http://www.raclub.org/

The StarGazer

Newsletter of the Rappahannock Astronomy Club No. 2 Vol. 9 August–October 2020

Discoverer of Comet Shoemaker-Levy 9 Addresses RAC

By Bart and Linda Billard

Composite Photo of Shoemaker-Levy 9 Approaching Jupiter. Photo Courtesy of NASA

On October 22, 2020, RAC was privileged to jointly host Dr. David H. Levy, internationally known comet hunter, for a presentation via Zoom. The Richmond Astronomical Society joined us, volunteering to host the session. David's appearance was at the invitation of RAC member Jerry Hubbell. Jerry and David had first in met at an imaging conference in Tucson in 2013. Currently they participate in the Tuesday night Explore Scientific Virtual Star Party series on YouTube.

David, a Canadian astronomer and science writer, co-discovered Comet Shoemaker–Levy 9 in 1993, which then collided with the planet Jupiter in 1994. In total, he has discovered 22 comets, either independently or with Gene and Carolyn S. Shoemaker. He has also written 34 books, mostly on astronomical subjects, such as *The Quest for Comets*, a biography of Pluto-discoverer Clyde Tombaugh, and his tribute to Gene Shoemaker, *Shoemaker by Levy*. His most recent book is his autobiography, *A Night Watchman's Journey.* He also provides periodic articles for *Sky and Telescope* and *Astronomy Magazine*, among other publications.

David introduced his talk as a retrospective of how he had "pursued his dream." He described how, at an early age, he was sent to summer camp in Vermont. When asked to sing a song, he chose "All Through the Night." He sang some of it to illustrate that the song described nighttime and included a passage about the Moon. When he was somewhat older, he returned as a junior counselor to the same camp during the time of the Apollo 11 mission. David remembered that on the night of the Moon walk, the senior camp counselor directed that should the campers spend the evening in individual activities. David said that he thought everyone should watch the Moon walk instead. He was chastised for interrupting, but the camp director, who overheard the interchange, said that watching the Moon walk was a much better choice for the group. David recalled the drama of seeing the ladder on the LM and waiting to see Neil Armstrong appear, carefully descend the ladder, and step out onto the Moon's surface. He noted that the Apollo 8 television program from lunar orbit probably had an even more profound impact on him. ***(Continued on page 4)***

How to Join RAClub

RAClub, located in the Fredericksburg, Virginia, area, 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. We also have several members who live outside Virginia and have joined to have the opportunity to use the Mark Slade Remote Observatory (MSRO)—one of the benefits of joining the club.

RAClub annual membership is $20 per family. Student membership is $7.50. Click here information on how to join.

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.

The StarGazer
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Website: www.raclub.org
Groups.io: Members-only group. When you join RAC, you will receive an invitation to join from the RAC President.

RAClub Officers
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Scott Busby Equipment Loan
Jerry Hubbell Astrophotography
Myron Wasiuta Mark Slade Remote Observatory (MSRO)

Upcoming Events*	Recent Outreach Events Completed
Our public events are cancelled until November. However, to attend a club meeting via Zoom, email president@raclub.org for an invitation.	Scheduled star parties for August, September, and October were cancelled owing to weather.
Star Party, Caledon State Park November 14†	
Star Party, Caledon State Park December 12**	
Star Party, Caledon State Park December 19†	

*Owing to varied and changing restrictions, please check the website raclub.org for updates.
†simultaneous star parties at Caledon State Park and Belmont Observatory—Caledon events are for the public, if public meetings are permitted (please check our website for updates before attending); Belmont events are for RAC members only

**Belmont Observatory only

President's Corner

Dear Members,

The annual election of club officers takes place during the November business meeting. Nominations for the four club officer positions opened in October, but you may still nominate someone before the elections are held. Please consider nominating someone or offering to serve as a club officer yourself. The more we contribute our time and talent, the better RAC will be able to serve us and the community.

Owing to government restrictions, RAC is still conducting its business meetings via Zoom Video Conferencing. I send Zoom meeting invitations to all RAC members via BCC eMail. Non-members may also participate by sending me a request at president@raclub.org. RAC plans to continue to make its meetings available via Zoom so those who cannot attend in person may participate.

May God bless you with transparent skies and excellent seeing.

Glenn Faini
President

New PayPal Option for Dues Payment

We are happy to report that you can now pay your dues in two ways:

- **By Mail:** As always, you can make out a check to RAC Treasurer and send it to Matthew Scott, RAC Treasurer, PO Box 752, Fredericksburg, VA, 22404-0752. Both new and renewing members should also print out the membership application here, fill it out, and return it with their payment to keep our records up to date.
- ***NEW—PayPal***: You can also pay your dues online. Simply go here and scroll down to the bottom of the page. Select the appropriate membership type from the dropdown box and click *Pay Now*. You do not need to complete an application because the notification the club receives of your payment will contain all the additional info needed. NOTE: If you pay using PayPal, your actual charge (including the PayPal usage fee) will be: Single/Family $20.91, Student $8.03, Single/Family & AL $28.63, Student & AL $15.76, AL Only $8.03.

For reference, the RAC membership year is January to December, and if you join anytime in the last quarter, your membership will be for the upcoming year. Astro League dues run July to June.

Did You Know? **by Scott Busby**

On March 22, 1931, Clyde Tombaugh, discoverer of Pluto, discovered a nova, a star undergoing an outburst, in the constellation of Corvus. That object was never reported officially. His plate notes: "I nova suspect. 'T 12' near southwest corner of plate, magnitude about 12, confirmed well on 5" Cogshall plate of March 22. No trace of the object on 13-inch plates of March 20 and 17, 1931. The image is exactly deformed, like the other star images in the neighborhood. Evidently, a very remarkable star to rise from 17 or fainter to 12 in 2 days' time. Position: Epoch 1855 RA (1855.0) 12h 13m Dec -17deg 40' or RA (1930.0) 12h 16'.9 Dec -18 degrees 05'. This object was discovered on May 25, 1932, at 11:00 am."

