

The Geminid meteoroid stream depletion and dispersion by planets

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Abstract

When a planet encounters a meteoroid stream, it removes some mass from the stream and disperses the stream. We study this process numerically in application to the Geminid meteoroid stream.

1. Introduction

The Geminids is the meteoroid stream producing one of the major annual meteor showers with maximum activity about December 14. The orbits of the Geminid meteoroid stream as well as that of the asteroid (3200) Phaethon (the Geminid's parent body) are located far inside Jupiter's orbit. Orbital elements of Phaethon (and the stream) are: semimajor axis = 1.27 au, eccentricity = 0.9, inclination = 22°, so the stream orbit intersects Mercury, Venus, Earth, and Mars orbits. The last 3 planets pass through the stream, remove meteoroids from the stream due to collisions and disperse other meteoroids due to close encounters perturbations. This problem was discussed by Valsecchi et al. [2], and some estimations were made using an analytical approach and the extended Öpik's theory of close encounters.

Inspired by this paper we decided to estimate the Geminids depletion and dispersion by Venus, Earth and Mars, using numerical approach.

2. Model

The method of modelling was described in details by Ryabova [1]. The main idea is simple: to simulate particles ejection, calculate their evolution and follow their encounter with planets.

Ryabova [1] integrated the equations of motion of the meteoroids using the Everhart 19th-order procedure, i.e. numerically. Numerical integration is expensive: to calculate a frugal model in 30 000 particles a usual desktop computer has to make calculations about one

month [1]. So we decided to use also the Halphen–Goryachev method. This Gauss-type semi analytic method allows for only secular perturbations of the first order, but is very fast.

3. Summary

On the moment of this abstract presenting there are no results to publish. We made preliminary runs and made some preliminary estimation, which needs refinement and qualification.

References

- [1] Ryabova, G.O.: A preliminary numerical model of the Geminid meteoroid stream, MNRAS, Vol. 456, pp. 78–84, 2016.
- [2] Valsecchi, G.B., Lega, E., and Froeschlé, Cl.: Stream lifetime against planetary encounters, Meteoroids: The Smallest Solar System Bodies, Proceedings of the Meteoroids Conference held in Breckenridge, Colorado, USA, May 24–28, 2010. Edited by W.J. Cooke, D.E. Moser, B.F. Hardin, and D. Janches. NASA/CP–2011–216469, pp.19–25, 2011.