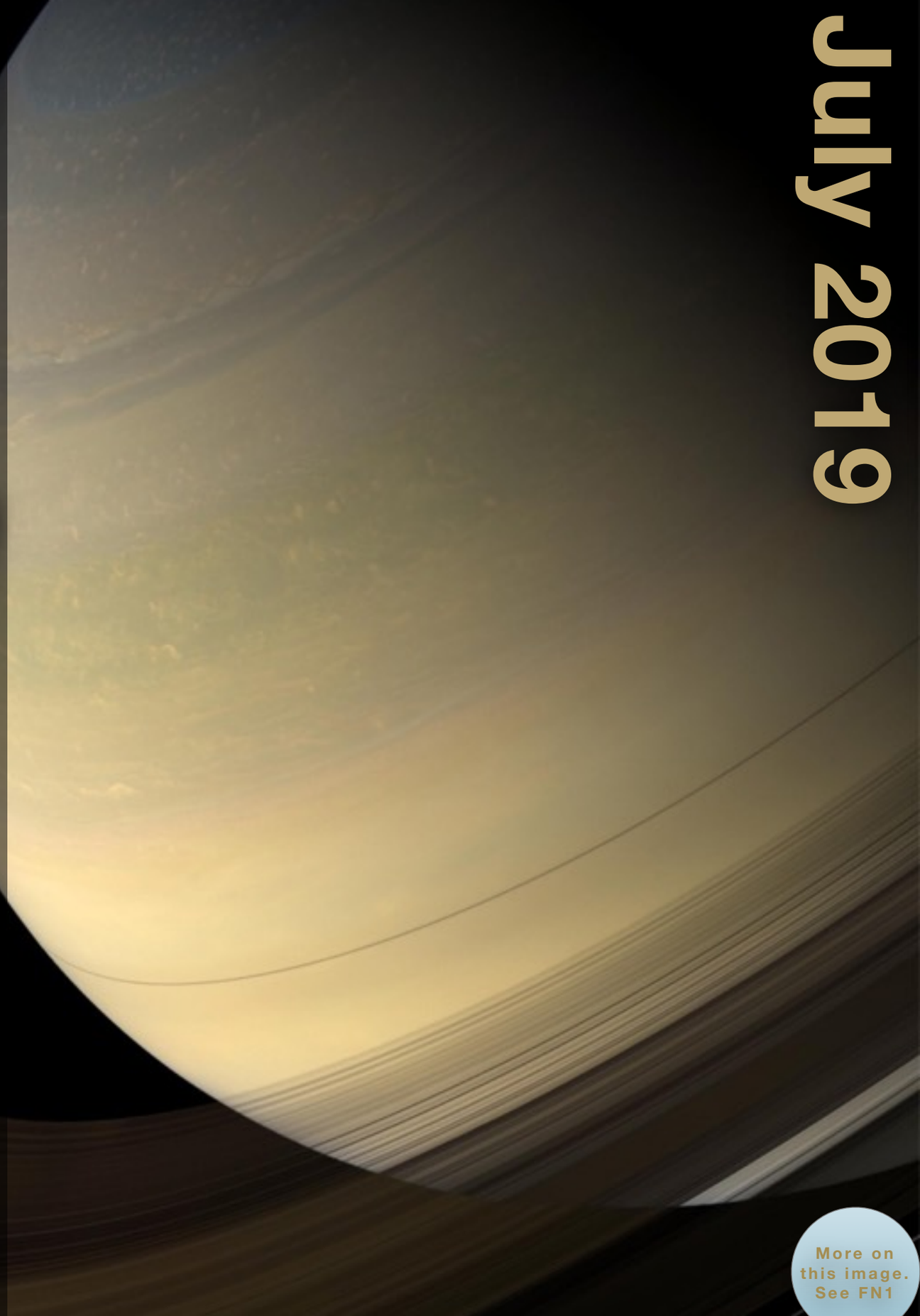
The Monthly Newsletter of the

Bays Mountain Astronomy Club

July 2019



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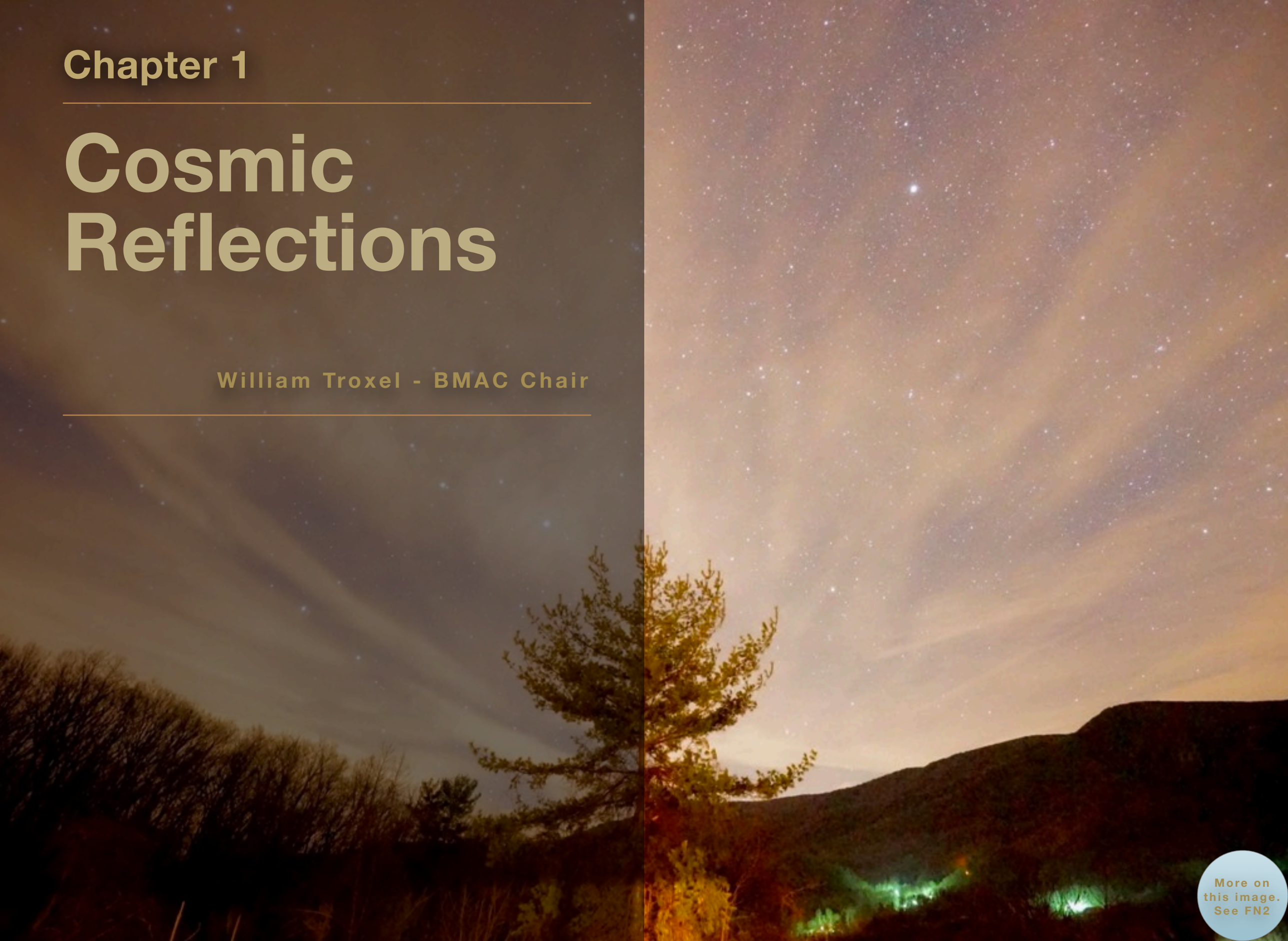
Edited by Adam Thanz

Chapter 1

Cosmic Reflections

William Troxel - BMAC Chair



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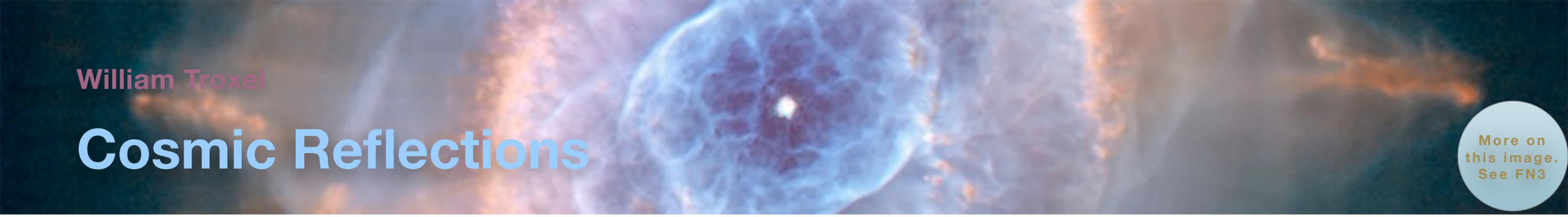

William Troxel

Cosmic Reflections

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Greetings to everyone. Here we are at the 7th month of the year. This year is moving very fast. Well, not really, it just seems like it to me. I want to thank Brandon for closing out the last few months of programs for newbies to Amateur Astronomers. I hope that you received a bit of information that will help you in your understanding of astronomy from some of the topics that we covered. Brandon did a wonderful job of touching on the process of getting a picture of the night sky. During his presentation, I showed my newest toy that allows the use of a smart phone that attaches to your scope. The biggest advantage is that it prevents the shaking by holding your phone still enough to get the picture. Several of the members have already found one very much like mine and some even had the very same kind as I had. I have hopes to try it out in the near future. I will share the photos, good or bad, so those of you waiting to see what type of photo you can get will have more data to consider whether to buy or not. Brandon finished with a review of equipment and average cost to get into astrophotography. I think it was a good way to end this segment.

Our constellation conversation for the month is Scorpius. This is one of those constellations that is very interesting. Jason will cover more of the technical aspects in his article later in the newsletter. I hope you will continue on after you finish this article. Many think that July is the best month to see this constellation. Let me tell you a bit about the myth surrounding this summer constellation. Scorpius and Orion are often intertwined in Greek mythology. According to one myth, Orion boasted that he would kill every animal on the Earth. Upon hearing this, the goddess-hunter Artemis and her mother, Leto, dispatched a scorpion to kill Orion. Zeus put the scorpion in the heavens after it won the battle. In another myth, the god Apollo, Artemis's twin brother, grew angry and sent a scorpion to attack Orion because he claimed to be a better hunter than Artemis. Zeus put Orion and Scorpius in the sky, but they are visible at different times of the year. Another myth expanded on this story by adding that the reason that Zeus put the two in the sky at different times was to keep them apart. No matter what myth you have read or learned, this constellation is very interesting and I would encourage you to research it more and it may prove to be one that you will want to add to your viewing list for the month.

Our words for this month are:

Galaxy - A galaxy is a gravitationally bound entity, typically consisting of dark matter, gas, dust and stars. Galaxies populate the Universe, mainly residing in clusters and groups.

Perigee - the point in the orbit of an object (such as a satellite or the Moon) orbiting the Earth that is nearest to the center of the Earth.

