

<http://www.raclub.org/>

# The StarGazer

Newsletter of the Rappahannock Astronomy Club

No. 2, Vol. 2 August 2013–October 2013

## Foray into Radio Astronomy

By Scott Lansdale

Ever since college, I have been "looking" at astronomy in a whole new light. Never much of a night owl, and with an interest in treading new territory, I decided to explore the spectrum of radio astronomy. At Randolph-Macon College (R-MC), I worked on a project where I constructed an antenna that observed the Hydrogen line emission at 1,420 megahertz. By analyzing recorded data on a PC from the antenna, I was able to first observe the Sun and then the galactic plane of the Milky Way Galaxy. The project was the highlight of my college career—spanning three semesters and a summer research project. Overall, it was a success and a great learning experience, but after graduating, I no longer had access to the 10-foot alt/az mounted satellite dish I used to perform my observations (see picture at right). My work at R-MC is summarized [here](#). Several years passed before I heard about various smaller projects I could work on at home and that were within the rules of my home owners association. This article describes a project that has again made radio astronomy possible, even for the amateur.



10-ft Alt/Az Mounted Satellite Dish at Randolph-Macon College

The project I chose was small, simple, inexpensive, and, for the most part, plug-and-play. Called a "Super SID monitor," the unit joins a small antenna, amplifier, and PC to observe Sudden Ionospheric Disturbances (SID). These "disturbances" are caused by solar storms—energy from a solar flare or coronal mass ejection (CME) colliding with the atmosphere. The highly energetic particles change the properties of the ionized layers of our atmosphere, causing terrestrial very low frequency (VLF) waves to propagate differently. The VLF signals monitored are generated here on Earth and are used by navies to communicate with submarines at long distances. Although activity is not as intense as in years past, the Sun is currently at its maximum of an 11-year solar sunspot cycle. During the maximum, solar storms, such as solar flares and CMEs, become relatively frequent, and therefore, this couldn't be a better time for studying these interesting phenomena.



Super SID Monitor

Originally produced by the [Stanford Solar Center](#) and called a Space Weather Monitor, the device is built and was recently made available through the Society for [Amateur Radio Astronomers \(SARA\)](#). I joined SARA back in college in an effort to learn and meet new people during my research in building the Hydrogen line antenna. For about \$85, the club provides the SID receiver unit, coax cable, antenna wire, software, and instructions for getting started. You or your group may also receive the unit at reduced or no cost if you or they qualify for the grant program. What the creative user has to do is build the antenna structure to support the wire loop and then connect it all together. (My antenna is shown at left with the Karl Jansky antenna in the background.) The PC does

require an HD sound card. Many new PCs include them; however, *(continued on page 10)*

## 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

August 2013–October 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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### Calendar of Upcoming Events

Star Party, Shiloh School, Northumberland County	November 9
Club Meeting, Maury School	November 20
Star Party, Caledon	November 30
Club Meeting, Maury School	December 18
Star Party, Caledon	December 28
Club Meeting, Maury School	January 15
Star Party, Caledon	January 25

### Recent Outreach Events Completed

Star Party, Cub Scout Pack 1425, Stafford	August 2
Star Party, Caledon State Park, King George	August 10
Star Party, Caledon State Park, King George	August 29
Star Party, Caledon State Park, King George	September 28
Observe the Moon Night, Wilderness Elementary School, Spotsylvania, and Porter Library, Stafford	October 15
Outreach, Park Ridge Elementary, Stafford	October 25
Star Party, Caledon State Park, King George	October 26

## President's Corner

Welcome to New RAClub Members (August–October)

❖ Alfredo Rayms-Keller

The fall weather is upon us, and although the opportunity to observe the night sky may be hit-or-miss, there is always time to share our love of the night sky with those who are new to amateur astronomy. My recent attendance at the Virginia Association of Astronomical Societies (VAAS) annual meeting hosted by NOVAC again brought home to me the continuing need to share our avocation with the larger community. I was invited to sit on a discussion panel with other officers of the area clubs in attendance, and a large part of the discussion was about how to recruit new membership.

The bottom line, best summarized by Jim Browder (Richmond Astronomical Society) was "... to work mainly to raise awareness and plant the seed in school-age children to reap the benefits of future membership in clubs such as ours." While we may lament the aging of our membership, that is how it has always been with astronomy clubs across the nation. It is only when we have the time and disposable income that it becomes possible for us to enjoy this hobby to the fullest. What I realized at the meeting was that as long as we continue to talk and share ourselves and our hobby with anyone that will listen, I think that the membership issue will take care of itself. As Ben Ashley's article in this issue on our support of International Observe the Moon Night demonstrates, even our small club can spread the word to hundreds of people in a single night!

I know you will enjoy this quarter's newsletter. Linda has done another wonderful job putting it together. We have contributions from Joe Francis (Eyepieces), Scott Lansdale (Radio Astronomy), Scott Busby (Polar Shifts, Astronomy Math), and an update from Linda on comet ISON. Another diverse set of articles, to say the least!

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

## Astronomy Math: Diffraction Limit

by Scott Busby

The bending of light that causes this interference pattern is known as "diffraction," and the Airy disk is also known as the diffraction pattern of the scope. The radius of the central disk of this pattern, in radians—let's call it "R"—is given by the formula

$$R=1.22\lambda/D_{\text{scope}}$$

where  $\lambda$  is the wavelength of light (which happens to be  $550 \times 10^{-9}$  m for green light) and  $D_{\text{scope}}$  is the diameter of the objective in *meters* (it's the same thing as the objective diameter but it's in meters, not millimeters).

With regard to your telescope, what is important in this equation is that the size of the Airy disk depends on the diameter of the objective *ONLY*, and as the diameter of the objective gets bigger, the Airy disk gets smaller.

This means as the diameter of your scope gets bigger, you can see smaller and smaller details—or equivalently, you can differentiate stars that are closer and closer together. Conversely, this means that there is a limit to the detail you can see with your scope. That limit is dictated *ENTIRELY* by the diameter of the scope, and it is due to the diffraction effects caused by the scope opening. For this reason, the radius of the Airy disk, as calculated above, is known as the "diffraction limit." Consequently, when you can see the rings of the Airy disk, you know you are operating at the limit of the scope's power to resolve detail.