Source: *Clyde Tombaugh Discoverer of Pluto*, David H. Levy, The University of Arizona Press, Tucson, 1991. Lent to Scott Busby by Myron Wasiuta

Discoverer of Comet Shoemaker-Levy 9 Addresses RAC *(cont'd from page 1)*

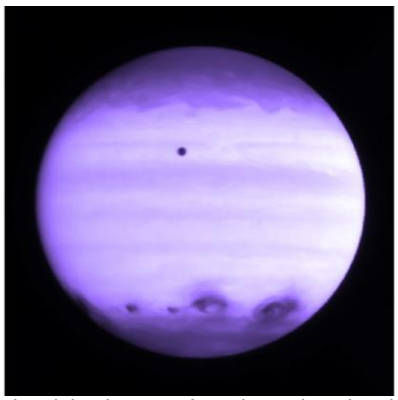
David's story of deciding to become a comet hunter included an incident involving an oral exam in his high school French class. He expected to answer a question on what career he would like to pursue and thought of comets. The teacher was skeptical when David answered, "Je veux découvrir une comète." But then the teacher relented a little and gave him a good mark. However, the teacher said he would expect to hear of David's discoveries, and if there were none within 20 years, he would retroactively lower the grade. David discovered his first comet—Comet Levy-Rudenko—19 years later. Rudenko shared naming honors because he independently discovered the same comet the next day before David's discovery had been officially verified.

During the talk, David had his 6-inch telescope (named "Minerva") on the desk in front of him. He told the story of explaining to his grandfather why he was saving up to buy it when he already had an 8-inch telescope. When he explained his desire to hunt comets and the need for a larger field of view to help his chances of seeing one, his grandfather, like the French teacher, was impressed with his seriousness and diligence in his pursuit and said he wanted to part of that. His grandfather bought the telescope for him. Minerva has had many mount changes and several tube changes, but the original optics (now more than 50 years old) are still present.

David began working with Gene and Carolyn Shoemaker in 1989 after meeting them at an asteroid conference. The three of them worked successful together, finding quite a few comets. David then described a night in March 1993 when Gene discovered, after using some of a large package of film, that the package had previously been exposed to light, possibly deliberately, causing those initial photos to be useless. In hopes of finding some undamaged film that could be used to continue that night, Gene checked near the bottom of the package and found the light exposure had not been long enough to compromise some of the film underneath. They used that film to continue that night's imaging. Although the second night was fairly cloudy, they got some shots near Jupiter. It was on the third night that Carolyn said she saw something like a "squashed comet." When Gene saw it, he said that they should ask Jim Scotti to confirm. When they called Scotti, he was very busy and would look at the object they were seeing later, When he didn't call them back, David called him again. David described a funny noise Jim made after looking at the object and asked he was all right. Jim said the sound was "him picking his jaw up off the floor." Scotti confirmed it was a comet and said it was the strangest comet form he'd ever seen. This was the discovery and confirmation of Shoemaker-Levy 9 (SL9). SL9 was captured in the gravitational field of Jupiter and broke up before crashing piece by piece into the planet in 1994, a widely studied event thanks to the advance prediction resulting from their discovery. Their lives changed radically from that point on. David recalled being pulled out of a press conference by Gene because they had received an invitation to the White House.

He ended his talk by singing his own lyrics about seeing comet NEOWISE to the tune of singer/songwriter Leonard Cohen's *Hallelujah* and by reciting the last stanza of Ralph Hodgson's poem *Silent Hill:*

I stood and stared; the sky was lit,
The sky was stars all over it,
I stood, I knew not why,
Without a wish, without a will,
I stood upon that silent hill
And stared into the sky until
My eyes were blind with stars and still
I stared into the sky.



Ultraviolet image of Jupiter taken by the Wide Field Camera of the Hubble Space Telescope showing Jupiter's atmosphere at 2550 Angstroms after many impacts by fragments of comet Shoemaker-Levy 9. Text & Photo from 7/23/94 NASA Press Release.

After the presentation, David was asked whether any of his comets were visible to the naked eye. He mentioned Comet Levy 1990 and said one other was "just barely" visible. He said SL9 was not naked-eye visible but was famous for what it did: showed us how comets could bring the building blocks for life to Earth. SL9 was discovered on March 25, 1993, and was in pictures taken March 23. It took 2 months to determine that it would hit Jupiter. David also mentioned that an 8th magnitude comet would be visible in Orion during the night after this program. When asked about his latest book, he said it was available from the Royal Astronomical Society of Canada. A recording of this presentation is available here.

The Legacy Survey of Space and Time (LSST)

By Linda Billard

Vera C. Rubin Observatory. Photo Courtesy of LSST Project/NSF/AURA

The Vera C. Rubin Observatory—recently named in honor of the late pioneer in the discovery and investigation of dark matter—is designed to support the National Science Foundation's Legacy Survey of Space and Time (LSST) project. (Previously, "LSST" referred to the telescope under constructed for this project—the large synoptic survey telescope. The team decided to retain the acronym but change its meaning to something that addressed the overall system's use and the project being undertaken.) The LSST project will deliver 20 terabytes of images and data products *per night* during its 10-year duration.

Astronomers will use these images and data to address four scientific areas: Dark Matter and Dark Energy; Hazardous Asteroids and the Remote Solar System; The Transient Optical Sky; Formation and Structure of the Milky Way.

While these are complex areas of inquiry, the LSST design concept is remarkably simple: a deep survey of an enormous area of sky—nearly half that visible from the observatory's location in the mountains of Chile—using a frequency that enables capture of images of the entire visible sky every few nights. The survey will produce astronomical catalogs thousands of times larger than any that currently exist.

The facility needed to conduct the survey includes a large-aperture, wide-field, optical imaging telescope; a gigapixel camera; and a sophisticated data management system.

Site—The Rubin Observatory Summit Facility is located on the Cerro Pachón ridge in north-central Chile. The site is inland and approximately 60 miles by road from the support town of La Serena, the location of the Rubin Observatory Base Facility. On September 28, about 6 months after the COVID-19 pandemic brought construction on Cerro Pachón to an unexpected halt, the Rubin Observatory team restarted limited construction activities on the summit, hoping to ramp up in the next few months.

Telescope—The 8.4-meter Simonyi Survey Telescope uses a three-mirror design to obtain a gigantic field of view capable of surveying the entire sky in only three nights. It will image the sky continuously each night, on an automated cadence, and over the course of the 10-year survey, will collect about 800 images of each location in the sky.

Camera—The Rubin Observatory LSST camera must produce data of extremely high quality with minimal downtime and maintenance. To take advantage of the high-quality views that the telescope provides over such a wide field, the camera will be the largest digital camera ever built for astronomy. According to the project website, it is the size of a small car, weighs more than 3 tons, and has a resolution of 3,200 megapixels. In a March 2014 TED Talk, University of Washington astronomer and LSST Simulations Lead Andrew Connolly said the camera will produce images so large that 1,500 high-definition TV screens would be required to view each one.

