http://www.raclub.org/

The StarGazer

Newsletter of the Rappahannock Astronomy Club No. 3, Vol. 3 November 2014–January 2015

Looking for a Grab-and-Go?—Try a Short Tube Refractor

by Ron Henke

Although I am very fond of my NexStar 8SE—it's my first telescope and it provides great views—it's a beast. It takes at least three trips from the basement to the front yard to set it up. I wanted a "grab-and-go," not just to make setup quicker but also to have a telescope I could carry with me when I travel. I make at least one trip to England every year, and now that I'm into astronomy, if I get there and see a clear night and don't have a telescope, I start twitching.

So I started looking around. My first thought was a smaller Schmitt-Cassegrain Telescope (SCT), but found that while they can pack a lot of aperture into a small package, they won't fit into a carry-on bag. And just by their design, Newtonian reflectors were out of the question. That left refractors. By their nature, refractors can be very long. With the NexStar 8SE, I already had a scope with a long focal length. So now I was down to a short-tube (aperture of 90 mm or less and tube length of less than 600 mm) refractor. A short-tube refractor would also give me the advantage of a wide field of view.

So, after doing some research, I narrowed to two choices: an Orion ShortTube 80A or something (much) more expensive. The advantage(s) of the Orion ShortTube 80A are that it is cheap and…it's cheap. Okay, it uses a finder scope (instead of a red dot finder), which is extra on most other telescopes that I researched. But, as I was calling around getting quotes on various short-tube refractors, my wife encouraged me not to go cheap, or I would regret it later. I have to mention that my wife is a very smart lady, so I took her advice. I found a discontinued Stellarvue EDO doublet at a price I thought was very reasonable. So my Christmas present from my wife is a Stellarvue SV80ED-SFC1. So, now to the unboxing of the OTA.

The box itself is sturdy enough to keep for future use and it is well packaged on the inside (Figures 1 and 2).

Figure 1: Sturdy, reusable outer packaging

Figure 2: Good interior cushioning

(continued here)

How to Join RAClub

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

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

RAClub annual membership is $15 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 dark of the Moon. Our website, www.raclub.org is the best source of information on our events.

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

The StarGazer
November 2014–January 2015
Published Quarterly by Rappahannock Astronomy Club
Editor: Linda Billard

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

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Calendar of Upcoming Events

Club Meeting, Maury School	February 18
Star Party, Caledon	February 21
Club Meeting, Maury School	March 18
Star Party, Caledon	March 21*
Club Meeting, Maury School	April 15
Star Party, Caledon	April 18

*Messier Marathon

Recent Outreach Events Completed

Star Party, Shiloh Schools, Northumberland County	November 15
Star Party, Caledon	November 22
Star Party, Caledon	December 27
Star Party, Caledon	January 17*

President's Corner

Welcome to New RAClub Members (November–January)

- Monica Fesq

This is my first President's Corner, and there are a few things I would like to express. By the time you read this, I will have been president for all of a month. I knew there would be some work involved, but even after just a month, I am surprised at what goes on "behind the scenes" to keep the Club running. To Jerry Hubbell, I want to express the Club's gratitude for all the work he put in and for a job well done. I would also like to comment on the *StarGazer*. I am relatively new to amateur astronomy and the Club—one of the things that piqued my interest in the Club was this newsletter. It is a quality product full of quality articles. The expertise of the authors is clearly evident.

This edition of the *StarGazer* is no different. The meat of the newsletter is the articles by Bart Billard, Jerry Hubbell, and Linda Billard. Bart describes a new photography technique that uses super-cooled components called microwave kinetic inductance detectors (MKID) that are potentially a big improvement over today's CCD cameras. Jerry writes about one of the newest phenomena in amateur astronomy—remote observatories. Remote observatories not only allow you to operate a permanently mounted telescope in your backyard from your house, but you can also buy observing time from a number of commercial remote observatory networks all over the world. Linda's article is about a book she just read called *Celestial Sleuth: Using Astronomy to Solve Mysteries in Art, History and Literature.* The author, Donald W. Olsen, and his team used charts, almanacs, meticulous calculations, and sky-mapping programs to identify celestial objects in famous works of art and history. You'll have to read the article to find out more. In this edition of the *StarGazer* you will also find articles about presentations given at the club meetings and an event we participated in at Shiloh Schools in Northumberland County.

As always, this is an excellent newsletter. It's made excellent by the outstanding editing of Linda Billard and exceptional articles provided by those who contributed.

Clear Skies! Ron Henke

Astronomy Math by Scott Busby

Sidereal Time

Astronomers use coordinate systems to find and map objects. Because Earth's time is not exact, they rely on Sidereal time. A sidereal day is the time it takes the Vernal Equinox to move from one upper meridian crossing to the next. The Vernal Equinox occurs when the Sun passes the Celestial Equator between the northern and southern hemispheres. An easier way to remember this is that a sidereal day is measured by a complete Earth rotation with respect to the stars (not the Sun, which would be a standard Solar day).

$$1 \textit{ Sidereal Day} = 23^h 56^m 4.091^s$$

Midnight at the Vernal Equinox is 00:00 hours local Sidereal time.

It is also important to understand that astronomers often use different time measurements than we are accustomed to—for example, our watches are synchronized with the Sun. This means that 1 day is equal to Earth's rotation with respect to the Sun. This is called a Solar day. To gain more accuracy, astronomers use Sidereal time, which is Earth's rotation with respect to the stars. This means that the same constellation appears at the same place after a complete rotation of the Earth. A Solar day is 4 minutes longer than a Sidereal day:

$$\text{Sidereal Day} = \text{Solar Day} - 4 \text{ minutes}$$

This is the reason that the night sky is different depending on the time of year; objects rise 4 minutes earlier each night. So why 4 minutes? A complete circle is 360°, and Earth orbits the Sun in 365.25 days, or about 1° per day. An Earth rotation is also 360°, which is 24 hours (or 1,440 minutes). Divide 360° into 1,440 minutes and there is 4 minutes left over. To match Sidereal time, the Earth must rotate 1° more for the Sun to appear in the same spot each day.

