http://www.raclub.org/

The StarGazer

Newsletter of the Rappahannock Astronomy Club — No. 4 Vol. 7 February 2019–April 2019

Adventures at the 2019 NEAIC and NEAF in Suffern, NY

By Jerry Hubbell

As most of you probably know, I've attended the North East Astronomy Forum (NEAF) show in New York for 9 years now. I began helping at the Explore Scientific (ES) booth even before being hired as a company employee in 2013. My first stint at the booth was as a customer showing my Astronomical Imaging System (AIS) and demonstrating the Telescope Drive Master (TDM), a high-precision mount drive correction system.

In 2012, I also began attending the North East Astro Imaging Conference (NEAIC), held the Thursday and Friday before NEAF. In 2013 and 2014, I was fortunate to be asked to speak at the conference. This imaging conference is one of best in the country if you want to learn all about astrophotography and what you can really do with your AIS.

Giving my NEAIC talk on exoplanet observing at the MSRO (courtesy Mike Hatch)

This year, I was again asked to give a talk at NEAIC. My presentation was similar to the one I gave at the March RAC meeting, discussing our work on exoplanet transit observations at the Mark Slade Remote Observatory (MSRO). I described the development of a new instrument we are using at the MSRO to make high-precision photometric measurements. You can find my presentation online and a video interview here.

I arrived in Suffern with my family on Wednesday, April 3, and checked into the conference hotel (Crowne Plaza). The other ES representatives, Scott Roberts and Mike Hatch, had arrived earlier in the day from company headquarters in Springdale, AR, and had set up our table in the vendor area at the conference. It was great seeing my vendor friends, most of whom I see only once a year. I gave my talk on Thursday, April 4, the first day of the conference. It was well attended, and everyone seemed very interested—I got lots of questions, both general and very specific.

Manning the NEAIC Explore Scientific table in the vendor area.

The meals provided to the vendors and attendees were what I would characterize as "upscale cafeteria." However, because I was a conference speaker, I attended the "Speakers Dinner" on Thursday evening. The buffet spread here was, not surprisingly, much nicer, and I ate well. The highlight for me was meeting and talking with astronaut Don Pettit. Previously, I had met one other astronaut—Story Musgrave. My "story of meeting Story" got a chuckle from Don. I won't tell that "story" here, but ask me about it the next time you see me. Don was very approachable and was very interested in the work that amateurs do in astrophotography. (Continued on page 3)

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. We also have several members who live outside Virginia and have joined to have the opportunity to use of 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 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** through which you will receive official timely information regarding club activities, including meetings, star parties, and special events. Just click this link, then the blue “Join this Group!” button, and follow the instructions to sign up. We also have a Facebook presence.

The StarGazer
February 2019–April 2019
Published Quarterly by Rappahannock Astronomy Club
Editor: Linda Billard
Copyright 2019 by Rappahannock Astronomy Club
All rights reserved

Fair Use Notice:
In accord with Title 17 U.S.C. Sections 107–118, all copyrighted material herein is reproduced under fair use without profit or payment and is intended solely for the benefit of those receiving the information for nonprofit research and educational purposes only.
[Reference: https://www.law.cornell.edu/uscode/text/17/107]

Website: www.raclub.org
Yahoo Group:
http://tech.groups.yahoo.com/group/rac_group/

RAClub Officers
Glenn Faini President
Glenn Holliday Vice President
Tim Plunkett Treasurer
Bart Billard Secretary
Points of Contact
Glenn Faini Public Outreach
Glenn Holliday Scout Clinics
David Abbou School Programs
Glenn Holliday Star Parties
Scott Busby Yahoo Group Admin
Don Clark Web Editor & Image Gallery Editor
Don Clark Internet Administrator
Tim Plunkett Librarian
Scott Busby Equipment Loan
Jerry Hubbell Astrophotography
Myron Wasiuta Mark Slade Remote Observatory (MSRO)

Calendar of Upcoming Events

Star Party, Caledon State Park	May 4
Star Party, Mt. View HS, Stafford	May 10
Star Party, Caledon State Park	June 1
Star Party, Caledon State Park	June 29
Backyard Astronomy, Science Café, Porter Library	July 15
Star Party, Caledon State Park	July 27

Recent Outreach Events Completed

Star Party, Caledon State Park	February 2
Star Party, Caledon State Park	April 6
Math & Science Night, Park Ridge Elem.	April 10

President's Corner

I am happy to announce that the Rappahannock Astronomy Club now has embroidered gear and patches. Beginning this year, all new members will be offered a RAC patch. Current members may purchase patches for $10 each. RAC members may also purchase embroidered polos, t-shirts, hoodies, and other items. A custom brochure and order form will be available soon at our meetings and on www.RAClub.org. Note that the patches are not iron-on.

Yahoo!Groups is how the club sends out emails to its members. Please make sure you are subscribed to the RAC email list so that you receive timely club emails concerning meetings, star parties, and other events. Subscribe by sending an email to:
rac_group-subscribe@yahoogroups.com.

Wishing you transparent skies and excellent seeing.
Glenn D. Faini

Adventures at 2019 NEAF and NEAIC (Continued from page 1)

I also met and talked with a scientist and pioneer in CCD imaging and photoelectric photometry—Arne Henden. I think I have communicated with him through email before, but this was the first opportunity to meet him. Arne was the director of the American Association of Variable Star Observers (AAVSO) for more than 10 years starting in 2004. Previously, he did work at the USNO and other observatories. He approached me at our table, and said he had attended my talk. I began chatting with him without realizing who he was. When I glanced down at his nametag and realized who he was, I told him that I had purchased his classic book, *Astronomical Photometry*, back in the 1980s. He requested to use a couple of the figures in my presentation for a presentation he would be giving at the Society for Astronomical Sciences (SAS) Symposium at the end of May. Of course, I said "Yes." (I am also submitting a paper on our MSRO exoplanet work for the proceedings of that symposium.)

On Friday afternoon, Scott, Mike, and I dismantled our booth at NEAIC and moved over to Rockland Community College where NEAF would be held on Saturday and Sunday. We had three additional pallets worth of equipment to set up that should have arrived that morning but actually didn't arrive until after 8 p.m. Based on previous experience, we knew it would take at least 4 or 5 hours to set up our large booth. As usual, we didn't finish until about 2:30 a.m. I got only about 3 hours of sleep because the show starts at 8:00 a.m. Not a good way to start a show but it was still a good day because I talked to a lot of booth visitors, some of whom I had previously communicated with online. Our new mount, the iEXOS 100 PMC-Eight, was a big hit, along with our full range of telescopes and mounts.


With Brian Tucker and Steve Siedentop in the ES display area at NEAF.

Poster announcing the new series editor for the Patrick Moore Practical Astronomy Series

Representatives of Linda Billard's and my book publisher, Springer Books (New York), were at the show, and I met our editor Hannah Kaufman. The Springer Editor for Astronomy books, Maury Solomon, was also there, as always. Their display included a poster announcing my appointment as the series editor for the Patrick Moore Practical Astronomy series. It was cool but at bit strange seeing my picture up in their booth.

By the end of the Saturday, I was exhausted. I hadn't eaten much all day and was more than ready to crash in the hotel room. My family had spent the day visiting Long Island and so they were ready to crash too.

I managed to get a reasonable amount of sleep and woke up on Sunday in plenty of time. Because the show didn't open until 10 a.m., Scott, Mike, and I had time to get a good breakfast at the Airmont Diner. If you ever go to the show, this restaurant is a "must visit"…everyone goes there. It's just down the street from the Crowne Plaza hotel.

Sunday wasn't quite as busy as Saturday (it never is), and by the afternoon, we were ready to start packing up, which (again) took about 5 hours. During the afternoon, I had a brief chat with Dave Eicher, the Chief Editor of *Astronomy* magazine about an article I am writing (due by the end of June) that is scheduled to appear in the September issue. The article is, again, about the exoplanet work we are doing at the MSRO. I look forward to getting that article done and seeing it published—it's the first one for me in a widely circulated magazine.

