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The video Geminids

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Abstract

In this study, we concentrate on the influence of errors on the distribution of meteor orbits within the stream of Geminids and on the dispersion of their radiant points. The accuracy and dispersion of the orbital elements are studied, comparing several catalogues, which enables the specific features of the Geminids, as well as the diversities of the catalogues, to be shown.

1. Introduction

The initial dispersion of meteoroids in a stream is influenced by a number of processes, which appear during different stages of the stream evolution. The orbits of the Geminids indicate that the gravitational forces of the other outer planets are negligible, so the stream structure is dominated by their initial spread and the non-gravitational effects. Therefore, the Geminids are rather a compact stream as it was shown in various Geminid stream models, e.g. [1, 2].
However, when studying the structure of meteoroid streams, the fact that the original orbital dispersion can be smeared by much larger observational and measurement errors also has to be considered. Kresak [3], analyzing photographic shower meteors of the IAU MDC, showed that, for the widely dispersed annual meteor showers, the measurement errors can be two or three orders of magnitude larger than the dispersion produced by planetary perturbations integrated over several revolutions. For the short-period meteor showers, the differences in the velocities are, however, less representative, and the dispersion in the semi-major axes smaller. Discovering errors is more difficult because they do not produce a spurious hyperbolicity as clear evidence of their presence, as is the case with long-period showers [4, 5].

2. Video meteor orbits

Meteor orbits of Geminids were selected from the European Video Meteor Network Database (EDMOND) [6], the Czech Catalogue of Video Meteor Orbits [7], the Cameras for Allsky Meteor Surveillance (CAMS) [8], and the SonotaCo Shower Catalogue [9]. The observed orbital dispersions of video Geminids, including the measurement errors, were compared with those obtained from the photographic and radar orbits of Geminids selected from the IAU Meteor Data Center [10, 11]. The semi-major axes of meteor orbits in almost all the video datasets seem to be systematically biased in comparison with the photographic and radar meteors. The observed distributions in 1/*a* are shifted towards higher values of 1/*a*. The determined velocities seem to be underestimated (fig. 1), probably as a consequence of the methods used for the measurement of the meteor positions, and/or the orbit determinations, presumably by absent or insufficient correlations for atmospheric deceleration.

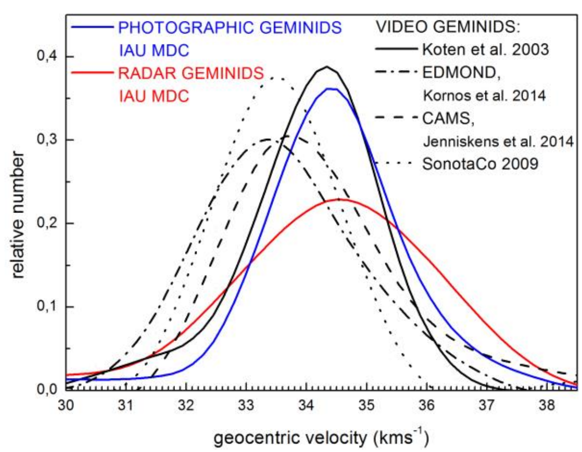

Figure 1: Normalised distributions of the geocentric velocities of the video Geminids from the different catalogues used and compared with the photographic and radar Geminids from the IAU MDC.

3. The observed orbital dispersion

The observed dispersions were described by the median absolute deviation in terms of 1/a, and ranges from 0.029 to 0.042 AU^{-1} for the video catalogues.

Their comparison with the Geminids' dispersion from the photographic and radar data is shown in figure 2. The deviation of the median reciprocal semi-major axis from the parent, (3200) Phaethon, obtained from the photographic and radar orbits of the IAU MDC, and from the Czech Video Orbits Catalogue, is significantly larger than it was in the case of the other meteor showers investigated [4, 5]. The smaller deviations visible in the other video datasets are only a consequence of their above-mentioned shift. The actual reason for this deviation can be found when investigating the dynamical evolution of the Geminid meteoroids.

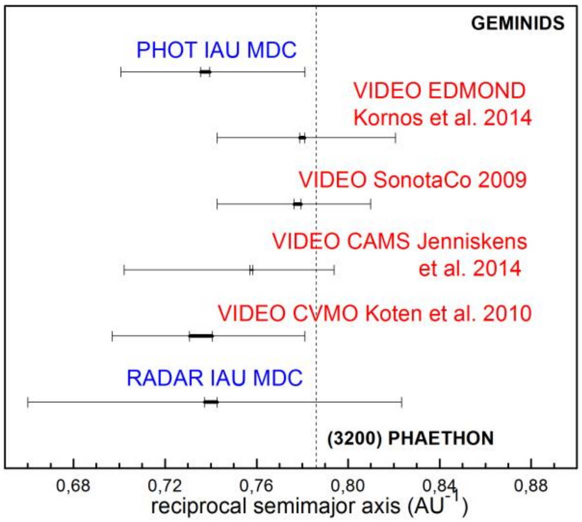

Figure 2: Observed orbital dispersion for Geminids described by absolute median deviation in terms of $1/a$: Thin line - interval between two limiting values of $(1/a)_{1/2}$, which includes 50 percent of all orbits. Bold line - interval between two limiting values of the uncertainty $(1/a)_L$ of the resulting values of median $(1/a)_M$. Dashed vertical lines - parent body.

4. Summary and Conclusions

The observed dispersions of Geminids is moderate and does not differ significantly between the different video sets of data. It clearly demonstrates that the Geminids are a strongly concentrated meteoroid stream. The observed dispersions in 1/a differs slightly between the datasets obtained by different observational techniques, which may be partly a consequence of different dispersions in the orbital elements for particles belonging to different mass ranges. The orbital characteristics of Geminids, including their dynamical evolution, and a further detailed error analysis concerning different catalogues will be presented.

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