Cosmic dust interactions with the solar wind

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Dust in the solar system originates from various sources within the solar system or the Interstellar medium. Such dust is affected by the Sun, especially from the solar wind plasma. Indeed, on top of the particle-to-dust contacts that push the dust or possibly destroy the dust grains, the solar wind shapes the interplanetary magnetic field and therefore bends the motion of the electrically charged dust grains. These plasma-dust interactions take place at the heliopause (~100 au, only for the interstellar dust entrance in the solar system), or closer to the Sun, in the interplanetary medium (from fractions of au to a few au).

Dust and its motion in the solar system can be studied by spacecraft specifically designed for its study or by other spacecraft impacted by dust grains. These impacted spacecraft, whose plasma wave antennas record a signal, essentially serve as unexpected dust grain detectors. One such example is the Wind/WAVES instrument. The Wind/WAVES dust impacts database (Malaspina & Wilson 2016) offers more than 25 years of data, however not calibrated or without detailed information on dust properties (velocity, electric charge, etc.).

We use this Wind/WAVES dust impacts database to study the dust-plasma interaction in the interplanetary medium, with a particular focus on Interstellar dust.
First, long-term variations – from months to years - of dust impact counts provide insights into the origin of the dust and its response to solar cycles.
Second, a frequency analysis in the dust impact counts highlights a solar rotation signature – 27 days and harmonics - (see Baalmann et al., submitted). This solar rotation signature is possibly linked to the Corotating Interaction Regions (CIRs) created by the solar wind.
Third, such effect of solar plasma on dust impacts is corroborated by a study that crosses Wind/WAVES dust impact data with solar events like Coronal Mass Ejections (CMEs) and Stream Interaction Regions (SIRs) catalog to look for short-term – a few days – effects. A statistically significant depletion of dust counts during such solar events is visible (see Péronne et al., in preparation).
Both studies show increased solar signatures on Interstellar dust and give new information on the cosmic dust interactions with the solar wind.

The interpretation of the data analysis from the Wind/WAVES instrument benefits from numerical simulations, especially for Interstellar dust trajectories within the heliosphere. Such simulations complement our understanding of how the Interstellar dust can reach the interplanetary medium, and how the properties of such grains make them particularly sensitive to the solar events mentioned before.