Data Management—Not surprisingly, software is one of the most challenging aspects of Rubin Observatory because more than 20 terabytes of data must be processed and stored each night. About 60 petabytes (PB) of data will be collected in the 10 years of operation. The total data volume after processing will be several hundred PB, will be processed using about 150 TFLOPS (trillion floating point operations per second) of computing power for the first Data Release, increasing to 950 TFLOPS by Data Release 11 at the end of the 10-year survey. Clearly, it will be a daunting task to process and convert such a large volume of data accurately, implement automated data quality assessment and automated discovery of moving or transient sources, and archive results in useful form for potential users.

To learn more about LSST, visit the project website. To learn more about Vera Rubin, re-read the article "Vera Rubin, Dark Matter, and Kitt Peak" by RAC member Ron Henke, which appeared on page 8 of the January 2019 issue of this newsletter.

Virtual Astronomy with Scouts on International Observe the Moon Night

By Glenn Holliday

Photo Courtesy of Glenn Holliday

Scout groups frequently ask Rappahannock Astronomy Club to hold star parties or teaching events. For most of 2020, I've had to tell them we aren't doing in-person public events during the pandemic. I've spent some time developing an online program to offer. Consequently, I felt enthusiastic when the University of Arizona (UA) suggested a nationwide virtual event for Girl Scouts for International Observe the Moon Night.

Observe the Moon Night coordinators typically pick a night near First Quarter. The Moon is already up in the sky at sunset, and at this phase, shadows on the features of the Moon make them easier to see. The date chosen this year was September 26. During the month leading up to the event, I forwarded several mailings from UA with information and how-to activities to Scout troops and other youth organizations with which I've recently exchanged email. I added some activities of my own that I've developed and used with groups of youths. UA set up a Zoom call with the organizers of Astronomy Camp there, Drs. Larry Lebofsky and Don McCarthy. I left it to each group to decide whether they were able to meet together or whether individual families would go out to observe in their yards.

On the 26th, I went to visit my own granddaughter, who is a Brownie Girl Scout. We had great weather—for a cloudologist—but not so for an astronomer. I did not set up a telescope under the fully overcast sky but showed my granddaughter how to search for features in trees with my binoculars. I got on the phone with the UA call and had a great conversation with the pros who had taught me at Astronomy Camp and some other Girl Scout leaders.

Just after the Zoom call ended, I saw a slit of clear sky moving through the clouds. The break moved across the Moon, and for about 5 minutes, we were able to observe Saturn, Jupiter, and the Moon together. Mars, which is at its most brilliant now, never appeared through the clouds. We got some of the neighbors interested as well, so it was a fun evening.

Here are how the moving parts I have mentioned fit together: NASA originated International Observe the Moon Night years ago as an educational opportunity and an encouragement to everybody to just go out and look at the Moon.

University of Arizona has been doing Astronomy Camp for years. They offer several varieties and flavors of camp for adults and youth. I attended their Astronomy Camp for Girl Scout leaders. This camp is a result of UA's contract with NASA to build parts of the James Webb Space Telescope—that contract requires an educational outreach. Their approach is to train adult Scout leaders and inspire them to go home and do astronomy with their youth. I got to go to camp because I have been both a Scout leader and our RAC Scouting Coordinator for many years.

Want to Broaden Your Astronomy Knowledge?…Get Involved With One of These Organizations

By Jerry Hubbell

Over the past several years, I have been fortunate, through my job, to meet astronomers from all over the world, many by joining amateur and professional groups and providing data and contributing written observing reports to several. Over the past 2 years, I have tried to cultivate these relationships not only for myself but for the benefit of MSRO Science and the Rappahannock Astronomy Club members. The following describes my experience with each of them. If you are interested in joining, let me know.

Association of Lunar and Planetary Observers (ALPO) I have been a member of this group for almost 10 years and on the staff for 6 years serving as an Associate Coordinator, Lunar Topographical Studies. My job is to coordinate observations of the lunar surface and discuss observations with the members of the lunar section. I also write a bi-monthly article called "Focus On" in the Lunar Section newsletter, *The Lunar Observer*. Many of these articles are reprinted here in the *StarGazer*. I recently introduced a proposal to add an "Exoplanet Section" to the ALPO for members who want to contribute exoplanet transit observations.

American Association of Variable Star Observers (AAVSO) Although I have been a member for about 10 years, I have only contributed a few visual observations of variable stars. We have thousands of images at the Mark Slade Remote Observatory (MSRO) that could be mined for hundreds of thousands of variable star photometric measurements and submitted, but I have not done this. It would be a good project. AAVSO runs the remotely operated Bright Star Monitor telescope network to which I am contributing by consulting with Dr. Arne Henden and the other staff members on general observatory operations. I am working with Arne to integrate the diffuser method of performing high-precision photometry for variable star and exoplanet observations. I also am involved with software maintenance work on the AAVSO VPhot network application.

Society for Astronomical Sciences (SAS) I have been a member of this group for several years and have contributed a paper written by the MSRO Science astronomers and given a couple of presentations too. This group holds an annual Symposium on Small Telescope Science that is well attended by astronomers all over the world. In June 2019, the MSRO team's paper entitled "A Comparison of the Diffuser Method Versus the Defocus Method for Performing High-Precision Photometry with Small Telescope Systems" was published here: https://arxiv.org/abs/1905.02790

American Astronomical Society (AAS) Within the past 4 months, I joined this organization, which, only this year, created a new membership class for amateur astronomers. I was fortunate to be asked to give two presentations at the AAS conference this past summer. one of which was on the work we have done at the MSRO on exoplanet transit observations and our work developing instruments and techniques for high-precision photometry.

NASA MIT Transiting Exoplanet Survey Satellite (TESS) Follow-up Observing Program (TFOP) In May 2019, I joined this group as a member of the Seeing-Limited SG1 subgroup headed by Dr. Karen Collins. We at the MSRO provide ground-based observations of identified TESS Objects of Interest (TOIs) to both screen for eclipsing binaries (which give false positives) and used to refine exoplanet ephemeris data. We have done several observations over the past year of TESS TOIs.

NASA JPL Exoplanet Watch I have been invited to attend meetings of this Jet Propulsion Laboratory (JPL)-sponsored project team headed by Dr. Robert Zellem. I try to attend as many of these bi-weekly meetings as possible. The team has developed open-source exoplanet transit analysis software for citizen scientists interested in providing follow-up observations of both TESS and KEPLER detected exoplanets.

