Chapter 1

Looking Up

Brandon Stroupe - BMAC Chair
Hello BMACers,

Welcome to April everyone. This is the first full month of Spring and I’m sure all the Spring and Summer time fans are loving it. Of course, here in Tennessee we never know what the weather is going to be like from one day to the next. If someone you know has ever wanted to experience the 4 seasons, just tell them to move to Tennessee for a week in early Spring. They will definitely get to experience them all in that amount of time. All joking aside, I just hope we have plenty of clear nights this month and plenty more the rest of the year. We all love clear night skies. I know I do.

This month we get to welcome back Steve Conard. Steve has given numerous presentations to our club in the past and they are always very enjoyable and informative. Steve is an optical systems engineer for Johns Hopkins Applied Physics Laboratory. He has had a 35-year career building spaceflight optical instruments for astrophysics and planetary science missions. As a hobby, he measures the size and shape of asteroids for the International Occultation Timing Association. His prestation will be on the New Horizons spacecraft and the Kuiper Belt Object 2014MU69. The New Horizons spacecraft will perform a flyby of a small Kuiper Belt Object, 2014MU69, on January 1, 2019. Until the summer of 2017, very little was known about this object—its size was estimated to be between 10 and 40 km in diameter. Knowing the size of the object would make the pre-planned observations during the New Horizons flyby much more effective and lower risk. In this talk we describe two expeditions to Argentina, where a diverse team used off-the-shelf amateur astronomy equipment to both measure the size and shape of this body. The results obtained reveal an unusually-shaped body that has further raised scientific expectations for next year’s encounter on January 1, 2019. Please make sure you come out to see Steve’s presentation. And don’t forget to tell your friends as well.

At our March meeting, we were given a presentation by one of our very own members, Dan Mullen. His presentation was entitled, “From Reality to Perception.” For those whose passion is visual astronomy, we may take for granted the view through our telescopes of our favorite objects. However, it is quite a feat that our instruments can deliver such images taking in
consideration of the obstacles or “filters” through which the light path travels. The discussion was on the effect of these “filters” on our viewing sessions, and taking a step further, how we perceive what we actually see in an esoteric sense. I hope everyone enjoyed Dan’s presentation. I unfortunately was unable to be there because of an event for work. I wish I could have been there. I will just have to settle with one of you to fill me in on the details. Thank you, Dan for your presentation.

Our constellation this month will be on Cancer. Cancer is translated to the Crab. In Greek mythology, the crab Karkinos played a small role in one of the Twelve Labors of Hercules, in which Hercules battled the multi-headed Hydra. Hera had sent the crab to distract Hercules and put him at a disadvantage during the battle. Instead, Hercules quickly discarded the crab by kicking it so hard that it was propelled into the sky. Another version of the myth says that the crab grabbed onto one of Hercules’s toes with its claws, but then Hercules crushed the crab under his foot. Hera was so grateful for the effort that the crab gave that she placed it in the sky. There are only a few deep-sky objects in Cancer. One is well-known, and it is M44, the Beehive Cluster. Another is M67, which is also an open cluster. Cancer is also home to QSO J0842+1835. It is a quasar that has been used to measure the speed of gravity in 2002. As always, when you are out this month, remember to give this constellation a look and enjoy all its beauty. If you would like to know more, check out Jason Dorfman's article, “Celestial Happenings.”

That will be it for this month. Please remember that the StarWatches started last month and will end this month. The SunWatches are in full swing. I hope everyone can come out and help with these. If you would like to volunteer to help run the scopes at Bays Mountain, you will need to be trained and authorized. You can contact Adam Thanz or Jason Dorfman if you are interested.

Also, this month is the month for Astronomy Day. It will be held on Saturday, April 21st. It will be from 1-4:30 p.m. for club-sponsored displays and then there will be the evening StarWatch. We will be setting up at about noon. We will be setting up tables of different information about our wonderful hobby in the early afternoon. It will be followed by a public StarWatch during the night. If the weather is good, the tables will be set up along the pathway in front of the Nature Center. If it is raining, we will be setup in the lobby of the Nature Center. I hope all of you will come out and celebrate Astronomy Day with us. Until next month... Clear Skies.
Chapter 2

BMAC Notes

More on this image. See FN4
Astronomy Day 2018
Saturday, April 21, 2018

BMAC members, if you would like to help out with this event, that’s great! There’s a number of ways you can help. Here are a few ways:

- Bring something to share with the public. This can be on most any topic. Here are some examples:
  - Books in astronomy
  - Astronomy software
  - How to read a star chart
  - Astronomy equipment
  - Astrophotography
  - Career in astronomy
  - Update on the upcoming Mars opposition this summer
  - Making craters
  - Most any kind of hands-on activity
  - Help with SunWatch and/or StarWatch
- Help set up and assist in providing astronomy-themed handouts.
- Share information about our club and all its coolness

Please note, if you come to be a part of the event, be prepared to be engaging with the public for most of the time.

