Abstract

In this thesis we design a suitable representation of spatial density and flux of meteoroids encountered by the Earth on its orbit around the Sun. A pair of distinct but interdependent models is introduced: an orbital model of the distribution of positions and velocities of small bodies in the inner Solar System, supplemented with information about temporal and mass distribution in different populations; and a related observational model, which describes the measurable properties of meteors as seen from the surface of the Earth. Each model is materialized as a probability density function in a suitable parameter space. In both cases, the input data consist of a set of observations represented by discrete points in a suitably chosen parameter space. A non-parametric adaptive multivariate kernel density estimation method is applied to the data and the underlying probability density function is approximated.

From the density function we are able to calculate the spatial density and flux of meteoroids in any volume of parameter space, or predict meteor shower activity as seen from the surface at any point in time and space covered by the model. The output of the method can also serve as an input distribution for Monte-Carlo simulations of meteoroids, both in interplanetary space and during their entry into the Earth's atmosphere.

In the thesis we provide the theoretical foundations of the kernel density estimation method applied to meteor and meteoroid observations, formulate suitable parameter spaces for both models, and describe the relevant parameters along with dissimilarity functions. The notion of metrics and metric spaces and their relevance to KDE is explained and several metrics suitable for evaluating the probability density function for meteors and meteoroids are analyzed. We implemented the data reduction and visualisation pipeline for the observational model in C++ and applied to the current database of meteor observations obtained by the AMOS camera network.

Keywords: meteor, meteoroid, population, observation, distribution, model, kernel density estimation