Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair
Hello BMACers,

It is finally September. It is finally the month before StarFest 2017. Before we know it, October will be here and a lot of us will be preparing for an awesome weekend at Bays Mountain Park & Planetarium. Most of you know how much I love that weekend in October. It is an awesome weekend with awesome people. I hope everyone will decide to attend. By the time you read this, the registration will be open and probably filling up quickly. Please make sure you get registered as soon as possible. I promise that it will be a weekend that you will all love. I hope to see everyone there!

At our meeting this month, we will be having a presentation I have titled, “Tales of Totality.” This presentation will be given by any of you. This will be a meeting where we will be opening the floor to anyone that would like to share their experience of the total solar eclipse. I know that there are plenty of stories to be told. Whether you were able to experience totality, a partial eclipse, awesome weather, or bad weather; please feel free to share your story. I will begin the presentation with my experience and show some pictures from the event. Please feel free to bring pictures or anything you would like to show from your experience. We will limit each story to about 10 minutes and we will have a laptop to show pictures if you bring some disc or memory card. I look forward to all the stories that will be told and I hope many of you will attend and share your experience of this awesome event.

At our meeting last month, we tried something a little new. We had a workshop on telescopes. We had 3 different types of telescopes setup on display. One telescope was a refractor, one was a reflector, and the third was a Schmidt-Cassegrain. The purpose of this presentation was to inform people that may be new to astronomy about the different types of telescopes there are to choose from. I believe we had a very good turnout and I believe we helped numerous people with learning the differences in these types of scopes. Adam Thanz taught people about the refractor telescope while Robin Byrne taught people about the reflector telescope. William Troxel and I taught people about the Schmidt-Cassegrain telescope. We discussed the advantages and disadvantages of each type of telescope. I hope everyone that was at the meeting really enjoyed this format. I would like to
Cygnus the Swan
Image from Stellarium
plan on having meetings like this more in the future. If any of you like this type of meeting, please feel free to let me know.

For our constellation this month, we will be looking at Cygnus. Cygnus is translated to the Swan. Most of us are aware of this constellation because of where it lies in the night sky. Cygnus lies on the plane of the Milky Way and it contains the well-known asterism of the Northern Cross. There are many myths about this constellation. In Greek mythology, Zeus disguised himself as the swan to seduce the Spartan King Tyndareus’s wife. Another myth is that Orpheus was transformed into a swan after his murder, and was placed in the sky next to his lyre who is referred to as the constellation Lyra. I always seem to find some of these myths fascinating. As for interesting objects that are located in this constellation, the most notable one is the star Deneb. Deneb is one of the 3 stars that make up the Summer Triangle that is high overhead this time of year. There are also plenty of deep-sky objects in Cygnus. M39, which is an open cluster, is one of them. The North American Nebula is also located within Cygnus along with the Veil Nebula, Gamma Cygni Nebula, the Crescent Nebula, and the Fireworks Galaxy.

Needless-to-say, there is a lot to look at in the constellation. I know I will pay more attention to this constellation when I am out under the night sky and I hope you do too.

That will be it for this month. Don’t forget about the SunWatches, they take place on Saturday and Sunday at the dam if it is clear. If you would like to volunteer to help with the SunWatches, please arrive a little before 3 p.m. to help with setup. Also, please remember that the StarWatches will begin again in October. These are held on every Saturday night of October and November if it is clear. If it is not clear then there will be a live tour of the night sky in the awesome Bays Mountain Planetarium. If you would like to volunteer for these StarWatches, please come about 30 minutes before dusk to help setup. Also, again, don’t forget to register for StarFest 2017. Until next month… Clear Skies.
Telescope for Sale
The planetarium department received a call about a telescope for sale. It was not used much. It is a slightly older model of a Meade 12” Schmidt-Cas. It is an LX200 EMC with a Classic MHC hand controller. A price has not been set yet, but won’t be for super cheap. Contact the planetarium department for contact info.

StarFest 2017
StarFest is now available for registration! Please visit the website for all the details.

http://www.baysmountain.com/astronomy/astronomy-club/?GTTabs=5

The theme is “Stellar Places.” It looks at astronomical places in which stars inhabit and their effect on their environment.

