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Geminid meteor shower activity should increase

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Abstract

Mathematical modelling has shown that activity of the Geminid meteor shower should rise with time, and that was confirmed by analysis of visual observations 1985–2017.

1. Introduction

The Geminid meteor shower is an annual major shower with the maximum activity on December 14. In 2017, asteroid (3200) Phaethon, recognised parent body of the stream, had a close encounter with the Earth on December 16. When the Earth passes closer to a parent body orbit of a meteoroid stream, an increased activity of the shower is expected. We elaborated the model to see, if it is the case, and made a comparison with visual and video observations of the Geminid shower activity [1].

The origin of the parent asteroid is not clear. Dynamical and spectral properties of Phaethon seem to support the asteroidal nature of the object. However modelling of the Geminid stream formation has shown that a cometary scenario [2] is in very good agreement with the observed structure features of the shower, as opposed to the collisional or eruptive scenarios. Lately (in 2009, 2012 and 2016) a weak recurrent activity in perihelion was observed [3]. Thermal fracture/decomposition of the surface was considered the most probable mechanism for the activity [3], but it can not be the main Geminid source [4, 5]. So we used the cometary stream model, presented in [6].

In this report we are going to present our study [1], and to compare our theoretical expectations and observations of the Geminids 2017.

2. Model

We used one a model with meteoroids of the 'visual' mass of 0.02 g from [6] and extended it until 2025 January 1. The model consists of 30 000 meteoroids generated around starting epoch JD 1720165.2248 (perihelion passage) using, as we mentioned, the cometary scenario of ejection. For details of the model, method, and references, see [6].

Why activity should increase? The answer is clear from Fig. 1. Phaethon's node and the mean orbit of the stream (i.e. the densest part of the stream) gradually approach the Earth's orbit. So the Geminid shower activity should increase *slowly*. Why we should not expect an outburst? Because the Geminid stream had no replenishment after the initial catastrophic generation [2, 6].

The increase of activity should be replaced by decrease about 2200, when the stream core should intersect the Earth orbit (Fig. 1).

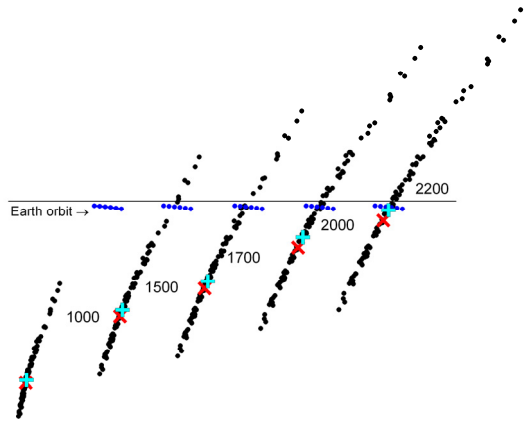

Figure 1: Evolution of the model Geminid stream (100 particles, mass = 0.02 g) cross-section in the ecliptic plane. The figure is modified after [1, fig. 2].

3. Observations

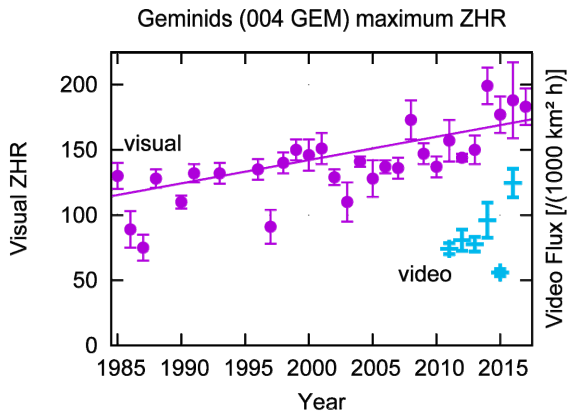

Figure 2: Activity level of the Geminids in 1985–2017. The figure is modified after [1, fig. 3].

Analysis of 60 yr of visual observations (1944–2003) [7] has shown that the shower activity is rather stable. We revisited the analysis using only homogeneous observations, only the peak activity and a constant population index. The result is shown in Fig. 2. We added Geminids 2017 to [1, fig. 3] and we see that the general trend is the same, but the shower activity in 2017 was not extra-high.

4. Summary

We analysed visual observations of the Geminid shower in 1985–2017 around the shower maximum using homogeneous series of visual observations. It was found that the shower activity slowly increases. The same was obtained for video observations (2011–2016). These results were supported and explained by mathematical modelling. Activity of the shower increases because the core of the Geminid stream moves towards the Earth.

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