Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair
Hello BMACers,

The month is March and once again, I am going to complain about the weather. I don’t know about any of you, but I will never understand the weather around here. It seems to not be able to make up its mind. One day the high is 70 degrees and the next it is 30 degrees. It is also taking a toll on my immune system. A lot of us are staying sick with all the crazy changes in weather. I don’t know if any of you are convinced of Global Warming, but it seems the weather we are seeing is proof that it is happening. Hopefully I didn’t just lose any of you readers with that previous statement. I would just really like to have the correct type of temperatures in the correct season once in a while. Oh well, I am done with my ranting. Thanks for sticking with me this long.

Our meeting this month will feature our very own Robin Byrne. She will be giving a presentation entitled, “A Trip Through Poland’s Scientific History.” A conference in Warsaw provided Robin and Adam the opportunity to explore Poland and visit many sites commemorating Polish scientists. Although Copernicus dominated, there were others waiting to be discovered as well. Robin is an Associate Professor of Astronomy in the Science Department at Northeast State Community College in Blountville, TN. She has been a member of the Bays Mountain Astronomy Club since 1992 and has been chairperson of the club as well. She also writes the ongoing science history column in this very newsletter every month. Robin always gives a very entertaining and knowledge-filled presentation so make sure you will be able to attend. I hope to see you all there.

At our February meeting, we enjoyed a planetarium show. The show took the place of a monthly speaker. The show was entitled, “The Hot and Energetic Universe.” The show took us on a cosmic journey that used astronomical observatories throughout the world and those above the Earth’s atmosphere. It mentioned how all types of celestial phenomena are studied, but the focus was set upon that of high energy. These objects were part of the very hot and violent Universe. The show showed us how High Energy Astrophysics probed hot gases in clusters of galaxies, which are the most massive objects in the Universe. It showed us how it also probes hot gas accreting around...
supermassive black holes in the centers of galaxies. It also showed us how 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 producer of this documentary was the “Integrated Activities in the High-Energy Astrophysics Domain” (AHEAD). If you missed the meeting, make sure you take the time to come to Bays Mountain and see this show up through April 16. It was a great show.

We also had an unplanned special speaker come and talk to us about information and benefits of the Astronomical League. The speaker was John Goss, President of the Astronomical League. He spoke to us about all the different observing awards and scholarships that the Astronomical League provides to all ages. If you are a member of our astronomy club, then you are a member of the Astronomical League. There are a ton of resources that we have access to and benefits as well. If you were not able to make it to the meeting, feel free to contact me or William Troxel for more information about the Astronomical League. [Ed.: As part of the educational outreach of our club to its members, there are a few facets that you may not be aware. Regarding the AL, if you do any of the observing programs, you need to turn in your paperwork to me as I am the ALCOR (Astronomical League Coordinator) or Jason Dorfman. I do the initial check for completeness and, for some of the programs, the grader. I then hand off to the specific observing program coordinator for official recognition. The BMAC also has the Astronomy Knowledge Compendium Test http://www.baysmountain.com/astronomy/astronomy-club/?GTTabs=0. Once completed at home, bring your answers to me. A 90% correct grade will award you a special BMAC gift like a hat, pin or patch.]

For our constellation this month, we will talk about Canis Minor. It is translated as The Lesser Dog. We spoke last month about Canis Major, so I only thought it would be right to talk about its nearby neighbor, Canis Minor. Canis Minor is the other one of Orion’s hunting dogs. In Greek mythology, Canis Minor was sometimes connected with the Teumessian Fox, a beast that was turned into stone by Zeus with its hunter also. Zeus placed them in heaven as Canis Major and Canis Minor. The dog was placed along the “banks” of the Milky Way, which the ancients believed to be a heavenly river, where he would never suffer from thirst. Canis Minor contains a few notable objects in it. A couple of them are pretty well known. One of them is the star Procyon. It is the seventh-brightest star in the night sky, as well as one of the closest. Procyon is also a binary star system. Canis Minor also contains a few star clusters. They are NGC 2459 and NGC 2394. A few galaxies are also in this constellation. They are NGC 2508, which is a lenticular galaxy, and NGC 2402 which is actually a pair of near-adjacent galaxies that appear to be interacting with each other. There are always good constellations to see during the Winter months. This one is no exception. Next time you are out, make sure you take a look at this great constellation.
That will be it for this month. Just a reminder that the StarWatches begin this month. The SunWatches will begin as well. We would love to have volunteers come up and help run the scopes and talk to the visitors about our night sky. If you come up, please arrive about 30 minutes before dusk to help setup. We look forward to these public events so we can show everyone how awesome our night (& 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 off-premise 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.
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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The triple conjunction of Mars, Venus and the Moon. January 31, 2017. 90mm lens, f2.8, 1s, ISO2000.

