http://www.raclub.org/

The StarGazer

Newsletter of the Rappahannock Astronomy Club No. 1, Vol. 4 May 2015–July 2015

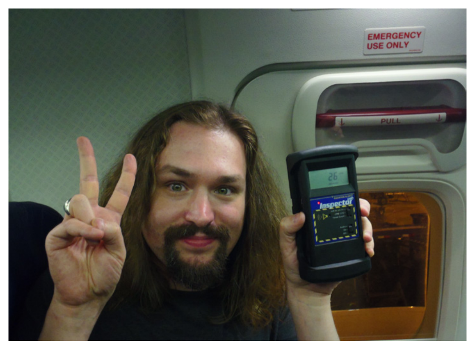
Cosmic Radiation—What Happens in Space May Not Stay in Space

by Tom Watson

Since I was a young child, I have been interested in nearly every branch of science, but no branch drew my attention quite so enthusiastically as nuclear physics. When I held a Geiger counter over an old piece of green Depression glassware from the 1930s, I was amazed when I heard the ticking of the decaying uranium atoms. Each of these little atoms could decay into something lighter than it currently was and in doing so emit that surplus energy as gamma rays, beta particles, alpha particles, and even x-rays. This amazed me because it was something I could test directly.

The Basics

Background radiation is the ever-present radiation that exists in our natural environment. When you turn on a Geiger counter, you hear intermittent detections. (Most Geiger counters make a clicking sound whenever they detect a radioactive particle passing through them.) These emissions, when counted over a long period of time, work out to a very stable average. At some point, I began to question where this background radiation came from. What in my environment was so radioactive? While it is true that the Earth itself is slightly radioactive as a result of the decay of naturally occurring radioactive material (such as uranium, thorium, potassium) and a few other radio nuclides (radioactive atoms), these sources do not account for all the radiation in our environment. The remainder comes either from manmade sources, such as x-ray machines or nuclear meltdowns, or from the very cosmos itself. Over time, my curiosity about the detection of cosmic sources of radiation grew. It was not long before I had set up detectors pointed not at soil samples or mineral samples, but at the sky.



Tom with Geiger Counter

Ionizing radiation from space arrives on Earth mostly in the form of high-energy positively charged protons, but also high-energy alpha particles (an alpha particle is a combination of two protons and two neutrons), x-rays and gamma rays, and even some heavy atomic nuclei (cores of atoms with their electrons stripped), such as carbon, oxygen, and nitrogen.[1] Upon interacting with our atmosphere, many of these high-energy particles break apart into smaller lighter particles. This tearing apart and creation of new smaller particles is called spallation. These spallation events create small areas of increased radiation directly below them. As a result, they are sometimes referred to as Cosmic Showers. It is mostly these spallation fragments that impact our bodies and that our instruments can detect. In this way, most radiation that impacts the ground and that comes from space is the result of secondary interactions between the matter in our atmosphere and the original high-energy particles from space.

Radiation can come from our own Sun, but also comes from other distant stars and even other galaxies. A multitude of objects in the cosmos emit radiation. The closest source of radiation in space is our own star, the Sun. *(continued 5)*

How to Join RAClub

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

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

RAClub annual membership is $15 per family. Student membership is $7.50. Click here for a printable PDF application form.

The RAClub offers you a great opportunity to learn more about the stars, get advice on equipment purchases, and participate in community events. We meet once a month and hold regular star parties each month on the Saturday closest to the dark of the Moon. Our website, www.raclub.org is the best source of information on our events.

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

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

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Calendar of Upcoming Events

Picnic/Star Party, Belmont Observatory*	August 8
Star Party, Big Meadows, Shenandoah National Park	August 12
Star Party, Caledon State Park	September 5
Club Meeting, Maury School	September 16
Club Meeting, Maury School	October 21

*Members only

Recent Outreach Events Completed

Astronomy Q&A, Park Ridge Elementary School	May 4
Astronomy Q&A, Park Ridge Elementary School	June 1
Outreach, England Run Library	June 6
Astronomy Night on the Mall, National Mall	June19

President's Corner

Welcome to New RAClub Members (May–July)

- Tom Watson
- Dave Algert

There is a lot of variety in this edition of the StarGazer. It starts off with an article by one of the club's newest members, Tom Watson, on cosmic radiation. It's followed by a report from Scott Lansdale on our outreach event at England Run Library—our first effort with type of event. Over a 3-hour period, we provided displays of various types of telescopes and gave lectures on a range of subjects associated with astronomy. It was a success due to the Scott's efforts. Next is an article by Scott Busby describing globes of the Moon and Mars that he uses to help him identify features on both. In another article, Jerry Hubbell describes the unusual volcanic lunar feature known as the Mons Rumker. This article is accompanied by two very good pictures. Terry Baker explains the concept of the Radioisotope Thermoelectric Generator (RTG), the role it plays as a power supply, even the part it plays in the book The Martian. Next, I talk about the events at the annual Astronomy on the Mall event. Let's say it was wetter than last year. Scott Lansdale provides an interesting description of his visit to the Society of Amateur Radio Astronomers (SARA) annual East Coast conference in Green Bank, WV. Finally, Bart Billard's synopsis of the club presentations since the last StarGazer.

Note that we have two major events coming up very soon. The first is the annual club picnic at Scott Busby's house. The picnic is worth the membership dues all by itself. A few days after the picnic, we will be doing a star party at Shenandoah National Park at their request. We may discuss holding star parties there on a regular basis (twice a year) if this one goes well.

Thanks to all the contributors and to Linda for putting the StarGazer together.

Clear Skies! Ron Henke

Astronomy Math by Scott Busby

How Many Planets Are There in the Observable Universe?

A galaxy is a gigantic collection of stars. If there are a hundred billion stars per galaxy, a hundred billion galaxies in the observable Universe, and two planets per star, how many planets are there in the observable Universe?

Recall from high school that "a hundred billion" can be written in scientific notation as:

$$100 \times 10^9$$

Because you want to estimate how many planets there are in the observable Universe and you're given the number of stars in a galaxy and the number of galaxies in the observable Universe, start by calculating the number of stars in the observable Universe:

$$100 \times 10^9 \text{ galaxies} \times 100 \times 10^9 \text{ stars/1 galaxy} = 1 \times 10^{22} \text{ stars}$$

With this estimate of the number of stars in the observable Universe, you can determine the number of planets in the observable Universe by multiplying the number of stars by the average number of planets per star:

$$1 \times 10^{22} \text{ stars} \times 2 \text{ planets/1 star} = 2 \times 10^{22} \text{ planets}$$

So there are ***1×10^{22} planets*** in the observable Universe.

England Run Event—Escape the Ordinary

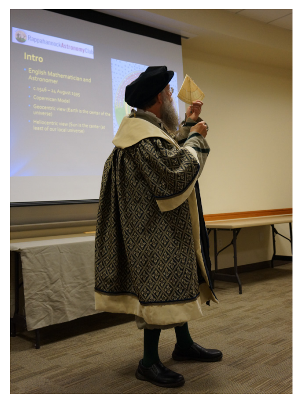
By Scott Lansdale

On June 6, 2015, in coordination with the England Run Library and the "Escape the Ordinary" summer reading program, RAClub held an outreach event to present a tour of our solar system and demonstrate astronomical observation techniques. From 2 to 5 pm, telescopes (10 in all) and other equipment were on display, along with presentations about the solar system, observing the Moon, and an interactive history of the beginnings of modern astronomy. About 60 people visited over the course of the afternoon.

