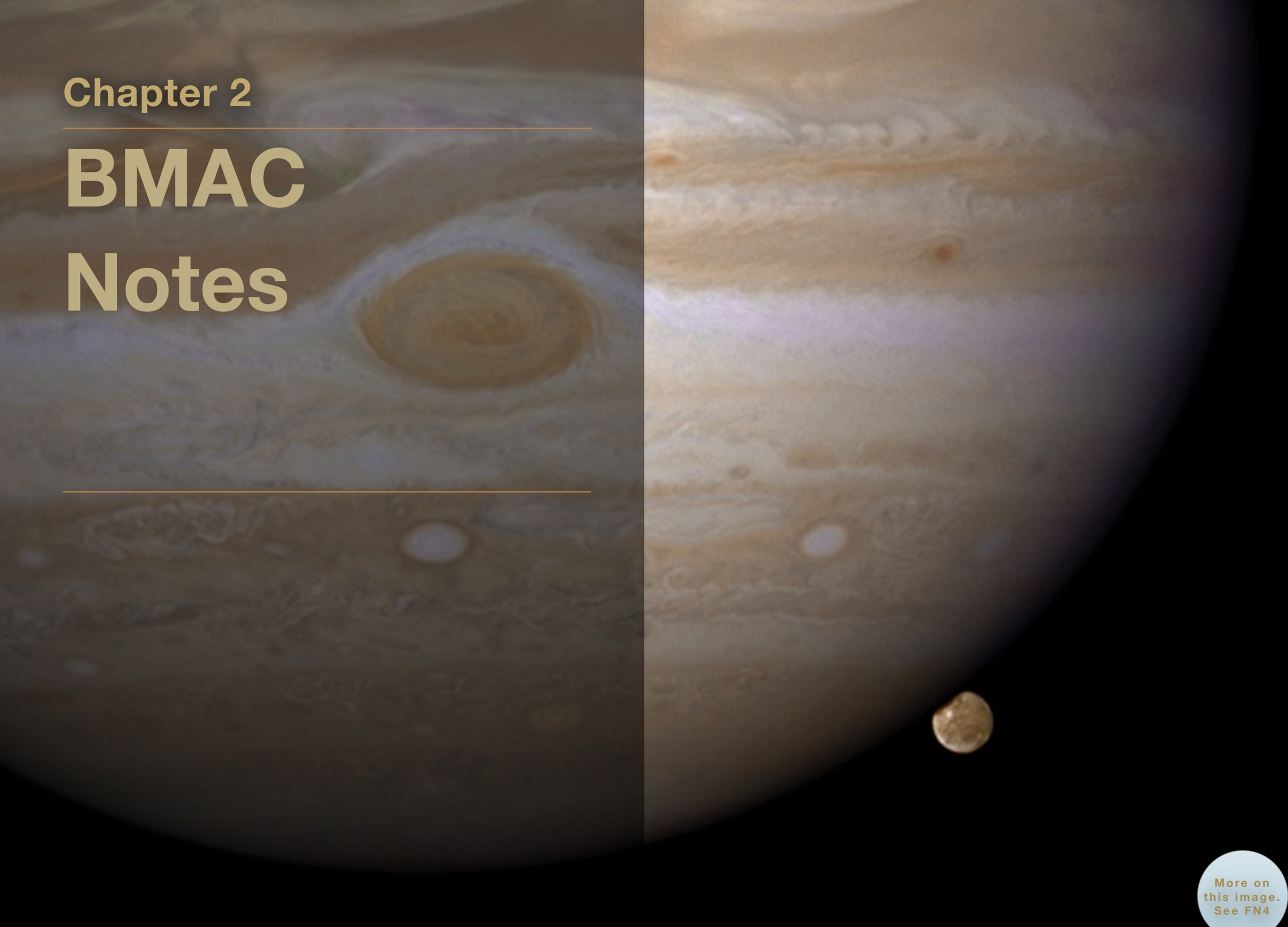
Our September constellation is Capricornus. It is more commonly known as Capricorn. Most of the constellations’ names originated from Greek, but this time the name Capricornus is Latin for “horned goat” or “goat horn,” and it is commonly represented in the form of a sea-goat. It is often depicted as a mythical creature that is half goat, half fish. This constellation does still exist in Greek mythology. Capricornus has two different myths behind it. One is that it is sometimes referred to as Amalthea, which is the goat that suckled the infant Zeus after his mother, Rhea, saved him from being devoured by his father, Cronos. Another myth is that Capricornus is sometimes referred to as Pan, the god with a goat's head, who saved himself from the monster Typhon by giving himself a fish’s tail and diving into a river. There are not very many significant objects in Capricornus. M30, which is a globular cluster, and HCG 87, which is a galaxy group, is really the only deep-sky objects that lie in this constellation. Even without having many objects in it, it still deserves a mention. Every constellation is unique in one way or another.

