Investigating the Variability of Extreme Debris Disks from Disk Detective

Abstract

Debris Disks (remnants of planetesimal collisions) can reveal major events in the formation process of solar systems. While finding debris disks was the primary goal of the NASA-launched citizen science project Disk Detective, this project also uncovered other types of objects, primarily Young Stellar Objects (YSO), Classical Be/Shell stars, and a mysterious subclass of debris disks with exceptionally large amount of dust: Extreme Debris Disks. Extreme Debris Disks have similar infrared excess to both Young Stellar Objects and other types of candidates; however, given the different ages and natures of these objects, we may be able to differentiate Extreme Debris Disks from YSOs (and other types of objects) via their variability. To examine the variability of interested objects, we used data from the Transiting Exoplanet Survey Satellite (TESS) and analyzed them with the Lightkurve python package that helped us remove scattered light and obtain accurate light curves. Furthermore, we established an assessment matrix that could classify targets into following categories based on their variability and features on the Lomb-Scargle Periodograms: Periodic Variable, Quasi-Periodic Variable, Irregular Variable, Low-Amplitude Quasi-Periodic Variable, and Not Variable. We found that high-amplitude variability is more frequent among YSOs, who are composed of predominately quasi-periodic or irregular variables; however, Extreme Debris Disks have a low occurrence of variability, and those that are variable are mostly low-amplitude quasi-periodic variables. In addition, we observed that there exists a positive correlation between Hα emission and stellar variability for the YSO candidates, which could give us clues about the accretion activities in these systems. In the future, we will conduct more analyses to compare the variability between different types of Disk Detective candidates, trying to answer questions about the physical mechanism behind their variability and understand how variability might be used to classify Disk Detective candidates when other data are unavailable.