As expected we weren't finished with tear-down until after 9 pm. We're always one of the last vendors to leave because there are only 3 of us—not the 8- to 10-person crews that some dealers bring to set up and sell their wares. However, I always enjoy going to NEAF and feel very privileged to be asked to speak at NEAIC. The setup and tear-down is always the worst part, but it is worth it every time because I get to interact with all the wonderful attendees and meet people who support my work in the industry. I have lots more stories about the conference and forum but those are for another time.

If you think that you might want to attend NEAF, you should make a plan—it is the best show to attend if you are a gear-head about astronomy equipment. NEAIC is a bit more of an investment, but I think it's well worth the money and time.

Did You Know? **by Scott Busby**

On the evening of January 31, 1862, the Clarks-–Alvan watching the time, and his son Alvan Graham at the eyepiece of the 18½-inch telescope—were trying to ascertain how long the light of Sirius was perceptible before the star itself was in view. While Sirius was still behind the corner of a building, Alvan Graham noticed the Pup before the star was in the field of view for 3 seconds. For this discovery, Alvan Clark was awarded the 1862 Lalande Prize of the French Academie des Sciences. This was his most noted discovery.

Source: *Alvin Clark & Sons Artists in Optics*, Deborah Jean Warner, Smithsonian Institution Press, 1968

Note: The telescope the Clarks used was the largest at the time and was located at the Dearborn Observatory of the University of Chicago. Its lens was made by Alvan Clark.

The X Factor: Planet Nine

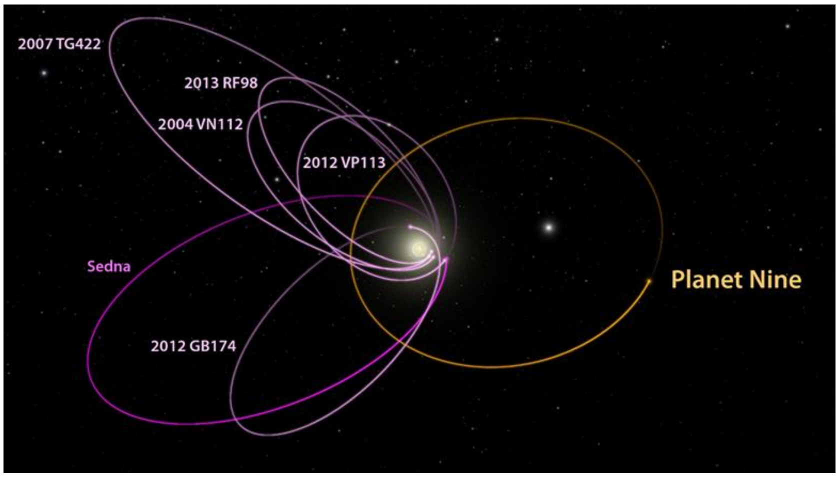
By Linda Billard

Prior to the discovery of Pluto in 1930 at the Lowell Observatory, Percival Lowell predicted that a massive "Planet X" (more recently referred to as "Planet Nine") was the cause of the perturbation of the orbits of Uranus and Neptune. When Pluto was found, it was thought to be Lowell's Planet X. More recent calculations showed that not only was Pluto too small to cause such orbital changes but the perturbations were actually nonexistent and the result of inaccurate calculations by Lowell.

However, about the same time as Planet X was being dismissed as a mistake, other astronomers were beginning to examine the behavior of the thousands of objects in the Kuiper Belt, most of which have orbits influenced by the planets. In 2002, Michael Brown (Professor of Planetary Science at Caltech) and his team discovered Sedna in the Kuiper Belt. Its orbit is so stretched that it takes 10,000 Earth years to go around the Sun. Initially, it was proposed that this strange orbit was the result of the influence of a passing *star* early in the history of our solar system. That star's proximity could have been enough to move Sedna's orbit away from Neptune's. Sedna was thought to be a fossil record of that period.

However, in 2012, a Brazilian astronomer, Rodney Gomes, proposed that the elongated orbits of Sedna and some other Kuiper Belt objects could be products of the influence of a distant massive *planet*. Others noted that when these objects with extremely elongated orbits were at points closest to the Sun, they moved from below the plane of the solar system to above it. While a distant planet could be responsible for this behavior, no one had a good explanation of what the exact effect could be. At that point, astronomers concluded that although the behavior seemed consistent and was statistically robust, it must be a fluke.

In 2016, Professor Brown and another astronomer, Konstantin Batygin, sorted out the mystery. They found that all the most elongated orbits pointed in the same direction and were tilted in the same direction. Such consistency of behavior could not persist without something holding them in place. Brown and Batygin concluded that a massive distant planet would produce exactly that result. In the last 3 years, they have refined their calculations to describe Planet Nine as six times the mass of Earth, tilted with respect to the ecliptic by less than 20 degrees, and having an orbit 400 times as far from the Sun as Earth. No competing hypothesis has been proposed so far, and Brown and Batygin's most recently published analysis shows only 0.2% probability that the behavior of the objects with elongated orbits could be the result of observational bias or chance.



The six most distant known objects in the solar system with orbits exclusively beyond Neptune (magenta) all mysteriously line up in a single direction. Moreover, when viewed in 3-D, their orbits are tilted in the same direction, away from the plane of the solar system. Credit: JPL-Caltech/R. Hurt

Their analysis may be convincing but no one has actually observed Planet Nine so far. In a March 2019 article in *Physics Today*, Brown says: "…we have confidence that within a few years an astronomer somewhere will find a faint, slow-moving point of light in the night sky and triumphantly announce the discover of another new planet in our solar system." …And it won't be Pluto!

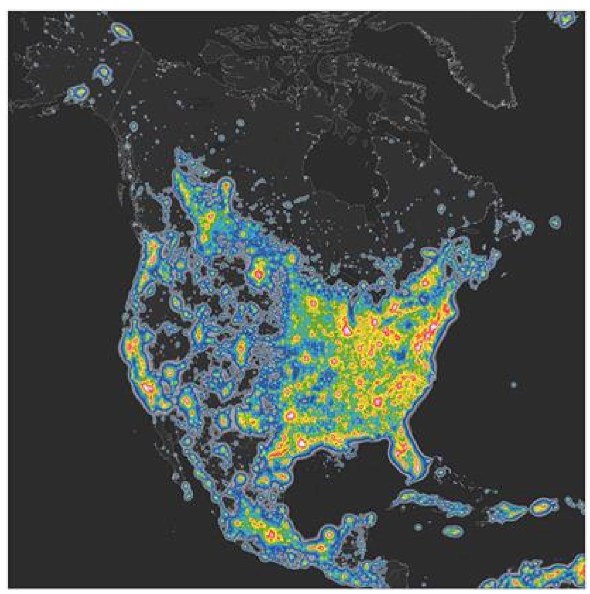
Measuring Darkness

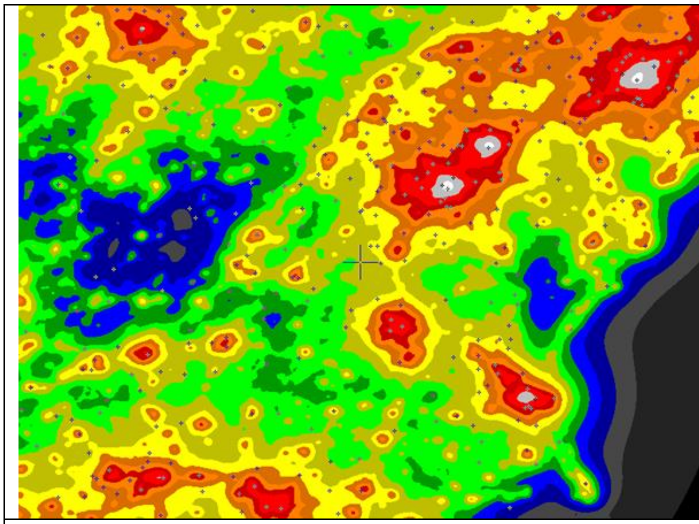
By Scott Busby

It usually doesn't take most amateur astronomers long to ask the question: How dark is my sky? Whether it's our own backyard or a favorite dark site, we usually want to know just how bad the light pollution is. Generally, we turn to star charts and try to determine how many stars we can visually acquire in a particular constellation from our chosen location. Another option is to review our location in the context of a published light pollution map.