I am very happy to announce that the registration for StarFest 2016 is now open. It is our 33rd StarFest. Attendance will be limited and registration must be received prior to the deadline of Sept. 30, 2016. If you are considering going, DON’T! Just GO! It is a great, fun weekend with awesome speakers, food, swap shop, and friends. I look forward to this weekend every year. I hope everyone will be there.

That will be it for this month. Please remember that the SunWatches will still happen every Saturday and Sunday from 3:00-3:30 p.m. if it is clear and we are always happy to have volunteers from the club to help out with this too. If you would like to help out, please arrive about 30 minutes early to help set up the equipment. I hope to see everyone at our meeting this month. Until next month… Clear Skies.

Chapter 2

BMAC Notes



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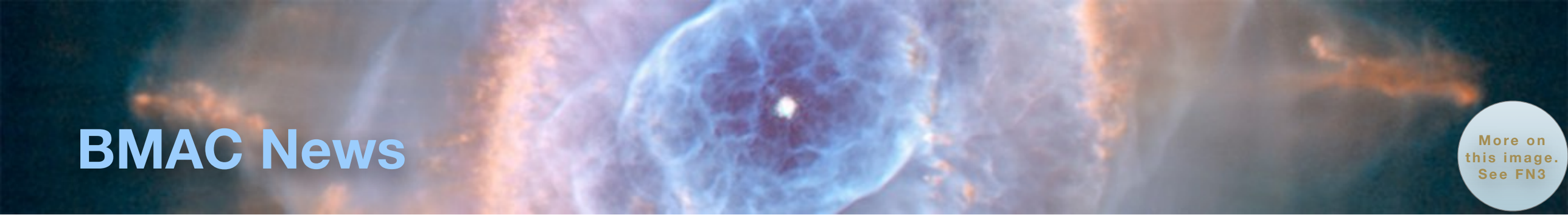


BMAC News

BMAC Youtube!

The BMAC has a YouTube channel. Click here to see what's on!

(https://www.youtube.com/channel/UCwIQM6nUs9qxJtDQe4AaAWQ)

The presentation by Steve Conard, who spoke about the telescope instrument on the New Horizons spacecraft, is now online. More to come!

2016 Virginia Association of Astronomical Societies (VAAS) Conference -- Registration Now Live!!!

Greetings Astronomy Enthusiasts!

Registration is now live for the 40th annual conference of the Virginia Association of Astronomical Societies (VAAS)!

The 2016 VAAS conference will be held on Saturday, October 29th, and is hosted by the Roanoke Valley Astronomical Society, of Roanoke, Virginia, and the Department of Mathematics, Computer Science and Physics of Roanoke College. The site of the conference is the Colket Center at Roanoke College, in Salem, Virginia. The event begins at 8:30 a.m. and continues through 4:00 p.m. A meeting of representatives of Virginia societies attending the conference will take place immediately thereafter to name the VAAS 2017 host.