Here’s the information shared with the public:

Join the Bays Mountain Astronomy Club in celebration of The International Day of Astronomy!

Learn about the science and hobby of astronomy.

Perfect fun for the entire family!

Highlights: Bays Mountain Astronomy Club members will be providing a number of fascinating displays and hands-on activities. Learn about astronomy, telescopes, careers and education in astronomy, the sun and more! The club will also be hosting daytime viewing of the sun and nighttime viewing of the Moon, Jupiter, and much more!
All non-planetarium astronomy-related activities are free on Astronomy Day!

Planetarium tickets are $5 per person for ages 6 and above.

Schedule of Events:

Afternoon:

1 p.m. – 4:30 p.m. Displays & Information (free!): Walkway in front of Nature Center (inside Nature Center, if raining.)

3 p.m. – 3:30 p.m. Solar Viewing (free!): Dam.

Thrill at viewing different layers of the Sun up close and in great detail. Safely see sunspots and prominences. Weather dependent.

Evening:

8:30 p.m. – 10 p.m. Nighttime Viewing (free!): Observatory.

Spectacular views of celestial delights await you with the Bays Mountain Astronomy Club’s telescopes. Savor a wonderful view of the colorful bands of Jupiter and its four largest moons, feel like you’re flying low over the moon, and be awe-struck by the distance to galaxies. These views and more will be seen at our Observatory. A live presentation about what is up in the night sky will take place in the Planetarium Theater, if the weather does not cooperate.
In spite of my age and lifelong interest in astronomy, I can happily say I am a novice astronomer. That status permits me to ask the dumb questions, look through the telescope backwards, and still thoroughly enjoy aligning the spotting scope. Ah, it is the little things in life that must bring satisfaction. The Messier Marathon is absolutely the greatest excuse I have ever heard to get out there and actually use the telescope. A mere list of objects in the night sky has not been enough to trigger action on my part, but the thought of a marathon, a time restricted challenge, a training plan, a strategy; oh my, I was hooked!

I do have a telescope that I have had out in the yard a few times. It is at least 20 years old, a 4 1/2” reflector, has a fiendishly inspired equatorial mount, and two eyepieces. One eyepiece seems quite nice for viewing; the other seems more akin to watching sunsets in fast motion. The telescope, in my case, seems well matched with my observing abilities. I have heard that a telescope’s capabilities should slightly outdistance the observer’s skill level, at least to start out - check!

Prep time: With the challenge two weeks in front of me, I thought I might familiarize myself with my 20 year-old scope. The club’s discussion of different telescopes and mounts had at least prepared me with understanding the purpose of the equatorial mount. The benefits of using the single right ascension fine adjustment to keep objects in view seemed quite obvious. A nice YouTube video “How to Align an Equatorial Mount” - https://www.youtube.com/watch?v=plx6XXDgf2E was really quite helpful. The first step was balancing the scope. It seemed straightforward, possibly unnecessary – after all, the scope had been on the stand for years, and had never fallen over. But since I am a stickler for both reading and following directions when in unfamiliar territory, I proceeded on with the exercise. Steadying the scope with my left hand I loosened the right ascension clutch (actually a thumb screw) with my right hand, at which point I realized the scope was considerably out of balance, and much heavier than I anticipated. Several expletive deleted comments, a band aid, and 2 ounces of hydrogen peroxide later, I had a well-balanced scope that I could twist to virtually any position. To finish the exercise, I needed to polar-align the scope. Naturally, from my house, I have no northern exposure, so I approximated Polaris’s location and accomplished, at least procedurally, a polar alignment, without any further injury.
Panorama of Natural Tunnel State Park
Gazebo Area - Eastern Horizon

