A study of the dynamics of the grains of the dust exosphere of Mercury

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In this work we study the dynamics of the dust grains that build a dust exosphere around Mercury. In a similar way to the atoms and molecules that are part of the exosphere, the grains of the dust exosphere are gravitationally bound to Mercury and mostly follow ballistic trajectories after being released from the surface by hypervelocity impacts (> 80 km/s) of micrometeoroids mainly of cometary origin. We focus on the submicrometric population and consider grains as small as tens of nanometers, given that the smallest (submicrometric) ejecta grains, may be able to achieve the largest ejection speeds. Apart from trying to estimate some properties of the dust exosphere, we try to answer whether instruments like the Mercury Dust Monitor (MDM) on board the Mercury Magnetospheric Orbiter, also known as Mio, would be able to detect some of the grains of the hermean dust exosphere once in orbit around Mercury. Mio, from the Japan Aerospace Exploration Agency (JAXA) is part of the BepiColombo mission, which among its many objectives will study the hermean exosphere after November 2026. In particular, MDM is a piezoelectric (PZT) dust impact instrument that will be dedicated to study the distribution of interplanetary dust at the orbit of Mercury.

In the end, our estimations suggest that MDM could be able to detect grains from the dust exosphere as small as 50nm if their relative speed with respect to MDM is >5 km/s, however, it may easily detect ≥100 nm if their relative speed is ≥1 km/s.