A Reproducible Method for Determination of the Meteoroid Mass Index : Application to CMOR data

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The measurement of the distribution of meteoroid masses is commonly defined by the differential power law mass index s, where the number of meteoroids, dN, having masses between m and m+dm is given by $dN \propto m^{-s}dm$. The mass index plays a crucial role in estimates of meteoroid flux and mass input and is a powerful constraint for models of the origin and evolution of the meteoroid complex. However, different authors use different approaches to fit observed data, making results difficult to reproduce and the resulting uncertainties difficult to justify. The real, physical, uncertainties may in some cases be an order of magnitude higher than reported values.

Here we use the cumulative amplitude distribution of underdense meteor echoes measured by the Canadian Meteor Orbit Radar (CMOR) to estimate the meteoroid mass index at mm to sub-mm meteoroid sizes.

We derive uncertainties in the mass index based on the posterior samples of Bayesian statistics provided by the Multinest algorithm. Application of the Multinest algorithm also allows for fully automated estimates of the mass index from radar data. Here we apply this approach to CMOR data to investigate mass indices of the sporadic meteoroid complex on daily basis for five consecutive years 2011-2015 (Figure 1). Our best estimate for the average debiased mass index for the sporadic meteoroid complex as measured by radar appropriate to the mass range $10^{-3} > m > 10^{-5}$ g was $s = -2.10 \pm 0.08$. For comparison, application of MultiNest to data gathered by the Canadian Automated Meteor Observatory (CAMO) multi-station optical influx system appropriate to in the 10^{-1} > $m > 10^{-3}$ g having shower meteors removed produced $s = -2.08 \pm 0.08$.



Figure 1: Variations of the mass index measured over five consecutive years 2011-2015 by the 29.85 MHz CMOR radar. Color coded dots represent the mass index for each 1° solar longitude bin and color coded lines show the moving average with 10° window averages. Arrows with labels denote maxima of Arietids (ARI), Southern Delta Aquariids (SDA), and Geminids (GEM) meteor showers.