Collisions in Space: Nanoscale Charge Dust Pickup as an Indicator of the Collision Rate in Interplanetary Space

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The Pioneer Venus Orbiter spacecraft was the first to detect the cusp-shaped magnetic field increases in the solar wind magnetic field that have been called interplanetary field enhancements or IFEs. These enhancements are usually accompanied by an abrupt current sheet near the peak field, almost reversing the magnetic field direction. However, all interplanetary spacecraft equipped with magnetometers see these structures at about the same rate of 7 times per year. Pioneer Venus provided an important clue as to their cause by observing an association of a fraction of these events with the asteroid 2201 Oljato where its orbit crossed the ecliptic plane in front of Venus, whenever Oljato was close to, but not necessarily in conjunction with, Venus.

The disturbance appears to travel with the speed of the solar wind, but is not correlated with solar activity or solar wind properties. We have many two- and three-spacecraft observations of these interplanetary field enhancements (IFEs) and recently have obtained a four- and a five-spacecraft observation. These confirm the high speed of these disturbances. We have studied these events for over a solar cycle and see no correspondence with solar cycle phase or events on the Sun.

A possible explanation for the magnetic field increase is that it is a magnetic barrier that transfers momentum from the solar wind to the material in the IFE. A possible source of the random but continual appearance of IFEs is that they arise from the collisions of small bodies and that the solar wind is sweeping up the fine dust particles (resulting from such collisions) that have become charged. Only fine-scale (nanometer-sized) dust can be accelerated by the solar wind. Given the observed dimensions of these disturbances, if the magnetic forces are balancing solar gravity, the amount of dust in them is significant, about 10^8 kg. This in turn can be used to estimate the expected collision rate between small bodies in space, based on objects entering the Earth's atmosphere of varying mass. We find that the detection rate is consistent with terrestrial small body encounters. In this presentation, we show examples of these events, discuss the statistics of their detection, and explain what we know about their physical structure and physical behavior.