The event was held in at the England Run Library using two conference rooms, one for displays and the other for presentations. On display were the following telescopes: four refractors, three Newtonians (tiny to 8-inch), one Schmitt-Cassegrain, one Dobsonian, and one solar scope. Also on display was a radio antenna for Sudden Ionospheric Disturbance (SID) monitoring during solar flares and an Itty Bitty Telescope (IBT) used to show that nearly everything emits light, even you. One of the other great displays for beginners presented all of the gadgets and lenses needed for basic observational astronomy.

The presentation topics were about buying your first telescope, the solar system, the Sun, the Moon, and a living history presentation of what astronomy was like in Elizabethan times. There were many good questions from the audience throughout, especially from the youngest attendees.

Overall, the event was a success, and there was even a visitor who subsequently attended the June club meeting and became a member. Hopefully the RAClub was able to indeed "reach out" to the community to spark interest in astronomy and enlighten those who needed a reminder of how amazing our universe is.



Equipment display (top left)

Glenn Holliday (aka Thomas Digges) in costume (top right),

Radio telescope (left)

Astronomy Globes

by Scott Busby

Many tools are available to amateur astronomers to observe the night sky. Aside from the usual and expected—binoculars, telescopes, mounts, eyepieces, etc.—there are tools that can help you find and identify objects you want to observe or photograph.

Usually, the first “extras” that come to mind are star charts or software programs that have star chart applications. But, what if you were observing the Moon or perhaps the planet Mars and wanted to identify craters, mountain ranges, or terrain features? Where would you go to learn the names of these features you’re seeing through your telescope? Sure, there are plenty of computer atlas software programs you could use, but that’s not too friendly to your dark-adapted eyes. Or, you could thumb through pages of hardcopy books with your red-lensed flashlight trying to identify pictures and feature names out of context with the global view. Doing it this way can be tedious and generally takes away from the enjoyment of the observing session. I recommend that the lunar or planetary observer use globes for this purpose.

Just as you would use an Earth globe to identify a country or geographic region, you can use planetary globes to identify features you see through your telescope. Specifically, globes for the Moon and the planet Mars are very helpful and fun to use. Certainly, globes for any of the other planets are less useful largely because of the thick, ever-changing gaseous atmospheres of those planets…save perhaps Mercury or Pluto. Then again, these two are too far away to distinguish terrain features anyway.

I use lunar and Mars globes to identify craters and terrain features quickly and easily within a global context. Just as we see the Moon and planet Mars in a global context through our telescopes, so too can we relate what we see to a global model. I use two globes, one each for the Moon and the planet Mars. These globes are 12 inches in diameter and graphically depict all known and named features, including the sites of manned lunar exploration landings in the case of the Moon and unmanned exploratory probes for both the Moon and Mars. Pictures of these globes are shown below.

These particular globes are manufactured by a company called Replogle, which specializes in Earth and Moon globes and maps. They are quite accurate and fun to use or display. The Mars globe is a recent addition to the company’s products. Both globes are also NASA approved. You can visit Replogle’s website at http://www.replogleglobes.com/products.php to see their various products and to find a store where the globes are sold retail. Both the Moon and Mars globes cost about $102. Replogle also has a Venus globe for about $105. You can also order the globes at the Replogle Store at http://www.replogleglobestore.com/

I encourage you buy a Moon, Mars, or Venus globe to enhance your astronomy observation experience. They may seem a bit pricey, but I believe they're worth every penny.

Exploring the Moon: Mons Rümker—An Unusual Volcanic Feature

By Jerry Hubbell

My interest in the Moon was first sparked when I was a young lad of only 8 years during the time of the Apollo lunar missions. I was fascinated by the photographs I found of the lunar surface and especially liked the smaller craters and the isolated mountainous features such as Piton and Pico near the crate Plato. Later in life, I learned about other features through active visual observation of the Moon. Chief among these features were volcanic rilles and canyons and volcanic domes. Volcanic domes can be difficult to observe, but with practice and by learning the landscape, you can find them all over the near-side face of the Moon. One of the easiest of these volcanic dome features to find and study is Mons Rümker.

As you may know, the main features of the Moon are named after famous scientists, engineers, and astronomers of the past, and so it is for Mons Rümker. It was named after German astronomer Karl L.C. Rümker who lived from 1788 to 1862. His most renowned work was the cataloging of 12,000 stars of the southern hemisphere while an astronomer at an observatory in New South Wales. He was also awarded a medal by the Royal Astronomical Society for re-discovering comet Encke.

Mons Rümker (see Fig. 1) is a fairly large volcanic mountain about 44 mi. in diameter and rises up 3,700 ft above the surrounding plateau. Mons Rümker is located in the northwest quadrant of the Moon's near-side in Oceanus Procellarum, close to the limb at selenographic coordinates 40.8° N 58.1° W. Aristarchus is to the south of the volcanic mound and provides a good landmark to help lead you to it. Mons Rümker is best observed 1–2 days prior to a full Moon and also 1–2 days prior to a new Moon early in the morning a couple hours before sunrise. There are 30 smaller volcanic mounds on top of the mountain a few of which can be seen in Fig. 1. Some of these smaller mounds also have craters in the top of the mound, which are probably caldera or volcanic craters. Fig. 2, a Lunar Aeronautical Chart (LAC-23 Rümker) depiction of the mound, shows several smaller mounds and craters on and near the mountain.

Volcanic mounds are created when lava flows from below the Moon's crust and bursts out onto the surface. This is a different process from the lava flows that result from an asteroid impact; for these impacts, which result in the larger craters, asteroid penetrates the crust and fills up the crater with lava in a fairly short time period. Craters such as Plato and Gassendi are good examples of this type of lava plain formation.

In contrast, volcanic mounds are formed by very slow (relatively speaking) seeping of the lava flow, allowing the lava to cool and form a mound over time. This type of process typically forms caldera craters at the top of the mound. Mons Rümker may have formed in a slightly different process where the lava welled up underneath a thin layer of crust thus pushing up the crust and forming a bulging mound with several vents forming small mounds with caldera. This whole area below Mons Rümker may have been a huge underground lava pool that was the result of a deep fissure in the crust forming after the crust had solidified. Admittedly, this is speculation on my part.

However Mons Rümker was formed, it is a most challenging and interesting formation to observe on the lunar surface also a challenging object to image.