Image by Adam Thanz
Chapter 3

Celestial Happenings

Jason Dorfman
Guest Author: Adam Thanz

Greetings All!

We’ve been extremely busy here at the Park getting our “Totality” planetarium show complete. Jason is currently finishing up the audio while I’m finishing up the visuals. So, I’ll provide a quick update on the night sky of March 2017.

February 28 (yes, I know it’s not in March) will be a nice triple conjunction with Venus, Mars and the Moon in the west after sunset. The day after on March 1, the Moon will be 5° to the left of Mars.

The night of March 4 will provide an occultation of Aldebaran, the brightest star in Taurus, by the first-quarter Moon for most of the contiguous US. The star will wink out around 10:56 p.m. EST and reappear around 11:52 p.m. EST. Note, these times are approximate!

Daylight Saving Time starts at 2 a.m. on the morning of Sunday, March 12. Booo!

The morning of the 20th highlights the last-quarter Moon being about 3° away from Saturn.

By the end of the month, Venus will be very close to the Sun in the sky. During this month, see it become a very large, thin crescent. Mars sinks towards the Sun later. Also by the end of the month, Mercury will be extended 19° away from the evening Sun. Can you spot it?

Jupiter is close to opposition at the end of the month with an angular diameter of 44 arc seconds.

Saturn rises around 3 a.m.

Uranus is in the Mars/Venus conjunction area. Neptune is close to the Sun in the morning sky.
Chapter 4

The Queen Speaks

Robin Byrne
This month we celebrate a man who may not be well known, but who made numerous contributions to astronomy.

Friedrich Argelander was born on March 22, 1799 in East Prussia (later known as Germany). He studied in Elbing and Koenigsberg. His initial plan was to study economics and politics. However, this changed when he attended lectures given by Friedrich Bessel at the University of Koenigsberg. This got him interested in astronomy. Argelander studied under Bessel and received his PhD in 1822.

In 1823 Argelander was given the position of Director of the Abo Observatory in Finland. He worked there for 4 years until the observatory was destroyed by fire. In 1828 he was given a position as Professor of Astronomy at the University of Helsinki and later as Director of the observatory there.

Argelander’s early work was mostly a continuation of the work done by Bessel, which was the mapping of stellar positions. While at Abo, he concentrated on measuring the proper motions of more than 500 stars and published a catalog of these measurements.

Argelander then looked at the work done by William Herschel to measure the Sun’s motion through space. Herschel had measured the relative velocities of 7 nearby stars. Argelander was known for his thoroughness. He felt that Herschel had used far too few stars for this study. So Argelander measured the relative motion of about 400 stars to determine the Sun’s motion. His conclusions confirmed Herschel’s finding that our Sun is moving through space toward the constellation of Hercules.

During the upheavals that followed the Napoleonic Wars, the Argelander family housed the young princes of the Prussian Kingdom. The crown prince (who later became King Friedrich Wilhelm IV) promised to build Argelander a new observatory. This was done and Argelander was made Director of the Bonn Observatory in 1837. (Is it just me, or are there an awful lot of Friedrich’s in this story?)

It was in 1844 that Argelander began studying variable stars. Although this is the field that he is most associated with, there is very little information about what he specifically did. Most likely, he measured the variation in brightness and established the period of variability for the stars he studied. It is known that he
was instrumental in establishing the study of variable stars as an independent branch of astronomy.

From 1859 to 1862 Argelander worked on one of his greatest works: a catalog listing the positions and magnitudes of all the Northern Hemisphere stars down to 9th magnitude. Bonner Durchmusterung contained 324,188 stars and was the last catalog of this scope done without the use of photography. It was reissued in 1950.

Friedrich Argelander died February 17, 1875 in Bonn, Germany. Although he is not widely known, Argelander's devotion to precision and thoroughness established him as one of the great astronomers of his time.

References:

The New Encyclopaedia Britannica 1995

The Biographical Dictionary of Scientists - Astronomers; Ed. David Abbott; 1984
Chapter 5

Space Place

More on this image. See FN6
On August 21, 2017, North Americans will enjoy a rare treat: The first total solar eclipse visible from the continent since 1979. The sky will darken and the temperature will drop, in one of the most dramatic cosmic events on Earth. It could be a once-in-a-lifetime show indeed. But it will also be an opportunity to do some science.

