Author’s Accepted Manuscript

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PII: S0032-0633(16)30238-0
DOI: http://dx.doi.org/10.1016/j.pss.2016.12.007
Reference: PSS4258

To appear in: *Planetary and Space Science*

Received date: 2 September 2016
Revised date: 6 December 2016
Accepted date: 21 December 2016

Cite this article as: D. Koschny, E. Drolshagen, S. Drolshagen, J. Kretschmer, T Ott, G. Drolshagen and B. Poppe, Flux densities of meteoroids derived fror optical double-station observations, *Planetary and Space Science* http://dx.doi.org/10.1016/j.pss.2016.12.007

Flux densities of meteoroids derived from optical double-station observations

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Abstract

We have developed a new method to determine flux densities of meteoroids using optical double-station meteor observations. It is based on the assumption that the velocity distribution is constant for all mass bins. By comparing the observed velocity distribution with a model distribution we determine de-biasing factors to correct for meteors too slow to emit a detectable amount of light.

We use this method to correct a dataset of about 20000 double-station meteoroids detected over a period of about 3.5 years with the Canary Island Long-Baseline Observatory (CILBO). The resulting cumulative flux density has a slope comparable to the model of Grün *et al.* (1985). The largest uncertainty is the luminous efficiency. Depending on which values for the luminous efficiency are assumed, the mass estimate deviates by about one to 1.5 orders of magnitude. Using the luminous efficiencies derived by Weryk *et al.* (2013) results in an excellent agreement of our data with the Grün data.

1. Introduction

In recent years, a number of video camera setups have been installed to monitor meteors in the night sky (*e.g.* Molau 2013, Toth *et al.* 2015, Jenniskens 2016). ESA's Meteor Research Group has installed a system called CILBO (Canary Islands Long-Baseline Observatory) in 2011/2012 that has been operating regularly since then. The goal of the system is to monitor the night sky to (a) determine the rates of meteors entering the Earth's atmosphere over an extended period of time; (b) determine the physical properties of the meteoroids by e.g. analyzing light curves; (c) constrain the chemical composition by using an objective grating on one of the cameras. In this paper, we will focus on point (a) and derive properly de-biased flux densities as a function of mass for the observed meteoroids. This will allow not only to gain a scientific insight into the meteoroid distribution in our solar system, but also to constrain engineering meteoroid models.

Meteoroid models have been developed both in Europe for the European Space Agency (*e.g.* Dikarev *et al.* 2005, Soja *et al.* 2014) and in the US (McNamara *et al.* 2005). These developments go back to work done in the 60s of the last century (*e.g.* Hawkins and Upton 1958). The prediction of an outburst of the Leonid meteor shower in 1999, 2001 and 2002 led to an increased work in modeling the dynamics of meteoroid particles in the solar system (*e.g.* McNaught and Asher 1999, Vaubaillon *et al.* 2005). Bellot-Rubio (1994) developed a method to derive meteoroid flux densities from photographic observations; Koschack and Rendtel (1990) derived a method for deriving flux densities from visual observations. The Leonids were directly addressed in a multitude of papers, we cite only a small fraction to give the reader a starting point for further investigations (Beech *et al.* 1997, Brown *et al.* 2002, Trigo-Rodriguez *et al.* 2004). Video-based determination of meteoroid flux densities were performed *e.g.* by Molau *et al.* (2014) or Blaauw *et al.*