

Rappahannock Astronomy Club

Minutes, December 19, 2018, Meeting

In attendance:

Jean Benson
Bart and Linda Billard
Don Clark
Joe Garcia
Jerry Hubbell

Scott Lansdale
Tim Plunkett
Ryan Rapoza and daughter
Matt Scott

The meeting began shortly after 7:00 p.m. Ten members and a visitor were present.

Program

Bart Billard presented “The Transiting Exoplanet Survey Satellite Mission (TESS),” the recently launched NASA Space Telescope surveying nearly all the sky looking for nearby exoplanets. He said it was the next step after the Kepler Mission. For background and comparison with TESS, Bart began by revisiting a talk he gave about Kepler in March 2014. His talk included some NASA videos, starting with the April 18, 2018, launch of TESS on a SpaceX Falcon 9 rocket.

Bart said exoplanet discoveries started in the mid-1990s. Early planets were mostly Jupiter sized because their large mass made them easier to detect. Kepler was designed to monitor more than 150,000 stars continuously for 3-1/2 years or more using a 95-megapixel camera to detect brightness changes of as little as 100 parts per million. This precision, along with the mission length, were needed to detect planets similar to Earth in size orbiting stars similar to the Sun with periods like Earth’s. Bart played a NASA video on detecting planets by transits. It showed how dips in the light from a star occur if a planet orbiting it passes between us and the star. Smaller dips indicate smaller planet size, and multiple dips can occur when more than one planet orbits a star. Bart showed a model of transit data, a “light curve” of a star with a sequence of smaller dips that could be an Earth-sized planet and a pair of larger dips that could be a Jupiter-sized planet. He said analysis of Kepler data showing more than one set of transits of a single star provides evidence that could be enough to confirm the transits were truly the result of planets orbiting the star. In some cases, the timing of one of the planet’s transits could be seen to vary because of the gravitational influence of the other planet.

In February 2014, NASA announced verification of 715 planets in orbit around 305 stars. Prior to the announcement, there had been 2,823 additional candidate planets, many of which will also likely be confirmed.

Bart played another video illustrating the difference between the sky covered by Kepler and its K2 follow-up mission and the coverage TESS has. TESS has four cameras each covering a square area of 24 degrees on a side. These sky patches are arranged in a strip covering 24-by-96 degrees. TESS began covering the first 24-by-90-degree strip, called a sector, last July. Each sector is covered for about 27 days before the telescope moves on to the next sector. After covering 13 sectors south of the ecliptic plane in the first year of its mission, TESS will begin covering the sky north of the ecliptic plane in the second year. The sectors overlap at the ecliptic poles to allow continuous coverage of a part of the sky. The total area covered will be 350 times that covered by Kepler and K2. Bart showed a map of the TESS sectors covered in the first year on a grid showing celestial coordinates. Sector 6, which TESS began monitoring in early December, is the sector farthest north of the celestial equator. Along with its two neighbors, Sector 6 will be the most likely to produce targets we can observe from our latitude during this first year. Another video showed the orbit of TESS and how it was achieved with a “gravity assist” from the Moon. The orbit has a resonance of 2 orbits to 1 with the Moon’s and thus is very stable.

The last topic was the TESS Follow-up Program. Amateur observers can contribute with observations on the ground to resolve ambiguities in TESS survey candidates. The resolution of the TESS cameras results in a photometric aperture of about 2 arc minutes. That aperture could include several stars, requiring additional ground-based observations to identify which of the “blended” stars was responsible

for the apparent transit signal. Some signals could actually be caused by a background eclipsing binary system blended with foreground stars. Amateur light curves could reveal this as a deep transit signal in the fainter background star system, as opposed to a shallower planet-like transit in a brighter blended star. Bart illustrated how follow-up observations such as the exoplanet light-curve measurements he and Jerry Hubbell have done can provide parameters of a particular exoplanet system. A screenshot from the Exoplanet Transit Database [website](#) illustrates an observation they made of the system HAT-P-30/WASP-51 b after fitting it to a transit model with tools provided by the website. It showed the derived planetary radius was in fairly good agreement with the catalog value, and the derived orbital inclination had quite good agreement. Inclinations for planet transits near the center of the star's disk have flatter-bottomed light curve dips than planet transits near the limb of the star. Bart showed results of AstrolmageJ analysis of a recent observation Jerry made from MSRO. The data fit the model transit light curve nicely, and the scatter of the individual measurements was less than .003 of a magnitude.