The centerpiece of the conference is our line-up of four extraordinary speakers, Dr. Brad Barlow, Mr. Steve Conard, Dr. Dwight Holland and Dr. Harold ("Hal") McAlister, representing a wide spectrum of astronomical and space science fields that will be of interest to all. An observing session may be held that evening on the Blue Ridge Parkway, if sufficient interest is indicated by those registering in advance.

For full information regarding the 2016 VAAS annual conference, please visit our website at http://www.rvasclub.org/vaas2016.

C11 scope for sale. See notes.

Brandon Stroupe was the speaker for the August 2016 meeting on astrophotography.

Photo by Adam Thanz

Telescope for Sale:

NEW Celestron 11” Telescope with Tripod and Wheelybars

Price: $2,500.00; **Posted By:** IBTRUCKING; **Phone:** (423) 288-8696

TOP OF THE LINE COMPUTERIZED CPC CELESTRON HIGH POWERED 11" TELESCOPE ON CELESTRON STAND WITH WHEELS. This was bought new and it's like new. It has been used very little due to my husband's cancer. This is a Celestron CPC COMPUTRIZED TELESCOPE. THE MODEL IS 51611 AND HAS A 9 X 50 LENS (finder). I have never used it so I don't know anything about it except it cost over $5,000 for the telescope and stand. It has a Sky Align Alignment Technology. There is a number 970654 on the side. It has ergonomics enhanced computerization features. It has an instruction booklet with it.

It’s Time to Clean Up Orbiting Space Junk

Johnson City Press • Aug 6, 2016 at 12:00 AM

The Salt Lake Tribune reports a late-night light show seen in parts of northern Utah last month was produced by falling space junk. It says the pyrotechnics that lit up the starry skies for less than 20 seconds was a Chinese rocket booster burning up in the atmosphere.

Jonathan McDowell, an astronomer at the Harvard-Smithsonian Center for Astrophysics, told the newspaper that the debris was part of the second stage from the first Chang Zheng 7 rocket, which was launched in June.

Space seemed to be a desolate frontier when the former Soviet Union sent Sputnik I into orbit in 1957. Now, scientists say space junk cluttering Earth’s orbit could pose a significant threat to space travel in the coming years.

The U.S. Space Surveillance Network is tracking more than 13,000 human-made objects larger than 4 inches in diameter orbiting the Earth. These include both operational spacecraft and the remains of booster rockets.

That space junk includes Vanguard I, a satellite the United States launched in 1958. Although the American satellite was operational for only six years, its presence continues to pose a risk to some commercial and research flights into space.

Much of the debris now orbiting the planet comes from explosions of satellites, especially old upper stages left in orbit with leftover fuel.

Much of the space junk is found in an area between 550 miles and 625 miles above the Earth. Most manned orbital flights — including work on the International Space Station — are conducted at an altitude of about 250 miles.

NASA scientists say these objects travel at speeds of more than 22,000 miles an hour. At this velocity, even a small piece of junk can damage a spacecraft or destroy a satellite.

That's why the United States and other governments are investing in systems to better locate orbital debris.

Officials say space junk is a problem that must be addressed in the coming years. The Inter-Agency Space Debris Coordination Committee, made up of space agencies from 10 countries and the European Space Agency, has concentrated its efforts on preventing new debris.

Commercial space companies and national space agencies are working on new launch and design standards (such as limiting the use of explosive bolts to separate rocket stages) to reduce the amount of space junk entering low-earth orbit.

The private SpaceX program is returning part of its rocket propulsion system back to earth once its payload reaches orbit. Last month, SpaceX landed the first stage of its Falcon 9 rocket on the launch pad.

This article appeared on the opinion page of the Johnson City Press on Saturday, Aug 6. I thought it would be an informative article for the club newsletter. I talked with Robert Houk, the Opinion Page Editor. He said the article was written "in house." He also gave permission to use it as long as credit was given to the JC Press and the date of publication was also noted. Terry Alford.

