Analysis of Exoplanet Mass-Radius Relation from NASA Archival Data

Aniruddha Bhattacharya

University of Calcutta

The rapid growth of exoplanet discoveries has enabled a transition from the study of individual worlds to population-level analyses that probe the fundamental processes of planet formation and evolution. Among the most important empirical relationships is the mass–radius (M–R) relation, which links observable properties to planetary interior composition and structure. In this study, we rederive the M–R relation across the full range of confirmed planets queried from the NASA Exoplanet Archive. After filtering the catalog to exclude controversial detections, and high-uncertainty measurements, we obtain a robust sample of well-characterized planets having verified mass and radius measurements. We apply Orthogonal Distance Regression (ODR) and Markov Chain Monte Carlo (MCMC) methods to fit segmented power-law models to the M–R distribution. Our results identify statistically significant breakpoints that correspond to major structural regimes: terrestrial, Neptunian, and Jovian planets. We quantify the slopes and uncertainties in each regime, and find that our results align with published literature values. These findings refine the empirical M–R relation and provide constraints on theoretical models of planet formation. More broadly, this work highlights the value of statistical modeling of exoplanet populations in guiding future observational campaigns.