Rappahannock Astronomy Club

Minutes, January 17, 2018, Meeting

In attendance:

Bart Billard
Andrea De Paol
Don Clark
Ranny Heflin
Glenn Holliday
Ki Suh Jung
Susie Mclintock
Payal Patel
Tim Plunkett
Ryan Rapoza
Tom Watson
Adam, Noah, and Joshua Zwierko

The meeting began at about 7 p.m. Seven members and 5 visitors were present.

Program

Tom Watson presented "Radiation from the Sun." He talked about the different kinds of radiation, including particles, radio waves, light, x-rays, and gamma rays. Tom said another member had equipment for observing radio waves, but Tom was interested in radiation of higher energies. He said some radiation could not be detected on the ground and required having a satellite to get above the atmosphere. In fact, astronauts were exposed to radiation in space and sometimes saw flashes in their eyes from it.

Tom had various examples of his equipment with him to show in operation. He started with a gamma scintillator connected to a counter and turned them on to let us hear the amount of activity in the room. Tom said this activity was mainly from traces of uranium in the ground. He listed the kinds of solar and cosmic radiation he has recorded with his equipment:

1. Solar wind, a stream of many particles spit out by the Sun. Tom said solar wind was hard for him to measure because it was so steady. He noted we might have seen pictures of the Earth's magnetic field being pushed and stretched out downstream by solar wind or read about the van Allen radiation belt containing particles from solar wind that are trapped in the magnetic field around the Earth.
2. Particles from solar flares, which occasionally are sent out in our direction and cause magnetic disturbances and auroras.
3. Coronal mass ejections (CMEs). The Sun has an atmosphere, and the corona is the outer part. Tom said that changes in the Sun's magnetic field were thought to eject mass from the corona occasionally.
4. Cosmic rays, which Tom said were not rays. They are mostly protons, with other particles occasionally occurring. Tom talked about the high speeds, and hence energies of cosmic rays. He gave examples of observations of unstable particles and pointed out that they were so fast that time passed more slowly for them according to our clocks, allowing them to reach the detectors before they decayed. Tom also mentioned the "Oh-My-God particle" detected October 15, 1991, and described in *Wikipedia*. Its energy was $3x10^8$ TeV, compared with about 13 TeV for particles in the Large Hadron Collider (a factor of more than 23 million larger). It traveled at about 99.99999999999999999951 percent of the speed of light.
5. Gamma Ray Bursts. Tom said he had hopes that he could detect these even though NASA used satellites and the NASA scientists he had contacted were resistant to the idea he might detect any on the ground. He said high-energy particles entering the atmosphere could cause showers of secondary particles and x-rays, which would be an indirect way of detecting the arrival of a burst of high-energy gamma ray photons. Tom was not sure whether the reaction of NASA scientists might have been influenced by hearing from a lot of people with pet theories disputing mainstream science.

Tom demonstrated how the scintillator worked and how he connected it with a "multichannel spectrum analyzer" to get energy spectra of x-rays reaching the scintillator. The scintillator's sensitive element is a crystal that flashes when hit by an x-ray photon, and the brightness of the flash is proportional to the energy of the photon. The scintillator tube contains a photomultiplier tube that converts the light flashes to electrical pulses with charge proportional to the brightness. The analyzer records the pulses, sorting them

into bins corresponding to the brightness of the flash and counting the number of pulses for each bin. Tom connected the scintillator to the analyzer and displayed the resulting histogram of increasing counts in the different bins. To show the relation of bins to x-ray energy, Tom put his cesium-137 calibration source next to the scintillator tube, and counts began building up much faster in two groups of bins, producing bell-shaped curves at those two locations, one near the left and one toward the right. One location corresponded to the x-ray energy of the cesium-137 and one to barium-137 (the decay product of the cesium-137). The locations of these signals allowed calibration of the energy spectrum of the x-rays hitting the scintillator.