The night of the peak for the annual Perseid meteor shower, Aug. 11, 2016. No meteors, but a partly cloudy sky and a bright first quarter Moon. Notice the southern Milky Way. Sony A7II, 35mm, f/2.8, 2.5s, 8,000ISO. 10 p.m. Image by Adam Thanz.

The morning of the peak for the annual Perseid meteor shower, Aug. 12, 2016. Modest cloud cover, Notice the meteor below the Andromeda Galaxy. The streak behind the cloud is a satellite. Witnessed about 100 meteors from 4:30-5:30 a.m. Sony A7II, 35mm, f/2.8, 5s, 6,400ISO. 5:30 a.m. Image by Adam Thanz.

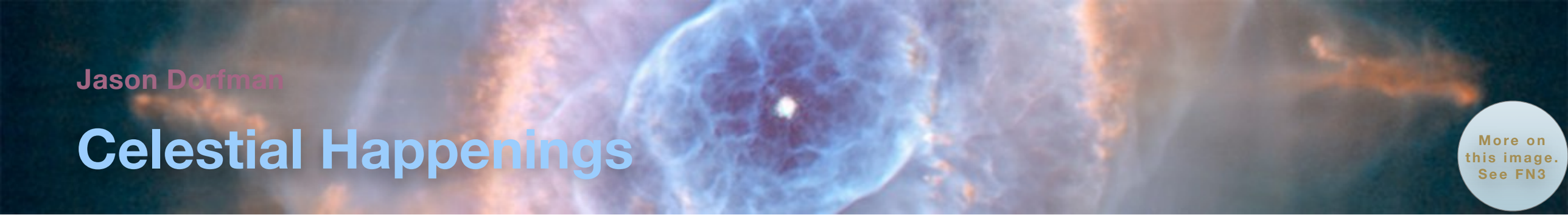
The morning of the peak for the annual Perseid meteor shower, Aug. 12, 2016. Modest cloud cover, Notice the meteor to the left of Orion and Taurus. Orion was most definitely in the twilight sky. Witnessed about 100 meteors from 4:30-5:30 a.m. Sony A7II, 35mm, f/2.8, 5s, 6,400ISO. 5:40 a.m. Image by Adam Thanz.

Chapter 3

Celestial Happenings

Jason Dorfman

More on this image. See FN5



Jason Dorfman

Celestial Happenings

More on this image. See FN3

For September viewing, not a lot has changed in terms of what's observable. Mars and Saturn are still in Scorpius at the start of the month. Mars will actually only spend one day in Scorpius for September as it quickly moves through Ophiuchus and into Sagittarius by the end of the month. On the 8th, a nearly first quarter Moon will be just a few degrees above Saturn. Also, Neptune reaches opposition on the 2nd. At magnitude 7.8, you'll need binoculars but, if you've never viewed this ice giant, now would be a good time to add it to your list.

But I'd like to stray a bit for the rest of this month's article from the normal what's up in the sky and share a story from my observations of the Perseid meteor shower. From several accounts that I've read, it appears that the predictions for an increase in the number per hour were fairly accurate. I hope that everyone was able to at least get outside for a little while to catch a glimpse.

Due to family matters, I found myself in California for the peak night of the shower. As I was getting ready to climb into bed just after midnight, I decided that I should be a good amateur astronomer and at least go out and look for a bit. Being that I was in the middle of light-polluted Silicon Valley, my expectations were not too high for what I might see. I stepped out onto the patio and headed for the back yard. Luckily, I happened to see the large garden spider hanging from the end of the patio roof before I ran into it. That would have been a bad start to my observations. Carefully stepping around his web, I planted myself at the end of the patio with a nice view towards the northeast.

It was only a minute later when a bright streak appeared almost due east. I was looking in that general direction, so I was able to pick it up rather quickly. As it shot towards the northeast, it began to slow and brighten considerably. This one was a fireball! Then, It brightened even more as it burned up spectacularly in a fiery flash of blue and orange.

