



[www.raclub.org](http://www.raclub.org)

# THE STARGAZER

Newsletter of the Rappahannock Astronomy Club

No. 4, Vol. 1 February 2013–April 2013

## NEAF—The World’s Premier Astronomy and Telescope Show

By Linda Billard with Jerry Hubbell, Terry Barker, and Don Clark



Over the past 22 years, the Northeast Astronomy Forum ([NEAF](#)) has become the largest space and astronomy gathering of its kind on the planet. It’s hosted by the Rockland County Astronomy Club at Rockland Community College in Suffern, New York (30 minutes west of NYC). This year, the show space—the college’s gymnasium—covered 90,000 square feet, with more than 110 vendor booths and other activities. The show, held April 20–21, was preceded by the 2-day Northeast Astronomical Imaging Conference ([NEAIC](#)) at a nearby hotel. Both events featured a full roster of speakers, including our own Jerry Hubbell (at NEAIC), and was attended by other RAClub members Terry Barker, Don Clark, and Joe Fordham.

**Day 1, NEIAC.** The festivities began Thursday with the opening of NEAIC at the Crowne Plaza Hotel in Suffern. Prior to making his presentation, Jerry attended a fascinating talk by (medical) Dr. Robert [Gendler](#), prize-winning astrophotographer and amateur astronomer. Gendler described how amateurs can now access [legacy data from Hubble](#) to make their own images. His talk was full of tips and tricks for combining data to produce new images and described the tools offered on the archive site.

Jerry wasn’t scheduled to speak until 1 pm, so he spent the intervening time wandering the vendor exhibits (yes, there were vendor exhibits here as well as at NEAF), and chatting with camera distributors. Jerry’s talk, “Engineering a Scientific Observing Program: Getting the Best from Yourself and Your Equipment,” went very well. He had given the talk the previous week at the invitation of the Richmond Astronomical Society, and consequently was relaxed presenting very familiar material based on the principles at the heart of his recently published book. He got lots of good questions, many centering on his experience with different cameras and how your observing program (your overall observing objectives) affects your choice of camera. These questions were gratifying because they showed the audience had gotten the point of the talk—decide what you want to image and *then* choose equipment appropriate to the task and to your own capabilities.

(continued on [page 8](#))



(Courtesy of Rockland Astronomy Club)

## 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](http://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

February 2013–April 2013

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[Editor: Linda Billard](#)

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Website: [www.raclub.org](http://www.raclub.org)

Yahoo Group:

[http://tech.groups.yahoo.com/group/rac\\_group/](http://tech.groups.yahoo.com/group/rac_group/)

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[Jerry Hubbell](#) Astrophotography

## Calendar of Upcoming Events

Star Party, Caledon State Park, King George	May 4
Club Meeting, Maury School	May 15
Star Party, Post Oak Middle School, Spotsylvania	May 17
Star Party, Caledon State Park, King George	June 1
Astronomy Festival, National Mall, DC	June 14*
Club Meeting, Maury School	June 19
Star Party, Caledon State Park, King George	June 29
Club Meeting, Maury School	July 17

\*Rain Day June 15

\*\*Messier Marathon

## Recent Outreach Events Completed

Star Party, Caledon State Park, King George	March 9**
Barrett Elementary School Skywatch, Stafford	March 21
Star Party, England Run Library, Stafford	March 23
Star Party, Stafford Elementary School, Stafford	March 23
Aquia Boy Scout District Spring Camporee, Fauquier	April 12

## President's Corner

This quarter has been a busy one for the club and for me personally as spring has sprung! There are several interesting items in this issue of the *StarGazer* that demonstrate the wide diversity of activities that even a small club like ours is engaged in. You will find several articles on our ongoing outreach activities and the good work our members are doing to help get the word out on the exciting world of amateur astronomy. Our editor, Linda Billard, has written an excellent article on several club members' trip to New York this past month to the largest astronomy equipment show in the world, the Northeast Astronomy Forum (NEAF 2013) and the associated imaging conference—the Northeast Astro Imaging Conference (NEAIC 2013). I am sure you will find it interesting—and it may entice you to attend yourself next year. I find the show very exciting and a “must” for me to attend every year.

Several other articles link our personal activities to the larger world of amateur astronomy. To me, these demonstrate what makes our club activities so relevant to the larger world of amateur and professional astronomy—it shows that the amateur astronomy community is really one big family when it comes to observing, outreach, and the scientific research that amateurs are capable of today. Last quarter's meeting presentations were particularly interesting. Scott Lansdale's VLF radio astronomy discussion, Glenn Holliday's talk about the Voyager adventures, and my own presentation about fiber-fed astronomical spectroscopy were all about science and/or the amateur's role in doing science. We also have practical articles on dust and the next installment of Scott Busby's “Astronomy Math.”

Please continue to report your personal observing activities to the club management and also to Linda for inclusion in the *StarGazer*. David Abbou's imaging experiences are just the sort of story we're looking for—short or detailed, we all want to hear what you're doing. It keeps every one of us motivated to do more and improve our skills and knowledge of our equipment and of the cosmos.

