

Meteoroid population near Mars

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Abstract

The database of solar system small bodies was analyzed for selecting potential parent bodies of Martian meteoroids. The obtained model allows estimating probabilities and velocities of possible meteoroid encounters with Mars and its moons.

1. Introduction

In this work, we divide all the meteoroids into three main groups:

- a. Cometary meteoroids that form streams. Their parent bodies are long periodic comets (orbital period $T > 200$ years) and Halley-type ($20 < T < 200$ years) comets.
- b. Cometary sporadic meteoroids. In this work it was assumed that the source of these meteoroids are Jupiter-family comets ($T < 20$ years).
- c. Asteroidal meteoroids.

2. The Model

The model of the meteoroid flux near the orbit of Mars was constructed using JPL's HORIZONS [1] database of solar system bodies. Orbits of 1037 periodic comets and about 28000 asteroids were analyzed and possible parent bodies of Martian meteoroid showers were identified.

2.1 Cometary meteoroids

From the database of 1037 periodic comets 64 long period, 10 Halley type, and 54 Jupiter-family comet orbits were selected that approach Mars orbit within less than 0.15AU. The following assumptions were made for modeling:

- 1) The orbits of the comets change very slowly over time; the theoretical stream radiant positions are therefore fixed.

- 2) The density of meteoroids in the stream tube is distributed symmetrically with respect to the parent comet orbit, and the maximum flux occurs at the comet orbit.
- 3) Meteoroids are uniformly distributed along the stream orbit, and their distribution does not depend on the position of the parent comet.

Using the above simplification we can estimate the flux density at any point within the stream at known distance r from the parent orbit by $\rho r = ae^{-br}$, where parameter a – describes the cumulative mass distribution and b – depends on specific stream structure and describes the profile index (mass concentration of the stream). The method of this simulation was presented previously in detail [2].

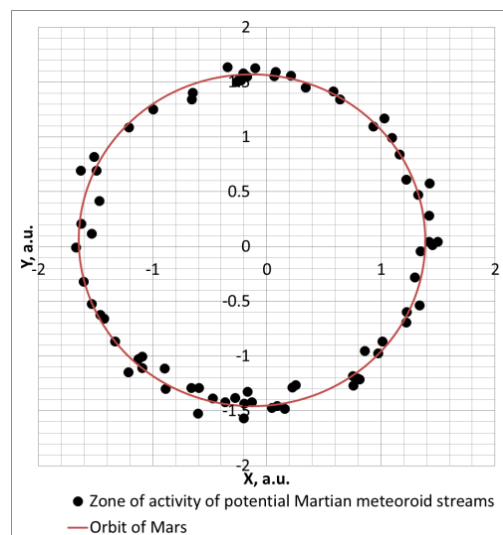


Figure 1 Projection on the ecliptic plane areas of activity of Martian meteor streams and orbit of Mars

2.2 Asteroidal meteoroids

Mars-approaching asteroids are another important source of Mars meteoroids due to Mars' proximity to the asteroid belt. From about 28000 asteroids that could potentially have close approaches to Mars orbit, 5920 asteroids were selected, that approach orbit of Mars less than 0.1 AU. Asteroidal parent bodies of Martian meteoroids can be Mars-crossers, inner main belt asteroids, or some of the near-Earth asteroids (see table 1). Using Opik's technique [3] we can estimate the probability of impact with Mars and its satellites and the body-centric velocity of meteoroids (Fig. 2).

Table 1 Asteroids approaching Mars orbit, less than 0.1AU.

Asteroidal group		Definition	Crossing Mars orbit	Total number
Near Earth	Apollo	$a > 1.0 \text{ a.u.}; q < 1.017 \text{ a.u.}$	1728	4862
	Amor	$1.017 \text{ a.u.} < q < 1.3 \text{ a.u.}$	1265	3384
Mars-crossers		$1.3 \text{ a.u.} < q < 1.666 \text{ a.u.}; a < 3.2 \text{ a.u.}$	2496	10930
Inner Main belt		$a < 2.0 \text{ a.u.}; q > 1.666 \text{ a.u.}$	431	9413

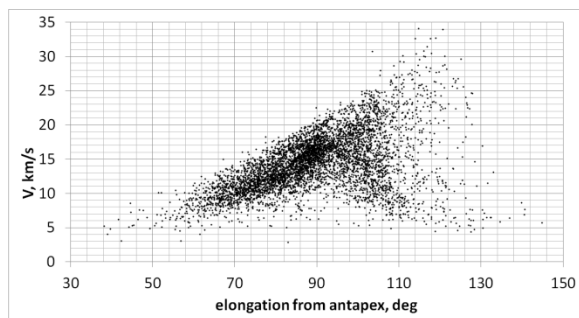


Figure 2 Distribution of Mars-centric velocity of asteroidal meteoroids with respect to elongation from antapex.

Conclusion

A database of comets and asteroids was analyzed for identifying potential sources of Martian meteoroids. The time of activity of potential Martian meteoroid showers was obtained. This model can be used for modeling of the meteoroid bombardment of Mars, Phobos and Deimos.

Acknowledgements

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References

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