Needless to say, I was awestruck. Did I just observe a bolide?! I couldn't believe that I had gotten so lucky with my timing. And, it wasn't even a Perseid as it was heading toward the Perseus constellation!

I remained outside for another half hour craning my neck towards the heavens hoping for another amazing sight, but no such luck. I

did observe about 5 Perseids which must have been fairly bright considering my light-polluted skies. However, realizing that nothing was going to top a bolide, I headed back inside for some much needed shut eye.

Chapter 4

The Queen Speaks

Robin Byrne

Robin Byrne

Happy Birthday Thomas Wright

More on this image. See FN3

This month we celebrate the life of an amateur astronomer who was way ahead of his time. Thomas Wright was born September 22, 1711 in Byer's Green, England. The son of a carpenter and yeoman, Wright attended private school from age five to eight. He then went to a public school. However, due to a speech impediment, he struggled with Latin, so he dropped out of school to study mathematics and writing on his own.

At the age of 14, he began an apprenticeship with a watch and clock maker. During his free time, Wright studied astronomy, spending all his money on books. While Wright's mother encouraged this, his father thought his behavior was so odd, he took drastic measures in the hopes of saving his son from this insanity - he burned his books. Wright ran away from home with the few books he could save. After some harrowing encounters, he heard from his father that he was welcome to come back home. However, that was the end of his apprenticeship.

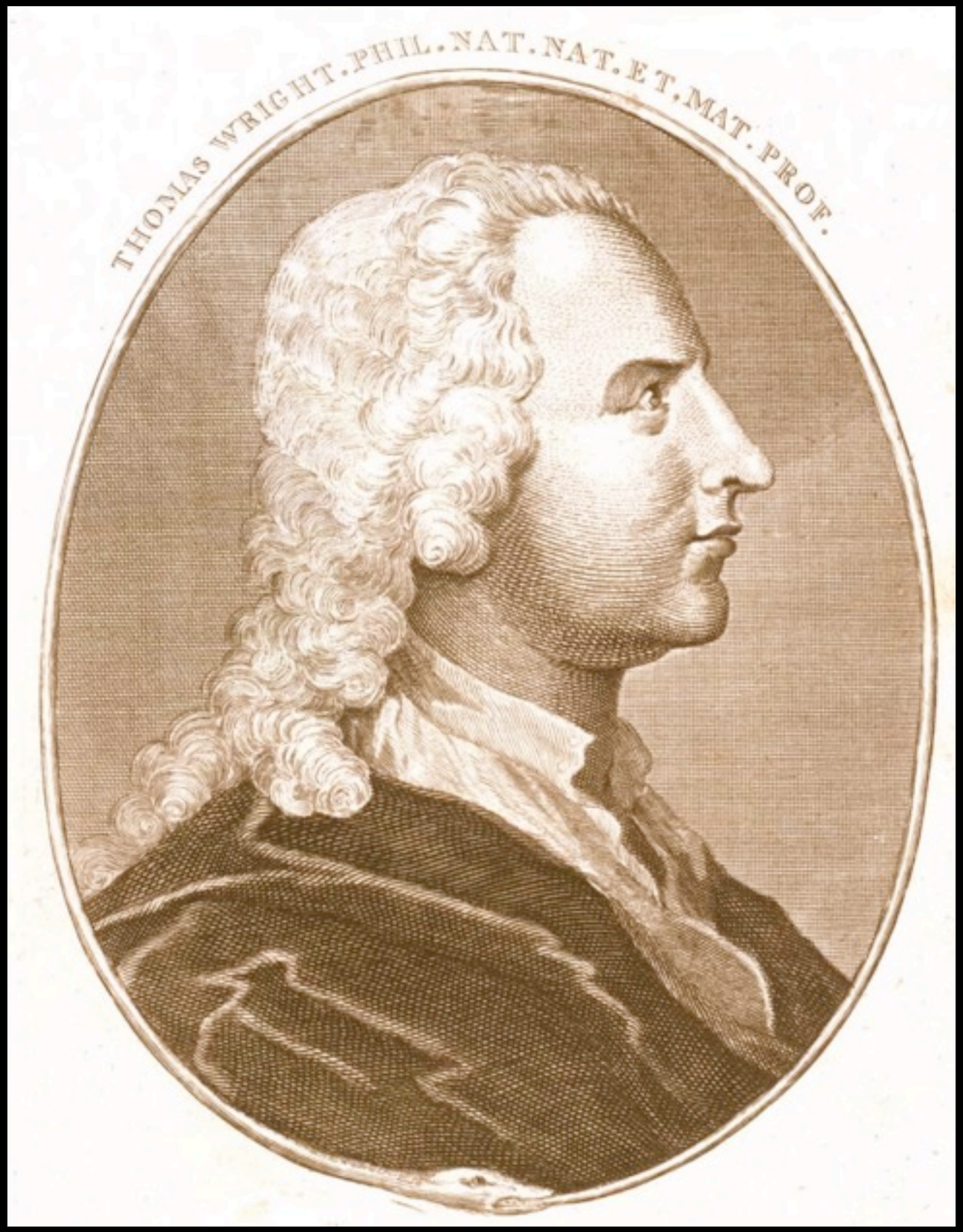
So here Wright is, age 18, and no job. While figuring out what he should do, Wright studies astronomy, math, navigation, and geography. In January 1730, Wright signs on to be a sailor, making a journey to Amsterdam. Along the way, they hit rough seas, and he was almost thrown overboard. That was the end of his sailing career. Instead, Wright opens a school to teach mathematics and navigation to seamen.

