Meteor showers as a means of recovering the past orbital history of comets The case of comet C/1917 F1 (Mellish)

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Introduction

When a swarm of particles is released from the surface of a parent body, they start orbiting the Sun along very similar orbits to that of the parent comet. Sometimes, the perturbations of big planets can change the orbits of a part of a stream so that it can split into two or more filaments [1]. If more than a single filament passes through the Earth's orbit, we observe several meteor showers associated with the same parent body.

Modelling theoretical streams and studying their dynamical evolutions for a suitably long period allows all these alterations of the initial orbital corridors to be revealed. The theoretical predictions are evaluated by comparing them to the actually observed meteors. Differences between the observed and predicted filaments of the meteoroid stream represent the possibility of an eventual recovery of the comets' orbit evolution.

Modeling meteoroid streams using the nominal and cloned orbits of comet C/1917 F1

We modeled the theoretical stream of C/1917 F1, which associates at least two, possibly four, meteor showers that were recorded in the meteor databases. The orbital period of the comet is about 145 years, so its stream needed a relatively long time to spread along the whole orbit. Increasing evolutionary time resulted in a significant part of the test particles also moving into other orbital corridors. This proves that meteoroids in various showers that originate in the same parent body can be of different ages.

However, the appropriate meteor showers were not perfectly predicted by assuming the past evolution of the nominal osculation orbit of C/1917 F1, as well as of the stream meteoroids, only because of the gravitational perturbations of planets [2]. Neither did the Poynting-Robertson (P-R) drag, influencing the dynamical evolution of the meteoroids, improved the agreement between the theory and observation sufficiently. Taking various strengths of the P-R drag into consideration, we clearly obtained a better match of three of the four showers [3]. However, when considering the nominal orbit of the parent comet, determined by Asklof with a relatively high precision [4], a perfect match in all four filaments was impossible to reach.

In the past, the orbit of a comet could be significantly influenced and, therefore, modified by non-gravitational effects. The currently observed stream could be, and most likely was, formed when the comet moved in a slightly different orbit than it moved at its last return to the perihelion.

We tried to find the appropriate modification of the orbit in the time when the meteoroids of its stream were released. We created 24 cloned orbits and repeatedly modeled the theoretical streams, assuming various strength of P-R drag. We found a cloned orbit which resulted in a perfect prediction of the properties of the most problematic filament. Unfortunately, the simultaneous perfect match of the other three filaments failed [3].

In the future, a much more robust modeling could possibly reveal a convergence in cloning at a narrow interval of P-R drag strength. If success was achieved, meteor databases and meteoroid streams modeling could become tools for tracing the past dynamical history, caused by the action of non-gravitational effects, of the parent comet that associates more than single meteor shower.

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