The Monthly Newsletter of the Bays Mountain Astronomy Club

September 2020

Edited by Adam Thanz
Chapter 1

Cosmic Reflections

William Troxel - BMAC Chair
Greetings fellow BMACer’s! September is here already! I hope my letter finds you all doing well and staying safe as we continue to work thru the global pandemic. I wanted to share some of the things that we are going to do during our September meeting later in this article.

Before I do that I wanted to give a big shout out to Dan for sharing a virtual tour of his private observatory with us. It will be great to visit and maybe if mother nature is on our side, we can see it in action. I also wanted to explain the concept behind these groups of programs I have been providing. I wanted to show you some of the types of observatories that people like you and I could have in our back yards. We are going to take a break in September from this structure and do “ten minute” talks as the program. I am still working on how we will make this happen over zoom, so let me say that you should get your your equipment out, dust it off, get your references handy and be ready to take a topic and talk for 10 minutes. Also, I want to let you know that we will also have a poll running during the meeting with questions on Comet NEOWISE. That's right, you read it correctly. So review the facts so you can answer the questions as they appear on the chat. There will be 6 questions that will challenge you, or that is at least the plan.

Also don’t forget about show and tell which I think is really enjoyed by everyone. Maybe if you continue to enjoy this feature, maybe I can find a way to add it into the the program when we are able to meet again in person.

We all know that these are very unusual times we are living in and we are going to get out of this together. Until we are able to be back together in person I am trying to make our online meets as interesting and fun as I can. If you have an idea for a feature or program please let me know. If you would like to be a presenter for a meeting, I would love to give you the Zoom stage. I will help you as much as I can. So please consider it.

Now as I close this month’s letter, I really want to thank all of you that have spoken up, ask questions, show your new, or new to you, rebuilt and created things to help you enjoy our hobby of astronomy. You are the best members and it is an honor for me to be your chairman. Please continue to be safe. See at the online meeting on September 4 at 7 p.m.
Chapter 2

BMAC Notes

More on this image. See FN4
Wanted
A Meade ETX controller, either the AutoStar or AudioStar version.
Please contact Ezra Wilson at writer3655@gmail.com.

StarFest 2020 Cancelled
I’m sure you’ve heard and expected that StarFest has been cancelled for this year due to the COVID-19 pandemic. The dates for next year have been set for October 29-31, 2021.
Comet NEOWISE, taken with 25 minutes of exposure to reveal fainter details. Image by David Reagan.
Chapter 3

Celestial Happenings

Jason Dorfman
What a strange summer! I guess, for me, it feels odd because I normally do a bit of traveling during the summer months, which didn’t happen this year. And now with September upon us, summer is ending and fall is on our doorstep. The Autumnal Equinox occurs this month on the 22nd at 9:30 a.m. bringing with it shorter daylight hours. Which, of course, means more observing time for us!

For September, the Sun will rise at 7 a.m. and set at 8 p.m. on the 1st. By the end of the month, we’ll see the daylight hours shorten by more than an hour with the Sun rising a half hour later and setting 45 minutes earlier.

This month, you’ll find the Summer Triangle high overhead and the Milky Way stretching across the sky just as night begins. Pegasus is rising in the east bringing with him the autumn skies and some wonderful planetary views.

**Planets**

For September, Jupiter and Saturn continue their role as the planetary highlights for the evening sky. Both are found just east of the Teapot asterism in Sagittarius, with Saturn about 10° to the east of Jupiter. An hour after sunset, the pair of giants sit roughly 30° above the SSE horizon. Jupiter shines brightly at magnitude -2.5. It will reach its highest elevation of 31° two hours after sundown. Saturn will climb a bit higher to 32.5° a half hour later.

Jupiter’s retrograde motion will slow as the month begins and the planet will appear to stand still amongst the background stars on the 13th. In the second half of the month, the planet will begin its regular eastward motion bringing it closer to Saturn. In telescopes, you’ll find a disk spanning an impressive 44”, allowing you to easily see the colorful bands of this gas giant world. By month’s end, as Earth continues to move around its orbit taking it further from Jupiter, we’ll see Jupiter’s magnitude drop to -2.3 and the span of the disk decrease to 40”.

