Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair
Hello BMACers,

It is now November and the year is coming quickly to a close. It seems like this year is just flying by. Before we know it, it will be 2017. The weather this month is finally seeming to be where it should be. I love these crisp, clear nights. I really enjoy just sitting outside with a chair, blanket, and hot chocolate just staring up at the night sky. You can really feel just how small we are if you look long enough into the beautiful, starry sky. Hopefully, the rest of this year will provide us with some good, clear nights so you can go out and enjoy the night sky just as I do.

The speaker for our November meeting will once again be Mark Marquette. Mark is one of our club members who has recently been able to visit some pretty cool places. His presentation this month will be titled, “MarQ’s 2016 Space Places: From Odessa Meteor Crater to Surveyor 3’s Moon Scoop.” Mark has visited numerous places in the recent year during his retirement and he is going to share pictures and stories from his travels. I think we all would like to be able to do what he is being able to do. So, come on out and be fascinated or maybe even a little jealous of Mark’s recent trips.

Also, during our business meeting after Mark’s presentation, we will be discussing our upcoming annual dinner. I need any suggestions you might have for locations for our dinner. I would like to have 2-3 choices if possible. I look forward to seeing everyone at our meeting.

We did not have a speaker for our October meeting. The meeting last month was as always the clean-up of the observatories for the StarWatches as well as for StarFest. After the clean-up, William Troxel went over a few upcoming events. After William’s announcements, everyone just hung out and talked the rest of the night. It was a very informal meeting. I believe everyone had a good time, though. I am sorry that I was not there at the meeting. I was on vacation with my family. I want to thank William for taking the reins for me last month in my absence. He always does a great job.

There will not be a constellation this month. Instead, I want to talk briefly about StarFest 2016. It was held on October 21-23. As always, it was an awesome weekend. There were 80 people in attendance. A third of which were students! I love to see all the young minds so interested in astronomy. It makes the future of
astronomy look very good. We had 3 great keynote speakers for StarFest this year. They were Les Johnson, Angela Jackman, and Jim Spann. All 3 are from the Marshall Space Flight Center in Huntsville, Alabama. All 3 gave wonderful presentations from the different fields they worked in. Les Johnson is from NASA’s Advanced Concepts Office and spoke on his work with solar sail propulsion systems. Angela Jackman is from the NASA Space Launch System Formulation/Evolvability Group and spoke on the future of NASA’s heavy lift rocket system that could one day soon carry us to Mars. Jim Spann is from NASA’s Science and Technology Office and spoke on the different research focus areas of his office. Jim also gave our final presentation on Sunday morning about the movie “The Martian.” On Saturday morning of StarFest, all 3 speakers took part in a panel discussion where they answered a number of questions previously prepared and then some questions from all of us.

One thing that I almost forgot to mention was of course, the food. As always, the food was great. We got to enjoy 5 meals that weekend that were as always, very good. The Sunday morning breakfast was my favorite. Who doesn’t love a good breakfast. All and all, it was an awesome weekend. I hope you all were able to attend. If not, you will not want to miss it next year. I foresee it being just as good if not better. I also want to thank Adam Thanz for all his hard work putting our StarFests together. I know it is a lot of hard work and he does a fantastic job. THANKS ADAM!!!

That will be it for this month. Just a reminder that the StarWatches are going on this month and will last until the end of November. The StarWatches will begin at 7 p.m. on the first Saturday night of the month and then move to 6 p.m. for the remainder of the month because of Daylight Saving Time. If you would like to volunteer, please arrive about 30 minutes early to help set up. The SunWatches ended in October and will return in March 2017. I want to thank Wayne Manley and anyone else that helped with the SunWatches this year. I hope to see everyone at our meeting this month. Until next month… Clear Skies.
Chapter 2

BMAC Notes

More on this image. See FN4.
Thanks!
A big thanks goes out to Bill Johnson, brand-new member of the BMAC. He helped out by evaluating, removing and replacing the motor that rotates the observatory dome. Yes, it was filled with bugs. We now have a nicely rotating dome!

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

Dr. Gary Henson’s presentation about the SARA Observatories has just been uploaded. Enjoy!