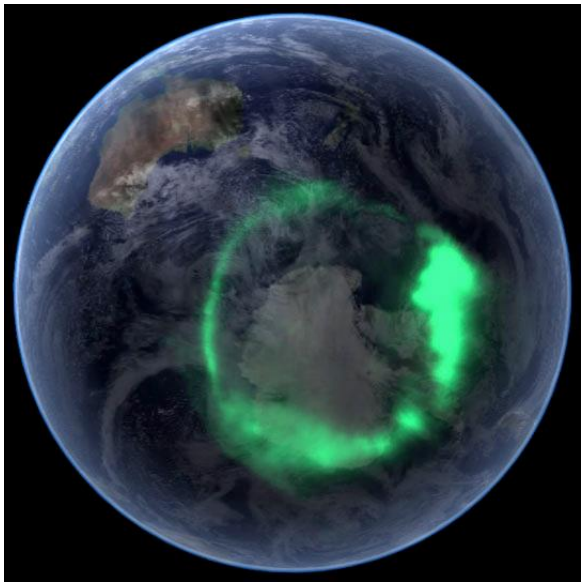
World Wide Variable Star Hunters (WWVSH) Most recently, I have been invited to join the team that operates a remotely controlled observatory located in Abu Dhabi, United Arab Emirates (UAE). This observatory houses a 0.6-m (24-inch) PlaneWave CDK24 Corrected Dall-Kirkham (CDK) Cassegrain telescope with FLI camera and filter system. I have been working with team leader Michael Aitkens to get involved with WWVSH's exoplanet observing program and contribute. I look forward to performing exoplanet and other observations with that observatory and working with the team on TFOP data contributions.

Various Media Over the years I have been able to spread the word about the Rappahannock Astronomy Club and the MSRO via social media and live and recorded broadcasts. I have been interviewed several times by Marty Kunz of Astronomy.FM on his "Space Pirate Radio" broadcast. I have been interviewed twice over the past year by Steve Mallia, owner of Ontario Telescope, and a host of the Astro Backyard Podcast. Finally, I have been interviewed by Tony Darnell, the producer of the Deep Astronomy broadcast on YouTube and available on his website deepastronomy.com

I am currently the co-host, with Scott Roberts, the president and founder of Explore Scientific, of a weekday show called "Explore Alliance OpenGOTO Community Live." This hour-long show provides a way for our Explore Scientific customers to learn about our products and for us to answer questions daily about our equipment in a live broadcast. We have produced 100 episodes so far this year. I am also involved with the Explore Scientific "Global Star Party" (GSP) broadcast that we hold every week on Tuesday evenings. If there the weather is clear, I showcase the Mark Slade Remote Observatory by using it during the GSP. At the time of this writing, we have held 17 GSPs. Keynote speakers for these broadcasts have included famous comet discoverer Dr. David H. Levy, *Astronomy Magaz*ine Editor in Chief and author, David J. Eicher and longtime *Sky & Telescope* contributing editor, J. Kelly Beatty.

Joan Feynman, Astrophysicist, 1927–2020

By Linda Billard



Aurora australias. Photo taken September 11, 2005, by the IMAGE satellite and then overlaid on NASA's Blue Marble image of the Earth to show the aurora's location circling Antarctica. *Image courtesy of NASA*

I am ashamed to admit that I didn't know Richard Feynman (arguably one of the world's most famous physicists), even had a sister—much less one who made groundbreaking discoveries regarding auroras and sunspots!

Joan Feynman credited her brother with showing her her first aurora when she was about 8. He insisted that she get out of bed and come with him to a nearby golf course. She was amazed to learn that, at that time (1930s), their cause was unknown. Although she had already decided she wanted to be a scientist, auroras channeled her interests toward astronomy.

However, becoming a scientist was difficult. She faced obstacles that few of her gender would confront today, most based on the assumption that women didn't have the innate brain power to do science. She proved them wrong, obtaining her PhD in Physics from Syracuse University and working at such prestigious institutions as the High Altitude Observatory, the National Center for Atmospheric Research, the National Science Foundation, and Boston College, and finally, starting in 1985, the Jet Propulsion Laboratory, where she remained until her retirement.

Over the course of her career, Feynman focused on understanding solar wind and its interaction with the Earth's magnetosphere. Her accomplishments range from discovering the shape of the Earth's magnetosphere and identifying the origin of auroras to creating statistical models to predict how many high-energy particles would collide with spacecraft over time. In 1974, she became the first woman elected an officer of the American Geophysical Union, and in 2000, she was awarded NASA's Exceptional Scientific Achievement Medal.

More recently, Feynman studied the effects on climate change of transient solar events and solar cycle variations. One interest was the influence of the Sun on patterns of wintertime climate anomalies known as the Arctic oscillation or North Annular Mode (NAM). She and her colleagues found that during lower solar activity, the NAM index is systematically lower. This low solar activity coincides with cooling periods in some parts of the world. They also discovered a link between solar variability and climate change in water levels of the Nile River. During high solar activity, conditions along the Nile were drier, and when solar activity was low, conditions were wetter.

Focus On: The Lunar 100—Features 11 through 20

By Jerry Hubbell

(Note from the author: A version of this article was published in the July 2020 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 the photos in this article, go to http://www.alpo-astronomy.org/gallery3/index.php/Lunar/The-Lunar-Observer/2020/tlo202005. To see the latest issue of The Lunar Observer, go to http://www.alpo-astronomy.org/gallery3/index.php/Lunar/The-Lunar-Observer/2020/tlo202007)

This is the second of 10 articles in a new series on Chuck Wood's Lunar 100 list. Chuck, the founder of the Lunar Photo of the Day (LPOD), first discussed this list of lunar features in a *Sky & Telescope* article published in 2004 and later published on the *Sky & Telescope* website. This series will run until at least January 2022. Along the way, I may also insert a few articles on other topics, so the last article may appear as late as the end of 2022. Chuck wanted this list of lunar features (L1 to L100) to be the lunar equivalent of the well-known list of Messier objects, giving lunar observers a way to progress in their study of the Moon and become lifelong observers. The list contains all the diverse features of the Moon, including mare, craters, rilles, mountains, and volcanic domes, It begins with the naked eye view of the full disk of the Moon and progresses to more difficult-to-observe features.

These articles are meant to be the basis for a lunar visual observing program but are not limited to that purpose. They can be the basis for starting your own image-based study of the Moon, which will allow you to use the Lunar Terminator Visualization Tool (LTVT), a sophisticated software program used to do topographical measurements of the lunar surface. These articles will introduce and show each of the Lunar 100 features as observed and submitted by our members through narrative descriptions, drawings, and images. Although you can use your naked eye and binoculars to start observing objects L1–L20, seeing objects L21–L80 will require use of a 3-inch (76-mm) telescope. Features at the end of the list (L81–L100) will require a 6- to 8-inch (152- to 203-mm) telescope. The best views of many of the different features may be at different phases of the Moon.

