

Neutral Matter Collisions in Interstellar Space: Dust Production and Pick-up on the Smallest Scale

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Abstract

The smallest bodies in the solar system, participate in a collisional cascade that continues until the dust particles are either small enough to be carried out of the solar system by the solar wind or to spiral into the Sun by the Poynting-Robertson effect. At 1 AU, catastrophic disruptive collisions are produced when the mass ratio of colliding bodies is no greater than 10^6 for the typical relative collisional speed of 20 km/sec. The smallest collisionally-produced dust that, after ionization by the solar ultraviolet radiation, can be treated as heavy solar wind ions such that the debris forms a cloud of very heavy ions accelerating in the solar wind.

We have studied these magnetized clouds since they were first discovered in 1982, at Venus by Pioneer Venus. We have recently used multiple spacecraft near Earth (at 1 AU) that carry magnetometers to define the speed, geometry, and magnetic draping about these objects. If the charged dust is slower than the solar wind, the draping signature will be such that the field lines make a ‘massive’ concavity being pulled away from the Sun. When the dust crosses the standing bow shock in front of the Earth, its velocity will be largely unaffected because it is much more massive than the protons in the solar wind. After this, downstream from the bow shock where the ambient field is slower than the incoming dust, the draping of magnetic field should reverse, decelerating the dust cloud. We observe such reversal of draping and conclude that these phenomena are associated with ‘puffs’ of collisionally-produced dust that is accelerated in the solar wind and decelerated in the magnetosheath.