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Planetary Edge Trends (PET). I. The Inner Edge-Stellar Mass Correlation

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Recent advancements in exoplanet detection have led to over 5,700 confirmed detections. The planetary systems hosting these exoplanets exhibit remarkable diversity. The position of the innermost planet (i.e., the inner edge) in a planetary system provides important information about the relationship of the entire system to its host star properties, offering potentially valuable insights into planetary formation and evolution processes. In this work, based on the Kepler Data Release 25 (DR25) catalog combined with LAMOST and Gaia data, we investigate the correlation between stellar mass and the inner edge position across different populations of small planets in multi-planetary systems, such as super-Earths and sub-Neptunes. By correcting for the influence of stellar metallicity and analyzing the impact of observational selection effects, we confirm the trend that as stellar mass increases, the position of the inner edge shifts outward. Our results reveal a stronger correlation between the inner edge and stellar mass with a power-law index of 0.6-1.1, which is larger compared to previous studies. The stronger correlation in our findings is primarily attributed to two factors: first, the metallicity correction applied in this work enhances the correlation; second, the previous use of occurrence rates to trace the inner edge weakens the observed correlation. Through comparison between observed statistical results and current theoretical models, we find that the pre-main-sequence (PMS) dust sublimation radius of the protoplanetary disk best matches the observed inner edge-stellar mass. Therefore, we conclude that the inner dust disk likely limits the innermost orbits of small planets, contrasting with the inner edges of hot Jupiters, which are associated with the magnetospheres of gas disks, as suggested by previous studies. This highlights that the inner edges of different planetary populations are likely regulated by distinct mechanisms.

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