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Solar Wind Slowdown Due to Dust Pickup during Interplanetary Field Enhancements

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The interplanetary field enhancements (IFEs) are characterized by their cusp-shaped enhancement in the magnetic field magnitude. They are observed throughout the inner solar system from 0.72AU by Pioneer Venus Orbiter to 5AU by Ulysses. The annual IFE rate is ten at 0.72AU and around eight at 1AU, i.e. decreases as the heliocentric distance increases. Multiple-spacecraft observations show that IFEs are moving radially away from the Sun at nearly the ambient solar wind speed. During the IFE events, case studies show that while there are correlated diamagnetic compensations in pressure there are no significant correlated changes in the solar wind speed. An IFE formation mechanism that explains most of the IFE features is that IFEs result from interactions between solar wind and clouds of picked up nanoscale charged dust, which is released in interplanetary collisions between objects of 10 to 1000m in diameter. The enhanced magnetic field behaves as a magnetic barrier that can transfer momentum to the charged dust from the solar wind. Momentum lifts the dust outward in the solar gravitational well. A prediction of this hypothesis is that solar wind will be slowed down even when the IFEs have reached exactly the solar wind speed. To test this hypothesis, we perform a superposed analysis on the radial velocity of IFEs observed at 1AU. In contrast to the case studies, the statistical results have a significant change in speed. The velocity on the solar wind side of the IFEs is smaller than the ambient velocity. This slowdown increases for larger IFEs with larger estimated mass. In addition, the amount of momentum due to the solar wind slowdown is quantitatively consistent with the momentum expected to be needed to lift the dust out of the Sun's gravitational potential well, which is in strong support of our IFE formation mechanism.