A Sidereal Month is also used; it is the orbit of the Moon with respect to the stars, which takes 27.3 days. A Synodic Month is the "standard" Moon orbit about the Earth—from full Moon to full Moon—which is 29.5 days.

Superconducting Detectors—Taking Spectral Imaging to a New Level

by Bart Billard

Imagine taking color astronomical images without having to expose the same bit of sky with three or more filters, one at a time, but instead taking dozens of filtered images simultaneously. That gives you an idea of the goals for the development of microwave kinetic inductance detectors (MKID). I first learned about this technology and proposed applications at last year's Northeast Astro-Imaging Conference (NEAIC) in a talk given by Ben Mazin, who heads a group at University of California Santa Barbara. Collaborators include researchers at Caltech and the Jet Propulsion Laboratory. Since the mention of this talk in the April 2014 *Stargazer*, I have had a chance to read more on the technology. To help understand what MKIDs can offer, let's start with some background on existing technology.

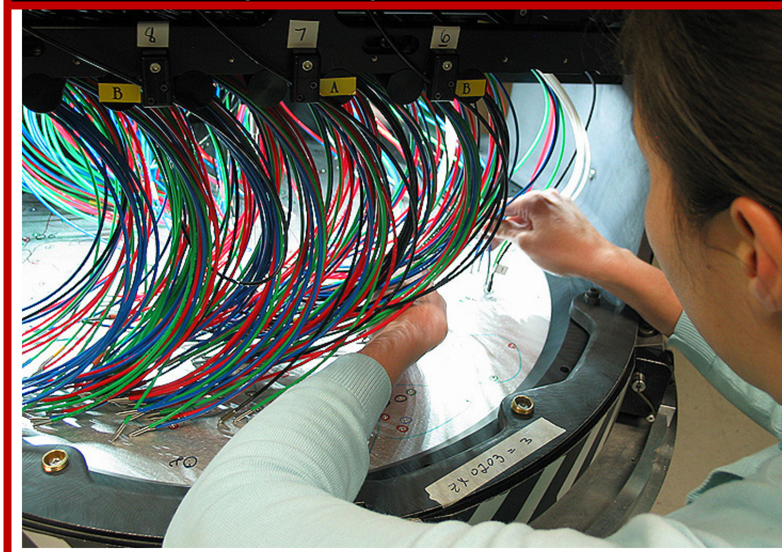
Color or Spectral Imaging With Semiconductor Detectors

With conventional semiconductor imaging technologies, such as charge-coupled devices (CCD), a two-dimensional array of semiconductor detectors registers the amount of light in the corresponding part of the area imaged. The image is made up of pixels containing the amount of light registered by each detector. The amount of light is indicated by the number of electrons recorded, each resulting from a packet of light energy—a photon—falling on the detector. The only information obtained about the color (or wavelength), which depends on the energy of the photon, is that it fell within the detector's sensitivity range. Thus the resulting image is monochrome. To reproduce colors, astrophotographers must use filters. Usually, each filter for color imaging allows about a third of the energy range of photons arriving to reach the detectors. Images in three colors typically provide enough information to make a color image.

The photons rejected by each filter do not get recorded, so it takes longer to get a color image than a monochrome one. Some cameras have individual filters for each pixel. Typically a quarter of the pixels have a red filter, a quarter blue, and half green. They produce three color images with one exposure, but each image has fewer pixels than a monochrome image would have.

For many astronomical measurements, a few colors do not provide enough detail about the

Example: Current Astronomical "Gymnastics" for Avoiding Use of Filters in Spectroscopic Studies



Source:newscenter.nmsu.edu

The Sloan Digital Sky Survey (SSDS) is an example of how astronomers currently get the most out of sacrificing spatial information for spectral information. SSDS can record data from the equivalent of thousands of filters applied to the light of some 640 galaxies in a given field of the telescope.

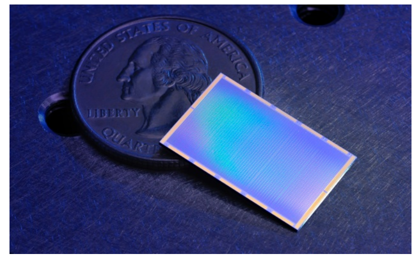
Based on an image of the field, a specially made mask is placed in the telescope's focal plane with a hole in it at the location of each galaxy. Optical fibers inserted into each hole direct the light from the corresponding galaxy to a spectrograph. The light coming out of each fiber then goes through a system with a diffraction grating, and ultimately, light from each galaxy (fiber) is focused onto a different row of detectors in a CCD imager. The grating deflects photons with different energy by correspondingly different amounts, resulting in their arrival at different pixels in the row.

The effect is like having a different filter for every pixel, but without the loss of light because photons with different energy just go to different pixels. An SSDS "image" of this type would be just 640 pixels, one dot for each galaxy, but with many "colors." Researchers even have to shine light back through every optical fiber and note which hole in the plate lights up to be sure they know which row goes with which galaxy.

light to learn all we would like to know. Nebulae and stars, for example, have emission or absorption "lines," which are surfeits or deficits of light in narrow ranges of photon energy. They can provide information about chemical elements or molecules in the nebulae or stellar atmospheres as well as show motion of the object toward or away from us by the effect that motion has on the apparent energy of the line. Using individual filters to get this kind of detail would require many images or many fewer pixels per color in an image.

