Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair
Hello BMACers,

February is here and we are in full swing of winter, well, except for the warmer weather. I will never understand the weather around here. At least it has been a little warmer at night to do some stargazing, that is if it were clear. I’m hoping that we will have a lot more clear skies this year than we did last year. You all know that clear skies are an astronomer’s best friend. I am hoping we can all do a lot more club star parties this year as well. I am going to try my best to organize as many as possible. We all need our time under the stars.

Our meeting this month will consist of a planetarium show. The show will take the place of our speaker this month. The show is entitled, “The Hot and Energetic Universe.” This show will take us on a cosmic journey that uses astronomical observatories throughout the world and those above the Earth’s atmosphere. All types of celestial phenomena are studied, but a focus is set upon those of high energy. These objects are part of the very hot and violent Universe. High energy astrophysics probes hot gas in clusters of galaxies, which are the most massive objects in the Universe. It also probes hot gas accreting around supermassive black holes in the centers of galaxies. Finally, high energy radiation provides important information about our own galaxy, neutron stars, supernova remnants and stars like our Sun which emit copious amounts of high energy radiation. The XMM-Newton and the Integral missions, are leading the exploration of the X-ray and gamma-ray Universe. ESA’s mission ATHENA, to be launched in 2028, will carry the most sensitive X-ray telescope ever and it will be the flagship of all high X-ray missions. The producer of this documentary is the “Integrated Activities in the High-Energy Astrophysics Domain” (AHEAD). Please come and join us for the great new show at our wonderful planetarium. I hope to see you all there.

At our meeting last month, we once again welcomed Steve Conard. Steve is a member of the International Occultation Timing Association (IOTA) and his presentation described the opportunities for amateur astronomers to contribute scientifically by timing occultations. Occultations of stars by the Moon are a very regular occurrence, and about 1 in 100 video-timed occultations result in a previously unknown double star’s discovery. Asteroid occultations, while somewhat rarer, can result
Canis Major
The Greater Dog

Image from Stellarium
layout by Adam Thanz
in generating a silhouette of the asteroid--giving important size and shape information that is not otherwise easily obtained. These asteroid observations have also produced occasional discoveries of asteroid satellites and double stars. His presentation was very informative and showed us just how much we can contribute to the science. Steve showed us examples of some of the occultation timings that he has done and he also gave us some upcoming dates to some occultations that will be occurring in our area. We look forward to Steve coming back in the future for another presentation. If you missed the presentation, it will be up on the club's YouTube channel soon. This meeting was also our annual dinner and it took place at Pratt’s BBQ in Kingsport. The food was awesome and so was the service. Thanks for everyone for coming out.

For our constellation this month, we will talk about the very well-known Canis Major. Canis Major translates to the Greater Dog. Canis Major is one of Orion’s hunting dogs. In Greek mythology, Canis Major represented the dog Laelaps, a gift from Zeus to Europa. It was so famed for its speed that Zeus elevated it to the sky. The brightest star in this constellation is Sirius, which is often called the Dog Star. Another notable aspect of this constellation is that the Milky Way passes through it and there are also several open clusters that lie within its borders, the most notable is M41. Most of us recognize this constellation every winter, if you do not, make sure you check it out next time you are out.

That will be it for this month. Just a reminder that the StarWatches will begin next month. The SunWatches will begin in March as well. We look forward to these public events so we can show everyone how awesome our night (and day) sky is. Astronomy Day will also be here before we know it so please express your ideas on how to intrigue the public on our wonderful hobby. I do plan within the next few months to start organizing periodic star parties for our club. William Troxel will be helping me with this, so if anyone knows of any good locations or has ideas of good locations, please contact me or William. I believe that star parties are a pivotal part of any astronomy club and we have gone long enough without them. I hope everyone feels the same way. Until next month…. Clear Skies.
Chapter 2

BMAC Notes
Appalachian Eclipse 2017
Witness one of nature’s most exciting, and rarest, celestial events - a total solar eclipse! The next one to occur will be on August 21, 2017.

The goal is to travel to the narrow path of totality as it stretches across the continental United States. The Bays Mountain Park Association is proud to announce an exclusive excursion to enjoy this experience. To do so, you need to be one of the 112 very lucky few who pre-register, with payment, to attend this special adventure.

