The Monthly Newsletter of the Bays Mountain Astronomy Club

Edited by Adam Thanz

April 2016
Hello BMACers,

It is now April and the year is moving right along. We are now in Spring and with that, usually rainy weather is with us for a little while. Many of us will be unable to enjoy the beauty of the clear night sky. Maybe mother-nature will be kind to us though and grace us with a few clear nights. We are also now in the dreaded Daylight-Saving Time. I do not like this nighttime wasting time at all. I wish Tennessee would vote to end it all together. Many people enjoy it not getting dark until 9 o’clock. We amateur astronomers can’t stand it. By the time the sky gets dark enough after sunset, it is after 10 o’clock. And if you work a typical day job like me, that limits your observing to the weekends. Of course, the weekends will be rainy and/or cloudy. Oh, the troubles with our hobby. Hopefully mother-nature will be on our side this year.

Our meeting this month will feature one of our very own members, Robin Byrne. She is an Associate Professor of Astronomy in the Science Department at Northeast State Community College in Blountville, TN. She has been a member of the Bays Mountain Astronomy Club pretty much since 1992 and has also been the chairperson of the club as well. She also writes an ongoing science column in this very newsletter every month. Her presentation will be on Margaret Geller, a woman in astronomy who has met both success and frustration in her quest to discover the structure of the Universe. This will be our 3rd and final part in our “Women in Astronomy” series. I know it will be a very interesting presentation and I hope that everyone will be able to attend.

At our March meeting, we welcomed Sabrina Hurlock, a teacher in Murfreesboro, TN. She gave a very informative presentation on “Women in Science: The Good, the Bad, and the Ugly.” Her presentation explored the history of women in the fields of physics, astronomy, and engineering and how they were treated in the past as well as how they are treated in today’s world. She spoke on the state of affairs in the STEM (Science, Technology, Engineering, and Mathematics) fields and how the trends of occupations of women in those fields differ compared to males. She also spoke on the differences in salary between the males and females in those fields across all the different education levels. She then spoke on the struggles of how to motivate young...
Hydra the Serpent
image from Stellarium
layout by Adam Thanz
women to pursue careers in these fields with the unfair but improving statistics. She ended her presentation with a well involved Q&A session. I hope that Sabrina can return again in the future to give us another great presentation. After Sabrina’s presentation, William Troxel gave a short presentation on his plan for the upcoming Astronomy Day activities. He has a lot of good plans for the tables that will be set up for that day and we are encouraging any members to come and help with the activities.

The constellation for this month is Hydra. It is translated to the Water Serpent. Hydra, which is also called the serpent of Lerna, was a beast with the body of a hound and 100 serpentine heads. It also had poisonous breath and it was so hideous that it caused most people to die of fear from simply seeing it. Hercules had the great task of killing this monster. When he started to fight the monster, he discovered that every time he cut off one of the heads, three grew back in its place. So he had his charioteer, Iolus, burn the stump after he cut off each head, which prevented the growing of more. The last head was immortal so after cutting it off, they trapped it under a rock. Hydra is the largest constellation in the sky. It measures 1303 square degrees. Hydra only has one reasonably bright star in it called Alphard. It is a 2nd magnitude star. Hydra does have a few deep-sky objects in it though. M48, which is an open cluster that is visible to the naked eye in dark skies, M68, a globular cluster that is visible in binoculars, and M83, which is a spiral galaxy, also called the Southern Pinwheel Galaxy. These are just a few worth naming in this constellation. M83 is an 8th magnitude galaxy that is easily visible in skies south of 40°N latitude. It is host to 6 supernovae, which is more than any other Messier object. When you are out this month, try to find a few of these objects and enjoy their beautiful sights.

That will do it for this month. I would like to remind everyone that the StarWatches are in full swing and will happen every Saturday night beginning at dusk if it is clear. If it is not clear, there will be an alternate presentation of the current night sky in the planetarium. The SunWatches will happen every Saturday and Sunday from 3:00-3:30 if it is clear. We are always happy to have volunteers from the club to help out. If you would like to help out, please arrive about 30 minutes early to help set up the equipment. Also, we still need volunteers to help out with Astronomy Day. For the public, it will be on Saturday, May 14th beginning at 1:00 PM and will go until about 10:00 p.m. Members manning a table must set up prior to 1 p.m. Show up by 12-12:30 p.m. Any help is welcome. If you would like to help, please contact me or William Troxel. I also want to remind everyone about the Mercury Transit coming up on May 9th. It will be held from 10:00 a.m. to 3:00 p.m. at “the Yards” which are located on ETSU grounds in Johnson City, TN. This will probably be a very popular public event, so please feel free to come out and help and enjoy the transit for yourself. Until next month… Clear Skies.
Chapter 2

BMAC

Notes

More on this image. See FN4
BMAC Youtube!
The BMAC has a YouTube channel. Click here to see what’s on!

(https://www.youtube.com/channel/UCwIQM6nUs9qxJtDQe4AaAWQ)

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

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Rescheduling
Note, due to scheduling needs, the June 2016 meeting will be held on the 10th.