One of the best ways to help you learn the features of the Moon is by sketching the lunar surface. Springer Books publishes an excellent book, released in 2012, called *Sketching the Moon* (Handy, et al.). There are also other resources on the Internet to help you get started observing and sketching the Moon, including the ALPO's excellent *Handbook of the ALPO Training Program.*

This article covers features 11 through 20 on Chuck's list. We highlight the excellent drawings of each of these features submitted by Michel Deconinck from Provence, France. Here is a list of features 11–20:

Designation	Feature Name	Description/Significance
L11	Aristarchus	Very Bright Crater with Dark Bands on its Walls
L12	Proclus	Oblique-Impact Rays
L13	Gassendi	Floor Fractured Crater
L14	Sinus Iridum	Very Large Crater with Missing Rim
L15	Rupes Recta	AKA "Straight Wall" - Best Example of a Lunar Fault
L16	Petavius	Crater with a Domed and Fractured Floor
L17	Schröter's Valley	Giant Sinuous Rille
L18	Mare Serenitatis	Distinct Mare Areas with Different Compositions
L19	Alpine Valley	Lunar Graben
L20	Posidonius	Floor Fractured Crater

Table 1. The Second Set of 10 Lunar 100 Features

Lunar 100: Features 11 and 17—Aristarchus & Schröter's Valley

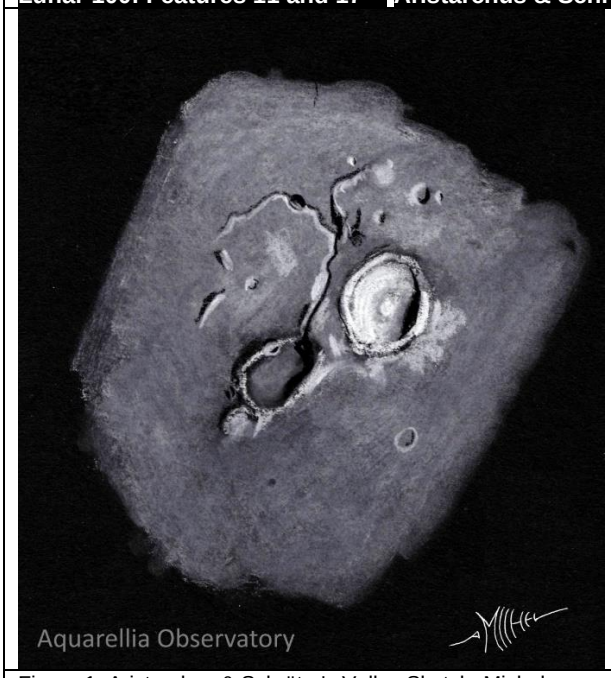


Figure 1. Aristarchus & Schröter's Valley Sketch, Michel Deconinck, Artignosc-sur-Verdon, Provence, France, 09 June 2014, 2100 UT, Colongitude 53.8°, Bresser refractor 102/1000, 10mm Delos eyepiece, Magnification 100x, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. North/Up, East/Right.

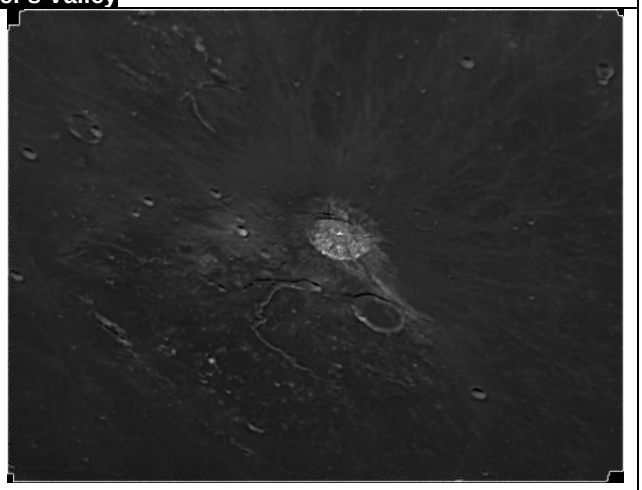


Figure 2. Aristarchus & Schröter's Valley, Alberto Anunziato (Paraná, Argentina, SLA), 19 June 2016 0215 UT, Colongitude 77.9°, 250 mm. Schmidt-Cassegrain (Meade LX 200), QHY5-II camera, North/Left, East/Up.

The Lunar 100: Feature 12—Proclus

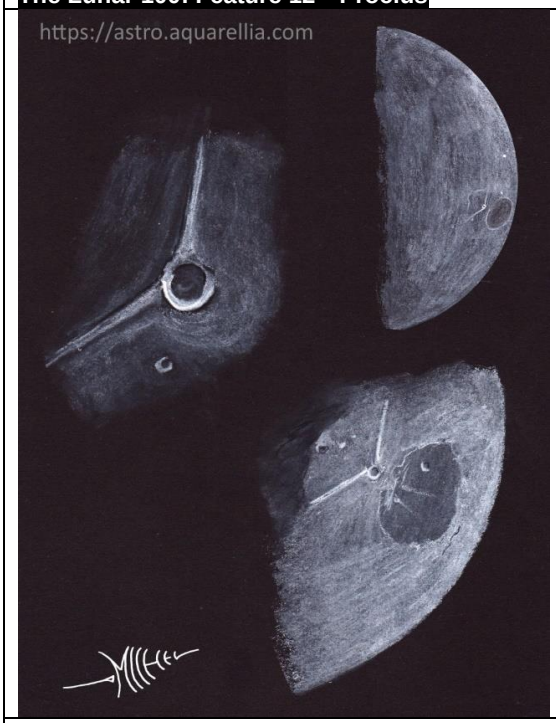


Figure 3. Proclus Sketch, Michel Deconinck, Artignosc-sur-Verdon, Provence, France, 04 May 2014, 2100 UT, Colongitude 334.1°, Bresser refractor 102/1000, 26mm Bresser eyepiece, 10mm Delos eyepiece, Magnification 38x, 100x, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. North/Down, East/Right.

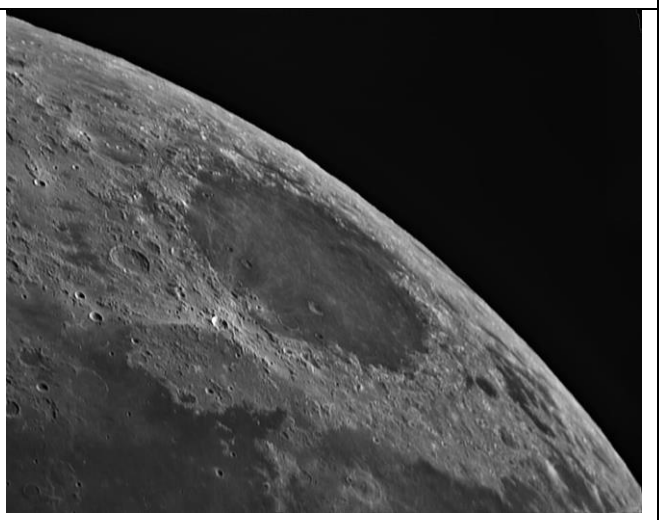


Figure 4. Proclus, Sergio Babino, Montevideo, Uruguay, SAO, 29 April 2020, 2240 UT, Colongitude 356.2°, 8-inch (200 mm) Schmidt-Cassegrain, Camera ZWO174mm. North/Up, East/Right.