Nova - a star that suddenly increases its light output tremendously and then fades away to its former obscurity in a few months or years.

July holds, as you all know, the annual club picnic meeting. The meeting/picnic will be on July 13 starting at 6:00 p.m. and is for club members and family. The location will be sent to all full BMAC members separately. If you would like to help set up or would just like to come early, plan on getting there around 5 p.m. Like with all our club picnics, please bring a covered dish and your own chair. I think you will enjoy all the fun and fellowship with the other club members. Please feel free to bring your family. Note: The Park Association will provide the paper and plastic wear.

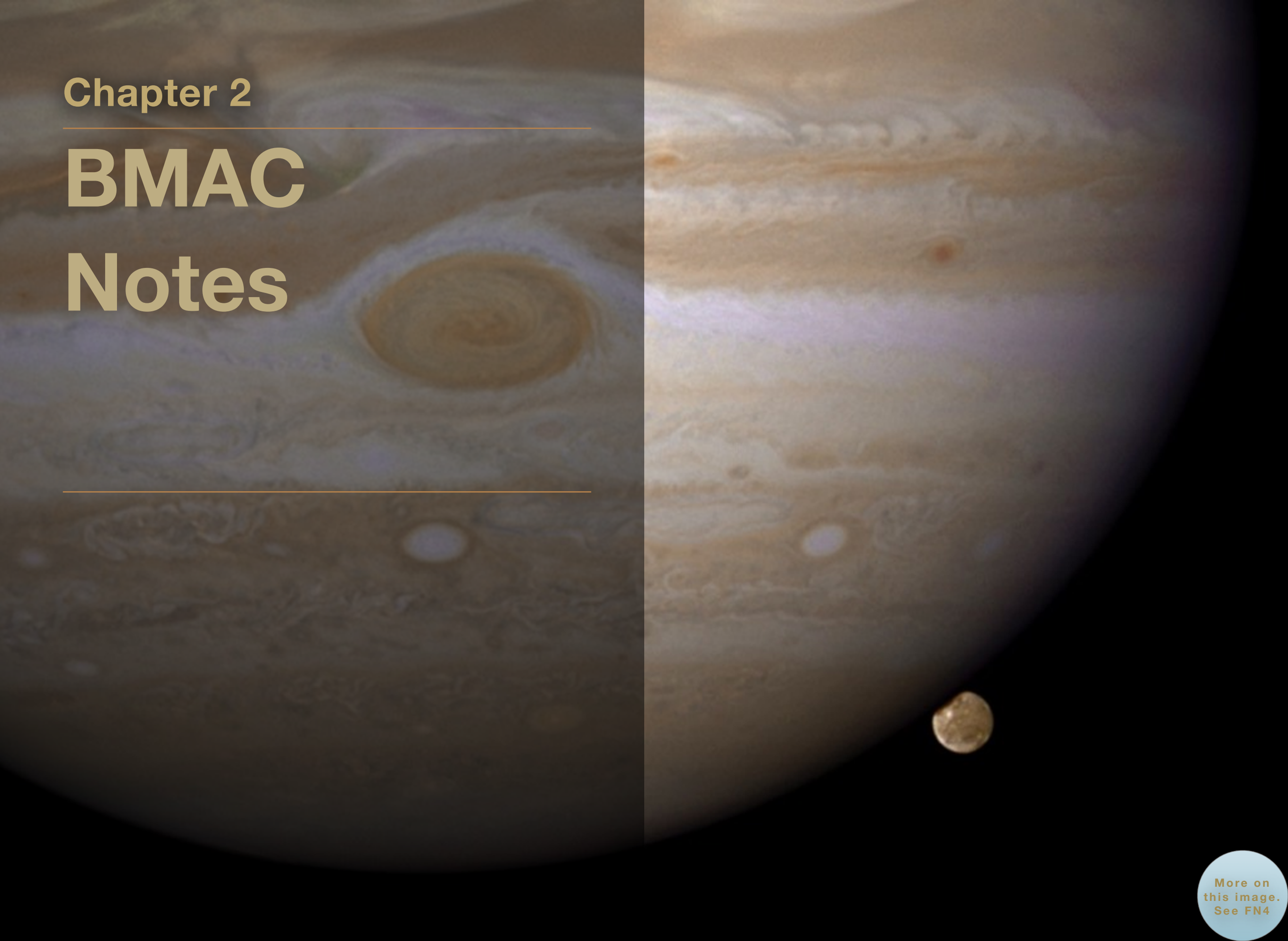
Before I close this month's article, I wanted to say thank you for allowing me to serve another year as the face of our club as your chairman. It is an honor to serve the club. I told you that I would love to hear the things you would like to learn about. Some of you offered some great ideas and I hope you will continue to do so. I am excited that we seem to be adding new members and I hope that we can continue to grow over the next year. Remember, each of us make the club the fun place to come each month. I want to encourage you to seek out ways that you can apply your interests into the program each month. I would love to have you speak at a meeting sharing your area of interest, all you have to do is say "Hey William, I enjoy ___. I want to know when I could do a talk at the club meeting." Even providing a short, five-minute show and tell would be great! Believe me, I have open dates for you….

I leave you with this last thought, amateur astronomy is a hobby that puts one on a life long path of learning and exploring. I have not yet met anyone that knows everything about astronomy. I meet people every day that know many times more than myself. So far, everyone tells me the same thing. "I do not think I will ever know everything there is to know about astronomy." I, for one, think that is one of the best parts of this hobby.

Until Next time…. Clear Skies.

Chapter 2

BMAC Notes



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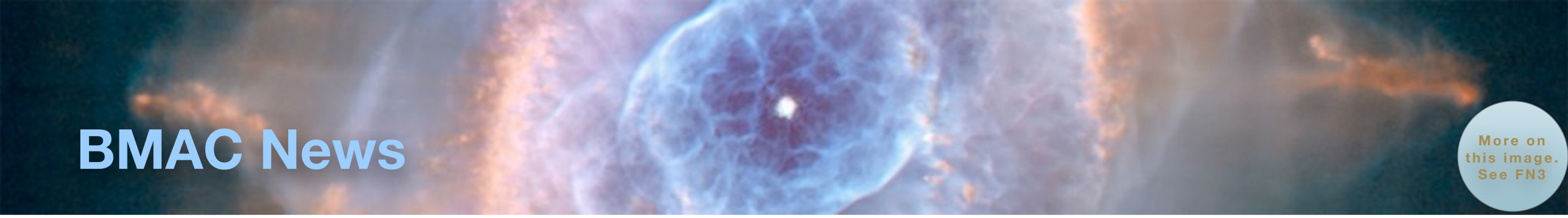

BMAC News

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BMACers Expand Our Universe!

Two of our BMACers, Brandon Stroupe and William Troxel, shared the world of astronomy with three programs for young audiences at the Greeneville Library in mid-June. A total of 95 students with parents enjoyed the presentations.

Erin Bontempt, coordinator of the library's summer reading program, writes in thanks: "Thank you so much for your time and the sharing of your expertise yesterday! We have received positive feedback about your presentations on Facebook and directly from mothers/grandmothers who had children in the program. One mother in particular stated that you both had taught her things she did not know about space and the stars and that she will have to add her new knowledge to her homeschooling lessons."

Honorable praise, indeed!

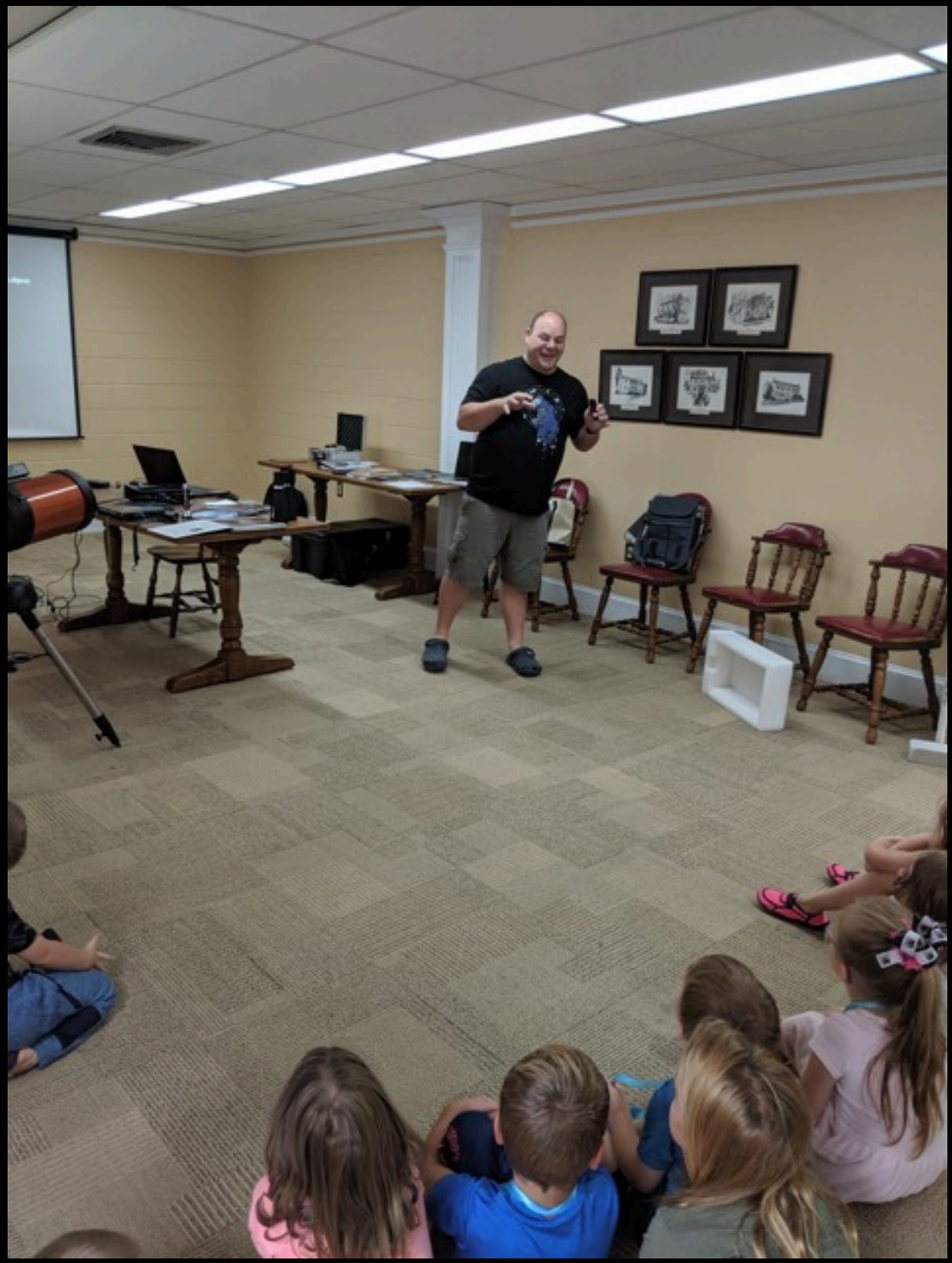
If you would like to do some outreach programs like this or other volunteer opportunities to share our love of astronomy, please contact our Park's volunteer coordinator, Krystal Haney at krystalhaney@kingsporttn.gov. Please see the photos by Brandon and William.

