Chapter 1

Cosmic Reflections

William Troxel - BMAC Chair
Greetings fellow BMACers, February’s meeting is upon us already!

I wanted to give you a report on the annual dinner which of course was in January. We had 22 members and family, which I thought was a wonderful turnout. I have added a picture of the evening. The event started when we had drinks over at the bar. Much of our group attended that, which made it fun. It was crowded, but that was due to the very large civic group holding their event at the same time. Once we sat for dinner, of course, we worked an astronomical crossword puzzle to start the meeting. Overall, the group seemed to enjoy the activity. Following that, we had a brief power blackout due to the major storm that passed through the area! Once the lights came back on, we had an activity that required each person to use a list of words written on a card that they had to use in a short paragraph as part of a "continuing story." It was fun to hear the story that was created by each person’s addition. After the activities, we enjoyed a wonderful meal. We had some of our new members join us for the dinner. I am so happy that they were able to be with us.

I think this a good time to welcome all our new members. I hope you will make yourselves known to everyone. I have said this many times over the year(s). I have been your chairman and I still mean it. I would love to know what your interests are in astronomy. Maybe you would like to know why I write this. That is a good reason. The reason is that I want to understand what you enjoy so that I can plan programs for the meetings. I have been using my own interests for the most part. Please share your interests with me. If you are uneasy sharing with me maybe you would share with Adam or Jason and that is cool, they can pass the information on to me. You see there are lots of ways to get information to me!

This month has some really good chances to see our Moon, for those of you that enjoy studying, observing and recording it, you will have a New Moon, Full Moon and "Super Moon" all this month. Also for those of you that enjoy the planets, this month Mercury will be at its Greatest Eastern Elongation. I saw this listed in “The Sky Guide.” Of course, I have to write that seeing these events is dependent on the weather!
BMAC Dinner 2020
Image by William Troxel
February’s meeting will feature “Einstein’s Gravity Playlist” in the planetarium theater. This is a good chance to see one of the shows here in the Park.

Hope you will be able to come out. Until next time….

Clear Skies.
Chapter 2

BMAC Notes
Scope for Sale

BMAC Jack Dison has a Meade 8" LX200 GPS for sale. Here are the specs:

- Meade dew shield
- 8x50 Meade finder
- Telrad finder
- Meade moto focuser
- Losmandy vixen style rails top and bottom
- Losmandy sliding counterweight set
- Nelson devices “slo-mo gennie” joystick controller
- Meade 507 cable set 20 ft and serial/usb connector
- 12 volt power cable
- Field tripod no rust
- Meade anti vibration pads
- New Meade wedge
- Original Meade fitted shipping box

He’s asking $1200 cash. Contact him with any questions. He prefers not to ship and will meet in 150 mile radius from Kingsport, TN. Jackelrd@yahoo.com, 276-690-0861
**Stellarium Software Update**

I recently discovered that the free planetarium software we use for basic sky views for our desktop research, Stellarium, is now available through a web browser! You don’t have to download the software, just click on the “Stellarium Web” link on the top of the main Stellarium page. Or, you can use this address to go directly there. [https://stellarium-web.org](https://stellarium-web.org).

- First, you’ll want to set your place on Earth. That’s the button on the bottom left.

- You can change the date and time (bottom right).

- You can click and drag the sky to change your orientation.

- Click on an object and an info window pops up.

- Click on the circled star icon just below to center.

- Click on the + - to zoom in or out. You’ll see more detail for objects including planets.

- The x# next to the Moon means that it is showing the Moon that much larger than real size. This allows you to see the Moon easier when zoomed out.

- Search for an astronomical object (top center).

- The icons on the bottom of the screen toggle features.

- Be aware that it can tax a weaker computer.

Not only is it great for research, but also for educational purposes. The downloaded program versions have more features and controls and are still free.
Southern Star 2020
The Charlotte Amateur Astronomers Club invites you to attend the 34th annual Southern Star Astronomy Convention at the beautiful Wildacres Retreat in the Blue Ridge Mountains near Little Switzerland, NC.

Wildacres has comfortable dormitory lodging with private baths, a dining hall serving three delicious meals daily, and a well equipped lecture hall where you will see presentations from experts on a variety of topics in astronomy and space science.

