ROGUE WORLDS TWO

A MISSING STAR STORY

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Formation of free-floating planets via planet-planet ejection

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Microlensing observations suggest that the mass distribution of free-floating planets (FFPs) follows a declining power-law with increasing mass. The origin of such distribution is unclear. Using apopulation synthesis framework, we investigate the formation channel and properties of FFPs, andcompare the predicted mass function with observations. Assuming FFPs originate from planet-planetscattering and ejection in single star systems, we model their mass function using a Monte Carlo basedplanet population synthesis model combined with N-body simulations. We adopt a realistic stellarinitial mass function, which naturally results in a large fraction of planetary systems orbiting low-massstars. The predicted FFP mass function is broadly consistent with observation: it follows the observed power-law at higher masses (10-10000 $M_\oplus$), while at lower masses (0.1-10 $M_\oplus$) it flattens, remaining marginally consistent with the lower bound of the observational uncertainties. Low-mass, close-in planets tend to remain bound, while Neptune-like planets at wide orbits dominate the ejected population due to their large Hill radii and shallow gravitational binding. We also compare the mass distribution of bound planets with microlensing observations and find reasonably good agreement with both surveys. Our model predicts roughly 1.20 ejected planets per star in the mass range of 0.33 $<m/M_\oplus<6660$, with a total FFP mass of roughly 17.98 $M_\oplus$ per star. Upcoming surveys will be crucial in testing these predictions and constraining the true nature of FFP populations.

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