William Troxel showing off his catadioptric.

William showing the importance of a flashlight with red light.

William talking about stars.

Brandon talking about how we learn about objects in space.



Brandon Stroupe.

Brandon discussing different types of stars.

Brandon Stroupe giving a presentation on the basics of astrophotography at the June 2019 BMAC meeting.

Image by William Troxel.

Chapter 3

Celestial Happenings

Jason Dorfman

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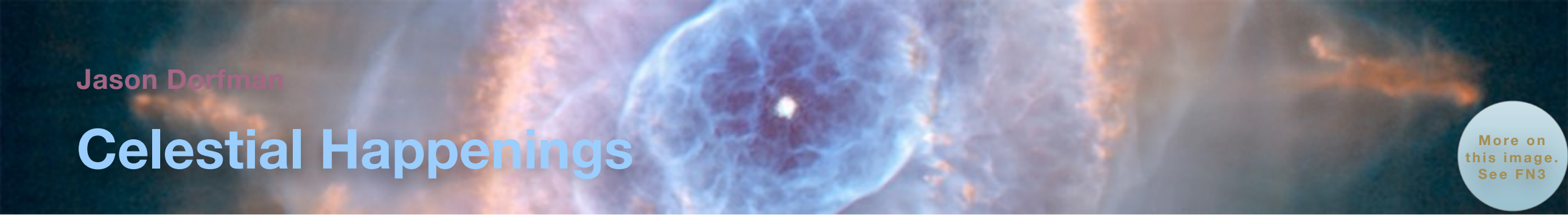

Jason Dorfman

Celestial Happenings

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With the start of July, we are officially into summer. The days are long but are beginning to shorten and the temperatures are rising. As we are all celebrating our independence in our own way, perhaps awaiting a spectacular fireworks display, Earth will be reaching aphelion, the farthest point in its orbit from the Sun. This officially occurs at 6:10 p.m. on the 4th and is a reminder that it's not the distance of Earth from the Sun that causes the warmer summer temperatures, but the tilt of Earth's northern axis towards the Sun. This is also the reason that the days are longer and the nights shorter. The Sun rises at 6:15 a.m. on the 1st and 6:35 a.m. as we reach the end of the month. Sunset occurs at 8:52 p.m. on the 1st and shifts to 8:37 p.m. by the 31st.

This month we celebrate the 50th anniversary of the Apollo 11 Moon landing, still one of the most amazing accomplishments in human space exploration. So, be sure to make some lunar observations this month.

On the 2nd, there is a total solar eclipse along a narrow path that crosses the South Pacific, Chile and Argentina. Unless you have plans to be in South America, the eclipse will not be visible for us. Also, there is usually a corresponding lunar eclipse associated with a solar eclipse, which occurs two week prior or after the solar eclipse. There will be a partial lunar eclipse on the 16th, however, it occurs during our daytime and thus will not be visible for our location. My apologies for teasing you with these possibilities, but I think it's good to know what is happening astronomically.

For lots of stuff that you will be able to observe — read on!

Planets

July begins with a wonderful pairing of the two smallest planets in the Solar System, Mercury and Mars. Look to the WNW on the 1st an hour and a half after sunset and you'll find the pair side-by-side about 5° above the horizon and roughly 4° apart.

Mars is on the right and slightly brighter at magnitude +1.8 than Mercury at magnitude +1.1. As the first week continues, Mercury will drop a bit lower each night as it's brightness fades, as well. Mercury and Mars will be in conjunction on the 7th after Mercury has moved to 4° south of Mars. But, now at magnitude +2, Mercury will be near impossible to spot against a bright twilight

sky, even with binoculars. Mercury will continue its swift westward movement reaching its solar conjunction on the 21st.

Jupiter and Saturn, the two gas giants of the Solar System, will be the planetary highlights this month with Jupiter having reached opposition last month and Saturn reaching opposition this month. First, you'll want to look for Jupiter. It will be about 20° high in the southeast an hour after sunset on the 1st and will reach its highest altitude of approximately 32° due south just before midnight. Jupiter shines at a bright -2.5 and continues its slow retrograde movement through the southern part of Ophiuchus. Through a telescope you'll see the disk of the planet spanning 44.4" across its equator.

Next, turn your gaze about 30° to the East for Saturn. As the month begins, Saturn is just rising in the ESE after sunset. It will be about 5° high an hour and a half after the Sun goes down. Saturn will be at magnitude +0.1 and moving in slow retrograde just east of the Teapot in Sagittarius. Optimal views of the ringed planet will come just after 2 a.m. on the 1st as Saturn reaches its highest altitude of about 32° due south. By the end of the month, it will reach this same altitude 2 hours earlier. Saturn reaches opposition on the 9th. At opposition the planet will span 18.4" in diameter along its equator and 16.9" across its polar diameter. The rings extend to 41.8" in diameter and are tilted 24° to our line of sight.

For a more challenging planetary observation, look for the two ice giants, Uranus and Neptune, in the early morning hours. Neptune rises in the east around midnight on the 1st and 2 hrs earlier by the 31st. It lies in Aquarius just east of 4th-magnitude Phi Aquarii and shines dimly at magnitude +7.8. Telescopic views will show a 2.3" diameter disk with a blue-grey hue. In early July it will climb to 45° just as the sky is beginning to show the first hints of the coming dawn.

Uranus rises 2 hours later and a little farther north along the horizon than Neptune. It is currently in southern Aries about 10° south and slightly east of 2nd-magnitude Hamal (alpha Arietis). Look for it about 30° above the eastern horizon at 5 a.m. just as the morning twilight is beginning to touch the sky. By the end of the month, it will climb to almost 60° in the ESE as dawn approaches. Uranus shines at magnitude +5.8 and will display a 3.5" disk.

Luna

Our Moon returns to the evening sky just as the month is beginning. On the 4th, look for a very young crescent a little below 15° above WNW horizon about a half hour after sunset. It will be a little less than 10° to the east of Mars and Mercury.

On the 13th, a bulging gibbous Moon will be 4° east of Jupiter. Two nights later, a nearly full Moon will be just 3° to the west of Saturn. The Full Moon occurs a day later, on the 16th.

On the 21st, a waning gibbous Moon will dampen your observations of Neptune as it will lie just shy of 5° south of this distant ice world.

With the 50th anniversary of the Apollo 11 Moon landing, I began to wonder what was the phase of the Moon during the landing? It turns out, for all of the lunar landings, the phase was a waxing crescent. This phase was chosen for the landing so that the astronauts would have optimal light conditions to see the relief of the terrain. An important aspect of the landing that became very critical for Apollo 11 as Neil Armstrong had to take control of the LEM to avoid some rocky terrain at the chosen landing site.

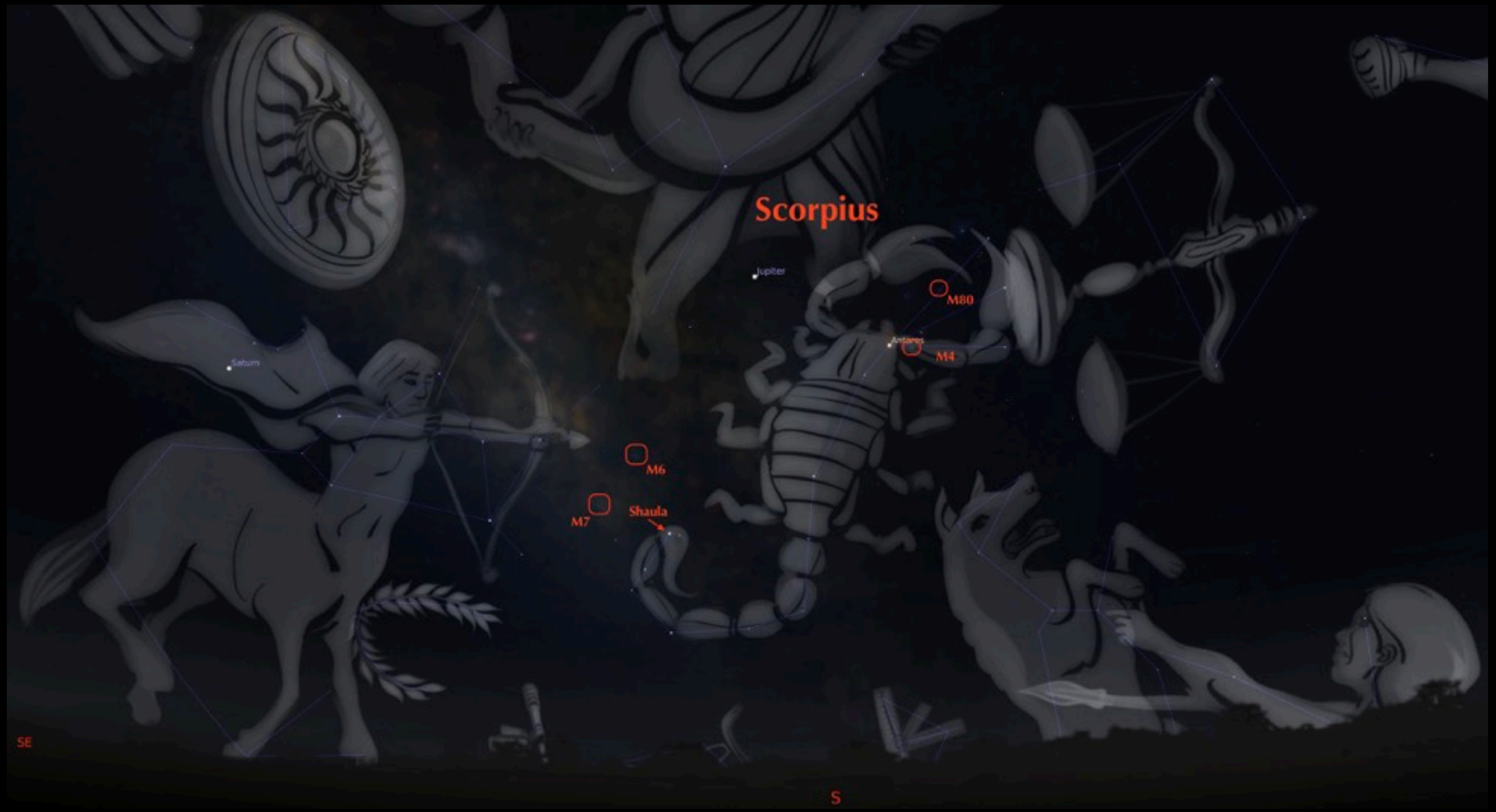
Constellation of the Month

For July, we return to an object-rich part of the sky with the constellation of Scorpius. Located very close to the heart of the Milky Way, Scorpius has a plethora of double and variable stars, star clusters and nebulae — including 5 Messier objects. Scorpius appears quite low for our location as it resides in the south celestial hemisphere extending from 10-40°S in declination and 16-18h in right ascension. It is bordered by Ophiuchus to the north, Libra and Lupus to the west, Ara and Norma to the south, and Corona Australis and Sagittarius to the east. The center of the Milky Way lies roughly 6° north and 3° east of Shaula, the star marking the tip of the scorpion's tail.