Meanwhile, Wright's interest in writing took hold with his first attempts to publish. He had compiled almanacs for the years 1732 and 1733. After traveling 200 miles to London, the publisher who had indicated they would print them, backed out. Walking back home with a few shillings in is pocket, Wright was despondent. Then he heard from a publisher in Edinburg, offering to print his work. Only a few copies were sold, and the publisher extorted money from Wright, so he was not off to a good start.

With the publication of "Calculation & Type of the Total Eclipse of the Moon for November 20, 1732" things began to look up. In 1733, the Rector of Sunderland, impressed with Wright's intelligence, hired him as a companion. With his situation much improved, Wright went on to publish many more writings, covering topics ranging from navigation to astronomy. He also created brass dials of his own design to determine the Sun's position. Wright's passion for teaching continued, as well, spending every winter in London to teach courses for the next 13

Thomas Wright, 1737

image from Wikipedia



Thomas Wright

image from Wikipedia

years.

Wright's writing continued, publishing various books, including three devoted to astronomy: "The Use of the Globes, or The General Doctrine of the Sphere" (1740), "Clavis Coelestis, Being the Explication of a Diagram Entitled, A Synopsis of the Universe or the Visible World Epitomized" (1742), and "An Original Theory or a New Hypothesis of the Universe Founded on the Laws of Nature" (1750). It was in these books that Wright's ideas about the nature of the Universe were first brought forth. Concerning comets, Wright had made his own telescopic observations, and made calculations of the orbits of comets. Contrary to the popular belief that comets were transient objects, Wright agreed with Halley that they are in orbit around the Sun and will return. Looking at the stars, he believed that he was looking at objects similar to our Sun, just very far away, and that each would have its own system of planets. Wright also thought that stars were not all at one distance fixed to a celestial sphere, but instead were distributed at a variety of distances. He also held the belief that all stars are in motion, even measuring the proper motion of a few stars as confirmation. This led to his idea about the structure of the Milky Way, picturing it shaped like a disk with all the stars orbiting in one direction. Wright even went so far as to propose that faint nebulae were objects like the Milky Way, but much farther away. In other words, Wright proposed that there were galaxies beyond the Milky Way. However, due to his amateur status, professional astronomers took no notice of Wright's ideas.

