http://www.raclub.org/

The StarGazer

Newsletter of the Rappahannock Astronomy Club No. 2 Vol. 7 August 2018–October 2018

Pilgrimage to the Great Refractor

By Scott Busby

"Time always takes from us those things we hold most dear"

The Yerkes Observatory belongs to the Department of Astronomy and Astrophysics of the University of Chicago (UChicago). Established in 1897 on Lake Geneva in Williams Bay, Wisconsin, the observatory, situated on a 78-acre park site, houses all the Department's activities. Most of the important history of Yerkes Observatory can be found at astro.uchicago.edu. I won't elaborate too much on its history here; suffice it to say that this great observatory was the result of the hard work and dedication of George Ellery Hale (1868–1938). Hale had a unique ability to talk wealthy tycoons into funding his astronomical endeavors—pun intended. We can thank him for some of the great telescopes of our time. Some of the more familiar are the 60- and 100-inch Hooker reflecting telescopes on Mount Wilson near Pasadena and his namesake, the Great 200-inch Hale reflecting telescope at Mount Palomar observatory near San Diego.

The 40-Inch Alvan Clark & Sons Refractor Credit: Scott Busby

On March 7, 2018, UChicago announced plans to wind down its activities at Yerkes Observatory. As a result, the observatory will close its doors to visitors and researchers on October 1, 2018, with no prospects and no immediate plans to reopen

In the last month, my wife Debbie and I decided to take a trip to Williams Bay to visit the Yerkes Observatory and its great 40-inch refractor telescope. It was an important trip because UChicago, which owned the observatory and its environs since 1897, was relinquishing control and responsibility. To whom the ownership of the observatory will fall remains unknown.

We arrived in Williams Bay on September 16, 5 short days before my 66th birthday. We stayed at a little bed & breakfast called Lazy Cloud B&B located less than a mile from the observatory. After a goodnight's rest, we went to the observatory in time for the 12:30 p.m. tour. Only two daytime tours were offered, one at 12:30 p.m. and again at 2:00 p.m. Each $10 per person "barebones" tour was guided by a staff astronomer or administrator and lasted about an hour and a half. The weather was very rainy, and it seemed, by the number of visitors, to be a popular rainy-day activity by mostly local folks. It was a big crowd. Incidentally, the observatory is locked all the time except during the authorized tour schedule. Only then do they unlock the doors and open the gift shop. We had planned on staying 4 days so I could catch more than one daytime tour and one evening tour so hopefully, I would get an opportunity to observe through the 40-inch refractor. Plus, it would give me some time to walk the grounds and study the unique and beautiful Victorian era architecture of the main observatory building and its giant telescope domes.

Our tour guide opened the main doors a little early so we could get out of the rain. The twin foyer opened into a huge rotunda with a bronze bust of Charles T. Yerkes prominently displayed alongside an early pendulum astronomical clock. The observatory has two wings; one leads to (continued on page 4)

How to Join RAClub

RAClub is a non-profit organization located in the Fredericksburg, Virginia, area. The club is dedicated to the advancement of public interest in, and knowledge of, the science of astronomy. Members share a common interest in astronomy and related fields as well as a love of observing the night sky.

Membership is open to anyone interested in astronomy, regardless of his/her level of knowledge. Owning a telescope is not a requirement. All you need is a desire to expand your knowledge of astronomy. RAClub members are primarily from the Fredericksburg area, including, but not limited to, the City of Fredericksburg and the counties of Stafford, Spotsylvania, King George, and Orange.

RAClub annual membership is $20 per family. Student membership is $7.50. Click here for a printable PDF application form.

The RAClub offers you a great opportunity to learn more about the stars, get advice on equipment purchases, and participate in community events. We meet once a month and hold regular star parties each month on the Saturday closest to the new Moon. Our website, www.raclub.org is the best source of information on our events.

We also have an active Yahoo group that you can join to communicate with the group as a whole. Just click the link, then the blue Join this Group! button, and follow the instructions to sign up. We also have a Facebook presence.

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Jerry Hubbell Astrophotography
Myron Wasiuta Mark Slade Remote Observatory (MSRO)

Calendar of Upcoming Events

Star Party, Stratford Hall	November 10
Star Party, Caledon State Park*	January 6

Recent Outreach Events Completed

MSRO Training Session, Orange Library	September 29
Star Party, Caledon State Park	October 6
Meet the Moon, Porter Library, Stafford	October 20
MSRO Training Session, Orange Library	October 27

*A program will precede this star party. To learn the topic, visit raclub.org prior to your visit.

President's Corner

Welcome all astronomy-lovers to another great fall edition of *The StarGazer* newsletter. It has been a busy few months, and there is a great variety of articles included below about Yerkes Observatory, club activities, the Mark Slade Remote Observatory, reviews and another focus on the Moon.

Thanks goes to Scott Busby for hosting another annual club picnic at Belmont Observatory in August. October was the first Caledon star party of the fall, and the sky really cleared up for an hour or so, just at the right time. Our next observing event will be 10 November at Stratford Hall, weather permitting. Hope to see you all out there among the stars.