Tom said that with this equipment he could recognize when someone was driving by after taking a nuclear stress-test. His detector was located high in his house with 200 pounds of lead shielding under it, because he only wanted to detect radiation coming from the sky. He could detect energies from less than 5 KeV to about 5 MeV. Tom also had a detector for lower energies, and a couple of Geiger counters to help compensate for the lack of extra detectors to use for anti-coincidence logic. (For example a Geiger counter under the lead shielding that detected a burst of radiation when the detectors above did not would indicate it was from a source other than the sky, such as a stress-test patient driving by.)

To help confirm when he detected radiation from an astronomical source, Tom looked for a correlation with NASA data. He said it had to be with better than 1 minute tolerance based on the accuracy of his computer clock. He said he had seen big spikes correlated with coronal mass ejections detected by NASA's satellite at the L1 point.

Tom showed his recording for the time of the solar eclipse. (He said two out of three of his detectors failed while he was away at Caledon for the eclipse.) There was some change with more activity during the last 1/3rd of the time the Moon crossed in front of the Sun. Some NASA GEOS x-ray data also showed some activity, somewhat similar, over that time period.

During his presentation, the spectrum of the calibration source had built up, and Tom was able to show the peaks from the cesium-137 and barium-137. The latter was sharper. He then demonstrated how he could set the analyzer to record a time series of counts within a selected energy range. For this demonstration, he chose 1 second as the time the analyzer would count for each bin before moving on to the next. This mode would record a peak corresponding to the time a burst of additional radiation was detected, which Tom demonstrated by briefly moving the calibration source near the scintillator. Tom ended by discussing a little more about what he thought his equipment could detect and the evidence he was successful. In addition to the nuclear stress-test patients, he related detecting x-rays, probably from an examining room at the dentist's office, while he was at the front desk paying his bill. He said although the NASA scientists suggested gamma ray bursts could not be detected on the ground, scientists have also suggested a possibility of a gamma ray burst sterilizing life on Earth, if it occurred close enough. That certainly suggested something in between was possible.

A PDF of the presentation is available on the club website on the monthly programs page.

Old Business

- Treasurer's Report for December 31, 2017—Tim Plunkett's report showed no changes for the month. He did say he had left a payment to Glenn Holliday along with his dues payment in the November report.
- Communications—Payal Patel had received the printed sample of 250 postcard club flyers. The picture came out well, but she would like to improve the font used on the back. She passed them around for members to look at and take a few samples.
- MSRO—Bart Billard reported the new 165-mm refractor was installed in place of the smaller refractor. Some work was also done on the MSRO2 telescope and mount. Matt Scott made stronger replacement brackets for the prototype plastic brackets for the azimuth and declination motors and pulleys. He reported additional exoplanet observing with Jerry Hubbell, including a successful one that they submitted to the Exoplanet Transit Database website.
- Recent Events Held—Glenn Holliday reported on the December Caledon star party. Three members and nine guests attended for a clear, cold night. He said he went hiking recently in similar cold weather and found he did not get cold feet and got by with less protection from the cold than needed for the star party.
- Programs for Upcoming Club Meetings—Glenn said more volunteers or ideas were needed for club programs. Tom volunteered to do "Autoguiding on the Cheap" in April. He said he was

pleased to finally be able to get some longer exposure astrophotos. Glenn also asked members to volunteer for star party programs for the warm months.

- Website Update—Don Clark said he was working on archiving the image of the month pictures. In some cases they were cropped to fit, and he would like copies of the original for the archive. He also talked about doing the Night Sky Network calendar and submitting reports of outreach events held. David Abbou was now doing his outreach events, and Don wanted to set it up so other members doing outreach could enter their events. He listed some members he had done this for and requested others doing outreach to let him know so he could add them.

Next Meeting

The next meeting is on Wednesday, February 21, 2018, at the Headquarters Library on Caroline Street, downtown Fredericksburg. We will be in room 2.