Bart wrapped up with another TESS video showing data from the testing phase of TESS last summer. TESS captured NEOWISE Comet C/2018 N1 and other interesting features. The comet's tail changes direction, some variable stars blink, and when the video is sped up at the end, numerous asteroids are picked up moving among the stars. This [presentation](#) is posted online at the RAC website.

Joe Garcia asked whether orbital planes are randomly oriented and whether there were any planets around binary stars. Bart said the Kepler discoveries were consistent with the proportion of stars expected for random orientation. He also thought molecular clouds that collapse and become star-forming regions appear to clump up from influences such as supernova explosions, and the resulting turbulence seems likely to randomize the orientations. He said the first discovery of a circumbinary exoplanet was made by two participants in the Planethunters citizen science project that lets users apply their pattern recognition skills to light curves of Kepler data.

Ryan Rapoza asked how big the TESS satellite is. Bart went back to the slide showing the satellite image with the arrangement of the four cameras and another image of one of the cameras in the laboratory with people suited up to prevent contamination working on it. We concluded it was somewhere near the size of a washing machine.

Joe asked about typical orbital periods and how hard it was to predict the next transit. Bart noted that Kepler required at least two transit detections, four for planets near Earth size, so the periods could be found from the time between transits. Afterward, he spoke with Joe and learned he was thinking of how follow-up observations would be done if TESS detected only one transit of a star. It was a good question because TESS is only spending about 27 days on each sector (except for the continuously observed areas at the ecliptic poles) for the first 2 years. However, Jerry and Bart had indicated that fitting a transit model to a light curve can provide some indication of the orbital period.

Don Clark asked whether Hubbell could be used to confirm exoplanet candidates from TESS. Bart thought it could be used to resolve ambiguity for blended stars or for detecting a blended eclipsing binary false positive. He thought radial velocity observations would need to be made with ground-based telescopes and that adaptive optics telescopes would also provide some of the high-resolution imaging need for blended stars. Don also asked how you determine planet size. Bart said the transit depth depends on the planet's area compared with the star's area.

Old Business

- Treasurer's Report—Tim Plunkett presented the reports for October 31 and November 30. October's report included six dues payments and expenditures for Astronomical League dues and reimbursement of Don Clark's fees payment for the club website. November's included dues from three members, one of them for 3 years.
- Communications—Don Clark mentioned the recent update of WordPress and said he set our website up for us to continue using the classic editor instead of the new editor that comes with the update. He said he planned to change the theme again, using a subdomain to check it out first. The new theme would help with using the website on tablets and phones.
- MSRO Update—Jerry Hubbell remarked that some new members in October joined from outside the area to become MSRO users. He said MSRO now has five fully trained users. Some were getting serious about exoplanet observing. Jerry said a Telescope Drive Master (TDM) problem came up, but it turned out it was a power switch outlet that failed. Fortunately, he had a spare outlet. Meanwhile, he received a spare TDM from his Explore Scientific boss, who wanted him to

test it before returning. During the time the TDM was down, the mount tracked pretty well. The filter wheel clearance problems were resolved when Myron managed to sand down the thickness of the filter holder that did not fit in the filter wheel. Matt Scott asked about the missing O-ring, and Jerry said he managed to find it in the yard. The next MSRO Commission meeting is scheduled for late January.

- Recent Events and Possible Upcoming Events—Scott Lansdale said he did not have any to report. Jerry mentioned that the Governor's School student he was mentoring tried an event at STEM night, but the publicity was poor and resulted in a low turnout. Linda reported a conversation she had with a ranger at Widewater State Park (near Aquia) who expressed interest in having an astronomy event there, once the park is fully open. Linda said she planned to check in with them again in the spring. Scott said he had a request from Westmoreland State Park about holding an event. Don suggested Westmoreland was equidistant from us and from Richmond, and might be a possibility for a combined event with the Richmond club.
- *Stargazer* Update—Linda said that the next *Stargazer* would come out at the end of January, and she had a few articles banked but was not yet spending a lot of time on it.

New Business

- Planned Events—David Abbou events? Linda asked about the Marine Corps Museum. Two recent tries were clouded out. Scott said he had not heard from them and noted construction was still ongoing. The next Caledon date was January 5, 2019. Glenn Holliday's tentative schedule had February 2, and March 2 or March 9 as the following dates. Don verified that he needed to give Glenn Holliday access to the calendar.
- Other Business—Tim said he just remembered he needed to count up the \$20 dues payments accumulated since they were increased from \$15 to provide MSRO support. He said he would email the total to Bart so the MSRO Commission would be able to discuss it when it meets in January.

Next Meeting

The next meeting is on Wednesday, January 16, 2019, at the Headquarters Library on Caroline Street, downtown Fredericksburg.