That didn't stop others from appreciating Wright's thoughts. He became a popular guest of prominent people, including the Duke and Duchess of Kent, giving evening lectures to their guests. He would talk about a variety of topics, including navigation, surveying, astronomy, and mathematics. The philosopher Immanuel Kant heard Wright's ideas, and became a prominent endorser of the idea that our galaxy is shaped like a disk, and that there are other galaxies beyond the Milky Way. In 1742, Wright was offered a position as Professor of Navigation in the Imperial Academy in St. Petersburg, but Wright declined, saying that the annual salary of 300 Pounds was not enough to lure him away from his homeland.

In addition to his astronomical work, Wright also designed magnificent gardens, and drew up architectural designs. He documented archaeological sites in Ireland, helping to preserve many antiquities.

In 1762, Wright retired, returning to Byer's Green. Here he enjoyed a solitary life, his neighbors deeming him to be eccentric. His house was filled with books, and Wright even began building a tower to use as an observatory. Sadly, he died before its completion on February 25, 1786.

Thomas Wright had the freedom to "think outside the box" when it came to established astronomical ideas, and often turned out to be right well before the professionals figured it out. He is quoted as saying,"Every age of the World as Knowledge is increased

AN

ORIGINAL THEORY

OR

NEW HYPOTHESIS

OF THE

UNIVERSE,

Founded upon the

LAWS of NATURE,

AND SOLVING BY

MATHEMATICAL PRINCIPLES

THE

General PHÆNOMENA of the VISIBLE CREATION;

AND PARTICULARLY

The VIA LACTEA.

Compris'd in Nine Familiar LETTERS from the AUTHOR to his FRIEND.

And Illuſtrated with upwards of Thirty Graven and Mezzotinto Plates,
By the Beſt MASTERS.

By THOMAS WRIGHT, of DURHAM.

One *Sun by Day, by Night* ten Thouſand *ſhine,*
And light us deep into the DEITY. Dr. YOUNG.

LONDON:
Printed for the AUTHOR, and ſold by H. CHAPELLE, in *Groſvenor-Street.*
MDCCL.

Cover page

image from Wikipedia

either from improved Imagination or repeated Observations, producing something new concerning it.” Wright’s imagination definitely served him well. As we peer through our telescopes, remember this fellow amateur astronomer who took ideas to a whole new level.

References:

Vera Gushee. "Thomas Wright of Durham, Astronomer." Isis 33, no. 2 (1941): 197-218.

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Thomas Wright (astronomer) Wikipedia

https://en.wikipedia.org/wiki/Thomas_Wright_%28astronomer%29

Chapter 5

Space Place

More on this image. See FN6

Dr. Ethan Siegel

Is There a Super-Earth in the Solar System Out Beyond Neptune?

More on this image. See FN3

When the advent of large telescopes brought us the discoveries of Uranus and then Neptune, they also brought the great hope of a Solar System even richer in terms of large, massive worlds. While the asteroid belt and the Kuiper belt were each found to possess a large number of substantial icy-and-rocky worlds, none of them approached even Earth in size or mass, much less the true giant worlds. Meanwhile, all-sky infrared surveys, sensitive to red dwarfs, brown dwarfs and Jupiter-mass gas giants, were unable to detect anything new that was closer than Proxima Centauri. At the same time, Kepler taught us that super-Earths, planets between Earth and Neptune in size, were the galaxy's most common, despite our Solar System having none.

