High Precision Photometry of Bright Transiting Exoplanets with MINERVA

Maurice Wilson\textsuperscript{1,2}, Jason Eastman\textsuperscript{1}, John Johnson\textsuperscript{1}

\textsuperscript{1}Embry-Riddle Aeronautical University, 600 S Clyde Morris Blvd, Daytona Beach, FL 32114, USA
\textsuperscript{2}Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02139, USA; maurice.wilson@cfa.harvard.edu

MINERVA

- Mission: Detect exoplanets, confirm candidate exoplanets, and characterize Earth-like exoplanets
- Location: Mt. Hopkins in Arizona
- 4 telescope array
- PlaneWave CDK-700 telescopes, 0.7m diameters

Objectives

- Photometric precision of < 1 millimagnitude
- Doppler Shift precision of ≤ 0.8 m/s
- Automatic analysis of photometric data via software for photometry pipeline

Significance

- For exoplanets with a radius 1 to 5 times the radius of Earth, the physical properties evaluated for most of these planets either have high uncertainties or cannot be ascertained at all. This problem is exacerbated by the faintness of the host star. However, the rate at which transiting Earth-like exoplanets around bright stars are detected and characterized with satisfactory precision can be substantially increased with MINERVA.

The struggle of Bright Star Photometry is overcome with MINERVA

- To precisely determine the physical properties of an exoplanet, such as the mass and radius, both high precision spectroscopic and high precision photometric data on the host star are needed [1].
- To achieve high precision spectroscopy of Earth-like exoplanets, we observe bright stars.
- Thus, high precision photometry must come from the same bright stars.
- To find precise mass and radius of planets, we analyze exoplanets that transit their bright host stars.

Photometry pipeline will expedite results from bright star survey

We will combine the multi-telescope aspect of MINERVA with the defocusing technique throughout the bright star survey we plan to conduct in 2016. Due to the substantial amount of data coming from this bright star survey, there is a need for software that can automate the photometric data analysis so that the physical properties of the detected Earth-like exoplanets may be deduced. Here are the most significant capabilities of my code:

Pre-observation
- User can query for satisfactory comparison stars
- Creates observation schedules which can be read by the autonomous MINERVA telescopes

Post-observation
- Perform aperture photometry and relative photometry
- Produce light curve of primary target star

References

[2] Swift et al., 2015, JATIS, 1, 2

Want More Details?

Visit http://mwilson1.github.io/cool_research/High_precision/photometry.html

Acknowledgements

This work was supported by the Banneker Institute at the Harvard-Smithsonian Center for Astrophysics and Embry-Riddle Aeronautical University’s Honors Program, Ignite Spark Funds, and the McNair Scholars Program. I am grateful to have collaborated with all of my fellow Banneker Institute peers as we shared our ideas and expertise to help each other with class work and research.