## Eyepieces for Beginning Astronomers

By Joe Francis

### Eyepieces: How Important Are They?

Eyepieces are the most important accessories for your telescope. They are to a telescope what speakers are to an audio system. "Spend half your audio budget on speakers" is the guidance you get from audio experts. As a beginner, you can easily spend more than half your budget on eyepieces if you choose ones that are "keepers." A beginner probably won't spend more than about \$600 on a first telescope and could spend about \$200 or more on each of three beginning eyepieces. Just remember, eyepieces are the key to your ability to see the image formed by your telescope, so you don't want them to be the weak link in the chain.

Most good books recommend that beginning astronomers choose a Dobsonian telescope with a 6-, 8-, or 10-inch aperture—in order of decreasing portability. The light-gathering capability of a telescope increases as the area of the aperture, which increases the brightness of the objects in your view.

Light-gathering capability is proportional to the square of the radius of the aperture. The aperture measurement is usually stated as the diameter of the objective lens or mirror. Of course, Dobsonians have a mirror as the objective, and the only lenses will be those in the eyepiece. Good eyepieces normally have at least 4 lenses, and maybe as many as 10 or more. The box above lists some examples of beginner telescopes with parabolic mirrors.

#### Example Beginner Telescopes

Model	Price	Focal Length	Focal Ratio
Orion SkyQuest XT10	\$580	1200 mm	f/4.7*
Orion SkyQuest XT8	\$360	1200 mm	f/5.9
Orion SkyQuest XT6	\$310	1200 mm	f/8.0

\*I have one of these

### Terminology—The Basics

Often we talk about aperture in inches or millimeters (mm). Remember that an inch is equal to 25.4 mm. We normally convert telescope measurements to mm because eyepiece focal lengths are stated in mm and we have to use that in calculating magnification in the next section. The box below presents some useful definitions.

**Apparent Field of View (AFOV) of the Eyepiece:** Width of the eyepiece view in degrees. Good eyepieces provide 50° to 110° AFOV. More AFOV provides a wider view of the sky for a given telescope focal length.

**True Field of View (FOV):** The actual FOV of the telescope image as viewed through the eyepiece.

**Eye Relief:** The optimum distance from the eyepiece to your eyeball so that you can see the full FOV of the image. Eye relief is very important for viewers who wear glasses. They will probably want about 15–20 mm of eye relief in their eyepieces to have room for their glasses in the optical path. (Remember that 20 mm is still less than an inch.)

**Exit Pupil:** The diameter of the image from the eyepiece that goes into your eye. A young adult eye has a pupil diameter of about 7 mm when that eye is "dark adapted," i.e., opened to gather the most light. The pupil diameter decreases as people grow older. So you don't want the eyepiece to produce an Exit Pupil greater than 7 mm or you are just wasting the light, and you will begin to see the secondary mirror (black spot) in the Dobsonian view. Also, you don't want the Exit Pupil to be much smaller than 2 mm, which is where your eye gives the best resolution. So, the best Exit Pupil range is from 7 mm to about 0.5 mm. The Exit Pupil is determined by the eyepiece and telescope combination, not the eyepiece alone.

**Focal Length:** The distance, usually measured in mm, from the objective lens or mirror to the focal point of the optical path. If you focus sunlight with a 10-inch focal length lens, then the smallest hot spot will be located 10 inches from the lens.

**Focal Ratio:** The ratio of the Focal Length to the Aperture (diameter). Called the f-number, it is expressed as f/ratio. The lower the ratio, the faster the telescope; that is, the greater light-gathering capability it has for a given focal length. However, reflector telescopes with f/4.5 or less tend to have other problems.

**Magnification:** The factor of increase in the apparent size of the object in view that is produced by the telescope and the eyepiece.

**Brightness:** Brightness of a point of light, such as a star, is determined by the area of the telescope aperture, which is proportional to the square of the radius, and does not decrease with increased magnification. However, the brightness of extended objects, such as nebulae, galaxies, and planets, is proportional to the square of the Exit Pupil, which decreases with greater magnification. Therefore, the dark sky brightness decreases with magnification (becomes darker), giving a star greater contrast with the background. However, extended objects become dimmer with more magnification.

## Basic Formulas

Magnification = Telescope Focal Length (TFL)/Eyepiece Focal Length (EFL)

Remember that atmospheric turbulence normally limits useful magnification to about 400 unless you are in an unusual area or on a mountaintop. Atmospheric turbulence is what causes stars to twinkle when viewed through the Earth's atmosphere.

Exit Pupil = Telescope Aperture (TA)/Magnification =  $TA/(TFL/EFL) = EFL (TA/TFL) = EFL/f$  ratio

Remember you usually want the Exit Pupil to be in the 7- to 0.5-mm range, which limits the range of eyepiece focal lengths to be used with a particular telescope.

Therefore, *maximum* useful Eyepiece Focal Length = Exit Pupil x (f/ratio) = 7mm x f/ratio, and *minimum* useful Eyepiece Focal Length = 0.5mm x f/ratio.

True Field of View = Apparent Field of View (AFOV)/Magnification

Thus, for a TeleVue Ethos eyepiece with 100 degree AFOV, I can see the 0.5° "whole Moon" at 200x ("x" usually means times or magnification), provided the focal length ratios give me the 200x magnification. However, a less expensive beginner eyepiece will probably have an AFOV of 50° to 80°; so for the same magnification, it will see only part of the Moon.

Ghost Images: These can form in low-quality eyepieces when reflected light bounces around among the lenses. Multicoating the eyepiece lenses suppresses the reflections that can cause ghosting.

## Eyepiece Selection

Let's assume you have a new telescope with a 1200-mm focal length and want to purchase some eyepieces. You could get away with two eyepieces and a Barlow lens, which doubles (or triples) the magnification for each eyepiece, but with some loss of light. Or, you could skip the Barlow and buy three eyepieces.

Recognize that your example first telescope (as described in the box above) has a 2-inch focus tube, so a 2-inch diameter eyepiece is what you want. Most eyepieces are either 2 inches or 1.25 inches in diameter. As you upgrade your telescope in the future, the better ones will probably have 2-inch focus tubes. Of course, adapters are available to enable you to use a 1.25 diameter eyepiece in a 2-inch focus tube.

The first eyepiece you should buy is the wide field, longer focal length eyepiece for low magnification in your telescope. You need this eyepiece to calibrate the finder scope on your telescope and to "find" or "locate" most anything you want to view in greater magnification.