The International Dark Sky Association (IDA) has defined for us what light pollution actually is, its causes and effects, and the steps we can take in our communities to help educate others about limiting the effects of light pollution. To learn more about the IDA and light pollution, please visit https://www.darksky.org/light-pollution/

The IDA has recognized a groundbreaking study documenting light pollution across the globe. It found that more than 80 percent of the world's population lives under light-polluted skies. It's even worse in the United States and Europe, with 99 percent of the population experiencing sky glow at night.


Light Pollution Map of the United States

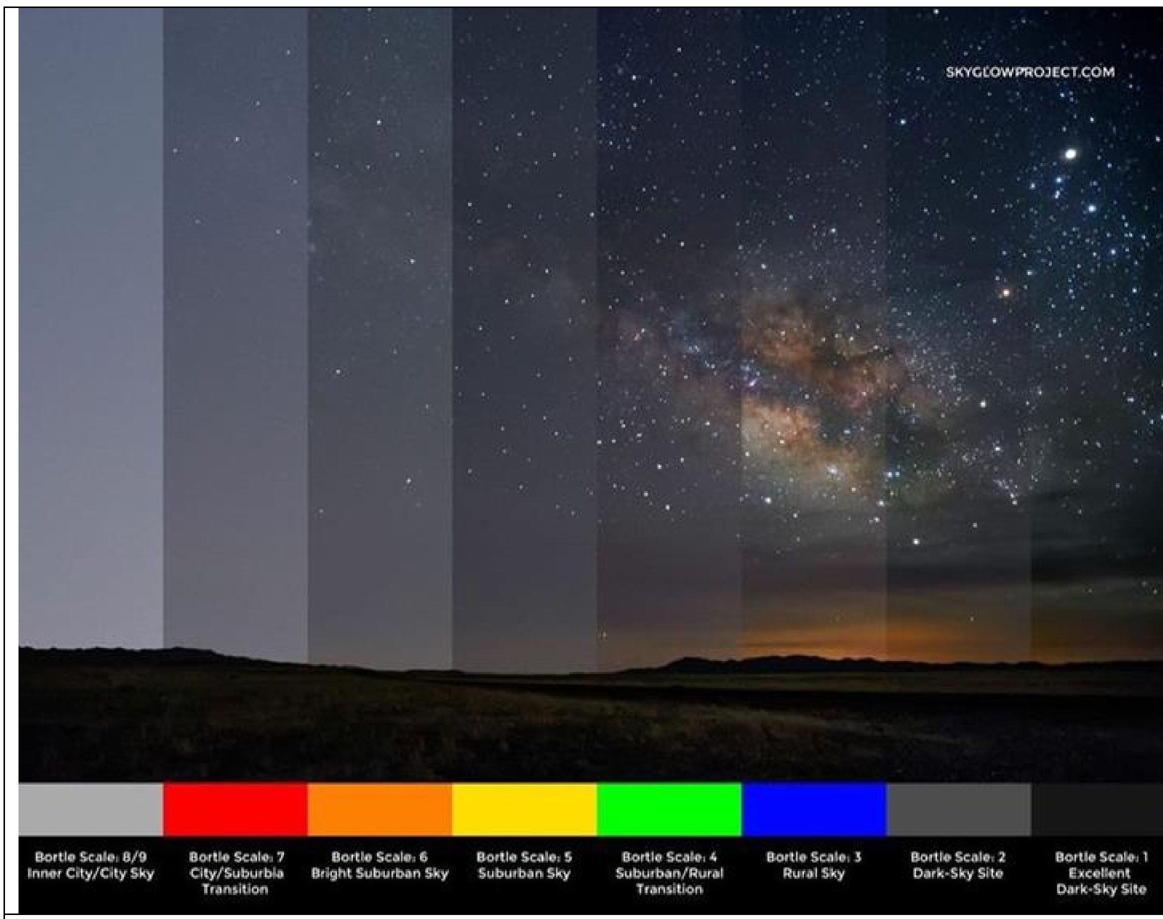


The center crosshair is the location of Belmont Observatory. Credit: David Lorens (University of Wisconsin-Madison)

The open access journal *Science Advances* publishes the "World Atlas of Artificial Night Sky Brightness," which documents a world that, in many places, is awash in light. According to the study's authors, "…humanity has enveloped our planet in a luminous fog that prevents most of Earth's population from having the opportunity to observe our galaxy. This has a consequent potential impact on culture that is of unprecedented magnitude."

Clear Sky Chart provides more locational detail from the same atlas to access a light pollution map of the area we live in or a favorite dark site. The Clear Sky Chart light pollution map for my site at Belmont Observatory is shown in the illustration above and can also be found at:
http://www.cleardarksky.com/lp/BlmtObVAlp.html?Mn=telescope%20accessory

The colors in the illustration for my site correspond with the colors used in the Bortle Scale, which is shown below with color indicators. It can also be found at:
http://www.cleardarksky.com/lp/BlmtObVAlp.html?Mn=lenses



Bortles Scale. Credit: Skyglowproject.com

The **Bortle scale** is a nine-level numeric scale that measures the night sky's brightness of a particular location. It quantifies the astronomical observability of celestial objects and the interference caused by light pollution. John E. Bortle created the scale and published it in the February 2001 edition of *Sky & Telescope* magazine to help amateur astronomers evaluate the darkness of an observing site, and secondarily, to compare the darkness of observing sites. The scale ranges from Class 1, the darkest skies available on Earth, through Class 9, inner-city skies. It gives several criteria for each level beyond naked-eye limiting magnitude (NELM). The accuracy and utility of the scale have been questioned in recent research, but for now, it serves as a reasonably accurate way to evaluate our local skies for astronomy. The following table, without color indicators, more accurately describes each class, 1 through 9, and the corresponding NELM.

