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FROM DUST TO TECHNOSIGNATURES: SEARCHING FOR STELLAR OCCULTERS WITH MACHINE LEARNING

Abstract

Over the last decade, NASA has launched two major space missions that were designed to collect photometry data over a large swath of sky: the Kepler telescope and Transiting Exoplanet Survey Satellite (TESS) have each monitored hundreds of thousands to millions of stars on sub-hour cadence over month or longer timescales, respectively. The quality of photometry in terms of precision, sampling frequency, and sheer number of targets is far superior to that traditionally obtained from the ground. While these missions were conceived to detect and investigate the populations of exoplanets in our galaxy, both are making significant contributions to other areas of astrophysics as well. Stellar brightness fluctuations encode a diverse range of phenomena, from outbursts and explosions, to exoplanetary transits, to asteroseismic pulsations. If there are other advanced civilizations in the galaxy, we may also be able to detect their "technosignatures" via monitoring large numbers of stars. In particular, artificial structures around a host star (e.g., Dyson swarms; Dyson 1960) may produce pronounced fading events in light curves. This possibility was recently brought to the forefront with the discovery of Boyajian's Star (KIC 8462852), which displayed erratic brightness dips. Various hypotheses have been put forth for the behavior of this object, from artificially-engineered megastructures to transiting exocomets.

While no theory provides a perfect explanation for the fading events seen in Boyajian's star, the large volume of imaging data emerging from the TESS mission is now enabling a new search for similar behavior in additional objects. Our team has created light curves for a set of 50 million relatively bright stars across the sky. We are using a combination of supervised and unsupervised machine learning to discover and classify rare fading events. We will follow up on the most unusual objects with ground-based optical and radio observatories to determine the origin of such variability. Ultimately, this program will either discover or put an upper limit on the frequency of transiting artificial megastructures around main sequence stars in our galaxy.