Cryogenic Detector Technology and How MKIDs Work

In semiconductor detection technology for astronomical applications, the detectors operate best at moderately low temperatures (100°K or higher). MKIDs and two other types of cryogenic detectors operate at temperatures a thousand times lower than that (about 0.1°K). Also, because photon energies are relatively high compared with the energy needed to cause a detectable change, one photon can cause changes proportional to its energy. Thus cryogenic detectors can measure not only the arrival of a photon, but also the energy of that photon.



A 10,000-pixel optical and near-infrared MKID array. Photo credit: JPL NASA, obtained from the Mazin Lab website

A MKID detector consists of a circuit built like an integrated circuit with superconducting films on a substrate such as silicon or sapphire. In MKIDs, a photon breaks up superconducting electron pairs, called Cooper pairs, creating "quasiparticles." The number of quasiparticles generated is proportional to the energy of the photon. While the quasiparticles are present, the electronic properties of the circuit are modified, and then return to normal when the particles recombine into Cooper pairs. Each circuit, comprising a pixel, acts as a "resonator," much like the tuning circuits of radio and television receivers; the change in circuit properties when a pixel absorbs a photon changes its tuning.

The big advantage of MKIDs stems from the ability to read out many pixels with just one "feed line" connecting into and back out of the detector array through a single amplifier. So far, other cryogenic technologies require more feeds and individual amplifiers or specialized readout devices. Many-pixel arrays are then more complicated and more difficult to keep cold. In contrast, each MKID pixel is designed to tune to a distinct resonant frequency, like listening to a separate radio station. The feed line input carries signals for all the "stations," and what comes back out is sorted out by station. When a photon is absorbed by a pixel, changes in the feed line signal coming out at its tuned frequency show when the photon arrived and how much it changed the tuning, indicating the photon energy. An interesting consequence is that instead of an image or sequence of images, the data are stored as a list of photons detected. Each list entry includes the time of arrival, energy, and pixel location of the photon.

Applications of MKIDs

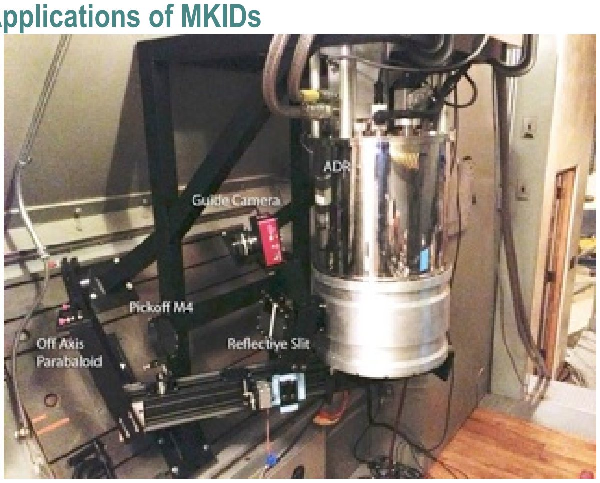


Figure 2: ARCONS equipment mounting. Source: Mazin Lab website

The Array Camera for Optical to Near-infrared Spectrophotometry (ARCONS) is a 44- by 46-pixel MKID array that has seen light at the Palomar 200-inch and Lick 120-inch telescopes. One published paper compares optical and "giant" radio pulses from the Crab pulsar. Some "giant" radio pulses arrive soon after the optical pulse peak, while others, "early giant" radio pulses, arrive simultaneously. The optical pulses associated with the giant radio pulses are enhanced, but those associated with the early giant radio pulses are enhanced more than three times as much as the others. The ARCONS sensor can resolve spectral information about the light in optical pulses and compare enhanced pulses with other pulses. The lack of significant spectral differences suggests the same mechanism is responsible for all optical emissions from the pulsar.

NASA is funding a 10,000-pixel MKID version called DARKNESS (Dark-speckle Near-IR Energy-resolved Superconducting Spectrophotometer) for use with existing coronagraphs on the Palomar 200-inch and Subaru telescopes. Coronagraphs help image areas surrounding stars by blocking the direct light from the star. However, speckle from atmospheric turbulence (seeing) results from scattered light from the star, making it harder to see dimmer objects in the vicinity. The photon energy and time resolution of DARKNESS will allow suppression of the speckle because speckle at one wavelength can be scaled to look like that at another wavelength during the short time before the turbulence changes. The result is expected to provide simplified optical design with improved light efficiency, better spatial detail, an extended range of wavelength sensitivity, zero readout noise, and zero dark current.

Is there a potential for use of MKIDs in amateur astronomy one day? That was a question asked when Professor Mazin talked at the 2014 NEIAC. Cooling detectors to a fraction of a degree above absolute zero is expensive and requires a lot of equipment (cryogenics). As a result, the MKIDs and cryogenics must remain stationary as the telescope moves, limiting use to telescopes with a coudé focus. Professor Mazin said using high-temperature superconductors to reduce the complication and expense of the cryogenics would sacrifice energy resolution. Still, I would like to think some sort of compromise might eventually result in a device that could be used at least for color astrophotography.

Remote Observatories for the Amateur Astronomer

By Jerry Hubbell and Rich Williams (Owner, Sierra Stars Observatory Network (SSON))

Remote Observing—Pushing Down the Technology

Today, the amateur astronomer has access to a broad range of information and technology, as well as the help and service of a large community of experts and professionals willing to spend time helping you quickly get up to speed on doing professional-level work if you so desire. The Internet is largely responsible for our ability to share this vast amount of data and observations from astronomers all over the world.

