EPSC Abstracts
Vol. 12, EPSC2018-549, 2018
European Planetary Science Congress 2018

Apparent hyperbolic meteoroid orbits

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Abstract

The identification of interstellar particles among detected meteors is a challenging task involving a careful data treatment and a detailed error analysis. In fact, a hyperbolic orbit is the only easily measurable property of a meteoroid that might indicate an interstellar origin. However, the semi-major axis *a*, which defines the type of the orbit, strongly depends upon the derived heliocentric velocity v_H and so speed measurements are central to this discussion. We demonstrated how sensitive the influence of the measurement errors on the resulting orbit is [1].

The effect of measurement errors on the resulting orbit

Interstellar meteors are expected to arrive at Earth with speeds exceeding the Sun's escape velocity, typically, by a few kms^{-1}; but they may also arrive with almost zero excess velocity. Identifying such a small effect requires extremely high accuracy measurements. Therefore, on the one hand, possible interstellar meteors remain hidden within the error bars; on the other hand, measurement errors can transfer near-parabolic orbits over the parabolic limit and create an artificial population of hyperbolic meteors, often interpreted as of interstellar origin. The error required for this change need not be large. The higher the heliocentric velocity v_H of the meteoroid, the smaller the error needed. This effect can be demonstrated by 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 [2] (figure 1). Meteors are distributed in a very narrow zone of the diagram, where the possibility of discriminating between orbits of different semi-major axes is most demanding. It is clearly seen that for large *a*, the value of the semi-major axis derived is strongly affected by any small errors in the measured speed or radiant position. Consequently, concentrations of shower meteors with known local sources (the Perseids, Orionids, Lyrids and Leonids) are present among hyperbolic orbits. A detailed error analysis of the same sample as used for figure 1 showed that the vast majority of hyperbolic orbits (red crosses in figure 1) were only apparent, and their proportion in the data shrank massively from 11% to 0.02% [3].

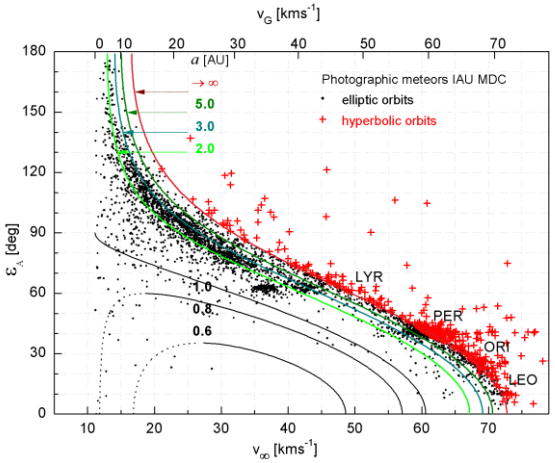

Figure 1: The angular elongation of the apparent radiant from the apex ε_A is plotted against the non-atmospheric velocity of meteors v_{inf}, using rough photographic data of the IAU MDC [4]. The curves, representing the relation between ε_A and v_G, are constructed for different values of semi-major axes *a*.

Acknowledgements

This work was supported by the Natural Sciences and Engineering Research Council of Canada, and by the Slovak Scientific Grant Agency, grant No. VEGA 2/0037/18, and the Slovak Research and Develop-ment Agency, contract No. APVV-16-0148.

References

[1] Hajdukova, M., Sterken, V., Wiegert, P., Interstellar meteoroids, in Meteoroids: Sources of Meteors on Earth and Beyond, CUP, submitted

[2] Kresak, L. and Kresakova, M., A note on meteor and micrometeoroid orbits determined from rough velocity data, Bull.Astron.Inst. Czech. 27, 106, 1976

[3] Hajdukova, M., Meteors in the IAU Meteor Data Center on Hyperbolic Orbits. EM&P, 102, 67, 2008

[4] Lindblad et al., IAU Meteor Database of photographic orbits version 2003, EM&P 93, 249, 2003