Until next time, Clear Skies!—*Jerry Hubbell*

### Help Lowell Observatory Restore the Clark Telescope

RAClub received an e-mail from Lowell Observatory soliciting publicity for its efforts to [restore the 117-year-old 24" refracting Alvan Clark Telescope](#). It's the Observatory's primary education tool and has been looked through by more than a million people. The Clark Telescope also helped study Mars, found the theory of the expanding Universe, and map the Moon for Apollo 11. *It needs significant repairs to be able to stay open to the public.* RAClub was requested to mention this effort in our newsletter and Yahoo group. Click [here](#) to read more about the restoration.

## Shoestring Astrophotography

by David Abbou



*"Lightman" (1981) (Source: David Abbou)*

In a club like RAC, you get the opportunity to see the incredible astrophotos taken by our talented members and learn from them too. For me, although mastery of the art of astrophotography has required a gradual learning curve over the years, today's technology makes it a bit easier to take decent photos of the heavens above.

I began experimenting with basic photography when I was in high school in the early 1980s—about the same time, I purchased my Celestron-8 (C8) telescope. I bought an inexpensive, used Minolta SRT-101 35mm camera and tripod, and began taking time exposures of lights in the sky and on the ground. In one of my earliest photos, I took a time exposure of a high-school friend as I traced him with a flashlight. In addition, I began taking time exposures of cars driving by at night, showing their lights as trails along the road. Of course, I also photographed constellations and learned the limitations of light pollution and star trailing caused by the Earth's rotation (see Orion below). Soon, I was ready for the next step—I began attaching the camera to my C8 and taking photos of the Moon and planets using what I had learned taking the time exposure photos.



*Orion (Source: David Abbou)*

Taking these photos taught me the fundamentals of basic photography as I tried different film speeds (yes, real photographic film before digital cameras were available), exposure times, lenses, and other settings. Although the Moon and Sun called for very short exposures (fractions of a second) because of their brightness, I had to use time exposures of several seconds for the planets—with the turbulent atmosphere, film grain, and telescope/camera vibrations all working against me. Eventually, I learned to balance these issues to get good photos of the Moon such as the ones shown below, taken in 1982.



*Crescent Moon (1982) (left) and Lunar Eclipse (1982) (Source: David Abbou)*

In those days, seeing my results meant taking the film to the local camera shop and waiting several days for the photos to be developed, so patience was something I learned. Usually, I was lucky to get one decent shot from a roll of 36 exposures; all the other shots would be blurry or incorrectly exposed. However, to me, it was worth it—I was learning with each roll of film. The photos of Jupiter and Saturn at right represent the best I could do with my modest setup.

Today, the art of astrophotography is more commonly known as astroimaging because we use digital webcams and high-tech devices to capture images of the night sky. Gone are the days of waiting for film to be developed. Although I still use an SLR camera coupled to my trusty old C8, it is a Canon D30 digital camera. This setup is good for very short exposures only. I learned that a webcam, such as the Celestron NexImage5 I purchased last year, is a simple, economical way to take decent photos of the Sun, Moon, and planets. It attaches to the telescope in place of the digital camera and connects to a laptop computer via USB cable. Using Registax software, I can process the raw image to yield a much better result than the old digital camera attached to the C8 method. Compare the 2013 webcam shots of the Moon below with my older shots.



**Moon and Saturn (1982) (Source: David Abbou)**



**Moon, 19 Jan 2013 (left) and Moon Close-Up, 2 Jan 2013 (Source: David Abbou)**

The transition from SLR digital camera astrophotography to webcam astroimaging has a learning curve, but webcam imaging certainly beats older methods for taking sharp photos. I have a long way to go to master webcam astroimaging, but the experience has been enjoyable and worthwhile. That said, even with all the high-tech equipment available today, simple setups can still yield great results depending on the subject. A great example is Comet Hale-Bopp, which I captured using my old Minolta on a tripod with a 15-second exposure. As you can see, bare bones equipment can still yield surprisingly good results.



Comet Hale-Bopp (Source: David Abbou)

Although I have yet to dabble in deep sky astroimaging, it certainly intrigues me, especially after seeing the great images by RAClub members. I know much more specialized and expensive equipment is required, so that will have to wait a few more years before I am ready. In the meantime, I need to get a good shot of Saturn this spring or summer!

## The Flashlight Test—Inspecting Your Telescope and/or Eyepiece Optics—Why Bother?

By Linda Billard with Jerry Hubbell

Before you get out your flashlight or other high-intensity light to look for dust or flaws in your optics...read on. The assumption is that the point of this exercise is either to identify dust or other foreign matter and remove it, or to verify that the optics are not flawed in some way through substandard manufacturing. Usually, this is a waste of time. Here's why.

Generally speaking, if it takes a high-intensity light to see the optical "flaws," they are probably not flaws but artifacts seen in all telescopes, even the largest ones used by the professionals. Telescope manufacturer Meade warns that if you point a flashlight or other high-intensity light source down the main telescope tube, the view (depending on your line-of-sight and the angle of the light) may reveal what appear to be scratches, dark or bright spots, or uneven coatings, suggesting poor quality optics. However, you only see these effects when high-intensity light is transmitted through lenses or reflected off the mirrors. These effects can be seen in any high-quality optical system, including giant research telescopes.