Other activities include observing (weather permitting), a nature hike and visit to local artisan, swap table, door prizes, and wine and cheese and ice cream socials. The interesting program, idyllic setting, and camaraderie of fellow astronomy enthusiasts keeps many people returning year after year. Highlights of this year’s program are on the attached flyer. Registration will open in late February, at which time registration forms will be available on our website charlotteastronomers.org/southernstar. Save the dates and we look forward to seeing you at Southern Star 2020!
Chapter 3

Celestial Happenings

Jason Dorfman
This month, we'll continue our exploration of star clusters, focusing now on open clusters. Last month, we looked at globular clusters with some examples to observe in the skies overhead. In this month's article, we'll see how open clusters differ from globulars and I'll highlight some excellent examples that you can observe in our winter skies above.

Open Star Clusters
The differences observed between open clusters and globular clusters are a result of where and when they formed. As was stated in last month's article, almost all of the globular clusters we see formed long ago in the halo of our galaxy, back when the disk of our Milky Way was still developing. The stars that make up globulars have low metallicity, which means that the percentage of elements heavier than helium is low. The primordial soup from which the globulars formed had not yet been enriched with heavier elements from billions of years of stellar evolution. In contrast, the open or galactic clusters are younger and formed within the disk of the Milky Way. Being just a few hundred million years old or younger, the stars of open clusters have higher metallicities than globular cluster stars because the clouds of gas from which they formed were enriched with heavier elements from billions of years of stellar formation and death. Like globulars, all the stars of open clusters form within a giant molecular cloud at roughly the same time. This is what makes both globular and open clusters such excellent samples for studying star formation and evolution.

Open clusters are smaller than globulars. They contain anywhere from a few hundred stars up to a few thousand stars. With fewer stars, they are more loosely bound by gravity than the larger globular clusters and thus tend to have more irregular shapes. This lesser gravitational adhesion also results in galactic clusters only lasting for a few hundred million years as they eventually become disrupted by close encounters with other clusters and clouds of gas. Currently, there are over 1100 galactic clusters in the Milky Way, all of which are located within the disk of our galaxy where star formation is occurring.

There are many open clusters to observe throughout the year, however, the winter season holds one of the brightest and easily viewed - the Pleiades or M45 (Image 1). This is a spectacular cluster located in the constellation of Taurus, the Bull (Image 2). It
2. Taurus the Bull. Image from Stellarium.
formed back when dinosaurs roamed the Earth, about 100 million years ago. Find the V-shape that outlines the face of Taurus and look about 12° to the northwest for a tight grouping of stars. If you look carefully under a dark sky, you should be able to count about 7 bright stars in that grouping, this is possibly how it received the nickname "The Seven Sisters." Of course, seeing 7 stars is easier said than done. Most people can count 5 bright stars that form a mini-dipper; Alcyone, Atlas, Electra, Maia, and Merope. They range from 2.9 to 4.2 in magnitude. A straight line through Alcyone and Maia leads you to the sixth star, Taygeta, about 7' to the northwest and magnitude 4.3. The seventh star, Pleione, is a bit more challenging. This 5.1 magnitude star is located just 5' north of brighter Atlas. You’ll need your eyes to be well dark adapted and try a bit of averted vision for this one.

There is another open cluster found in Taurus - the Hyades cluster (Image 3). The stars that form a letter V and outline the face of the bull belong to this cluster. However, the glowing red eye of Taurus, Aldebaran, is not a cluster member, but merely a foreground star at a distance of 65 light years. At 153 light years distant, the Hyades is the closest and one of the most studied open clusters. The Hyades is an older cluster than the Pleiades at an age of about 653 million years. The five brightest members are now evolving into giant stars. The Hyades appears more spread out on the celestial sphere than the more distant Pleiades cluster, which is 444 light-years away. This is truly due to it being closer to us and thus appearing larger, as both clusters have a similar core radius.

Now, let’s turn our gaze further to the east for a fainter cluster in the constellation of Cancer, the Crab (Image 4). Gazing into the very heart of the crab, we find the Beehive Cluster (M44). This cluster is also known as The Praesepe, which is Latin for the manger (Image 5). It’s position is given as R.A. 8h 41m 34.3s and DEC +19° 35' 36.1". It shares similar traits with the Hyades cluster as the two clusters have similar ages. The Beehive, however, is much more distant at about 590 light-years from Earth. This cluster appears as a nebulosity cloud under dark sky conditions as many of the brighter stars are at 6th and 7th magnitude.