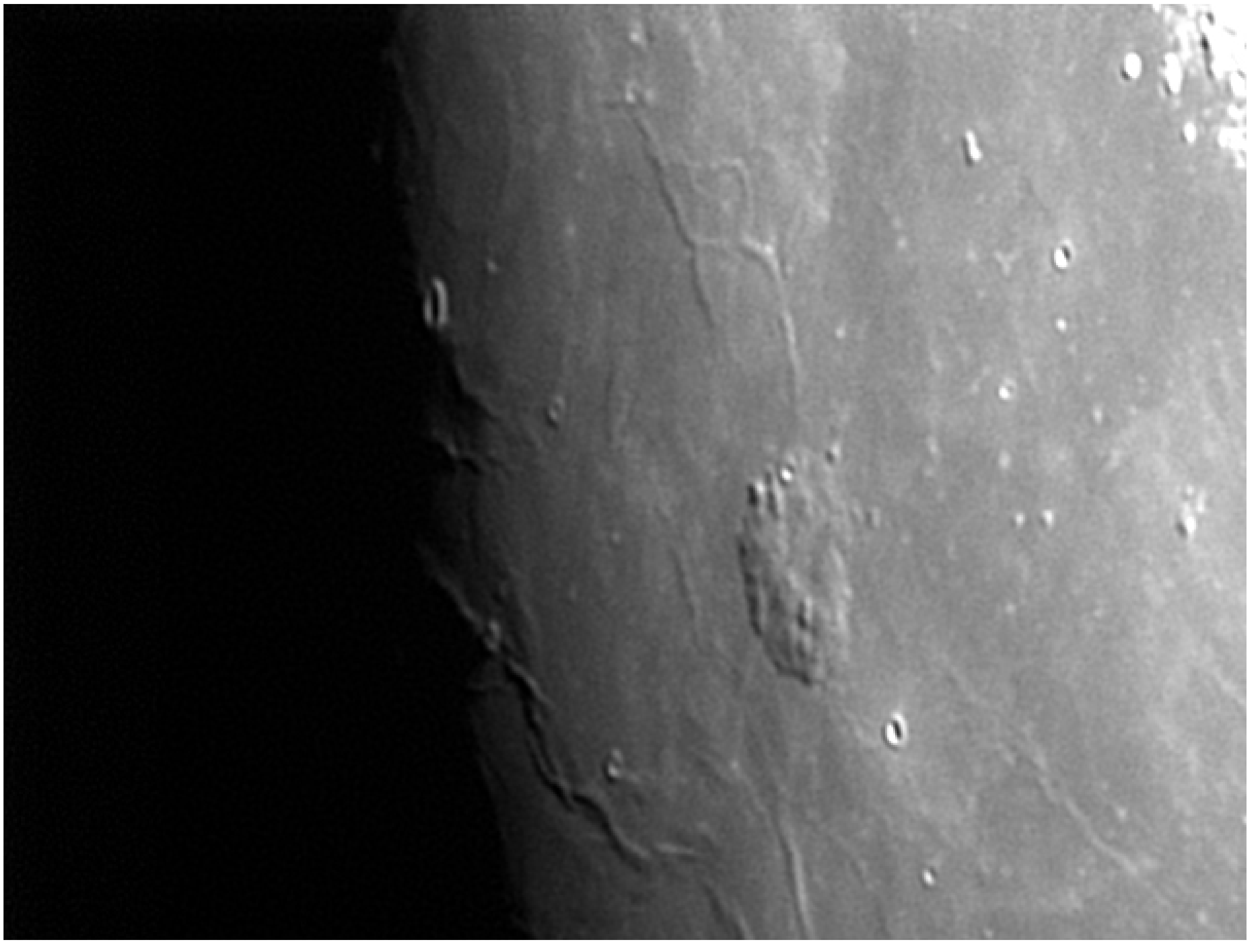


Figure 1. Mons Rümker on January 6, 2012 21:33 taken by Jerry Hubbell at the Lake of the Woods Observatory (MPC I24)

If you are interested in learning about the Moon's topography and how to identify and locate its different craters, rilles, and mountains, then you should download the Virtual Lunar Atlas. This program is very comprehensive, showing you all the features visible in your telescope as well as tell you the current phase of the Moon or for any date you choose. Another very cool resource is the Lunar Aeronautical Charts series of topographical maps freely available on the Internet. This resource is made available by the Lunar and Planetary Institute. They also have other types of maps and charts available.

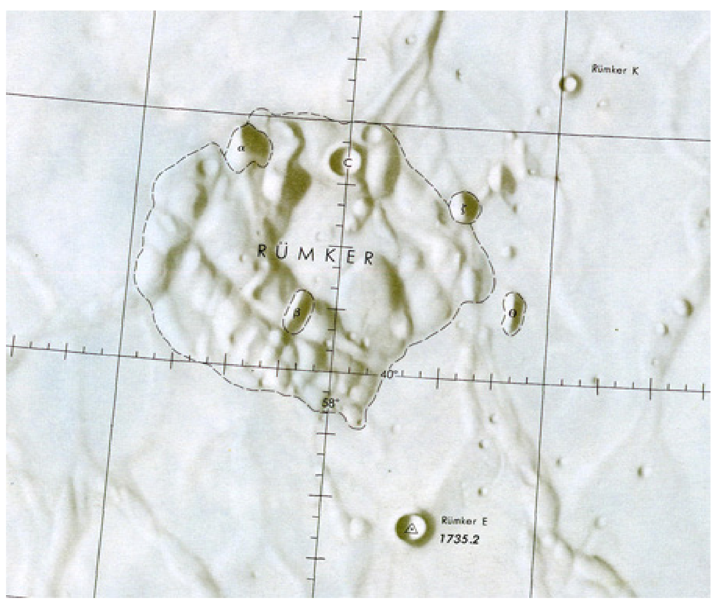


Figure 2. Lunar Aeronautical Chart (LAC-23 Rümker) depiction of the volcanic mound Mons Rümker

For me, looking at and photographing the Moon reminds me of my younger days of excitement and fascination with the first voyages to the Moon by the Apollo program and enables me to create in my mind my own voyage to the Moon. Observing the Moon close up is like being in orbit around it, inspiring your imagination and leading to all kinds of other adventures in astronomy, including observing and virtually visiting the planets in the solar system on your own.

RTGs, Mars, and *The Martian*

By Terry Barker

First, let me explain what an RTG is so it will make more sense to you how all the items in the title go together. The RTG, or Radioisotope Thermoelectric Generator, is what furnished the electricity for the two Voyager ships, New Horizons, the Curiosity Rover, and many other spacecraft and robots. These devices require an alternative to solar panels because such panels would not be able to furnish enough power once you get so far away from the Sun. RTGs are also used to heat the fuel tank so it doesn't freeze in the cold temperatures of space.

The RTG is powered by radioactive materials such as Plutonium (how apt for New Horizons). The radioactive material heats up a thermocouple, which is a device that generates electricity when heated. The reason Plutonium is used is because it has a long half-life—necessary for long-term missions. For instance, New Horizons has been cruising for 10 years, and the Voyagers even longer.

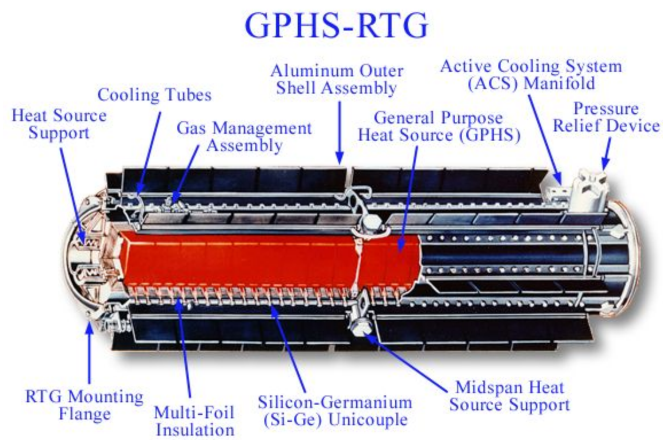
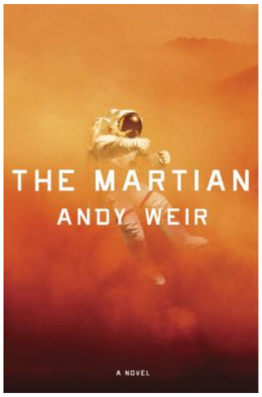


Diagram of RTG. *Source: https://en.wikipedia.org/wiki/Radioisotope_thermoelectric_generator*

How does the RTG connect Mars and *The Martian*? When I was reading the book *The Martian* (a 2011 novel by Andy Weir), part of the plot involves the survivor using the RTG for a heat source. A quick summation of the plot—an astronaut gets accidentally abandoned on Mars because the team thinks he has been killed by flying debris. He's left alone, with no one on Earth even realizing he's alive. And even if they did, it would take 4 years for a rescue mission to reach him. He uses his ingenuity to reengineer the few artifacts left from the mission, including an RTG that was used for heating the cabins of vehicles, a greenhouse, or any one of several places that need heat.



