A Study on the Impact of Early System Dynamical Evolution on Planetary Distribution

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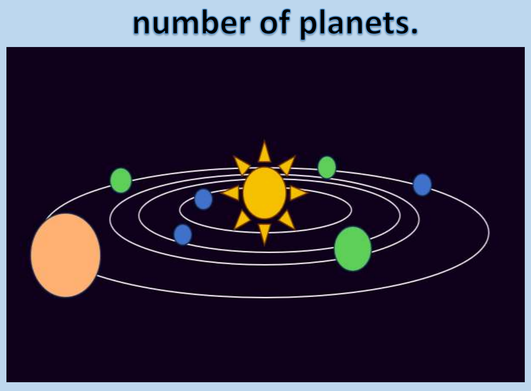
Introduction

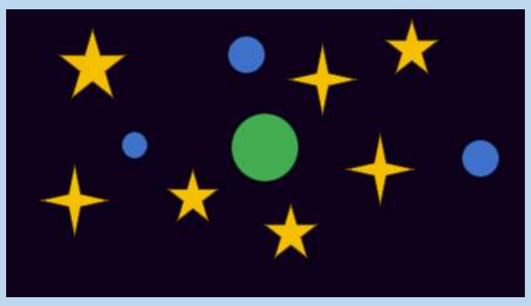
In the field of planetary science, the distribution pattern of planets has always been a key research point. Recently, with advanced observational technologies, astronomers have discovered that the mass characteristics of “unbound” planets and “bound” planets are significantly different. In this study, the n-body simulation technique is introduced to conduct a preliminary investigation into this phenomenon.

Background

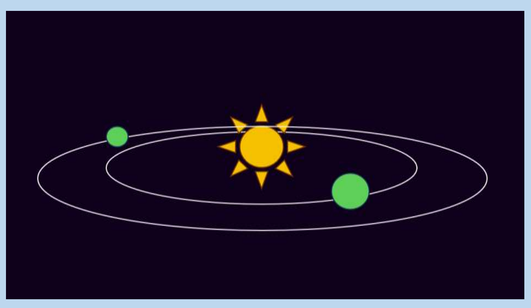
An initial system with a larger number of planets.

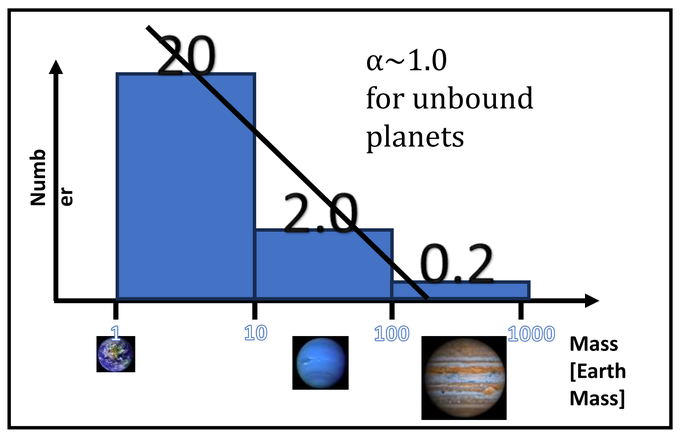


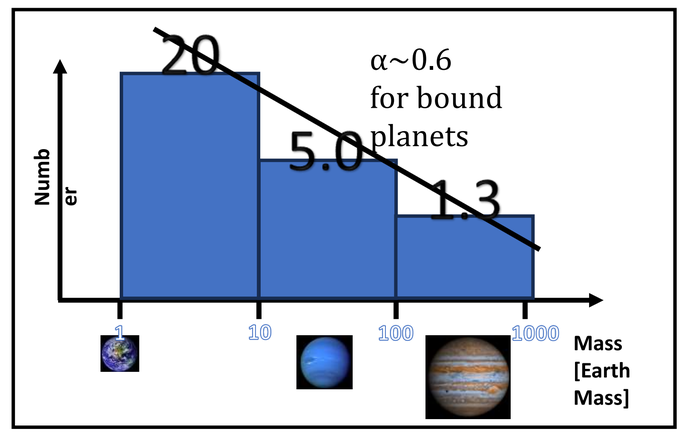
Under the complex gravitational influence of the system, some planets are scattered to farther orbits or ejected from the system, which we refer to as “unbound planets”.