You need to determine the minimum useful magnification of your telescope-eyepiece combination by calculating:

$$\text{Maximum useful eyepiece focal length} = (\text{Focal ratio of telescope}) \times 7 \text{ mm} = 5.9 \times 7 = 41.3 \text{ mm}$$

If you are using an 8-inch Orion with f/5.9, then the maximum eyepiece focal length needed is 41.3. I would recommend about 30 mm for the first eyepiece—then the lowest magnification will be  $1200/30 = 40$ , and the exit pupil will be  $8 \times 25.4/40 = 5.1$  mm. For this first eyepiece, I recommend the 27 mm Panoptic by TeleVue, which provides magnification of 44x. It's a wonderful wide-field, long eye relief, super clear eyepiece that I used on my earliest telescopes and later on my most advanced telescopes. It is the first eyepiece I use to find my targets. The price new is about \$350, but if you are lucky, you can get a used one from another astronomy club member for about half price. Or, try to find a used one on the Astronomics website.



Planetary observing is best enabled with 20x to 30x per inch of aperture; therefore, for your example telescope, you would have 160x to 240x magnification for planets. Remember, the minimum eyepiece focal length should keep the exit pupil at 0.5mm or above; therefore,  $5.9 \times 0.5\text{mm} = 3 \text{ mm}$ . Thus, our maximum magnification would be about  $1200/3 = 400$ , which is too high for planetary observing. Thus, choose a 6-mm eyepiece for a magnification of 200x and an exit pupil of 1 mm, or a 7-mm eyepiece for a magnification of 171x and an exit pupil of about 1.2 mm.

I recommend the TeleVue 7mm Nagler Type 6; it's available only in a 1.25-inch diameter size, so you need an adaptor for the 2-inch focus tube. It provides an  $82^\circ$  AFOV with an eye relief of 12 mm. This eyepiece retails at about \$300, so find a good used one if you can.

You can stop right here for your first two eyepieces.

For double star resolution viewing, you may need up to 50x per inch of aperture; therefore, for the example, you would have 400 magnification, which is about the practical upper limit for most observing locations. This eyepiece would have a focal length of  $1200/400 = 3 \text{ mm}$  and an exit pupil of 0.5mm, which is about the minimum you want. For this beginner eyepiece, I recommend adding the TeleVue 2x Powermate (2-inch) Barlow to give you the equivalent of a 3.5 mm eyepiece with the 7 mm above. It will cost about \$330 new, but should also be available used for less. The Powermate is an improved version of the Barlow. It keeps the eye relief the same for the eyepiece.

### Eyepiece Summary

Assuming you have the 8-inch Dobsonian telescope with 1200 mm focal length and f/5.9, you could choose:

- 27 mm TeleVue Panoptic, 2 inch, for 44x
- 7 mm TeleVue Nagler Type 6, 1.25 inch, for 171x
- TeleVue 2x Powermate, 2 inch and 1.25, for 343x and 88x.



TeleVue Panoptic 27 mm  
Source: Televue.com

The Powermate includes a 2-inch to 1.25-inch adapter, so you won't need to buy one separately.

### Advice from the Experts

If you consult the TeleVue website for advice on eyepieces for 6-, 8-, or 10-inch Dobsonians with a focal length of 1200 mm, you will see:

- Low Power recommendation: 35 mm Panoptic or 26 mm Nagler Type 5
- Medium Power recommendation: 12 mm Nagler Type 4 or 13 mm Nagler Type 6
- High Power recommendation: 7mm Nagler Type 6.

### Contrarian Advice

Many astronomers will advise you to buy cheaper eyepieces made by Meade, Orion, or Celestron, or others. The better versions of their Plossl eyepieces cost about \$50 each. Although Celestron and Orion make some good value telescopes, I have never been happy with any of their eyepieces. ONLY TeleVue quality eyepieces work for me. TeleVue eyepieces are usually guaranteed for life and are in high demand as used items. There are other very high quality eyepiece manufacturers, including Pentax, but I have not had experience with those. I believe the reason that beginning astronomers sometimes give up is because they buy lots of cheap eyepieces and NEVER get a good view.

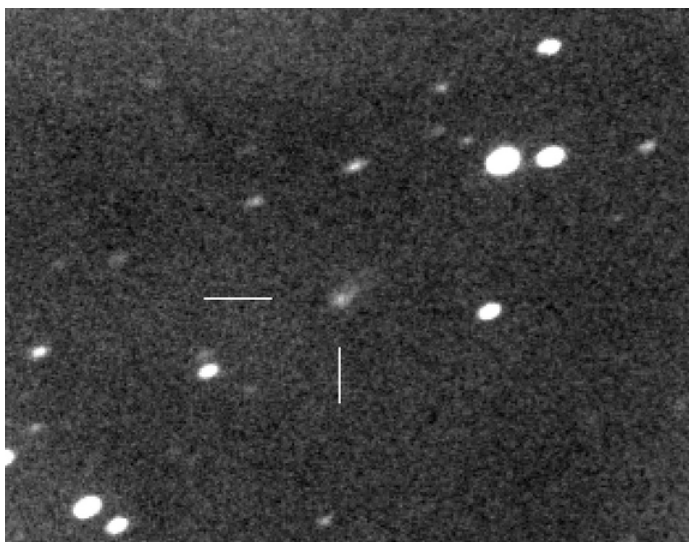
### Bottom Line Advice

- Don't buy eyepieces smaller than 1.25 inches in diameter
- Don't buy eyepiece types of lower quality than Orthoscopic or Plossl
- You only need three or four well-selected eyepieces, a Barlow (or Powermate), and maybe some filters
- Buy quality rather than quantity
- Read a good astronomy book for beginners such as *Night Watch* by Terence Dickinson
- Subscribe to a good magazine, such as *Astronomy*
- Get a *Sky & Telescope* magazine *Pocket Sky Atlas*
- Study the sky and learn the constellations
- Join an Astronomy Club and gain knowledge from the members.

Finally, if you can't afford a telescope yet, buy astronomical binoculars—The best handheld ones (I think) are the Astro-Physics 10.5x70 binoculars for \$400. They will knock your socks off! Other lesser ones are available for \$200. Binoculars will always be useful no matter how many telescopes you acquire.

## Update...ISON—Dazzle or Dud?

by Linda Billard



ISON Reappears August 12 (Source: Bruce Gary)

The article in last quarter's newsletter began, "At best, comets are unpredictable even for the experts." Nothing has changed in that regard...ISON is continuing to behave just as it chooses and not necessarily as we would like. When it vanished temporarily behind the Sun, it had not brightened as astronomers had expected, but there was hope that it would be brighter when it reappeared. Unfortunately, that was not the case.