A total solar eclipse is when the Moon travels between the Earth and Sun. The viewer, if on a narrow path, will see the Sun fully obscured to reveal the faint, tenuous Corona. Totality typically only lasts a few minutes or so. A brief, fleeting of time.

Our event boasts privacy, safety, and quietness. The reason is important. There is much that occurs in the natural world during a total solar eclipse. The temperature drops, the wind picks up, and the birds start to chatter. When totality approaches, it becomes a false twilight. The lighting becomes quite eerie as the Sun’s light reaches us indirectly from all sides as we become bathed in the Moon’s shadow. The birds, and wind, quite down. There is more to experience, and you should, on our excursion.

This trip includes: motor coach ride to the astronomical site and back, private access to PARI (the Pisgah Astronomical Research Institute), a special tour of PARI, snacks, lunch, and exceptional dinner, unique t-shirt, solar glasses, access to telescopes with solar filters, hosted by degreed astronomers, and more!

Not only are there only 112 seats available on our trip, but PARI is limiting access to their site so as to not overload their facility. They will have guarded gates for safety. Our group will have a private corner of their campus including our own bathrooms, water access, and air conditioning. PARI is an astronomical marvel with an amazing history in America’s space program. There are lots of details, so please visit the Park’s website here:


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

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

There are now four entries in our channel. Check them out!

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**BoBfest**
The 25th annual Regional Gather of Amateur Astronomers, aka BoBfest is less than a month away!

This year’s event will be held at the Catawba Science Center in Hickory, NC on Saturday, February 18. The details are available here: http://www.catawbascience.org/events/bobfest-regional-gathering-of-amateur-astronomers/

We have a great line-up of morning speakers and a new afternoon format with eight 30 minute presentations to chose from over a two hour period. Also, since the event has partnered with the Catawba Science Center, a free Science Center pass, including Aquaria and Millholland Planetarium admission, will be included. As always, BoBfest is a FREE event and we will have an exciting selection of door prizes for you to chose from with your $1 tickets, available for purchase all day. Your generous purchase of door prize tickets will support the event allowing it to continue into the future!

In addition to presentations, Science Center admission, and door prizes we will have refreshments available all day, a Family Activities Space, solar observing over our 90 minute lunch break, an exhibit by the Pisgah Astronomical Research Institute (PARI) and special order catered lunch available from Groucho’s Deli (place and purchase your order at when you register at the door).

OH yeah...AND, Camera Concepts plans to be on hand with their traveling astronomy gear store!

As usual, BoBfest will provide swap tables, space for art exhibits, and the opportunity to display your astro-photos between speakers and all afternoon. Please bring slide-show astro-photos on a thumb drive. We also encourage area astronomy clubs to bring your club banner to display in the venue.

Doors open at 8:30 am, welcome and presentations begin at 9:45am with door prize drawings at approximately 4pm. The Lucile Miller Observatory at Maiden Middle School in nearby Maiden, NC will be open for observing at 7pm.
As I write this, the month of January has turned into quite a rainy one with unusually warm temperatures. This, of course, has resulted in not too many cloud-free nights. Not sure what February has in store, but we’ll keep our fingers crossed for some good observing nights.

The Full Moon will occur on the 11th. Also, this month is an eclipse month, though nothing too spectacular like the total eclipse coming up in August. For our location on the 10th, we will witness a deep penumbral lunar eclipse. A lunar eclipse is when the Moon passes through the Earth’s shadow. The shadow has two parts due to the fact that the Sun is not a point light source, but quite large compared to the Earth. The inner, darker part of the shadow is called the umbra and the fainter outer part is called the penumbra. The Moon will pass completely into the penumbral part of the Earth’s shadow. And, although none of the Moon will go dark, because the Moon’s northern limb will pass within a 100 miles of the umbra, the shading will be quite easy to see along the Northern part of the Moon. It all begins at about 6:14 p.m. EST and ends at 9:14. The best time to look will be around mid-eclipse at 7:44 p.m. The counter part to this eclipse will be an annular eclipse of the Sun on the 26th. However, this will only be visible in the southern hemisphere.

Venus continues to dominate the early evening sky in February. It reached magnitude -4.7 in January and will continue to brighten slightly by mid-month. On the night of the 16th/17th, Venus will be at it’s greatest illuminated extent and will reach it’s peak brightness of -4.8. The greatest illuminated extent means that the daytime, or illuminated, side of Venus is covering more square area of sky than at any other time during it’s appearance in the evening sky. At that time, we will see the disk of Venus about 25 percent illuminated.