Antares, the alpha star of the constellation, is an M-type or red supergiant located at the heart of the scorpion. Its name comes from the Greek and translates to "Rival of Mars." This name was given to it because Antares lies close to the ecliptic and, due to its reddish hue, it was often mistaken for Mars. Looking a little more than a degree to the west of Antares, we find M4, one of the nearest globular clusters to Earth and quite bright at about 6th-magnitude. At its highest, it reaches about 26° due south for our location. About 4° to the NW of M4 is M80, another globular cluster. It is smaller than M4 and about 3 magnitudes fainter.

Above the tail of the scorpion, we find two bright open clusters, M6 and M7, the Butterfly Cluster and Ptolemy's Cluster, respectively. M6 is located about 5° north of the tail star, Shaula, and 3.5° NW of M7.

That’s all for this month. Have a safe and happy 4th and Happy Observing!



Scorpius from Stellarium.

Image annotation by Adam Thanz

Chapter 4

The Queen Speaks

Robin Byrne

Robin Byrne

Happy 50th Birthday Apollo 11

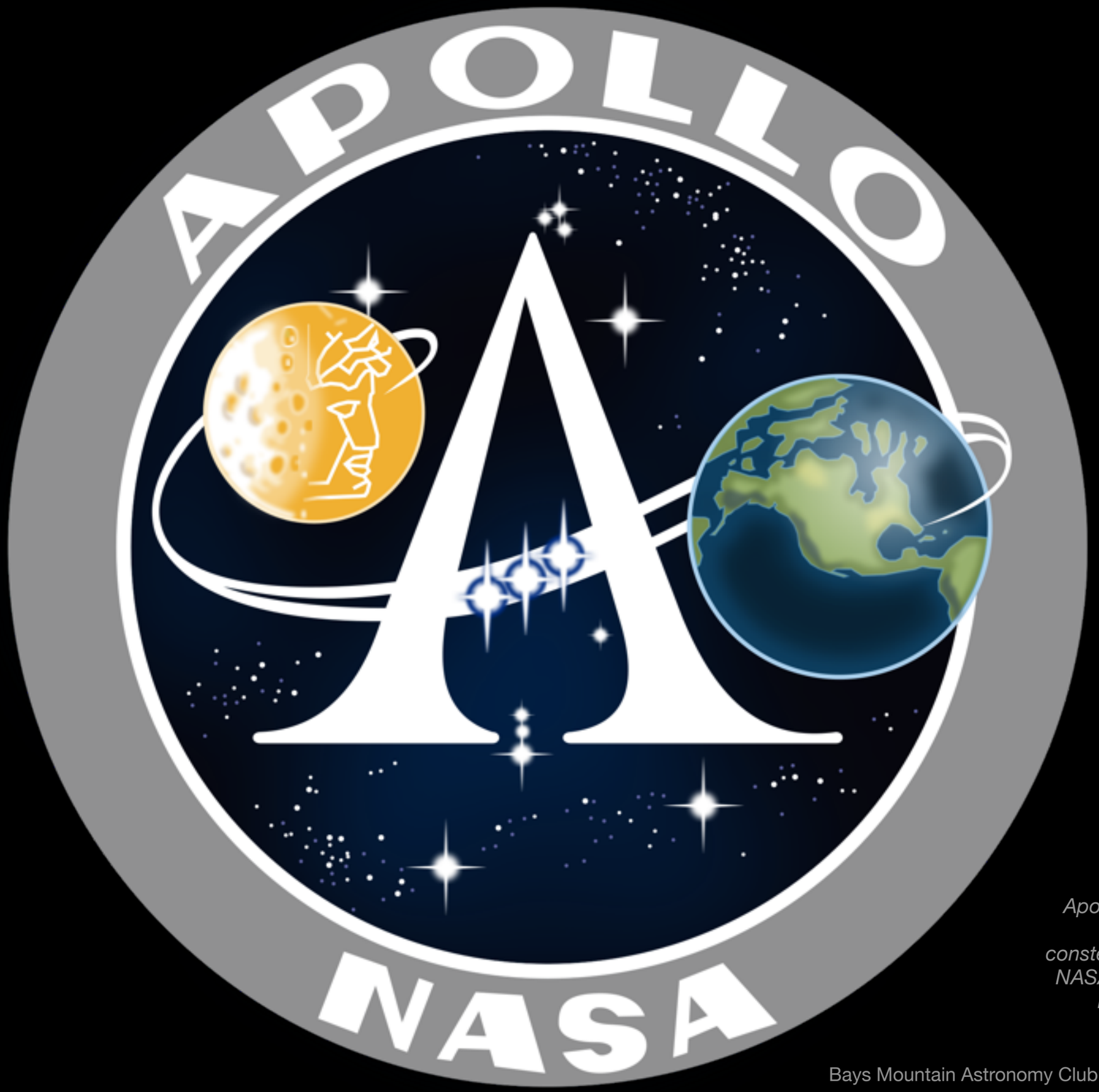
More on this image. See FN3

This is the anniversary we've been waiting for. Fifty years ago, men first set foot on the Moon. The story of how we got there is fascinating.

It all began in 1957, when the Soviet Union put the first manmade object in Earth orbit, Sputnik. The United States didn't get a satellite in orbit until 3 months later. Four years later, the USSR put the first man in orbit, Yuri Gagarin, with the US once again lagging behind, finally launching Al Shepard into space (but not orbit) a month later. The Space Race had begun, and America was bringing up the rear, largely due to the Soviets already having more powerful rockets built to propel ballistic missiles. President John Kennedy wanted to set a goal that would require technology that neither the US nor the USSR had, giving us an equal starting point. So, one month after Al Shepard's 15 minute trip into space, Kennedy made the announcement, "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth." Over the intervening years, the Gemini program tested all the components necessary during a lunar mission, except actually going to the Moon. At the same time, all the hardware needed for the mission was developed and built. Despite the horrific setback experienced by the Apollo 1 fire that killed the crew, the program moved forward. Apollo's 7, 8, 9, and 10 all tested various components of the Command Module (CM) where the astronauts were housed; the Lunar Module (LM) that would land them on the Moon; the Service Module (SM) which provided the electrical power, life support, and propulsion for the trip; and the Saturn V rocket that would launch everything into space and to the Moon.

The crew for this historic mission were Neil Armstrong (Commander), Michael Collins (Command Module Pilot), and Buzz Aldrin (Lunar Module Pilot). For all three men, this would be their second trip into space, and their last. In the fledgling space program, that was unusual, with Apollo 10 being the only other mission with all crew members having been in space on a previous mission. It wouldn't happen again until 1988 on the Space Shuttle mission STS-26.

Long before going into space, it was traditional for the crew to design an insignia for the mission patch. Michael Collins wanted the insignia to include a symbol of peace to represent the idea of



Apollo insignia. Can you find the constellation? Image by NASA. Vector version by Lommes.

Saturn V SA-506, the rocket carrying the Apollo 11 spacecraft, is rolled out of the Vehicle Assembly Building and down the 3.5 mile crawlerway to Launch Complex 39-A. Image by NASA.

“coming in peace.” Jim Lovell, the backup Commander, suggested a bald eagle to also symbolize the United States. One of the simulation instructors, Tom Wilson, thought they should include an olive branch as a symbol of peace. He originally proposed the eagle could carry the branch in its beak, but the images created looked aggressive with the eagle’s talons extended. The director of the Manned Spacecraft Center (MSC), Bob Gilruth, had the idea of moving the olive branch so that the eagle was carrying it in his talons. Collins wanted the background to be the Moon’s surface with the Earth above it. All three crew members thought the Moon and Earth should be in realistic colors, with the border being in gold and blue. They chose not to have their names on the patch, emphasizing that the mission was the work of everyone who had contributed to the program.

On missions that included both the CM and LM flying separately, each vehicle needed its own call sign. Since an eagle was included in the insignia, it was decided to the name the LM “Eagle.” For the CM, a name was chosen that had several references associated with it, “Columbia.” In the Jules Verne book, “From the Earth to the Moon,” the rocket was launched by a giant cannon, named Columbiad. It is also a reference to Christopher Columbus, and several ships that have been dubbed Columbia.

Before traveling to the Moon, a location for landing needed to be decided. The criteria for the landing sites included: being near the Moon’s equator, relatively free of craters, no large hills or other obstacles along the approach path, the Sun located between 7 and 20 degrees behind the LM for visibility, and terrain that is not too steeply angled. Notice that scientific interest was not a consideration. Five possible sites had been chosen based on pictures taken by various unmanned probes. The Sun angle, in particular, really limited their options, with launches being restricted to a few days per month. The time of landing needed to be when the Sun was still low in the sky to minimize the temperature extremes. Of the original five sites suggested, the Sea of Tranquility was chosen as the top candidate, with Sinus Medii and Ocean of Storms as the backups, in case of a launch delay. During the Apollo 10 mission, they flew over the Sea of Tranquility, and confirmed that it would be an acceptable landing site.

Before leaving Earth, another decision had to be made: who would walk first on the Moon? In all the earlier missions that involved an EVA (Extravehicular Activity or spacewalk), it never was the Commander, but the Pilot. This was done in case a problem arose, and the person performing the EVA had to be abandoned in space, so that the Commander could continue the mission. Because of this precedent, many people assumed that Buzz Aldrin would be the first to leave the LM and walk on the Moon. Aldrin, naturally, was all for going first, but NASA officials had a different plan. On April 14, 1969, it was officially announced that Armstrong would be first. There were two reasons for this

Apollo 11 Patch. Image by NASA.

The Apollo 11 lunar landing mission crew, pictured from left to right, Neil A. Armstrong, commander; Michael Collins, command module pilot; and Edwin E. Aldrin Jr., lunar module pilot. Image from NASA.

decision. First, the way the LM was designed, and where each man was located, it would have been more difficult to maneuver into position if Aldrin were to exit first. The second reason, which was based on the private views of the NASA brass, was that they wanted the first man on the Moon to be more like Charles Lindbergh, calm and quiet. Those two criteria could not be applied to Buzz.

After all of the preparations were complete, it was time to launch. The day before, the fuel tanks of the Saturn V were filled. That night, flood lights lit the spacecraft for all to see. On the morning of July 16, 1969, Deke Slayton, head of the Astronaut Office, woke up the crew at 4:00 a.m. for their tradition breakfast of steak and eggs. The crew suited up and were taken to the spacecraft. Fred Haise, the backup Lunar Module Pilot, and one of the pad technicians helped get the three men strapped into their seats. Once everyone was set, the support team left, and the hatch was sealed. At that point, the cabin was pressurized. The countdown began.

It is estimated that around one million people packed into coastal Florida to watch the launch from beaches and roadsides. At the VIP section of the Kennedy Space Center, attendees included hundreds of politicians from all over the US, including Vice President Agnew and former President Johnson, and thousands of media representatives from all over the world, with a third of the people present coming from 55 different countries. The launch was shown live on television, and estimates say that 25 million people watched in just the US, with millions more watching all over the world. At 9:32 a.m. EDT, on July 16, 1969, Apollo 11 launched for the Moon.

The first step was to get into Earth orbit. This required using the first two stages of the Saturn V rocket. The crew completed about one and a half orbits of Earth, taking a little over two hours, when the third stage was fired to initiate TLI, Trans-Lunar Injection, to leave Earth's orbit and head to the Moon. Once the fuel was completely used, the CM and SM separated from the third stage, turned around, and docked with the LM, which was stored inside the top of the third stage. Once they were docked, the LM was extracted from the rocket. Now it was time to head for the Moon.