Source: csu.edu.au

Over the past 15 years, and particularly over the past decade, the technology used by the professionals has steadily decreased in cost, moving it into the affordable realm for the amateur astronomer. Computers and computing technology have enabled you to continuously increase the performance and accuracy of the data generated by your backyard telescope, or astronomical imaging system (AIS), and allowed new astronomers everywhere to quickly learn the techniques and acquire the skills to contribute substantially to this avocation that we all love and pursue.

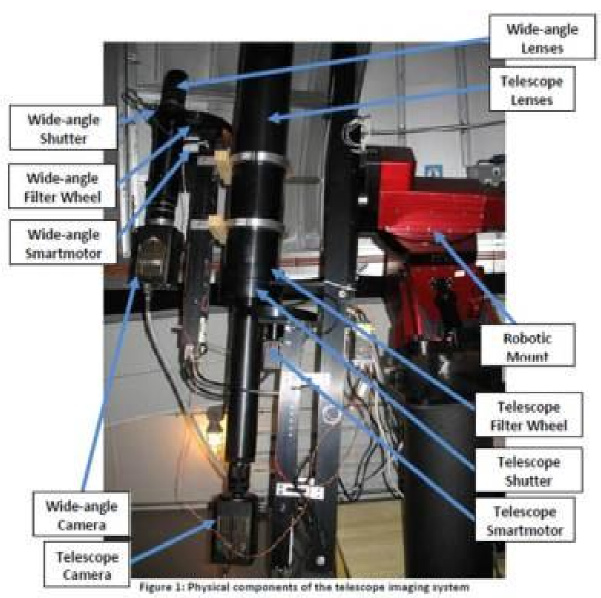
The data are acquired mainly using charge-coupled device (CCD) cameras, which, over the past decade, have increased in performance and in the sheer amount of data you can collect with them. The sensitivity of today's CCD cameras exceeds the capabilities of the equipment that the professionals were using even a decade ago, and the data that amateurs are acquiring today rival what the largest observatories in the world were gathering even in the 1980s. Another major contributor to the increased value of observations made by amateurs is the availability of very large databases and catalogs of astronomical objects that make it much easier to identify those objects on the images you acquire and report on the constantly changing condition of those objects. Using the UCAC4 (USNO CCD Astronomical Catalog 4) enables you to very precisely match the objects in your image to the catalog and quickly identify any stray objects in your images that are then identified using the Minor Planet Center's database of minor planets. If you are very lucky, you may identify a new object never seen before. In that case, you may be credited with a new discovery and given the chance to name the object.

The astronomical community has many contributors who volunteer their time developing state-of-the-art software applications to process the raw data we acquire with our AISs and distill the information down to something that is most useful to the community at-large.

The most recent developments have further enhanced the use of your AIS. Typically, the small amateur telescope has been a portable system that is set up at the beginning of the observing session and then taken down at the end of the session. Usually, setup takes about 30 to 60 minutes and then subsequent polar alignment, sky alignment, and data acquisition of the calibration frames take additional time at the beginning of the evening. Then, after several hours of use, the system is dismantled and stored in the appropriate protective containers, which again takes up to 60 minutes.

Over time, this somewhat time-consuming and tedious setup and take-down process tends to add to your reluctance to set up your AIS unless the weather is predicted to be really good for observing. (The seeing is good or better, and the transparency is very good, although for science imaging this is not necessarily a requirement.) The result is that you do less observing rather than more.

A relatively new option is to take advantage of a remotely operated AIS, either local or located up to several hundred or thousands of miles away. This opportunity is available to you today at a reasonable cost.



Source: projects-circuits.com

The ultimate version of this type of observing operation is available through an observatory service owned by a third party. This arrangement allows you to rent time on several different AISs. You pick the system and schedule your observations to be performed by that system. There are also systems available that allow you to directly control the AIS remotely with live feedback using video monitoring and live data feeds. Using these commercial services may be the best choice if you want to learn the professional techniques of gathering and processing your own data without the large investment in time and money it takes to build your own system.

Do-It-Yourself Remote-Controlled Observatories

The state of the art in personal observatories has advanced to the point where you can operate your remotely controlled AIS from the comfort of your office or anywhere in your home you choose to be. Many of you are interested not just in using a remotely controlled observatory, but in buying and integrating your own components into subsystems and fully operational AISs.

There are basically two types of do-it-yourself observatories—remotely located and locally located. If you typically set up and take down your AIS for each observing session, your next step may be to set up a locally located observatory to save you the time and effort of setup and take-down.

Of course, this still presents several issues, principally the fact that you still have to sit outside in the elements. One advantage is that if any of your AIS equipment has problems or fails in any way, then you are right there to correct it immediately.

Once you have your permanent observatory set up and operating reliably to the point where you do not have to babysit your equipment, it is not that much more effort to add the subsystems necessary to remotely operate your equipment in the comfort of your home office.

The two separated systems are connected to each other via a high-speed communications link that gives you real-time control of your remotely operated AIS instruments. There are other enhancements you may want to make even if you are within a few yards of your AIS instruments, including upgrades to your power supply system and addition of some monitoring instruments, including a web camera (webcam) so that you can watch your AIS in operation from your home office.

What You Can Do Using a Remote Observatory

Once you have your remotely controlled observatory up and running, you can use it to do all the things you did previously while sitting next to your AIS. If you are into the scientific study of astronomical objects, then you should understand the specific objects (asteroids, planets, deep sky nebulae) that you want to observe, and design your equipment configuration and imaging train to match your object.

By having access to a remote observatory that is configured and set up for quick startup and shutdown, you can concentrate on your observing program instead of worrying about your equipment configuration every time you have an observing session.