Image by Wayne Davis
Now I needed a checklist, after all, if you are going to see 110 night sky objects plus or minus a few, you at least need something on which to keep score. The wonderful world wide web (www) had a number of choices. After looking at a few, I settled on “Larry McNish’s Messier Marathon Planner, Version 1.51.” It provided several suggested viewing sequences, and other information that, at the time, I thought were critical to include – the rise, transit, and setting times, the right ascension and declination of the object, the constellation in which each object resides, its visual magnitude, and of course a picture of each object. The pictures were indeed helpful in identifying the star clusters. After all, wherever your scope settles there will most definitely be a cluster of stars, each with their own beauty and majesty. The objective is of course to find the ones that Messier had included on his list!

At last, after scheduling a vacation day a week in advance, and watching a very uncooperative weather forecast progress through the week, the day before the big night arrived. The 10 day outlook had varied between a complete rain-out, overcast skies, and, at best, a mostly cloudy forecast up to and including the current day. We had received the official club email indicating that the event was cancelled, but, if we were still interested to contact Ray and Kate O’Connor. As I viewed the satellite cloud imagery on the internet (every amateur astronomer must be a closet weather forecaster at heart), it struck me that while the forecast for sundown was for mostly cloudy skies with a 50% change of rain after midnight, and close to 100% chance of rain the following morning, that there was not a single cloud in the imagery between Knoxville and western Arkansas. In addition there was a weak high pressure system northwest of us that should be funneling cooler, drier air down toward our area. So, with Ray and Kate soon on the phone, I could tell they were concerned about the forecast, but were just itching to go. Sometimes it just takes one more buddy, and a little enthusiasm to reach critical mass.

We met at the Natural Tunnel State Park gazebo about 6 p.m., and were greeted by clear skies and a great horizon-to-horizon view. I knew at that time we were at least going to see some of the Messier objects, and I would see some objects that I had never seen before.

Marathon results: I had always thought it was pretty cool to recognize some of the major constellations. So many folks can’t even name a single true constellation. Now, faced with trying to find all of the Messier objects, and essentially the only thing to go on being maps of not-so-familiar constellations, I pledge to redouble my efforts to learn these markers in the sky. This has to be one of the best reasons for learning the constellations. Certainly, to understand constellation shapes and inverted positions at unfamiliar times will do the most to assist in the quick location and eventual observation of so many awe-inspiring sights. Knowing the location of the component stars, if
not their names, will quicken the pace and add to the object count. What about a go-to mount? Dialing in the location and allowing the telescope to track to the position – there is certainly a place for that in this fast paced world, but finding the objects with little more than a map that has remained unchanged for hundreds of years really adds to the sense of satisfaction.

Happy viewing!
Chapter 3

Celestial Happenings

Jason Dorfman
The month of April brings many wonderful opportunities to view the brighter planets in the Solar System both in the evening and early morning skies. Below, you’ll find details on when and where to look to see Venus, Jupiter, Mars and Saturn. As in March, we find a nearly full Moon at the start and end of the month. The Moon will not make an appearance, however, during the peak of the Lyrid meteor shower. Finally, we’ll explore the constellation of the month, Cancer.

**Planets**

The evening star, Venus, will be the highlight of the sky over the next few months just after sunset. As April begins, you’ll find Venus shining brightly at magnitude -3.9 about 13° above the western horizon. It will rise a bit higher each night and by the end of the month will be about 20° above the horizon a half hour after sunset. It starts the month in the constellation of Aries and moves into Taurus on the 19th. As the month wanes, Venus will glide past the Pleiades star cluster in Taurus, about 3.5° away to the SSE on the 24th. On the 27th, Venus will appear almost exactly halfway between the Pleiades and Hyades star clusters. A telescopic view will show a disk spanning 10.5” and 90% lit at the beginning of the month. This will change only slightly during April as the disk grows to 11.5” by month’s end and the illuminated portion wanes to 89%.

Last month, Neptune crossed behind the Sun and this month, the other ice giant, Uranus, will do the same. Uranus will be in conjunction with the Sun on the 18th.

Speaking of giants…the largest planet in our Solar System, Jupiter, will be coming up not long after the Sun goes down. Look for it on the 1st rising in the east by 11 p.m. Jupiter is in the middle of Libra this month, moving in retrograde just a bit. Our view of Jupiter will not change much over the course of the month. It’s magnitude will go from -2.4 to -2.5 and through a scope the disk will grow slightly from 43” to 45”. The best views will be when Jupiter and Libra are highest in the south, which will be about 4 a.m. on the 1st and about 2 a.m. at the end of the month.