The Lunar 100: Feature 13—Gassendi

Figure 5. Gassendi Sketch (rotated 180°), Jorge Arranz, Lunar Group of the Madrid Astronomical Association (AAM), Madrid, Spain, 07 March 2009, 2227 UT, Dobsonian 250mm f/5, 15 mm eyepiece, 282x magnification, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. Colongitude 47.4°, North/Up, East/Right.

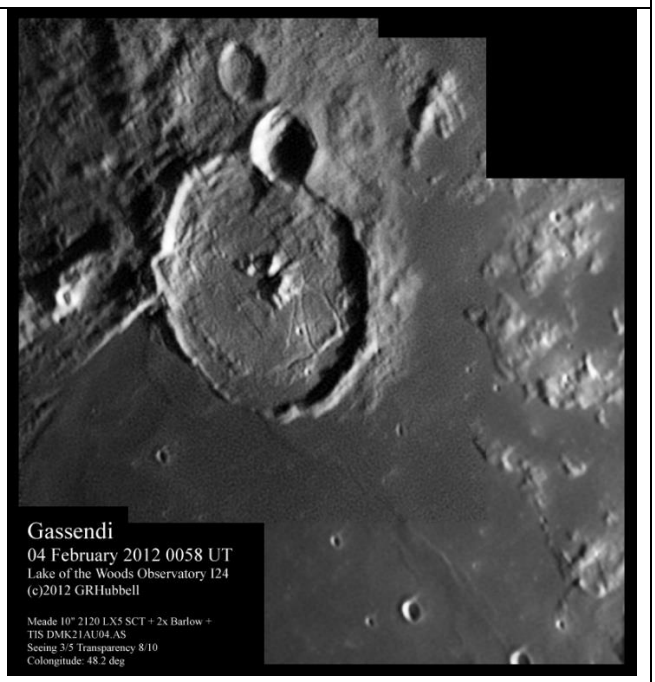


Figure 6. Gassendi, Jerry Hubbell, Lake of the Woods Observatory (I24) Locust Grove, Virginia, USA, 04 February 2012 0058 UT, Colongitude 48.2°, Meade 10-inch LX5 Schmidt-Cassegrain, DMK21AU04AS camera. Seeing 6/10, Transparency 5/6. North/Up, East/Right.

The Lunar 100: Feature 14—Sinus Iridum

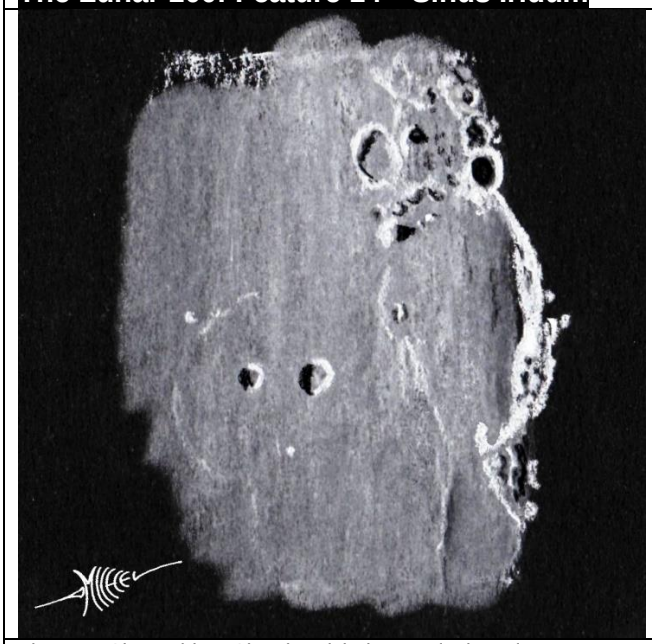


Figure 7. Sinus Iridum Sketch, Michel Deconinck, Artignosc-sur-Verdon, Provence, France, 05 June 2017, 1930 UT, Colongitude 45.3°, Bresser refractor152mm/1200mm, 10mm Delos eyepiece, Magnification 120x, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. North/Up, East/Left

Figure 8. Sinus Iridum, Jay Albert, Lake Worth, Florida, USA, 05 October 2019 at 0103 UT. Colongitude 345.3°, 200 mm f/10 Celestron 8" NexStar Evolution SCT, 7mm Orthoscopic eyepiece projection, iPhone 6s Camera, Seeing 5/10, Transparency 3/6 North/Up, East/Left

The Lunar 100: Feature 15—Rupes Recta "Straight Wall"

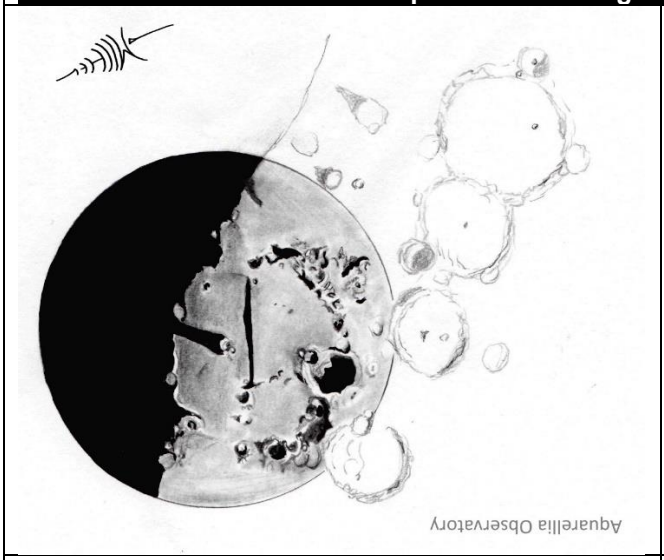


Figure 9. Rupes Recta "Straight Wall" Sketch (rotated 180°), Michel Deconinck, Artignosc-sur-Verdon, Provence, France, 07 May 2014 2140 UT, Colongitude 10.8°, Bresser refractor 102/1000, 26mm Bresser eyepiece, 10mm Delos eyepiece, Magnification 38x, 100x, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. North/Up, East/Right.