You may also see dust and other detritus, but the effects of such small objects on what you see through your telescope/eyepiece is insignificant. To illustrate—the classic example (on a much larger scale) is the mirror of one of the telescopes at the University of Texas McDonald Observatory. In 1970, an Observatory employee went a little nuts and shot up the mirror with a handgun and also hit it with a hammer. The incident made the

national television news. The resulting holes (see picture on the next page) and scratches have not affected the usefulness of the telescope. Happily, fused silica is tougher than ordinary glass so the big mirror didn't shatter. The small craters were subsequently bored out and painted black, and the only effect of the “flaws” is to make the 107-inch telescope equal in power to a 106-inch. Today, MacDonald Observatory researchers continue to take very high quality images, and the damage has had very little effect on overall performance. This extreme example illustrates how insignificant the effect of artifacts or dust is on telescope optics. It's also worth remembering that many large telescopes have frequent avian visitors. As disgusting as it might seem, bird guano is also ignored.

In general, you should only touch your optics when they get noticeably dirty. Scott Roberts of Explore Scientific advises that allowing your telescope optics to become completely covered with dust will reduce contrast, and should be cleaned for the best performance. “We provide [instructions on cleaning optics yourself](#), and we also provide a cleaning service at Explore Scientific should you ever require it.” Typically, if you keep your optics covered when not in use, you should be able to go at least 2 years without touching them, depending on your observing frequency. An exception might be when observing in the spring during pollen season. Pollen will stick to your optics and should be cleaned off as necessary. An alternative regimen is to use an air blower (squeeze type) regularly to blow the dust off your optics to minimize the accumulation of dust and other contaminants. Bottom Line: If you can restrain yourself, don't clean your optics until they are REALLY dirty.



“Flawed” Mirror at McDonald Observatory (Source: [http://www.agnew.biz/travel06/2007\\_02\\_01\\_archive.html](http://www.agnew.biz/travel06/2007_02_01_archive.html))

## Astronomy Math—Focal Ratio

by Scott Busby

To compute the focal ratio of any telescope (or any lens system, for that matter), divide the focal length by the clear aperture (usually expressed in millimeters):

$$\text{FOCAL RATIO} = \text{Telescope Focal Length} / \text{Clear Aperture}$$

For example, a telescope with a focal length of 1,000 mm and a 100-mm (4-inch) clear aperture has a focal ratio of f/10 (1000/100=10). While a higher focal ratio does not always mean a higher quality image, it often means as good an image for similar cost. However, a higher focal ratio with the same size aperture means a longer scope, which can translate into transportation woes.

## NEAF—The World’s Premier Astronomy and Telescope Show (*continued from page 1*)

Jerry sat in on the next talk by Olivier [Thizy](#) of Shelyak Instruments on “Small Scope Spectroscopy.” After the talk, he chatted with Thizy about the spectrometer he’s been playing with for the last few months (see [presentation summary](#) later in this issue). He also met Tim Puckett for the first time. Puckett, a sales engineer for Apogee by day, is the creator of the [POSS](#) (Puckett Observatory World Supernovae Search), a team of dedicated amateur astronomers from around the world that has discovered more than 270 supernovae since 1994. Their discoveries include 7 (of a total of 25) of a new type of supernova (Iax). These objects are spectroscopically similar to other types, but have lower maximum-light velocities. [Note: look for a feature article in the next issue of the StarGazer on Tim Puckett and his fascinating work.]

That evening, the NEAIC speakers’ dinner offered an opportunity to meet and get to know Jerry Bonnell, NASA scientist and editor of the popular “Astronomy Picture of the Day” ([APOD](#)), Bob Moore, Chair of NEAIC, David Snay, contributor to the online magazine, *Astronomy Technology Today*, and amateur astronomer John Davis, Hollywood writer and producer of the Nickelodeon TV series, *The Adventures of Jimmy Neutron: Boy Genius*.

**Day 2, NEAIC.** On day 2 of NEIAC, Jerry attended a talk by Yuri Beletsky, an astronomer at [Las Campanas Observatory](#), Chile, a complex of large telescopes built and operated by the Carnegie Institution and several U.S. universities. Beletsky’s talk, “Uncovering the Dust,” addressed his professional work on space dust and other obscuring materials. Jerry spent most of the rest of the day sitting with Tim Puckett in the [Apogee](#) booth and chatting with Tom and Steve Bisque of [Software Bisque](#) about mounts and mount software. Bisque specializes in high-end mounts and the software to run them and is also the author of the planetarium program “[TheSky](#).”

At the end of the day, Jerry was scheduled to help Gregg Bragg and Sheldon Faworski set up the [Explore Scientific](#) booth for the opening of NEAF. However, when the equipment did not arrive on time, Jerry brought in his own equipment in preparation for setup the next morning, and then he and Sheldon went to the *Sky & Telescope* meet-and-greet at the Mahwah Sheraton. This swanky event included some pretty nice food and drink. Turns out the Explore Scientific equipment went (temporarily) to the wrong place but eventually was delivered later that evening.