Clear Skies,

Scott Lansdale

Astronomy Math: The Doppler Equation — by Scott Busby

In the Doppler equation, the apparent wavelength λ_{app} and the true wavelength λ_{true} can be expressed in any units of length (meters, km, μm, or nm), as long as they are the same units. Likewise, the speed of recession ν_{rec} and c (the speed of light) can be expressed in any units of speed (such as feet per second, kilometers per hour, or miles per hour), as long as they are the same units. Because ν_{rec} is the speed of recession, its value is positive if the source and observer are getting farther apart (receding) and negative if they're getting closer together (closing).

Of course, most things in the Universe are moving much more slowly than the speed of light, so the ratio ν_{rec}/c is almost zero, making the right side of the equation very close to 1. And if the right side is about 1, then λ_{app} is almost identical to λ_{true}; consequently, you must make very precise measurements (and keep lots of decimal places in your calculations) to see any difference at all. The following example illustrates.

A star is moving away from the Earth at a speed of 300 km/s. If that star is emitting radiation at a wavelength of 530 nm, what wavelength would be measured by an observer on Earth?

Because you're given the emitted wavelength λ_{true} and the speed of recession (ν_{rec}), and you're trying to find the apparent wavelength λ_{app}, you can plug your values directly into the Doppler shift equation. As always, it's a good idea to rearrange the equation to solve for the quantity you're trying to find (λ_{app} in this case) before plugging in any numbers.

$$\frac{\lambda_{app}}{\lambda_{true}} = 1 + \frac{\nu_{rec}}{c}$$

$$\lambda_{app} = \lambda_{true}\left(1 + \frac{\nu_{rec}}{c}\right),$$

$$\lambda_{app} = (530\ \text{nm})\left(1 + \frac{300\ km/s}{3\ x\ 10^5\ km/s}\right)$$

(Note that you must use the same units for c and ν_{rec}.) Thus:

$$\lambda_{app} = (530\ \text{nm})(1 + 0.001) = 530.53\ \text{nm},$$

a change of wavelength of only 0.53 nm, which is only 0.1% of the true wavelength.

Can such a small shift really be detected? After all, 530 nm is in the green portion of the spectrum, and so is 530.53 nm. So the "redshift" in this case does not change the color of the light from green to red. Fortunately, astronomers know (with extreme precision) the exact wavelength of many spectral lines, and tiny shifts in those spectral lines have been used to measure Doppler shifts from the objects moving at speeds less than 1 m/s relative to the Earth.

Pilgrimage to the Great Refractor (continued from page 1)

the 40-inch refractor dome and the other is dedicated to an observatory museum and leads to the domes for the 40-inch reflector (called the 41-inch to avoid confusing it with the 40-inch refractor) and a 24-inch reflector telescope. In an adjacent facility (called the south building), there is a 14-inch go-to reflector and a 9-inch Schmidt camera, each under its own dome.

After describing the observatory facility and providing a brief history lesson, our guide directed us up a long staircase to the dome that housed the great 40-inch refractor. I took the lead as our guide opened the door and was the first to take in the amazing view of the huge telescope. Our guide directed the group to file along the curved wall observatory dome where seats were available for visitors. Our guide counted off the number of guests, and after we were seated, I learned that he did that so the last 19 people would be directed onto the observatory's elevator floor. We learned that the elevator floor had a maximum capacity limit of no more than 20 people at a time. At one point, our guide demonstrated the raising and lowering of the floor. Because the refractor was mounted high up on its mount, the elevator floor had to be raised so an observer could reach the eyepiece end of the telescope.

Owing to the impending closure, most of the observatory's prime gift shop retail items had long since been purchased. I did, however, score a couple T-shirts, some photos, and a coffee mug. Because I collect coffee mugs from famous observatories, this was a must. The problem though, was that the mugs were sold out. Debbie was quick to ask the vendor if there might be some in the back. She was told that there were two mugs but they were damaged. I asked to see the least damaged mug and offered to buy it, with a discount of course. The mug had a couple of small chips, but it was good enough for me.

At this point, I had already decided to do the day tour again before my scheduled nighttime telescope viewing tour on the 40-inch. Interestingly, a fellow amateur astronomer named John Gill had posted on FaceBook that he had arrived in Milwaukee from South Africa and needed a ride down to Yerkes Observatory. He ended up taking an Uber down to Yerkes for about $60. At the observatory, just before the second day tour began, I noticed a gentleman step from an Uber car with a T-shirt depicting a telescope. I assumed this was John so I approached him and introduced myself. John had planned on taking the 2:00 p.m. day tour and viewing that night with the 24-inch telescope. John and I hung out together for the day tour and talked astronomy all the while. After the tour, I pulled John aside and told him to hang back so we could ask our guide, Richard Dreiser, more pointed questions. As the other visitors peeled away, I asked Richard what amateur astronomers who had travelled so far from northern Virginia and South Africa had to do to get a more in-depth tour of the observatory and the other telescopes. Richard, being in a very magnanamous mood, responded with a welcomed, "I have a little time, so I'll take you around." Yes! This is just what John and I had hoped for.