The Martian. Source: https://en.wikipedia.org/wiki/The_Martian_%28Weir_novel%29#/media/File:The_Martian_2014.jpg

An RTG is well shielded, so it's safe for a human to be fairly near it. One interesting item I came across is the misuse of RTGs in Russia. In the 1950s, the USSR employed thousands of them in lighthouses and navigation beacons. Their locations have not been tracked, and they have become orphaned sources of radiation. There have been many reports of hikers and salvagers trying to open the RTGs or use them for scrap metal—with deadly results.

Because a mission to Mars is being contemplated, RTGs will almost certainly be used as heat sources. Have you heard of Mars One? It's a nonprofit organization that projects sending humans to Mars in the 2026 time frame. There's an interesting stipulation for volunteers—there will be no return flights. That's right, Mars will be your new home, and you can forget about changing your mind and returning to Earth.

When I read *The Martian*, I didn't realize that an RTG was used so much in space travel. Reading about New Horizons and its RTG connected the two in my mind, and now that I've done some research on it, it's definitely helped my understanding of one of the many components making up a satellite or a rover.

Astronomy Festival on the National Mall

by Ron Henke

Astronomy Festival on the National Mall (otherwise known as Astronomy Night on the Mall), an annual event sponsored by Hofstra University was held again this year on June 19. A number of scientific organizations participated and put on demonstrations. A number of amateur astronomers from local clubs also participated. As in previous years, the event took place on the lawn just north of the Washington Monument.

Who said it was going to rain? Ron and Jerry relaxing before the event.

This was the third year that RAClub participated, and it turned out to much different than previous years. Last year, it was so fast paced that once we took our lens covers off our telescopes, we did nothing but monitor the scopes for the rest of the evening, with long lines of curious people waiting for an opportunity to look at the sky.

Lots of visitors despite not much to see in the sky. *Source: Rachel Konopa*

This year, not so much. Jerry Hubbell, his daughter Rachel, Lauren Nicholson, her fiancé Ben, and I represented the club this year. Jerry, Rachel, and I left the North Stafford Market Place around 3 p.m. and were in place and set up at the Washington Monument at about 5 p.m. At about 8 p.m., Lauren and Ben arrived to help answer questions and provided another telescope for observing the Washington Monument. Last year the Moon was clearly visible when we arrived. This year it was nowhere to be seen. It would have been nice if it was out so we could have something to observe.

It was questionable whether the weather would cooperate, but when we got there, the Sun was out and it was actually hot. However, the clouds continued to roll in, and soon it was completely overcast. That didn't stop people from stopping by and looking in the telescopes. We never really had any lines at the telescopes, which meant more opportunity to discuss astronomy in general and telescopes in particular with those that did stop by. While there weren't hundreds of people (literally) waiting to look in our telescopes like last year, those we spoke with had a genuine interest in amateur astronomy. I found this rewarding.

We pointed our scopes at various places on the Washington Monument for people to look as the clouds started to move in. At about 9 p.m., we packed it in because it started to rain. There was another major difference from last year: I wasn't nearly as tired and I could actually function the next day. I estimate that we discussed and provided views to about 150 people. This is a far cry from the approximately 1,250 we provided views to last year.

There is an interesting side note: Voice of America (VOA) interviewed Jerry at some length. The VOA reporter decided that he that wanted to pursue this more in depth. To obtain a better understanding of amateur astronomy and see some equipment first hand, he and his crew will be at the club picnic in August at Scott Busby's house.

There was a major lesson learned this year: Astronomy on the Mall can be a success and an a satisfying experience even if there aren't any objects in the sky to see. Don't let the weather scare you away.

View of Washington Monument through 80-mm Stellarvue refractor (left); Jerry Interviewing with VOA Reporter. *Source: Rachel Konopa*

2015 Society of Amateur Radio Astronomers Conference

by Scott Lansdale

Each year I make the trek to the National Radio Astronomy Observatory (NRAO) in Green Bank, WV, to attend the Society of Amateur Radio Astronomers (SARA) annual east-coast conference. This year it was held Sunday, June 21 through Wednesday, June 24. The conference consists of demonstrations of equipment, presentations on various subjects, social gatherings for "tech talk," and even a tour of the facility. Green Bank is the home of several large radio telescopes, including the Green Bank Telescope (GBT) or "Great Big Telescope," which is the largest fully steerable radio telescope in the world at 100 m x 110 m. It's a big draw for attendees and other visitors hoping to get up close, and for some, the chance to get to visit the receiver room hundreds of feet up near the focus.

The conference typically begins midday on Sunday with an introduction to radio astronomy, followed by a demonstration at the site's 40-foot educational telescope. Monday focuses on presentations and the society's board meeting after dinner. Tuesday continues with more talks but after lunch there is a tech tour of the facility or a tour of the GBT. On Wednesday, the conference wraps up after breakfast. Another popular conference activity is the nightly project and equipment setup on the lawn behind the dormitory. This gives the members an opportunity to set up mobile antennas for Radio Jove, Super SID, Inspire, and meteor detection. It is generally the best chance to see various projects in action.

The GBT at Green Bank, WV. *Source: Scott Lansdale*

Several good topics were presented this year, but my favorite was about Meteor Detection given by Chip Sufitchi. He described how to use an inexpensive ($25 each) software-defined radio (SDR) and a small antenna to detect meteor echoes from a distant radio station. To detect these echoes, an FM or VHF station that is ordinarily beyond the reach of the antenna is tuned in. When a meteor travels through the atmosphere, the trail of material enables a distant radio signal to be "forward scattered" to an antenna. To observe these events, a program such as SDR# (free) can be used to monitor the radio spectrum for a distinct and normally short "blip" in the signal. These observations can be taken a step further by recording and counting the events day after day to create a chart. Typically, a trend of detecting more at night and in the pre-dawn hours should be found. Overall, the project seems pretty simple, inexpensive, and something almost anyone should be able to do at home. All that is needed is a small UHF/VHF/FM antenna, a cheap SDR, and a computer loaded with the free SDR# software.

Following the presentations, someone was actually selling a version of an SDR that cost only $25. It basically looks like a large USB flash drive. Later that evening, I downloaded the software and set the radio up at Chip's recommended frequency of 55.525 MHz; this is a TV station in Canada. Using the Jansky antenna (a replica of his original located outside the dormitory), I was actually detecting meteors after just a few minutes of setup. Each detection showed up on the tuned frequency as a smallish signal increase with a coordinated sound. Now, all I need at home is a good VHF/FM antenna to continue.

Each year I attend the SARA conference to hear about new projects both complicated and simple but am most impressed by the ones that a novice can experiment and have success with at home. You can find many interesting and cool projects at www.radio-astronomy.org.