One of the unique features of the Jupiter system that is often mentioned is that we often see the four largest moons of Jupiter appear along a line with Jupiter’s equator. This is due to the fact...
that we are often looking edge-on at the Jupiter system. But Jupiter does have a small axial tilt of about 3°. With a 12 year orbit, about every 6 years we get to see a bit more of one polar region as it is tilted towards our direction. This month, we’ll see more of the south pole of Jupiter as the tilt reaches a max of 3.4°. Though the planet will not appear any different, the effect is highlighted in the orbit of the moons - specifically the two outer Galilean moons, Ganymede and Callisto. Their orbital motion will take them farther north and south of Jupiter's center than normal. Look in the early morning hours of the 8th, to see first the shadow of Ganymede and then the moon itself cross the northern pole of Jupiter. The shadow will cross from 1:17 to 3:01 a.m. and the moon will traverse the same region from 4:25 to 5:27 a.m. On the 18th/19th, both Ganymede and Callisto will be on the far side of Jupiter. When Jupiter rises, Ganymede will be eclipsed by the south polar region and will emerge about 10:30 p.m. Callisto will pass below the south pole, never being blocked by Jupiter or it’s shadow. It will appear directly below the south pole around midnight.

Mars and Saturn continue their prominent reign in the early morning skies, this month. Both rise together in the east on the 1st just after 2:30 a.m. On the morning of the 2nd, they will be in conjunction and separated by only 1.3° with the globular cluster, M22, just 0.4° to the southwest of Mars. Their close appearance will not last long, however, as Mars moves swiftly eastward during the month while Saturn remains within 2° of M22. The pair will end the month with a separation of 14°.

Saturn will brighten a little over the month from magnitude +0.5 to +0.3. The ring plane remains tilted quite a bit to our line of sight at 25° providing good views of the ring system. The rings span 39” and the planet about 17” at the equator.

Mars will clearly outshine Saturn by month’s end as it’s brightness almost doubles from magnitude +0.3 to -0.3. The disk of the Red Planet will grow from 8.4” to 11.0” bringing some of the surface features within reach of medium size scopes. Now’s the time to start practicing your observations of Mars as we head towards opposition in July.

**Luna**

With a full Moon occurring on the last day of March, April will begin with a nearly full Moon, look for it rising in the east just after sunset. New Moon falls in the middle of the month and the official full Moon for April occurs on the 29th. On the 3rd at six in the morning, a waning gibbous Moon will be high in the southwest just 5° to the northwest of Jupiter. This pairing will occur again on the 30th when the two are a bit closer and lower in the WSW. Also during the early morning hours of the 7th, look to the southeast for a not-quite 3rd-quarter Moon 2° northwest of Saturn and 4° from Mars. For evening observers, look to the west in the early twilight on the 17th for a very thin crescent Moon to the left of
Venus. A half hour after sunset, the pair will be 5° apart and about 15° above the horizon.

**Meteor Showers**
This month the Lyrids will peak on the night of the 21st/22nd. The Lyrids are a medium strength shower with a ZHR of about 18. Meteors of this shower usually lack persistent trains but can produce some fireballs. As with most showers, the best time to view is in the pre-dawn hours around 2 a.m. With the Moon at crescent phase, you’ll have a moonless sky making for perfect viewing conditions - depending upon the weather, of course. ; )

**Constellation of the Month**
Cancer is the constellation this month, the Crab. Facing south, look up towards the zenith. Cancer is found between the stars of Gemini and Leo. There are 6 stars between 3rd and 5th magnitude that form sort of a simple headless stick figure with it’s arms in the air. This represents the crab, with one side of the stick figure as the claws and the other side as the body and legs. The alpha star of Cancer is not the brightest star, beta and delta are a little brighter.

As Brandon mentioned in his article, there are two Messier objects within the constellation - M44 and M67. M44 is also known as the “Praesepe” or the “Beehive” star cluster. It is a bright and nearby galactic star cluster located in the heart of the crab. Galileo was the first to observe this cluster with a telescope, but noted only 36 bright members of the roughly 200 known today. It’s overall magnitude is about +4.5 and the cluster spans over a degree in apparent size. In reality, the cluster is about 525 light years away and about 13 light years in diameter.