I was able to talk Richard into a behind-the-scenes tour of the observatory backrooms, instrumentation, and photographic archives. I videotaped most of the tour a little GoPro camera I had with me. Richard gave us access to areas of the observatory normally reserved for only select staff. With the impending closure, everything was more or less in disarray, and we found areas that had not been visited by observatory staff in years.


The photo-archive room at Yerkes Observatory Credit: Scott Busby

I hope I didn't annoy Richard when I asked him to open every box, cupboard, and cabinet we came across in hopes of discovering something historically significant. We did find one of the circa 1960s glass plate cameras that was used on the 40-inch refractor, several filar micrometers and even an old spectrograph reader. All of these rediscovered items were either tucked away in wooden boxes or on a bench with years of dust on them. There was a ton of old photographic equipment scattered about, including several old-school photographic enlargers. In the image archive, thousands upon thousands of 8x10 glass and film photographic plates were safely tucked away in labeled envelopes and stored in IBM filing cabinets. I was even allowed to use the light table to study a glass plate of Messier 92, a globular cluster, taken by the 40-inch refractor. This rare plate was one of 127,000 photographic plates stored there.

Over the course of our semi-clandestine tour, it was obvious that Richard was very proud of showing us all of the goodies he could remember—and a few that he didn't, from his 38 years at the observatory. In payment for our secret expedition, John Gill and I helped Richard load a small refrigerator and some tubs of personal gear from his office into his car. He and the other staff members were under a deadline to vacate their offices by the coming Friday. John was very grateful that I had pulled him along into what turned out to be a 2-hour extension to the normal day tour. John, Debbie, and I had a nice dinner together on Lake Geneva waiting for the weather to clear and the sky to get dark for our anticipated telescope viewing tours.

On the evening of September 20 at about 10:15, we started our 40-inch telescope observing experience. The weather had miraculously cleared, giving us a good 4-hour window for observation. The telescope operators, Chuck Flores and Katya Gozman, were very knowledgeable and filled us with plenty of telescope and astronomy knowledge. Katya is an astronomy student at UChicago and was volunteering her time operating the 40-inch telescope for public outreach.

John Gill and Scott Busby examining old photographic plates

We began our observations on the 40-inch with Saturn. It was low on the horizon since Williams Bay is at almost 42 degrees north latitude. The view of Saturn was unremarkable largely because of the planet's low elevation and the somewhat poor seeing. I have seen better performance on Saturn with my 12-inch FRC telescope, but nevertheless, Saturn's moons did jump right out at you and were quite obvious as very small disks. Cassini's Division was well rendered but not so the Encke Gap. Atmospheric turbulence created sort of a false color rendition of Saturn that was a little distracting. Rating on a scale of 1-5, I gave Saturn a 2.

Next, the great refractor was positioned over the crater Gassendi on the Moon. Now this was spectacular! Detail of the crater was phenomenal, and the number of craterlets visible in Mare Humorum nearby was incredible. I gave the Moon a 4.

The next object we observed was Mars. The atmosphere had settled down a bit, and some terrain features were obvious on the red planet, but not detailed. The south polar cap stood out amazingly and was vivid and relatively sharp during moments of good seeing. I could tell that on a night of exceptional seeing, the 40-inch refractor's performance on Mars would be spectacular. Owing to that night's seeing conditions, Mars was given a solid 3.

Following Mars, the staff slewed the telescope to the globular cluster Messier 15 (M15). Here is where the 40-inch really starts to perform. The stars in M15 were visually well resolved all the way to the core. M15 is a small globular, not nearly as spectacular as Messier 13, but well worth the view through the 40-inch refractor. I gave the view of M15 a solid 4.5.

The final object for the night was National Galactic Catalogue (NGC) 7662, commonly known as the Blue Snowball Nebula. It is a planetary nebula located in Andromeda about 2,000–6,000 light-years distant at magnitude 8.6. In terms of performance, the 40-inch telescope blew this object out of the water. This nebula has a very obvious electric blue color with a very prominent inner shell. At its center, with averted vision one could see the small white dwarf star slowly burning away its remaining fuel. I spent the most time on this object, and I gave the view of the Blue Snowball a solid 5.

Over the course of the roughly 2.5 hours of telescope time, the elevator floor failed twice, and the staff lost some time repositioning the telescope on each object. I noticed that each time the telescope was repositioned, the operators would look up the R.A and Sidereal coordinates on an IPad and use the Declination and Right Ascension setting circles on the telescope mount to target the fainter objects—no “go-to” capability here. The operators would then verify the object was in the finder/guide scope and then use the hand controller to fine-tune the telescope so the object was centered in the eyepiece field-of-view.

The other thing I noticed while sitting in the darkness was the cacophony of strange noises everywhere under the dome. Everything had its own unique and eerie sound—from the movement of the elevator floor, rotation of the dome, slewing the telescope, and a hundred other things. It would be rather disconcerting to be alone in the dome at the telescope at night with all the weird noises. One might think that they had inadvertently broken something.

Of the 12 or so visitors in our group, only a handful had ever looked through a telescope at all. One older lady just couldn't see anything through the scope no matter how much she tried even while being assisted by the staff. During the dead time, some of the older visitors lost interest and just sat in the dark. I suppose they might have had greater expectations of what they were going to see and were disappointed. On the other hand, I took advantage of the situation and was at the eyepiece every time it went vacant for more than a few seconds.