Saturn’s magnitude will also lessen by about two-tenths dimming from +0.3 to +0.5 over the month. Though further from the Sun, Saturn is still a wondrous sight with the rings spanning 42”. The planet itself spans 18” and though it lacks the colorful contrasts of Jupiter’s belts, with favorable conditions, you can often spy its own belt structure within its yellowish atmosphere.
With a telescope, you can’t help but notice a few of the large moons of these gas giants. Over a few hours, you can track the changing positions of some of them. With Jupiter, transits occur often and are quite fascinating as you see the moon and its shadow transit across the planet’s atmosphere. As Jupiter begins its regular eastward movement in the second half of the month, it will begin to close the apparent distance between it and Saturn. The two are headed towards a spectacular conjunction on the winter solstice.

This month brings a good opportunity to view the most distant planet (…not dwarf planet) in the Solar System. Neptune reaches opposition on the 11th, which means we’re at our closest approach to this distant, icy world. Neptune is in the northeastern section of Aquarius and at opposition will be about 2.5° east of the star Phi Aquarii. Around the day of opposition, Neptune will climb to almost 50° in elevation due south at 1:30 a.m. The Moon is also well positioned so as to not interfere. A slightly past 3rd quarter Moon rises just as Neptune reaches its highest altitude. Neptune shines faintly at magnitude +7.9, so you’ll need binoculars or a telescope to catch a glimpse of the planet. Look for a bluish-green dot spanning 2.3".

As Jupiter and Saturn are exiting stage left, Mars is moving in to take center stage for the next few months. With its opposition coming up in October, we’ll enjoy some wonderful views of the "Red Planet" beginning this month and lasting into November. Though Mars was a bit closer during its last opposition in 2018, that event was marred by a global dust storm and lower altitude of the planet. Barring another dust storm (cross your fingers), this coming opposition should provide some more rewarding views with the planet climbing to almost 60°.

Mars rises just after 10 p.m. on the 1st and will ascend to roughly 22° above the eastern horizon by midnight. Currently in the bottom of the V-shape of Pisces, Mars will end its normal eastern motion on the 9th and begin to move in retrograde for the rest of the month. The span of the disk will grow from 19” to 22” over the month, making it close enough to view some of the distinct surface features seen on the planet. Optimal viewing will be in the early morning hours as it climbs to its highest elevation. Mars will brighten considerably over the month increasing from magnitude -1.8 to -2.5, putting it on par with Jupiter.

For the morning observers among us, Venus continues its reign as the morning star, shining brilliantly at magnitude -4.3. It rises shortly after 3 a.m. on the 1st and climbs to an elevation of 30° an hour before sunrise. Though past its greatest western elongation and now moving back towards the Sun, a steep inclination of the ecliptic to the horizon will keep Venus at a good observable altitude throughout the month. Venus begins the month just south of the bright stars Castor and Pollux in the constellation Gemini. Telescopes will reveal a large orb spanning 19” and appearing 60% illuminated. On the 14th, our sister world will lie just 2.5°
south of the Beehive cluster. A thin crescent Moon can be found about 5° east of this pair on the same morning. By month’s end, when Venus has moved to a position 3° west of Regulus in Leo, it will appear 71% lit with a slightly smaller disk spanning 15.6”.

**Luna**

September will begin and end with a Full Moon, or close enough to appear full. Technically, the first Full Moon occurs on the morning of the 2nd at 1:22 a.m. On the night of the 30th, the Moon will appear 99.3% illuminated just before midnight with the official Full Moon occurring the following afternoon. Regardless, it will look like Full Moons are bookends to the month of September.

On the 5th, a waning gibbous Moon passes just 0.5° south of Mars shortly after 11 p.m. as the Red Planet is rising in the east. For more southern latitudes closer to the equator, observers will see the Moon occult Mars.

As mentioned above, on the 14th, when Venus is just south of the Beehive Cluster, a thin waning crescent will lie within 5° of the two. Look at 6 a.m. just before the first light of dawn begins to touch the eastern sky and you’ll see the Moon and Venus side by side 25° above the horizon.

