Pre-atmospheric parameters and fragment distribution: Case study for the Kosice meteoroid

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We present results on our investigation on the Košice meteorite — one of the recent falls with a well-derived trajectory and large number of recovered fragments. A fireball appeared over central-eastern Slovakia on February 28, 2010. The bolide reached an absolute magnitude of at least -18, enabling radiometers of the European Fireball Network to track the fireball despite the cloudy and rainy weather. The landing area was successfully computed on the basis of data from the surveillance cameras operating in Hungary and led to a fast meteorite recovery (Borovička et al. 2013). The first reported fragment of the meteorite was located northwest of the city of Košice in eastern Slovakia (Tóth et al. 2014). 218 fragments of the Košice meteorite, with a total mass of 11.285 kg, have been documented with almost 7 kg belonging to the collection of the Comenius University in Bratislava and Astronomical Institute of Slovak Academy of Sciences (Gritsevich et al. 2014).

Based on the statistical investigation of the recovered fragments, bimodal Weibull, bimodal Grady, and bimodal lognormal distributions are found to be the most appropriate distributions for describing the Košice fragmentation process. The most probable scenario suggests that the Košice meteoroid, prior to further extensive fragmentation in the lower atmosphere, was initially represented by two independent pieces with cumulative residual masses of approximately 2 kg and 9 kg respectively (Gritsevich et al. 2014). About 1/3 of the recovered Košice fragments were thoroughly studied, including magnetic susceptibility, bulk and grain density measurements reported by Kohout et al. (2014). This analysis revealed that the Košice meteorites are H5 ordinary chondrites that originated from a homogenous parent meteoroid.

To estimate the dynamic mass of the main fragment, we studied the first integral of the drag and mass-loss equations, and the geometrical relation along the meteor trajectory in the atmosphere. By matching these equations to the trajectory data obtained by Borovička et al. (2013), we determine key dimensionless parameters responsible for the meteoroid drag and ablation rate along its visual path in the atmosphere. These parameters allow us to estimate the pre-atmospheric mass, which is in good agreement with the photometric estimate derived by Borovička et al. (2013). Throughout this study, we permit changes in meteoroid shape along the trajectory. Additionally, we estimate the initial shape of the Košice meteoroid based on a statistical analysis (Vinnikov et al. 2014). We also conclude that two to three larger Košice fragments of 500-1000g each should exist, but were either not recovered or not reported by illegal meteorite hunters.

References:

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