After our observing session, I spent a little time talking with Chuck Flores, one of the telescope operators. He was a 30-something guy and his helper was a young woman with black hair and glasses named Katya Gozman. She reminded me of Kate Micucci who plays Raj Koothrapali's quirky girlfriend Lucy on the TV series *The Big Bang Theory*. Both Katya’s mannerisms and hesitant, apprehensive speech were just like the TV character.

All things considered, the whole week’s events and our lucky tour, capped with some unforgettable telescope time on a historically significant telescope in a renowned observatory facility, made it a uniquely perfect trip. It is very sad that this telescope will be closing.

The 40-Inch Refractor Under the Observatory Dome Credit: Scott Busby

Successful "Meet the Moon" Event

By Linda Billard

In conjunction with International Observe the Moon Night (IOMN), RAClub members David Abbou and Mark Burns set up their telescopes at the Porter Library in Stafford for the Meet the Moon event on October 20. IOMN is a worldwide celebration of lunar science and exploration held annually since 2010. One day each year, everyone on Earth is invited to observe and learn about the Moon together and to celebrate the cultural and personal connections we all have with our nearest neighbor. The event at Porter Library was one of 1,037 expected group events and individuals observing the Moon on their own!


David Abbou at Meet the Moon event

David and Mark had about 100 people attend. The skies began partly to mostly cloudy but cleared for the last hour, which made for great views of the Moon for the adults and many children. Mark was also able to show Saturn to the attendees.

Richmond Astronomical Society Sponsors VAAS 2018

By Linda Billard


Keeble Observatory
Credit: Glenn Faini

Glenn Faini attended the Virginia Association of Astronomical Societies (VAAS) convention held September 20 at Randolph Macon College (RMC). This year, the convention was sponsored by the Richmond Astronomy Society (RAS), and Glenn bumped into our old friend Terry Barker, who chaired the event on behalf of RAS. Presentations included such topics as:

- Back to the Future: A Brief History of Astronomy at RMC
- Studying Jupiter's Volcanic Satellite Io with the World's Largest Telescope
- The Chesapeake Bay Impact Crater: The Inside Story of America's Largest Impact Crater
- Interstellar Molecules: The Search for Molecular Complexity

Glenn attended all the presentations and especially enjoyed those on Io and the Chesapeake Bay impact crater. The day closed with a tour of the Keeble Observatory (apparently not much has changed since our club members visited last year) and an evening picnic at a nearby farm.

MSRO Training Sessions Held

By Linda Billard

As most of you know, the Mark Slade Remote Observatory (MSRO) is an advanced, state-of-the-art small telescope observatory that can be remotely operated over the Internet from your home computer.

On September 29, Myron Wasiuta and Jerry Hubbell presented the first session of training for those interested in using the system. The training was held at the Wilderness Branch of the Orange County Library in Locust Grove. This session introduced the MSRO equipment and operations and included a field trip to the observatory, which is just 3 miles from the library. Besides in-person training, the training was available online via a webinar. Participants included Ryan Ryposa and two NASA ambassadors. The ambassadors participated via the Internet.

On October 27, the session was repeated for those who missed the first session.

A second session, date to be determined, will address how to do observations based on your specific observing program. Equipment troubleshooting techniques will also be presented.

The training is free to current members of the Rappahannock Astronomy Club (RAClub.org) and to new members joining to take advantage of this training opportunity. For more information about the observatory, visit the MSRO page at RAClub.org/MSRO , For information on how to join RAC, go to the Join page at https://www.raclub.org/join/. If you have questions, please email MSRO@raclub.org.

Product Review: ZWO ASI290MC CMOS Planetary Camera

By Ron Henke

When I lived in Virginia, I had an Imaging Source planetary camera. Although it took decent pictures, it had a small chip (640 X 480 pixels). Getting an object on the chip proved to be difficult, at least for me. And because there is always some drift, keeping the object on the chip wasn't easy. So, as with all my other astronomy equipment, I wanted to get a better planetary camera here in Arizona.

I purchased a ZWO ASI290MC CMOS camera. There are several advantages to this camera. First, it has small pixels, 2.9 microns, which helps with clarity. Next, the camera supports many different resolutions: 1936X1096, 1920X1080, 1600X900, 1360X768, 1208X720, 1024X768, 640X480 and 320X240. Using the highest pixel density makes it easier to get the object on the chip…much easier. As you can see, there is a pixel density to suit anyone's need. I use the highest resolution to get the object on the chip and then go to a lower density to focus. I have been imaging on the 640X480 to get the largest size.

