The exosphere of Mercury as a detector of Encke meteoroids

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The variation and intensity of meteor activity in the Earth's atmosphere is well characterised, thanks to the proliferation of survey programmes employing radar, radio & optical techniques. Combined with rigorous analysis of the data, they constrain the nature and sources of meteoroids. Still, the potential of utilising other planetary bodies to extend our knowledge of the spatial distribution of meteoroids remains largely untapped. The recent close passage of comet C/2013 A1 (Siding Spring) to Mars, which coincided with a sudden increase in the meteoric metal content of its upper atmosphere as detected by orbiting spacecraft [1], highlighted the role of techniques other than those principally used at the Earth as proxies for meteoroid flux variations in the vicinity of planetary bodies.

The planet Mercury is enveloped in a tenuous atmosphere, a collisionless cloud of neutrals and ions [2]. Recent observations by the Mercury Atmospheric, and Surface Composition Spectrometer (MASCS) onboard the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft [3] found that the atomic Ca abundance in the exosphere varies as a function of Mercury's true anomaly f. Subsequent modelling [4] showed that these variations may be attributed to impact vaporization of surface material by meteoroid infall. However, an additional dust source was required to explain a Ca excess at $f = 25^\circ \pm 5^\circ$. Killen & Hahn suggested that particles from comet 2P/Encke, crossing just outside Mercury's orbit at $f = 45^\circ$, may be the culprit.

By simulating numerically the stream of meteoroids ejected from Encke up to 50kyr ago we sought to identify those particles that impact Mercury at the present epoch and test the Killen & Hahn conjecture.

We find that Encke particles evolving solely under the gravity of the planets and the Sun encounter Mercury at $f = 50 - 60^\circ$, well after the Ca excess emission. This result is independent of the time of ejection. However, adding Poynting-Robertson (P-R) drag in our model causes smaller, older particles to encounter Mercury progressively earlier in the Hermean year. In particular, mm-sized grains ejected between 10 and 20 kyr ago impact on the nightside hemisphere of Mercury at $350^\circ < f < 30^\circ$ [5] (Fig. 1).

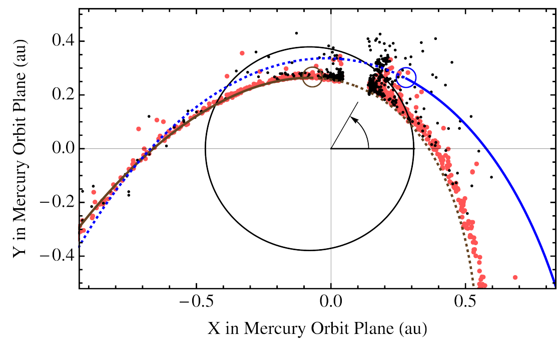

Figure 1: Descending nodes on Mercury's orbit plane at JD2487500 of 1000 particles ejected from Encke 10k yr ago and with $\beta = 2 \times 10^{-3}$. Red points: particles with $v_{ej} < 10$ m s^{-1}; black points: particles with 10 m s^{-1} < $v_{ej} < 100$ m s^{-1}. The arrow indicates the direction of increasing f away from Mercury's perihelion (+x axis). Most particles with $v_{ej} < 10$ m s^{-1} intersect Mercury's orbit (black ellipse) at $f \simeq 30^\circ$.

In this presentation, we will describe our model results and discuss the implications of our findings for the Encke stream of meteoroids. Linkages between the Mercury-intercepting part of the stream and documented Taurid activity at the Earth will be attempted.

References

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