EMPIRICAL FRAGMENT DISTRIBUTIONS IN METEORITES.

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Introduction: Meteorite samples provide invaluable data on spectral, chemical and physical properties of interplanetary matter. The set of recovered fragments give additional insights into the history of the parent asteroid, e.g. [1]. Statistical analysis can be used complementary to study fragment distribution and to investigate if the pieces recovered within one meteorite fall belong to a single pre-entry body. This analysis is especially useful if the recovered meteorite collection is missing some (yet unrecovered) splinters.

Methods: We approximate the masses of meteorite fragments using distribution laws that were found to be the best candidates among other sigmoid functions related to the fracturing processes [2]. The meteorite cases represented by a large number of recovered pieces are selected for the study. We start with a normal and lognormal distribution of fragment masses in logarithmic and linear scales, respectively. Next, we consider more advanced distributions commonly used in fragmentation theory. These functions with carefully calibrated parameters were successfully applied earlier, e.g. [3, 4].

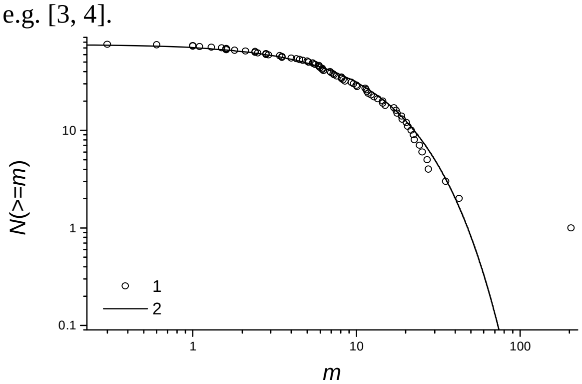

Figure 1: *Complementary cumulative number of fragments vs fragment mass. 1 – data for the Sutter's Mill meteorite* [10], *2 – Weibull distribution with the shape parameter μ=11 and the scale parameter γ=1.*

Besides distribution law, mathematical statistics can hint at pre-entry parameters not directly retrievable from the detailed trajectory data, such as, for example, the initial meteoroid shape. This knowledge is crucial, since the meteoroid pre-entry mass, terminal meteorite mass, and fireball luminosity are proportional to the pre-entry shape factor of the meteoroid to the power of 3 [5, 6]. Therefore we follow the study [7] and apply a modified technique described by the authors for pre-entry shape estimation of a meteoroid.

At the end we make predictions of meteoroid mass distributions following fragmentation events. These recommendations can be used, in particular, to generate most realistic population of fragments in the dark flight numerical simulations for meteorite-producing fireballs.

Results: Based on the recovered meteorite fragments, we have constructed a robust theory for meteoroid mass distribution during fragmentation. Our investigation suggests the use of the following models as being most appropriate to derive the meteorite fragment distributions: Weibull, Grady and lognormal. Furthermore, the Weibull and Grady functions have a more extensive physical basis [8, 9] and are thus the most highly recommended.

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References: [1] Kohout T. et al (2014) *Icarus*, 228, 78-85. [2] Gritsevich M. et al. (2014) *Meteoritics & Planetary Sci.*, 49, 1-19. [3] Silvestrov V.V. (2004) *Combustion, Explosion, and Shock Waves*, 40(2), 225-237. [4] Elek P. and Jaramaz S. (2009) *FME Transactions*, 37, 129-135. [5] Gritsevich M. I. *Doklady Physics* (2008) 53(11), 588-594. [6] Gritsevich M. and Koschny D. (2011) *Icarus*, 212(2), 877-884. [7] Oddershede L. et al. *Europhys. Lett*. (1998) 43(5), 598-604. [8] Weibull W. (1951) *J. Appl. Mech.-Trans. ASME* 18(3): 293–297. [9] Grady D. E. (1990) *J. Appl. Phys.* 68(12), 6099-6105. [10] Jenniskens P. et al. (2012) *Science*, 338(6114), 1583-1587.