Cosmic Radiation—What Happens in Space May Not Stay in Space (cont'd from p. 1)

Most people are familiar with visible light and ultraviolet radiation—the more readily observable forms of radiation from the Sun—but the Sun also emits other forms of radiation. The Sun constantly bombards us with clouds of ejected particles called the solar wind. This nonstop breeze of particles coming from the Sun and blanketing our planet is traveling about 400 km/s (approx. 900,000 mph).[2] On occasion, the Sun even emits larger bursts of this radiation as flares or coronal mass ejections, in which masses of the star's outer layer, the corona, are ejected in random directions, sometimes at Earth.

Radiation also comes from outside our solar system. Sources can be neutron stars (super-dense stars made of mostly neutrons), novae (large ejections from a star of material moving at extremely high velocity), and even black holes (tiny points in space with gravity so great that not even light can escape). Sometimes these distant objects send huge bursts of gamma radiation, called gamma ray bursts. The chance of any one of these emissions hitting the Earth is generally very small, but there is so much radiation in space that we are hit by them nearly daily. It has been hypothesized that a significantly powerful gamma ray burst that happened to directly hit the Earth could wipe out all life. This is one of the reasons scientists study cosmic events. From large meteorites to gamma ray bursts—what happens in space doesn't always stay in space.

My Experiments

My experimentation with detection of cosmic radiation has taken many different forms. On routine airplane flights, I brought some of my equipment to detect radiation. I discovered that when my altitude rose above 3,000 meters (roughly 10,000 feet), radiation from naturally occurring materials in the Earth were no longer a major component of my background radiation counts. Instead, the cosmic radiation became the dominant source of my background. By the time I reached altitudes of about 11,000 meters (roughly 36,000 feet), my background was solely from cosmic radiation. Using a gamma ray detector, I was able to detect gamma rays resulting from the annihilation of anti-electrons (called positrons) and electrons. These two particles are generated simultaneously when a powerful cosmic ray strikes the atmosphere in a process known as pair production. The annihilation of an electron in a positron creates gamma rays with energy of at least 511 keV (511,000 electron volts). (See Figures 1 and 2.)

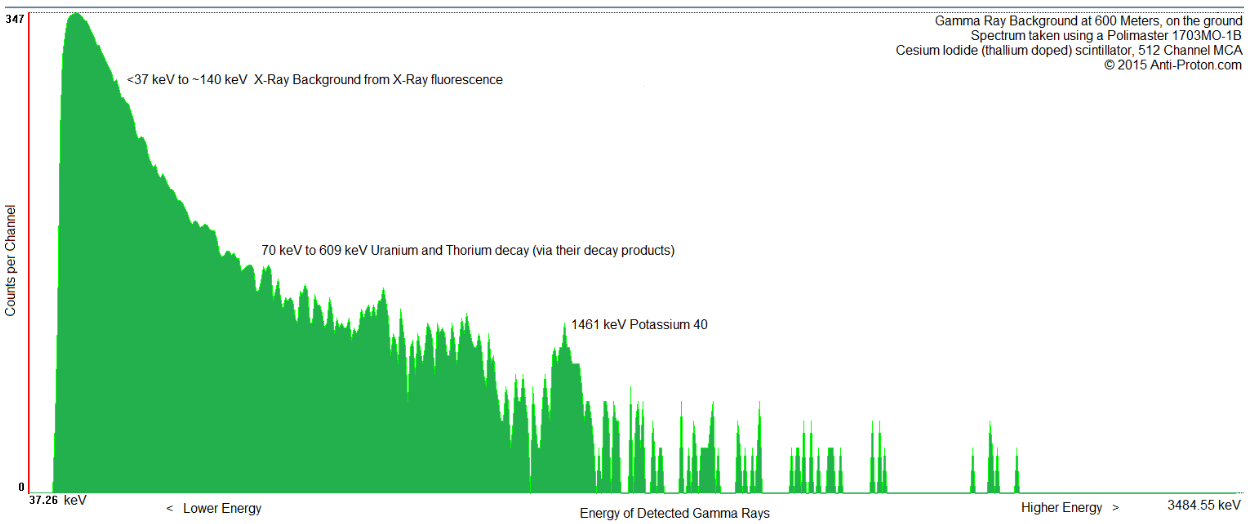


Figure 1. Gamma Ray Spectrum Taken in California at 600 Feet, on the Ground. ***Source: Tom Watson***

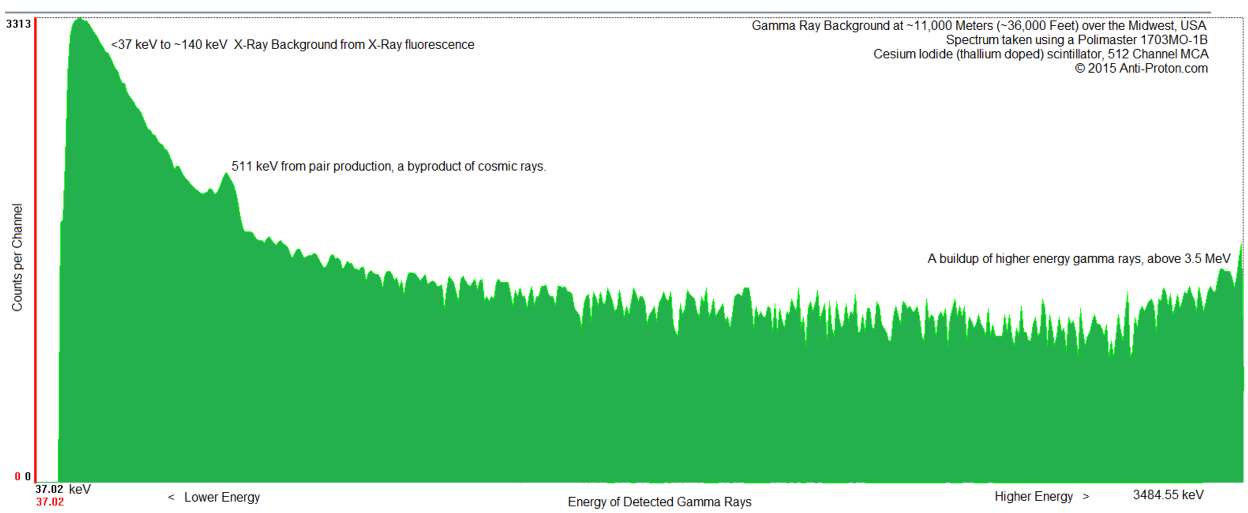


Figure 2. Gamma Ray Spectrum Taken at 36,000 feet Over the Midwestern United States. ***Source: Tom Watson***

Various radiation detectors can be used to detect space radiation. The most common practice for the amateur astronomer is to continuously sample the ever-present background radiation found on Earth and look for small variations in this otherwise stable environment. Using a properly calibrated instrument and recording a long, long sample of detections yields a reasonably uniform reading. When the Sun ejects material toward the Earth or a powerful cosmic ray slams into our atmosphere and spalls, the detector might pick up the sudden increase in radiation. It is these variances that can be tested. An example of the device that can perform this basic form of test is a common Geiger counter or a scintillator. These devices record a radioactive particle passing through them by producing a single pulse of electricity recorded as a single count in a given period time.