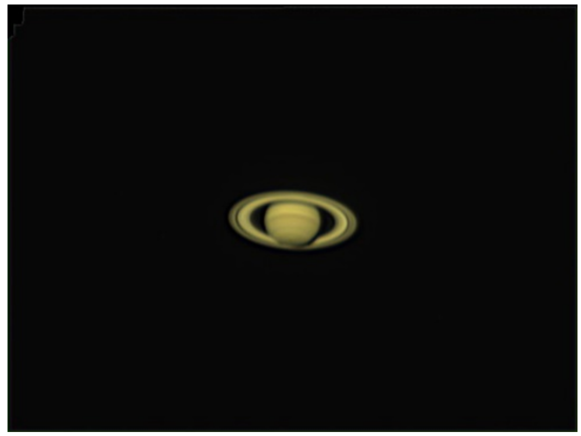
ZWO ASI290MC CMOS camera. Credit: Ron Henke

When I was looking for a planetary camera, I wanted to get one that could also be used as an auto guider. While there are numerous auto guiders available that can function as both types of cameras, my choice came down to CMOS or CCD. As a side note, my deep sky camera is a 6MP large pixel CCD camera that I am happy with, but I paid dearly for it. That said, I looked more closely at CMOS cameras. CMOS cameras are the rage at Starizona, where I buy all my equipment. With everything considered, I bought the CMOS camera described in this article, which cost $299. A comparable CCD camera would have been at least twice as much.

I have included some images I have taken. I have to say that I don't think I am as happy as I thought I would be. The images are not as clear as I had hoped, but they are not bad. I was disappointed at first, the images were not clear at all. I had the tube collimated to see if that might help, and it did but I still wasn't happy with the results. I took some of the data files to Starizona to see if they could do any better. They couldn't. We started talking about my technique. That's when I learned a lot.

Planetary imaging in this part of the country is difficult. Why? Humidity. I know, it's supposed to be a dry heat. However, June through September is Monsoon Season here, and it rains here in the afternoon almost every day. This puts is a lot of moisture in the air, which makes the seeing bad…sometimes very bad. The research-grade observatories here have their maintenance done at this time of year because the poor seeing conditions make observing problematic. The suggested method for improving image quality is to take a huge number of frames. One of the staff members at Starizona said he was using 8,000 frames as a minimum. During processing, he would keep only the best 25 percent. I have now started using 8,000 frames for my AVI files also. The data files are huge. It is not unusual to have an AVI file in excess of 5GB. There is another interesting twist to using this camera: Registax can't be used to stack the frames. There is too much data. I'm using a German share-ware program called AutoStakkert to stack the frames and then take the stacked file from AutoStakkert into Registax to finish the processing.

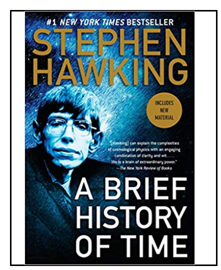
I think I will need another season of planetary imaging to get to know the camera better. It is easy to use but I think I can get better results.



Jupiter and Saturn. Both images taken September 10, 2018, using a Celestron AVX mount with an 8-inch SCT OTA. The data capture AVI file was 8,000 frames, keeping the best 25 percent and were processed using AutoStakkert and Registax. Credit: Ron Henke

Reprise—Hawking Memorabilia to Be Auctioned for Charity

By Linda Billard



Got a spare $126,000? That's the reserve price of Stephen Hawking's personal copy of his Ph.D dissertation dated October 15, 1965. It is Lot 31 in a Christie's online auction entitled "On the Shoulders of Giants: Newton, Darwin, Einstein, and Hawking." The auction will be held October 31–November 8. Other Hawking items include a copy of *A Brief History of Time* signed with his thumbprint (the only way he could "sign" anything, given his physical limitations), his copy of the script of The Simpsons show in which he played himself, and one of his motorized wheelchairs. Proceeds will go his charitable foundation, The Stephen Hawking Foundation. Visit the auction site—it's an eye opener!

Focus On: Apollo 17 Region Sea of Serenity

Jerry Hubbell

(Note from the author: A version of this article was published in the September 2018 ALPO The Lunar Observer *as the Focus On bi-monthly article. Part of my role as the Assistant Coordinator (Lunar Topographical Studies) is to write articles periodically on research done by ALPO contributors. To see full-size versions of our photos, go to http://moon.scopesandscapes.com/tlo.pdf)*

The 50th anniversary of the first NASA manned lunar landing mission, which occurred in July 1969, is approaching fast. I fondly remember following the Apollo program with great interest—I couldn't get enough. I was a bit too young to follow and understand the Mercury and Gemini programs, but by the time the Apollo 7 mission in October 1968, I had started third grade and was reading everything I could get my hands on about the program.

A few months ago, I decided that the TLO Focus On series of articles should commemorate this achievement by focusing on the Apollo 11 Mission in the July 2019 issue. Because I felt that we should commemorate all the manned lunar landings here in the TLO, I decided that the Focus On Apollo mission articles should be on the regions explored by the NASA astronauts. Because there were six successful lunar landing missions, that gave me six articles that would start this month but the only way to have the Apollo 11 50th anniversary article appear in July 2019, was to start with Apollo 17 work backward through Apollo missions 17, 16, 15, 14, 12, to reach 11. Kind of like a launch countdown. ALPO Lunar Section Coordinator Wayne Bailey agreed and supported this plan, so that is how these articles came about.

I plan to follow a specific outline for each of the articles, including a mission summary. The main topic of each article is the region around the landing sites, the interesting topographical features that can be observed and imaged, and the purpose and reasoning for the selection of these locations by NASA for each of the missions. I think this should give us further context when we observe these regions. I plan to include three NASA images in each of these articles for historical purposes and to compare them with our own images and observation notes that Wayne and I receive.

