Tracking Planetary Debris to the Asteroid Belt

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Introduction

For successful terrestrial planet formation, a given scenario must match the following observable constraints: the **small eccentricities** of planetary orbits, the masses of the terrestrial planets, specifically **Mars' small mass**, the **structure of the asteroid belt**, **Earth's large water content**, and the **formation timescales** of Earth and Mars. Most current models of planetary formation produce results that do not satisfy all observable constraints. We want to consider the early instability model, which triggers a giant impact phase that may satisfy the observable constraints.

Methodology

We are using an **astrophysical N-body integrator** to model the dynamics of bodies in the protoplanetary disk and we model the outcomes of debris-producing collisions using an algorithm that is **a function of their mass ratio, impact angle and velocity** (Leinhardt & Stewart, 2009).
We analyze the **eccentricity and semimajor axes** of the created debris particles, as well as the **total amount** created.

Debris is created by collisions

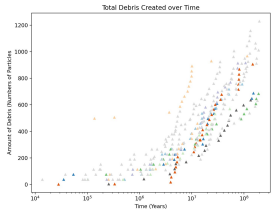

Figure 1. Comparing the amount of debris created by each run over time. Different runs are represented by different colors.

Where does all this debris go?

Debris is scattered into the asteroid belt

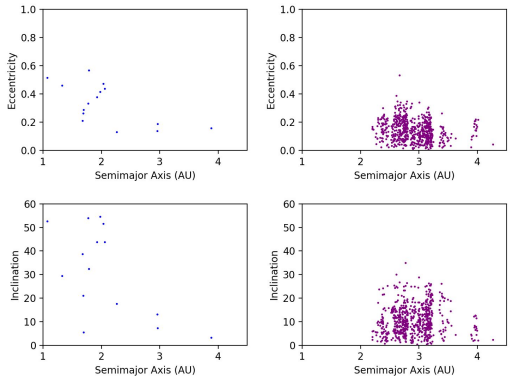

Figure 2. Comparing the planetary debris emplaced in the asteroid belt with the known asteroid belt (MPCORB at 200 Myr.

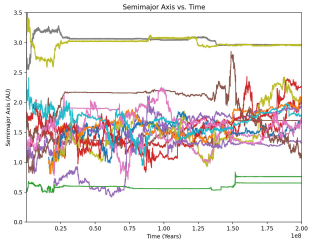

Figure 3. Tracking the semimajor axis of debris particles over time.

Conclusion and Next Steps

Figure 1 demonstrates the amount of debris created in our simulated collisions.

Giant impact collisions produce a lot of debris. Some of this debris falls into the sun or is accreted by a planet. Debris is also scattered into the asteroid belt as seen in Figure 2.

Tracking this debris and comparing it to the known asteroid belt demonstrated that planetary debris is emplaced in the asteroid belt.

Future work will incorporate data from more simulations to understand the structure of the asteroid created by giant impact runs.

We will also use early instability models to obtain results that are closer to the known asteroid belt.

References

Leinhardt & Stewart, 2009. Collisions Between Gravity-Dominated Bodies: 1. Outcome Regimes and Scaling Laws.

Raymond, 2009. Building the terrestrial planets: Constrained accretion in the inner Solar System.

Acknowledgements

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