Chapter 1

Cosmic Reflections

William Troxel - BMAC Chair
Greetings fellow BMAC’ers!

As you know we did not have a meeting in July. July is always the club’s annual picnic meeting. Due to the global pandemic, that was not able to take place. Because of that, this month’s article is going to be very short because I do not have very much to report to you. I would like to give you the August meeting topic. August will feature the second of three programs on personal observatories. As you know, we started out with a trip to Jonathan Peters’ observational observatory. The second in those programs will be Dan Merrick’s observatory that he also built in his back yard. His topic title is “Building, Maintaining & Things I Learned.” Many of you have been to his observatory. I hope you will be able to connect on Zoom with us at the August meeting on the 7th @ 7pm as we explore this exploration into personal observatories.

We are continuing to meet via online due to the continued health concerns that the Coronavirus is causing. Adam sent out notices reminding each of us that we will be meeting like this until further notice. Until we can meet safely together, I hope you connect when you can through the online format. I encourage each of you to get your new toys or old ones that you love and share them with the members. Maybe you are using this time to start a new observation project or theory about the night sky or our star we call “the Sun.” I encourage you to share what you are doing and have learned so far. We are all interested in the same general area of astronomy yet there are so many different paths to walk within this very interesting hobby which makes for a wonderful, diverse group of amateur astronomers. I think of it as an easy way to learn together. I hope you will be able to connect in August.

Please continue to be safe during this time. We are getting through this together! Until next time...

Clear Skies!

William Troxel
Cosmic Reflections
Chapter 2

BMAC

Notes

More on this image. See FN4.
BMAC News

BMACers Capture Comet!
Well, not literally the comet, but images of it! Please see the collection of images from your fellow clubmates! If you weren’t able to capture an image (photo or sketch) due to the weather, don’t fret. You can always submit an image at a later time.
Comet NEOWISE (C/2020 F3)
Latitude 36°, 10 p.m. EDT
Image from Stellarium
This image is from Greg Penner. Here’s the comet on the morning of July 12, 2020.
Greg Penner captured this image on the evening of July 14, 2020.
This image is from David Reagan from the 13th!
David Reagan's image from the 14th.
This image was from July 14, 2020, 10 p.m. The comet is just being able to be seen in the evening skies. Image by Adam Thanz.
The comet on July 15, 2020, 10 p.m. Now it is in darker skies, but still low. The duskeness of the image is from pollen and desert sand in our atmosphere. Image by Adam Thanz.
Joseph Slusher took this image through a 72mm refractor with a DSLR and 20 stacked images. 7/18/20, 10:20p.
Chapter 3

Celestial Happenings

Jason Dorfman
With the first evening of August, just as the last glimmer of twilight glow from the setting Sun is beginning to fade, you’ll find Virgo sitting low in the WSW with the bright star Arcturus in Boötes a bit higher. At the zenith sits Hercules and the bright globular cluster, M13. Get away from the city lights this month and you’ll see the magnificent Milky Way stretching across the sky from south to north. It holds a wealth of numerous deep sky treats for those willing to explore the rich field of stars.

The Sun rises at 6:36 a.m. and sets at 8:35 p.m. on the 1st. By the end of the month, these times will compress the day by an hour bringing the night skies a bit earlier. The Sun will rise a half hour later and set a half hour earlier on the 31st.

As I write this, Comet NEOWISE has been putting on quite a show. I hope that many of you have had a chance to view the comet. I may have missed my opportunity on the last clear night as the early evening skies have been dominated by clouds in the northwest. I’m hoping for another clear night in the coming days.

Our exploration of the planets this month begins with the giants of the Solar System, Jupiter and Saturn. An hour after sunset, look to the SE to find the gas giants along with a nearly full Moon. Jupiter will be about 22° above the horizon with the Moon sitting roughly 3° directly below. Saturn sits about 7° to the left of the Moon. Though both planets passed through opposition last month, the views this month of these immense worlds will still be spectacular.

Both planets are in the eastern side of Sagittarius, to the left of the Teapot. The two have been moving in retrograde since the beginning of June. This apparent backward motion will begin to slow and stop by month’s end. Jupiter will climb to an altitude of 31° just after midnight on the 1st. Saturn will reach its highest point of about 33° almost 30 minutes later. By month’s end, the two will reach this prime observing spot two hours earlier.