M67 is a much fainter but equally rich galactic open cluster located 1.8° west of the star Alpha Cancri. It spans a much smaller diameter of only 15’ and has an overall magnitude of +7. There are about 500 member stars in the 10th to 16th magnitude range. Most open star clusters are found close to the plane of our Milky Way. M67, however, lies nearly 1500 lights years above the plane. Plotting the stars in an H-R diagram reveals similar characteristics to that of a globular cluster. With an age of about 10 billion years, perhaps M67 is a sort of special type of cluster between globulars and galactic clusters.

Finally, we find an interesting object in Cancer that isn’t always a part of this constellation, the dwarf planet Ceres. Ceres, the first asteroid discovered, is moving through the northern part of Cancer over the month and midway into next month. Look about 2° north of the 4th magnitude star Zubanah (48 Cnc). Over the month, it will move about 3° westward above this star. In the first week of April, Ceres will pass very close to the 6th magnitude star 46 Cnc - coming within 5’ on the 4th.

That’s all for this month. Thanks for reading!
This month we celebrate the life of a man whose name may not be familiar, but whose contributions to science are well known. Harold Clayton Urey was born April 29, 1893 in the small town of Walkerton, Indiana. Both of Harold’s parents had college degrees in teaching, though by the time he was born, his father, Samuel, was working primarily as a farmer and lay preacher, while his mother, Cora, was a full-time mother and farmer. In 1899, when Harold was six years old, his father died of tuberculosis. With few resources, his mother and her three children were forced to move in with Harold’s paternal grandmother in Corunna, Indiana. Five years later, his grandmother died, and the family moved again, making ends meet by growing and selling onions. Harold was raised in the Church of the Brethren, which was a pacifist Christian denomination and would influence his later life. He attended a one-room Amish school for his elementary school years, and then went to high school in Kendallville, Indiana, which was paid for by his father’s life insurance that specified the money be used solely for the children’s education. Harold excelled in high school, taking biology and physics, plus joining the debate team. Looking back on the opportunity to attend high school, Harold said, “If it hadn’t been for that, I’d still be in Indiana, working as an unsuccessful farmer – I just can’t see me being a successful farmer.”

In 1911, Urey graduated from high school and went to Earlham College in Richmond, Indiana. Here he earned a teaching certificate. He taught in a few small rural schools for a few years, first in Indiana, then in Montana, where his mother was now living. In 1914, Urey, who had been teaching in a mining camp, decided to attend the University of Montana in Missoula, where he majored in Zoology, with a second major in Chemistry. Urey graduated in 1917 with a BS in Zoology. The United States had now entered World War I, and Urey’s chemistry background was in high demand. He began working at an explosives manufacturing plant in Philadelphia called Barrett Chemical Company, where he helped make TNT. This was when Urey realized that chemistry was his life’s calling. When the war ended, Urey returned to the University of Montana to work as a Chemistry instructor for the next two years.

Since Urey was interested in an academic career, he knew he would need a doctorate degree. In 1921, Urey entered the University of California at Berkeley to begin his work toward a
PhD in Chemistry. Working under Gilbert Lewis, who was known for his work in the area of chemical bonding, Urey spent two years on his research. His dissertation was on electron energy distributions in a hydrogen atom. Urey graduated in 1923.

While in graduate school, Urey became interested in quantum chemistry. After graduation, he was fortunate to receive a fellowship from the American-Scandinavian Foundation to further study at the Niels Bohr Institute in Copenhagen, Denmark for one year. Just the previous year, Bohr had received the Nobel Prize in Physics for his discovery of the quantum energy levels in an atom. While at the Institute, Urey had the opportunity to meet and work with not only Bohr, but other notables like Heisenberg and Pauli. At the end of his year, Urey spent some time in Germany, where he met Albert Einstein.

Returning to the United States in 1924, Urey had two job offers, one from Harvard and one from Johns Hopkins; he chose Johns Hopkins. But first, he went to Seattle, Washington to see his mother. While visiting a friend in Everett, Washington, Urey was introduced to Frieda Daum, a bacteriologist. They were quickly engaged and married in 1926. They would have four children, three girls and a boy.