Jerry Hubbell Showing Visitor Explore Scientific's 6" Triplet APO Refractor and Prototype 3" 30 mm Eyepiece (Source: Jerry Hubbell)

**Day 3, NEAF.** Saturday, the NEAF show began at the college. Because of the Explore Scientific equipment delivery snafu, Jerry, Sheldon, and Greg scrambled to get everything set up by 8:30 am when the exhibition doors opened. As a result, Jerry was still setting up his own telescope in the Explore Scientific booth while talking to the many people who stopped by to ask questions about the 6" (152mm) Triplet APO refractor and the Telescope Drive Master (TDM), a product for which Jerry wrote software to record and measure its performance. He finally had his system running by about noon, including the spectrometer, but hardly had time for lunch with the steady stream of people coming by the booth. Jerry signed books there all day, and late in the afternoon, spent time at the Springer booth signing copies for purchasers there. All the copies brought by Springer and Explore Scientific were sold the first day.



Don Clark with the telescope he *really* wanted to buy. (Source: Terry Barker)

During that same day, Terry Barker and Don Clark also attended. They had driven up Friday afternoon. Don's view as a first-timer to the show was, "It was somewhat overwhelming, but a great opportunity to actually see and touch the equipment, talk to vendors, and see what bargains were available...if you're not careful, you can really get carried away. I used it as a learning experience to help me make practical astronomy decisions."

Here are some of Terry's impressions....He had not attended in 5 years but was pleased it hadn't diminished...in fact it was bigger, with the entire gymnasium floor filled with vendor booths. He reported that every major vendor you've ever heard of was there—all the astronomy magazines (*Astronomy*, *Sky and Tel*), telescope makers (Meade, Celestron), local telescope retail shops (Hands-On Optics, Highpoint Scientific), book sellers (Willmann-Bell, Springer), astronomy software (Sky Safari, Software Bisque, Starry Night), portable domes (Explora-Dome), eyepiece vendors (Tele Vue, Explore Scientific), camera makers (Canon), and much more.

"As you can guess, it took all of a full day just to explore the floor. And that's not even mentioning the astronomy talks going on during the day. We hit the show at 8:30 Saturday morning. I had a backpack to carry all my purchases, and as the day wore on, my billfold got lighter, and the backpack got heavier. By 5 pm, we were whipped and ready to give up. Although the show goes until 6 pm on Saturday, the only 'booth' we wanted to see was one in a restaurant somewhere," Terry said.

In addition to Jerry, Terry and Don ran into Joe Fordham, as well as members of the Roanoke and Richmond astronomy clubs. John Raymond and Ray Moody, members of the Richmond club, were part of the [Solar Observing Group](#) that set up in front of the gymnasium.



John Raymond, Richmond Astronomical Society, helping the Solar Observing Group show off the Sun (Source: Terry Barker)



Terry Barker's Bino Stand (Source: Terry Barker)

Terry observed that NEAF was not only worth it for the vendors and talks, but also for the great deals on merchandise. "I bought a gizmo made of half-inch gas pipe that lets you hang your binoculars in front of you as you're sitting down and easily adjust the direction you're looking. My 20 x 60 binoculars are too heavy to hold with your hands for longer than a few seconds so this new gadget should come in handy for star parties. I also bought an Ottewell Calendar for \$21 (normally \$27)." Don bought a 102 mm Explore Scientific refractor for \$379. The best deal they saw was a Celestron 102 mm for \$79. No, that's not a typo. "The only drawback was that it appeared to be an f/8, and I like shorter rich field telescopes," Terry said.

**Day 4, NEAF.** On the last day, Jerry was up and running quickly, even setting up the large monitor so visitors to the Explore Scientific booth could see the results of taking spectra of the sodium lights in the exhibition hall. The rest of the day was consumed with talking to people who came by the Explore Scientific booth. About 5, they began disassembling and packaging the equipment for shipping. Jerry reports, "At 7, I was finally able to meet my wife and kids for a nice dinner and then go get some sleep before starting the 6-hour trip home the next morning!" Clearly, a good time was had by all, and this fantastic event offers anyone interested in astronomy, whether beginner or old hand, many opportunities to learn, meet new people, and get some great deals.

## Three Outreach Events in Two Days!

By Linda Billard, David Abbou, and Terry Barker

In the third week of March, club members outdid themselves, participating in three hands-on outreach events in 2 days. We held star parties at the England Run Library, as part of its Discover Earth program, and at well-attended student events at two Stafford schools.