Over the month, Jupiter’s magnitude will decrease slightly from -2.7 to -2.6. The span of the disk of the planet across the sky will also lessen a bit from 47” to 44”. More distant Saturn appears dimmer. It will also decrease over the month from +0.15 to +0.31. Saturn is about twice as far from the Sun as Jupiter. Knowing
this gives us a better understanding of the impressive size of Saturn’s ring system as they span almost the same distance across the sky as the planet Jupiter, about 42” this month. The planet itself is also quite a sight spanning about 18” over the month.

Rising just before midnight on the 1st is the "Red Planet," Mars. Wait about 50 minutes for Mars to rise up to about 10° above the horizon almost due east. Currently in the southeastern section of Pisces, Mars has been moving swiftly eastward but will begin to slow this eastward motion over the month. Mars will continue to climb as the morning dawn approaches, reaching an altitude of almost 57° about a half hour before sunup on the 1st. By month’s end, it will reach 60° due south around 4:30 a.m.

Our views of Mars will continue to improve as we get closer to its opposition in October. During August, the magnitude of Mars will brighten from -1.1 to -1.8. The disk will continue to grow, as well, swelling slightly from 14.6” to 18.8”.

For the early risers, Venus will dominate the eastern skies as the morning twilight approaches. Shining brilliantly at magnitude -4.5, you’ll find Venus 25° above the horizon in the east an hour before sunrise. This sister world of ours starts out north of Orion in the horn stars of Taurus. On the 2nd, it will pass within 2° of the horn star zeta Tauri also called Tianguan, which is derived from Chinese astronomy meaning “Celestial Gate.” It will cross into Orion on the 5th, passing through the stars of the club that he wields above his head.

Venus reaches its greatest western elongation at 9:27 p.m. on the evening of the 12th, when it will be 45.8° west of the Sun. Just 20 minutes later, it will cross from Orion into Gemini. We won’t see Venus rising until 3:30 in the morning, however. Start looking just after 4 a.m., as it begins to climb from 10° up to almost 35° in elevation by the time the early twilight begins to dominate and wash out the starry sky.

For those who enjoy watching the changing appearance of Venus, this is a good month to get up early and point your scope towards the east. Venus starts out the month at magnitude -4.5. The disk spans 27” and the planet appears like a thick crescent at 43% lit. At its greatest elongation, the planet will have shrunk slightly to about 24” as Venus moves away from the Earth. The illumination at greatest elongation is technically 50%, but it normally does not appear to be exactly that on that day due to the effects of Venus’ atmosphere. When do you think it occurs? At month’s end, the planet, now at magnitude -4.3, will look gibbous at 59% lit, but will have shrunk a bit more to 19.6”.

**Luna**

August begins with a nearly full Moon just southeast of Jupiter. The official Full Moon occurs on the 3rd. Stay up a bit later on the 9th for a nice pairing of Mars and the Moon. The waning gibbous Moon will pass within a degree of Mars in the early morning hour.
Almost a week later, on the 15th, try to spot the thin, waning crescent Moon about 4° north of Venus. Look to the east just before 6 a.m. and you’ll find Venus approaching 30° in altitude. Then, look to the upper left for the thin, crescent Moon.

For those who prefer evening observations, the Moon will appear in the west after sunset on the 22nd. At 9 p.m., just as the sky is darkening and the stars are making their appearance, look for a thin, 4-day old crescent Moon just over 5° to the upper right of Spica, the brightest star in Virgo. August will end with a gibbous Moon passing under Jupiter and Saturn on the 28th and 29th.

**Meteor Showers**

We can’t have an article about the skies for August without mentioning the Perseids. The peak this year occurs on the night of the 11th/12th. Prime observing for meteor showers is always around 2 in the morning when our position on Earth has us facing towards the radiant, in this case the constellation Perseus. The peak occurs a day after a third quarter Moon, so, unfortunately, we'll have the light of a thick crescent Moon obscuring many of the fainter events at that time. However, there is often lots to see in the earlier hours of the night.