Also, your remote observatory allows you to observe more often (when the weather allows) because you can start up your remote observatory in a very short period of time, typically within 10 minutes, and start executing your observing plan. By collecting more data, more often, on a given astronomical object, you can contribute more to the greater astronomical community and accomplish your goals at a higher quality than ever before.


Source: Scott Busby

If you choose to go with a commercial service, there are basically two types of remote observatories available—those that you control directly in real time and those to which you submit an observing request that is scheduled for you. The latter systems automatically perform the data gathering and then typically email you when your data are available to download to your local computer system.

Whether you build your own, or use a commercial remote observatory, you will be embarking on a noble quest to gather unique and fresh data on various astronomical objects; sharing that data is one of the best things you can do for the astronomical community. Remember that we, amateurs and professionals alike, are all in this together, and because we are a small community we need to support each other the best that we can.

Looking for a Grab-and-Go?—Try a Short Tube Refractor (continued from page 1)

Out of the box, it is quite an elegant-looking scope (Figure 3). It's only 17.5 inches long, making it great for traveling. Several features appealed to me when I bought the scope. While these may seem simple, they supported what I was trying to accomplish. First, it uses 2-inch diagonals and lenses but comes with an adaptor for 1.25-inch diagonals and lenses (Figure 4). This is great, because everything I already have is 1.25-inch equipment.

Figure 3: An elegant instrument

Figure 4: Adapter for 1.25-inch diagonals and lenses

Two other "up-scale" features that I like are compression rings (Figure 5) instead of tension screws and a Crayford–style focuser (Figure 6) instead of a rack-and-pinion focuser.

Figure 5: Compression rings

Figure 6: Crayford focuser

However, there's one thing that came with the telescope that I'm not at all happy with—the instructions. There is so little included in them that Stellarvue shouldn't have wasted its time or paper. Instead, I am learning about refractors with the help of Google.

I have had the scope out a couple of times already. I also bought a used iOptron Cube alt azimuth mount and a lightweight travel tripod to use with the scope. I am looking forward to using the whole setup at a dark site where I can take advantage of the telescope's wide field.

Another Successful Outreach Event at Shiloh Schools, Kilmarnock

By Linda Billard

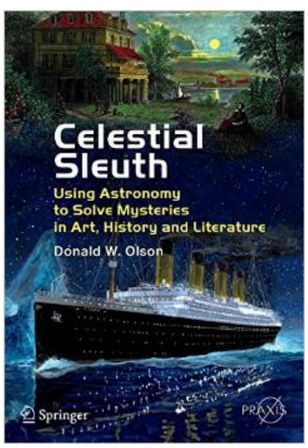
For the third year, the club was the guest of the Northumberland Preservation Inc. (NPI). at its Shiloh Schools site. NPI's mission is "to generate community-wide interest in preservation of sites and structures with special character, providing tangible links to the past, maintaining a public sense of identity." NPI's Jane Towner again invited us to hold a star party at this site, designated as a Virginia Historic Landmark and listed on the National Register of Historic Places.

On November 15, the skies were clear and dark…so dark that, as in our previous two visits, you could see the Milky Way clearly at twilight. Six RACers were there, plus about 30–40 NPI guests. Joining me were Bart Billard, Ron, Henke, Jerry Hubbell, Scott Lansdale, and Melvin McDaniel. We brought an assortment of telescopes and binoculars. It was cold, very cold. Thankfully, our hosts provided us with hot apple cider in their renovated schoolhouse–that and their hospitality were most welcome. There was no Moon to observe this time but plenty of other worthy objects. This is an event that the club will look forward to again in 2015. We plan to choose a date when the Moon is visible but not full to allow viewing it as well as a range of other targets.

Forensic Astronomy—New CSI Series?

by Linda Billard

Back in December, Springer Books sent me a $30 gift card toward purchase of any of their books. After browsing through zillions of books, I happened upon *Celestial Sleuth: Using Astronomy to Solve Mysteries in Art, History, and Literature* by Donald W. Olsen, published in 2014. After reading the squib, I was intrigued and ordered it. It seemed to combine two things I love to read about: astronomy and mysteries.



Source: Springer

This highly entertaining book is written by a Texas State University professor of physics whose passion is puzzles in literature, history, and art. Olson uses the tools of astronomy—charts, almanacs, meticulous calculations, and sky-mapping programs—to identify celestial objects in famous artists' and photographers' work, explain apparently mysterious historical happenings, and pinpoint astronomical references in well-known literature. These tools are supplemented with field trips to the actual locations to take measurements and researching of letters, old photographs, and other relevant documents. He is likely the world's most prominent "forensic astronomer."

Here's a taste of what he and his students do. Everyone knows the story of Paul Revere's midnight ride to warn the rebel Americans at Concord, Massachusetts, that the British were coming to seize a concealed cache of guns and gunpowder. The story of the ride is related in a number of places, including in Henry Wadsworth Longfellow's poem "Tales of a Wayside Inn." The poem contains a number of astronomical references, including five mentions of the full Moon. Olson asked himself whether these references were accurate or just poetic license, and decided to find out.

It is important to note that before he could begin his ride at midnight, Paul Revere had to cross Boston Harbor in a rowboat to get to Charlestown, where he mounted his horse to start his journey in the direction of Concord. How could he have crossed the harbor without being seen in the light of the rising Moon by the crew of the British warship *Somerset* anchored there specifically to prevent anyone from leaving Boston?—after all, it was a blockade!

Professor Olson's team used computer programs to calculate that the Moon was full on April 15, 1775—3 days before Revere's ride on the night of April 18–19. Moonrise on the 18th was at 9:53 p.m. local apparent solar time. (Note that until 1883, time in colonial America was based on a system equivalent to the time read on a sundial.) The computer estimate was consistent with times recorded in no less than four different almanacs published at that time.