The Bays Mountain StarFest will, as always, have three days of fabulous food, keynote speakers, other activities, observing and more at an affordable price.

Adam Thanz, StarFest Chair
The Sun on eclipse day, Aug. 21, 2017

Image by Adam Thanz
The Sun on eclipse day,
Aug. 21, 2017

Image by Brandon Stroupe
September is here and that means that the long awaited total solar eclipse has come and gone. I hope that all of you were able to view the eclipse, whether partial or total, and had clear skies for the event.

I, like many of you, had been looking forward to this event for the last couple of years. I had never witnessed a total solar eclipse before. In the weeks leading up to the eclipse, Adam and I were doing lots of media interviews and outreach presentations, which only increased my anticipation of the event. And with the promising weather outlook in the days leading up to eclipse day, I found myself getting even more excited with the increasing possibility that I was actually going to witness totality. …Alas, my hopes were dashed as large amounts of cloud cover began to close in as totality approached. Though we were able to see the start of the eclipse and some partial phases when the clouds cleared, the eclipsed Sun remained hidden behind the clouds when the main event came and went. And, as if to rub it in a little deeper, the clouds cleared in the minute after totality. Ugh!

None the less, the experience was amazing! The change in the lighting was noticeable leading up to totality. The temperature definitely dropped. And, though we couldn’t see totality, the experience was still quite dramatic. When we reached totality, the area was plunged into a dark twilight over a matter of seconds! No wonder ancient people attached such ominous predictions to total eclipses. I hadn’t noticed the birds before totality, but was very aware of how quite it became during totality. Once totality passed, the sounds of birds returned.

Cassini’s Farewell
On September 15, the Cassini spacecraft will make its final close approach to Saturn. Back in April, Cassini began a series of orbits that took the craft closer to the planet than ever before and then back out by Titan’s orbit. Each pass has brought the craft closer to the giant planet’s atmosphere. In the final close approach, the spacecraft will enter the upper atmosphere of Saturn where it will burn up, bringing an end to the 20 year mission.

The achievements of the Cassini mission are too numerous to mention here. It has explored the atmosphere and ring system of this giant world, providing us with a much deeper understanding of Saturn while simultaneously opening up new mysteries, such
as the hexagonal pattern found in the atmosphere at the poles of the planet. We have now seen many of the moons up close revealing some surprising features and also new discoveries. Cassini found seven newly undiscovered moons. Both Sky & Telescope and Astronomy magazines have articles this month on Cassini. Be sure to check them out to see some of the mission and image highlights.

Asteroid Florence
On September 1, a large near-Earth asteroid named Florence, in honor of Florence Nightingale, will pass safely by Earth.

“‘While many known asteroids have passed by closer to Earth than Florence will on September 1, all of those were estimated to be smaller,’ said Paul Chodas, manager of NASA’s Center for Near-Earth Object Studies (CNEOS) at the agency’s Jet Propulsion Laboratory in Pasadena, California. ‘Florence is the largest asteroid to pass by our planet this close since the NASA program to detect and track near-Earth asteroids began.’”*

Florence is estimated to be about 2.7 miles in size. NASA is planning some radar observations to get a clearer picture and better understanding of Florence. The asteroid will be passing at a distance of about 4.4 million miles or about 18 times the Earth-Moon distance. It should be about 9th magnitude when it passes, so you should be able to find it in your telescope for a few nights before and after the closest approach on the 1st. It will be moving through Piscis Austrinus, Capricornus, Aquarius and Delphinus.

This puts it lower in the sky for our latitude. The better opportunity to view will be closer to midnight.

That’s all for this month. I’ll give you more of what’s up in the current sky next month. Until then, wishing you all clear skies!

Chapter 4

The Queen Speaks

Robin Byrne
This month we celebrate the life of a self-taught rocket man who laid the foundation for how we venture into space. Konstantin Eduardovich Tsiolkovsky was born September 17, 1857 in Izhevskoye, Russia, although, because Russia had not yet adopted the Gregorian Calendar, he thought of his birthday as September 5. His father, Eduard, was originally from Poland and was deported to Russia in 1849, where he worked as a forester. Konstantin’s mother, Maria, came from Russian nobility. Konstantin was their 5th child, and they would go on to have a total of 18 children.