**Discover Earth/England Run Library**—At the Library, Ben Ashley, Jerry Hubbell, Bart Billard, Melvin McDaniel, and Linda Billard participated in a star party in connection with the Discover Earth exhibit displayed at the library. The Central Rappahannock Regional Library system is 1 of only 10 libraries in the country to host the grant-funded, museum-quality science exhibit, [Discover Earth: A Century of Change!](#) Interactive, multimedia displays allow visitors to interact with digital information in a dynamic way, encouraging new perspectives on our planet and reinforcing STEM (Science, Technology, Engineering, and Math) concepts. Discover Earth is supported through a grant from the National Science Foundation. RAClub was asked to participate in one of a variety of events held over the 2-month period that the exhibit was here. On March 23, we set up in the parking lot of the library. Because of the significant light pollution in the area and the mandated early start (6 pm), we were only able to show the Moon and Jupiter (and four of its moons) but had a steady stream of parents, grandparents, and children of all ages for nearly 3 hours, a number of whom stayed the entire time. A couple of visitors brought telescopes, and Bart helped a father/son team learn how to focus their recently purchased small telescope properly. Nancy Buck, the Library's Branch Manager, was our host.



Setting Up at England Run (Source: Nancy Buck)



Viewing the Sky at Stafford Elementary (Source: David Abbou)

east coast Friday night along with Comet Pan-Starrs.

**Barrett Elementary School.** Two days earlier, Terry Barker participated in a unique event. Have you ever wished you had a warm fire at your back while observing outside in the winter? The third-grade class at Barrett Elementary School, in Stafford, had that very idea and it worked beautifully. They combined several bonfires with a weenie roast, cooking s'mores, and viewing the skies. A NOVAC member also made it—Wade Hampton, with his 12" Dobsonian—so he and Terry were able to show the Moon and Jupiter to the families that attended. They tried to spot comet Pan-Starrs, but had no luck.



Skywatch at Barrett Elementary (Source: Terry Barker)

Terry gave an introductory talk to the students using the monthly sky map from [skymaps.com](http://skymaps.com). As you know, to orient yourself when using the map, you must know what direction you're facing. It's always fun to ask students what direction west is, especially when the Sun is still setting. Terry says he's gotten all kinds of wrong answers, even from middle school students. That night was no exception. Once it was decided on where west was, Terry pointed out how to reference some of the brighter stars, such as Sirius and Procyon, in relation to directions, and several students were able to point out Sirius as the first star seen in the twilight. From there, Jupiter was easy to spot. Jupiter showed three moons, which really fascinated everyone. One student, in particular, impressed Terry—he wanted to make sure Terry knew that Pluto was no longer a planet. Priceless.

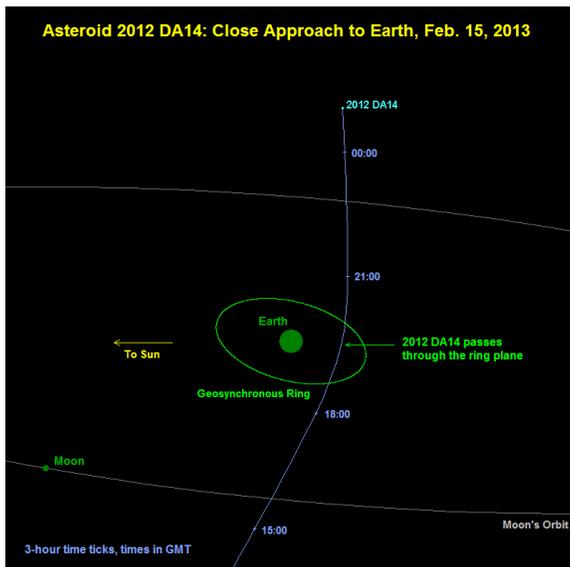
## Near-Earth Objects: Find Them Before They Find Us

by Linda Billard

On January 29, thanks to a “heads-up” from Don Clark, RAClub members had the opportunity to join others around the country who dialed in to a [teleconference/network presentation](#) sponsored by the [Night Sky Network](#). Don Yeomans, senior NASA scientist and manager of NASA's [Near-Earth Object Program Office](#), is the author of 170 papers and 4 books, including his latest, *Near Earth Objects: Finding Them Before They Find Us*, which was also the title of the presentation. After a brief discussion of what NEOs are (comets and asteroids), Dr. Yeomans laid out the history of NEO discovery. Dedicated study of NEOs began in the 1990s. As of 2012, 600,000 minor planets, 9,450 NEOs, and 1,350 PHAs (potentially hazardous asteroids) had been detected.

Yeomans explained that NEOs are important for four reasons: pursuit of science, future space resources, exploration, and last, but not least, planetary defense. Science can be advanced through study of the chemical composition of NEOs to understand their formation. For resources and exploration, they are accessible and could serve as “watering holes” for interplanetary exploration. Finally, to protect our planet from collisions with these objects, JPL established the automated [Risk Sentry System](#), which monitors objects of potential concern 24 hours a day. It predicts the behavior of objects for the next 100 years.

NASA's NEO Observation Program uses a number terrestrial telescopes at a variety of locations (Socorro, NM, Tucson, AZ, Haleakala, HI, etc.), which participate in several different surveys. In addition, the NEOWISE Space Infrared Survey uses a satellite-based infrared telescope. NEOWISE allows ground-based telescopes operating in the visible region to follow up on newly discovered moving objects. Another project uses planetary radars to send and receive signals to assist in developing shape models of asteroids.



