

Acknowledgement

First and foremost, I would like to thank my advisor, Juraj Tóth, for all the coffees and the hours spent in conversation about everything relevant (and often not) to the topic of this thesis.

I am very grateful to Peter Vereš for suggesting a simulation, as this interesting idea has become the cornerstone of the thesis. Developing and testing it was very entertaining and taught me a lot.

Special thanks belong to Justína Nováková for the provided pictures, and for her moral support during these difficult and demanding times.

Abstrakt

Inštalácia viacstaničných sietí meteorových kamier umožňuje okrem iného aj určenie celkového toku meteoroidných častíc. Priame meranie však nie je možné, pretože získané dáta sú zaťažené značnými systematickými chybami a výberovými efektami. V tejto práci predkladáme dve metódy odstránenia výberových efektov. V práci sme použili dáta z kamier AMOS, vyvinutých a prevádzkovaných na FMFI UK.

Prvá metóda je založená na postupnej identifikácii a odstraňovaní výberových efektov, ktoré ovplyvňujú pozorované frekvencie meteorov v zemskej atmosfére. Vplyv uvažovaných efektov sme odhadli na základe kalibrácie systému s vizuálnymi pozorovateľmi. Druhou popísanou metódou je simulácia meteoroidov vstupujúcich do zemskej atmosféry. Na zaznamenané dráhy virtuálnych meteorov boli aplikované zvolené výberové kritériá a výsledný štatistický súbor bol uložený do databázy. Tieto dáta sme následne analyzovali štatistickými metódami a porovnávali s observačnými dátami z kamier AMOS. Celý proces sme následne mnohokrát opakovali s modifikovanými parametrami až do nájdenia najlepšej možnej zhody s observačnými dátami a následne odhadli výsledný tok pre meteorický roj Perzeíd.

Kľúčové slová: meteor, meteoroid, tok, model, pozorovanie, výberové efekty

Abstract

Deployment of multi-station video meteor networks presents a unique opportunity to measure the total mass flux of meteoroids impinging on the surface of the Earth. However, direct measurement of flux is not possible as raw data are heavily distorted by selection bias. In this thesis, we present two possible methods of debiasing the data used for flux estimation. We used data obtained by AMOS, an all-sky video camera system developed and operated by Comenius University in Bratislava.

The first method is based on sequential identification and elimination of possible sources of bias. Each identified effect is measured and adequate correction procedures are developed. The second presented approach is a simulation of meteoroid particles entering the atmosphere. The trajectory of each virtual meteoroid is tracked and after application of biases the resulting meteor observation is recorded. Once a sufficiently large dataset is obtained, statistical tests are performed and the distributions are compared to observational data. The entire procedure is repeated and the parameters of the simulation are gradually adjusted until best possible agreement with observational data is found.

Keywords: meteor, meteoroid, population, video, flux, model, debiasing, AMOS

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Chapter 1

Introduction

*You saw sagacious Solomon,
You know what came of him,*

Edsger Dijkstra

The final product would thus be a five-dimensional map, or distribution, of meteor activity, with independent variables being

- the **temporal coordinate**, representing the variation of meteor activity in time
- the **mass spectrum**, describing the distribution of meteoroid masses, typically in terms of *mass index* s ;
- and the **velocity spectrum**, describing the velocities of objects passing through this point, which can be in turn described by
 - two spatial coordinates, the **right ascension and declination** of the radiant, or α and δ ;
 - and **speed** v .

described by the **meteor activity function**

$$\rho(t, \vec{v}, m) \equiv \rho(\lambda_{\odot}, \delta, \alpha, v, m). \quad (1.0.1)$$

Within this map we are able to distinguish two main features:

- the **sporadic background**, which forms the main contour lines of the maps, the “terrain”;
- and the well-defined peaks, representing the **meteor showers**. All such peaks are invariably very narrow in the speed domain,

Due to influences of various acting forces, such as differences in initial velocities with respect to the parent body, tidal disruptions, perturbations arising from close encounters with large bodies of the Solar System, Poynting-Robertson effect, etc., the stream gradually widens and disperses in all components until it is no longer recognizable from the background.

density,

1.0.1 Time

In examining the evolution we may recognize two distinct components:

- the **periodic component**, emerging as the result of the Earth orbiting the Sun. This coordinate can be thus expressed in terms of the **longitude of the sun** λ_{\odot} .
- the slowly-varying **secular component**, associated with appearance of new meteoroid streams and gradual decay of older streams which are not replenished.

The peaks produced by meteor showers appear relatively abruptly after the parent body passes through the vicinity of the Earth, producing small bodies due to heating or outgassing. Even so, returns of parents bodies on periodic orbits, such as comets 1P/Halley or 109P/Swift-Tuttle, do result in resupply of meteoroid material, and thus form an extra periodic component, included in the secular evolution of the stream.

which can be expressed as and a secular component, which is the result of the evolution of the associated stream;

Bibliography

- [1] Martin Baláž, Juraj Tóth, Robert Jedicke, and Peter Vereš. ASMODEUS meteor simulation toolset. **Planetary and Space Science**, in prep.