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Effects of measurement errors on a meteoroid orbit's determination

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Abstract

The influence of measurement errors on the determination of meteoroid orbits is discussed. We test how heliocentric orbital elements change in dependence on the directly measured parameters, the pre-atmospheric velocity, and the position of the radiant, by a simple model of the geometry of the meteoroid encounter with the Earth. To demonstrate this effect on real data, we used video meteors from several databases [1, 2, 3].

Results and Conclusions

For fainter meteors obtained by video techniques, the discrimination between orbits of different natures is highly demanding. The difficulty arrives from the methods used to measure both meteor position and speed. Based on Kresak and Kresakova [4], we demonstrate the effects of measurement errors in both the radiant position and the velocity, with a diagram showing the correlation between the non-atmospheric velocity v_{inf} (or geocentric velocity v_G) and the angular elongation of the apparent radiant from the apex, ε_A (Figure 1). Resolutions needed to distinguish between different kinds of orbits can be deduced from the graph.
We concentrate on the regions where the occurence of meteoroid orbits is exceptionally rare. Here belong, for example, hyperbolic orbits or orbits which correspond to nearly perpendicular encounters. In both cases, a large dispersion of the measurement errors, can produce spurious meteoroid orbits and their enhancements.

High accuracy is as important for observations and measurements as it is for meteor trajectory determination and meteoroid orbit calculation. Each analysis that uses rough velocity data without a proper error examination will be seriously affected by measurement errors.

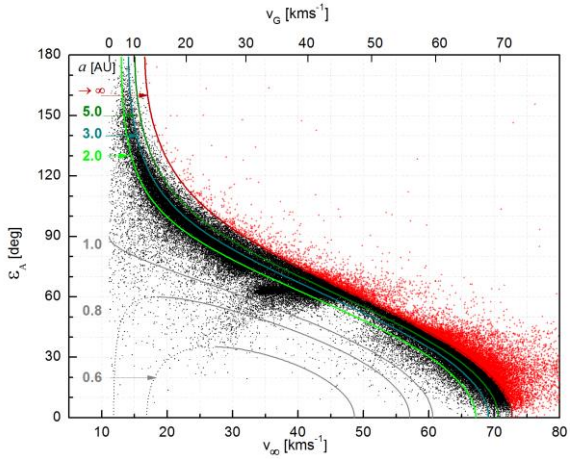

Figure 1: The angular elongation of the apparent radiant from the apex is plotted against the non-atmospheric velocity of meteors from the CAMS data, in which 12.5 % orbits were determined as hyperbolic (red crosses). The curves represent orbits with different values of semi-major axes a.

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