Path of 2012 DA14 (left) and Path of Comet ISON (right) (Source: Donald Yeomans Presentation, 29 January 2013)

Yoemans provided details on the mission of NEO Program Office at JPL. It provides automatic orbit updates, determines whether any of the NEOs are a threat, maintains a relational database on all detected NEOs, and studies deflection strategies. The Office's [Asteroid Watch](#) website provides impact warnings and public outreach. Recent activities have included Human Exploration Target Body Identification, which addresses which near-Earth asteroids would be desirable mission targets and a deflection mission study for asteroid 2011 AG5, which is now moot because the orbit of the asteroid has been refined to show it is not a threat. Yoemans also discussed asteroid 2012 DA14, whose closest approach is expected February 15 but is not a threat (see diagram above left). He closed with a discussion of the ISON comet, which is expected to provide a spectacular display (see diagram above right).

## Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes

### February 2013—Engineering a Fiber-Fed Spectrometer for Astronomical Use

**Jerry Hubbell** presented "Engineering a Fiber-Fed Spectrometer for Astronomical Use." He recently purchased a fiber-optic spectrometer and integrated it with his telescope. Jerry's talk focused on the how-to of designing and putting together the spectrometer, telescope, and other parts and software to get it all to work, but also included some spectra he had taken. Questions he addressed included how to match the telescope with a fiber and focus the light on the fiber tip, how sensitive the spectrometer CCD is and how that limits the magnitude of objects you can measure, how to guide the telescope to keep the light on the fiber tip, and how to calibrate the wavelength and intensity response of the spectrometer system.

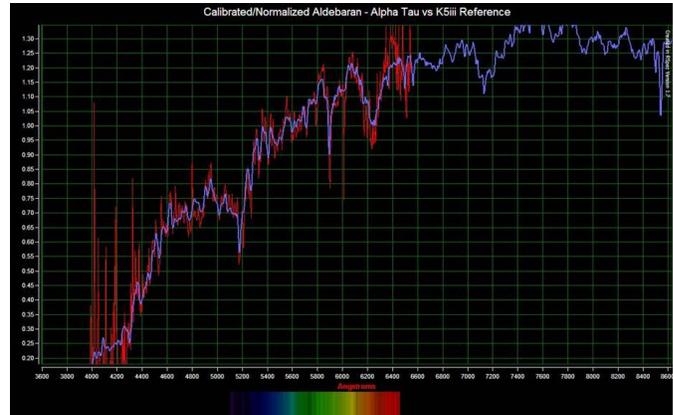
Jerry found a [Science-Surplus Spectrometer](#) with do-it-yourself alignment for just \$200, less than 1/10 the cost of new fiber-optic spectrometers, and not a lot more than the transmission diffraction gratings mounted in filter holders that amateurs normally use. These spectrometers are very compact—a 4x6-inch box holding the circuitry and the spectrometer optical bench. Jerry showed the layout of the optical bench and how it folds the light into a compact path, from the fiber interface with the slit, to the collimating mirror, to the grating, to the focusing mirror, and then to the linear CCD. The spectrometer includes a fiber, which Jerry connected to the telescope. For this interface, he designed a fiber optic head.



Science Surplus Spectrometer (Source: Science Surplus)

The fiber optic head allows him to bring the light in the desired wavelength band into the fiber connection to the spectrometer, to pass the light in another band to the guide camera so he can guide on the same object he is measuring, and to adjust the focus of the light so that the guide camera and fiber are at their proper focus position simultaneously. The fiber optic head is based on a flip mirror that Jerry modified. He made a hole in the mirror provided to allow light to pass through to the guide camera without flipping the mirror up and then replaced the mirror with one that passes infrared wavelengths while reflecting visible wavelengths. This type of mirror is often called a "cold mirror" because of the association of heat with infrared light. A fiber-optic cable adapter mounted in a nosepiece that fits the eyepiece holder in the right-angle leg of the flip mirror provides the connection for the fiber. Jerry also added a focal reducer to get a better match of the cone of light from the telescope with the range of angles accepted by the fiber. He worked out that the fiber angular acceptance, given as a numerical aperture of 0.22, corresponded to a matching focal ratio of  $f/2.27$ . The focal reducer produces focal ratios of  $f/4$  and  $f/3.75$  for his two telescopes, which is a reasonably good start but could be improved.

Jerry also discussed adjusting to locate the position of the object on his CCD to correspond to correct positioning of the light on the fiber, the benefits of auto guiding, and writing software to acquire the data and format it so he could store a series of spectra in FITS image format with wavelength along one axis and time along the other. He said the spectrometer controller limits the exposure to 64 seconds, and because the light is spread out over many pixels to record the wavelength dependence, it produces a limiting magnitude of about 6 for detecting the spectrum peak, or 4 to 5 for getting a good signal-to-noise ratio over a range of wavelengths. Jerry was able to use the spectral lines in fluorescent light (from his iPad display) to provide known wavelengths to calibrate the scale of the spectrometer. He used Tom Field's RSpec software to normalize the response, which takes care of effects such as the wavelength variation in the sensitivity of the CCD in the spectrometer, and the reflection efficiency of the cold mirror as a function of the wavelength. He concluded his presentation with illustrative results obtained from measuring the light from the Sun, Moon, Jupiter, and various stars such as Alpha Tau, Eta Tau, Alpha Ari, Alpha Gem, and Alpha And.