Figure 1. Apollo 17 Mission Patch, NASA image.

The Apollo 17 mission was launched at 12:33 a.m. EST on December 7, 1972. The crew consisted of Commander Eugene Cernan, Command Module Pilot Ronald Evans, and Lunar Module Pilot Harrison Schmidt. One of the main features of this mission crew was that Harrison Schmidt was the first scientist to be included on a lunar mission. He is a professional geologist (Figure 2.)


Figure 2. Apollo 17 Astronauts. (left to right) Harrison Schmidt, Eugene Cernan, and Ronald Evans. NASA image.

The landing site was just east of where Mare Serenitatis (the Sea of Serenity) and Mare Tranquilitatis (the Sea of Tranquility) come together in the mountainous terrain of the Taurus Littrow Valley. Landing occurred on December 11 at 07:55 p.m. EST. The landing site is located at Selenographic coordinates 20°10’ north, 30°46’ east.

One reason NASA chose the Taurus Littrow Valley was that the region provided an excellent opportunity to sample a wide range of materials—those from the maria and also from the mountainous region to the immediate east of Mare Serenitatis.

ALPO member and TLO contributor David Teske provides further comments on the exploration of Taurus Littrow Valley:

> “…[Because] the Taurus-Littrow Valley has both highland material in the massifs and dark mare material on the valley floor, this site was chosen in anticipation of sampling ancient highland material and young volcanic materials in the same landing site. Massifs surrounding the Serenitatis basin seemed likely to contain ancient, pre-Imbrium rocks. During Apollo 15, Al Worden in orbit had seen dark-halo craters in this region that looked like cones scattered all over the region’s brighter surfaces. This dark mantle also showed up clearly as streaks on the massifs, supporting its interpretation as a pyroclastic deposit that had been forcefully fountained from volcanic vents. Perhaps interest in these dark coatings would have been satisfied during the same Apollo 15 mission if the drill core had not been stuck and prevented astronauts Scott and Irvin from visiting the North Complex, which was believed to have a thin coating of pyroclastic material. In the end, this dark mantle area, which was thought to be relatively young, turned out to be ancient, 3.64 billion years old, which was much older than predicted. There were few craters in this dark mantled region because the craters that were formed occurred in a thick-glass-rich regolith, and the original pyroclastic layer had softened the initial shapes and softened more quickly than they would have in hard rock….”

There are several popular targets for observing and imaging in the lower east quadrant of the Sea of Serenity, including the craters Posidonius (58.0 mi, 96.0 km), Plinius, and Dawes, and further east in the higher terrain craters Cleomedes, and Macrobius and Romer. Crater Jansen is south of the landing site in the Sea of Tranquility. The interesting features Dorsa Smirnov and Lister are also to the northwest and west of the Apollo 17 landing site. (See figures 3, 4, and 5.)

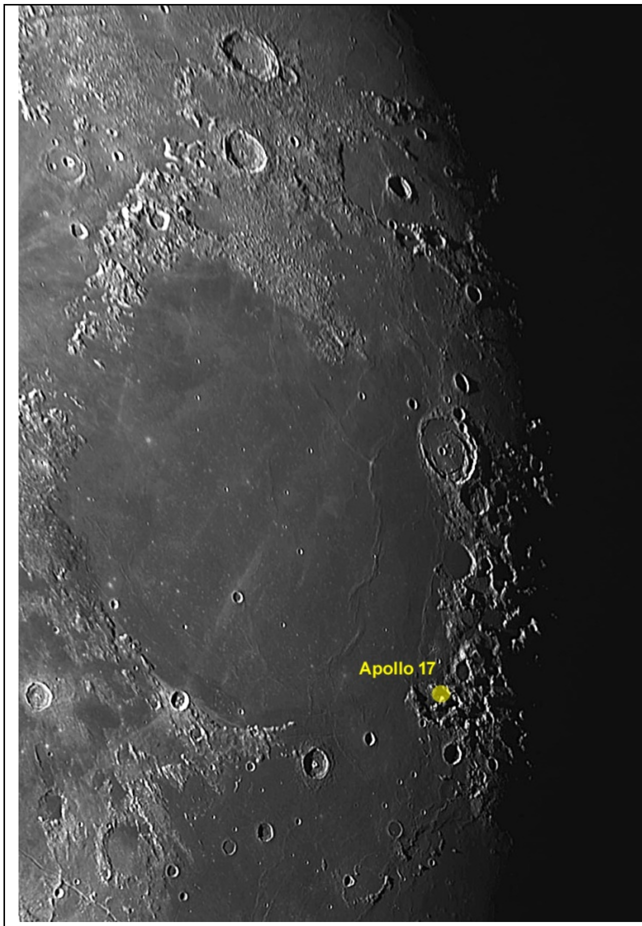


Figure 3. Apollo 17 Landing Site—Mare Serenitatis, David Teske, Louisville, Mississippi, USA. 13 July 2017 at 0939 UT. Colongitude 141.9 deg., seeing 6/10, 4-inch APO refractor, 2x Barlow, Mallicam GMTm camera, 518 frames. (ed. highlighted label added)