That’s all for this month. I hope you’re all well and staying safe. Have fun observing!
Chapter 4

The Queen Speaks

Robin Byrne
This month we celebrate the birth of America’s first female astronomer.

Maria Mitchell was born August 1, 1818 in Nantucket Island, Massachusetts, the third of 10 children. Being Quakers, who valued education for all, Maria and all her siblings were raised to be knowledgeable on many topics. Maria owes her career to her father, a school teacher, who had a scientific inclination and was interested in astronomy. At the age of 13, Maria helped her father watch and calculate the exact timing of an eclipse of the Sun.

In 1835, Maria opened her own school, where she used innovative instructional techniques, and insisted on teaching both Black and white children. A year later, Maria followed in her mother’s footsteps and worked as a librarian at the Nantucket Antheneum for 20 years. During that time, her father’s example led her to read as many math and science books as she could find. So Maria was a self-taught astronomer.

At the same time, she spent her evenings in an observatory her father built on the roof of their house. They surveyed the sky to assist the local seamen in navigation. In 1847, on October 1, while working on this project, Maria discovered a comet. Once it was confirmed, it was named after her: “Miss Mitchell’s Comet.” She was only the third woman to ever discover a comet. This brought world-wide attention to Maria. One year later, she became the first woman elected to the American Academy of Arts & Sciences (and it was several decades before another woman joined their ranks).

In 1849, Maria went to work for the U.S. Nautical Almanac Office, working on the U.S. Coast Survey. Her responsibility was to track the positions of planets, especially Venus, to aid in navigation.

In 1865, a new college for women opened: Vassar College. Maria was asked to teach astronomy. She was reluctant, due to her lack of formal training. However, the additional incentive of being made the director of an observatory with a 12” reflector built just for her was what it took to bring her on board. Her teaching style was unconventional - she didn’t take attendance or assign grades. Her teaching philosophy can be seen in this quote: “I cannot expect to make astronomers, but I do expect that you will invigorate your minds by the effort at healthy modes of thinking. When we are chafed and fretted by small cares, a look at the
Maria Mitchell, US astronomer and pioneer of women's rights, from a portrait by H. Dassell, 1851 - Image from Wikipedia
stars will show us the littleness of our own interests." After teaching for several years, Maria discovered that her salary, and that of the only other female professor, were much lower than that of less experienced male professors. Maria insisted upon getting a raise. She got it.

Maria studied almost every area of astronomy during her career. She pioneered the practice of photographing sunspots on a daily basis to study their changes. She also studied comets, nebulae, double stars, variable stars, solar eclipses, and the satellites and atmospheres of Saturn and Jupiter.

Maria died June 28, 1889 in Lynn, Massachusetts, just a month shy of her 71st birthday.

Being the first to do anything is always noteworthy, but does not necessarily have an impact on others. Being the first female astronomer in America is important, but Maria went beyond that. By teaching at Vassar, she inspired more women to follow in her footsteps. Maria also helped found the Association for the Advancement of Women so that other women could have the same opportunities she had. Today, roughly one third of professional astronomers are women. All women in astronomy can trace their heritage back to this month’s birthday-girl. Thank you, Maria Mitchell.

References:
The New Encyclopaedia Britannica, 1995

Notable American Women 1607-1950; Ed’s: James, James & Boyer, 1971

Chapter 5

Space Place

See FN6
The Summer Triangle is high in the sky after sunset this month for observers in the Northern Hemisphere, its component stars seemingly brighter than before, as they have risen out of the thick, murky air low on the horizon and into the crisper skies overhead. Deneb, while still bright when lower in the sky, now positively sparkles overhead as night begins. What makes Deneb special, in addition to being one of the three points of the Summer Triangle? Its brilliance has stirred the imaginations of people for thousands of years!

Deneb is the brightest star in Cygnus the Swan and is positioned next to a striking region of the Milky Way, almost as a guidepost. The ancient Chinese tale of the Cowherd (Niulang) and the Weaver Girl (Zhinü) - represented by the stars Altair and Vega - also features Deneb. In this tale, the two lovers are cast apart to either side of the Milky Way, but once a year a magical bridge made of helpful magpies – marked by Deneb – allows the lovers to meet. Deneb has inspired many tales since and is a staple setting of many science fiction stories, including several notable episodes of Star Trek.

