EMBRY-RIDDLE
AERONAUTICAL UNIVERSITY

Orbital Evolution of Dust-Sized Particles Released from Catastrophic Asteroid Disruptions

Presentation By: Giovanni Bacon, Akash Joseph, Phillip Mann, Chloe Nelson, Brendan Powers, Kiara Richardson

Abstract

Infrared satellite detectors, such as *IRAS*(1) (Infrared Astronomical Satellite) and *WISE*(2) (Wide Field Infrared Survey Explorer), provide observational evidence of catastrophic asteroid disruptions in the form of zodiacal cloud dust bands. With observations of these bands, the asteroid parents and their families (fragments of disruptions) are studied to better understand the zodiacal cloud prior to disruption, as well as how asteroids contribute to the debris disk of the solar system, the zodiacal cloud.

Introduction

The research utilizes the Dynamical Evolution Code(3), in IDL, that simulates the orbital evolution of debris particles of varying sizes post collision. Input parameters include;

- Particle Size
- Particle Ejection Velocity
- Time Step Size
- Total Simulation Time for Orbital Evolution

The code takes into consideration the following forces to account for solar system dynamics that affect the orbital evolution of the particles;

- Radiation Pressure
- Poynting-Robertson (P-R) Drag
- Solar Wind (S.W.) Drag

Discussion

The outcome of the simulations show the results from the disruption of the Emilkowalski(4,5) asteroid family that occurred 220,000, over a range of particle sizes. The radiative forces cause the particles to spiral towards the inner solar system, while also circularize their orbits. (see eccentricity vs time) The variation of the other orbital elements and the divergence of the values for different particle sizes can be explained by their varying distance from gravity-dominating Jupiter. The distribution of orbital elements allow us to create models of the dust structures, that can than be compared to observational infrared data. Comparing our models to the observations yields information on the parent asteroid, the dust structures, and the contribution of asteroids to the zodiacal cloud.

