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Ejection of dust from asteroid (3200) Phaethon in 2009

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Abstract

In 2009 asteroid (3200) Phaethon has shown a short unexpected brightening, which could be interpreted as the ejection of dust particles. A numerical model was constructed to answer the question: could the dust swarm be observed at the Earth?

1. Introduction

In 2009 June being near its perihelion asteroid (3200) Phaethon (the Geminid meteoroid stream parent body) underwent a short unexpected brightening, which could be interpreted as the ejection of dust particles [1]. To study a possibility that the produced hypothetical dust cloud could be observed in the nearest 10 years we examined a numerical model of this cloud or, in other words, meteoroid swarm. The method of modelling was quite standard: ejection of meteoroids from the asteroid was simulated and their orbits were numerically integrated till 2021 January 20.0. In the process we followed up the close encounters of meteoroids with the Earth and calculated theoretical radiants for such meteoroids. We looked for the following answers: could the dust produced be observed on the Earth as meteors? could these meteors be stand out against the regular Geminid's activity?

2. What was found

The first close approach of the model swarm to the Earth was in 2014, then in 2017, 2018, and 2020. In 2017 (the year when Phaethon should approach the Earth on the distance about 0.0689 au) the model meteor shower was several times more abundant. All other approach circumstances (maximum of activity, radiant area) were identical.

The outburst in the Geminid's activity due to this swarm may take place at the solar longitude 262°.5, i.e. after the main Geminid's maximum. To exceed the usual level of activity mass of the 2009 swarm should exceed approximately 2×10^8 kg. The mass of dust ejected from Phaethon should be somewhat larger. The upper limit of dust production by Phaethon due to thermal fracture is estimated about 10^{10} kg [1].

The radiation area of the model outburst meteors is a small spot: $\alpha \approx 114°.65 \pm 2°.5$, $\delta \approx 32°.7 \pm 0°.1$. A concentration of radiants of meteors of various magnitudes in this spot is a feature allowing distinguishing the outburst. The lack of observational data to study the fine structure of the Geminid's radiants is a problem to solve in future. The observational bias also calls for further investigations.

In all the cases of the model swarm approaches the minimal distance between particles and the Earth was not less than 0.018 au. Taking into account that the radius of the Earth influence sphere is about 0.03 au we can consider observation of the resulting meteors as possible, but the probability of the event is not high. It was found that the distance between the model swarm and the Earth slow decrease with time, so it was decided to continue integrations till the 2050, when the next calculated close approach of Phaethon and the Earth takes place (the minimal distance is 0.0826 au, JD 2470152.2595). Indeed, the minimal distance between the swarm and the Earth became 0.015 AU in 2050. All approach features were the same as in 2017. The details could be found in [2].

References

[1] Jewitt, D., Li, J.: Activity in Geminid parent (3200) Phaethon, AJ, Vol. 140, pp. 1519-1527, 2010.

[2] Ryabova, G.O.: On the possible ejection of meteoroids from asteroid (3200) Phaethon in 2009, MNRAS, 2012 (in print).