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BoBfest 2017 Info
Check out the inserted flyer.
StarFest 2016 - BMACers William Troxel and Robin Byrne ably handle the check-in process at the Farmstead. Photo by Adam Thanz.
StarFest 2016 - Adam Thanz and William Troxel at the check-in counter. Photo by Robin Byrne.
StarFest 2016 - StarFest is Cool! Two Northeast State students check in and don some free solar glasses from NASA. Photo by Robin Byrne.
StarFest 2016 - Lloyd Watkins, long time StarFest attendee, shows off his stinkin’ badge. Photo by Adam Thanz.
StarFest 2016 - Keynote speaker Les Johnson illustrated how his work with solar sail technology can provide astronomy research to far away places. Photo by Adam Thanz.
StarFest 2016 - Keynote speaker Les Johnson is describing the extremely thin material for a solar sail to college student Ciera Miller. StarFest 2016 had the largest percentage of students attend, over one-third! Photo by Adam Thanz.
StarFest 2016 - StarFest Chair Adam Thanz is introducing the panel discussion. Photo by Brandon Stroupe.
StarFest 2016 - Keynote speakers Jim Spann, Angela Jackman, and Les Johnson answer candidly to questions related to their field during the panel discussion. Photo by Adam Thanz.
StarFest 2016 - An interesting panorama of the Farmstead Museum while the panel discussion is taking place. Photo by Robin Byrne.
StarFest 2016 - Long time StarFest attendee Chris Waldrup enjoys an H-alpha view of the Sun through BMAC member Wayne Manly's scope as Chris' son, Alex, looks on. Photo by Adam Thanz.
StarFest 2016 - No, it’s not Franz Anton Mesmer, it’s keynote speaker Jim Spann! He spoke about the major science fields that the Marshall Space Flight Center is involved.

Photo by Adam Thanz.
StarFest 2016 - BMAC Chair Brandon Stroupe enjoying a StarFeast! Photo by Robin Byrne.
StarFest 2016 - Meteorites! John Sinclair from PARI brought meteorites from PARI’s collection to show. Photo by Robin Byrne.
StarFest 2016 - An aerial view of the Bays Mountain Observatories from BMACer Brandon Stroupe’s drone. Photo by Brandon Stroupe.
StarFest 2016 - The group photo. Photo by Adam Thanz.
Chapter 3

Celestial Happenings

Jason Dorfman
Autumn has definitely arrived! The weather has cooled down, the leaves are falling and another great StarFest event has come and gone. There was an amazing turnout for the StarWatch program on the Saturday night of StarFest and, though the clouds had lingered around most of the afternoon, the skies were wonderfully clear that evening. StarWatch continues through the month of November, so be sure to come out and lend a hand.

My theme for November is planets. For those so inclined, the opportunity to view all of the planets* in the Solar System is achievable this month. *(Sorry to all the Pluto lovers - but it’s not included.) Also, don’t forget to set your clocks back on the morning of the 6th as Daylight Saving Time ends, which will bring those dark skies a bit earlier.

Beginning at dusk at the beginning of the month, we find Saturn low in the Southwest. On the 2nd, a thin crescent Moon will be just above Saturn. We will however be saying goodbye to Saturn by month’s end as it dips lower to the horizon and into the bright, twilight sky. But, Mercury should be visible by then as it makes its way towards its greatest Eastern elongation. On the 30th, find a clear view towards the southwest horizon. Mercury will only be 4 degrees above the horizon, but it should be visible in the bright twilight at magnitude -0.5.

Just a few degrees below Saturn at the start of November, you’ll find Venus. Though, in reality, you’ll see bright Venus long before Saturn. At magnitude -4.0, it is shining brightly in the early twilight skies despite its low altitude. On the first, Venus spans about 14” (arc-seconds) and is showing 78% illumination of its visible surface. Through the month, Venus will move into darker skies as it swiftly passes through Sagittarius. At mid-month, it will be moving through the top of the Teapot. At month’s end, we will see 69% illumination by the Sun, but the diameter will grow to 17”.

Mars continues its rapid movement eastward against the background stars. Through October, we watched as it passed through much of Sagittarius. This month, it will enter Capricornus on the 8th and pass through most of the constellation by month’s end. The Earth continues to pull away from Mars in its faster orbit, increasing the distance to the red planet. This means that the fantastic views which we had this summer are now a distant memory. At just 7”, Mars will appear as an orange blob through
small telescopes. On the 5th, though, the crescent Moon will pass above Mars giving us a beautiful pairing.