On August 12, Bruce Gary, amateur astronomer and exoplanet expert, was the first to see ISON as it reappeared from behind the Sun, where it had been since June. He reported he was using an 11-inch telescope at his home observatory, known as [Hereford Arizona Observatory](#) (HAO). Pointing the

telescope only 6 degrees above the eastern horizon near dawn, he took a series of photos and stacked them to produce the composite above. The fuzzy point with a tail pointing away from the Sun appeared exactly where predicted. When he measured the image, Gary found that the magnitude was only  $14 \pm 0.2$ , which is 2 magnitudes fainter than most predictions and 1,000 times fainter than the dimmest star that can be seen with the naked eye.

As reported at [Space.com](#), well-known comet observer John Bortle is even more pessimistic than he was earlier (see [StarGazer, July 2013](#)). "That the comet continues to appear as faint as it does implies that its intrinsic brightness (absolute magnitude) is low and that the nucleus is probably small and relatively inactive," he said.

In the coming weeks, many other observations of ISON made by amateur and professional astronomers worldwide, as well as by orbiting satellites (no fewer than 16 NASA satellites will be watching), will allow experts, including Bortle, to refine their assessment of ISON's chances.

ISON's encounter with Mars before it reaches the Sun occurred the week of October 7. Astronomer Carey Lisse of the Johns Hopkins University Applied Physics Laboratory had reported that "on Oct 1st, the comet will pass within 0.07 AU of Mars, about six times closer than it will ever come to Earth." Lisse said the best bet for seeing the comet was NASA's Mars Reconnaissance Orbiter (MRO). MRO is equipped with a powerful half-meter telescope named HiRISE that is more than capable of detecting the comet's atmosphere and tail. However, scientists in charge of HiRISE say the long-awaited comet did not live up to expectations. "Based on preliminary analysis of the data, the comet appears to be at the low end of the range of brightness predictions for the observation," HiRISE scientists Alan Delamere and Alfred McEwen wrote on the instrument's website.

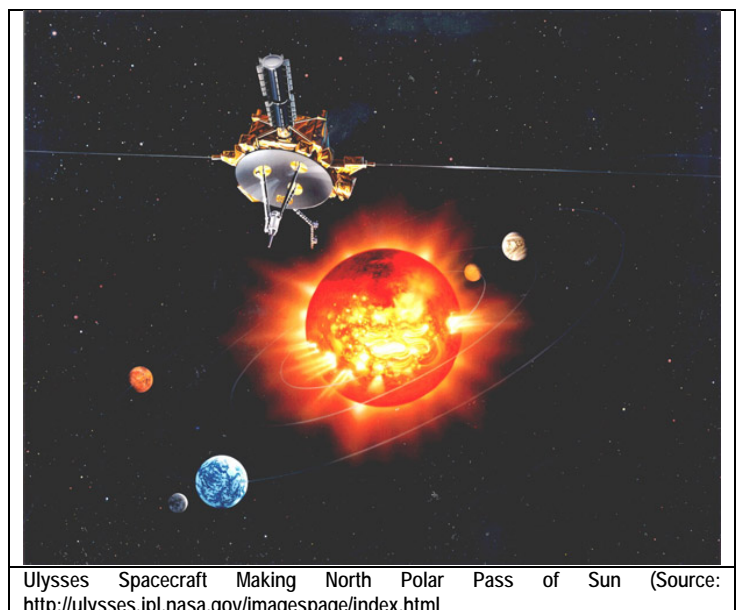
It's too early to say what that means for ISON's swing by the sun in November, when observers on Earth are expected to get their best chance to see the comet in the sky. Current predictions indicate ISON will become visible with the naked eye by about Halloween at dark sky sites. Views are expected to improve in December, possibly with a spectacular tail visible after about December 8.

## Sun and Earth 2012 Polar Shifts

By Scott Busby

Humans have an innate ability to change things—we have exercised dominion over planet Earth for the last 6,000 years, changing things all the while. However, when it comes to unexplained natural occurrences, acts of God, or naturally occurring phenomena, many are perplexed and/or choose to remain ignorant and unaffected. Fortunately, a small contingent of Earth's human inhabitants dares to ask questions and delve into the unknown. Astronomers are just such a group...they seek to observe, collect data, and gaze on the awesome universe with a hyperactive sense of discovery and a desire to understand just how things came to be the way they are.

This brings me to the topic at hand, the phenomena known as solar polar shift. Although this shift has been discussed in astronomy circles over the past few years, the actual event (or non-event) occurred just few short months ago—did you notice? The last time the Sun did a magnetic flip was in February 2001. That's about 11 years ago. That matches our knowledge that the Sun's solar activity occurs in 11-year cycles. The Sun waxes and wanes in solar activity between a fiercely active, sunspot-invested, flare-generating, aurora-producing main sequence star (known as solar maximum) and a calm, inactive star, vacant of sunspots and flares, producing minimal or no aurora (known as solar minimum). It boringly continues to burn its vast supply of hydrogen, bathing our planet in light and keeping us warm and snuggly in the cold universe.



Ulysses Spacecraft Making North Polar Pass of Sun (Source: <http://ulysses.jpl.nasa.gov/imagespage/index.html>)

Like clockwork, the solar polar shift or flip-flop of the Sun's magnetic poles occurs about the time of solar maximum. The magnetic field of the Earth also flips, but with less regularity. Earth flips occur from 5,000 years to 50 million years apart. The last reversal was 740,000 years ago, so I think we are a little overdue.

