Nanoscale Dust Production at 1 AU: Identification and Tracking with 12 Spacecraft

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1. Interplanetary Field Enhancements (IFEs)

Collisions break the interplanetary objects into smaller and smaller debris. At 1 AU, an impactor can disruptively destroy a target of 10^8 times its mass at a colliding speed of 20 km/s. This creates small clouds of charged dust that are accelerated up to the solar wind speed. When the cloud reaches the solar wind speed the magnetic field strength relaxes to that in the surrounding solar wind but the direction is expected to remain twisted. We call these structures IFEs.

2. An IFE Penetrating the Bow Shock

On 2018 January 16, an IFE was observed by 12 spacecraft arrayed from interplanetary space to the terrestrial magnetopause. The above figure shows the locations of the spacecraft (GSE) when the IFE was detected. The abbreviations are: A for ACE, W for Wind, D for DSCOVR, AP for ARTEMIS P2, M for MMS, C for Cluster, and numbers 1 to 4 for Cluster 1 to 4, respectively. These spacecraft were all in the solar wind except Cluster which was in the magnetosheath downstream from the bow shock which slows the solar wind. The spacecraft in the solar wind see the signature expected for an accelerating cloud while the signature in the magnetosheath is that of a decelerating cloud moving at 317 km/s which is faster than the expected magnetosheath speed.

The Estimate Speed of the IFE:

In the Interplanetary Space: 365 km/s, close to the local solar wind speed.

In the Magnetosheath: ~317 km/s, still close to the solar wind speed. No Slowdown after the Bow Shock!

3. An IFE Destroying a Target

On 2018 January 16, an IFE was observed by 12 spacecraft arrayed from interplanetary space to the terrestrial magnetopause. The spacecraft in the solar wind see the signature expected for an accelerating cloud while the signature in the magnetosheath is that of a decelerating cloud moving at 317 km/s which is faster than the expected magnetosheath speed.

4. The IFE was detected by five spacecraft simultaneously. The well separated observations enable us to reconstruct the magnetic field geometry. A draping black dashed line is clearly shown in the plane containing the flow direction and background magnetic field direction. This indicates that the IFE is moving slower than the solar wind and is being accelerated. Momentum is transferred from the solar wind to the IFE if the IFE were to move faster than the solar wind we would expect the Bx component (parallel to the solar wind flow) to reverse.

5. In the Interplanetary Space, the solar wind is..