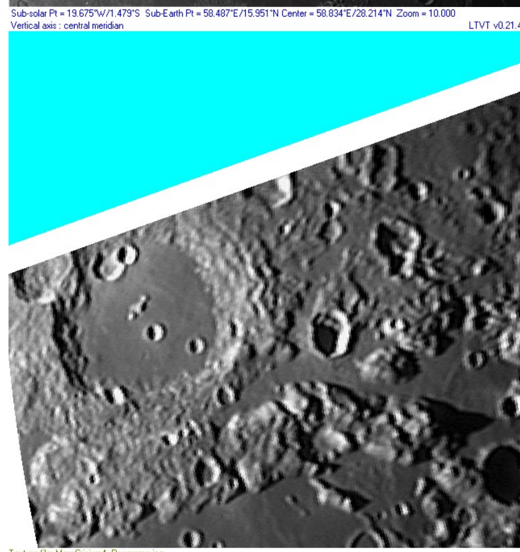


Figure 4. (top) Dawes—Mare Serenitatis, Luis Francisco Alsina Cardinali, Oro Verde, Argentina, 01 July 2017 2334 UT, Colongitude 5.4 deg., 0.2-m Refractor, QHY5-II CCD camera.

Figure 5. (bottom) Aerial View of Cleomedes, Jerry Hubbell, Locust Grove, VA, USA, 04 August 2012 0054 UT, 0.13-m APO Refractor (Explore Scientific 5-inch ED APO), Imaging Source DMK21AU04 CCD, 4x Powermate. Seeing 8/10, Transparency 5/6, north/up, east/right.

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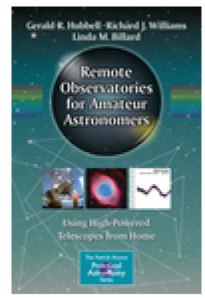
New Book Resources for RAClub

By Linda Billard



Jerry Hubbell recently became the Series Editor for the Patrick Moore Practical Astronomy Series published by Springer Books (Springer Nature Switzerland AG). In this role, he will be reviewing book proposals, helping series authors, and looking for people interested in proposing a book to be included in the series.

One of the benefits of this position is that Jerry has access and rights to share any of the final published individual electronic downloads (mainly chapters) or portions thereof for all the books in the series for non-commercial educational use. This will provide us with a wealth of material to use in developing our Mark Slade Remote Observatory training material going forward, including any materials we create for our observing programs and also our procedures.

If you have a non-commercial need for any of the material in the Patrick Moore Practical Astronomy Series, Jerry is also permitted to share this material with his colleagues. You can search the material here: https://www.springer.com/series/3192?detailsPage=titles If you have comments or questions, please contact Jerry at astrophotography@raclub.org

Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes

(Note: The club picnic was in August so there was no presentation that month.)

September 2018—Radiation

Tom Watson began his presentation by stating that radiation can be classified as non-ionizing and ionizing. The latter refers to radiation with enough energy to rip electrons from atoms. The distinction is important, he noted, because ionizing radiation can cause damage or harm humans. Tom mentioned that "Sieverts" have replaced some older units of measurement for radiation as part of the International System of units (abbreviated SI). "Curies" and "rems" now have SI replacements.

Tom first discussed radiation from terrestrial sources. He showed a chart of (mostly terrestrial) sources in the United Kingdom that contribute a total yearly ionizing radiation dose of 27 millisieverts per person. Radon gas from the ground accounted for nearly half the dose, while a similar amount resulted from medical sources, terrestrial gamma sources, cosmic rays, and intakes of radionuclides (excluding radon).

Next, Tom talked about sources of radiation from space (cosmic sources): solar radiation and galactic cosmic radiation. Solar radiation includes visible, infrared, and ultraviolet sunlight, solar wind particles, some radiation from solar prominences (although most of the material falls back to the surface of the Sun), more from solar flares (which eject more material), and solar "proton events." Another source is coronal mass ejections. Geomagnetic storms are a result of solar charged particle emissions when they interact with Earth's magnetic field and atmosphere.

Glenn Holliday asked about other sources of radiation in the solar system. Tom agreed other sources exist but he said it was hard to say how significant they were. A little later, Glenn said he found that Jupiter is a source of (non-ionizing) radio waves. Scott Lansdale said he had heard some, and they sounded something like ocean water.

When Tom talked about cosmic rays, he said his equipment detects secondary radiation from the rays striking the Earth's atmosphere. These are called particle showers and can be triggered by protons (90 percent of the cosmic ray particles), alpha particles (9 percent of the particles), or other elementary particles (making up the other 1 percent). Gamma ray bursts can also trigger them. Some of the phenomena involved are pair production (for energies higher than 1024 keV) and spallation. Tom said particle showers might help initiate lightning. He said gamma ray bursts are grouped as short (less than 1 second), long (more than 2 seconds), and ultra-long bursts of more than 10,000 seconds. They may come from collapsing giant stars.