Class	Title	NELM	Approx. SQM (mag/ arcsec^2)	Description
1	Excellent dark-sky site	7.6–8.0	21.7–22.0	• Zodiacal light is visible and colorful • Gegenschein is visible • Zodiacal band is visible • Airglow is readily visible • Scorpius and Sagittarius regions of the Milky Way cast obvious shadows • Many constellations, particularly fainter ones, are barely recognizable due to the large number of stars • Many Messier and globular clusters are naked-eye objects • M33 is a direct vision naked-eye object • Limiting magnitude with 12.5" reflector is 17.5 (with effort)
2	Typical truly dark site	7.1–7.5	21.5–21.7	• Zodiacal light is distinctly yellowish and bright enough to cast shadows at dusk and dawn • Airglow may be weakly visible near horizon • Clouds are only visible as dark holes against the sky • Surroundings are barely visible silhouetted against the sky • Summer Milky Way is highly structured • Many Messier objects and globular clusters are naked-eye objects • M33 is easily seen with naked eye • Limiting magnitude with 12.5" reflector is 16.5
3	Rural sky	6.6–7.0	21.3–21.5	• Zodiacal light is striking in spring and autumn, and color is still visible • Some light pollution evident at the horizon • Clouds are illuminated near the horizon, dark overhead • Nearer surroundings are vaguely visible • Summer Milky Way still appears complex • M15, M4, M5, and M22 are naked-eye objects • M33 is easily visible with averted vision • Limiting magnitude with 12.5" reflector is 16
4	Rural/suburban transition	6.1–6.5	20.4–21.3	• Zodiacal light is still visible but does not extend halfway to the zenith at dusk or dawn • Light pollution domes visible in several directions • Clouds are illuminated in the directions of the light sources, dark overhead • Surroundings are clearly visible, even at a distance • Milky Way well above the horizon is still impressive but lacks detail • M33 is a difficult averted vision object, only visible when high in the sky • Limiting magnitude with 12.5" reflector is 15.5
5	Suburban sky	5.6–6.0	19.1–20.4	• Only hints of zodiacal light are seen on the best nights in autumn and spring • Light pollution is visible in most, if not all, directions • Clouds are noticeably brighter than the sky • Milky Way is very weak or invisible near the horizon and looks washed out overhead • When it is half moon (first/last quarter) in a dark location, the sky appears like this, but with the difference that the sky appears dark blue • Limiting magnitude with 12.5" reflector is 15
6	Bright suburban sky	5.1–5.5	18.0–19.1	• Zodiacal light is invisible • Light pollution makes the sky within 35° of the horizon glow grayish white • Clouds anywhere in the sky appear fairly bright • Even high clouds (cirrus) appear brighter than the sky background • Surroundings are easily visible • Milky Way is only visible near the zenith • M33 is not visible; M31 is modestly apparent • Limiting magnitude with 12.5" reflector is 14.5

Class	Title	NELM	Approx. SQM (mag/ arcsec^2)	Description
7	Suburban/urban transition	4.6–5.0	18.0–19.1	• Light pollution makes the entire sky light gray • Strong light sources are evident in all directions • Clouds are brightly lit • Milky Way is invisible • M31 and M44 may be glimpsed, but with no detail • Through a telescope, the brightest Messier objects are pale ghosts of their true selves • When it is full moon in a dark location, the sky appears like this but with the difference that the sky appears blue • Limiting magnitude with 12.5" reflector is 14
8	City sky	4.1–4.5	<18.0	• Sky is light gray or orange—one can easily read • stars forming familiar constellation patterns may be weak or invisible • M31 and M44 are barely glimpsed by an experienced observer on good nights • Even with a telescope, only bright Messier objects can be detected • Limiting magnitude with 12.5" reflector is 13
9	Inner-city sky	4.0	<18.0	• Sky is brilliantly lit • Many stars forming constellations are invisible, and many fainter constellations are invisible • Aside from the Pleiades, no Messier object is visible to the naked eye • The only objects to observe are the Moon, the planets, and a few of the brightest star clusters

Product Review: ZWO 30-mm Mini Guidescope

By Ron Henke

For about the last 18 months, I have been using a Hyperstar lens and have really enjoyed it. It's quick and easy, but the longest duration of subframes I can get with it is about 40 seconds, and that is only after a really good alignment. Typically, the subframes I take with Hyperstar are 30 seconds, and although I am quite pleased with the results, I started to wonder whether I could do better with longer exposures. I had seen other astrophotographers using Hyperstar and guiding with an 80-mm short tube Orion. That seemed like a lot to be guiding with, so I didn't bother to get one. For those of you not familiar with Hyperstar, it is a special lens that fits on the front of a SCT where the secondary lens would be located. This allows you to image at F2. The camera then screws into the Hyperstar lens (see my Hyperstar review in the April 2017 issue of the *StarGazer*).

More recently, I saw others using a little guidescope with their Hyperstar lens. I was more than a little intrigued, so I bought one. The guidescope is the ZWO 30F4 MiniScope. The aperture is 30 mm, and it is only 5.5 inches long. This may be the part I like the best about it—it fits in my accessories case just fine.

The photos at left give you an idea of the MiniScope's actual size. The photo on the far left shows the scope without the camera and with the foot attached. As mentioned above, it is only 5.5 inches long. The quarter gives an idea of the size. The photo on the near left shows it with the guide camera attached. The camera is a ZWO ASI290MC one-shot color CMOS. This camera also doubles as my planetary camera. The two together are only 6.75 inches long.

The picture below shows the MiniScope attached to my SCT. It's so unobtrusive I don't even bother to take it off.

So how well does it work? With the Hyperstar lens, it works great. I haven't had any problems, so far. I use MaxIm DL 6 to do my imaging, and it connects just fine. I've had no problems finding a guide star and calibrating…works every time. Focusing is accomplished by turning the black barrel at the end of the MiniScope, and the focus is set by using the red locking ring in the middle of the scope. I focused once and haven't touched it since. The FWHM with MaxIm DL 6 is 6.5, which works just fine for guiding purposes. I am told this scope is good for guiding wide-field imaging (F2) and that it doesn't work at high F ratings such as F10. I'll have some more to say on that at the end of this review. The image of M35 below was taken using my Celestron 8-inch SCT on a Celestron AVX mount using a Hyperstar lens at F2 and an Atik 460EX CCD one-shot color camera, using the ZWO MiniScope, four subframes of 180 seconds, using MaxIm DL 6, and no post-processing. What I like most is how round the stars are.

As with everything, there are pros and cons. The pros first: As I said before, it's small and fits in my accessory case. I like that. I have to lug all my equipment out and take it back in each time I observe or image so this is another piece of equipment I don't have to haul back and forth separately. Because of its size and weight, I don't need a dove tail and I don't have to adjust the counterweight at all. Next up, it's cheap, only $99. An 80-mm short tube Orion is the same price, but its much larger and heavier. Finally, and maybe the best part—it works "as advertised."

As for the cons, I really haven't found any. I've been told that it is only good for wide-field imaging. Well, if you know me, you know I just had to try guiding with this scope at F10. I have actually had some success with this setup. I don't want to say it works well this way just yet. I need to do some more experimenting.

So, If you need a wide-field guide scope that is small and cheap, I highly recommend the ZWO 30F4 MiniScope.

Recent Club Events and Star Parties

By David Abbou, Glenn Faini, and Linda Billard

RAC member and NASA Solar System Ambassador David Abbou participated in the **Park Ridge Elementary School Math and Science Night** on April 10, 2019. About 250 adults and children attended. David's presentations centered on astronomy and the space program as he discussed Earth's rotation and revolution around the Sun and how those motions govern our measure of time, including our ages. David also discussed Earth's 23 ½ degree tilt resulting in our seasons. He also discussed the various types of telescopes and NASA's ongoing/upcoming space missions. The emphasis was on how math and science are the fundamentals of understanding all of these amazing astronomical things. David provided NASA outreach materials from various missions, including LRO, SDO, New Horizons, InSight, and JWST, which were a big hit with the kids and parents and drew many more questions.

RAC's **April 6 star party at Caledon State Park** was also a great success. RAC President Glenn Faini arrived to find he was the only club member present and that one telescope was set up—an Orion 4" Newtonian on a GEM similar to the one pictured at right. The scope was a Christmas present to a 15-year-old astronomer named Sarah. She was very eager to learn and had many questions. She said she would join the club and would probably ask for more mentoring.

About 20 guests attended, including several families, a Cub Scout pack, and some Webelos.

Glenn began by giving the whole group instruction on setting up and using Sarah's telescope. He also answered questions for the Cub Scouts, who were working on an Astronomy badge. He spent the rest of the evening helping Sarah learn to use her scope and guiding everyone around the sky, pointing out stars, Mars, constellations, and the Orion Nebula. Unfortunately, Sarah only brought a 9-mm eyepiece, so it was a bit difficult finding things, but Glenn thought she went home more confident. [NOTE: Sarah and her mother attended the April 17 RAC meeting, joined the club, and showed interest in being trained to use the club's remote observatory, MSRO, in addition to practicing with her own scope.]