During the three day journey, the crew prepared for their historic encounter with Earth's satellite. Along the way, they aired two TV broadcasts. The first was from the CM, while the second, on July 18, was from the LM, with Armstrong and Aldrin suited up to check out the Lunar Module's systems. The next day, they were in orbit around the Moon. During each of the 2 hour trips around the Moon, they photographed the lunar surface to be used in studies of lunar geology. They also looked at their landing site in great detail.

On July 20, it was time for Neil and Buzz to suit up and enter the LM. After five hours of getting everything ready, the lunar module separated from the command module, with Armstrong saying,

The Apollo 11 Saturn V space vehicle lifts off with astronauts Neil A. Armstrong, Michael Collins and Edwin E. Aldrin, Jr., at 9:32 a.m. EDT July 16, 1969, from Kennedy Space Center's Launch Complex 39A. Image by NASA.

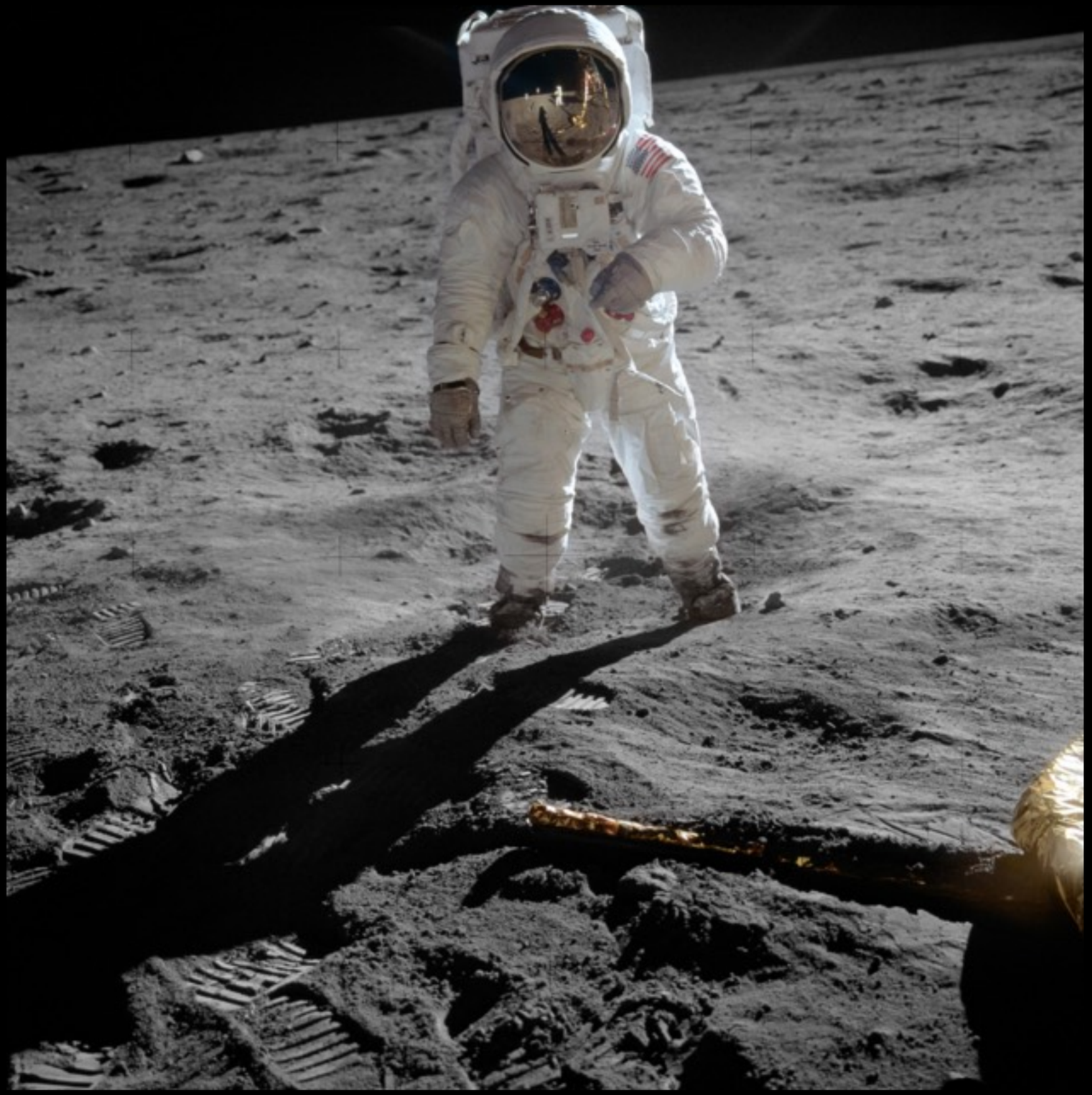
The Apollo 11 Lunar Module Eagle, in a landing configuration was photographed in lunar orbit from the Command and Service Module Columbia. Inside the module were Commander Neil A. Armstrong and Lunar Module Pilot Buzz Aldrin. The long rod-like protrusions under the landing pods are lunar surface sensing probes. Upon contact with the lunar surface, the probes sent a signal to the crew to shut down the descent engine. Image by NASA.

“The Eagle has wings!” As Armstrong and Aldrin flew down to the surface, they realized that they were passing landmarks earlier than they should, and they concluded that they would be “long,” meaning that they would fly miles past their landing site before they were on the surface. Meanwhile, the guidance computer started showing program alarms. These turned out to be due to the computer being inundated with so much data, it couldn’t process it all in real time, so non-critical data was being stored for later processing. Margaret Hamilton, the Director of Apollo Flight Computer Programming, described the situation this way: “The software's action, in this case, was to eliminate lower priority tasks and re-establish the more important ones. The computer, rather than almost forcing an abort, prevented an abort. If the computer hadn't recognized this problem and taken recovery action, I doubt if Apollo 11 would have been the successful Moon landing it was.” It was eventually determined that both the landing radar and the rendezvous radar (to be used when docking back with the CM) were on. Turning off the rendezvous radar eliminated the information overload on future missions.

Now that they knew for sure it would be safe to land, the crew had more troubles arise. Armstrong saw that where they were headed to land would be an area filled with large boulders. The only thing to do was to take manual control and try to find a more suitable site. As Aldrin kept Armstrong appraised of the navigational data, and Mission Control notified them of their rapidly declining fuel levels, Armstrong concentrated on flying the craft to a safe location. He spotted a level area, but discovered a crater in the middle of it, however past the crater was a perfect place to land. At 100 feet above the surface, and 90 seconds of fuel remaining, Armstrong began his descent. The closer he got to the surface, the more the LM’s engines kicked up dust, making his ability to see what he was doing more difficult. Armstrong used two boulders jutting above the dust as his reference points to gauge how fast he was moving as he descended. With 25 seconds of fuel remaining, one of the probes hanging down from the landing pads touched the surface, prompting Aldrin to announce, “Contact light!” Armstrong was supposed to cut the engines at this point and let the spacecraft drop the remaining 5 feet, but he forget and turned off the engines after they had landed. With 650 million people worldwide watching (20% of the world’s population), Armstrong radioed, "Houston, Tranquility Base here. The Eagle has landed.” Calling their location “Tranquility Base” was a spur of the moment decision by Armstrong, which caught his CAPCOM, Charlie Duke off guard, who replied, "Roger, Twan— Tranquility, we copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot."

The schedule had been set for the astronauts to sleep for five hours after the landing. The crew didn’t think they’d be able to sleep, so they began preparations to perform their EVA after eating a small meal. Two hours after landing, Aldrin radioed, “This is the LM pilot. I'd like to take this opportunity to ask every

The Apollo 11 Command and Service Modules (CSM) are photographed from the Lunar Module (LM) in lunar orbit during the Apollo 11 lunar landing mission. The lunar surface below is in the north central Sea of Fertility. The coordinates of the center of the picture are 51 degrees east longitude and 1 degree north latitude. About half of the crater Taruntius G is visible in the lower left corner of the picture. Part of Taruntius H can be seen at lower right. Image by NASA.



Astronaut Buzz Aldrin, lunar module pilot, stands on the surface of the moon near the leg of the lunar module, Eagle, during the Apollo 11 moonwalk. Astronaut Neil Armstrong, mission commander, took this photograph with a 70mm lunar surface camera. While Armstrong and Aldrin descended in the lunar module to explore the Sea of Tranquility, astronaut Michael Collins, command module pilot, remained in lunar orbit with the Command and Service Module, Columbia. Image by NASA.

person listening in, whoever and wherever they may be, to pause for a moment and contemplate the events of the past few hours and to give thanks in his or her own way." Aldrin was an elder in the Presbyterian Church and had brought with him a communion kit to commemorate the achievement. He intentionally left out any specific religious reference in his transmission due to complaints that had been made after the Apollo 8 mission had read from Genesis on their Christmas Eve broadcast.

Just landing had accomplished half of their primary goal: land on the Moon and return safely to Earth. Other objectives included: send TV broadcasts of the Moon; photograph the moon, the lander, and themselves; deploy experiment packages to measure the solar wind and seismic activity; set up the Laser Ranging Retroreflector, and gather samples from the Moon's surface. To accomplish those goals, they had to leave the spacecraft. In training, it had taken two hours to get ready to perform the EVA, but that was in ideal conditions and with everything laid out nicely. In reality, it took over three hours. Once they were set, the cabin was depressurized and the hatch was opened. Armstrong squeezed out of the hatch, his Portable Life Support System proving to be more awkward to maneuver with than expected. As Armstrong climbed down the ladder, he pulled a cord to open up the compartment on the side of the lander and activate the TV camera inside. At least 600 million people around the world watched Armstrong climb down onto the Moon.

Before stepping on the Moon, Armstrong uncovered the plaque attached to the part of the lander that would remain on the Moon, with images of the Earth, signatures of the crew members and President Nixon, and the caption, "Here men from the planet Earth first set foot upon the Moon, July 1969 A.D. We came in peace for all mankind." Armstrong described the powdery texture of the lunar surface and noted how far the landing pads had sunk into the dust. And then he stepped off the lander onto the Moon's surface, uttering the now famous declaration, "That's one small step for [a] man, one giant leap for mankind."

One of Armstrong's first tasks was to collect a sample of the soil and stow it in his spacesuit. This was a contingency plan, in case they had to leave quickly without any other samples. He then used the camera on the lander to film a panorama, and then the camera was mounted on a tripod for the remainder of the mission. Armstrong also carried with himself a camera for still images. Most of the photographs from this mission were taken by Armstrong with this camera. Twenty minutes after Armstrong stepped on the Moon, Aldrin joined him, describing the Moon as, "Magnificent desolation."

After testing out different ways of moving in the lower gravity, the astronauts settled on loping as the best method. The soil proved to be slicker than expected, so they had to think about what they were doing before actually moving. Aldrin noted that their spacesuit maintained temperature evenly from sunlight to

Apollo 11 Lunar Module Pilot Buzz Aldrin's bootprint. Aldrin photographed this bootprint about an hour into their lunar extra-vehicular activity on July 20, 1969, as part of investigations into the soil mechanics of the lunar surface. This photo would later become synonymous with humankind's venture into space. Image by NASA.