Although solar and terrestrial magnetic fields behave differently, they do have something in common—their shape. During solar minimum the Sun's field, like Earth's, resembles an iron bar magnet, with great closed loops near the equator and open field lines near the poles. Scientists call this type of field a "dipole." The Sun's dipolar field is

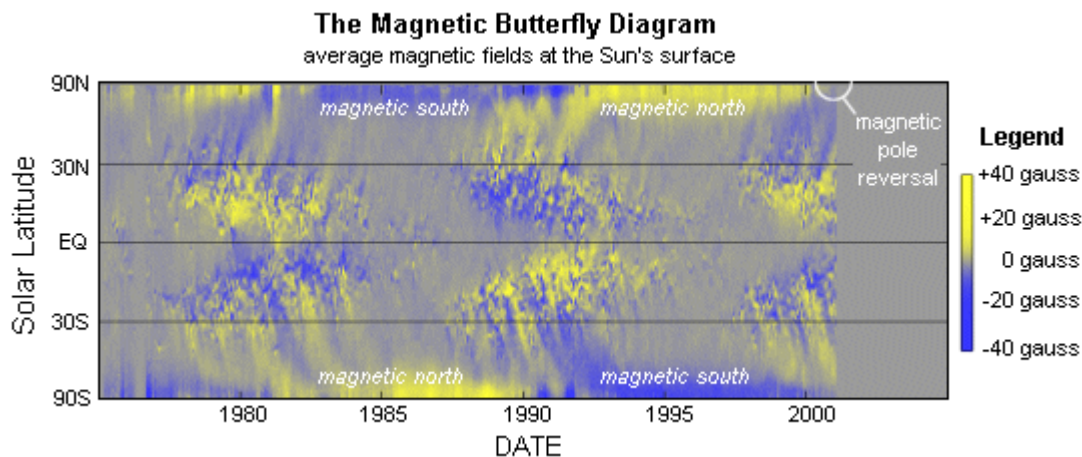


about as strong as a refrigerator magnet, or 50 gauss (a unit of magnetic intensity). Earth's magnetic field is 100 times weaker.

When solar maximum arrives and sunspots pepper the face of the Sun, our star's magnetic field begins to change. Sunspots are places where intense magnetic loops—hundreds of times stronger than the ambient dipole field—poke through the photosphere.

“Meridional flows on the Sun's surface carry magnetic fields from mid-latitude sunspots to the Sun's poles,” explains David Hathaway, a solar physicist at the Marshall Space Flight Center (MSFC). “The poles end up flipping because these flows transport south-pointing magnetic flux to the north magnetic pole, and north pointing flux to the south magnetic pole.” The dipole field then steadily weakens as oppositely directed flux accumulates at the Sun's poles until, at the height of solar maximum, the magnetic poles change polarity and begin to grow in a new direction.

Using data collected by astronomers and the US National Solar Observatory on Kitt Peak, and plotted on a Magnetic Butterfly Diagram, Hathaway plotted the Sun's average magnetic field, day by day, as a function of solar latitude and time from 1975 to present. The plots reveal evolving magnetic fields on the Sun's surface. The Butterfly Diagram gets its name from the sunspot pattern that looks like the wings of a butterfly. It shows, through a color change, when the polar fields have switched sides.



Sun's Magnetic Butterfly Diagram  
Source: [http://www.bibliotecapleyades.net/ciencia/ciencia\\_sol08.htm](http://www.bibliotecapleyades.net/ciencia/ciencia_sol08.htm)

These changes are not confined to the space immediately around our star, Hathaway adds. The Sun's magnetic field envelopes the entire solar system in a bubble that scientists call the “heliosphere.” The heliosphere extends 50 to 100 astronomical units (AU) beyond the orbit of Pluto. Inside the heliosphere lies our solar system. Outside it lies interstellar space.

“Changes in the Sun's magnetic field are carried outward through the heliosphere by the solar wind,” explains Steve Suess, another solar physicist at the MSFC. “It takes about a year for disturbances to propagate all the way from the Sun to the outer bounds of the heliosphere.” Because the Sun rotates (once every 27 days), solar magnetic fields corkscrew outward in the shape of an Archimedean spiral. Far above the poles, the magnetic fields twist around like a child's Slinky toy.

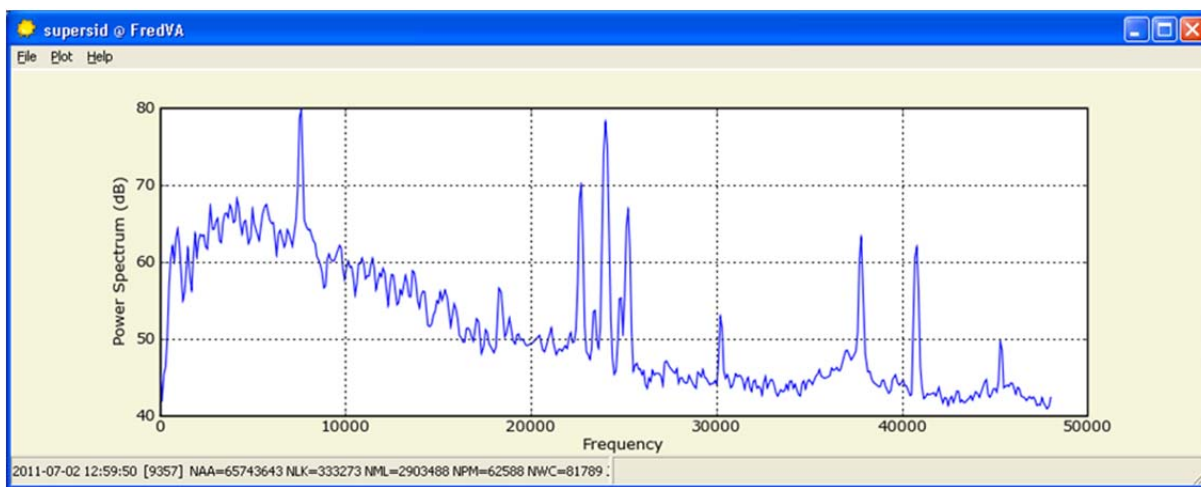
Because of the twists and turns, “the impact of the field reversal on the heliosphere is complicated.” says Hathaway.

As stated earlier, sunspots are sources of intense magnetic knots that spiral outward even as the dipole field vanishes. The heliosphere doesn't wink out of existence when the poles flip—there are plenty of complex magnetic structures to fill the void. Or so the theory goes....

Researchers have never seen the magnetic flip happen from the best possible vantage point—that is, from the top down. But now, the unique [Ulysses](#) spacecraft may give scientists a reality check. Ulysses, an international joint venture of the European Space Agency and NASA, was launched in 1990 to observe the solar system from very high solar latitudes. Every 6 years, it flies 2.2 AU over the Sun's poles. No other space probe travels so far above the orbital plane of the planets. "Ulysses just passed under the Sun's south pole," says Suess, a mission co-investigator. "Now it will loop back and fly over the north pole this fall. This is the most important part of our mission." Ulysses last flew over the Sun's poles in 1994 and 1996, during solar minimum, and the craft made several important discoveries about cosmic rays, the solar wind, and more. "Now we get the Sun's poles during the other extreme: Solar Max. Our data will cover a complete solar cycle."