As the month’s end approaches, the Moon will be back in the early evening skies and passing under the gas giants, Jupiter and Saturn. Look due south on the 24th just as the last twilight glow is fading and you’ll find a waxing gibbous Moon about 4° to the SW of Jupiter. It will have moved to within 3° by the time Jupiter sets just after 1 a.m. On the following night, the Moon will have jumped over to about 4° to the south and a little east of Saturn.

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
Sometimes I’m slow to getting around to reading a book, so it’s no surprise that four years after it came out, I finally read Dava Sobel’s “The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars.” Regardless of the delay, reading this book was a pure joy.

I’ve been a fan of Dava Sobel since “Longitude,” so I wasn’t surprised by how much I enjoyed the book. What did surprise me were the number of stories and accomplishments of women coming out of the Harvard Observatory. The story begins in the 1880’s when Anna Draper began looking for a way to memorialize her late husband, Henry, while also continuing the work he had begun in studying the spectra of the stars. Corresponding with her friend, Edward Pickering, who was the director of Harvard Observatory, ultimately led to Mrs. Draper establishing a fund to produce a catalog of the spectra and characteristics of stars. This immense project would lead to Pickering hiring more women to work as “computers” to analyze the spectra, and, ultimately, the publication of the Henry Draper Catalog of Stars. If you’ve ever seen a star referenced by its HD number, that is the number it was assigned in this catalog.

Before the funding from Anna Draper, Pickering had already been using women at the observatory to do computational work, but with this influx of money, he could expand the number of projects being conducted by the observatory, and even build new observatories at Harvard and abroad.

Among the notable women discussed in the book, easily the most famous was Annie Jump Cannon. The way we classify stars can be traced back to her system of classification. But in the book, we learn about Annie Cannon as a person, and her lifetime of contributions. Henrietta Leavitt is also highlighted, with her discovery of the Period-Luminosity Relationship for Cepheid variable stars. We then see how that relationship gets used by Harlow Shapley, who will be Pickering’s successor as Director of the observatory, to measure the size of the Milky Way, and by Edwin Hubble to prove that there are galaxies beyond the Milky Way.

In addition to the above two women, who are deservedly considered to be astronomy superstars, we meet many other women who also merit recognition, but have been in the shadows for too long. One of the very first women to work as a
“Positively glows... [Sobel] lucidly captures the intricate, interdependent constellation of people it took to unlock mysteries of the stars.” — NPR

**THE GLASS UNIVERSE**

**HOW THE LADIES of the HARVARD OBSERVATORY TOOK the MEASURE of the STARS**

DAVA SOBEL

#1 NEW YORK TIMES BESTSELLING AUTHOR OF *Longitude* and *Galileo's Daughter*
computer for Pickering was Williamina Fleming, who began as Pickering’s housekeeper, but proved to have exceptional astronomical ability. It was her classification system of stars that Annie Cannon modified to create the system still used today. Additionally, Fleming was very good at discovering spectroscopic binaries - binary star systems too close together to see two separate stars, but whose spectra indicated that there were multiple stars contributing to one spectrum.

“The Glass Universe” spans the era of the women computers from the 1880’s to the 1950’s, and shares the stories of almost twenty different women who worked at the Harvard Observatory over the years. Some had no formal training in astronomy, but others held some of the first advanced degrees in astronomy awarded to women. One of the last women spotlighted in the book was Cecelia Payne, who came to the observatory after being the first to earn her doctorate in astronomy at Harvard. Through the study of the spectra of stars, she determined the relative abundances of different elements in the stars. Her finding, that stars are composed of primarily hydrogen and helium, was dismissed by the astronomical establishment, who “knew” that the stars are composed of the same materials as Earth. It wasn’t until many years later that her critics relented and accepted her findings. Payne became a professor of astronomy at Harvard, and was later appointed chair of the Astronomy Department.

With the development of mechanical computers, the era of women working as computers at the observatory ended. But it was the vision of two of the male observatory directors, Edward Pickering and Harlow Shapley, that allowed so many women to not only work at the observatory, but to be valued as contributors to the science. Both men created a supportive environment that encouraged the women to pursue degrees in astronomy and to be active members of the professional astronomical community. If the observatory had been run by men with a very different attitude toward the women working there, we would likely not know about any of these women, and the advances made in astronomy and astrophysics during this era would have suffered as a result.