More advanced detectors can sort out the energy of the particles that hit them, listing them by energy. These devices can detect a range of energies; particles outside this range are not detected. When a particle enters the device, it is registered, and an electrical pulse is created by the device. Energy-sensitive probes produce electrical pulses with greater voltage if the particle they detected is of greater energy and lower voltage if the particle is of lower energy. Because the detection pulses are recorded and stored by voltage, the scientist simply needs to calculate what energy of particle corresponds to which voltage. The result is a graph displaying energy versus count. The horizontal axis indicates the energy of the particle, typically lowest to highest energy from left to right. The vertical axis indicates the number of detections over a given period of time for each specific energy range. I used this type of device to detect the cosmic radiation in the airplane.

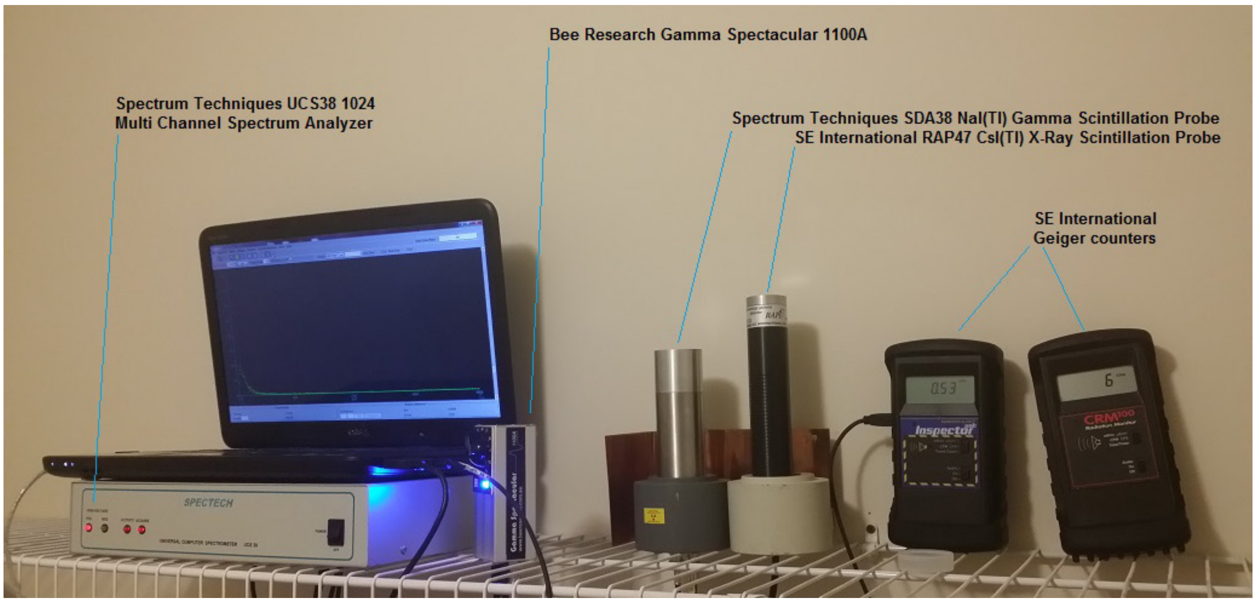


Figure 3. Equipment I Use for Cosmic Radiation Detection. ***Source: Tom Watson***

I normally point a gamma ray detector, x-ray detector, neutron detector, and the Geiger counter toward the sky and then review the data I receive for a few hours to as long as a day. My basic equipment is shown in Figure 3. In the early hours of the morning on June 20, 2015, I detected a solar x-ray flare from the Sun. To do this, I used a small x-ray detector that could detect x-ray energy from 8 keV to 140 keV (8,000 thousand electron volts to 140 thousand electron volts). The detector accumulated counts in 10-second blocks for the entire night. At 4:53 a.m. EDT, the x-ray detector began detecting counts much greater than the average background. Over the next half-hour, three significant increases were detected. The greatest of these detections exceeded five standard deviations from the average background (see Figure 4).

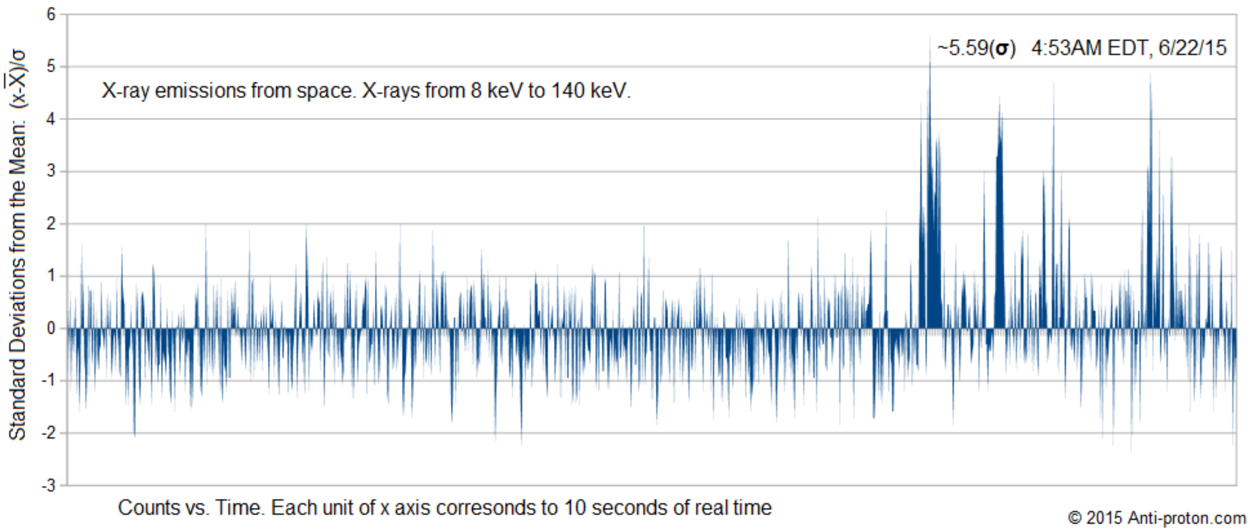


Figure 4. Detection of an X-Ray Flare from the Sun. ***Source: Tom Watson***

To confirm a detection, I correlate my data with NASA data. It is possible to confirm a detection without this correlation, but additional sensors are required and significantly more effort must be applied. During the exact time that I detected x-rays, NASA logged increased x-ray flare activity from the Sun. The likelihood that these flares were detected is very high given their correlation with the NASA data. (See Figure 5.)

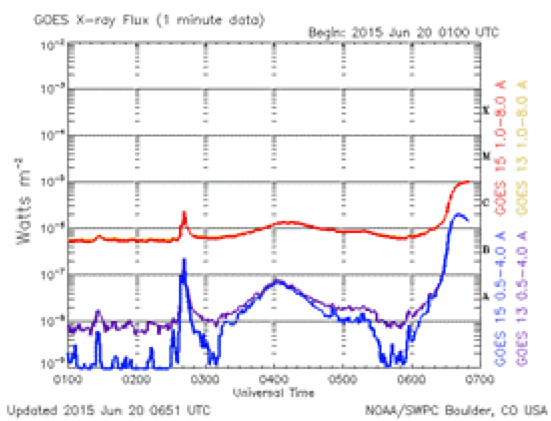


Figure 5. NASA GEOS X-Ray Flux Data Correlating to the June 20 X-Ray Flare. Source: NASA

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1. http://www.telescopearray.org/index.php/about/what-are-cosmic-rays
2. http://solarscience.msfc.nasa.gov/SolarWind.shtml