## Foray into Radio Astronomy (continued from page 1)

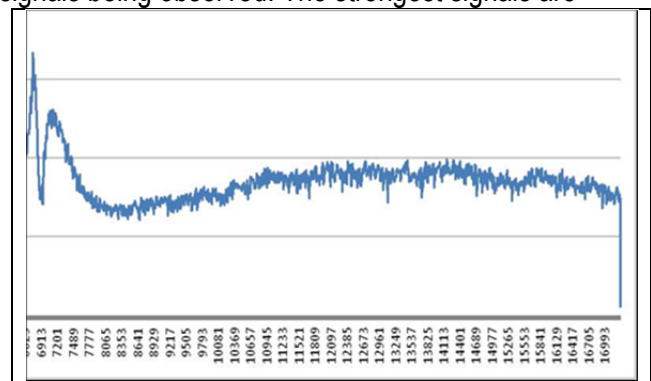
...however, older ones may need to be upgraded. Once everything is powered up and ready to go, you simply start the executable file, and an active plot opens in a window on the screen.



Screenshot of output from SID software

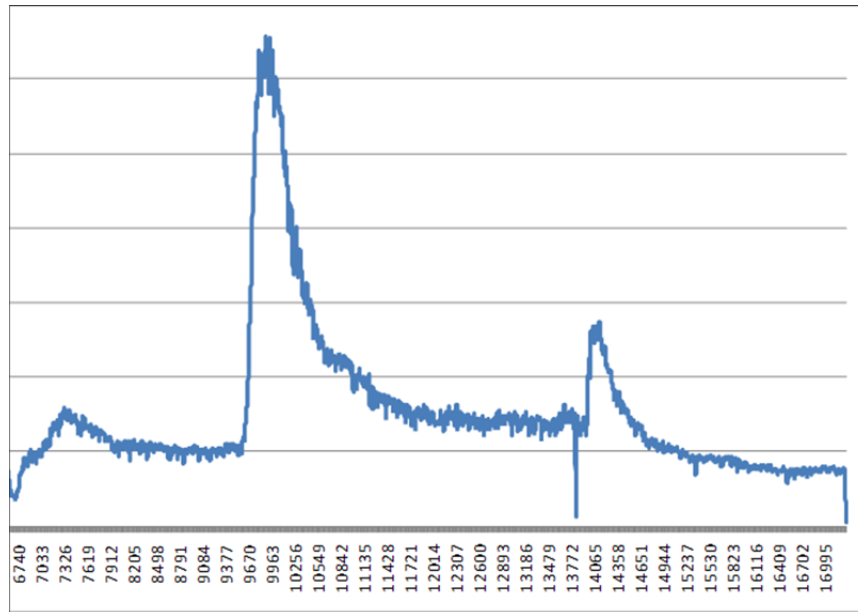
Operating the software is easy because it is already configured to monitor a few stations of interest. The program records the signal amplitude versus time and saves a file for each station every 24 hours. The files can be viewed within the program or opened and plotted later in Microsoft Excel for further analysis. In the active plot displayed on the computer screen, you can see a jagged horizontal line that runs across the frequencies being observed from around 5 kilohertz (KHz) to 50 KHz (units are in Hertz). The signals of interest are shown as several large peaks in the center with a few smaller ones off to each side. The plot shows the current signal strength relative to the background noise (see the screenshot included above). In some cases, you may observe interference, which should be recognizable and hopefully not correlate to known signals being observed. The strongest signals are typically from Maine (NAA—24 KHz), North Dakota (NML—25.2 KHz), and Puerto Rico (NAU—40.8 KHz), but it depends on your location and antenna alignment.

Once the data are saved at the end of the day, the files can be opened to view the results. Typically, if I am going through several days' or weeks' worth of data, I pick one station and make a single plot for each day (see example to right). If I see anything of interest in the plot, I look at another station to compare the observations. Finally, I verify any observations against the [Geostationary Operational Environmental Satellite \(GOES\)](#) data. This

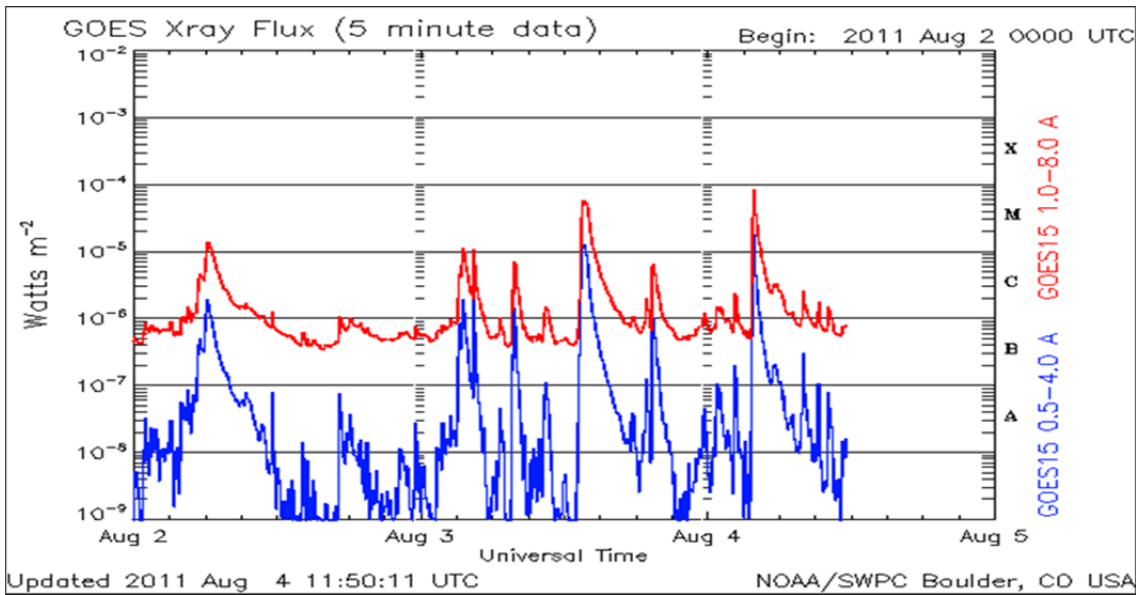


Typical daytime pattern—no SIDs

satellite measures the X-rays generated from the solar storm directly, and the plot is usually very similar to the data collected by the SID monitor. The SID monitor software can also be set up to automatically send the data to the Stanford Solar Center for backup and later research if you have an active Internet connection. Shown below is a comparison of data taken from a SID observation with the SID unit versus the GOES satellite data. This was an example of a large solar event on August 3, 2011. The plot shows a sharp increase in signal strength with a gradual drop off as the ionosphere returns to normal. Most events follow the same pattern but vary in strength with single or multiple peaks observed. What you discover over time is that a simple loop of wire connected to a computer can observe the same things as a multi-million dollar satellite. Although this is not the full story, it is nonetheless an amazing feat and something you will want to share with your family and friends.