Only during an eclipse, when the Moon blocks the light from the Sun’s surface, does the Sun’s Corona fully reveal itself. The Corona is the hot and wispy atmosphere of the Sun, extending far beyond the solar disk. But it’s relatively dim, merely as bright as the full Moon at night. The glaring Sun, about a million times brighter, renders the Corona invisible.

“The beauty of eclipse observations is that they are, at present, the only opportunity where one can observe the Corona [in visible light] starting from the solar surface out to several solar radii,” says Shadia Habbal, an astronomer at the University of Hawaii. To study the Corona, she’s traveled the world having experienced 14 total eclipses (she missed only five due to weather). This summer, she and her team will set up identical imaging systems and spectrometers at five locations along the path of totality, collecting data that’s normally impossible to get.

Ground-based coronagraphs, instruments designed to study the Corona by blocking the Sun, can’t view the full extent of the Corona. Solar space-based telescopes don’t have the spectrographs needed to measure how the temperatures vary throughout the Corona. These temperature variations show how the Sun’s chemical composition is distributed—crucial information for solving one of the long-standing mysteries about the Corona: how it gets so hot.

While the Sun’s surface is ~9980° Fahrenheit (~5800 Kelvin), the Corona can reach several millions of degrees Fahrenheit. Researchers have proposed many explanations involving magneto-acoustic waves and the dissipation of magnetic fields, but none can account for the wide-ranging temperature distribution in the Corona, Habbal says.

You too can contribute to science through one of several citizen science projects. For example, you can also help study the Corona through the Citizen CATE experiment; help produce a high definition, time-expanded video of the eclipse; use your ham radio to probe how an eclipse affects the propagation of radio waves in the ionosphere; or even observe how wildlife responds to such a unique event.
[Ed: Important note - This illustration that accompanied the article is incorrectly implying that the eclipse path ends north of Athens, GA. The path of totality actually continues through Charleston, SC and out into the Atlantic Ocean.]
Image of the Earth with the August 21, 2017 eclipse path. The red path illustrates totality. The pale area is the penumbral shadow, and thus partial eclipse.

Image by Adam Thanz, Bays Mountain Productions.
Otherwise, Habbal still encourages everyone to experience the eclipse. Never look directly at the Sun, of course (find more safety guidelines here: https://eclipse2017.nasa.gov/safety). But during the approximately 2.5 minutes of totality, you may remove your safety glasses and watch the eclipse directly—only then can you see the glorious Corona. So enjoy the show. The next one visible from North America won’t be until 2024.

For more information about the upcoming eclipse, please see:

NASA Eclipse citizen science page
https://eclipse2017.nasa.gov/citizen-science

NASA Eclipse safety guidelines
https://eclipse2017.nasa.gov/safety

Want to teach kids about eclipses? Go to the NASA Space Place and see our article on solar and lunar eclipses! http://spaceplace.nasa.gov/eclipses/

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
<table>
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<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, March 3, 2017</td>
<td>7 p.m.</td>
<td>Nature Center Discovery Theater</td>
<td>Program: Topic BMACer Robin Byrne, Associate Professor of Astronomy at Northeast State Community College will speak on “A Trip Through Poland’s Scientific History”; Free.</td>
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<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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<tr>
<td>Friday, May 5, 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. 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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<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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<td>Mar. 18, 25, 2017</td>
<td>8:00 p.m.</td>
<td>Observatory</td>
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<tr>
<td>Apr. 1, 8, 15, 22, 29, 2017</td>
<td>8:30 p.m.</td>
<td>Observatory</td>
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<td><strong>Special Events</strong></td>
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<tr>
<td>Saturday, April 29, 2017</td>
<td>1-4:30 p.m. 8:30-10 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
Another caveat is that Hubble searched for a specific type of planet called a "hot Jupiter," which is later rather than sooner in the universe. Building planets. If this is the case, then planets may have formed later in the universe's evolution, always considered the ancient globular cluster an unlikely abode for planets for a variety of reasons. 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. 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 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 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. Illustration showing the United States during the total solar eclipse of August 21, 2017, with the umbra (black oval), penumbra (concentric shaded ovals), and path of totality (red) through or very near several major cities. Credit: Goddard Science Visualization Studio, NASA