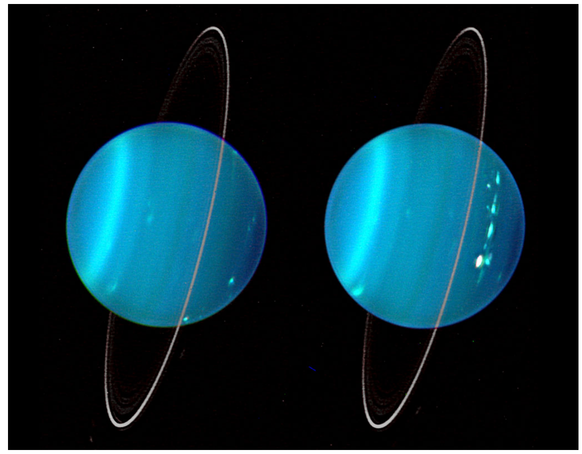
Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes

May 2015—Practice Run for England Run Library Outreach Event

Ron Henke and Scott Lansdale practiced dry runs of the talks they had prepared for the England Run Library outreach event planned for (and held) June 6. Ron's topic was buying a first telescope. He included discussion of various considerations that might influence the choice of equipment to buy: types of observing, i.e., whether planetary or deep sky; whether the telescope would be for the backyard or needed to be more portable; whether photography was an interest, and how complicated a setup was suitable; and, of course, budget. Ron then explained the three types of telescopes. He said refractors can run from a decent 80-mm Orion for about $200 up to pricy. They are the "sports cars" of the bunch. Ron said reflectors come in a variety of sizes, are known for their light-gathering capabilities, and are the "pickup trucks" of telescopes. Schmidt Cassegrains are the "minivans" of telescopes. He said they can do a bit of everything and tend to fall between refractors and reflectors in price.

Ron emphasized that the choice of tripods and mounts was an important consideration in the purchase of a new telescope. Manual mounts can save money and have less that can go wrong, but are of limited use for photography. At the other end of the cost scale, computerized mounts allow for photography but can be heavy. Ron also briefly discussed radio astronomy as a less well-known alternative. It doesn't have to be expensive, and you can observe in the daytime as well as at night. The last part of his talk was about where and how to learn more, starting with visiting England Run Library. Ron included websites such as Cloudy Nights and Astromart, and said he found "so much good stuff on YouTube." The advice in his final slide was "Go to a star party!" and listed our June 13 Caledon star party.


Uranus. ***Source: https://solarsystem.nasa.gov/planets/profile.cfm?Object=Uranus&Display=Gallery***

Scott had two presentations. First was "Our Own Star," about the Sun, and the second was on the planets in the solar system. He had excellent images for his slides, but many were filled with data. We discussed how much of it he should talk about and leaned toward simplifying what he said. Some highlights from Scott's second presentation included—Mercury is smaller than Jupiter's moon Ganymede, Venus has a 900°F temperature because its atmosphere is 96-percent carbon dioxide, the atmosphere of Mars is mostly carbon dioxide but the planet is much colder because its atmosphere is so thin, and Uranus has rings and rotates "on its side." One of Scott's Uranus pictures showed an aurora.

June 2015—*Free Lance-Star* Astronomy Column and NASA Ambassador Duties

David Abbou presented a program on his experience with astronomy outreach and serving as a NASA solar system ambassador. His interest in astronomy began in 1972 as a result of the Apollo program. He has been a NASA Solar System Ambassador since 2008 and started writing a monthly astronomy column for the *Free Lance-Star* the year before. His telescope is a vintage orange 8-inch Celestron.

David did his first outreach program in 1999 at his daughter's elementary school and has been asked back there every year since. He now does about one outreach a month during the school year at various schools, either making a presentation indoors or holding a star party, and acts as a representative of both NASA and RAClub.

David described the NASA Solar System Ambassador program, showing us its website with a map with markers for volunteers. People can click on a marker in their area to get a page about a nearby volunteer. David showed us the page for him. He is one of 628 Ambassadors in the 50 states, Washington, DC, Puerto Rico, the Virgin Islands, and Guam. NASA accepts applications once a year in September.

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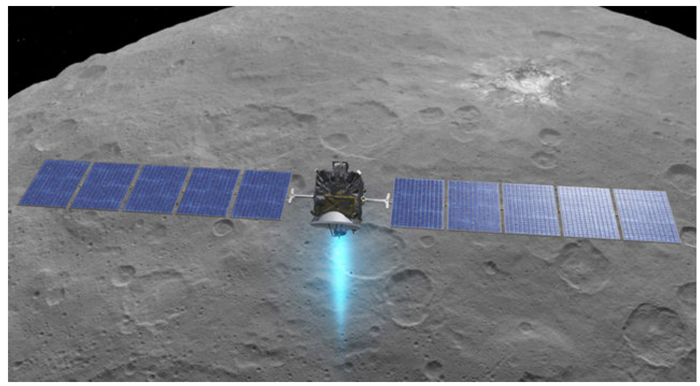
Ron Henke asked whether David would welcome someone else in our area signing up. David noted he is the only volunteer in north central Virginia, so more ambassadors would be welcome. Volunteers must be willing to conduct at least four events per year and log them on the website. Benefits include materials for conducting outreach events and participation in teleconferences in which volunteers can talk with astronomers, scientists, and engineers and ask questions. Of course, outreach events also provide the benefit of opportunities to talk about astronomy. At the end of his presentation, David passed out New Horizon Mission DVDs, an example of the outreach materials available to volunteers.

July 2014—New Planetary Science From Dawn, Rosetta, and New Horizons

Glenn Holliday began by saying that the latest planetary missions—Dawn, Rosetta, and New Horizons—were revealing new science about minor planets, overturning things we thought we knew. With Dawn and New Horizons, NASA has become the first space organization to send probes to all the planets in the solar system and to the largest minor planets. Dawn was the first to orbit an asteroid and is now the first to orbit two different deep space objects. (Glenn explained that, for NASA, a deep space object is one beyond the Moon.) Rosetta, a European Space Agency (ESA) craft, was the first mission to orbit a comet, and it is hoped will be the first to make two landings on one.

Glenn made a brief digression to talk about NASA's Messenger mission, which ended April 30. He said Brenda Conway did two programs on it in prior years. The time limit on the mission was a result of the need to use fuel to maintain Messenger's orbit of Mercury. Because Mercury is so close to the Sun, the Sun's gravity varies significantly in the vicinity of Mercury where Messenger orbited. The variation caused disturbances in the orbit that required regular use of fuel to correct. As the fuel was running out, NASA adjusted the orbit as low as possible to Mercury. Glenn said Messenger unexpectedly found Mercury's magnetic field varies in response to solar activity. He also showed an image of hollows formed in the floor of impact craters that are evidence for geologic activity.