The Great Extinction Debate: Did an Asteroid Do It?

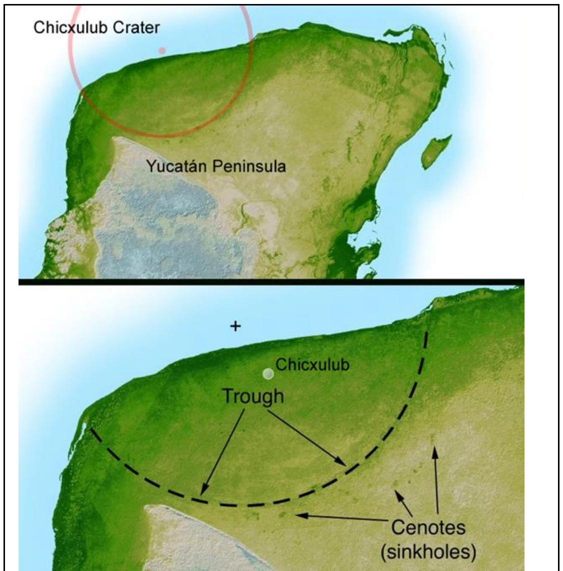
By Linda Billard

Bet you thought everything was settled…an asteroid hit the Earth and caused the extinction of the dinosaurs.

Not so fast….This mass extinction hypothesis was first proposed in 1980 by the father-and-son team of scientists Luis and Walter Alvarez, physicist and geologist, respectively. Their hypothesis (nota bene: it's still referred to as a *hypothesis*) posits that the mass extinction of the dinosaurs was caused by the impact of a large asteroid with the Earth about 65 million years ago. The gigantic crater near Chicxulub, Mexico, in the Yucatán Peninsula certainly affirms that the asteroid strike occurred, but to this day, there are still some who believe that the extinction was well under way *before* the asteroid hit.

Artist's rendering of Chicxulub asteroid impact. Source: NASA

Adding fuel to the controversy is the recent work of a paleontology graduate student named Robert De Palma. The initial story of his discovery is described in, of all places, *The New Yorker* magazine…certainly not where one would expect scientific discoveries to be reported. Douglas Peterson, in his story, "*The Day the Dinosaurs Died*," describes his first encounter with De Palma in 2013 and the latter's initial discovery. Excavating in the Hell Creek Formation in North Dakota at a site he later christened "Tanis," De Palma found millions of microtektites relatively near the surface. These small glass droplets are produced when an asteroid strikes the Earth, causing molten rock to shoot up and then rain back in solid form. As a result of his surveying and mapping, De Palma initially hypothesized that a huge surge of water from the inland sea flooded this low-lying area, perhaps as part of a tsunami that occurred immediately after the asteroid impact. As the water settled, it dumped everything it had swept up, including dying and dead animals and plants; other plant and animal detritus, including tree trunks, shells, teeth, and eggs; and minerals, including tektites, diamonds, and iridium-laden dust and ash. As this mess settled, tektites of all sizes continued to rain into the mud. The site appears to be snapshot of the day the asteroid struck. According to Peterson, after Walter Alvarez visited the site last summer, he described it as "…truly a magnificent site….surely one of the best sites ever found for telling just what happened on the day of the impact."



Map of asteroid impact area. Source: Wikipedia Commons

From 2013 to 2018, De Palma continued excavations at the site, sharing his findings with only a half-dozen other scientists, including Alvarez, enlisting help in establishing the significance of his finds. In an attempt to prove that the tsunami that produced his bed of detritus resulted from the “extinction” asteroid, he gathered some Chicxulub tektites from a known site in Haiti and sent them, along with some tektites from the Tanis site, to an independent laboratory for comparison. The lab found they were a nearly exact geochemical match.

In 2016, De Palma presented limited findings of his discoveries at the annual meeting of the Geological Society of America. He was met with the full range of responses—from gasps of wonder, to harrumphs of skepticism, to charges of fabrication. In response to one of the criticisms, De Palma, with the aid of Jan Smit, a Dutch paleontologist, and Mark Richards, a University of California geophysicist, subsequently reassessed his data to conclude that the water event was not a tsunami but a series of *seiches* (pronounced sayshes)—repeated sloshing of bodies of water that occurs at the same time as earthquake tremors. (For example, 6-foot seiches were seen in otherwise calm Norwegian waters 30 minutes after the 2011 Japanese earthquake.) Calculations made by Richards concluded that the seiches at Tanis would have occurred within minutes of the asteroid impact in the Caribbean.


Robert DePalma (right) and Walter Alvarez (left) at the Tanis site in North Dakota. Source: Robert DePalma

De Palma and his collaborators’ discoveries and conclusions were finally published April 1, 2019, in the Proceedings of the National Academy of Sciences. A review article published by PBS’s NOVA on April 3 discusses the PNAS paper as well as the generally positive responses to it. Many scientists interviewed for the NOVA article felt that the PNAS paper was convincing but the scope might be limited. They noted that at Tanis, the mud layers containing the fossils were capped by a thin clay veneer rich with iridium, an element abundant in meteorites, but relatively rare on Earth. This and other evidence certainly links the Tanis site directly to the asteroid impact. However, debate continues about whether the asteroid impact alone caused the mass extinction or just contributed to it. Other scientists have theorized that the prolonged volcanic activity or climate fluctuations that occurred prior to the event may have already begun the process and that the asteroid just finished the job. Whatever the full truth, it seems clear that the asteroid impact directly contributed to a disaster of monumental proportions.

Focus On: Apollo 16 Region—Descartes and the Cayley Plains

Jerry Hubbell

(Note from the author: A version of this article was published in the November 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 the photos in this article, go to http://moon.scopesandscapes.com/tlo_back.html To see the latest issue of* The Lunar Observer, go to *http://moon.scopesandscapes.com/tlo.pdf*)

Figure 1. Apollo 16 Mission Patch, NASA.

This is the second in a series of Focus On articles in *The Lunar Observer* (TLO) on the Apollo lunar landing missions that will end on the 50th anniversary of the Apollo 11 mission in the July 2019 issue of TLO. To learn about the background behind this series of articles, see the October 2018 *StarGazer* Focus On article.

The Apollo 16 mission launched at 12:54 pm EST on April 16, 1972. The crew consisted of Commander John Young, Command Module Pilot Ken Mattingly, and Lunar Module Pilot Charles Duke (Figure 2).

Figure 2. Apollo 16 Astronauts. (from left to right) Ken Mattingly, John Young, and Charles Duke. NASA.

At Descartes, the Cayley and Descartes formations were the primary areas of interest because scientists suspected, based on telescopic and orbital imagery, that the terrain found there was formed by magma more viscous than that which formed the lunar maria. The Cayley Formation's age was estimated to be about the same as Mare Imbrium based on the local frequency of impact craters.

The landing site for Apollo 16 was in the Descartes Highlands region west of Mare Nectaris and the crater Alphonsus (Figures 3 and 4). The Cayley and Descartes formations are shown in Figure 5. Landing occurred on April 20, 1972 at 22:23:35 EST. The landing site is located at selenographic coordinates 8°58’ south, 50°30’ east, between craters Andel and Andel F (see Figure 4).