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Public Mercury Transit Viewing May 9, 2016
BMAC will co-host a free, public viewing of the Mercury transit with the ETSU Physics Dept. at ETSU on either the CPA Front or Side Yard. The viewing is 10 a.m. to 3 p.m. BMACers wanting to help man a scope will need to arrive by 9 a.m. If the weather is poor, the event is cancelled. Please see the website for details.

http://www.baysmountain.com/astronomy/observatory/?GTTabs=2

If you are able to spend the day, please come help. Bring a scope with a proper solar filter or use one of the Park’s scopes if one is available.

Remember, it will be outside in the sun most of the day (hopefully). Bring plenty of water, a hat, a chair, and lunch.

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Stolen C-14
The Astronomical Society of Eastern Missouri (ASEM) conducts public telescope viewing every clear Friday evening at the Broemmelsiek Park Astronomy Site in St. Charles County, Missouri. The C-14 telescope that we had permanently mounted in the Park observatory was recently stolen.

If you hear of anyone getting a pre-owned C-14, and have suspicions about the telescope’s origin, please contact jtwellman@asemonline.org and we can communicate further. If needed, we can provide images specific to the stolen telescope.
Pickett State Park Astronomy Weekend
An invitation has been offered to the club to an astronomy weekend, April 1-3, 2016 at Pickett State Park.

http://tnstateparks.com/parks/event_details/pickett/astronomy-weekend4

Special Registration Alert for Astrocon 2017
A Total Eclipse of the Sun is Happening!

The MARS region of the Astronomical League is helping to plan ASTROCON 2017 in the days leading up to the total solar eclipse of August 21, 2017. Volunteers from various clubs in Utah, Montana, Wyoming and Colorado are actively involved, helping to plan and coordinate this event. This will be a major outreach opportunity for amateur astronomy… a total solar eclipse!

ASTROCON 2017 is collaborating with and supporting the Wyoming Eclipse Fest to help educate and support the many eclipse chasers who will descend upon Casper for AMERICA’s GREAT ECLIPSE! Casper lies directly on the centerline of the moon's shadow and has excellent weather prospects for a clear, dry eclipse day.

Convention registrations are happening daily. League club members who choose to attend should act soon to experience this opportunity.

Please go to the event website at http://astrocon2017.astroleague.org, then go to the “Registration” tab to complete your online registration.

Useful links:

Astronomical League Website: www.astroleague.org

Event Website: http://astrocon2017.astroleague.org (Please go to the “Registration” tab)

Eclipse Information: www.eclipse2017.org (Look under “Community Links” and then “What some places are doing”)

Wyoming Eclipse Fest site: www.eclipsecasper.com
Every once in a while, we remind BMACers about our Astronomy Knowledge Compendium (AKC) test. It’s purpose is to introduce members (both new and seasoned) to the basics of astronomy. This test includes topics like the Solar System, using a telescope, galaxies, and much more.

The test is not required. But, if you do take it, there are a few simple rules:

- It is take-home. Look up the answers and write them down. But, do try to understand the content. That is the purpose of this exercise.

- There is no time limit. Take a month or two to go through all the different fields.

- Most answers do not need to be lengthy. Sometimes a few words, sometimes a sentence or two.

- A grade of 90% or greater results in passing. If you turn in your test and are less than 90%, then you can get the test back to fix your incorrect responses. Then, resubmit.

Upon passing, you will be regaled upon by your peers! You’ll also get the opportunity to choose a BMAC cap, pin, or patch for free. The real prize is your exploration into astronomy and learning a solid foundation. A foundation you can build upon.

The test questions are listed below. They are also in a PDF document on our website. Turn the answers in to me, Adam Thanz.

**Astronomy Knowledge Compendium**

**Sky Motions**

1. What is the zenith and horizon?
2. How does Earth rotate (in what direction)?
3. What are the North & South Celestial Poles and the Celestial Equator?
4. What is the ecliptic?
5. What is the zodiac?
6. What is precession?
7. Why do we experience seasons?
8. What is a solstice? What is an equinox? Where is the Sun located on these days?
9. What are the phases of the moon? Where are the Earth, Moon and Sun located at each phase? What are the rise & set times for each phase?
10. Where are the Earth, Moon and Sun located for a solar eclipse? For a lunar eclipse?

**History**

1. How was it first determined that Earth was a sphere and who (what culture) did this?
2. What did Eratosthenes do?
3. What is a geocentric model?
4. What are the contributions of Ptolemy?
5. What was the contribution of Copernicus?
6. What is a heliocentric model?
7. How does the heliocentric model explain retrograde motion?
8. What were the contributions of Galileo?
9. What were the contributions of Tycho Brahe?
10. What were the contributions of Johannes Kepler?
11. What are Kepler’s Laws?
12. What were the contributions of Isaac Newton?

**Light and Telescopes**

1. What is the definition of wavelength?
2. What are the colors of the spectrum?
3. How do astronomers use spectra to determine the chemical composition of objects?
4. What is the Doppler Effect?
5. What is a red shift and a blue shift?
6. What is the difference between a reflector and a refractor? What are the advantages & disadvantages of each type?
7. What is the difference between a Cassegrain and a Newtonian style telescope?
8. How does the aperture of a telescope affect the image?
9. What determines the brightness and resolution of an image?
10. How is the magnification of a telescope calculated?
11. What are the two numbers associated with binoculars?
12. What are the major differences of using a binocular and a telescope?

