Single vs. Multiple Planetary Systems: Insights from Analysis of Exoplanetary Data

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In the last few years, many exoplanetary systems have been discovered, especially by NASA's Kepler mission. Much recent work has focused on finding other Earth-like planets, within potentially habitable zones around stars. However, a lot of exoplanetary data has still not been fully analyzed. In my project, data from the NASA exoplanet archive and the Exoplanet Orbit Database were used to study various aspects of planetary system formation. In particular, I examined if the distributions of planet mass, radius, orbital period, stellar temperature, and metallicity are statistically different in single- and multiple-planetary systems. The cumulative frequency distributions of these parameters were plotted and compared and a two-sample Kolmogorov-Smirnov test performed to check if the distributions are statistically different. Planet properties (mass, radius, and period) and stellar metallicity appear significantly different for single and multi-planetary systems. The recently observed gap in the radius distribution between super-Earths and mini-Neptunes is shown to persist in both single and multi-planetary systems. A comprehensive study of the orbital period ratios of planets in multi-planetary systems was also performed to look for common types of two-body resonances using the updated dataset (612 systems). Robust resonances are observed at ratios 3:2, 5:3 and 2:1, with smaller but still significant resonances at 4:3, 5:2 and 3:1 ratios. Our findings confirm that the solar system is an atypical multi-planetary system. Modelling such observations may help us to better understand the formation and evolution of planetary systems.

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