Stories vary about how Konstantin lost most of his hearing. According to one source, which quotes what Tsiolkovsky himself wrote, says that when he was 10 years old, after going tobogganing, he fell ill from a bad cold to the point of delirium and near death. When he recovered, his hearing was mostly gone. Other sources say it was scarlet fever. No matter which, his hearing loss had a profound affect on his life and subsequent events. By the time he was 14, his teachers gave up on trying to teach him because of his inability to hear. So, instead, Konstantin turned to teaching himself through books. This was when his interest in math and physics began.

In 1873, at the age of 16, his father sent young Konstantin to Moscow to study further than the resources in his town would provide. There he made use of the Chertkovskaya Library to teach himself math, physics, mechanics and chemistry. While in Moscow, Tsiolkovsky encountered two sources of inspiration. First were the writings of Jules Verne. Second was meeting Nikolai Fyodorov, a philosopher who worked in the library and was a proponent of the idea that advances in science would lead to humans becoming immortal and needing to travel in space to find a place to live. Both turned Konstantin’s head to the stars. After reading Verne’s “From the Earth to the Moon,” Tsiolkovsky calculated that the method used in the book for going into space (a cannon) would produce accelerations so large that it would kill the passengers. Meanwhile, the little money his father could send was barely keeping Konstantin fed, especially after he spent most of it on books and equipment for doing experiments.

Worrying about his starving son, Konstantin’s father insisted he return home in 1876. Here he built his own centrifuge to test how
various objects respond to increasing forces of gravity. He used chickens as his test subjects. Tsiolkovsky then took an exam to become a teacher, which he passed, leading to his first teaching job in Borovsk, near Moscow, in the Kaluga region. Here he taught courses in mathematics. The town itself was very much a tough, rural, backward area, with a reputation for drunken fights and people believing in witchcraft. In his spare time, Tsiolkovsky tried his hand at writing science fiction like Jules Verne. However, he was more concerned about making the science accurate and got his stories bogged down in the mathematics, so he moved on to writing actual science papers, instead. In 1880, Tsiolkovsky met and married Varvara Sokolova.

Tsiolkovsky’s first scientific paper was written in 1881, titled “Theory of Gases.” In the paper, he proposed a kinetic theory of gases. He submitted it to the Russian Physico-Chemical Society (RPCS). They wrote back to inform him that he was 25 years too late in his discovery. One of many drawbacks of living in an isolated area, he was completely unaware of the discoveries of others. Konstantin’s second submission, “The Mechanics of Animal Organism” was better received, and he was admitted as a member of the RCPS. In 1883, his next paper concerned the problems of living in a weightless environment. It included a sketch of a spaceship with people floating in spacesuits, a cannon to be used as the propulsion, plus gyroscopes for orientation.

For the next couple of years, Tsiolkovsky focused on air travel in machines made of metal. His first venture was looking at dirigibles made of metal, and he even made a model of one. Then he looked at building airplanes out of metal. Once again, he was ahead of his time, with airplanes similar to his design being built within the next 18 years. In 1895, Tsiolkovsky published “Dreams of Earth and Sky,” which was about living in space and included characters that mined asteroids and had orbital greenhouses.

In 1897, Tsiolkovsky, in his house, built the first wind tunnel in Russia. This allowed him to study the motions of rockets even better. He used the wind tunnel to study the drag coefficients of a variety of shapes, including spheres, cylinders, and cones. His results were used by others in the field of aerodynamics. It was during this time that he came up with the equation describing how a rocket’s speed changes based on how fast the exhaust leaves and the initial and final mass of the rocket ($\delta V = v_e \ln(M_0/M_1)$). This equation is still used today in the field of aerospace engineering. Unfortunately, between the magazine in which he published closing down, and the fact that he was a mere schoolteacher living in a rural town, no one outside of Russia knew about his work. In the 1920’s, both Oberth, in Germany, and Goddard, in the United States, ultimately came to the same conclusions as Tsiolkovsky. Today, all three men are considered the “fathers of rocketry.”
“Exploration of Outer Space by Means of Rocket Devices” was published in 1903. This article, and two others Tsiolkovsky wrote in the following years, are considered the basis for spaceflight. He determined the speed necessary for a rocket to launch into Earth orbit, and also the speed necessary to leave Earth orbit to explore other planetary objects. He also calculated the flight time to other objects. He was the first to propose the use of a multistage rocket. He was the first to propose the use of fuel comprised of liquid oxygen and liquid hydrogen, which is even more notable considering that hydrogen had only been successfully liquified 5 years earlier. Sadly, once again his ideas didn’t get much circulation in Russia, let alone in other countries.