**General Solar System Information**

1. How much of the Solar System’s mass is found in the Sun?
2. How do the planets move around the Sun?
3. What are the characteristics of Terrestrial planets?
4. What are the characteristics of Jovian planets?
5. What is the criteria that differentiates a planet from a Dwarf planet?
6. What is the current scientific theory of how the Solar System formed?

7. How are extrasolar planets detected?

8. What are the characteristics of the extrasolar planets that have been found so far?

**Earth & Moon**

1. What are the layers of Earth’s interior?

2. What is plate tectonics and what causes it?

3. What is the composition of Earth’s atmosphere?

4. What is the greenhouse effect and what causes it?

5. What is the composition of the Moon and what parts of the Earth is it similar to?

6. What are the lunar highlands and what are they composed of?

7. What are the lunar mare and what are they composed of?

8. How did the mare form?

9. How are craters formed?

10. What is the current scientific theory on how the Moon formed?

**Terrestrial Planets**

1. What is the temperature range on Mercury?

2. What is the composition of Mercury?

3. What is unusual about the temperature and pressure on Venus? How did Venus get to be so hot?

4. What is the composition of Venus’ surface?

5. What is the composition of Venus’ atmosphere?

6. What are the highlands of Mars and where are they located?

7. What are the lowlands of Mars and where are they located?

8. What is Olympus Mons?

9. What is Mariner Valley?

10. How do winds affect the surface of Mars?

11. What is the composition of Mars’ atmosphere?

12. What is the evidence for water once flowing on Mars?

**Jovian Planets & Beyond**

1. What is the composition of the Jovian planets’ atmosphere?

2. Which planet is largest?

3. What is unusual about the density of Saturn?

4. What is unusual about the tilt of Uranus’ axis?

5. What is the Great Red Spot?

6. What is the source of heat that allows Europa to have liquid water?

7. What causes volcanoes on Io?

8. What is the composition of Titan’s atmosphere?
9. Which planets have rings and what are they composed of?

Small Bodies

10. Who is Clyde Tombaugh and what did he do?

11. What is unusual about Pluto’s orbit?

12. How does Pluto’s atmosphere change with distance from the Sun?

13. What is the Asteroid Belt and where is it found?

14. What are the main parts of a comet?

15. What are the parts of a comet’s tail?

16. What is the Oort Cloud?

17. What is the Kuiper Belt?

18. What is the largest Kuiper Belt Object?

19. What causes meteors to give off light?

20. What causes a meteor shower?

21. What are the main types of meteorites?

The Sun

1. What is the composition of the Sun?

2. What are the layers of the solar atmosphere?

3. How are sunspots formed?

4. Name two features found in the chromosphere and explain how they are formed.

5. Name two features found in the corona and explain how they are formed.

6. How does the Sun produce energy?

7. What are the layers of the Sun’s interior?

8. What happens in the Sun’s core?

Stars

1. What is the stellar classification system and who developed it?

2. What are Cepheid variable stars, who discovered them, and how are they used for finding distances?

3. What is an open cluster?

4. What is a globular cluster?

5. What is the composition of the interstellar medium?

6. Where are stars born? Under what kind of conditions?

7. What is a protostar?

8. What is a main sequence star? How does it generate energy?

9. How does the chemical composition of a main sequence star change as it ages?

10. How does the lifetime of a main sequence star depend on its mass?

11. What is an orange giant star?

12. What is a red giant star?
13. How does a planetary nebula form?

14. How does the red giant stage of a high mass star differ from a low mass star?

15. What causes a supernova? What kinds of elements are created during a supernova?

16. What is a white dwarf and how big is it?

17. What sized object becomes a neutron star? A black hole?

18. What is a neutron star and how big is it?

19. Who discovered pulsars and what are they?

20. What are the main parts of a black hole?

**The Milky Way**

1. How did Harlow Shapley determine the Sun’s location in the Milky Way? Where are we?

2. What are the main characteristics and components of the disk of the Milky Way?

3. What are the main characteristics and components of the halo of the Milky Way?

4. What are the main characteristics and components of the nuclear bulge of the Milky Way?

5. Where does most star formation occur in the Milky Way and why?

**Galaxies**

1. How did Hubble measure the distance to the Andromeda galaxy?

2. What are the characteristics of spiral galaxies (physical appearance and composition)?

3. What are the characteristics of elliptical galaxies (physical appearance and composition)?

4. What are the characteristics of irregular galaxies (physical appearance and composition)?

5. How are irregular galaxies formed?

6. What evidence is there that the Universe is expanding? Who discovered it?

7. What is the relationship between velocity and distance to a galaxy?

8. What is unusual about the distance, brightness and size of quasars?

9. What is the source of power for quasars and active galaxies?

**Cosmology**

1. What is the Local Group?

2. What is the difference between a poor and rich galaxy cluster?

3. Where are giant elliptical and spiral galaxies found in clusters?

4. How much of the Universe is made of dark matter? What is the evidence for it?

5. What is the Cosmological Constant?

6. What is the difference between a closed and open Universe?

7. What is an accelerating Universe?
8. What are the key ideas of the standard Big Bang model?

9. Who detected the Cosmic Background Radiation and what is its temperature?

**Observational Astronomy**

1. What is “seeing?”