Results

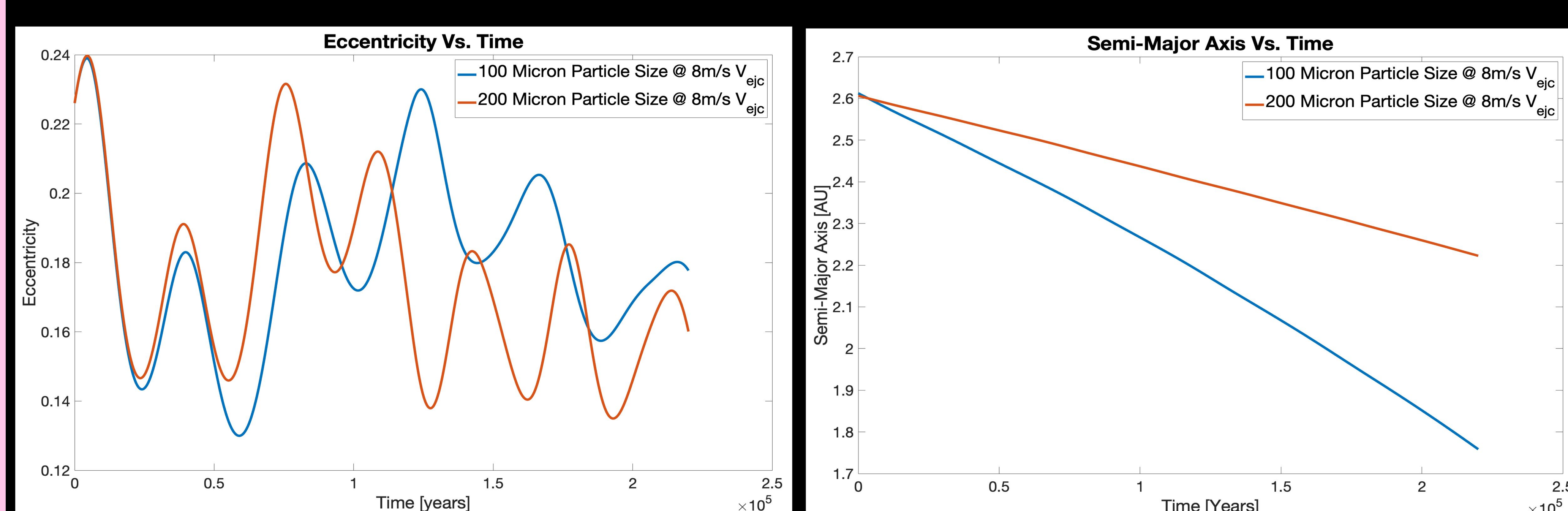

Figure 1: Orbital Evolution of 100 and 200 micron Particles

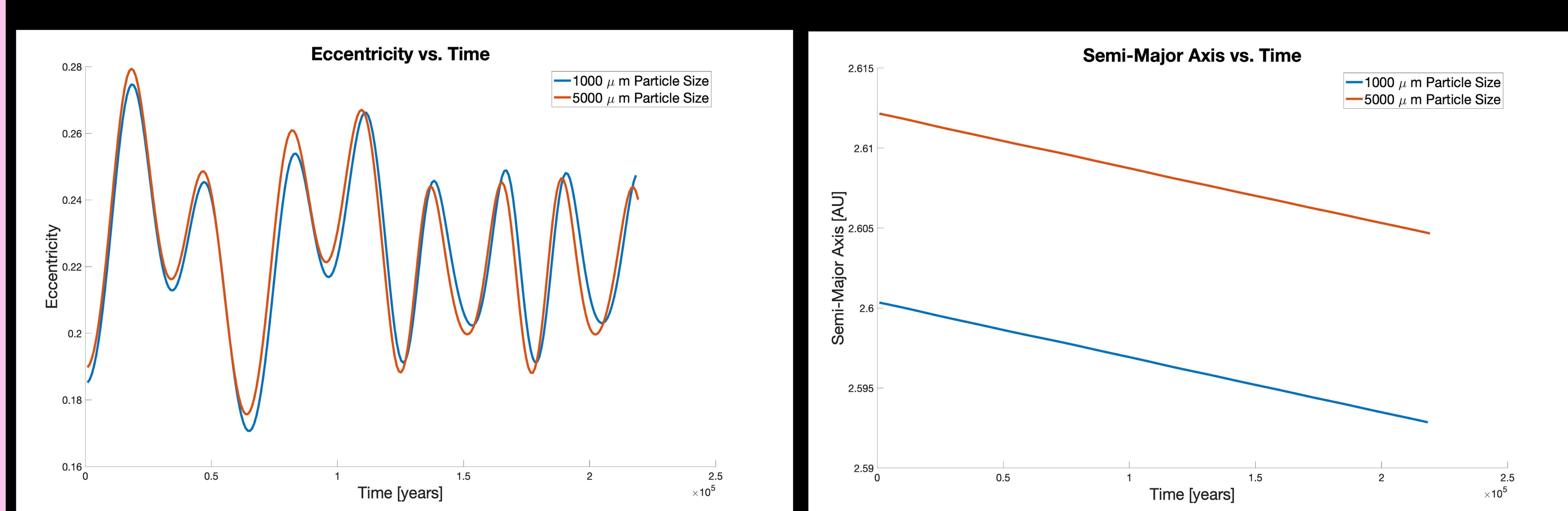

Figure 2: Orbital Evolution of 1000 and 5000 micron Particles

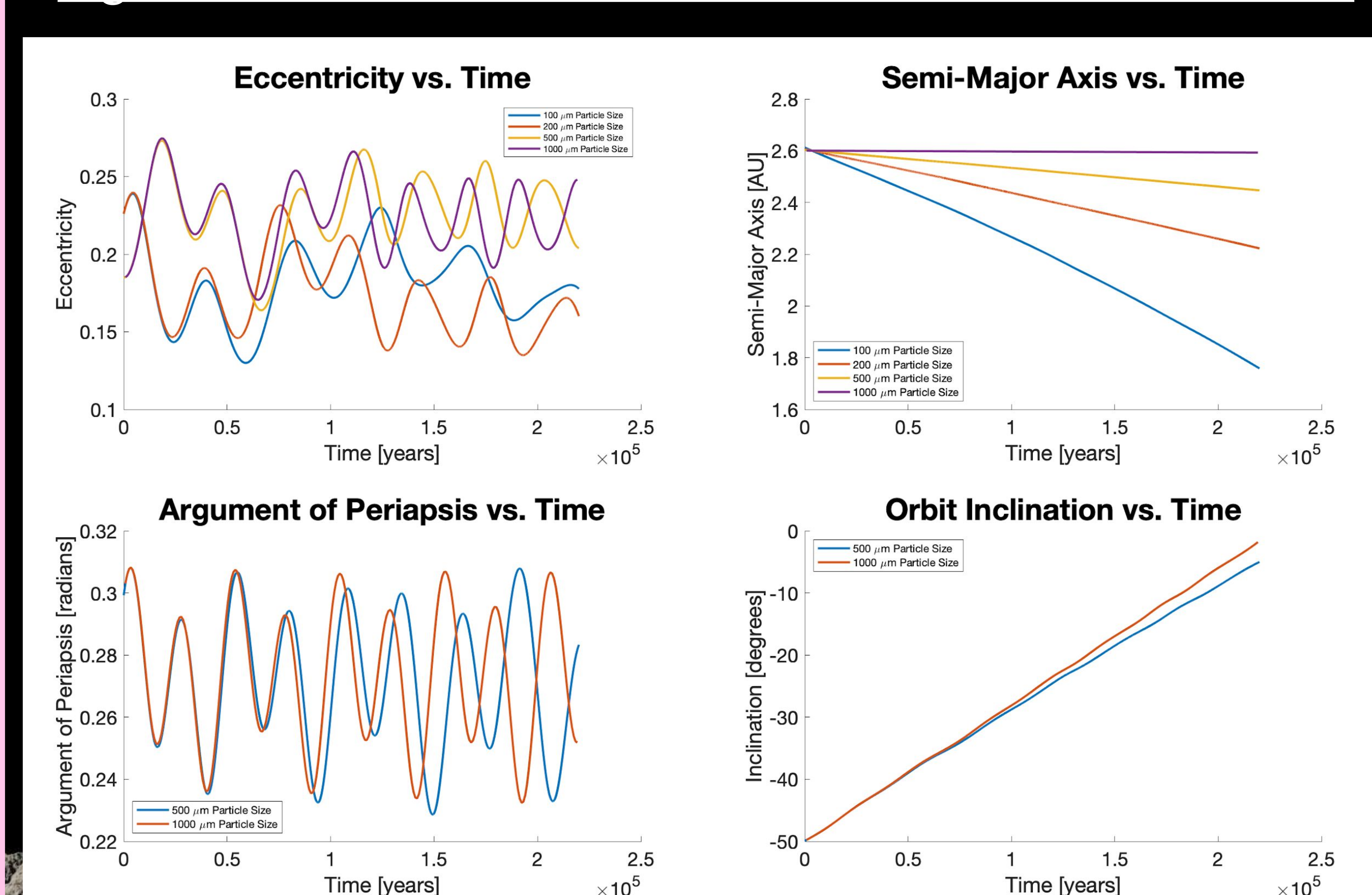

Figure 3: Evolution of Orbital Elements for Varying Particle Sizes

References

1. Low F.J., Beintema D., Gautier T., Gillett F. and 14 coauthors (1984) Infrared cirrus: New components of the extended infrared emission. Astrophys. J., 278, L19−L22.
2. Wright, E. L., et al. (2010) The Wide-field Infrared Survey Explorer (WISE): Mission Description and Initial On-orbit Performance. Astronom J. 140, 1868−1881
3. Espy, A. J., (2010). Dynamics of Asteroidal Dust and Structure of the Zodiacal Cloud. PhD Thesis, University of Florida.

4. Espy Kehoe A. J., Kehoe T. J. J., Colwell J. E., and Dermott S. F. (2015) Signatures of recent asteroid disruptions in the formation and evolution of Solar System dust bands. Astrophys. J., 811, 66.
5. Nesvorný, D., and Vokrouhlický, D.(2006). New candidates for recent asteroid breakups. AJ, 132, 582–595