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ANALYSIS OF KEPLER AND TESS EXOPLANET TRANSITS USING PYTHON FOR POTENTIAL FUTURE SPACE EXPLORATION

Abstract

The study of exoplanetary systems is crucial for our understanding of the origin and evolution of the solar system and assessing the conditions for life in the universe. The quest with the broadest appeal of exoplanetary science is the search for an Earth-like planet to determine whether it is a common outcome of nature, by measuring the occurrence of Earth-sized planets orbiting a single main sequence Sun-like star within the habitable zone. Exoplanets are, therefore, potential future destinations for space exploration and so that their detection is a clear and necessary precursor to exploration. This paper focuses on the detection and characterisation of the planet populations in our Galaxy observed by NASA's Kepler and TESS space telescopes. The existence of the planets is inferred by measuring the periodic dimming of the light from a star when a planet passes in front it during its orbit, which is the transit method. The light curves are processed via the detrending method and then phase-folded. Planetary and orbital parameters are extracted from the transit signal obtained from the light curve for a total of 56 systems. The nature of the project consists of fitting a piecewise linear function to act as a model to fit the data and employing the Chi-squared function to optimise the accuracy of the best-fit model. A pipeline that performs an automated and detailed statistical search in Python is implemented on Kepler and TESS data to define the frequency distribution of planets with certain characteristics such as size, structure, diversity. The demographics of the planets are explored by comparing the mass-radius diagrams and the mean densities with theoretical models to classify the planets and broadly assess their bulk composition. The results show that 89% of the 56 planets are mostly gas giants since they possess a radius $R > 3.4R_{Earth}$, of which 72% most likely are hot Jupiters, having a period below 10 days and lying in close-in orbits. These are believed to be the easiest type of planet to detect, at the same time, they are an intrinsically rare sub-class of exoplanets with an occurrence of $< 1\%$ for similar periods. Therefore, the result is not representative of the entirety of Kepler data set, which instead sees clustering of super-Earths and mini-Neptunes for radii between 2-3.5 R_{Earth}, making them the most abundant objects in our galaxy and the potential targets for future space exploration.