2. What is the definition of apparent magnitude and absolute magnitude?

3. How are numbers assigned in the magnitude scale?

4. What is a safe way to observe the Sun?

5. When is the best time to observe Mercury and Venus?

6. When is the best time to observe superior planets?

7. Name two prominent meteor showers and when they are visible.

8. Name a prominent constellation visible for each season and explain the mythology of each.

9. Name three prominent star clusters, planetary nebulae, supernova remnants, and galaxies, what constellation each is in, and what time of year it is visible.

10. What is star-hopping?

Note: Answers can be found in any astronomy textbook or online. There is no time limit to take this survey. Passing requires a grade of 90% or greater.
Chapter 3

Star Stuff

Terry Alford
April is going to be an outstanding month for viewing most of the planets! As twilight falls, Mercury shines brightly at –1.5 magnitude in the west-northwest. By the 18th of the month it will rise to an altitude of 19°, it’s greatest elongation for the entire year. It will still be fairly bright at mag 0. By the end of the month, it will fade to mag +1.5 and disappear from view on the 28th. The next time you can see Mercury will be when it crosses the face of the Sun on May 9.

Venus rises about 1/2 hour before the Sun at the start of April and basically disappears from view entirely within nine days.

Mars rises around midnight. Unfortunately it is pretty low in the sky, right above Scorpius. But very fortunately the apparent size of the Red Planet increases from 12” to 18”. This will be the largest Mars has been seen for 10 years! (It will get a little larger later in May) So get your scope out and wait until around midnight when Mars is nearest the meridian. A good scope on a steady night should show some interesting details. Mars also brightens dramatically from –0.6 to –1.4 mag during the month. If you get a decent photo or make a sketch be sure to bring your result to the next meeting to share with other club members. [Ed.: Please send it to me as well so it can be published!]

Mighty Jupiter shines bright practically all night long at –2.4 magnitude. It is in lower Leo and makes an excellent telescopic target these warm spring evenings. Of course, like any planet it is best observed when it is near the meridian. Use as much power as you think you can and then go a little higher. When you get one of those moments that the air steadies and Jupiter just “pops” it will have been well worth your efforts. Also, play around with various filters to enhance different details. If you have an OIII filter, pop it into your eyepiece. You will be rewarded with a very wild multi-colored view. The colors will be nowhere near accurate, but some details will pop out that you may have missed earlier.

Saturn lies just to the east of Mars. Saturn, Mars and the bright reddish star Antares make a very attractive triangle all month long. During the month, Saturn brightens a little to +0.2 mag and the globe grows to 18” wide. The ring system spans 40” wide and is still favorably tilted at 26° from the view point of us mere Earthlings.
Uranus and Neptune aren’t readily visible this month.

The Moon is new on April 7 and full on April 22.
Chapter 4

The Queen Speaks

Robin Byrne
Let’s take another trip to ye olde bookshelf and see what we might find. “A History of Pi” by Petr Beckmann is a look at how we determined the value of a number that is taken for granted. Beckmann is an electrical engineer with an interest in both mathematics and history. He takes us on an historical journey through the discoveries that ultimately lead to finding an accurate value for pi.

The earliest technique was likely a physical method. Draw a circle, use a piece of rope to measure the diameter, then see how many lengths of that rope would complete one trip around the circle. This would yield, approximately, a value of 3. Good enough for the time, and that value became the one used in the Bible. (As a side note, some state legislatures tried to pass a law fixing the value of pi to the Biblical amount. That didn’t fly.) [Ed. Isn’t three the magical number?]

The next method came along as mathematics advanced. The early Greeks were responsible for many discoveries in geometry, so it was natural that they would be interested in finding a more accurate value of pi. Their approach was to “square the circle,” which means to find a geometrical shape (preferably a square) which has the same area as the given circle. Knowing the area would then allow for the determination of pi. Many versions of this were attempted for centuries, and many approximations for pi were found. All of these values were quite similar and acceptable for practical purposes. (Historical aside: You might think that because pi is a Greek letter, it must have been the Greeks who proposed the symbol. Instead, it was a little-known mathematician, William Jones, who first used it in one of his publications, in 1706. However, due to his obscurity, it didn’t catch on until 1737, when Leonard Euler used the symbol in his writings.)

The third stage in the hunt for pi was to use mathematical equations to find its value. During the Renaissance, a wide variety of infinite series equations were developed, using trigonometry. This became the age of calculating, by hand, as many digits as possible. Various records were achieved and broken as each person took the challenge to more and more digits, reaching hundreds of decimal places.

With the development of calculus, more techniques (and digits) were discovered. Now the goal was to find a series that would
converge on the value of pi in the fewest number of steps. A whole slew of Who's Who in mathematics worked on this problem, including Newton, Leibniz, Huygens, Pascal, Gauss, and Euler. Last came the era of computers, which can brute force their way to as many digits as desired. The current record is around 13 trillion digits.