Both of the ice giants (Uranus and Neptune) make for more challenging observations this month. Neptune can be found high in the south at twilight’s end in the constellation of Aquarius. At magnitude +7.9, you’ll definitely want to use a finder chart so as to not confuse it with nearby stars, especially with binoculars. With a telescope and a good, clear night, you should see its distinctive blue-gray color and perhaps even notice its disk appearance with high magnification and the right conditions. Uranus will be a good sight later in the evening. It will be high in the south after 10 p.m. It’s just at the edge of naked-eye observation at magnitude +5.7, but an easy target through binoculars. The planet’s blue-green disk will show up well in a telescope. The challenge with Uranus is that it currently lies in Pisces which provides few easy reference stars for finding this ice giant.

In the pre-dawn hours, look to the east and you’ll find Jupiter shining brightly at magnitude -1.7. Currently in Virgo, you’ll see it above the bright star Spica. It will move a bit closer towards Spica each night of November. The calmer morning skies should make for good observations of Jupiter’s atmospheric features. Also, be sure to catch some of the shadow crossings from the larger Galilean moons. The shadow from Jupiter’s largest moon, Ganymede will be visible on the 8th. Catch Io’s shadow on the 21st and Europa’s on the 22nd. Check your favorite astronomy resource for the specific shadow crossing times. Another unique occurrence this month is the crossing of Callisto. On the 24th, it will pass just North of Jupiter highlighting the slight tilt of the moon’s orbit. The last time this occurred was 3.5 years ago.

This month’s article would not be complete without a mention of the Leonid meteor shower. The predictions call for a rate of about 15 per hour on the peak night of the 16th/17th. Leonids are often bright meteors. Unfortunately, with full moon occurring on the 14th, a bright waning gibbous Moon is most likely going to steal the show. And, speaking of the full Moon, the Moon will make its closest approach to the Earth since 1948 just 2.5 hours prior to the full Moon. I’m sure we’ll hear a lot about the “SuperMoon” this month, even though it’s only 7% larger than normal.
Chapter 4

The Queen Speaks

Robin Byrne
This month we celebrate the life of a woman who blazed the trail. Eileen Marie Collins was born in Elmira, New York on November 19, 1956. Her parents, James and Rose, were immigrants from Ireland, who had a total of four children. Growing up in Elmira, it’s no wonder Eileen became fascinated with flying at an early age. The city is known as the “soaring capital,” and is home to the Harris Hill Soaring Center, where people can fly gliders off of the ridges found in the area. Growing up, Eileen loved both watching the gliders, as well as airplanes taking off from the local airport. Piloting became her dream. Despite her parents’ divorce when Eileen was nine, and the economic hardships they faced during that difficult time, she never lost sight of her goal. Starting when she was in high school, Eileen worked nights at a pizza parlor, saving up for flying lessons. At the age of 19, she began her journey to the stars with her first flight.

In 1974, Eileen graduated from high school and entered Corning Community College to work toward an associate’s degree in math and science, which she received in 1976. She then transferred to Syracuse University to finish off a bachelor’s degree in math and economics. While at Syracuse, Eileen joined the ROTC, getting her first taste of military life.

Upon graduation in 1978, Eileen set her sights on the Air Force. It was only two years earlier that the Air Force even began accepting women. Eileen applied to the Undergraduate Pilot Training School at Vance Air Force Base in Oklahoma. A total of 120 women had applied that year, and only four were chosen, including Eileen. Meanwhile, there were 320 men in the same class. After completing the one year course of training, Eileen had earned the honor of being hired as the first female flight instructor for the U.S. Air Force. This would not be the last time Eileen was the first. She would work as a flight instructor at Vance for another three years.

In 1983, Eileen was transferred to the Travis Air Force Base in California. While here, she flew cargo planes for both military and humanitarian missions. In 1986, she was assigned to the U.S. Air Force Academy in Colorado, where she was an assistant professor of mathematics and a flight instructor. In 1987, Eileen married fellow pilot, Pat Youngs, who went on to become an airline pilot. They would eventually have two children, Bridget...
and Luke. It was during this time that she decided to also continue her education. She started with Stanford University, where she received a master’s degree in operations research in 1986. Later, she pursued a master’s degree in space systems management from Webster University, graduating in 1989.