While Tsiolkovsky was laying the groundworks for his legacy in the scientific community, sadly, his personal life suffered multiple tragedies. In 1902, his son, Ignaty, committed suicide while at college. In 1908, many of Tsiolkovsky’s papers were lost in a flood. Then, in 1922, his daughter, Lyubov, was arrested for her participation in activities leading up to the Russian revolution.

The lack of public recognition of his work led Tsiolkovsky to abandon his efforts in aeronautics. Instead, after the start of World War I, he worked on ways to end poverty. After the Russian Revolution, support for science and technology increased, and Tsiolkovsky was seen as an excellent symbol of those areas. The Soviet government made Tsiolkovsky a member of the Socialist Academy in 1918.

Tsiolkovsky continued teaching high school math until his retirement in 1920. It was not until then that he started to receive honors for his pioneering work, even being given financial backing from the government to continue in his studies. This was also the time when Tsiolkovsky came to be known by the next generation of rocket engineers. Valentin Glushko, who would become the developer of the rocket propulsion systems used by the Soviet Union, at the age of 15, began a correspondence with Tsiolkovsky which laid the theoretical foundation for the practical work for which Glushko would later be known.

Retirement was not the end of Tsiolkovsky’s work. He continued to explore various aspects of rocket travel. Tsiolkovsky went back to his early influences, with the idea of humanity ultimately needing to colonize space to survive. Much of his work related to the questions of how to live and survive in space. Tsiolkovsky worked out how to maneuver a spacecraft using graphite rudders and how to cool parts of the rocket using the existing propellants. He had the idea of using plants to provide oxygen and food for the people onboard, and pressurized spacesuits for working outside of the spacecraft. Solar power would be used to provide energy for orbital colonies, as well as settlements on asteroids, other planets, and, ultimately, around other star systems.

In the 1930’s, as his health began to decline, Tsiolkovsky found himself being interviewed and written about even more. His name was just starting to be known. Not long after undergoing an
operation for stomach cancer, Konstantin Tsiolkovsky died September 19, 1935 in Kaluga, Russia. He was laid to rest in the center of a city park, where the monument calls Tsiolkovsky “the great Russian scientist.”

Tsiolkovsky’s legacy ranged far and wide. Werner von Braun, the German rocket designer behind Germany’s V2 and America’s Saturn V rockets, had one of Tsiolkovsky’s books, in which he had written many notes in the margins. Sergey Korolev, Russia’s chief rocket designer for their space program, studied Tsiolkovsky’s work as a child and was inspired by it. Tsiolkovsky’s name has been commemorated in many diverse ways, from a crater on the Moon to a spacecraft in “Star Trek: The Next Generation.” His greatest legacy, though, is the desire to travel in space. Tsiolkovsky said, “The Earth is the cradle of mankind, but mankind cannot stay in the cradle forever.”

References:

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https://en.wikipedia.org/wiki/Konstantin_Tsiolkovsky

Konstantin E. Tsiolkovsky - NASA
https://www.nasa.gov/audience/foreducators/rocketry/home/konstantin-tsiolkovsky.html

Konstantin Tsiolkovsky: Russian Father of Rocketry by Nola Taylor Redd, space.com
https://www.space.com/19994-konstantin-tsiolkovsky.html

Konstantin Tsiolkovsky - Russian Space Web
http://www.russianspaceweb.com/tsiolkovsky_bio.html
Chapter 5

