Luminous Efficiency estimates from the Canadian Automated Meteor Observatory

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Of the many parameters involved in meteoroid ablation, luminous efficiency, the fraction of kinetic energy released as visible light, is the most uncertain. Dozens of studies of luminous efficiency have been published using various methods (lab experiments [1]; artificial meteors [2]; simultaneous radar and optical observations [3]) and the results vary by up to two orders of magnitudes; the studies also disagree as to how luminous efficiency varies with meteoroid speed. The luminous efficiency is necessary for determining the mass of a meteor, and with widely varying luminous efficiency values, it is difficult to ascertain the true masses of meteors. This affects measurements of meteoroid density and other properties, and meteoroid flux and hazard determinations.

Combining classical meteor ablation equations for photometric and dynamic masses allows us to compute the luminous efficiency, through a combination of observable (atmospheric density; meteoroid velocity; meteoroid deceleration; luminous intensity) and estimated (shape factor; drag coefficient; meteoroid density) parameters. This method, however, requires very precise deceleration measurements: any uncertainty in the position measurements will propagate through to the deceleration values, and can cause large uncertainties in the final luminous efficiency estimate. This method assumes that the meteoroid does not fragment, and has been used in the past on a single low-altitude Super Schmidt meteor [4] .

The Canadian Automated Meteor Observatory collects wide-field meteor observations and simultaneous narrow-field observations, the latter with resolutions as precise as 3 meters per pixel. Wide-field observations provide luminous intensity measurements, while narrow-field observations provide high-precision deceleration measurements. The narrow-field observations also provide information on the nature and spread of fragments, if any.

We have selected from our high quality observations the meteor events that show single-body ablation (that is, events that show minimal fragmentation in the narrow-field observations). These events are appropriate for use with the classical ablation equations. The uncertainty in position measurements for these events is typically around 5 meters.

For each of these high-quality non-fragmenting events, we can use the classical ablation equations to determine an approximate luminous efficiency. We will present how sensitive the method is to variations in the atmospheric density, meteoroid density, luminous efficiencies that change over time, and shape factor, using synthetic data from the ablation model of [5]. Preliminary results of this investigation will be discussed.

References

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