In 1989, with over 1500 hours of flight time, plus two advanced degrees, Eileen applied, and was accepted, to the Air Force Test Pilot School at Edwards Air Force Base. She was only the second woman to be accepted to the program. The following year, she graduated and was selected by NASA for the astronaut program.

For the next five years, Eileen trained and worked as ground support for other Space Shuttle missions. On February 3, 1995, Eileen Collins achieved another first, as the first woman to pilot a shuttle mission. The main goal of STS-63 was to rendezvous with the Mir space station, but not dock, so the mission was dubbed the “Near-Mir” mission. During the encounter with Mir, they tested how to maneuver near the space station, communications systems were tested, plus navigation aid sensors were evaluated. All of this was in anticipation of STS-71, which would be the first mission to dock with Mir. Despite some technical issues with the thrusters on the Shuttle, they were able to fly around the Space Station, and approach as close as 11 meters. On board the Shuttle was Mission Specialist Vladimir Titov, who was in charge of communicating with Mir, where he had lived for a record 365 days. Collins, remembering her first trip into space, said “The launch sounds like you’re standing in a room that’s on fire. The engines turn off at eight and a half minutes, and you’re immediately in zero gravity. I pulled out my pen and it floated. I thought, I’m here—I’m in space.” In recognition of being the first female Shuttle Pilot, Collins was awarded the Harmon Trophy, an annual award recognizing the highest achievement in space flight.

The following year, Eileen took some time off to give birth to her daughter, but the hiatus didn’t last long. In 1997, she would pilot her second shuttle mission, STS-84, which delivered 7000 pounds of equipment and supplies to Mir. At the end of this mission, Collins had amassed a total of 419 hours in space.

With that much space flight experience, it’s no wonder that for her next mission assignment, STS-93, Collins was given the position of mission commander. On July 23, 1999, Eileen Collins became the first woman to command a shuttle flight. The primary objective of the mission was to deliver the Chandra X-Ray Observatory into Earth orbit, but it had a rocky start. Due to faulty wiring, two of the three main engines blew out during launch. The backup engine kicked in to compensate, but then a leak developed in the fuel line. Despite all these problems, Collins remained calm and managed to successfully guide the Shuttle into orbit (although at a slightly lower altitude than originally planned).
After the tragic destruction of the Space Shuttle Columbia in 2003, the Shuttle program was grounded to rework the safety protocols. When the “return to flight” mission was announced for August 2005, Eileen Collins would again be in command. As one of the new safety procedures, the Shuttle, with Collins at the wheel, performed the first 360° pitch maneuver next to the International Space Station, so that all sides of the Shuttle, and especially the heat shields, could be inspected by the astronauts on ISS. They then docked with ISS, and spent most of the two-week mission unloading supplies to the Space Station. The success of the mission gave the green light to continue flying the Shuttle.

Due to all of her accomplishments, it comes as no surprise that Eileen Collins has been honored in many ways, including the Distinguished Flying Cross, the NASA Outstanding Leadership Medal, induction into the National Women’s Hall of Fame, plus being named in Encyclopedia Britannica’s list of 300 Women Who Changed the World. But the honor that may mean the most to Eileen is the construction of the Eileen Collins Observatory at her former community college in Elmira.

After spending a little over 38 total days in space, Eileen Collins had earned some time off. In 2005, she retired from the Air Force, and on May 1, 2006, she left NASA to spend more time with her family. While the Shuttle missions continued, Collins could be seen on CNN, providing coverage of the missions. She also served on the board of the United Services Automobile Association, which provides insurance, investment and banking services to those who served in the U.S. military and their families.

Eileen Collins definitely lived her dream and blazed many trails. I was fortunate to have the chance to meet her several years ago when she spoke at ETSU. Despite all of her achievements and accolades, she was very approachable, and she truly enjoyed talking with each person who waited in line for an autograph or picture. In fact, we chatted for so long, I felt guilty about monopolizing so much of her time, but she seemed content to spend as long as possible with each person there. What an amazing woman, and what an amazing life she had the good fortune to live. As she said in an interview, “I gotta tell you, I came back from my last flight and I tried to read a novel, and it was boring. I couldn’t get into it. My life was like, way above anything I could read in a book.” May we all be as lucky as Eileen Collins, and live lives more interesting than anything you could read in a book.