While at Johns Hopkins, Urey was a research associate. Here he continued his interest in quantum mechanics, and wrote a book with Arthur Ruark titled “Atoms, Quanta and Molecules” published in 1930, which was the first English text book about quantum mechanics. Urey’s research involved studying the spectra of molecules, but he was not happy with his progress. So, in 1929, before his book came out, Urey moved to Columbia University in New York City, where he was an associate professor of Chemistry. By 1934, he was a full Professor. It was here that Urey made his first major discovery. The idea of isotopes of atoms, atoms of the same element but different masses, had been discovered by J. J. Thomson in 1913, but the reason was not discovered until 1932 when James Chadwick discovered neutrons. So isotopes are atoms with different numbers of neutrons in the nucleus. In 1931, before the discovery of the neutron, Urey knew that hydrogen could have an isotope that was double the mass, known as “heavy hydrogen.” Urey found that the boiling point of the heavy hydrogen should be higher than that of regular hydrogen. His plan was to get four liters of liquid hydrogen, and slowly raise the temperature to boil off the lighter hydrogen. The relative abundance of hydrogen to heavy hydrogen had been determined to be about 1 atom of heavy hydrogen for every 4500 hydrogen atoms, but if 4 liters of liquid hydrogen was boiled down to one milliliter, Urey determined that the abundance of heavy hydrogen would be over 100x greater. Urey was also able to calculate what the spectrum of heavy hydrogen would look like compared to regular hydrogen. On Thanksgiving Day, 1931, Urey and his assistant took a spectrum of the distilled hydrogen and saw exactly the spectral lines Urey had predicted. Urey named the new element Deuterium. Urey, along with George
Murphy (his assistant), and Ferdinand Brickwedde (who performed the distillation), published their discovery in 1932.

During most of the 1930’s, Urey concentrated on processes for distilling elements to create a sample enriched in their isotopes. This ended up having a biochemical use. If a lab animal were fed food containing a traceable isotope, you could follow the path the nutrients take in the animal’s body. In 1932, Urey founded the Journal of Chemical Physics, acting as the editor for the next eight years.

In 1934, Urey was awarded the Nobel Prize in Chemistry for his discovery of Deuterium. However, instead of attending the ceremony, Urey stayed home for the birth of his daughter, Mary Alice. Urey was known for his generosity. Despite being named the sole recipient of the Nobel Prize, he shared the prize money with Murphy and Brickwedde. As part of the honors he received, Urey was asked to write the entry on Deuterium for the 1936 edition of the Encyclopedia Brittanica.

While Urey’s opportunities seemed to expand, he became increasingly concerned about his colleagues in Europe during the 1930’s. Urey chaired the University Federation for Democracy and Intellectual Freedom at Columbia University. Urey opposed Nazism and did what he could to help Jewish and other persecuted scientists escape to America, including Enrico Fermi.

By the time the United States entered World War II, people were already concerned about Germany developing an atomic bomb. The atomic bomb required an isotope of Uranium, Uranium 235. As one of the premier chemists involved with separating out element isotopes, Urey naturally was sought after to help with the Manhattan Project. From 1940 - 1945, Urey was Director of War Research, Atomic Bomb Project at Columbia University. Seven months before America was even in the war, Urey had been appointed to the S-1 Executive Committee, which was also known as the Uranium Committee of the National Defense Research Committee. This group represented the beginnings of the Manhattan Project. By 1943, Urey was in charge of 700 people working on separating the uranium isotope by the gaseous diffusion method. Other methods, such as centrifugal separation and thermal diffusion, were also being explored at other locations. The gaseous diffusion technique later became the only one used, especially after the war, due to its efficiency. Urey also worked on production of “heavy water,” which is water made with deuterium instead of hydrogen, to be used in nuclear reactors to control the chain reaction. However, the stress of the job got to Urey, and he left the program in 1945. Urey was opposed to dropping the bomb on Japan and tried to convince President Truman to explore other alternatives. He was awarded the Medal for Merit in recognition of his efforts in producing the Uranium isotopes. After the war, Urey championed for atomic weapons to be under civilian, rather than military, control, and proposed a ban on the production and stockpiling of atomic...
The S-1 Committee at Bohemian Grove, September 13, 1942. From left to right are Harold C. Urey, Ernest O. Lawrence, James B. Conant, Lyman J. Briggs, E. V. Murphree and A. H. Compton.