But the more interesting question for mathematicians moved from calculating more and more digits, to determining what kind of number is pi? Fairly early on, it was found that pi was not rational, which means it cannot be determined by a simple ratio of two numbers (that’s why they resorted to various infinite series to find the value). The next question was whether pi was transcendental, which means it is not even the root of an algebraic equation. It turns out that pi is, indeed, transcendental. One consequence of that discovery is the conclusion that you can never “square the circle.” So much for the early attempts.

Overall, I enjoyed this book, with some caveats. First, it’s a topic I hadn’t even considered as an area of discovery. We take pi so much for granted that it feels like we’ve always known its value. Also, the mathematical history is interesting and reveals topics I had not encountered before. However, if equations give you the willies, you may want to give this book a pass. Honestly, I glossed over the equations without losing the gist of what was going on. Beckmann tends to assume the reader has more than the average amount of mathematical knowledge and seems to leave out the kinds of details that would have made following the equations an easier process. So, I recommend just looking the other way when the equations crop up. My second concern has to do with Beckmann’s occasional political commentaries. The book was written in 1971, and Beckmann was originally from Czechoslovakia before taking residence in the United States. During this time, Czechoslovakia was under communist rule, and that has clearly influenced Beckmann’s view of politics. In particular, he has a very negative reaction to any society under a similar system of government and immediately dismisses any advancements made in those countries. Expect periodic tirades against totalitarianism.

So, is “A History of Pi” a book for you? If you enjoy the history of discovery and can tolerate discussions of math (with occasional political rants), you will likely enjoy it. If the mention of math gives you the hives, walk away and don’t look back.

A History of Pi by Petr Beckmann, St Martin’s Press, 1971
Imagine a world very different from our own: permanently shrouded in clouds, where the sky was never seen. Never had anyone see the Sun, the Moon, the stars or planets, until one night, a single bright object shone through. Imagine that you saw not only a bright point of light against a dark backdrop of sky, but that you could see a banded structure, a ringed system around it and perhaps even a bright satellite: a moon. That’s the magnitude of what LIGO (the Laser Interferometer Gravitational-wave Observatory) saw, when it directly detected gravitational waves for the first time.

An unavoidable prediction of Einstein’s General Relativity, gravitational waves emerge whenever a mass gets accelerated. For most systems -- like Earth orbiting the Sun -- the waves are so weak that it would take many times the age of the Universe to notice. But when very massive objects orbit at very short distances, the orbits decay noticeably and rapidly, producing potentially observable gravitational waves. Systems such as the binary pulsar PSR B1913+16 [the subtlety here is that binary pulsars may contain a single neutron star, so it’s best to be specific], where two neutron stars orbit one another at very short distances, had previously shown this phenomenon of orbital decay, but gravitational waves had never been directly detected, until now.

When a gravitational wave passes through an object, it simultaneously stretches and compresses space along mutually perpendicular directions: first horizontally, then vertically, in an oscillating fashion. The LIGO detectors work by splitting a laser beam into perpendicular “arms,” letting the beams reflect back and forth in each arm hundreds of times (for an effective path lengths of hundreds of km), and then recombining them at a photodetector. The interference pattern seen there will shift, predictably, if gravitational waves pass through and change the effective path lengths of the arms. Over a span of 20 milliseconds on September 14, 2015, both LIGO detectors (in Louisiana and Washington) saw identical stretching-and-compressing patterns. From that tiny amount of data, scientists were able to conclude that two black holes, of 36 and 29 solar masses apiece, merged together, emitting 5% of their total mass into gravitational wave energy, via Einstein’s $E = mc^2$.

During that event, more energy was emitted in gravitational waves than by all the stars in the observable Universe combined. The entire Earth was compressed by less than the width of a
proton during this event, yet thanks to LIGO’s incredible precision, we were able to detect it. At least a handful of these events are expected every year. In the future, different observatories, such as NANOGrav (which uses radio telescopes to detect the delay caused by gravitational waves on pulsar radiation) and the space mission LISA will detect gravitational waves from supermassive black holes and many other sources. We’ve just seen our first event using a new type of astronomy, and can now test black holes and gravity like never before.

This article is provided by NASA Space Place.

With articles, activities, crafts, games, and lesson plans, NASA Space Place encourages everyone to get excited about science and technology.