Figure 10. Rupes Recta "Straight Wall", Francisco Alsina Cardinalli, Oro Verde, Argentina, SLA. 20 December 2015 0031 UT, Colongitude 19.6°. 250 mm Meade LX200 SCT, Canon EOS Digital Rebel XS camera, North/Up, East/Right.

The Lunar 100: Feature 16—Petavius

Figure 11. Petavius, Alberto Anunziato, Oro Verde, Argentina, SLA, 04 March 2018 at 0748 UT. Colongitude 114.6°, 280 mm f/10 Celestron CPC 1100 SCT, Canon EOS Digital Rebel XS, Seeing 6/10, North/Up, East/Right.

The Lunar 100: Feature 18—Mare Serenitatis

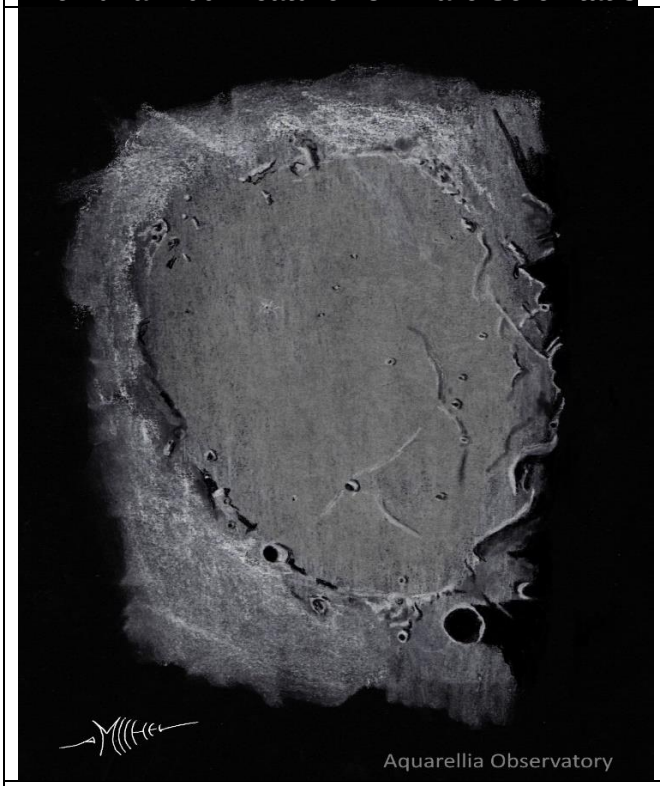


Figure 12. Mare Serenitatis Sketch, Michel Deconinck, Artignosc-sur-Verdon, Provence, France, 05 April 2018, 2000 UT, Colongitude 150.1°, Mewlon CRS (Dall Kirkham) 250mm f10 Ethos 13mm eyepiece 192x magnification, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. North/Up, East/Right.

Figure 13. Mare Serenitatis, Marcelo Mojica Gundlach, Cochabamba, Bolivia, SLA, 30 April 2020, 2324 UT, Colongitude 8.8°, 6-inch Maksutov FL=1800mm SkyWatcher, ZWO ASI178. Seeing 7/10, Transparency 5/6, North/Up, East/Right.

The Lunar 100: Feature 19—Alpine Valley

Figure 14. Alpine Valley Sketch, Michel Deconinck, Artignosc-sur-Verdon, Provence, France, 03 May 2020, 2115 UT, Colongitude 44.3°, Mewlon CRS (Dall Kirkham) 250mm f15 Ethos 13mm eyepiece 288x magnification, pastels Conté grey, B&W + blending stump on Canson paper 240gr black. North/Left, East/Up

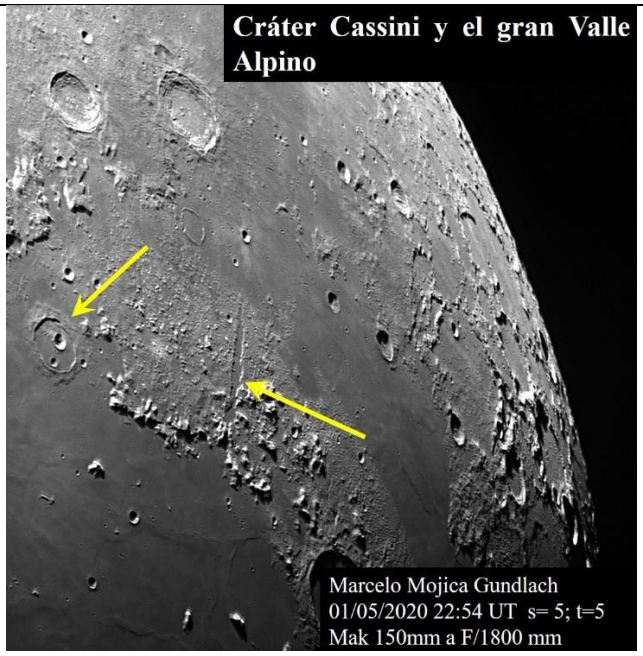


Figure 15. Alpine Valley, Marcelo Mojica Gundlach, Cochabamba, Bolivia, SLA, 05 January 2020, 2254 UT, Colongitude 36.2°, 6-inch Maksutov SkyWatcher FL=1800 mm, ZWO ASI178. Seeing 5/10, Transparency 5/6, North/Up, East/Right.

The Lunar 100: Feature 20—Posidonius

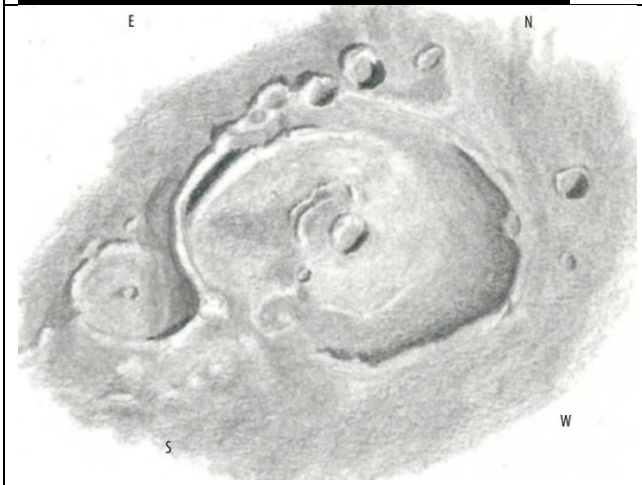


Figure 16. Alpine Valley, Jay Albert, Lake Worth, Florida, USA, 20 May 2011, 0615 UT, Colongitude 120.8°, 11-inch Celestron SCT, 311x magnification. Seeing 5/10, Transparency 4/6, Northeast/Up, Northwest/Right.