Buzz Aldrin salutes the U.S flag on the Moon (mission time: 110:10:33). His fingertips are visible on the far side of his faceplate. Note the well-defined footprints in the foreground. Buzz is facing up-Sun. There is a reflection of the Sun in his visor. At the bottom of Buzz's faceplate, note the white 'rim' which is slightly separated from his neckring. This 'rim' is the bottom of his gold visor, which he has pulled down. We can see the LEC straps hanging down inside of the ladder strut. In the foreground, we can see the foot-grabbing loops in the TV cable. The double crater under Neil's LM window is just beyond the LM shadow. Image by NASA.

shadow, but the helmet got warm in the sunlight.

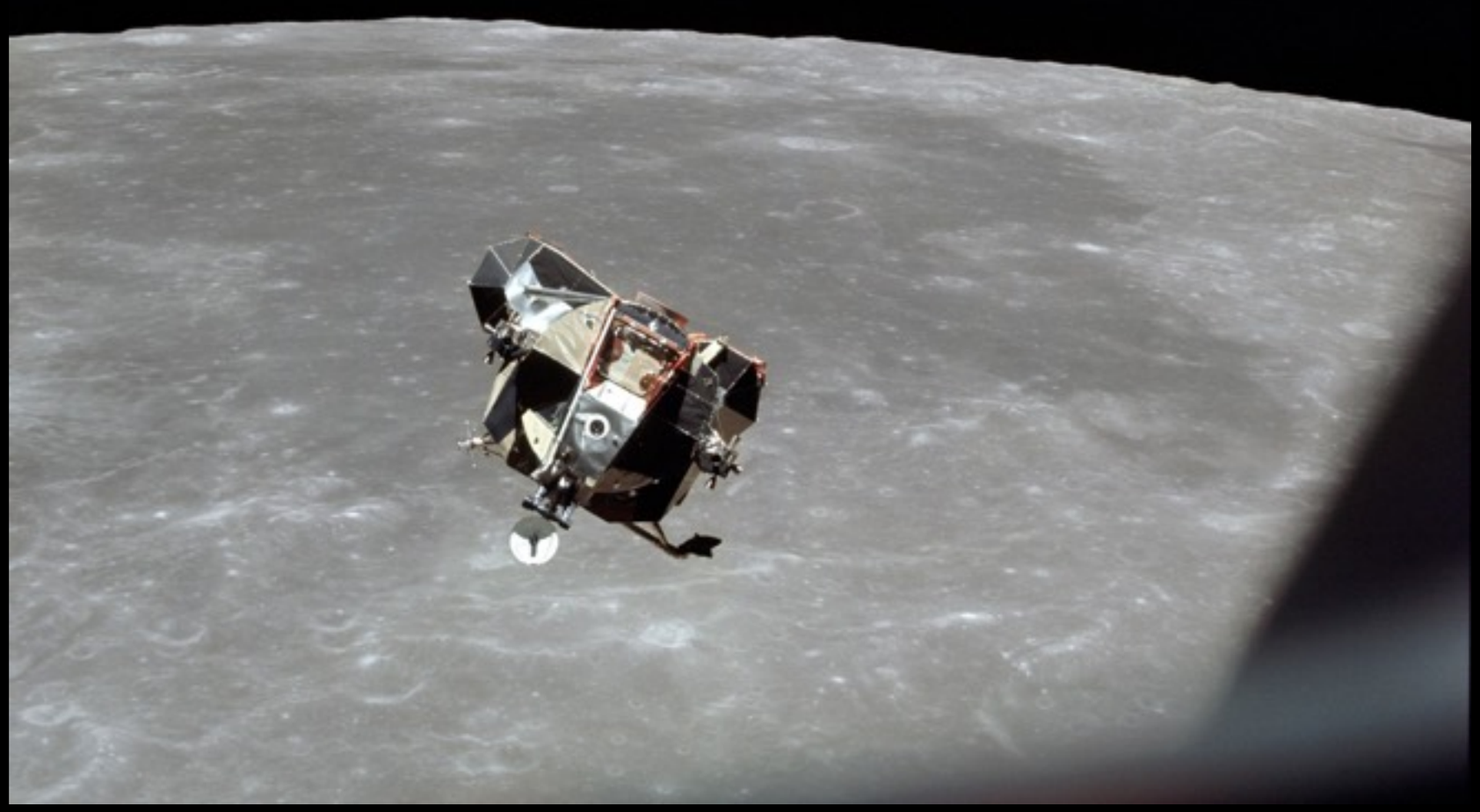
Before conducting any science, the crew set up the American flag. The hard ground prevented them from planting it as deeply as they wanted, and they were afraid it would fall over on live TV. President Nixon then spoke to the crew from the Oval Office to express his pride and thanks. Then they got to work taking care of all of the mission objectives. They accomplished them all, though it took longer than planned, so they stopped documenting things as thoroughly as they would like, and the crew was granted a 15 minute extension. All the experiment packages they left on the Moon worked, and they brought 47 pounds of lunar rocks and soil back home. The rocks were basalt and breccia. Three new minerals were found, which were dubbed armalcolite (named by combining Armstrong, Aldrin, and Collins), tranquillityite (named for the Sea of Tranquility), and pyroxferroite (named for the elements in the mineral). Later, all three types of minerals were found on Earth.

Unbeknownst to the crew, they almost weren't the first ones to return pieces of the Moon to Earth. Three days before the launch of Apollo 11, the Soviet Union launched Luna 15, which arrived at the Moon before the Americans. It was supposed to land on the Moon, retrieve a sample, and return to Earth. However, while Neil and Buzz were two hours away from leaving the Moon's surface, Luna 15 suffered a malfunction and crashed in Mare Crisium.

After two and a half hours of exploring the region within 300 feet of the lander, it was time to reenter Eagle. Aldrin went in first. Loading all of the sample boxes was a challenge, with the pulley system not working very well. It was ultimately decided that it would be easier to just carry the boxes up by hand. A bag of memorial items was left on the Moon, which included: medallions with the names of the three astronauts killed in the Apollo 1 fire and two cosmonauts who had died in accidents; a gold replica of an olive branch; a silicon message disk carrying messages from Presidents Eisenhower, Kennedy, Johnson, and Nixon, and from leaders of 73 other countries; plus names of various congressmen and NASA officials. Once this was placed on the surface, Armstrong entered the LM. The next task was to toss out anything not needed for the return trip in order to lighten the weight of the spacecraft. Then the hatch was closed and the ship was pressurized.

During all of this activity, Aldrin bumped into a circuit breaker and broke part of the switch needed to activate the engine for take-off. Fortunately, they discovered that they could use a felt-tip pen to hit the switch.

NOW they could sleep. However, the LM, being designed to be as light as possible, didn't even have seats, let alone a place to sleep, so Neil Armstrong slept on the floor, while Buzz Aldrin rigged up a sort of hammock in one corner. After sleeping for seven hours, it was time to wake up and leave the Moon. Two and



The Apollo 11 lunar module, the Moon, and the Earth.

A view of the Apollo 11 lunar module Eagle as it returned from the surface of the moon to dock with the command module Columbia. A smooth mare area is visible on the Moon below and a half-illuminated Earth hangs over the horizon. The lunar module ascent stage was about 4 meters across. Command module pilot Michael Collins took this picture just before docking at 21:34:00 UT (5:34 p.m. EDT) 21 July 1969. (Apollo 11, AS11-44-6642) Image by NASA.

President Richard M. Nixon was in the central Pacific recovery area to welcome the Apollo 11 astronauts aboard the USS Hornet, prime recovery ship for the historic Apollo 11 lunar landing mission. Already confined to the Mobile Quarantine Facility (MQF) are (left to right) Neil A. Armstrong, commander; Michael Collins, command module pilot; and Edwin E. Aldrin Jr., lunar module pilot. Apollo 11 splashed down at 11:49 a.m. (CDT), July 24, 1969, about 812 nautical miles southwest of Hawaii and only 12 nautical miles from the USS Hornet. Image by NASA.

a half hours later, they lifted off. Film footage showed the flag being whipped around violently from the exhaust. Although not filmed, Aldrin saw it fall over. On future missions, they made sure to plant the flag further away from the LM.

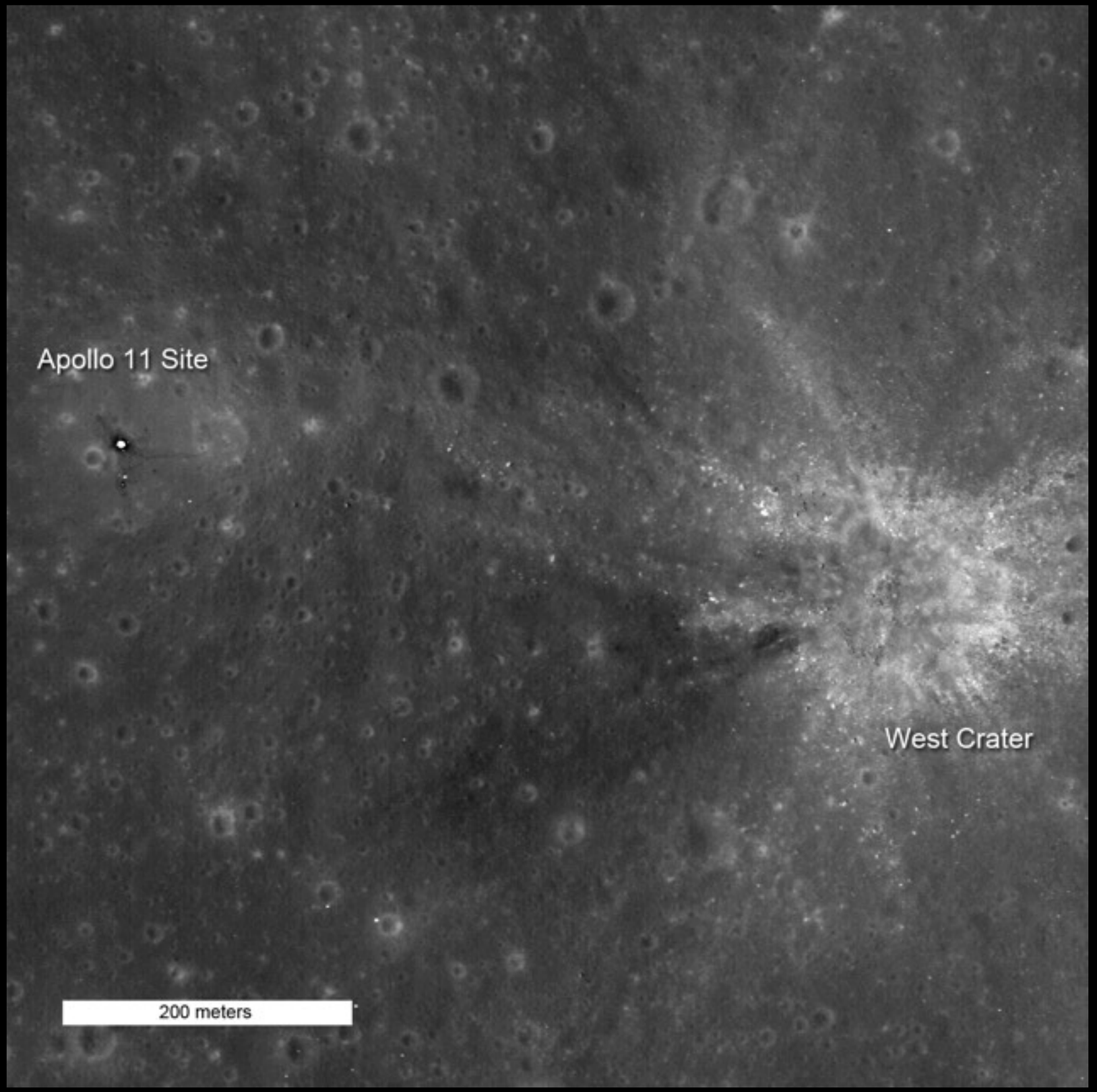
During the 21 hours that Neil and Buzz were on the Moon, Michael Collins was alone in the Command Module, but he didn't mind, later saying, "this venture has been structured for three men, and I consider my third to be as necessary as either of the other two." Out of each 2 hour orbit, 48 minutes were spent behind the Moon, where he had no radio contact with Earth or the crew on the Moon. Collins was not distressed by the isolation, describing his feelings as, "awareness, anticipation, satisfaction, confidence, almost exultation." And he didn't have a lack of things to do, either. He was supposed to find the LM on the surface, but despite several attempts, he never could find it, since they had landed four miles away from the expected spot. He also had various maintenance tasks to take care of, such as dumping excess water from the fuel cells and preparing the cabin for the crew's return. He experienced a problem with the coolant, with the possible result of part of the CM freezing up. Collins was instructed to control it manually. Instead, he just turned the system off and then back on, which seemed to fix it. (Isn't that always the case?) Once Neil and Buzz had settled in for sleep, Mike did, too.