Visit spaceplace.nasa.gov to explore space and Earth science!
Chapter 6

BMAC
Calendar
and more
## BMAC Calendar and more

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<th>Date</th>
<th>Time</th>
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<tr>
<td><strong>BMAC Meetings</strong></td>
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<tr>
<td>Friday, April 1, 2016</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: Robin Byrne from Northeast State Community College. Topic Margaret Geller, a woman in astronomy who has met both success and frustration in her quest to discover the structure of the universe. Part 3 of our 3-part series on “Women in Astronomy.” Free.</td>
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<td>Discovery Theater</td>
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<td>Friday, May 6, 2016</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: BMACer Tom Rutherford will have some of his Sullivan South High School students present their research work.; Free.</td>
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<td>Discovery Theater</td>
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<td>Friday, June 10, 2016</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Notice date! Program: TBA; free.</td>
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<td>Discovery Theater</td>
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<td><strong>SunWatch</strong></td>
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<td>Every Saturday &amp; Sunday March - October</td>
<td>3-3:30 p.m. if clear</td>
<td>At the dam</td>
<td>View the Sun safely with a white-light view if clear.; Free.</td>
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<tr>
<td><strong>StarWatch</strong></td>
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<td>Saturday, March 26, 2016</td>
<td>8:00 p.m.</td>
<td>Observatory</td>
<td>View the night sky with large telescopes. If poor weather, an alternate live tour of the night sky will be held in the planetarium theater.; Free.</td>
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<td>Saturday, April 2, 9, 16, 23, 30, 2016</td>
<td>8:30 p.m.</td>
<td>Observatory</td>
<td>View the night sky with large telescopes. If poor weather, an alternate live tour of the night sky will be held in the planetarium theater.; Free.</td>
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<td><strong>Special Events</strong></td>
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<tr>
<td>Monday, May 9, 2016</td>
<td>10 a.m. - 3 p.m.</td>
<td>ETSU CPA Front or Side Yard</td>
<td>Mercury Transit - Come help with this public viewing program. Please show up by 9 a.m. to set up. BMACers will need to bring a scope with proper solar filtration, plenty of water, a hat, a chair, and lunch. See the website for more details. <a href="http://www.baysmountain.com/astronomy/observatory/?GTTabs=2">http://www.baysmountain.com/astronomy/observatory/?GTTabs=2</a></td>
</tr>
<tr>
<td>Saturday, May 14, 2016</td>
<td>1-4:30 p.m.</td>
<td>Nature Center Observatory</td>
<td>Annual Astronomy Day - Displays et al. on the walkway leading to the Nature Center, 1-4:30 p.m.; Solar viewing 3-4 p.m. at the dam; Night viewing 8:30-10 p.m. at the observatory.</td>
</tr>
</tbody>
</table>
Bays Mountain Astronomy Club
853 Bays Mountain Park Road
Kingsport, TN 37650
1 (423) 229-9447
www.baysmountain.com
thanz@kingsporttn.gov

Annual Dues:

Dues are supplemented by the Bays Mountain Park Association and volunteerism by the club. As such, our dues can be kept at a very low cost.

$16 /person/year

$6 /additional family member

Note: if you are a Park Association member (which incurs an additional fee), then a 50% reduction in BMAC dues are applied.

The club’s website can be found here:
www.baysmountain.com/astronomy/astronomy-club/

Regular Contributors:

Brandon Stroupe
Brandon is the current chair of the club. He is a photographer for their business, Broader Horizons Photography and an avid astrophotographer. He has been a member since 2007.

Terry Alford
Terry is a founding member since 1980 and has been chair many times. He has worked as an astronomy lab instructor at ETSU since 2001.

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).

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.
1. The Rite of Spring

Of the countless equinoxes Saturn has seen since the birth of the solar system, this one, captured here in a mosaic of light and dark, is the first witnessed up close by an emissary from Earth … none other than our faithful robotic explorer, Cassini.

Seen from our planet, the view of Saturn’s rings during equinox is extremely foreshortened and limited. But in orbit around Saturn, Cassini had no such problems. From 20 degrees above the ring plane, Cassini’s wide angle camera shot 75 exposures in succession for this mosaic showing Saturn, its rings, and a few of its moons a day and a half after exact Saturn equinox, when the sun’s disk was exactly overhead at the planet’s equator.

The novel illumination geometry that accompanies equinox lowers the sun’s angle to the ring plane, significantly darkens the rings, and causes out-of-plane structures to look anomalously bright and to cast shadows across the rings. These scenes are possible only during the few months before and after Saturn’s equinox which occurs only once in about 15 Earth years. Before and after equinox, Cassini’s cameras have spotted not only the predictable shadows of some of Saturn’s moons (see PIA11657), but also the shadows of newly revealed vertical structures in the rings themselves (see PIA11665).

Also at equinox, the shadows of the planet’s expansive rings are compressed into a single, narrow band cast onto the planet as seen in this mosaic. (For an earlier view of the rings’ wide shadows draped high on the northern hemisphere, see PIA09793.)

The images comprising the mosaic, taken over about eight hours, were extensively processed before being joined together. First, each was re-projected into the same viewing geometry and then digitally processed to make the image “joints” seamless and to remove lens flares, radially extended bright artifacts resulting from light being scattered within the camera optics.

At this time so close to equinox, illumination of the rings by sunlight reflected off the planet vastly dominates any meager sunlight falling on the rings. Hence, the half of the rings on the left illuminated by planetshine is, before processing, much brighter than the half of the rings on the right. On the right, it is only the vertically extended parts of the rings that catch any substantial sunlight.

With no enhancement, the rings would be essentially invisible in this mosaic. To improve their visibility, the dark (right) half of the rings has been brightened relative to the brighter (left) half by a factor of three, and then the whole ring system has been brightened by a factor of 20 relative to the planet. So the dark half of the rings is 60 times brighter, and the bright half 20 times brighter, than they would have appeared if the entire system, planet included, could have been captured in a single image.