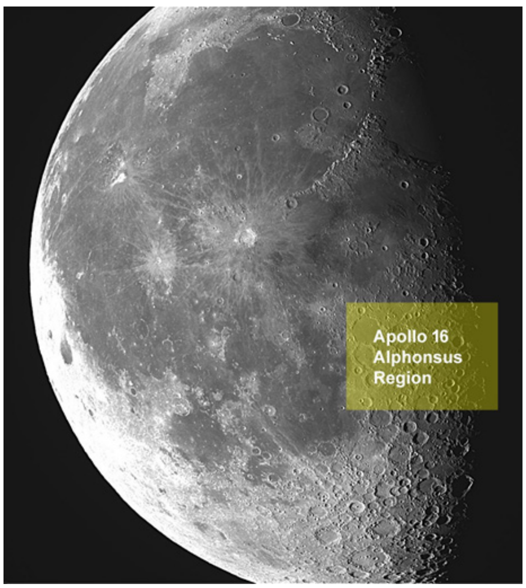


Figure 3. Apollo 16 Alphonsus Region—Third Quarter Moon, Jerry Hubbell, Wilderness, Virginia, USA. 30 October 2018 at 0730 UT. Colongitude 163.1°, seeing 7/10, transparency 3/6, 0.165-m APO refractor, 0.7x Focal Reducer, QHY174M-GPS TEC (deep-sky) Camera (ed. highlight label added)

Figure 4. Apollo 16 Landing Site—Third Quarter Moon (ed. crop), Jerry Hubbell, Wilderness, Virginia, USA. 30 October 2018 at 0730 UT. Colongitude 163.1°, seeing 7/10, transparency 3/6, 0.165-m APO refractor, 0.7x Focal Reducer, QHY174M-GPS TEC (deep-sky) Camera (ed. highlight label added)

The Apollo Field Geology Investigation Team provided the following summary:

“The Cayley Plains at the Apollo 16 landing site (Figure 5) consist of crudely stratified breccias to a depth of at least 200 meters, overlain by a regolith 10 to 15 meters thick. Samples, photographs, and observations by the astronauts indicate that most of the rocks are impact breccias derived from an anorthosite gabbro complex. The least brecciated members of the suite include coarse-grained anorthosite and finer-grained, more mafic rocks, some with igneous and some with metamorphic textures. Much of the traverse area is covered by ejecta from North Ray and South Ray craters, but the abundance of rock fragments increases to the south toward the younger South Ray crater. The Descartes highlands, a distinct morphologic entity, differs from the adjacent Cayley formation more in physiographic expression than in lithologic character.”

There are several popular targets for observing and imaging in the Ptolemaeus, Alphonsus, Arzachel region of the Moon (Figure 6). For beginners, this is often one of the most recognizable areas of the Moon because it is right on the terminator at first quarter, probably the most popular time to observe the Moon. Rupes Recta, the “Straight

Wall," (Figure 7) is very easy to see and a favorite. Other large and small craters such as Albategnius, Klein, Hipparchus, Herschel, Abulfeda, and Delambre, just to name a few, are clearly visible in a small telescope and can be explored at your leisure when imaged.

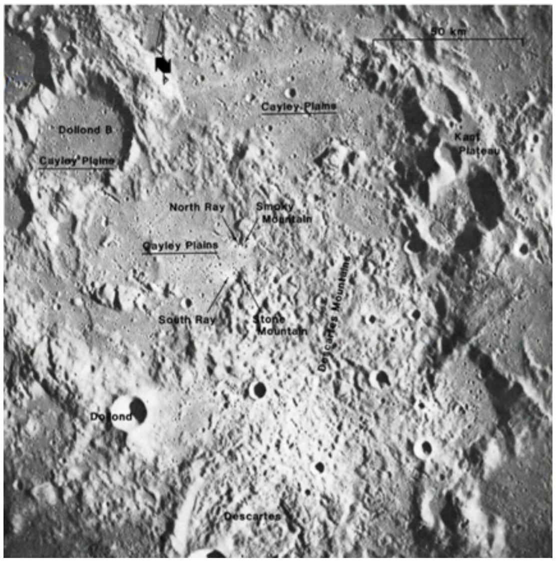


Figure 5. Apollo 16 Landing Site—Descartes and Cayley Plains, NASA Apollo Mission metric camera frame 439.

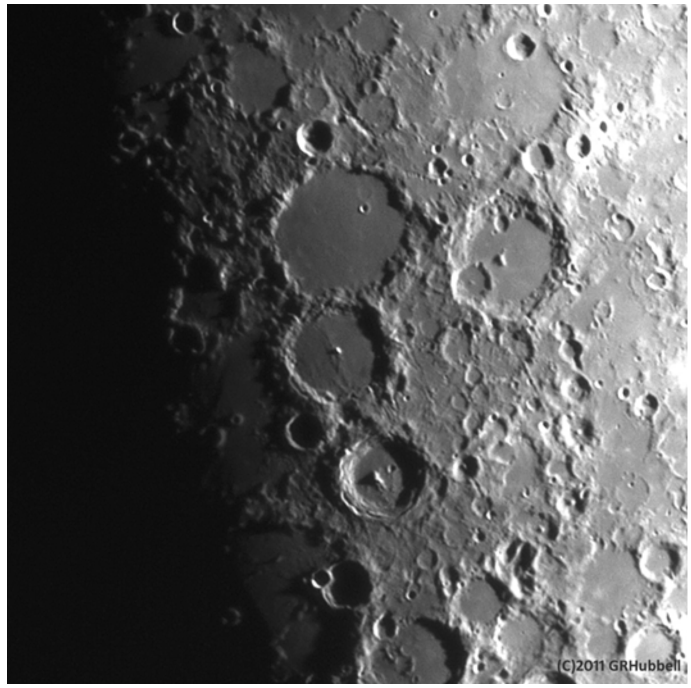


Figure 6. Ptolemaeus, Alphonsus, and Arzachel, Jerry Hubbell, Locust Grove, VA, USA, 03 March 2011 0217 UT, 0.13-m APO Refractor (Explore Scientific 5-inch ED APO), Imaging Source DMK21AU04 CCD, 4x Powermate. Seeing 8/10, Transparency 5/6, north/up, east/right.

Rik Hill contributed the following (refer to Figure 7):

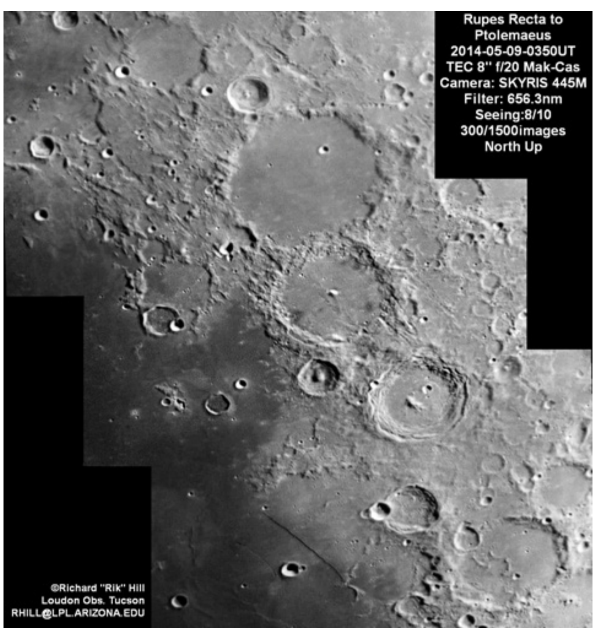


Figure 7. Rupes Recta to Ptolemaeus, Rik Hill, Tucson, AZ, USA, 09 May 2014 0350 UT, TEC 8-inch Mak-Cas Reflector, Skyris 445M CCD, 656.3nm Filter, seeing 8/10, north/up, east/right.

"Often, we look too much at the terminator. A day or so after the terminator passed over this area there is still a lot to see. The first thing that stands out is the great terraced walls of Arzachel. Look carefully at the floor of this crater, and you'll see the Rimae Arzachel. Just above this is the larger crater Alphonsus with the obvious dark haloed volcanic features, some of the best such features visible to the amateur. Just to the lower left of Alphonsus is the interesting crater Alpetragius, with its round-mound central peak. Compare this peak to the one in Arzachel. The huge crater Ptolemaeus is the topmost of the three great craters here. At low sun angles, its floor is filled with soft depressions and small craters. Then to the lower left of this is the heavily eroded crater Davy and the arc of little craters crossing the floor. This crater chain is thought to be formed from the impact of a fragmented asteroid or comet broken up by Earth-Moon gravitational forces. This is like the S-L/9 impact on Jupiter but with the much slower rotation of the Moon leaving them in a much shorter chain."