Data for a large solar flare taken from the SID antenna



Plot of 3 days worth of 5-minute solar x-ray flux values measured on the SWPC primary GOES satellite. It shows similar data to that recorded using the SID antenna

The Sun is part of everything we are and everything we do. Solar flares and CMEs are amazing solar-system-affecting events that can be observed in many direct and indirect ways. These events can be seen directly in the

visible light by a telescope on Earth or even recorded by the [Solar and Heliospheric Observatory \(SOHO\)](#) in space. The powerful X-rays emitted are monitored by the GOES satellites in Earth's orbit and can be simultaneously observed through the changes to Earth's ionosphere with devices like the SID monitor. Days after an event, the energetic particles from the solar wind bend Earth's magnetic field, which is measurable by magnetometers buried in the ground and seen by those few of us who live far enough North to enjoy the Auroras Borealis. Each of these methods teaches us something about how the Sun works and how our environment changes as a result.

Although this particular realm of astronomy will not produce any pretty pictures, the start-to-finish process and ongoing research more than make up for it. The Super SID monitor is just one tool of many to help us observe these fascinating events and better understand our universe. When you start to collect observations and measurements, you begin to create a picture of how everything is connected. The most rewarding part for me has been being involved in a different aspect of astronomy and ultimately, seeing things in a different light.

## RAClub Annual Picnic

By Scott Busby

For those who couldn't attend on August 17 at the Belmont Observatory grounds, you missed a great picnic! Attending were RAC members Joe Fordham and son Danny, Bart and Linda Billard, Joe and Sherry Francis, Glenn Faini, Ben Ashley, Melvin McDaniel, Jerry Hubbell, Scott Lansdale and wife, Scott & Debbie Busby plus their two sons, Brian and Aaron.

There was plenty of good food and good company. The gift exchange left many members with cool astronomical gifts to take home and enjoy. Joe Fordham was the big winner, taking home a brand new Celestron SLT102 achromatic refractor OTA.

Unfortunately, although the cloud cover prevented any star gazing that evening, I was still able to take some members out to the Belmont Observatory to look at the setup there. Scott Lansdale set up a radio telescope, but forgot a soundcard so we couldn't use it. Linda and Jerry worked together, with several others watching the process, to use Registax6 to refine some of hers and Bart's latest lunar photography efforts.

The very abbreviated business meeting addressed possible topics for the next issue of the newsletter. Linda got several good ideas for articles, and several volunteers to write articles, as you can see if you look through the rest of this newsletter.



Belmont Observatory

Unfortunately, I made the fatal decision to leave the picnic canopy up until Sunday which turned out to be a bad idea. During the early hours of Sunday, more than 3 inches of rain fell. The canopy started to collect water. When we woke up the next morning, we found the heavy weight of water that had collected on the canopy was too much for it to handle, and it collapsed catastrophically. Off to the dump I guess. Had to order another one so it would be here in time for a September LINUS group picnic Debbie is hosting.

For those of you who missed this year's RAC Annual Picnic—Pay close attention to the calendar so you can plan to attend next year. Hopefully, we can have an even bigger group next year.



## Two Successful “International Observe the Moon Night” Outreach Events

By Ben Ashley with Linda Billard

On October 15, the Rappahannock Astronomy Club (RAClub) participated in International Observe the Moon Night (InOMN) at Wilderness Elementary School in Spotsylvania and at Porter Library in Stafford. Earlier in the year, Linda White, the Wilderness Elementary School Librarian, requested that RAClub hold an outreach star party for the school’s students to support the event. In April, she also wrote to Dominion (of Dominion Resources/Power) to apply for one of the company’s Educational Partnership grants. I answered her many questions about binoculars and mounts to help her define what she wanted to purchase if the school received a grant. Subsequently, the school received \$1,000 from Dominion and purchased a pair of high-powered binoculars and a support mount.

On the night of the event, five telescopes and the grant-funded binoculars were set up by several RAClub members and a handful of Wilderness teachers. About 200 students and parents eagerly gathered to look at the Moon. Although the seeing was poor—with persistent clouds as well—the bright second quarter Moon shone through, revealing many smaller craters and the brilliantly glowing Copernicus. For many, it was the first time they had ever seen the Moon up close.

The full event schedule also included an array of activities before, during, and after that Tuesday night. Moon lessons in all 30 of Ms. White’s classes the week before the event, “going to the Moon” on Google Earth, and inclusion of “Moon facts” in morning announcements over the PA system were just a few. She also invited the science teachers from nearby Ni River Middle School to attend along with their students. Ms. White was so pleased with the outcome that she asked that RAClub come again next year.



Source: <http://observethemoonnight.org/>

On the same night, David Abbou partnered with Porter Library in north Stafford to hold an InMON event. David reports that although they were not able to view the Moon through telescopes because of the weather conditions, 150–200 people attended to learn about Earth’s natural satellite, and many inquired about the club.

## Highlights of Recent RAClub Presentations

Abstracted from Bart Billard’s Meeting Minutes

### September 2013—DSLR Imaging Using Narrowband Filters and the Hubble Palette

To begin his presentation, Ranny Heflin showed us his inspiration—“Pillars of Creation” (April 1, 1995), “the first super-wow image” from the Hubble space telescope. He explained that the filters one uses in normal color imagery approximate the three bands of sensitivity of the eye, giving “true color” images. Digital single-lens reflex (DSLR) cameras use four detectors for each pixel, one with a red filter, one with a blue filter, and two with green filters because the eye is more sensitive to green. These normal color filters cover the entire visible band with slight overlap, providing about 100 nanometers (nm) of band pass (range of wavelengths) for each. In contrast, narrowband filters range from about 3 to 15 nm in band pass, and they detect emissions of specific neutral or ionized atoms. The narrow-band filters Ranny uses detect doubly-ionized oxygen (OIII) near the overlap region of normal blue and green filters, hydrogen alpha (H-alpha) near the middle of the normal red filters, and singly-ionized sulfur (SII) near the long-wavelength edge of the normal red filters. He said his filters are not the narrowest band pass, and his SII filter could pick up a little of the H-alpha emission. It also picks up nitrogen emissions because it overlaps with the NII filters designed for that element.