The moon Janus (179 kilometers, 111 miles across) is on the lower left of this image. Epiimetheus (113 kilometers, 70 miles across) appears near the middle bottom. Pandora (81 kilometers, 50 miles across) orbits outside the rings on the right of the image. The small moon Atlas (30 kilometers, 19 miles across) orbits inside the thin F ring on the right of the image. The brightnesses of all the moons, relative to the planet, have been enhanced between 30 and 60 times to make them more easily visible. Other bright specks are background stars. Spokes — ghostly radial markings on the B ring — are visible on the right of the image.

This view looks toward the northern side of the rings from about 20 degrees above the ring plane. The images were taken on Aug. 12, 2009, beginning about 1.25 days after exact equinox, using the red, green and blue spectral filters of the wide angle camera and were combined to create this natural color view. The images were obtained at a distance of approximately 847,000 kilometers (526,000 miles) from Saturn and at a Sun-Saturn-spacecraft, or phase, angle of 74 degrees.

Image scale is 50 kilometers (31 miles) per pixel.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the mission for NASA’s Science Mission Directorate, Washington, D.C. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging operations center is based at the Space Science Institute in Boulder, Colo.


Image Credit: NASA/JPL/Space Science Institute

2. Duke on the Craters Edge

Astronaut Charles M. Duke Jr., Lunar Module pilot of the Apollo 16 mission, is photographed collecting lunar samples at Station no. 1 during the first Apollo 16 extravehicular activity at the Descartes landing site. This picture, looking eastward, was taken by Astronaut John W. Young, commander. Duke is standing at the rim of Plum crater, which is 40 meters in diameter and 10 meters deep. The parked Lunar Roving Vehicle can be seen in the left background.

Image AS16-114-18423

Creator/Photographer: NASA John W. Young

3. The Cat’s Eye Nebula

One of the first planetary nebulae discovered, also has one of the most complex forms known to this kind of nebula. Eleven rings, or shells, of gas make up the Cat’s Eye. Credit: NASA, ESA, HEIC, and The Hubble Heritage Team (STScI/AURA)

Acknowledgment: R. Corradi (Isaac Newton Group of Telescopes, Spain) and Z. Tsvetanov (NASA)

4. Jupiter & Ganymede
NASA’s Hubble Space Telescope has caught Jupiter’s moon Ganymede playing a game of “peek-a-boo.” In this crisp Hubble image, Ganymede is shown just before it ducks behind the giant planet.

Ganymede completes an orbit around Jupiter every seven days. Because Ganymede’s orbit is tilted nearly edge-on to Earth, it routinely can be seen passing in front of and disappearing behind its giant host, only to reemerge later.

Composed of rock and ice, Ganymede is the largest moon in our solar system. It is even larger than the planet Mercury. But Ganymede looks like a dirty snowball next to Jupiter, the largest planet in our solar system. Jupiter is so big that only part of its Southern Hemisphere can be seen in this image.

Hubble’s view is so sharp that astronomers can see features on Ganymede’s surface, most notably the white impact crater, Tros, and its system of rays, bright streaks of material blasted from the crater. Tros and its ray system are roughly the width of Arizona.

The image also shows Jupiter’s Great Red Spot, the large eye-shaped feature at upper left. A storm the size of two Earths, the Great Red Spot has been raging for more than 300 years. Hubble’s sharp view of the gas giant planet also reveals the texture of the clouds in the Jovian atmosphere as well as various other storms and vortices.

Astronomers use these images to study Jupiter’s upper atmosphere. As Ganymede passes behind the giant planet, it reflects sunlight, which then passes through Jupiter’s atmosphere. Imprinted on that light is information about the gas giant’s atmosphere, which yields clues about the properties of Jupiter’s high-altitude haze above the cloud tops.

This color image was made from three images taken on April 9, 2007, with the Wide Field Planetary Camera 2 in red, green, and blue filters. The image shows Jupiter and Ganymede in close to natural colors.

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

5. 47 Tucanae

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

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

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

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

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

Another caveat is that Hubble searched for a specific type of planet called a “hot Jupiter,” which is considered an oddball among some planet experts. The results do not rule out the possibility that 47 Tucanae could contain normal solar systems like ours, which Hubble could not have detected.

But even if that’s the case, the “null” result implies there is still something fundamentally different between the way planets are made in our own neighborhood and how they are made in the cluster.

Hubble couldn’t directly view the planets, but instead employed a powerful search technique where the telescope measures the slight dimming of a star due to the passage of a planet in front of it, an event called a transit. The planet would have to be a bit larger than Jupiter to block enough light — about one percent — to be measurable by Hubble; Earth-like planets are too small.

However, an outside observer would have to watch our Sun for as long as 12 years before ever having a chance of seeing Jupiter briefly transit the Sun’s face. The Hubble observation was capable of only catching those planetary transits that happen every few days. This would happen if the planet were in an orbit less than 1/20 Earth’s distance from the Sun, placing it even closer to the star than the scorched planet Mercury — hence the name “hot Jupiter.”