One additional cluster to investigate is found in the northwest and is actually a pair of open clusters located between the constellations of Cassiopeia and Perseus (Image 6). The Double Cluster (Image 7) is the common name for clusters NGC 869 (h Persei) and NGC 884 (χ Persei). NGC 869 is located at R.A. 2h 20m 27.2s and DEC +57° 13' 16.4" and about 3m to the east is NGC 884 at R.A. 2h 23m 50.75s DEC +57° 13' 2.1". At 12.8 million years old, both clusters are quite young. They both contain more than 300 blue-white super-giant stars producing a spectacular sight through a telescope or binoculars. Though we’re focusing on them now, the Double cluster is a circumpolar object which can be viewed throughout the year, though it is
7. The Double Cluster. Image by Brandon Stroupe.
found highest in the north in late fall/early winter.

I hope that you will take advantage of any clear nights this winter to go out and explore these clusters for yourself. Happy Observing!

References:


https://www.skyandtelescope.com/astronomy-news/many-pleiades-can-see10222014/ (January 16, 2020)


"I am Marie Curie" by Brad Meltzer and illustrated by Christopher Eliopoulos, is a book targeted to children ages 5 - 8 years old. I bought it for my niece (shhhhh! don’t tell her), but, of course, I wanted to read it first.

Having read biographies of Marie Curie before, there wasn’t anything in the book I hadn’t known about. However, the writing style was engaging enough to entertain not only this adult, but any child, as well. We learn about the major events in Marie’s life. It begins with her childhood and interest in her father’s scientific instruments. Meltzer discusses the expectations for women during the late 19th century, and how Marie wasn’t allowed to study science or attend college in Poland, due to the limits placed on women at that time. The book talks about how supportive Marie’s father was, and how he encouraged all of his children to be interested in learning, even his daughters, and the illegal “Flying School” that Marie attended with other women interested in furthering their education. We then see Marie finally able to attend the Sorbonne and become a chemist, and the hardships she endured to achieve her dream. We meet her husband and daughter, too. Then the book tells of Marie’s two Nobel Prizes, the mobile x-ray unit she developed during World War I, and her legacy to this day.

The illustrations by Eliopoulos are very cute, though I wished that Marie wasn’t drawn as a child throughout the story, when other women and men were shown at appropriate ages. My guess is that he wanted her depiction to be consistent throughout the book, but I found it misleading, implying that Marie did all of these things as a child. What did help to compensate were actual pictures of Marie Curie at the end of the book, showing her at different ages and working in her laboratory.

“I am Marie Curie” is part of a series of books meant to motivate young children, called Ordinary People Change the World. Others highlighted in the series include: Walt Disney, Neil Armstrong, and Billie Jean King, among many more. I found the book to be very inspiring, and at several points in the book, the author intentionally has other people, saying of Marie, “She’s such an inspiration!” She really is.

I truly enjoyed "I am Marie Curie," and it would be a good addition to any child’s library, though a good number of adults
The cover to “I am Marie Curie”
may want it as part of their library, too.

References:
I am Marie Curie by Brad Meltzer; Illustrations by Christopher Eliopoulos; Dial Books for Young Readers, Penguin Random House, 2019.
What happens when a star dies? Stargazers are paying close attention to the red giant star Betelgeuse since it recently dimmed in brightness, causing speculation that it may soon end in a brilliant supernova. While it likely won’t explode quite yet, we can preview its fate by observing the nearby Crab Nebula.

Betelgeuse, despite its recent dimming, is still easy to find as the red-hued shoulder star of Orion. A known variable star, Betelgeuse usually competes for the position of the brightest star in Orion with brilliant blue-white Rigel, but recently its brightness has faded to below that of nearby Aldebaran, in Taurus. Betelgeuse is a young star, estimated to be a few million years old, but due to its giant size it leads a fast and furious life. This massive star, known as a supergiant, exhausted the hydrogen fuel in its core and began to fuse helium instead, which caused the outer layers of the star to cool and swell dramatically in size. Betelgeuse is one of the only stars for which we have any kind of detailed surface observations due to its huge size – somewhere between the diameter of the orbits of Mars and Jupiter - and relatively close distance of about 642 light years. Betelgeuse is also a “runaway star,” with its remarkable speed possibly triggered by merging with a smaller companion star. If that is the case, Betelgeuse may actually have millions of years left! So, Betelgeuse may not explode soon after all; or it might explode tomorrow! We have much more to learn about this intriguing star.