Image from Wikipedia
weapons. He went on lecture tours promoting a pacifist agenda, among other things. His political endeavors ultimately led to Urey being brought before the House Un-American Activities Committee, though he was not found guilty of anything.

In 1945, Urey moved to the University of Chicago to work in the Institute for Nuclear Studies as a Distinguished Professor of Chemistry. Here he explored how temperatures would affect certain isotopes. By the ratio of isotopes present in a sample, he could determine the temperature the sample had been exposed to. He applied this techniques to a 100 million year old fossilized shellfish to determine the summer and winter temperatures it had been exposed to. This was one of the first experiments in paleoclimatology, and Urey was awarded the Arthur L. Day Medal by the Geological Society of America for this work.

By the early 1950’s, Urey became interested in the chemistry of space and the origin of life. After hearing about the idea of life coming from a “primordial soup” of carbon compounds, Urey suggested that lightening could trigger the chemical reactions necessary to produce the amino acids needed as the building blocks of life. He proposed that the original atmosphere of Earth would have been composed of hydrogen, ammonia, methane, and water. One of his graduate students, Stanley Miller, wanted to test this idea experimentally for his dissertation. The experiment, now known as the Miller-Urey experiment, involved a gaseous mixture of hydrogen, ammonia, methane, and water exposed to electrical sparks. Within a few days, a sludge of amino acids was present. This proved that organic molecules could be produced under naturally occurring conditions. When Miller went to publish the results, he wanted Urey’s name on the paper, but Urey refused, afraid that his notoriety as a Nobel Prize winner would overshadow Miller’s work and prevent Miller from getting the recognition he deserved.

After spending 1956-1957 in England as a visiting professor at Oxford, Urey retired from the University of Chicago and moved to the University of California San Diego as a Professor-at-Large. Here he helped build up the science faculty and created the school of chemistry in 1960. Urey was very politically active and served as a science advisor to President Kennedy. Despite being “retired,” Urey wasn’t done exploring new areas of research. He believed that the Moon had formed prior to the Earth and was captured by Earth. As such, he was a strong proponent of the Apollo Moon landing to bring back lunar samples that would, as he thought, represent early samples of the Solar System. Urey even approached Apollo 17 astronaut and geologist Harrison Schmitt, to offer going on a one-way trip to the Moon. After Apollo 11 brought back the first samples, Urey was one of only six people who had the first opportunity to study them. Because the samples showed that the Earth and Moon had a common origin, Urey threw out his original hypothesis and, in the spirit of the scientific method, revised his ideas.
Urey continued working hard at his research most of his life. When asked why, he said, “Well, you know I’m not on tenure anymore.” After retiring in 1970, Urey kept busy by gardening, not farming, and raised orchids. His later life was plagued by Parkinson’s Disease and cardiac issues. Harold Urey died January 5, 1981 in La Jolla, California and was buried in DeKalb County, Indiana.

Harold Urey made so many contributions to the scientific world, yet his name is barely known, and that’s a shame. From the discovery of deuterium to his work on the Manhattan Project to showing the chemical origins of life to the origin of our Moon, Harold Urey continued to do exemplary and astounding work. The next time you glance up at the Moon, take a moment to remember the man who not only helped us understand its origins, but so much more.

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Chapter 5

Space Place
As far as we know, water is essential for every form of life. It’s a simple molecule, and we know a lot about it. Water has two hydrogen atoms and one oxygen atom. It boils at 212°F (100°C) and freezes at 32°F (0°C). The Earth’s surface is more than 70 percent covered in water.

On our planet, we find water at every stage: liquid, solid (ice), and gas (steam and vapor). Our bodies are mostly water. We use it to drink, bathe, clean, grow crops, make energy, and more. With everything it does, measuring where the water on Earth is, and how it moves, is no easy task.

The world’s oceans, lakes, rivers and streams are water. However, there’s also water frozen in the ice caps, glaciers, and icebergs. There’s water held in the tiny spaces between rocks and soils deep underground. With so much water all over the planet—including some of it hidden where we can’t see—NASA scientists have to get creative to study it all. One way that NASA will measure where all that water is and how it moves, is by launching a set of spacecraft this spring called GRACE-FO.

GRACE-FO stands for the “Gravity Recovery and Climate Experiment Follow-on.” "Follow-on" means it’s the second satellite mission like this—a follow-up to the original GRACE mission. GRACE-FO will use two satellites. One satellite will be about 137 miles (220 km) behind the other as they orbit the Earth. As the satellites move, the gravity of the Earth will pull on them.