Calibrated/Normalized Spectrum Results for Aldebaran (Source: Jerry Hubbell)

Ben Ashley asked about effects of turbulence on guiding in the infrared. Jerry said guiding takes place on a long time scale compared with the turbulence effects. Although the turbulence spreads the image of the star, the size of the fiber is large compared with this spread. Auto guiding has proved unnecessary for the 60-second exposure times the spectrometer allows, but it can be helpful for taking a series of many spectra on the same object. Don Clark asked whether Jerry could measure the spectrum of the comet coming later this year, and Jerry said he would be able to. Bart Billard asked about trying the 200-micron fiber. Jerry said he had not tried it yet, but that he thought he would probably have to auto guide with it. Glenn Holliday asked about using the spectrometer on the Moon, and Jerry said he had done so and found the spectrum similar to the Sun's. Don asked about asteroids, and Jerry said it would be more difficult because he normally identified the position of asteroids *after* taking the image.

### March 2013—VLF Radio Astronomy—From Start to SID

**Scott Lansdale** presented a program on his amateur radio astronomy very low frequency (VLF) project: "From Start to SID." SID stands for "sudden ionospheric disturbance" caused by the Sun. The Earth's ionosphere refracts radio waves generated by terrestrial sources, and the disturbances can affect transmissions by changing the height of layers in the ionosphere. These changes can result when magnetic fields in active regions of the Sun reconnect.

Stanford University created the Super SID detector design and partnered with the [Society of Amateur Radio Astronomers](#) (SARA) to distribute kits that contain everything but the antenna itself (The wire for the loop and connector are included.) The SARA kits use a loop antenna, a preamplifier, and a high-definition sound card to detect and convert VLF signals to digital data. You build antenna from scratch because the design depends on where and how you want to mount it (indoors or outdoors). The kit also contains software that knows about the VLF stations. It can make a file showing the time dependence of the signal from each station. The kit price is \$60, but also available at no cost to educators or for other educational purposes (the club might qualify). There is no



VLF Antenna (Source: Scott Lansdale)

required design for the antenna as long as the loop of wire is taut. When Scott constructed his own antenna, he chose PVC pipe for design flexibility and ease of transport (see photo above). None of the parts are glued together, making assembly/disassembly relatively simple. The chart below lists the parts he used to construct his antenna.

Parts used	#	Cost ea.	Total
T Connectors	18	0.36	6.48
Crosses	5	1.98	9.90
90 Degree Bends	10	0.30	3.00
45 Degree Bends	12	0.62	7.44
90 Deg w/ sideout	4	1.62	6.48
1/2 to 3/4 with screw in	4	0.64	2.56
Rounded Ends	12	0.32	3.84
2 ft tubes (Approx)	26	1.15	29.90
Length Extenders	3	0.23	0.69
Connectors(1 1/2 pieces)	51	N/A	N/A
Totals	145	N/A	\$70.29

**Parts List for VLF Antenna (Source: Scott Lansdale)**

## April 2013—The Adventures of Voyager Across the Solar Heliopause

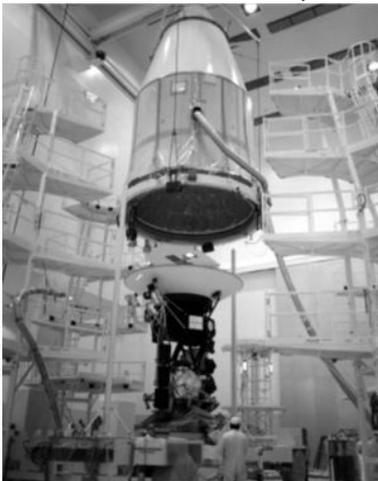
**Glenn Holliday** had seen stories about new findings from Voyager a few months ago, and then, not long after agreeing to present this program, Voyager was back in the news. Voyager 1 is part of the Grand Tour fleet of four probes made possible by the planetary alignment that occurred in the 1970s. The four craft were Pioneer 10 and 11, which practiced on Jupiter, and Voyager 1 and 2, which covered all four of the outer planets. The fleet made dozens of first discoveries, and the two Voyager craft are still doing astronomy after almost 40 years.

Pioneer 10, launched in March 1972, was the first craft to enter the asteroid belt and first to reach Jupiter. Besides demonstrating the feasibility of crossing the asteroid belt, it discovered unexpected clouds of helium in interplanetary space and hydrogen clouds around Io and Europa, and found that Jupiter is exothermic, emitting more heat than it receives from the Sun. Pioneer 10 was last heard from in January 2003 when its power source became too weak. Pioneer 11, launched in April 1973,



**Pioneer 10 (Source: NASA)**

flew by Jupiter and was the first craft to reach Saturn, discovering new rings and moons of that planet. It also discovered Saturn is exothermic. It was last heard from in November 1995.