Narrowband filters are useful for observing emission nebulae—clouds of gas that are emitting light. The emission occurs when the atoms or ions in the gas that have electrons with extra energy (“excited electrons”) give up some of that energy as they return to lower-energy states, releasing the energy difference as light of a corresponding color. Each species has a unique set of discrete energy states, resulting in characteristic energy and thus color of the emitted light. The energy that excites the electrons comes from the light of nearby stars when it is absorbed by the atoms or ions. We see emission nebulae by new light emitted by the gas, in contrast with reflection nebulae, which we see by the starlight itself reflected by dust particles. The narrowband filters show the presence of the particular types of atoms or ions, so images made with narrowband filters can provide scientific information. They can also inspire creativity, as Ranny illustrated in his presentation.



Pillars of Creation Source: Hubble Space Telescope

The OIII wavelength is 500.7 nm, and the dark-adapted human eye happens to be most sensitive to this wavelength, which makes OIII filters useful for visual observing as well as imaging. In addition to the H-alpha filter at 656.3 nm and the SII filter at 672.4 nm, other common narrowband filters are NII at 658.4 nm and H-beta at 486.1 nm. H-beta is another characteristic energy or color emitted by hydrogen. Ranny told us H-beta filters are also useful for visual observing of some nebulae because of the eye’s sensitivity.

Ranny said the Hubble palette makes the SII images red, the H-alpha images green, and the OIII images blue. After calibrating and stacking image sequences taken with each filter, he uses Maxim DL and Photoshop for his processing—he demonstrated how it works. Ranny exercises his esthetic creativity by choosing weights for the color assigned to each filter. In addition to his modified Canon 60D DSLR, his imaging equipment includes an 8-inch Celestron, an Orion Atlas mount, an Orion Short-Tube 80 refractor for guiding, and a Celestron 0.7x focal reducer to get more light for narrowband imaging.

Ranny summarized advantages and disadvantages of using narrowband filters with a DSLR for imaging. Pluses are you can image in light-polluted areas and get images of deep-sky objects in moonlight. You also can get greater contrast. However, it takes more time because of longer exposures needed, and lack of sensor temperature control in DSLRs adds to this problem. Ranny is looking forward to cold weather to help him overcome some of these limitations. The narrowband filters are more costly. When asked about

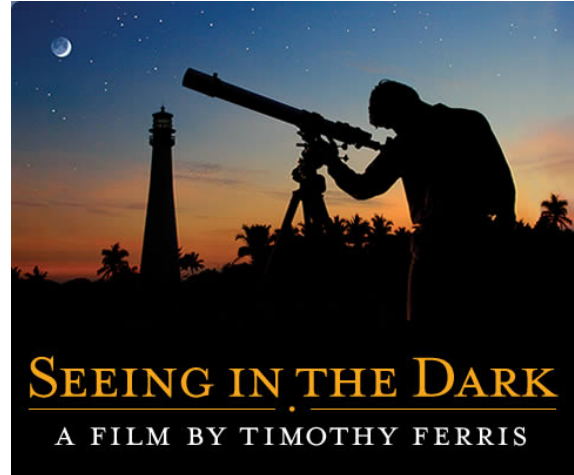


Pillars of Creation (Source: Ranny Heflin)

cost, he said the three he uses are the most common type and are two to three times as expensive as RGB filters. Others, such as NII, are more specialized and consequently even more expensive. Scott Busby said his 50 mm filter is about \$499. Ranny's filters are a special shape made for his camera model. He closed his presentation with a series of spectacular images taken with his setup.

### October 2013—Seeing in the Dark

Brenda Conway was unable to attend and present her program. Instead, we watched the PBS video, *Seeing in the Dark*, written, produced, and narrated by Timothy Ferris. This video illustrates the range of interest and activities of amateur astronomers, and how some participate in scientific investigations. It weaves together stories of various amateurs and some of Ferris's own activities and experiences starting out in the hobby. One amateur, Robert Smith, a former running back for the Minnesota Vikings, now coaches and introduces his players to observing, showing them how science teaches about careful examination of things and issues. Artist Steven O'Meara prefers sketching celestial objects to catch details of planets in rare glimpses of fine seeing. He remembers a beautiful red lunar eclipse he saw with his mother at a young age as the inspiration for learning the night sky. He learned so well he was given keys to the observatory at Harvard when he was 14. His passion for observing and sketching like 19th century astronomers led him to make a discovery that was not confirmed until Voyager reached Saturn: dark radial spokes in Saturn's rings. Robert Gendler, a radiologist, does astrophotography in his driveway and with a robotic telescope at New Mexico Skies.



Source: <http://www.pbs.org/seeinginthedark/>

The video also includes a stop at an annual meeting at Stellafane to see some of the homemade telescopes brought there by amateur astronomers. John Vogt and his daughters assemble their 32-inch Dobsonian made in his garage. Another amateur shows a refractor made with irrigation pipe. Ferris later visits with Barbara Wilson to look through her large Dobsonian at the star cluster NGC 1907. She once showed him the jet coming out of the core of an active galaxy, and they also once tried unsuccessfully to observe gravitational lensing visually.

Another amateur astronomer featured in the video, Michael Koppleman, is a musician who contributes to science by following up on gamma ray bursts (GRB). He is on a NASA email list so that he can try to capture light from a GRB within minutes of the detection of the gamma rays by a satellite. The video illustrates how far an amateur can see—a GRB that Koppleman captured in 2006 turned out to be 11 billion light years away! Ron Bissinger joined a team of amateurs organized by a group called Transitsearch to contribute to the science of extrasolar planets. He works with astrophysicist Barbra Fischer to make follow-up observations on extrasolar planets discovered by professionals to identify ones that transit their stars. Transit observations provide additional information about extrasolar planets, such as their size relative to that of their star.



## Image of the Quarter

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First Quarter Moon

This image is a composite of two image stacks taken with my ATIK 314e CCD camera and Explore Scientific 127 APO telescope at prime focus (952 mm). I took about 950 frames on January 19, 2013, from 2040 hrs to 2105 hrs. This was the first time I had taken that many frames with my deep sky camera and stacked them like video frames. The results were better than I expected because of the wider dynamic range of the camera—16-bit versus 8-bit for a video camera)—*Jerry Hubbell*