The Crab Nebula (M1) is relatively close to Betelgeuse in the sky, in the nearby constellation of Taurus. Its ghostly, spidery gas clouds result from a massive explosion; a supernova observed by astronomers in 1054! A backyard telescope allows you to see some details, but only advanced telescopes reveal the rapidly spinning neutron star found in its center: the last stellar remnant from that cataclysmic event. These gas clouds were created during the giant star’s violent demise and expand ever outward to enrich the Universe with heavy elements like silicon, iron, and nickel. These element-rich clouds are like a cosmic fertilizer, making rocky planets like our own Earth possible. Supernovae also send out powerful shock waves that help trigger star formation. In fact, if it wasn’t for a long-ago supernova, our Solar System - along with all of us - wouldn’t exist! You can learn much more about the Crab Nebula and its neutron star in a new video from NASA’s Universe of Learning, created from observations by the Great Observatories of Hubble, Chandra, and Spitzer: [bit.ly/CrabNebulaVisual](bit.ly/CrabNebulaVisual).
Crab Nebula - M1
CXO + HST + SST
CXO ACIS X-ray
HST WFPC2 Optical
SST IRAC Infrared

4 light-years
1.24 parsec 2.11’
Facing Southeast
February, early evenings

Taurus

Crab Nebula (M1)

Orion

Betelgeuse

More on this image. See FN9
Our last three articles covered the life cycle of stars from observing two neighboring constellations: Orion and Taurus! Our stargazing took us to the "baby stars" found in the stellar nursery of the Orion Nebula, onwards to the teenage stars of the Pleiades and young adult stars of the Hyades, and ended with dying Betelgeuse and the stellar corpse of the Crab Nebula. Want to know more about the life cycle of stars? Explore stellar evolution with “The Lives of Stars” activity and handout: bit.ly/starlifeanddeath.

Check out NASA's most up to date observations of supernovae and their remains at 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 nightsky.jpl.nasa.gov to find local clubs, events, and more!
Chapter 6

BMAC
Calendar and more

More on this image. See FN7
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMAC Meetings</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Friday, February 7, 2020</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: “Einstein’s Gravity Playlist” will be shown. Learn about gravity waves! Free.</td>
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<td></td>
<td></td>
<td>Planetarium Theater</td>
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<tr>
<td>Friday, March 6, 2020</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: Noah Frère from UT Knoxville, the Smokey Mountain Astronomical Society, the Knoxville Observers, and O.R.I.O.N will speak about “The Purple Edge Problem.” Noah Frère plans to graduate this year with a Masters Degree in Astrophysics at the University of Tennessee, Knoxville, focusing on the spectral analysis of Vesta-like meteorites and Vestoids. He owns an Astrotech f/4 6” imaging Newtonian and a 70 mm Celestron refractor. He is the Treasurer of O.R.I.O.N. and a member of the Knoxville Observers. Along with graduate school, Noah tunes Pianos and collects and studies Bonsai in his spare time.; Free.</td>
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<tr>
<td></td>
<td></td>
<td>Discovery Theater</td>
<td></td>
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<tr>
<td>Friday, April 3, 2020</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: TBA; Free.</td>
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<td></td>
<td></td>
<td>Discovery Theater</td>
<td></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>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>
</tr>
<tr>
<td><strong>StarWatch</strong></td>
<td></td>
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<tr>
<td>Mar. 7, 2020</td>
<td>7 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. 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>
</tr>
<tr>
<td>Mar. 14, 21, 28, 2020</td>
<td>8 p.m.</td>
<td>Observatory</td>
<td></td>
</tr>
<tr>
<td>Apr. 4, 11, 18, 25, 2020</td>
<td>8:30 p.m.</td>
<td>Observatory</td>
<td></td>
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<tr>
<td><strong>Special Events</strong></td>
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<tr>
<td>Friday, March 27, 2020</td>
<td>TBA</td>
<td>TBA</td>
<td>Messier Marathon. This is a BMAC members only event. Test your skills at finding Messier objects within a single night! Weather dependent.</td>
</tr>
<tr>
<td>Saturday, May 2, 2020</td>
<td>1-4:30 p.m.</td>
<td>8:30-9:30 p.m.</td>
<td>Annual Astronomy Day - Displays et al. on the walkway leading to the Nature Center, 1-4:30 p.m.; Solar viewing 3-3:30 p.m. at the dam; Night viewing 8:30-9:30 p.m. at the observatory. All non-planetarium astronomy activities are free.</td>
</tr>
</tbody>
</table>
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
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 bright (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 April 9, 2007, with the Wide Field Planetary Camera 2 in red, green, and blue filters. The image shows Jupiter and Ganymede in close to natural colors.