**Voyager 2 (Source: NASA)**

Voyager 1, launched in September 1977 (a month later than Voyager 2), overtook its sister craft. It flew by Jupiter and Saturn, performing a gravitational slingshot maneuver over Titan to investigate that moon. The maneuver took Voyager 1 out of the plane of the ecliptic, so it could not visit the other outer planets. Voyager 1 discovered new rings of Jupiter and volcanoes on Io. It took the Family Portrait of the solar system planets from beyond Neptune. Although it no longer sends images, Voyager 1 does send daily science data back to Earth.

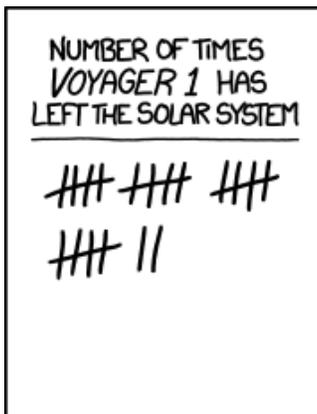
Voyager 2 also flew by Jupiter and Saturn and remains the only craft to visit Uranus and Neptune. A gravity slingshot maneuver over Triton ruled out a visit to Pluto. Voyager 2 discovered new moons of Jupiter and studied the unusual magnetic field of Neptune,

finding the field has a tail like a comet. Voyager 2 determined that features on Jupiter and Neptune are storms. It also continues to send science data back.

Glenn discussed the gravitational slingshot maneuvers that helped make the Grand Tour missions possible. The theory is relatively old—first used in 1965. The potential increase in speed is dramatic, reducing the trip from Jupiter to Saturn to 2 years. It is the only technology known with a chance to save the Earth from the Sun’s red giant phase. Glenn showed current speeds of the craft ranging from 11 km/sec for Pioneer 11 to 17 km/sec for Voyager 1. Pioneer 10 is 108 astronomical units (AU) from the Sun headed toward Aldebaran. It will take 2 million years to arrive. Pioneer 11 is 88 AU from the Sun headed toward the constellation Aquila and will take twice as long as Pioneer 10 to arrive. Voyager 2 is 101 AU out headed toward Sirius with about 496 thousand years to go, and Voyager 1 is 124 AU from the Sun headed in the direction of the star Gliese 445 with 40,000 years to go. Glenn also included the New Horizons probe in the table. It is 26 AU from the Sun and due to arrive at Pluto in 2 years. The table did not include its speed, but Glenn said it is the fastest.

Joe Francis asked about news reports suggesting that unexplained acceleration of the Voyagers might be related to dark energy. Glenn said some acceleration has been measured but that a more mundane explanation has been proposed and is gaining acceptance. Taking into account the directional distribution of thermal radiation produced by the radioactive power sources of the spacecraft appears to be sufficient to explain the acceleration.

The scientific data the Voyagers are now sending back relate to refining our models of the heliosphere, the region where the solar wind has influence. The probes have found and passed the termination shock region where the solar wind drops from supersonic to subsonic velocity. The models had a heliosheath of subsonic solar wind particles beyond the termination shock, ending in a heliopause and a bow shock between the solar wind and galactic particles. Although the Voyagers found the termination shock appeared as expected, the bow shock is not as expected: “the solar wind ends not with a bang but a whimper.” The solar wind and galactic magnetic fields interact in ways we didn’t know before. The heliosheath is also asymmetrical. Last August, Voyager 1 reached a stagnation region where galactic particles are distinguishable by their direction of flow is parallel to the heliopause.



(Source: [xkcd.com](http://xkcd.com))

These results introduced the issue of when or whether Voyager 1 has left the solar system and what is in store for it after leaving. Glenn noted that it may have “left the solar system” a number of times. It passed beyond Neptune’s orbit in 1989, found the termination shock in 2004, and encountered an unexpected region with no solar wind in 2010. The stagnation zone is also a region of “magnetic foam,” with each bubble the size of Earth’s orbit. In 2012, it found a sudden increase in cosmic rays and also found the magnetic highway, with galactic particles flowing along parallel to the heliopause. Voyager is still influenced by the Sun’s gravitation and will not reach the start of the Oort Cloud until it has traveled 2,000 AU. The definition of “leaving” becomes murky. Does the Oort Cloud end at 50,000 AU? Does it continue and mingle with a Proxima Centauri Oort Cloud?

Glenn closed with a discussion on what Voyager 1 might encounter after leaving the solar system, noting that it will become inert long before and will not send back any data. He described the messages the four craft carry in case they encounter other civilizations. The Pioneers carry plaques with diagrams indicating where they came from and show a man and a woman to scale compared with the spacecraft. The Voyagers carry recordings, including some music from Earth.

## Image of the Quarter



Comet Pan-Starrs over Massanutten Mountain, with a day-old Moon setting in the western sky (March 12, 2013)

I drove with my wife Jenny out to a hill east of Luray and took pics of Comet Pan-Starrs with the day-old Moon. It's the first comet either of us has ever seen. It was awesome!!!!—*Ranny Heflin*