Mars is found just above and to the left of Venus and the two reach a minimum separation on the 1st of 5.4 degrees. Mars starts the month at mag. 1.1 and will dim slightly to 1.3 by month’s end. Both Mars and Venus are seen in the constellation of Pisces. They are in the western fish of the two fishes, just below the Great Square of Pegasus and are trekking eastward from night to night. Mars will outpace Venus, though, as Venus slows its Eastern progress by month’s end in preparation for it’s swift movement back towards the Sun in March.
On the 25th, Mars will pass near the distant ice giant Uranus. Look to Mars from the 25th to the 27th. On the 26th, Mars will be just a bit more than half a degree to the North of Uranus. The contrasting colors of the red planet and the blue ice giant should make for a wonderful sight.

Jupiter rises by 11:30 p.m. as it has now moved into our late evening skies. By month’s end it will rise 2 hours earlier. Jupiter is just 4 degrees North of the bright star Spica in the constellation of Virgo. At magnitude -2.2, it outshines Spica in the night sky.

That’s enough on the planets for this month. For some other interesting observations look to the constellation of Gemini. One of my favorites is the bright star Castor. It is the head of the twin on the right of the bright two stars at the top of the constellation, the other is Pollux. It turns out that Castor is actually a complex, multiple star system. On a clear night, it’s easy to see with a medium amount of magnification through a telescope that the bright star resolves into two bright stars. But, look off to the side of that pair and you’ll find a faint red star that is gravitationally bound to those two, which would make it a triple star system. The faint red member is about 7 times the distance between the brighter two. Together they form a skinny triangle. But the fun doesn’t stop there! Using spectroscopy, astronomers have discovered that each of the stars is also a binary star system. This makes Castor a six-star system. I have no idea what you call that, but I always find it fun to look at and share with others at our StarWatch programs.

Another sight this month in Gemini is the asteroid 4 Vesta. This is one that you can do with binoculars. Again, look to the top two bright stars of Gemini. This time, you’ll want to focus on the other twin, Pollux. Vesta will be 3 degrees, or about half a binocular field, south of Pollux on the 1st and about 4 degrees southwest by month’s end. There are no bright stars in the background that could masquerade as Vesta, so you should be able to find it with a good star chart.

That’s all for this month. Enjoy some observing!
Chapter 4

The Queen Speaks

Robin Byrne
This month we celebrate the life of a man who will forever be tied to a very special comet. Klim Churyumov was born February 19, 1937 in Mykolaiv (or Nikolaev), Ukraine. His father, Ivanovich, died in 1942 during World War II. The fourth child of a total of seven brothers and sisters, Klim fondly remembers his older brother, Ivan, telling him stories about philosophy and countries around the world. They would also lay on the roof of a shed at night, while Ivan told stories about the constellations. In 1949, his family moved to Kiev. Klim attended public school through 7th grade, then entered the Kiev Railway College. When he graduated with honors in 1955, he was recommended to attend university.

Klim attended Kiev State University. In his third year, he was assigned to work with faculty in the optics department. He had hoped for theoretical physics, but there were no open spaces for more students. However, Klim continued to attend the theoretical physics lectures, against the wishes of the school’s authorities. Then an opening appeared in the astronomy department, so he was transferred there. He began studying comets under Sergej K. Vsekhsvyatskij, who was well known for his comet work.

Churyumov graduated with a Bachelors Degree in 1960. He was then sent to Tiksi Bay in the Yakut Autonomous Soviet Socialist Republic (ASSR) to work at a polar geophysical station. Here, Klim studied aurorae and the ionosphere. Two years later, he transferred back to Kiev to work at the “Arsenal” plant, where he developed optics to be used by the Soviet space program and military.

