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Meteoroid Collisions in the Solar Wind: Possible Signatures in the Interplanetary Magnetic Field

C. T. Russell (1), H.R. Lai (1), G.L. Delzanno (2)
(1) ESS and IGPP, UCLA, Los Angeles, CA (ctrussell@igpp.ucla.edu / Fax: 310-206-8042) (2) Los Alamos National Laboratory, Los Alamos, NM

Abstract

Interplanetary Field Enhancements appear as smoothly varying cusp-shaped enhancements in the interplanetary magnetic field that last minutes to many hours. These enhancements have been attributed to the pickup of charged dust by the solar wind, based on their associations with passage of asteroid, 2001 Oljato, near conjunction with the Pioneer Venus spacecraft during three successive apparitions and an association with comet De Vico. Because these phenomena are discrete events, their association is probably associated with collisions of material rather than the interaction of the solar wind with a continuous dust trail. Since these disturbances travel at or near the solar wind speed, the physical dimensions of these disturbances are large. Therefore, the force exerted by the magnetic field increase on the plasma and the charged dust is very significant, enough to move a charged object of many kilograms mass outward through the gravitational potential. However the force that the solar wind can exert on a single dust particle is small, so the particle(s) must be small as well. In order for a dust cloud to exert influence over perhaps 10^6 km, the dust cloud must have an inter-particle separation of much less than a Debye length (about 10m). We hypothesize that these disturbances represent the pickup of charged dust clouds produced by meteoroid collisions, producing large numbers of charged dust particles. In support of this hypothesis, we examine the ecliptic longitude of the events and find clustering of source locations over several years. We also find that the force exerted by the plasma on the "dust cloud" does not depend on solar wind properties such as speed. However, the force does depend on heliocentric distance as the IFEs travel outward in the gravitational potential well of the Sun. Thus, the cloud acts as if it has significant total mass.