In a 1798 letter, Revere recalls arriving in his boat on the Charlestown shore at about 11:00 p.m. with the Moon rising. For 200 years, historians have been baffled about how he could have made the trip without being seen by the vigilant *Somerset* sentries. Why wasn't he silhouetted in the moonlight or outlined in the glitter path in the water?

The answer is what Olson calls "Lunar Luck." Turns out that Revere had the good fortune to cross the harbor not on a night when the Moon rose due east, but rather during the time each month when the Moon is in the part of its orbit when it is farthest south of the celestial equator and thus rises in the southeast. Olson concluded that if Revere crossed about 45 minutes after moonrise (consistent with his recollections), the Moon would have been only 6° above the horizon and far to the southeast. Consequently, the sentries would have seen the Moon rising behind the city of Boston, not over the bay. There would have been no glitter path and no silhouette to see. Makes one a bit uncomfortable about how much luck was involved in building this country!

This is just one example of the fascinating investigations Olson and his team conduct. The writing style of each chapter is a seamless combination of careful scientific reporting and the classic buildup at the end of a mystery story. I highly recommend it.

Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes

Note: There was no presentation in November because the meeting was devoted to election of new officers.

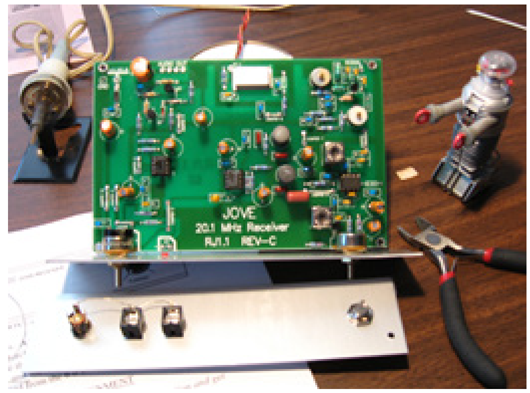
December 2014—Radio Jove Summary

Scott Lansdale presented the program "Radio Jove Summary." Radio Jove is one of several programs the Society of Amateur Radio Astronomers (SARA) recommends for amateurs. Sponsored by NASA, Radio Jove focuses on radio emissions from Jupiter and its satellite, Io. Another recommended program targets emissions from the Sun.

Bernard Burke and Kenneth Franklin first discovered that Jupiter was a strong source of radio emissions relatively early in the development of using radio for astronomical research. This discovery led C.A. Shain to reexamine records he had made of 18.3 megahertz (MHz) observations, and he found that it included bursts from Jupiter 5 years earlier that were unrecognized at the time. Consequently, scientists had a 5-year baseline of data to work with very soon after the first discovery of radio emissions from Jupiter.

In 1964, Keith Bigg discovered Io has a role in emissions from Jupiter. Scott said Io is heated by tidal forces, making it the most volcanically active world in our solar system. He said that Jupiter's magnetic field is 20,000 times stronger than Earth's, and particles from Io can become charged and trapped in a ring-like disk in the magnetic field. Some particles approach Jupiter's north magnetic pole region, where they emit radio waves in a cone-like pattern with a frequency range of about 15 to 29 MHz. We can detect these emissions when the cone is oriented toward Earth. The demodulated signals sound like ocean waves (these are called L bursts) or short bursts like static pops (S bursts). Scott played us some samples. One sample on the Radio Jove website had audio of S bursts slowed way down. They sounded like a bunch of changing-frequency whistles.

NASA offers kits for the antennas and receivers needed to monitor Jupiter's emissions, along with software for working with the equipment, sharing data, and predicting best observing times. The preferred antenna is a two-element phased array that can be adjusted to point at Jupiter. The equipment can also be used for observing radio bursts from solar activity. Scott said a kit, including a receiver, is about $200. You need some additional materials for the antenna supports.



Source: NASA

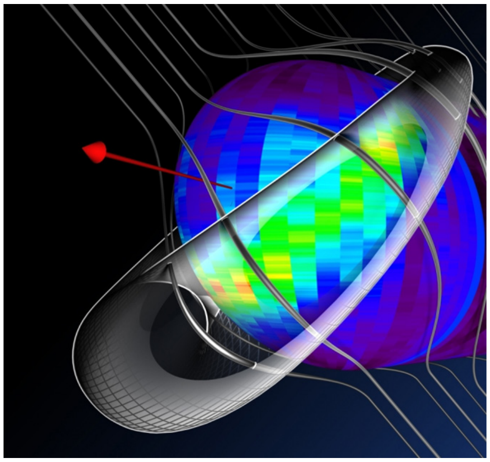
One person asked Scott about the significance of the data you can get monitoring Jupiter radio emissions. He said that one use of the data is to compare interactions of particles in Jupiter's magnetic field with Earth's. For himself and many amateurs, he suggested, it can be the educational value of working with the circuits and equipment and making the observations. The Radio Jove home page URL is http://radiojove.gsfc.nasa.gov/. Scott emailed a pdf of his presentation to Glenn Holliday for posting on the club website.

January 2015—So, How Big Is the Solar System?

Ron Henke presented the program "How Big Is the Solar System." He noted that the solar system is defined by the Sun's influence but that there is more than one way of defining "influence." The talk looked at three of them. One is the extent of influence of solar winds, the heliosphere. The second is the extent of gravitationally held bodies, which includes the Oort cloud. The third is the theoretical extent of the influence of the Sun's gravity, known as the Hill Sphere.