Gravity isn’t the same everywhere on Earth. Areas with more mass—like big mountains—have a stronger gravitational pull than areas with less mass. When the GRACE-FO satellites fly towards an area with stronger gravitational pull, the first satellite will be pulled a little faster. When the second GRACE-FO satellite reaches the stronger gravity area, it will be pulled faster, and catch up.

Scientists combine this distance between the two satellites with lots of other information to create a map of Earth’s gravity field each month. The changes in that map will tell them how land and water move on our planet. For example, a melting glacier will have less water, and so less mass, as it melts. Less mass means less gravitational pull, so the GRACE-FO satellites will have less distance between them. That data can be used to help scientists figure out if the glacier is melting.
GRACE-FO will also be able to look at how Earth’s overall weather changes from year to year. For example, the satellite can monitor certain regions to help us figure out how severe a drought is. These satellites will help us keep track of one of the most important things to all life on this planet: water.

You can learn more about our planet’s most important molecule here: https://spaceplace.nasa.gov/water

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!
BMAC
Calendar
and more
# BMAC Calendar and more

<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>
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<tr>
<td>Friday, April 6, 2018</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td></td>
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<tr>
<td>Friday, May 4, 2018</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: Topic TBA; Free.</td>
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<tr>
<td>Friday, June 1, 2018</td>
<td>7 p.m.</td>
<td>Nature Center</td>
<td>Program: Topic TBA; Free.</td>
</tr>
<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>
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<tr>
<td>Mar. 3, 10, 2018</td>
<td>7:00 p.m.</td>
<td>Observatory</td>
<td>View the night sky with large telescopes. If poor weather, an alternate live tour of the night sky will be held in the planetarium theater.; Free.</td>
</tr>
<tr>
<td>Mar. 17, 24, 2018</td>
<td>8:00 p.m.</td>
<td>Observatory</td>
<td></td>
</tr>
<tr>
<td>Apr. 7, 14, 21, 28, 2018</td>
<td>8:30 p.m.</td>
<td>Observatory</td>
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<td><strong>Special Events</strong></td>
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<tr>
<td>Saturday, April 21, 2018</td>
<td>1-4:30 p.m.</td>
<td>Nature Center</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 8:30-10 p.m. at the observatory. All non-planetarium astronomy activities are free.</td>
</tr>
<tr>
<td></td>
<td>8:30-10 p.m.</td>
<td>&amp; Observatory</td>
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Annual Dues:

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

$16 /person/year

$6 /additional family member

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

The club’s website can be found here:

www.baysmountain.com/astronomy/astronomy-club/

Regular Contributors:

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

Robin Byrne
Robin has been writing the science history column since 1992 and was chair in 1997. She is an Associate Professor of Astronomy & Physics at Northeast State Community College (NSCC).

Jason Dorfman
Jason works as a planetarium creative and technical genius at Bays Mountain Park. He has been a member since 2006.

Adam Thanz
Adam has been the Editor for all but a number of months since 1992. He is the Planetarium Director at Bays Mountain Park as well as an astronomy adjunct for NSCC.
Seen from our planet, the view of Saturn's rings during equinox is extremely foreshortened and limited. But in orbit around Saturn, Cassini had no such problems. From 20 degrees above the ring plane, Cassini’s wide angle camera shot 75 exposures in succession for this mosaic showing Saturn, its rings, and a few of its moons a day and a half after exact Saturn equinox, when the sun’s disk was exactly overhead at the planet’s equator.

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

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

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

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

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

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

This view looks toward the northern side of the rings from about 20 degrees above the ring plane. The images were taken on Aug. 12, 2009, beginning about 1.25 days after exact equinox, using the red, green and blue spectral filters of the wide angle camera and were combined to create this natural color view. The images were obtained at a distance of approximately 847,000 kilometers (526,000 miles) from Saturn and at a Sun-Saturn-spacecraft, or phase, angle of 74 degrees. Image scale is 50 kilometers (31 miles) per pixel.

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


Image Credit: NASA/JPL/Space Science Institute.
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 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 measured 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 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/STScI)
Acknowledgment: A. Riess (STScI)

8. An artist's rendering of the twin GRACE-FO spacecraft in orbit around Earth. Credit: NASA