A Search and Exploration of Multi-Exoplanet Systems Using Novel Photometric and TTV Algorithms for the K2 Mission

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Our Earth is in a multi-planet system, and this is thought to have been crucial for the formation of life. Yet it is poorly understood whether multi-planet systems like our Solar System are commonplace or rare. In this project, we use the K2 mission to search for and analyze multi-planet systems with the goal of finding out what types of multi-planet systems exist. The most successful methods for discovering exoplanets are all optimized for finding single-planet systems, which explains the apparent dearth of multi-planet systems. However, the transit timing variation (TTV), method, which searches for gravitational “tugging” on transiting planets by unseen planets in a system, allows for the unbiased detection of multi-planet systems. We developed a novel algorithm in Python to perform a scalable search for multi-planet systems using images taken by the K2 mission. The algorithm analyzes images taken by the K2 mission, creates light curves, and searches for TTVs on the order of a few minutes for every star in the images. We also performed n-body simulations to verify and analyze our findings. We detected 4 potential multi-planet systems of which 3 are new discoveries. One of the systems has known multiple transiting planets and exhibits TTVs consistent with theoretical TTVs from n-body simulations. Another multi-planet system likely has two hot-Jupiters. Our results indicate that multi-planet systems are highly diverse, and confirm the need to revise current theories of exoplanet formation. The algorithm used in this project is also particularly important because it is the only method with current instruments that can discover habitable planets around Sun-like stars.

Awards Won:

NASA: TEST - First Award of $2,500.00