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

Based on radial-velocity surveys from ground-based telescopes, which measure the slight wobble in a star due to the small tug of an unseen companion, astronomers have found nine hot Jupiters in our local stellar neighborhood. Statistically this means one percent of all stars should have such planets. It’s estimated that the orbits of 10 percent of these planets are tilted edge-on to Earth and so transit the face of their star.

In 1999, the first observation of a transiting planet was made by ground-based telescopes. The planet, with a 3.5-day period, had previously been detected by radial-velocity surveys, but this was a unique, independent confirmation. In a separate program to study a planet in these revealing circumstances, Ron Gilliland (STScI) and lead investigator Tim Brown (National Center for Atmospheric Research, Boulder, CO) demonstrated Hubble’s exquisite ability to do precise photometry — the measurement of brightness and brightness changes in a star’s light — by also looking at the planet. The Hubble data were so good they could look for evidence of rings or Earth-sized moons, if they existed.

But to discover new planets by transits, Gilliland had to crowd a lot of stars into Hubble’s narrow field of view. The ideal target was the magnificent southern globular star cluster 47 Tucanae, one of the closest clusters to Earth. Within a single Hubble picture Gilliland could observe 35,000 stars at once. Like making a time-lapse movie, he had to take sequential snapshots of the cluster, looking for a telltale dimming of a star and recording any light curve that would be the true signature of a planet.

Based on statistics from a sampling of planets in our local stellar neighborhood, Gilliland and his co-investigators reasoned that 1 out of 1,000 stars in the globular cluster should have planets that transit once every few days. They predicted that Hubble should discover 17 hot Jupiter-class planets.

To catch a planet in a several-day orbit, Gilliland had Hubble’s “eagle eye” trained on the cluster for eight consecutive days. The result was the most data-intensive observation ever done by Hubble. STScI archived over 1,300 exposures during the observation. Gilliland and Brown sifted through the results and came up with 100 variable stars, some of them eclipsing binaries where the companion is a star and not a planet. But none of them had the characteristic light curve that would be the signature of an extrasolar planet.

There are a variety of reasons the globular cluster environment may inhibit planet formation. 47 Tucanae is old and so is deficient in the heavier elements, which were formed later in the universe through the nucleosynthesis of heavier elements in the cores of first-generation stars. Planet surveys show that within 100 light-years of the Sun, heavy-element-rich stars are far more likely to harbor a hot Jupiter than heavy-element-poor stars. However, this is a chicken and egg puzzle because some theoreticians say that the heavy-element composition of a star may be enhanced after it makes Jupiter-like planets and then swallows them as the planet orbit spirals into the star.
The stars are so tightly compacted in the core of the cluster – being separated by 1/100th the distance between our Sun and the next nearest star — that gravitational tidal effects may strip nascent planets from their parent stars. Also, the high stellar density could disturb the subsequent migration of the planet inward, which parks the hot Jupiters close to the star.

Another possibility is that a torrent of ultraviolet light from the earliest and biggest stars, which formed in the cluster billions of years ago may have boiled away fragile embryonic dust disks out of which planets would have formed.

These results will be published in The Astrophysical Journal Letters in December. Follow-up observations are needed to determine whether it is the initial conditions associated with planet birth or subsequent influences on evolution in this heavy-element-poor, crowded environment that led to an absence of planets.

Credits for Hubble image: NASA and Ron Gilliland (Space Telescope Science Institute)

6. Space Place is a fantastic source of scientific educational materials for children of all ages. Visit them at:
   http://spaceplace.nasa.gov

7. NGC 3982
   Though the universe is chock full of spiral-shaped galaxies, no two look exactly the same. This face-on spiral galaxy, called NGC 3982, is striking for its rich tapestry of star birth, along with its winding arms. The arms are lined with pink star-forming regions of glowing hydrogen, newborn blue star clusters, and obscuring dust lanes that provide the raw material for future generations of stars. The bright nucleus is home to an older population of stars, which grow ever more densely packed toward the center.
   NGC 3982 is located about 68 million light-years away in the constellation Ursa Major. The galaxy spans about 30,000 light-years, one-third of the size of our Milky Way galaxy. This color image is composed of exposures taken by the Hubble Space Telescope’s Wide Field Planetary Camera 2 (WFPC2), the Advanced Camera for Surveys (ACS), and the Wide Field Camera 3 (WFC3). The observations were taken between March 2000 and August 2009. The rich color range comes from the fact that the galaxy was photographed invisible and near-infrared light. Also used was a filter that isolates hydrogen emission that emanates from bright star-forming regions dotting the spiral arms.
   Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)
   Acknowledgment: A. Riess (STScI)

8. Image credit: Observation of Gravitational Waves from a Binary Black Hole Merger B. P. Abbott et al., (LIGO Scientific Collaboration and Virgo Collaboration), Physical Review Letters 116, 061102 (2016). This figure shows the data (top panels) at the Washington and Louisiana LIGO stations, the predicted signal from Einstein’s theory (middle panels), and the inferred signals (bottom panels). The signals matched perfectly in both detectors.