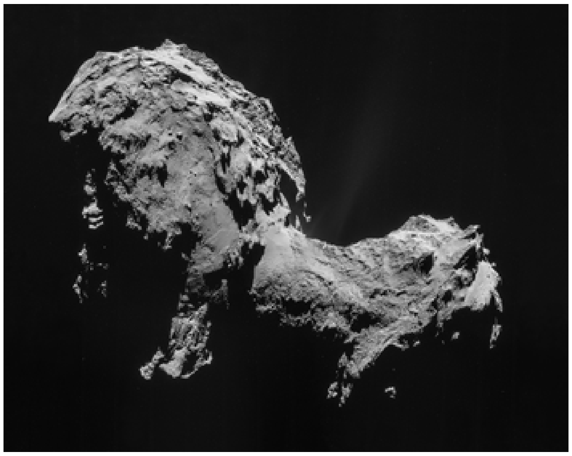

Dawn. *Source: NASA*

The Dawn spacecraft was not the first use of an ion engine in space but was the first long-range mission to use one. The ion engine was the key to entering and leaving orbit around more than one target (along with the low mass of the targets). Glenn said Dawn's targets, Vesta and Ceres, represent 10 percent and 33 percent, respectively, of the entire asteroid belt mass. Vesta is not spherical, but Ceres is, making it a minor planet. Vesta is differentiated, by its metal core, indicating melting and cooling. Its water is gone, similar to large moons. Ceres is still in its original primitive state—a uniform rocky body with an ice layer accumulated on its surface and a dust layer on top. It is similar to Kuiper Belt objects. Vesta is considered a protoplanet, but Ceres is not because it is undifferentiated. Their similarity in origin from our Sun's original accretion disk and difference in evolution were factors in their selection as targets for Dawn. Adam Zwierko asked how we know Vesta's core is iron, and Glenn explained it is inferred from density measurements.

Among the new Dawn mission findings Glenn listed the closest, best pictures of Vesta, showing streambeds and an unexpected mountain at its south pole. Dawn is still getting started at Ceres, where four orbit distances are planned. It had some problems after shifting from the first, outermost distance. NASA is still analyzing what happened and adjusting the mission schedule. However, it has already produced a photographic map of the entire asteroid and imaged an unexpected bright spot, actually several spots in closer images, inside a crater. A leading hypothesis suggests it is reflective ice. Someone asked about the minimum size a body has to reach before gravitation makes it spherical. No one was sure, but Glenn pointed out it is somewhere between Vesta and Ceres.

Glenn told us Rosetta's trip to rendezvous with comet 67P/Churyumov-Gerasimenko spanned 2004 to 2014 and included three flybys of Earth and one of Mars for gravity assists. The Mars flyby allowed it to get pictures from 250 km above the surface. The second Earth flyby in 2007 led to it temporarily getting a minor planet designation, 2007VN84, when it was mistaken for a near-Earth asteroid. Rosetta also flew by two asteroids on the trip. It entered orbit around comet 67P last September.

Rosetta carried the landing probe Philae, which landed on the comet November 12, 2014. The three landing feet on Philae carried anchors to be driven into the comet's crust and secure the probe, but they failed to penetrate. Glenn told us Philae bounced at least twice before coming to rest at an angle in the shadow of a cliff face. Its solar panels could not receive enough light for continuous operation, and the probe performed initial experiments before going to sleep with low battery charge. He said the landing mishap provided the interesting information that the comet's crust was unexpectedly hard. Philae woke up June 13, 2015, and sent results of another experiment on July 9, but communications are still intermittent.



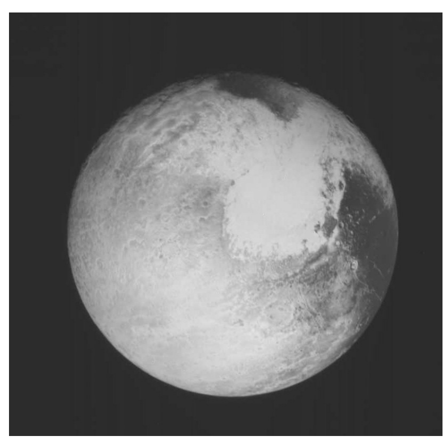
Comet 67P on September 19, 2014 *Source: https://en.wikipedia.org/wiki/Rosetta_%28spacecraft%29#/media/File:Comet_67P_on_19_September_2014_NavCam_mosaic.jpg*

Glenn said the comet had a surprisingly odd shape. The two lobes joined by a narrower neck suggest two smaller objects collided and stuck together. An image of a crack in the neck suggests the two lobes are weakly connected and may break apart as the Sun warms the comet. He showed illustrations of a number of significant findings from Rosetta. One shows much of the surface is shaped into dunes, suggesting piles of soft material, although Philae landed on hard ice and bounced. As the comet neared the Sun, some of the gas and dust that is becoming the comet's coma was released in jets at specific locations, instead of uniformly sublimating all over the surface as scientists expected. In June, the comet was close enough to the Sun for the jets of gas to continue after sunset at their locations. In July, Rosetta saw a sudden outburst of dust from the comet. Glenn said the water cycle on comet 67P is not what we thought. The Sun sublimates ice to water vapor, which subsequently breaks up into hydrogen and oxygen. Spectroscopy showed ultraviolet emission from water vapor characteristic of electron absorption instead of photon absorption. The conclusion is that the water vapor is ionized by the sunlight, and the resulting free electrons drive more splitting of the water than the sunlight photons do.

If Philae can generate enough electricity and establish reliable communication, scientists plan to command it to drill into the comet to get a measurement of its composition. Ultimately, ESA plans for Rosetta to complete its mission with a landing attempt on the comet surface. Glenn said it would probably be in late 2016.

New Horizons launched in January 2006, achieving the fastest launch speed of any spaceship. It took only 13 months to fly by Jupiter for a gravity assist, and its current final speed is second only to Voyager 1. Glenn said it turned off communications with Earth on July 13 to facilitate collection of science data during the flyby of Pluto the next day. It has now begun to download data from the flyby and will do so into next year to get it all. New Horizons is powered by a plutonium thermoelectric generator (see Terry Barker's article, earlier in this issue, for more about these devices) that will support science for another 11 years. Its next Kuiper Belt object target was found in a survey by the Hubble Space Telescope.

Glenn said photos of Pluto and Charon from New Horizons began to surpass Hubble's resolution when it neared Pluto in June. He said Charon is unexpectedly brighter than Pluto and has a dark spot at its north pole, while Pluto has a bright spot at its north pole that was shown to be twinkling in photos taken 30 minutes apart. The first color photos were returned on June 27. Glenn said Pluto and Charon are remarkably different in color and reflectivity. Until 1990, they were thought to be of similar composition. Then studies of eclipses showed Pluto is more rocky and Charon more icy.



Pluto (taken by New Horizons July 14, 2015) ***Source: http://pluto.jhuapl.edu/soc/Pluto-Encounter/***

Because of a software problem that caused New Horizons to enter a safe mode on July 4, science data were lost until July 8, while the probe was oriented to communicate with Earth for troubleshooting. Afterward, new photos revealed more details of Pluto, including geological features.

A more accurate diameter was determined for Pluto, revealing its diameter is larger than Eris. Therefore, it is less dense than thought and consequently less rocky and more icy. New Horizons detected traces of Pluto's atmosphere while still farther away than the orbit of Charon. That means they share an atmosphere.

Glenn's last New Horizons image of Pluto was returned July 13, just before the closest approach began. There was also an image of Pluto made by Rosetta the day before, and he said Google added Pluto to Google Earth using New Horizons images. Glenn said that because he was giving the presentation the day after closest approach, "We should check the web now for exciting new updates since I started talking." Lauren Nicholson was able to download a new image on her phone and confirm his prediction. His presentation with bibliography is on the club website monthly programs page.

Image of the Quarter

Moon—Archimedes Mountains & Crater, June 24, 2015, by Ron Henke
My first attempt at astrophotography taken with the club camera and my 8-inch SCT on 24 June at 9:30 p.m. It's the Archimedes mountain range and crater (to the right) and the Mare Serenitatis (to the left). I processed using AviStack2…not as complicated as RegiStax.