References:

Eileen Collins - Wikipedia
Just 25 years ago, scientists didn’t know if any stars—other than our own sun, of course—had planets orbiting around them. Yet they knew with certainty that gravity from massive planets caused the sun to move around our Solar System’s center of mass. Therefore, they reasoned that other stars would have periodic changes to their motions if they, too, had planets.

This change in motion first led to the detection of planets around pulsars in 1991, thanks to the change in pulsar timing it caused. Then, finally, in 1995 the first exoplanet around a normal star, 51 Pegasi b, was discovered via the “stellar wobble” of its parent star. Since that time, over 3000 exoplanets have been confirmed, most of which were first discovered by NASA’s Kepler mission using the transit method. These transits only work if a solar system is fortuitously aligned to our perspective; nevertheless, we now know that planets—even rocky planets at the right distance for liquid water on their surface—are quite common in the Milky Way.

On August 24, 2016, scientists announced that the stellar wobble of Proxima Centauri, the closest star to our Sun, indicated the existence of an exoplanet. At just 4.24 light years away, this planet orbits its red dwarf star in just 11 days, with a lower limit to its mass of just 1.3 Earths. If verified, this would bring the number of Earth-like planets found in their star’s habitable zones up to 22, with Proxima b being the closest one. Just based on what we’ve seen so far, if this planet is real and has 130 percent the mass of Earth, we can already infer the following:

• It receives 70 percent of the sunlight incident on Earth, giving it the right temperature for liquid water on its surface, assuming an Earth-like atmosphere.
• It should have a radius approximately 10 percent larger than our own planet’s, assuming it is made of similar elements.
• It is plausible that the planet would be tidally locked to its star, implying a permanent light side and a permanent dark side.
• And if so, then seasons on this world are determined by the orbit’s ellipticity, not by axial tilt.

Yet the unknowns are tremendous. Proxima Centauri emits considerably less ultraviolet light than a star like the Sun; can life begin without that? Solar flares and winds are much greater
around this world; have they stripped away the atmosphere entirely? Is the far side permanently frozen, or do winds allow possible life there? Is the near side baked and barren, leaving only the “ring” at the edge potentially habitable? [Ed.: It depends on the ellipticity. Any precessional change would shift this “ring.”]

Proxima b is a vastly different world from Earth, and could range anywhere from actually inhabited to completely unsuitable for any form of life. As 30m-class telescopes and the next generation of space observatories come online, we just may find out!

Looking to teach kids about exoplanet discovery? NASA Space Place explains stellar wobble and how this phenomenon can help scientists find exoplanets: http://spaceplace.nasa.gov/barycenter/en/

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 Calendar and more

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>BMAC Meetings</strong></td>
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<tr>
<td>Friday, November 4, 2016</td>
<td>7 p.m.</td>
<td>Nature Center Discovery Theater</td>
<td>Program: BMACer Mark Marquette will speak on his travels to spacey sites.; Free.</td>
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<td>Friday, December 2, 2016</td>
<td>7 p.m.</td>
<td>Nature Center Discovery Theater</td>
<td>Program: Topic TBA; Free.</td>
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<tr>
<td>Friday, February 3, 2017</td>
<td>7 p.m.</td>
<td>Nature Center Discovery Theater</td>
<td>Program: Topic TBA; Free.</td>
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<tr>
<td><strong>SunWatch</strong></td>
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<td>Every Saturday &amp; Sunday March - October</td>
<td>3-3:30 p.m. or 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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<tr>
<td><strong>StarWatch</strong></td>
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<td>Oct. 22, 29, Nov. 5, 2016</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>November 12, 19, 26, 2016</td>
<td>6:00 p.m.</td>
<td>Observatory</td>
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<td><strong>Special Events</strong></td>
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<tr>
<td>January ?, 2017</td>
<td>6:30 p.m.</td>
<td>?</td>
<td>Annual BMAC Dinner. Topic, date and place TBA</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
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 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 artist’s conception of the exoplanet Kepler-452b (R), a possible candidate for Earth 2.0, as compared with Earth (L). Image credit: NASA/Ames/JPL-Caltech/T. Pyle.