Figure 17. Posidonius, Sergio Babino, Montevideo, Uruguay, SAO, 14 March 2020, 0458 UT, Colongitude 145.3°, 203 mm SCT, ZWO 174mm camera, North/Up, East/Left.

Once again, we had a very large response to our request for images and drawings of the second set of 10 features of the Lunar 100 (L11–L20), again including a few taken with cellphone cameras. I am grateful for all the submissions. We had 87 images and drawings submitted from more than 20 astronomers. Most of the images came from Alberto Anunziato's groups, SAO-SLA, and LIADA. We look forward to future drawings and images submitted by ALPO, SLA, SAO, LIADA members. Please share with us any images you have in your image catalog—we hope to see everyone participate in these Focus On articles.

COMPUTER PROGRAMS

Virtual Moon Atlas, https://sourceforge.net/projects/virtualmoon/
Lunar Terminator Visualization Tool (LTVT), http://www.alpoastronomy.org/lunarupload/LTVT/ltvt_20180429-HTML.zip

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Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes
NOTE: The synopsis of the August presentation is below. There was no presentation at the September meeting. For info on the October presentation, see the lead article on page 1 of this newsletter.

August 2020—You Can Almost Touch the Stars

Tom Field, of Field Tested Systems LLC and creator of the Star Analyzer and RSPEC software program, began his presentation by pointing out that astronomy helped us add to dimensions we knew. Two dimensions were enough for finding places on Earth, but the Moon and planets showed us a third dimension. Later, time was recognized as a fourth dimension. Tom suggested that spectra supply a fifth dimension. Some of his suggestions for completing the phrase "You might want to capture spectra…" were:

"…if you remember the thrill of your first image."
"…if you want to do some science."
"…if you know you learn more if you 'own' the data."
"…if you don't want to have to rely on going to a dark-sky site."

Star Analyzer. Photo Courtesy of Tom Field

Starting with Isaac Newton's experiments with splitting sunlight with a prism, Tom sketched the history of spectroscopy in astronomy from Josef Fraunhofer's discovery of dark lines in spectra of the Sun to Robert Bunsen's and Gustav Kirchoff's contributions to explaining them. Bunsen used his burner invention to heat chemical compounds and discover bright lines in the resulting spectra, and Kirchoff helped explain the connection between dark lines (absorption) and bright lines (emission). The line patterns help identify elements in chemical compounds. Tom showed examples of these "fingerprints" for hydrogen, helium, nitrogen, and neon. He also showed a periodic table of spectra with line patterns in each element's box.

Tom continued his history with the story of Annie Jump Cannon and the women "computers" at Harvard. Their work on organizing and classifying stellar spectra resulted in the OBAFGKM sequence used today. Beginning with the Bohr model of the atom, quantum theory provided an explanation of emission and absorption lines as results of energy-level transitions in atoms.

Tom then turned to the subject of amateur spectroscopy, showing the hydrogen Balmer lines he recorded with a DSLR and one of his Star Analyzer gratings. He showed various types of spectra and explained what they indicated. For example, absorption bands indicate molecules, implying a cooler star. The hydrogen Hα line requires a hot star for electrons to reach the upper energy level but not too hot to cause ionization of the hydrogen. He described Hα as the dip in the robin-egg blue region and said although it was not necessary to use a color camera, it showed off the spectra.

An early problem Tom had when he first tried spectroscopy was producing a graph of the data. He wound up writing his own software, RSpec, which he showed us how to use for graphing and analyzing spectra. He then showed some examples of data that amateurs could obtain. One was a Wolf-Rayet star spectrum made by Janet Simpson with a Canon DSLR and an 85-mm lens. Another was a spectrum of the Orion Nebula, which was done with a slit. Tom asked us for memories of our first view of the Orion Nebula. His experience was going to a star party with a bunch of "cannons." Despite the size of the telescopes, the nebula was "just a smudge," and he noted that it gets more interesting when you learn about it. Tom also showed comet spectra, including NEOWISE with a sodium emission line, and meteor spectra.

Examples of getting Doppler shifts were the final topic. Tom showed how a spectrum of a supernova had a dip from silicon showing up at 6150 Å instead of 6355 Å. This "blue shift" indicated the shell of the supernova was expanding at 10,000 km/s. Another example was the spectrum of the quasar 3C273, studied by Maarten Schmidt, which seemed to have "mystery lines" until he recognized them as highly shifted Balmer lines.

Jerry Hubbell showed a spectrum of Nova Persei 2018 measured at MSRO with a Star Analyzer donated by Tom. It had a "big Hα" peak. Jerry also said Dave Dowhos, who was doing spectroscopy work at MSRO, had donated another grating for station 2. Tom was asked about using telescopes with chromatic aberration, and he said it should be avoided. He also said spreading the light into the spectrum costs about 5 magnitudes compared with just imaging stars. Glenn F. asked Tom to say more about why you should try to get spectra when you are not

likely to discover something new. Tom suggested there are some discovery opportunities but said he thought it was the satisfaction of seeing how the science works. Jerry said he thought there could be opportunities to help classify new supernovae.

Image of the Quarter

Occultation of a Star by Uranian Moon Umbriel by Myron Wasiuta and Bart Billard

Note: This is a somewhat unusual “image of the quarter” because it is actually a video. Click on the link below and read Myron’s description. This link will download the video onto your local machine so you need to open it with your video player.

Link to video: Umbriel occultation

Description from Myron: A few weeks ago, David Dunham [International Occultation Timing Association (IOTA)] sent out an alert describing a rare occultation of a 13.5 magnitude star by the faint Uranian moon Umbriel. Bart and I were able to successfully detect an approximately 50-second event using the MSRO Station 3 telescope (Explore Scientific 102mm F/7 APO and QHY 174 GPS CMOS camera). We captured 90 4-second exposures at prime focus (714mm fl). I thought it might be interesting to animate those images and did so by cropping in tightly on Uranus and scaling the images to reduce the glare of the planet. Because no guiding was performed, the images wobble back and forth slightly owing to the Periodic Error of the CGE PMC-Eight mount. The animation compresses 6 minutes of data into about 18 seconds. Umbriel is so faint that it can only be seen when the star is occulted just before it reappears. The target star is the object very close to the lower left of Uranus' over-exposed disk. The other two moons visible to the lower left are Oberon (farthest out) and Titania. I think another Uranian moon can be glimpsed touching the image of the planet at upper right. Thank you, David, for giving us a heads-up on this most unusual and rare event!