Credit: NASA, ESA, and E. Karkoschka (University of Arizona)

5. 47 Tucanae
In the first attempt to systematically search for “extrasolar” planets far beyond our local stellar neighborhood, astronomers probed the heart of a distant globular star cluster and were surprised to come up with a score of “zero”.

To the fascination and puzzlement of planet-searching astronomers, the results offer a sobering counterpart to the flurry of planet discoveries announced over the previous months.

“This could be the first tantalizing evidence that conditions for planet formation and evolution may be fundamentally different elsewhere in the galaxy,” says Mario Livio of the Space Telescope Science Institute (STScI) in Baltimore, MD.

The bold and innovative observation pushed NASA Hubble Space Telescope’s capabilities to its limits, simultaneously scanning for small changes in the light from 35,000 stars in the globular star cluster 47 Tucanae, located 15,000 light-years (4 kiloparsecs) away in the southern constellation Tucana.

Hubble researchers caution that the finding must be tempered by the fact that some astronomers always considered the ancient globular cluster an unlikely abode for planets for a variety of reasons. Specifically, the cluster has a deficiency of heavier elements that may be needed for building planets. If this is the case, then planets may have formed later in the universe’s evolution, when stars were richer in heavier elements. Correspondingly, life as we know it may have appeared later rather than sooner in the universe.

Another caveat is that Hubble searched for a specific type of planet called a “hot Jupiter,” which is considered an oddball among some planet experts. The results do not rule out the possibility that 47 Tucanae could contain normal solar systems like ours, which Hubble could not have detected. But even if that’s the case, the “null” result implies there is still something fundamentally different between the way planets are made in our own neighborhood and how they are made in the cluster.

Hubble couldn’t directly view the planets, but instead employed a powerful search technique where the telescope measures the slight dimming of a star due to the passage of a planet in front of it, an event called a transit. The planet would have to be a bit larger than Jupiter to block enough light — about one percent — to be measurable by Hubble; Earth-like planets are too small. However, an outside observer would have to watch our Sun for as long as 12 years before ever having a chance of seeing Jupiter briefly transit the Sun’s face. The Hubble observation was capable of only catching those planetary transits that happen every few days. This would happen if the planet were in an orbit less than 1/20 Earth’s distance from the Sun, placing it even closer to the star than the scorched planet Mercury — hence the name “hot Jupiter.”

Why expect to find such a weird planet in the first place?

Based on radial-velocity surveys from ground-based telescopes, which measure the slight wobble in a star due to the small tug of an unseen companion, astronomers have found nine hot Jupiters in our local stellar neighborhood. Statistically this means one percent of all stars should have such planets. It’s estimated that the orbits of 10 percent of these planets are tilted edge-on to Earth and so transit the face of their 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 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 February 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 of the Crab Nebula combines X-ray observations from Chandra, optical observations from Hubble, and infrared observations from Spitzer to reveal intricate detail. Notice how the violent energy radiates out from the rapidly spinning neutron star in the center of the nebula (also known as a pulsar) and heats up the surrounding gas. More about this incredible “pulsar wind nebula” can be found at bit.ly/Crab3D. Credit: NASA, ESA, F. Summers, J. Olmsted, L. Hustak, J. DePasquale and G. Bacon (STScI), N. Wolk (CfA), and R. Hurt (Caltech/IPAC)

9. Spot Betelgeuse and the Crab Nebula after sunset! A telescope is needed to spot the ghostly Crab.