Near-infrared Polarimetry of Tabby’s Star: A Strange Kepler Star
Kush Maheshwari1,2, Roshan Jagani3,2, Professor Dan Clemens2
1Wayzata HS, Plymouth, MN; 2Boston University Astronomy Dept., Boston, MA; 3North Hollywood HS, North Hollywood, CA

Abstract
We performed near-infrared wavelength polarimetry of Tabby’s Star in late May 2017 and June 2017 using the Mimir imaging polarimeter on the Perkins Telescope to characterize the nature of dust around the star and to test theories of its strange behavior. Tabby’s Star is in the area of the sky studied by NASA’s Kepler Space Telescope and has exhibited bizarre dips in brightness. We estimated distances to stars around Tabby’s Star to search for a layer of polarizing dust along our line of sight. However, there was ambiguity in our distances, so no clear relationship between polarization and distance could be found. We detect a very low polarization of 0.153±0.095% for Tabby’s Star. The polarization does not change significantly over time, regardless of whether Tabby’s Star dips in visible wavelengths. This suggests that alien megastructures are unlikely to be present.

1. Tabby’s Star Background
• The visible light reaching Earth from Tabby’s Star dips oddly. The dips occur at irregular intervals, are asymmetric, last for days, and range in depth from 1 to 20% of total brightness. This is unusual and cannot be explained by exoplanets blocking light[3].
• Several theories have been proposed for this irregularity, ranging from interstellar dust to alien megastructures[4].

2. Polarized Light
• Polarized light: light with more of its electric field in one orientation compared to the perpendicular orientation (Figure 1).
• Large amounts of dust between Earth and a star could result in high degrees of polarization.
• Light reflected off proposed alien megastructures could be polarized.

3. Polarimetry Methods and Results
Polarization of light around Tabby’s Star was measured in the H (1.6 μm) and K (2.2 μm) near-infrared bands. For each observation, multiple images of Tabby’s Star and its surrounding field were combined into one best quality image. Observations from multiple nights were combined to lower polarization uncertainties. Only the more extensive H-band measurements proved useful.

Final Tabby’s Star polarization: 0.153±0.095%
The location of any dust along the line of sight was probed in the Mimir star field in two ways:
• By comparing polarization vectors of Tabby’s Star to those of other stars in the field (Figure 3).
• By approximating distances to stars in the field to find any jumps in polarization as distanced increased (Figures 4, 5, 6). This approach failed to establish any polarization vs distance relationship.

4. Discussion and Conclusions
• There is likely no large reservoir of dust around Tabby’s Star or between it and Earth, since Tabby Star’s polarization is low. Alien megastructures could produce high polarizations, so their likelihood is reduced.
• Despite the failure to find a relationship between polarization and distance, Tabby’s Star showed lower polarization than stars of similar brightness in the field, suggesting there is more polarizing dust beyond the ~400 pc (1300 ly) to Tabby’s Star.
• The cause of Tabby’s Star’s small polarization is likely not intrinsic because the orientation of its vector agrees with the local field and because its polarization is consistent over time.

References

Acknowledgements
Prof. Clemens, RISE, and family are thanked for the research opportunity.