On July 21, Eagle and Columbia docked back together. After transferring their samples into the CM, Eagle was jettisoned and left in orbit around the Moon. It would eventually crash into the Moon's surface. Then they fired the engines to leave lunar orbit and head home. Once they were headed back to Earth, the astronauts slept for another 10 hours.

On July 23, the crew made their last TV broadcast before splashing down. Collins said, "All you see is the three of us, but beneath the surface are thousands and thousands of others, and to all of those, I would like to say, 'Thank you very much.'" Aldrin's statement included, "This has been far more than three men on a mission to the Moon; more, still, than the efforts of a government and industry team; more, even, than the efforts of one nation. We feel that this stands as a symbol of the insatiable curiosity of all mankind to explore the unknown." Armstrong closed the broadcast with, "We would like to give special thanks to all those Americans who built the spacecraft; who did the construction, design, the tests, and put their hearts and all their abilities into those craft. To those people tonight, we give a special thank you, and to all the other people that are listening and watching tonight, God bless you. Good night from Apollo 11."

Prior to splashdown, it was found that the weather at their target zone would have poor visibility, which would prevent the helicopters from finding the capsule. So it was decided to change

Ticker tape parade for the Apollo 11 astronauts. Location is Manhattan, New York City on the section of Broadway known as the "Canyon of Heroes". Pictured in the lead car, from the right, are astronauts Neil A. Armstrong, Michael Collins and Edwin E. Aldrin, Jr. Image by NASA.



West Crater with boulders which Neil Armstrong had to overfly before the first manned lunar landing. LROC (Lunar Reconnaissance Orbiter Camera) took this picture from orbit in autumn of 2009. The descent stage of the Eagle is to the upper left. Image by NASA.

the landing location to a spot about 200 miles away. This changed the flight plan, so new instructions were sent up to the crew. On the morning of July 24, four helicopters and three escort planes were launched from the USS Hornet, carrying divers, recovery equipment, cameras, and the decontamination team. After 8 days, 3 hours, and 18 minutes in space, Columbia splashed down in the Pacific Ocean, 13 miles from the aircraft carrier. Despite landing upside down, the flotation bags inflated and righted the spacecraft. The recovery helicopters arrived and stabilized the capsule. Divers brought the crew their Biological Isolation Garments, which the crew put on before leaving the capsule to prevent bringing back anything lethal from the Moon. After lifting the crew members into a helicopter, the life raft they were on was sunk to avoid any contamination. The capsule was wiped down with chemicals to kill anything that might be on its surface. On the Hornet, the crew entered the Mobile Quarantine Facility (MQF), which was a modified Airstream trailer. With them would be a physician and MQF project engineer, who would join them in the larger isolation facility in Houston two days later. They would remain in isolation for a total of 21 days (including their 8 days in space), to make sure they weren't carrying anything infectious. The Columbia capsule was placed next to the MQF and attached by a flexible tunnel. This allowed the crew to bring the lunar samples, film, data tapes, and other items into the MQF. On August 10, 1969, the Apollo 11 crew were set free.

But they weren’t done! Three days later, they were in not one, but two, ticker-tape parades: one in New York City, and the other in Chicago. Roughly 6 million people attended the parades. Then that evening, they were flown to Los Angeles for a state dinner with members of Congress, 44 governors, 83 ambassadors, the Chief Justice, Vice President Agnew, and President Nixon, who awarded each crew member with the Presidential Medal of Freedom. In September, the crew spoke to a joint session of Congress. Then they set off on a 38-day world tour to 22 countries. They weren’t the only ones on tour. The Columbia spacecraft visited every state and Washington, DC, before becoming part of the collection of the Smithsonian National Air and Space Museum. In anticipation of the 50th anniversary, Columbia has been on tour again, visiting Houston, Saint Louis, Pittsburgh, and Seattle. Neil and Buzz’s spacesuits had been on display at the Smithsonian up to this last December, when the Moon exhibit was closed, though there will be a special display this July. The Moon rocks are kept at Houston and White Sands, New Mexico. Over 100 labs have studied the samples, with roughly 500 samples sent out each year. The seismic experiment left on the Moon lasted for about a month, but the retroreflectors are still being used.

Landing on the Moon was one of the most spectacular human accomplishments, ever. NASA is now planning to return to the Moon in 2024. Will it spark people’s imaginations the same way Apollo 11 did? I hope so, but the cynic in me says that it won’t.

The Apollo era was a magical time that we will never be able to recreate. Maybe when we have people landing on Mars we will see the same enthusiasm return. Meanwhile, we can celebrate 50 years since we first landed on the Moon and relive a little of the excitement that the world felt in 1969.

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Chapter 5

Space Place

More on this image. See FN6

David Prosper

Observe the Moon and Beyond: Apollo 11 at 50

More on this image. See FN3

Saturn is at opposition this month, beckoning to future explorers with its beautiful rings and varied, mysterious moons. The Moon prominently passes Saturn mid-month, just in time for the 50th anniversary of Apollo 11!

Saturn is in opposition on July 9, rising in the east as the Sun sets in the west. It is visible all night, hovering right above the teapot of Sagittarius. Saturn is not nearly as bright as Jupiter, nearby and close to Scorpius, but both giant planets are easily the brightest objects in their constellations, making them easy to identify. A full Moon scrapes by the ringed planet late in the evening of the 15th through the early morning of the 16th. Some observers in South America will even see the Moon occult, or pass in front of, Saturn. Observe how fast the Moon moves in relation to Saturn throughout the night by recording their positions every half hour or so via sketches or photos.

While observing the Saturn-Moon celestial dance the early morning of the 16th, you can also contemplate the 50th anniversary of the launch of the Apollo 11 mission! On June 16, 1969, Apollo 11 blasted off from Cape Canaveral in Florida on a journey of almost a quarter million miles to our nearest celestial neighbor, a mission made possible by the tremendous power of the Saturn V rocket – still the most powerful rocket ever launched. Just a few days later, on July 20, 1969 at 10:56 p.m. EDT, Neil Armstrong and Buzz Aldrin set foot on the lunar surface and became the first people in history to walk on another world. The astronauts set up equipment including a solar wind sampler, laser ranging retroreflector, and seismometer, and gathered up almost 22 kilograms (48 pounds) of precious lunar rocks and soil samples. After spending less than a day on the Moon's surface, the duo blasted off and returned to the orbiting Columbia Command Module, piloted by Michael Collins. Just a few days later, on July 24, all three astronauts splashed down safely in the Pacific Ocean. You can follow the timeline of the Apollo 11 mission in greater detail at bit.ly/TimelineApollo11 and dig deep into mission history and science on NASA's Apollo History Site: bit.ly/ApolloNASA.

Have you ever wanted to see the flag on the Moon left behind by the Apollo astronauts? While no telescope on Earth is powerful enough to see any items left behind the landing sites, you can discover how much you can observe with the Flag on the Moon handout: bit.ly/MoonFlag.

The Moon

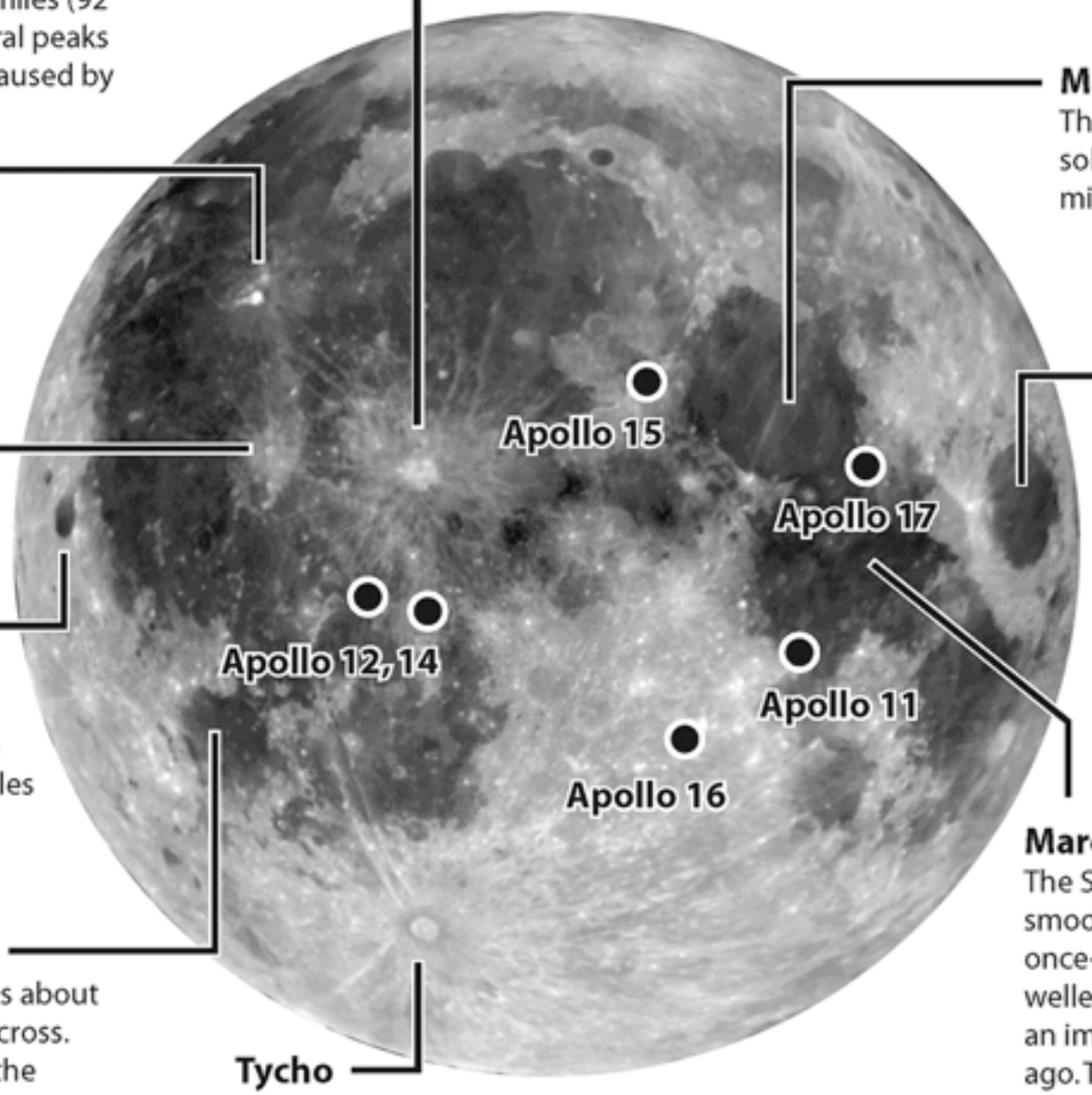
Copernicus
This crater (left) is easy to spot. It formed about 800 million years ago, and is 57 miles (92 km) wide. Note central peaks and terraced walls, caused by impact.

