CCD Imaging of KIC 8462852: Comets or Civilization?

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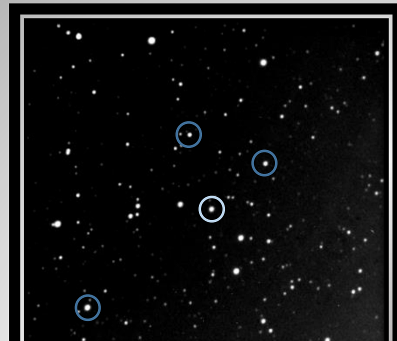
Abstract

A particularly interesting star, KIC 8562852, recently became famous for its enigmatic dips in brightness. The interpretation broadcast by many popular media outlets was that the dips were caused by a megastructure built around the star by an intelligent civilization. The best scientific hypothesis relies on a natural phenomenon: the break-up of a comet orbiting the star. To further address this problem, we have measured the star for four months using BGSU's 0.5m telescope and digital CCD camera, and we present the star's brightness as a function of time. Using two very clear nights, we refined the brightness of four comparison stars which can be used by the astronomical community to monitor the star's brightness. These newly refined magnitudes should reduce the uncertainties in our brightness measurements; this error analysis is essential in determining the significance of any brightness deviations. An observed dip in brightness would confirm the comet hypothesis by establishing a cyclical pattern, or may serve as a basis for new understanding of variable stars. An additional element to the project involves creating CCD calibration images and a well-documented procedure for future use.



KIC 8462852 and reference stars
RA: 20h 06m 15s
Dec: +44° 27' 24''

Observations

Observations were taken using the 0.5m telescope and CCD camera at Bowling Green State University, OH. A *V* filter was used for all observations. Observations took place between November 2015 and April 2016, with a total of 110 images taken.

Photometric observations require near-perfect weather conditions for the entire observational period, which can last for up to 3 hours. Two of the observational nights were deemed fair enough for photometry to take place.

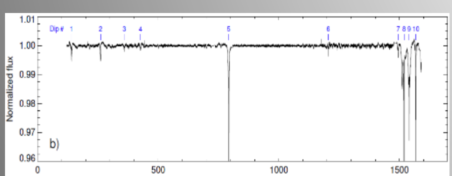
Bowling Green State University's 0.5m Telescope

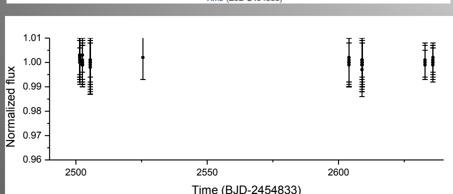
Processing

The images were processed using Maxim_DL and IRAF software. We removed the instrumental signature from each observation using standard bias, dark, and flat calibration. This leaves only the true measured light from each star, or instrumental magnitude *v*. A magnitude is the exact measurement of the brightness of light at particular wavelengths. The wavelength for our observations was in the *V* range, or "visual". *B-V* is a typical measurement for determining difference in "color" of a star. For this project, the *B-V* values used were predetermined from Landolt's photometry [1]. The last factor which affected observations was the airmass, or the optical path length through air that light from a star must pass through. The absolute and instrumental magnitude (*V-v*), color (*B-V*), and airmass (*X*) have a consistent linear relationship dependent upon constant values on photometric nights. These values were determined from the photometric observations across different parts of the sky carefully chosen for their comparison stars known to not be variable stars, and later used to refine the known magnitudes of the reference stars and KIC 8462852. This process of calculated magnitudes is called photometry.

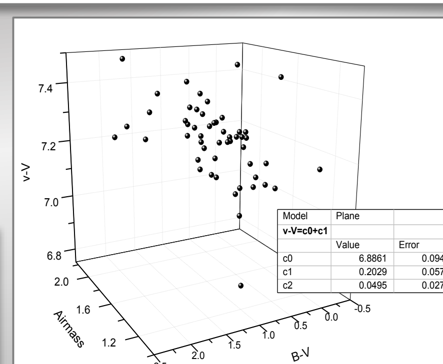
Conclusion

After refining the magnitudes of KIC 8462852 and the nearby reference stars, the true variation in brightness was plotted from night to night. Assuming the initial variation detected by Kepler was cyclical, we would have expected the variation to occur about every 800 days [2]. This cycle was not captured by our observations, although we do plan on continuing observations. Continued observation does have the chance of capturing a variation in brightness, however the chance is small if captured by luck alone. More observations will refine the true magnitudes of reference stars in this field of view making observations of KIC 8462852 much easier and more accurate. To determine to validity of the claim that KIC 8462852 has an advanced civilization harnessing the light of its star, the evidence must be extraordinary. This means taking precise measurements over a period of time to either verify or dismiss the claim. Ultimately this project's legacy will allow future BGSU students access to calibration images taken for processing, as well as a clear guide on how to use them.





Accepted Values					
	KIC 8462852	113	116	124	128
V	11.881	11.263	11.590	12.427	12.789
V Error	0.017	0.054	0.050	0.029	0.050
Revised Values					
	KIC 8462852	113	116	124	128
V	11.916	11.307	11.629	12.493	12.916
V Error	0.009	0.010	0.007	0.007	0.010



Left: The light curve from Kepler [2] (top left) and the continued observations from Bowling Green (bottom left).

Top: The revised values of the reference stars, later used to find the magnitude of KIC 8462852.

Right: Linear fit of photometric observations yielded the set of constants used to find the true magnitude of KIC 8362852 and further refine the reference star magnitudes.

References: [1] Landolt, A. U. 1992, AJ, 104, 340, "Photometric Standards"
[2] Boyajian, T.S., LaCourse, D., Rappaport, S. et al. 2016, MNRAS, 457, 3988, "KIC 8462852–Where's the flux?"