Astronomers have learned quite a bit about this star in recent years, though much is still not fully understood – in part because of its intense brightness. The distance to Deneb from our Sun was measured by the ESA's Hipparcos mission and estimated to be about 2,600 light years. Later analysis of the same data suggested Deneb may be much closer: about 1,500 light years away. However, the follow-up mission to Hipparcos, Gaia, is unable to make distance measurements to this star! Deneb, along with a handful of other especially brilliant stars, is too bright to be accurately measured by the satellite’s ultra-sensitive instruments.

Deneb is unusually vivid, especially given its distance. Generally, most of the brightest stars seen from Earth are within a few dozen to a few hundred light years away, but Deneb stands out by being thousands of light years distant! In fact, Deneb ranks among the top twenty brightest night time stars (at #19) and is easily the most distant star in that list. Its luminosity is fantastic but uncertain, since its exact distance is also unclear. What is known about Deneb is that it’s a blue- white supergiants star that is furiously fusing its massive stocks of thermonuclear fuel and producing enough energy to make this star somewhere between 50,000 and 190,000 times brighter than our Sun if they were viewed at the same distance! The party won’t last much longer; in a few million years, Deneb will exhaust its fuel and end its
Deneb in the Summer Triangle
Overhead, August Evenings
stellar life in a massive supernova, but the exact details of how this will occur, as with other vital details about this star, remain unclear.

Discover more about brilliant stars and their mysteries at [www.nasa.gov](http://www.nasa.gov).

This article is distributed by NASA Night Sky Network. The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit [www.nightsky.jpl.nasa.gov](http://www.nightsky.jpl.nasa.gov) to find local clubs, events, and more!
Chapter 6

BMAC
Calendar
and more
# BMAC Calendar and more

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
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<th>Notes</th>
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<tbody>
<tr>
<td><strong>BMAC Meetings</strong></td>
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<tr>
<td>Friday, August 7, 2020</td>
<td>7 p</td>
<td>Via Zoom</td>
<td>BMACer Dan Merrick will speak about his observatory that he also built in his back yard. His topic title is “Building, Maintaining &amp; Things I Learned.”</td>
</tr>
<tr>
<td>Friday, September 4, 2020</td>
<td>7 p</td>
<td>Via Zoom</td>
<td>Program TBA.</td>
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<tr>
<td>Friday, October 2, 2020</td>
<td>7 p</td>
<td>Via Zoom</td>
<td>Program TBA.</td>
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<tr>
<td><strong>SunWatch</strong></td>
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<tr>
<td>Every Saturday &amp; Sunday March - October</td>
<td></td>
<td></td>
<td><strong>Cancelled until further notice.</strong> 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>October 3, 10, 2020</td>
<td>7:30 p</td>
<td></td>
<td><strong>Cancelled until further notice.</strong> 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. If you are a club member and have completed the Park volunteer program, you are welcome to help out with this public program. Please show up at least 30 minutes prior to the official start time.</td>
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<tr>
<td>October 17, 24, 31, 2020</td>
<td>7 p</td>
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<td>November 7, 14, 21, 28, 2020</td>
<td>6 p</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:

https://www.baysmountain.com/astronomy/astronomy-club/#newsletters

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**Regular Contributors:**

**William Troxel**

William is the current chair of the club. He enjoys everything to do with astronomy, including sharing this exciting and interesting hobby with anyone that will listen! He has been a member since 2010.

**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.
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. Leo Rising
A sky filled with stars and a thin veil of clouds.
Image by Adam Thanz

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.

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 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.

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Image Credit: NASA/JPL/Space Science Institute

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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 August 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 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 where some theoreticians say that the heavy-element composition of a star may be enhanced after it 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 of 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. Long exposure shot of Deneb (brightest star, near center) in its richly populated Milky Way neighborhood. Photo credit: Flickr user jpstanley. Source: https://www.flickr.com/photos/jpstanley/1562619922 License: https://creativecommons.org/licenses/by-nc-sa/2.0/

9. Spot Vega and the other stars of the Summer Triangle by looking straight up after sunset in August!

10. The Summer Triangle straddles this image of the summer Milky Way. The streaks of light are from fireflies! Image by Adam Thanz.