Aristarchus
Young crater. So bright that Sir William Herschel thought it was an active volcano.

Kepler
Small version of Copernicus

Grimaldi
Lava-filled crater is one of the darkest spots you can see on the Moon. It's 145 miles wide (233 km).

Mare Humorum
The Sea of Moisture is about 220 miles (350 km) across. You can spot it with the naked eye. With a telescope, you might notice two craters along its edge.



Tycho
Young crater best seen during a full Moon. Rays of bright material are ejecta blasted out of the crust when a large asteroid struck about 109 million years ago.

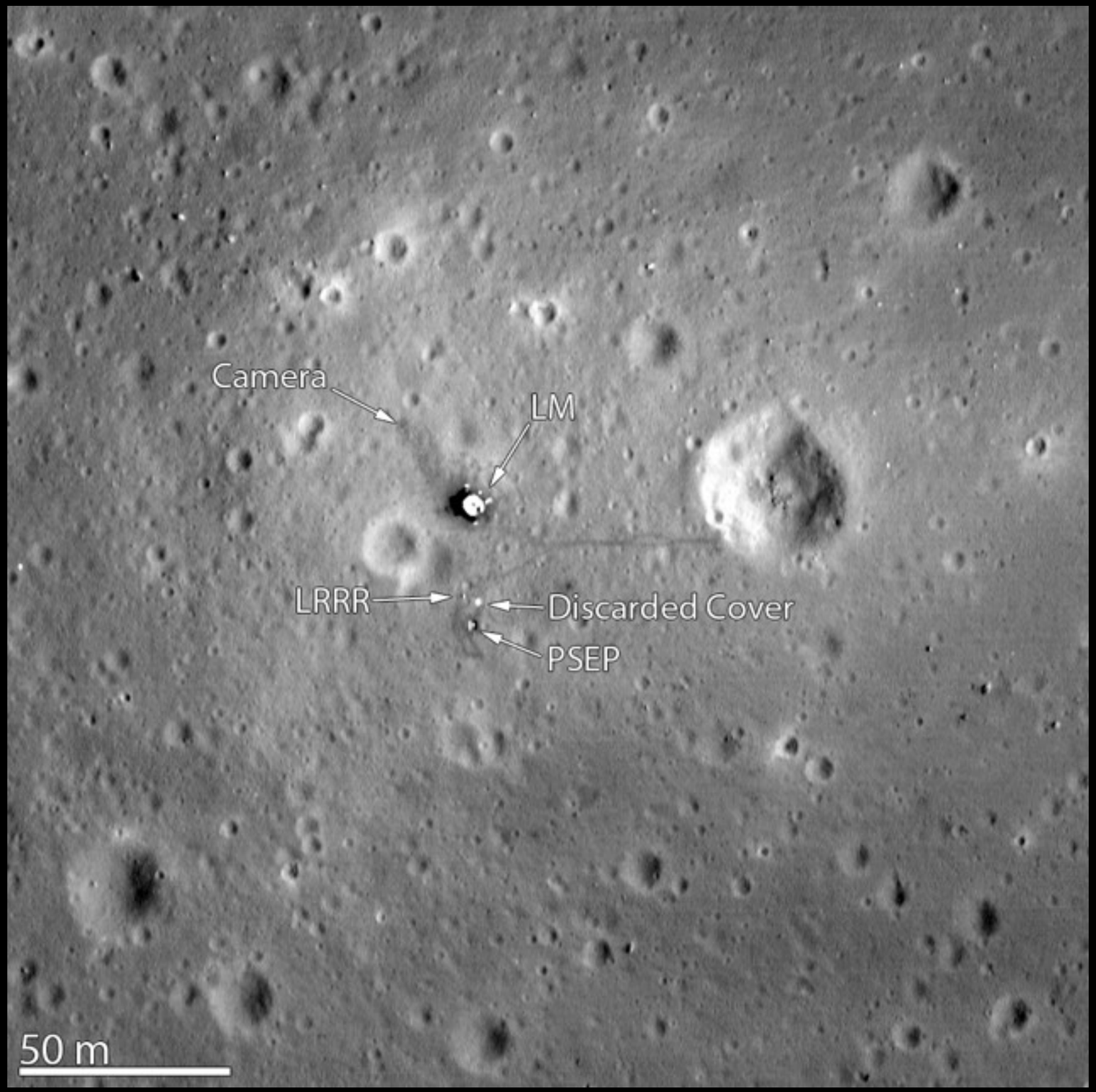
Mare Serenitatis
The Sea of Serenity is solid lava, some 380 miles (610 km) across.

Mare Crisium
The Sea of Crisis is about 340 miles wide (550 km) and visible to the naked eye.

Mare Tranquillitatis
The Sea of Tranquility is a smooth plain filled with once-molten lava that welled up from below after an impact billions of years ago. The first humans to walk on the Moon, Apollo 11 astronauts, landed near the edge.

SOURCES: NASA; ADVANCED SKYWATCHING; CAMBRIDGE ATLAS OF ASTRONOMY; DK VISUAL ENCYCLOPEDIA

Photos: James Scala. Layout and text for Moon map used with permission: Robert Roy Britt/SPACE.com.



More on this image. See FN9

You can catch up on all of NASA's current and future missions at nasa.gov.

This article is distributed by NASA Night Sky Network. The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.org to find local clubs, events, and more!

Chapter 6

BMAC Calendar and more

More on this image. See FN7

BMAC Calendar and more

More on this image. See FN3

Date	Time	Location	Notes
BMAC Meetings			
Friday, August 2, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program TBA; Free.
Friday, September 6, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program TBA; Free.
Friday, October 4, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program TBA; Free.
Friday, November 1, 2019	7 p.m.	Nature Center Discovery Theater	Program: Program TBA; Free.
SunWatch			
Every Saturday & Sunday March - October	3-3:30 p.m. if clear	At the dam	View the Sun safely with a white-light view if clear.; Free.
StarWatch			
Oct. 5, 12, 2019	7:30 p.m.	Observatory	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.
Oct. 19, 26, Nov. 2, 2019	7 p.m.		
Nov. 9, 16, 23, 30, 2019	6 p.m.		
Special Events			
Saturday, July 13, 2019	6 p.m.	To be sent directly to full BMAC members	Annual club picnic. BMACers and their families are most welcome to enjoy the evening of astronomy themed games and activities along with a potluck dinner and observing. Please bring a dish to share. Bring your own chair.
Oct. 18-20, 2019	-	Farmstead	StarFest 2019. Our 36th annual astronomy convention/star gathering for the Southeast United States. Three days of astronomy fun, 5 meals, 4 keynote speakers, unique T-shirt, and more. ***Pre-registration by Sept. 27, 2019 with full payment is mandatory for attendance. Sorry, no walk-ins nor "visits."*** Registration will open in August.

Bays Mountain Astronomy Club

853 Bays Mountain Park Road

Kingsport, TN 37650

1 (423) 229-9447

www.BaysMountain.com

AdamThanz@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:

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

Regular Contributors:

William Troxel

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

Robin Byrne

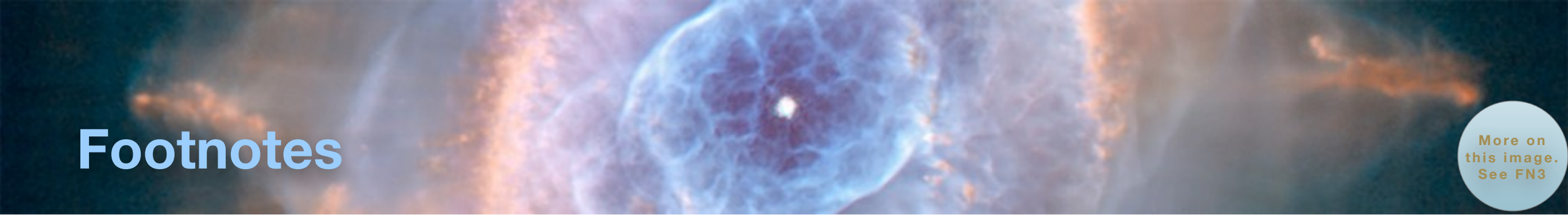
Robin has been writing the science history column since 1992 and was chair in 1997. She is an Associate Professor of Astronomy & Physics at Northeast State Community College (NSCC).

Jason Dorfman

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

Adam Thanz

Adam has been the Editor for all but a number of months since 1992. He is the Planetarium Director at Bays Mountain Park as well as an astronomy adjunct for NSCC.



Footnotes

More on this image. See FN3

Footnotes:

1. The Rite of Spring

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

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

The 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.

For more information about the Cassini-Huygens mission visit http://saturn.jpl.nasa.gov/. The Cassini imaging team homepage is at http://ciclops.org.

Image Credit: NASA/JPL/Space Science Institute

2. Leo Rising

A sky filled with stars and a thin veil of clouds.

Image by Adam Thanz

3. The Cat's Eye Nebula, one of the first planetary nebulae discovered, also has one of the most complex forms known to this kind of nebula. Eleven rings, or shells, of gas make up the Cat's Eye.

Credit: NASA, ESA, HEIC, and The Hubble Heritage Team (STScI/AURA)

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

4. Jupiter & Ganymede

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

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

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

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

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

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

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

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

5. 47 Tucanae

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

To the fascination and puzzlement of planet-searching astronomers, the results offer a sobering 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 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 July 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. Observe the larger details on the Moon with help from this map, which also pinpoints the Apollo landing site. Full handout available at bit.ly/MoonHandout.

9. Earth-based telescopes can’t see any equipment left behind at the Apollo 11 landing site, but the cameras onboard NASA’s Lunar Reconnaissance Orbiter (LRO) can. This is Tranquility Base as seen from the LRO, just 24 kilometers (15 miles) above the Moon’s surface, with helpful labels added by the imaging team. Image Credit: NASA Goddard/Arizona State University. See more landing sites at: bit.ly/ApolloLRO.