Ron described components of the heliosphere in the old model. The solar winds abruptly slow at the termination shock, resulting in a region of compression and a change in the magnetic field. It begins at about 75 to 90 astronomical units (AU) from the Sun. Beyond the termination shock is the heliosheath, at about 80 to 100 AUs. In it, the solar winds slow further and become more compressed. They also become turbulent from effects of interaction with the interstellar medium. Ron said the heliosphere finally ends in the heliopause, at about 100 to 120 AUs. Here the solar winds reach a standstill and can no longer push back against the winds of the interstellar medium. He said Voyager 1 reached the heliosheath in late 2010 and found that the velocity of particles in the solar wind had decreased almost to zero. He presented a plot of particles detected by Voyager 1 in the 12 months starting in late October 2011. It showed an abrupt drop in numbers in August 2012.

In another slide, Ron described the Interstellar Boundary Explorer (IBEX) satellite launched by NASA in 2008 in contract with Orbital Systems. Its objective is to discover the nature of the interactions between the solar wind and the interstellar medium by making a map of the boundary. Returning to his slide picturing the old heliosphere model, he pointed out it also showed the heliosheath stretches on one side into a tail. On the other side, the old model predicts a bow shock, like a wave forming in front of a moving boat.

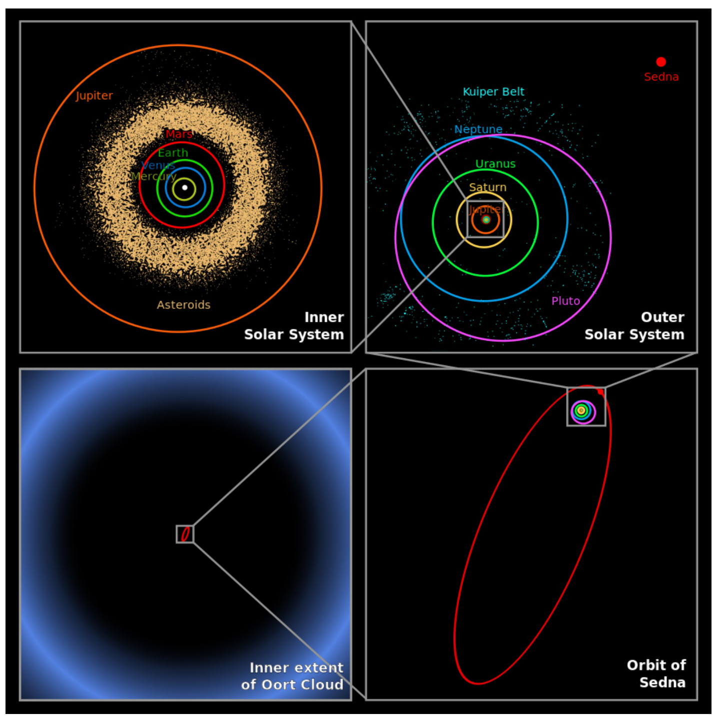


New Model of the Heliosphere. Source: NASA/IBEX

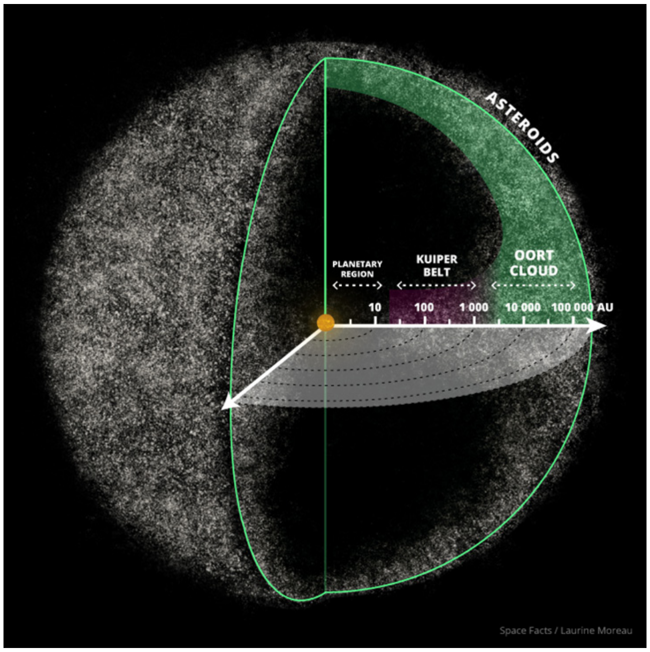
Ron explained the question mark after "bow shock" in the slide. IBEX found that there is no bow shock because the Sun and heliosphere are moving through the interstellar medium more slowly than originally thought. He said he tried without success to research whether that meant the solar system is orbiting the galaxy more slowly and asked our thoughts. Myron Wasiuta and Bart Billard agreed that the relative motion of the interstellar medium and the solar system is the reason there is no bow shock. That does not necessarily mean the solar system is moving more slowly through the galaxy. Jerry Hubbell wondered whether some sort of friction effect reduced the velocity difference so there is no shock. Myron mentioned that the star Mira moves through the interstellar medium at a very high speed and has a bow shock.

Another measure of the Sun's influence is the most distant gravitationally held bodies: the Oort cloud. Ron said its name refers to Dutch astronomer Jan Oort, who postulated its existence in 1951. Interestingly, the Kuiper Belt was theorized a year later. Ron found quite a variation in estimates of distances to the start and end of the Oort cloud. He said he went with the NASA estimates of 5,000 to 100,000 AUs, respectively. For perspective, he said the Oort cloude reaches almost half way to Proxima Centauri, and that the Kuiper Belt is only 0.001 as far from the Sun as the Oort cloud. Ron mentioned some widely varying estimates of the number of objects and total mass in the Oort cloud, but he considered them too disparate to choose numbers to put in writing on a slide. The objects are believed to have formed nearer the Sun and then thrown outward by the gravitational influence of the large planets early in the evolution of the solar system.