Klim returned to Kiev State University to pursue a graduate degree. He continued studying comets, first using the university’s observatory in a nearby village, Lisniki. Later, he went on expeditions to Central Asia, Siberia, the Caucasus, and other remote areas to study more comets. In 1969, Churyumov, along with Svetlana Gerasimenko and a lab assistant, were sent to the Alma-Ata Astrophysical Observatory. Using a Maksutov telescope, they were to photograph various known periodic comets and hunt for new comets. They would take two images of the same part of the sky, separated by about half an hour, to look for something that moved against the backdrop of stars. They imaged comet 32P/Comas Sola on September 9. It turns out that on the edge of their first image was another comet, but
Dr. Klim Churyumov
Co-Discoverer of Comet 67P/Churyumov-Gerasimenko

Image by Adam Thanz
they initially missed it. The next clear night was September 11. The next image showed a smudge in the center of the field (not where the known comet would have been), so they thought it was a defect due to improper development. Svetlana wanted to throw the photographic plate away, since it appeared to be useless. Their professor, Dmitri Rozhkovsky, explained the importance of keeping all the plates, because you never know what other useful information might be there. While the others returned to Kiev, Klim remained to take more photographs. Once they were all back in Kiev, Klim and Svetlana began making measurements of the comet positions on all of the images taken. They confirmed that the “smudge” was not the comet they were studying, and then they found it on four other images. At first, they were worried that it was a comet that had already been discovered, but, no, they were the first to see it. Officially named 67P/Churyumov-Gerasimenko, it was found to be a short period (6.5 year) comet from the Jupiter Family.

Klim went on to complete his degree in 1972 with a thesis titled “Studies of comets Ikeyya-Seki (N/1967n), Honda (C/1968), Tago-Sato-Kosaka (C/1969 T1) and new periodic comet Churyumova-Gerasimenko from photographic observations.” He then worked as a Fellow in the Astronomy Department at Kiev State University. His interest in comets never waned. In 1983, he made studies of the plasma tail of 67P. In 1986, he discovered another comet, C/1986 N1 (Churyumov-Solodovnikov), which is a long period comet that had never visited the inner Solar System before.


Klim had other interests, though. An avid poet since the age of 16, in 1999, he began publishing books of poetry for children. The last of these books was printed in 2002. In 2004, Klim was named the Director of the Kiev Planetarium. From 2006 - 2009, he was the editor of a Ukrainian astronomical magazine, “Our Skies.” Klim was also the president of the Ukrainian Society of Amateur Astronomy. He frequently appeared on television and wrote popular articles to bring astronomy to the general public.

On August 6, 2014, the Rosetta spacecraft entered orbit around comet 67P/Churyumov-Gerasimenko. Three months later, on November 12, the lander Philae, after bouncing three times, came to rest on the surface of the comet. When Churyumov first saw images of the comet’s unusual shape, he thought it looked like the traditional Ukrainian shoes used by farmers, that are made of straw - a “cosmic slipper.” The images of the surface made him think of mountains like the Alps or Carpathians, though on a smaller scale. He was hopeful that amino acids would be found on the comet, which they were - in particular glycine. Klim followed every aspect of the Rosetta mission as it studied “his” comet. He was passionate about studying comets, since they are [somewhat] pristine samples from the beginning of our Solar System.
System. He once said that he would have loved to be an astronaut walking on the surface of a comet.

The Rosetta Mission came to an end September 30, 2016. Sadly, two weeks later, while traveling to Kharkiv, Ukraine, Klim Churyumov died suddenly on October 14. It’s almost as though he were holding on long enough to witness all of the Rosetta Mission. Perhaps Klim is now out there, walking and exploring “his” comet.

References:

Klim Churyumov - Wikipedia

https://en.m.wikipedia.org/wiki/Klim_Churyumov

Klim Churyumov - Co-Discoverer of Comet 67P - ESA

http://sci.esa.int/rosetta/54598-klim-churyumov/

An Encounter with Klim Churyumov - Rosetta Blog


Notes from “Discovery of Comet Churyumov-Gerasimenko” June 21, 2016 IPS Conference Warsaw, Poland Robin Byrne
In a cosmic coincidence, three comets will soon be approaching Earth—and astronomers want you to help study them. This global campaign, which will begin at the end of January when the first comet is bright enough, will enlist amateur astronomers to help researchers continuously monitor how the comets change over time and, ultimately, learn what these ancient ice chunks reveal about the origins of the Solar System.

Over the last few years, spacecraft like NASA’s Deep Impact/EPOXI or ESA’s Rosetta (of which NASA played a part) discovered that comets are more dynamic than anyone realized. The missions found that dust and gas burst from a comet’s nucleus every few days or weeks—fleeting phenomena that would have gone unnoticed if it weren’t for the constant and nearby observations. But space missions are expensive, so for three upcoming cometary visits, researchers are instead recruiting the combined efforts of telescopes from around the world.