"At the bottom of this image [Figure 7] is clearly seen "The Straight Wall" or Rupes Recta. On the south end is what used to be called 'The Stag Horn Mountains.' They seem to have lost that name over the years."

"Lastly, back away and look at the whole glorious field and note the numerous diagonal gashes from the upper left to the lower right. These were carved out by mountain-sized and city-sized chunks of the lunar surface, blown out during the huge impacts that carved out the large mare to the north."

"The 4 images of this montage were each made by stacking 300 frames of 1500 frame AVIs taken with the equipment noted on the image. Assembly of the montage was done with AutoStitch and final processing was accomplished with IrfanView and GIMP."

Michael Boschat contributed the following (refer to Figure 8):

"I was just looking at the Moon's terminator using 140x and noticed that Alphonsus's central peak was catching the sunlight, and just near its base was a "halo" of sunlight just illuminating the crater floor. It was just an interesting observation, so I decided to try to get an image of the area. I used my Canon xsi with a 2x Barlow and took a series of exposures trying to get a decent image. I used the live view on the camera to focus the craters as sharply as possible. This was about the best image I could get. Also, I was shooting through my open apartment window and visually looking through the eyepiece—everything was sharp and clear with very, slight turbulence."

Figure 8. Alphonsus, Michael Boschat, Halifax, Nova Scotia, Canada, 27 October 2017 2158 UT, ETX 90mm Maksutov Reflector + 2x Barlow, Canon xsi DSLR. Seeing 8/10, transparency 4/6, north/up, east/right.

REFERENCES:

Curator, NASA, Apollo 16 Mission (summary) https://curator.jsc.nasa.gov/lunar/catalogs/apollo16/part1/apollo16mission.pdf (retrieved October 31, 2018)
Apollo Field Geology Investigation Team, Apollo 16 Exploration of Descartes: A Geologic Summary, *Science* 05 Jan 1973: Vol. 179, Issue 4068, pp. 62-69 DOI: 10.1126/science.179.4068.62 http://science.sciencemag.org/content/179/4068/62 (Abstract retrieved October 31, 2018)
Chen, James L. 2014. *How to Find the Apollo Landing Sites*. Springer, New York.
Wilhelms, Don E. 1993. *To a Rocky Moon: A Geologist's History of Lunar Exploration*, The University of Arizona Press, Tucson.
Lunar Reconnaissance Office ACT-REACT Quick Map, http://target.lroc.asu.edu/q3/ (retrieved October 31, 2017)
Patrick Chevalley, Christian Legrand, *Virtual Moon Atlas*, http://ap-i.net/avl/en/start (retrieved June 30, 2018)
Lunar and Planetary Institute, *Digital Lunar Orbiter Photographic Atlas of the Moon*, http://www.lpi.usra.edu/resources/lunar_orbiter/ (retrieved September 1, 2017).

ADDITIONAL READING:

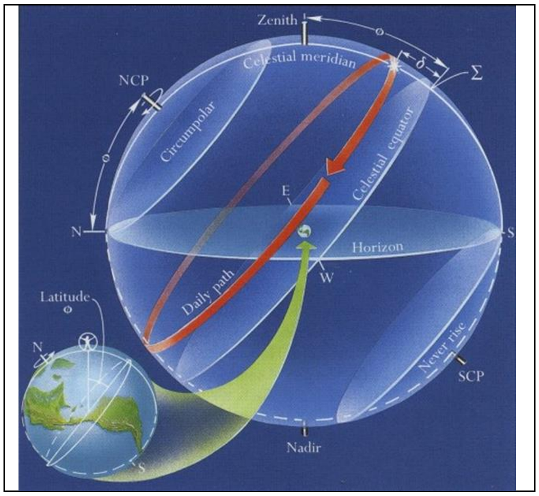
Bussey, Ben & Paul Spudis. 2004. *The Clementine Atlas of the Moon*. Cambridge University Press, New York.
Byrne, Charles. 2005. *Lunar Orbiter Photographic Atlas of the Near Side of the Mo*on. Springer-Verlag, London.
Chong, S.M., Albert C.H. Lim, & P.S. Ang. 2002. *Photographic Atlas of the Moon*. Cambridge University Press, New York.
Chu, Alan, Wolfgang Paech, Mario Wigand & Storm Dunlop. 2012. *The Cambridge Photographic Moon Atlas*. Cambridge University Press, New York.
Cocks, E.E. & J.C. Cocks. 1995. *Who's Who on the Moon: A Biographical Dictionary of Lunar Nomenclature*. Tudor Publishers, Greensboro
Gillis, Jeffrey J. ed. 2004. *Digital Lunar Orbiter Photographic Atlas of the Moon*. Lunar & Planetary Institute, Houston. Contribution #1205 (DVD). (http://www.lpi.usra.edu/resources/lunar_orbiter/)
Grego, Peter. 2005. *The Moon and How to Observe It*. Springer-Verlag, London.
IAU/USGS/NASA. Gazetteer of Planetary *Nomenclature*. http://planetarynames.wr.usgs.gov/Page/MOON/target.
North, Gerald. 2000. *Observing the Moon*, Cambridge University Press, Cambridge.

Rukl, Antonin. 2004. *Atlas of the Mo*on, revised updated edition, ed. Gary Seronik, Sky Publishing Corp., Cambridge.
Schultz, Peter. 1972. *Moon Morphology*. University of Texas Press, Austin. The-Moon Wiki. http://the-moon.wikispaces.com/Introduction
Wlasuk, Peter. 2000. *Observing the Moon*. Springer-Verlag, London.
Wood, Charles. 2003. *The Moon: A Personal View*. Sky Publishing Corp. Cambridge.
Wood, Charles & Maurice Collins. 2012. *21st Century Atlas of the Moon*. Lunar Publishing, UIAI Inc., Wheeling.

Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes
(Note: The club meeting was cancelled in February owing to bad weather so there was no presentation.)

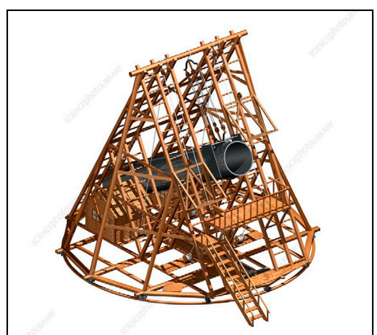
March 2019—Telescope Mounts



Scott Busby began his presentation by noting that he was inspired to do this presentation when a visitor to the January meeting on equipment brought in what he had picked out from a collection left by his father. It turned out he had a very good telescope but no suitable mount. Scott's presentation emphasized the importance of understanding what a mount *does* before getting into choosing one.

First, Scott presented diagrams of "Earth as an observing platform," showing its orbit and tilt and discussing its rotation speed in space. He also showed the sky as seen above someone's horizon, defining the zenith as the point straight overhead and the meridian going from north to south through the zenith. The rotation speed takes about 4 minutes less than 24 hours from one time a star crosses the meridian to the next. Someone said our days are longer because Earth moves in its orbit enough to change the direction where the Sun appears by the angle Earth turns in about 4 minutes. Scott also showed examples of star charts and explained the right ascension and declination coordinates on the celestial sphere used for stars and other objects on charts.

Scott explained that tracking stars involved rotating the telescope about a polar axis (parallel to Earth's rotation axis, which points at the north and south celestial poles) to compensate for the Earth's rotation moving the telescope away from its target. He described how to do polar alignment to get the telescope to track by rotating parallel to Earth's axis. For visual observing, getting within a degree of parallel should be good enough to follow an object for a half hour or so, but much more accurate alignment is needed for astrophotography. Scott said there are fancy telescope mounts with built-in GPS receivers to help you do the alignment. He also mentioned Polar Scope Align. This app shows you what you should see when sighting the sky parallel to the telescope's polar axis.