In contrast, the planets that remain within the system are referred to as "bound" planets.







Here, α reflects the distribution of planetary masses. For unbound planets, α is approximately 1, indicating that large planets are rare. For bound planets, α is approximately 0.6. We need to investigate why these two types of planetary mass distributions form.

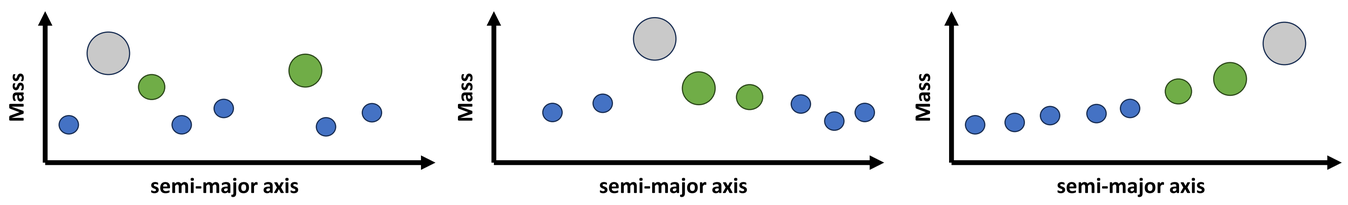
Methods and Goals

Methods:

- **Methods such as microlensing are used for exoplanet detection.**
- **Genga Code for N-body.**
- **Generate and place planets according to certain rules.**
- **100 Myr simulation.**
- **At least 24 sets for each case.**

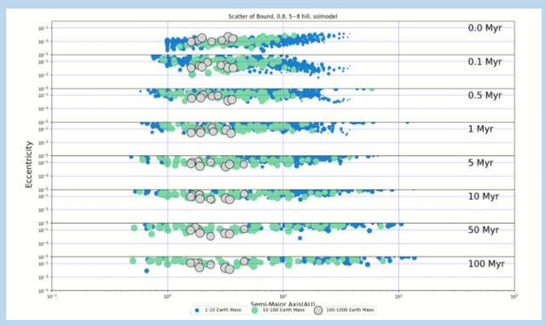
Focus on:

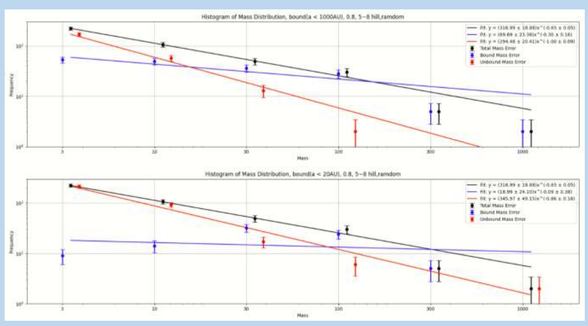
- **Distance between planets, mass distribution.**
- **Physical mechanism of phenomenon generation.**



To explore the laws of dynamics, different radial structures are currently being used. From left to right, they are: random distribution, solar system-like distribution, and distribution increasing with distance.

Early outcomes





We conduct statistics and analysis based on the results of N-body simulations to produce images of the related data.

1.The bigger the initial α value, the larger planets the system has, and the mutual scattering between large planets can eject a larger proportion of larger planets.

2.The larger the initial spacing, the weaker the effect of planetary dynamics instability, and the final result is closer to the initial distribution.

3.Currently, the impact of the distribution structure of planets on the results is not very obvious.

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