October 2018—High-Resolution Photometry for Exoplanet Observations

Jerry Hubbell began his presentation by saying that his interest in the topic started after reading a paper he discovered in April. Amateurs began making analog measurements of stellar brightness in the 1970s, when they began using scintillation tubes. In the mid-1990s, professional CCD techniques began to be adapted by amateurs as software became available for analysis. Jerry said the original analysis technique was to measure the total intensity recorded within a circular area encompassing the star and then the sky background intensity nearby, using the same aperture. A comparison star was measured in the same way to produce a differential magnitude. He said that when CCDs were adapted, an annulus around the star aperture could be used for the sky background. Image calibration was also added. Jerry showed some examples of CCD images to illustrate the use of circular apertures and annuli. He noted they are applicable to measuring stars, exoplanet transits, and minor planets. One showed an example of a potential problem: another star fell within the annulus around the minor planet being measured.

Jerry talked briefly about equipment. He said it was best to use a thermoelectrically cooled camera with a monochrome CCD, as opposed to a color CCD with a Bayer color filter array. With a monochrome CCD, one can still use filters, for example, a V-band filter, which tries to match the response of the human eye.

Jerry said the long-held standard for amateur photometry measurements was ±0.01 magnitudes (mags) (about a 1-percent error). His goal is less than half that error, or less than ±0.005 mags. In response to a suggestion by Glenn Holliday, Jerry agreed that "high precision" was a better term than "high resolution."

The main reason for high precision is to detect variations at the millimagnitude (millimag) level. This precision is necessary for exoplanets, minor planets, and variable stars. Jerry said most exoplanets are in the 7–15 millimag range, and he thinks amateurs can observe in the 7–10 millimag range. The 1-percent precision can be good for Jupiter-class exoplanets. He would like to do more than just that precision.

Jerry showed an observation he made with Bart Billard of a transit of the exoplanet HAT-P-30/WASP-51b. These data were reduced on the Exoplanet Transit Database (ETD) website and are available. He said that he and Bart took a course on exoplanet transit observations in 2017, and this was the first observation they reported to ETD. Jerry pointed out the significant scatter in the data and said he would like to get that down. He discussed other ways amateurs could contribute to science with precision photometric observations. The Transiting Exoplanet Survey Satellite (TESS) recently began its science mission. Jerry showed a statement on the need for follow-up observations. For example, because the TESS instruments cover such large regions of the sky, many transiting signals detected could be from more than one star merged in the TESS photometric aperture for that target. Ground-based observations would be needed to sort out which star has transits, or whether one of the merged stars is actually an eclipsing binary system.

Jerry also explained how minor planet light curves allow 3-D shape modelling and rotation rate determination. He said higher-precision photometry of variable stars could reveal smaller changes. Star spots could be detected, helping to characterize lifecycles of stars.

Jerry discussed error sources, categorizing them as shot noise, residual calibration errors, and scintillation. Shot noise depends on the square root of the number of photons collected, meaning the more data the better the precision. Jerry said it was analogous to polling. For the precision goal he chose, it is desirable to collect about 10E7 photons or more in the aperture, which would provide a theoretical shot-noise precision of ±0.3 millimags. Residual calibration errors can be determined by finding the variations over several flat calibration frames. The errors are smoothed out by averaging the calibration frames to make the master flat, but the remaining variations can cause errors as the star drifts to different pixel locations during measurements of light curves. Scintillation is based on environmental factors. Jerry said it comes in short-term and long-term forms. Scintillation determines the lower limit on the errors affecting precision once shot noise is reduced.

Jerry described the use of diffusers for spreading light to obtain greater precision. If a diffuser is used, light from a star that would cover 20 pixels could be spread over an area of 450 pixels. He said he considers precision at two levels: sample precision from shot noise, short-term scintillation, and residual calibration errors; and the precision of a light-curve measurement involving many samples (for example an exoplanet transit depth measurement's precision). A diffuser can improve sample precision by allowing averaging over a large number of pixels (up to the point where too many dimmer comparison stars are lost). The diffuser method also mitigates the impact of tracking errors or a meridian flip on residual calibration errors.

Jerry said he was working on this diffuser project with Dennis Conti, who ran the exoplanet transit observing course he took with Bart last year, and is also a designated NASA TESS Mission liaison to the amateur community and supports their exoplanet observation efforts. Jerry showed some images and light curves he made for testing the diffuser performance. One was the minor planet (19) Fortuna, which produced a light curve with very little scatter.

Ryan Rapoza asked about detecting star spots and how one could tell the difference between those and transits. Jerry suggested one would see the depth change over time, or it might disappear completely. Bart suggested the star spots might have relatively long transits. Jerry said he planned to clean up his slides for posting on the club website.

Image of the Quarter

Lagoon and Trifid Nebulae
By Glenn Faini

Date/Time: August 9, 2018/ approx. 22:30 EDT
Camera: Nikon 3300
Telescope: Celestron NexStar 102SLT
660mm
f/6.5
ISO 6400
15 sec unguided
10 x 15sec frames stacked with RegiStax
Post-processed with Paint Shop Pro 12

Glenn says: “My initial attempts at processing my images wasn't that good. At the annual RAC picnic, Scott Busby gave me pointers on how to post-process my images. I redid this one from scratch with much better results.