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High-Speed Dusty Plasma Clouds in the Inner Heliosphere

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Abstract

The STEREO spacecraft and their plasma wave antennas observe almost ubiquitous occurrence of small impulsive voltages that have been interpreted as encounters with nano-scale charged dust particles. On the same spacecraft we detect a macroscopic signature in the magnetic field and often in the total pressure that has been interpreted as arising of charged dust also moving at the solar wind speed. These structures are not nano-scale in size but extend to millions of km. Examination of these cusp-shaped magnetic structures called Interplanetary Field Enhancements from 0.3 to 1.0 AU with Helios 1 and 2 reveals that these enhancements may contain significant mass. If this mass consists of nano-scale particles, there could be over 10^{20} of them in a large IFE. Such a dusty plasma cloud could be formed by an inter-meteoroid collision at high speed. The particles should charge immediately upon release by the collision and be accelerated to the solar wind speed by electromagnetic forces. Initially the charged nanoparticles should have interparticle separations much less than the Debye length and thus form a dusty plasma which has coherent interaction with the solar wind flow. Later as the particles disperse because of slightly different forces on each and because of the expansion of the solar wind and dust cloud, the particles will continue at their high speeds but no longer create a coherent structure in the solar wind. Thus we would expect the high-speed dust strikes on the STEREO spacecraft to occur much more frequently than would be predicted by IFE occurrence that is roughly monthly and lasting about an hour. If we can gain greater quantitative understanding of this process, perhaps by computer simulation, we should be able to gain greater insight into both the rate of meteoroid collisions and the rate of nano-scale dust production.