The discovery of Sedna in 2003 turned out to be even more groundbreaking than astronomers realized. Although many Trans-Neptunian Objects (TNOs) were discovered beginning in the 1990s, Sedna had properties all the others didn't. With an extremely eccentric orbit and an aphelion taking it farther from the Sun than any other world known at the time, it represented our first glimpse of the hypothetical Oort cloud: a spherical distribution of bodies ranging from hundreds to tens of thousands of A.U. from the Sun. Since the discovery of Sedna, five other long-period, very eccentric TNOs were found prior to 2016 as well. While you'd expect their orbital parameters to be randomly distributed if they occurred by chance, their orbital orientations with respect to the Sun are clustered extremely narrowly: with less than a 1-in-10,000 chance of such an effect appearing randomly.

Whenever we see a new phenomenon with a surprisingly non-random appearance, our scientific intuition calls out for a physical explanation. Astronomers Konstantin Batygin and Mike Brown provided a compelling possibility earlier this year: perhaps a massive perturbing body very distant from the Sun provided the gravitational "kick" to hurl these objects towards the Sun. A single addition to the Solar System would explain the orbits of all of these long-period TNOs, a planet about 10 times the mass of Earth approximately 200 A.U. from the Sun, referred to as Planet Nine. More Sedna-like TNOs with similarly aligned orbits are predicted, and since January of 2016, another was found, with its orbit aligning perfectly with these predictions.

Ten meter class telescopes like Keck and Subaru, plus NASA's NEOWISE mission, are currently searching for this hypothetical, massive world. If it exists, it invites the question of its origin: did it form along with our Solar System, or was it captured from


More on this image. See FN8

another star’s vicinity much more recently? Regardless, if Batygin and Brown are right and this object is real, our Solar System may contain a super-Earth after all.

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, September 2, 2016	7 p.m.	Nature Center Discovery Theater	Program: Judy Beck, lecturer in the Department of Physics at UNC Asheville. “Gravity in Astronomy: Developments from Galileo to Gravitational Waves.”; free.
Friday, October 7, 2016	**6 p.m.**	**Observatory**	Program: Observatory cleaning and topic TBA; Free.
Friday, November 4, 2016	7 p.m.	Nature Center Discovery Theater	Program: Observatory cleaning and 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			
October 1, 8, 15, 2016	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. 22, 29, Nov. 5, 2016	7:00 p.m.		
November 12, 19, 26, 2016	6:00 p.m.		
Special Events			
October 21-23, 2016		Farmstead Museum, BMP	StarFest. Our 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. 30, 2016 with full payment is mandatory for attendance. Sorry, no walk-ins nor “visits.”*** Registration opens in August.

Bays Mountain Astronomy Club

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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:

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

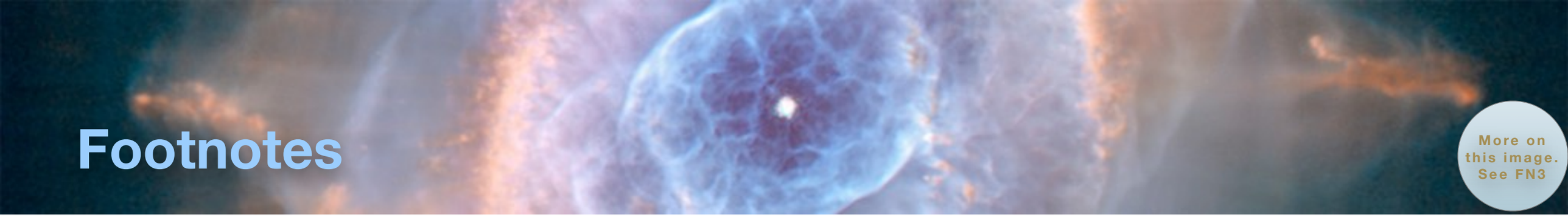
Robin has been writing the science history column since 1992 and was chair in 1997. She is an Associate Professor of Astronomy & Physics at Northeast State Community College (NSCC).

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

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. 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)

8. A possible super-Earth/mini-Neptune world hundreds of times more distant than Earth is from the Sun. Image credit: R. Hurt / Caltech (IPAC)