Herschel's telescope

Scott talked about tracking rates that mounts with motor drives offer. Sidereal rate tracks stars. Solar rate goes about a degree farther every 24 hours to follow the Sun's apparent motion as Earth orbits it. He warned that we must not try to observe the Sun without a telescope with a proper filter. There is a lunar rate that compensates for the Moon's orbital motion. Jerry Hubbell mentioned that the controller he worked with does not compensate for the declination component of the Moon's motion. Tim Plunkett commented that fortunately, short exposures were possible with lunar photographs.

Scott showed some pictures illustrating the history of mounts. One was Herschel's mount for his 40-foot telescope, a crude alt-azimuth mount with block-and-tackle elevation adjustment and a group of assistants (possibly with mules) required for azimuth adjustments. Hershel discovered Uranus with the telescope—Uranus can be seen easily with much smaller telescopes and modern mounts. Another example was the mount for the Yerkes 40-inch refractor (still the largest refractor ever made). Scott said he was able to experience the floor moving up and down to allow him to reach the eyepiece on his trip to see the Yerkes Observatory. He showed the 100-inch Hooker telescope mount with a yoke design that could not get within 30 degrees of the north celestial pole, and the yoke/horseshoe design for the 200-inch telescope that solved the problem. That mount uses oil bearings with an oil type formulated for the purpose. Scott's final example was the alt-azimuth mount for the Subaru 8.3-meter telescope. That telescope has adaptive optics and compensation for field rotation that results from alt-azimuth tracking.

The presentation ended with a sampling of mounts available for amateurs. Scott first showed a DM4 alt-azimuth mount. It has no motors for tracking but includes a computer that can tell you how to push your telescope to an object. The next alt-azimuth mount example was an iOptron Cube Pro 90 that included "go-to" capability and could take an 8-pound load. Scott also showed examples of a Dobsonian mount and a fork mount. They are alt-azimuth mounts, but some fork mounts offer an option to add a wedge to make them equatorial. Scott described the range of options for amateur equatorial mounts, which he said run from about $300 to thousands. Amateur German equatorial mounts include manual tracking versions and computer-driven versions. Scott and Jerry talked about a new low-end go-to model Jerry brought in. It had a capacity of 19 pounds including counterweights, or 15 pounds for use in astrophotography. Scott showed a picture of the mount in his observatory, an AM400 Takahashi high-end mount. He ended with some images taken with his telescope.

April 2019—The Apollo Landing Sites: What Can We See From Earth?

Myron Wasiuta talked about his experiences exploring Apollo Moon landing sites with his telescope. He launched his presentation with a history of the manned space program that led to the Moon landings, beginning with Mercury and Gemini. The Mercury program goals were to get men to space using the Redstone rocket and then to get them to orbit using the Atlas rocket.

The Gemini program came next. Myron said this program added the goals of launching two people at a time, getting them to orbit for up to 2 weeks to see how men did in orbit for long periods, practicing rendezvous with another spacecraft, and trying extravehicular activity (EVA) in orbit. All these capabilities were important in getting men to the Moon. Ed White was the first American to try EVA during Gemini. The first in-orbit rendezvous was between two Gemini spacecraft. They did not dock together. Neil Armstrong was on the Gemini mission that performed a rendezvous with docking to an Agena rocket. During this process, a thruster problem caused a loss of control, causing the two docked spacecraft to spin faster and faster, putting the astronauts in danger of losing consciousness. Armstrong used his test-pilot experience to work out thruster controls to slow the spinning. They undocked from the Agena, mistakenly thinking it was the cause of the malfunction. Instead, Armstrong had to regain control again when it turned out a Gemini capsule thruster malfunction was the cause. Myron said he thought Neil Armstrong was chosen to command the first Apollo Moon landing mission because of the abilities he demonstrated during this emergency.

Saturn V. Source: NASA

Myron showed diagrams of the Saturn V rocket developed for the Apollo program next to the Atlas and Redstone rockets. The size difference was striking. He said the booster stage of the Saturn V burned for 2 minutes and 40 seconds, going from 0 to 6,000 miles per hour and reaching an altitude of 40 miles. It burned 20 tons of fuel per second. Astronaut Harrison Schmitt reported that riding the Saturn V was like "driving 60 miles per hour across railroad ties." In contrast, Myron said the ride on the second stage was smooth as silk. He said there was also a smaller rocket, the Saturn IB, just for getting to Earth orbit.

Myron passed around some books he owned. One was *Full Moon*, by Michael Light, another was *Apollo: The Epic Journey to the Moon* by David Reynolds, and a third was *Painting Apollo*, by (Astronaut) Alan Bean, who was also an accomplished artist. Myron showed a Moon image with the Apollo landing sites marked. He said Neil Armstrong had to make adjustments to the Apollo 11 landing site when it proved too rough. Myron said the Apollo 14, 15, and 17 sites were especially interesting for the lunar features around them. His image of the Apollo 11 site showed that the terrain was mostly featureless. The nearest craters included three small ones that are now named after the three Apollo 11 astronauts. However, the astronauts never visited them because they were too distant from the landing site.

Apollo 14 landed near the Fra Mauro crater so the astronauts could look for ejecta from the Imbrium impact. It was originally the destination for Apollo 13. The Apollo 15 landing site was near Mons Hadley and the Apennine mountains, providing interesting features to view from Earth. Myron said it was the first extended mission (David Scott and James Irwin spent 3 days on the surface) and also featured the first buggy ride. He said the Apollo 16 mission was to collect geological samples—important scientifically—but the site, the Descartes and Cayley formations, was not so interesting for telescopic views. The Apollo 17 site was again right near mountains. Myron showed an interesting view taken by the NASA Lunar Reconnaissance Orbiter (LRO) currently orbiting the Moon. Then he went through the landing sites showing images he had made of them with his telescope, along with some NASA pictures taken during the missions.

In his image of the Apollo 14 site, Myron pointed out a pattern of ripples where liquefied lunar material had flowed. He also showed a picture of a hand cart the astronauts used to carry tools and samples as they walked around.

Recent Photo of Apollo 15 Landing Site. Source: Myron Wasiuta

Myron showed several images of the Apollo 15 landing site, which was up against a curve in the Hadley rille (Rima Hadley) and between the north and south complex of craters. He showed St. George Crater on Mons Hadley Delta. He said the Genesis Rock, found on Mons Hadley Delta, was the oldest rock found by the Apollo program. It is at least 4 billion years old. Myron showed images of Mons Hadley taken at the beginning and end of the stay on the Moon for comparison. The near side started in shadow and was sunlit by the end of the mission.

Myron briefly showed his telescope image of the Apollo 16 site location and then switched to a video of a buggy ride. He then showed LRO images of the Apollo 17 site, identifying the South Massif and North Massif, pointing out a small hill and crater south of North Massif. He then showed that those two features could be made out in his own telescope image. He also pointed out a possible landslide off of South Massif. It doesn't show in his telescope image but he said that it's possible to see it from Earth in the right viewing conditions.

Image of the Quarter

This photo of M51, the Whirlpool Galaxy, was taken by Myron Wasiuta on April 10, 2019. He used station 2 of the Mark Slade Remote Observatory, which consists of a Meade 12-inch LX-200 telescope and a cooled QHY 174 M camera. Auto guiding was accomplished via an AT-66 f6 Semi-APO refractor and cooled QHY 178c CMOS imaging and guiding camera. This image represents 50 180-second subframes stacked. In his accompanying email, Myron said, “The image shows a faint star to right of nucleus, which is actually an erupting luminous blue variable.” The arrow indicates that star.