“This is a way that we hope can get the same sorts of observations: by harnessing the power of the masses from various amateurs,” says Matthew Knight, an astronomer at the University of Maryland.

By observing the gas and dust in the coma (the comet’s atmosphere of gas and dust), and tracking outbursts, amateurs will help professional researchers measure the properties of the comet’s nucleus, such as its composition, rotation speed, and how well it holds together.

The observations may also help NASA scout out future destinations. The three targets are so-called Jupiter family comets, with relatively short periods just over five years—and orbits that are accessible to spacecraft. “The better understood a comet is,” Knight says, “the better NASA can plan for a mission and figure out what the environment is going to be like, and what specifications the spacecraft will need to ensure that it will be successful.”

The first comet to arrive is 41P/Tuttle-Giacobini-Kresak, whose prime window runs from the end of January to the end of July. Comet 45P/Honda-Mrkos-Pajdusakova will be most visible between mid-February and mid-March. The third target, comet 46P/Wirtanen won’t arrive until 2018.

Still, the opportunity to observe three relatively bright comets within roughly 18 months is rare. “We’re talking 20 or more years since we’ve had anything remotely resembling this,” Knight says.
“Telescope technology and our knowledge of comets are just totally different now than the last time any of these were good for observing.”

For more information about how to participate in the campaign, visit http://www.psi.edu/41P45P46P.

Want to teach kids about the anatomy of a comet? Go to the NASA Space Place and use Comet on a Stick activity! http://spaceplace.nasa.gov/comet-stick/

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
## BMAC Meetings

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<tr>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Friday, February 3</td>
<td>7 p.m.</td>
<td>Planetarium</td>
<td>Program: “The Hot &amp; Energetic Universe;” Free.</td>
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<tr>
<td>Friday, March 3, 2017</td>
<td>7 p.m.</td>
<td>Nature Center Discovery Theater</td>
<td>Program: Topic TBA; Free.</td>
</tr>
<tr>
<td>Friday, April 7, 2017</td>
<td>7 p.m.</td>
<td>Nature Center Discovery Theater</td>
<td>Program: Topic TBA; Free.</td>
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## SunWatch

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<th>Notes</th>
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<tbody>
<tr>
<td>Every Saturday &amp; Sunday March - October</td>
<td>3:30 p.m. if clear</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>
<th>Date</th>
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<tbody>
<tr>
<td>Mar. 4, 11, 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>
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<tr>
<td>Mar. 18, 25, 2017</td>
<td>8:00 p.m.</td>
<td></td>
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<tr>
<td>Apr. 1, 8, 15, 22, 29, 2017</td>
<td>8:30 p.m.</td>
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## Special Events

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<th>Date</th>
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<tr>
<td>Saturday, April 29, 2017</td>
<td>1-4:30 p.m.</td>
<td>Nature Center &amp; Observatory</td>
<td>Annual Astronomy Day - Displays et al. on the walkway leading to the Nature Center, 1-4:30 p.m.; Solar viewing 3-4 p.m. at the dam; Night viewing 8:30-10 p.m. at the observatory. All non-planetarium astronomy activities are free.</td>
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Annual Dues:

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

$16/person/year

$6/additional family member

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

The club’s website can be found here:

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

Regular Contributors:

Brandon Stroupe

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

Robin Byrne

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

Jason Dorfman

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

Adam Thanz

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

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.


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

Bays Mountain Astronomy Club Newsletter February 2017
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 counterpart 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 stars.

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 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. An orbit diagram of comet 41P/Tuttle-Giacobini-Kresak on February 8, 2017—a day that falls during the comet’s prime visibility window. The planet’s orbits are white curves and the comet’s orbit is a blue curve. The brighter lines indicate the portion of the orbit that is above the ecliptic plane defined by Earth’s orbital plane and the darker portions are below the ecliptic plane. This image was created with the Orbit Viewer applet, provided by the Osamu Ajiki (AstroArts) and modified by Ron Bailey (Solar System Dynamics group, JPL). http://ssd.jpl.nasa.gov/sbdb.cgi?orb=1;astr=41P