The Oort cloud is thought to be the source of long-period comets, and the Kuiper Belt is thought to be the source of short-period comets. Comets from the Oort cloud are thought to be caused by the perturbations of passing stars. Ron found the division into orbit periods as less than 200 years for short-period comets and more than 200 years for long-period comets did not make sense if the latter are from the Oort cloud. He illustrated with the orbit of Sedna, the planetoid with a diameter of about 1,100 miles discovered in 2003. With a sequence of 4 images (see figure at right), each zoomed out by 10 or more times the previous, he showed the inner solar system out to Jupiter, the outer solar system with Sedna's current position near its closest approach to the Sun showing in the corner, Sedna's entire orbit, and finally, the inner part of the Oort cloud, with Sedna's orbit a tiny loop in the center. The period of Sedna's orbit is about 10,000 years, so "more than 200 years" is a serious understatement for an Oort cloud comet.



Location of Sedna (red) Within the Oort Cloud. Source: Wikipedia / NASA / JPL-Cal Tech



The Hill Sphere. Source: Wikipedia

The last definition Ron discussed for the Sun's influence as it relates to the size of the solar system is a theoretical range of influence for the Sun's gravity called the Hill Sphere. When an object orbits a more massive object, its satellites are unstable unless they orbit within the Hill Sphere. The Hill Sphere thus defines the volume of gravitational influence for the object that orbits the more massive object. Ron had the equation in his slide but denied being able to calculate it for the Sun's Hill Sphere. He remembered finding an answer that was little more than half the distance to Alpha Centauri, but left it out of the slide because he could not find the reference again. Incidentally, Ron found that the very inner part of the Oort cloud includes a torus (donut-shaped) region called the Hill Zone, named after a different Hill.

In summary, the solar system size could be the size of the heliosphere (about 120 AUs), the size of the Oort cloud (100,000 AUs or more), or the size of the Hill Sphere (even bigger). Jerry commented on the Oort cloud being outside the heliosphere. He wondered whether if the size of the solar system includes the Oort cloud, do we still consider particles there as part of the interstellar medium? Scott Lansdale asked which direction Voyager 1 left the heliosphere. Ron said it went more or less out the front and that Voyager 2 went out at more of an angle toward the side, but not toward the tail. In conclusion, Ron said that the answer to the title question is: "REALLY BIG!"

Creating Flickr Photo Albums for the www.RAClub.org/about/gallery

by Don Clark

The RAClub website astrophotography is now stored on Flickr (www.flickr.com) instead of the Raclub.org website. Club members can create and maintain their own Flickr astrophotography albums. The club's member Yahoo rac_group albums can no longer be used. The old website's astrophotography was moved to the current website by creating Flickr albums for each of the old gallery albums under a single Flickr account. Once club members create their own Flickr albums, old albums will be deleted if requested. Club members can use the Yahoo ID account associated with the club's rac_group to sign up for Flickr. Yahoo group and Flickr processes and terminology are very similar. Use the following procedure to upload a set of photos and create a Flickr album:

1. At the Yahoo.com menu bar, click **Flickr** or go directly to www.flickr.com. Once you sign in to Flickr, the menu bar **You People Groups Explore Upload** appears.
2. Click **You** to go your Flickr page. The **Photostream Albums Favorites Photobooks Edit** menu bar appears above your photostream (i.e., all of your photos).
3. Click **Upload** and follow the instructions for selecting a set of photos to upload. Because Flickr creates multiple size copies, it is best to upload the original quality photo and let Flickr display the appropriate size photo.
4. Set the **Owner** settings to Visible to Anyone. Give each album the tags: Astronomy, Astrophotography, and rac_group. (Tags are search keywords.)
5. Click **Add to Albums**. From the popup window, enter an album name. Then click **Done**.
6. The selected photos are not actually uploaded until you click **Upload x Photos** (x is the number of selected to upload) located on the right of the menu bar. This completes the creation of the album itself.
7. To create an Album Cover Icon, select **Edit** from the **Album** menu bar. Drag the album photo you want to be the album cover square (cellphone image) just to the left of album name and then **Save** the change. This image will be used on the club's website gallery page to link to the album. Generally, this image would be the first photo in the album.
8. Email the Album URL link to the club's gallery admin (gallery@raclub.org). It provides the information necessary to create the website's link to the album. The URL will look like this:

   https://www.flickr.com/photos/97517901@N03/sets/72157641039176283/

   The 97517901#N03 is your Flickr user id and the 72157641039176283 is the Flickr album id.

It is up to you to add, rearrange, or delete your photos from your Album(s). The Flickr Help link (https://help.yahoo.com/kb/flickr) can assist with questions you might have. Googling "youtube flickr" gives a list of helpful youtube video tutorials on Flickr photo management. A good starter is: http://www.youtube.com/watch?v=t14kAJnu6rY

Notes:

1. Yahoo Groups and Flickr use the same basic concepts for storing and managing photos. Flickr stores alternate size copies of each photo.
2. For Flickr upload limitations, see: https://help.yahoo.com/kb/flickr/upload-limitations-flickrsln15628.html?impressions=true
3. These albums are directly viewable through Flickr.

Image of the Quarter

Comet Lovejoy taken New Year's night 2015 by Scott Busby. *Scott says:* "This tricolor image of Comet C/2011 W3 (Lovejoy) was taken last night at the Belmont Observatory. Image consists of 80 sec exposures in each RGB filter and combined in MaximDL and finished in PhotoShop. Image acquired with my Takahashi TOA 150 refractor using an SBIG STL11000 camera."