Nanoscale Dust Production at 1 Au; Identification and Tracking with 12 Spacecraft

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Interplanetary Field Enhancements are phenomena in the interplanetary magnetic field, first discovered near Venus, during an extremely long duration (12 hours) and large size (about 0.1 AU) passage across the Pioneer Venus spacecraft. Three and a half hours later and 21 x 10⁶ km farther from the Sun, this structure, somewhat weaker and off to the side of the expected radial path of any solar initiated disturbance, was seen by first Venera 13 and then Venera 14, trailing behind V13. Since this discovery, many smaller such disturbances have been observed and attributed to collisions of small rocks in space at speeds of about 20 km/s at 1 AU and faster, closer to the Sun. All sightings with magnetometers and other space plasma instruments give very precise measurements of the radial structure (of usually the magnetic field), but the scale transverse to the solar radius is poorly defined, as is the temporal evolution of the structure from single spacecraft data.

On January 16, 2018, near Earth, 12 spacecraft equipped with plasma spectrometers and magnetometers observed the passage of a single Interplanetary Field Enhancement. The magnetic field profiles at the four 1 AU spacecraft were very similar. The profiles were obtained at different times appropriate to their locations. The 4 Cluster spacecraft were closer to the Earth and in a region in which the solar wind had slowed down because of the Earth's bow wave (shock) in the solar wind. The disturbance in the shocked solar wind occurred at the time expected if the IFE structure had not been slowed by the plasma, but rather had proceeded with the momentum it had prior to the shock crossing. If the disturbance causing particles are small bits of rock (not protons), then they should have kept most of their momentum in crossing the bow shock. We view this as a complete test of the dust producing collisional origin of these Interplanetary Field Enhancements, and a clear demonstration of how the solar wind clears out the dust in the inner solar system produced by the continuing destructive collisional process.