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A preliminary numerical model of the Geminid meteoroid stream

G.O. Ryabova

Tomsk State University, Tomsk, Russia (rgo@rambler.ru)

The preceding model

Last year the work on the qualitative model of the Geminid meteoroid stream was finished [1, 2]. The mentioned publications summarized the results of 20-years efforts. This model explained most of the Geminid's structural features, including bimodality, but to find quantitative spatial density distribution of particles we need a more precise model. The first runs of the new numerical model were made, and some preliminary results have been obtained.

Method

The method of the stream model construction is quite common and described many times, for example in [3–5]; see also a review [6]. A point where particle(s) is/are ejected is chosen on the parent body orbit. Based on a certain assumptions on the ejection scheme, the velocity vectors of ejected particles are obtained using a generator of pseudo-random numbers, and the particle orbital elements are calculated. Then equations of motion of the model meteoroids are calculated in the given time interval using a precise numerical method. Here the Everhart procedure was used for this purpose.

An addition to this method is a weighting coefficients technique. The idea is not new, and some elements of the technique are considered in [5–8]. The procedure of numerical integration is expensive, so it is desirable to find a way to map changes in the initial parameters distributions to final orbital elements (or other parameters) distributions without recurring of integration. As it turned out in some cases it is possible. One of the goals of the report is to present the technique.

In this model we consider the stream age only 2000 years and less. Parent body of the Geminid stream is asteroid (3200) Phaethon [9]. A cometary pattern of ejection is used, when dust production rate is proportional to r^{-4}, where r is the heliocentric distance. Model particles were taken spherical with masses: 0.0003, 0.003 and 0.02 g with a density of 1 g cm^{-3}. Their ejection velocities have been determined using the Whipple [10] formula.

Results

The shower activity curve was the main thing we were interested at this stage. In the qualitative model the stream was dislocated, because to calculate evolution we used nested polynomials based on a Gauss-type method [1], allowing only secular perturbations of the first order. As it turned out in the new model the activity curve was also shifted relatively the observed shower. Possible reasons are discussed.

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