“The Glass Universe” by Dava Sobel celebrates the contributions of the women, and men, working at the Harvard Observatory, and is both entertaining and inspiring to read.

References:
Chapter 5

Space Place
Altair is the final stop on our trip around the Summer Triangle! The last star in the asterism to rise for Northern Hemisphere observers before summer begins, brilliant Altair is high overhead at sunset at the end of the season in September. Altair might be the most unusual of the three stars of the Triangle, due to its great speed: this star spins so rapidly that it appears “squished.”

A very bright star, Altair has its own notable place in the mythologies of cultures around the world. As discussed in our previous edition, Altair represents the cowherd Niulang in the ancient Chinese tale of the “Cowherd and the Weaver Girl.” Altair is the brightest star in the constellation of Aquila the Eagle; while described as part of an eagle by ancient peoples around the Mediterranean, it was also seen as part of an eagle by the Koori people in Australia! They saw the star itself as representing a wedge-tailed eagle, and two nearby stars as his wives, a pair of black swans. More recently one of the first home computers was named after the star: the Altair 8800.

Altair’s rapid spinning was first detected in the 1960’s. The close observations that followed tested the limits of technology available to astronomers, eventually resulting in direct images of the star’s shape and surface by using a technique called interferometry, which combines the light from two or more instruments to produce a single image. Predictions about how the surface of a rapidly spinning massive star would appear held true to the observations; models predicted a squashed, almost “pumpkin-like” shape instead of a round sphere, along with a dimming effect along the widened equator, and the observations confirmed this! This equatorial dimming is due to a phenomenon called gravity darkening. Altair is wider at the equator than it is at the poles due to centrifugal force, resulting in the star’s mass bulging outwards at the equator. This results in the denser poles of the star being hotter and brighter, and the less dense equator being cooler and therefore dimmer. This doesn’t mean that the equator of Altair or other rapidly spinning stars are actually dark, but rather that the equator is darker in comparison to the poles; this is similar in a sense to sunspots. If you were to observe a sunspot on its own, it would appear blindingly bright, but it is cooler than the surrounding plasma in the Sun and so appears dark in contrast.

As summer winds down, you can still take a Trip Around the Summer Triangle with this activity from the Night Sky Network. Mark some of the sights in and around the Summer Triangle at: https://bit.ly/TriangleTrip. You can discover more about NASA’s
Model of a fast-spinning star

Actual image of Altair from the CHARA Interferometer

Equator bulges and darkens as star spins faster

2.8 revolutions/day
observations of Altair and other fast and furious stars at https://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 https://nightsky.jpl.nasa.gov to find local clubs, events, and more!
Chapter 6

BMAC
Calendar
and more
# BMAC Calendar and more

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<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>Notes</th>
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<tr>
<td><strong>BMAC Meetings</strong></td>
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<tr>
<td>Friday, September 4, 2020</td>
<td>7 p</td>
<td>Via Zoom</td>
<td>“Ten Minutes” program. A few BMACers will be asked to provide 10 minutes from a variety of topics.</td>
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<td>Friday, October 2, 2020</td>
<td>7 p</td>
<td>Via Zoom</td>
<td>Program TBA.</td>
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<tr>
<td>Friday, November 6, 2020</td>
<td>7 p</td>
<td>Via Zoom</td>
<td>Program TBA.</td>
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<td><strong>SunWatch</strong></td>
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<td>Every Saturday &amp; Sunday March - October</td>
<td></td>
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<td><strong>Cancelled until further notice.</strong> View the Sun safely with a white-light view if clear.; Free.</td>
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<td><strong>StarWatch</strong></td>
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<tr>
<td>October 3, 10, 2020</td>
<td>7:30 p</td>
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<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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<td>October 17, 24, 31, 2020</td>
<td>7 p</td>
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<td>November 7, 14, 21, 28, 2020</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

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’ width and brightness, 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.
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 September 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 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 September 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. This image was created using optical interferometry: the light from four telescopes was combined to produce this image of Altair’s surface. Image credit: Ming Zhao. More info: https://bit.ly/altairsvsmode

9. Altair is up high in the early evening in September. Note Altair’s two bright “companions” on either side of the star. Can you imagine them as a formation of an eagle and two swans, like the Koori?