Space Place
On August 21st, the sky will darken, the temperature will drop and all fifty United States will be able to see the Moon pass—at least partially—in front of the Sun. It’s a solar eclipse! A solar eclipse happens when the Moon passes between the Sun and Earth, casting its shadow on Earth. Sometimes the Moon only covers up part of the Sun. That is called a partial solar eclipse. When the Moon covers up the Sun completely, it’s called a total solar eclipse. As our planet rotates, the Moon’s shadow moves across Earth’s surface. The path of the inner part of this shadow, where the Moon totally covers the Sun, is called the path of totality. The path of totality on August 21 stretches from Oregon to South Carolina. If you happen to be in that path, you will be able to experience a total solar eclipse! If you’re in any of the 50 United States during this time, you can see a partial solar eclipse. No matter where you’ll be for the eclipse, remember that SAFETY is very important. Never look at the Sun when any part of it is exposed, like during a partial eclipse! It can hurt your eyes very badly. If you want to view the eclipse, you can buy special eclipse glasses. Go the NASA 2017 Eclipse Safety website to learn more about what glasses to buy.

If you are in the path of the total eclipse, you may look directly at the eclipse only when the Moon has completely covered the Sun. This is called totality, and it lasts a very short time. You must be sure to put your eclipse glasses back on before the Sun peeks out from behind the Moon. You won’t be the only one watching this event! NASA scientists will use this eclipse to study our Sun. During a total solar eclipse, we can see the Sun’s atmosphere, called the corona. Usually the Sun is so bright that we can’t see the corona. However, when the Moon blocks out most of the Sun’s light, we can get a glimpse of the corona.

The surface of the Sun is about 10,000 degrees Fahrenheit, but the corona is much hotter. It’s about 2 million degrees Fahrenheit! The eclipse gives NASA researchers the chance to learn more about why the corona is so hot. In fact, while the eclipse will only last about two to three minutes in one place, scientists have found a way to have more time to study it. NASA will use two research jets to chase the eclipse as it crosses the country. The jets will fly very high, and spend seven minutes in the shadow of the Moon. Researchers are using jets to help look for small explosions on the Sun, called nanoflares. These nanoflares may help to explain the corona’s extreme heat.
Whether you’re watching with eclipse glasses from the ground, or in a NASA jet from the sky, the 2017 eclipse should be quite a show! It’s a fun reminder of our place in the Solar System, and how much we still have to learn.

To learn about what eclipse glasses to buy and other eclipse safety guidelines, visit: https://eclipse2017.nasa.gov/safety

To learn more about solar eclipses, check out this NASA Space Place video: https://spaceplace.nasa.gov/eclipse-snap

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 Meetings

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<tr>
<td>Friday, September 1, 2017</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: “Tales of Totality.” The floor will open to BMACers who would like to share their eclipse story; Free.</td>
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<tr>
<td>Friday, October 6, 2017</td>
<td>6 p.m.</td>
<td>Observatory</td>
<td>Program: Observatory cleaning and topic TBA; Free.</td>
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<tr>
<td>Friday, November 3, 2017</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: Topic TBA; Free.</td>
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### SunWatch

Every Saturday & Sunday March - October

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<tr>
<td></td>
<td>3-3:30 p.m.</td>
<td>At the dam</td>
<td>View the Sun safely with a white-light view if clear.; Free.</td>
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### StarWatch

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<tr>
<td>Oct. 7 &amp; 14, 2017</td>
<td>7:30 p.m.</td>
<td>Observatory</td>
<td>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.</td>
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<tr>
<td>Oct. 21 &amp; 28 &amp; Nov. 4, 2017</td>
<td>7:00 p.m.</td>
<td>Observatory</td>
<td>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.</td>
</tr>
<tr>
<td>Nov. 11, 18, &amp; 25, 2017</td>
<td>6:00 p.m.</td>
<td>Observatory</td>
<td>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.</td>
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### Special Events

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<tr>
<td>Oct. 27-29, 2017</td>
<td>-</td>
<td>Farmstead</td>
<td>StarFest 2017. 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. <strong>Pre-registration by Oct. 6, 2017 with full payment is mandatory for attendance. Sorry, no walk-ins nor “visits.”</strong> Registration is open.</td>
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Bays Mountain Astronomy Club Newsletter September 2017
Bays Mountain Astronomy Club
853 Bays Mountain Park Road
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:
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:

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 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.


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 scorching 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 theorists 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 map of the United States showing the path of totality for the August 21, 2017 total solar eclipse. Image credit: NASA's Scientific Visualization Studio