

EGU22-10957

<https://doi.org/10.5194/egusphere-egu22-10957>

EGU General Assembly 2022

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Dust detection by antenna instruments with applications to the STEREO spacecraft

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Plasma Wave antenna instruments are employed on a range of space missions and can also be used to characterize the population of cosmic dust particles. Such measurements are complementary to those made by a dedicated dust instrument and suitable for the detection of larger (> 1 micron) particles. These booms or deployed wires with receiving elements are sensitive to the plasma cloud generated by the hypervelocity impact of a dust particle on the spacecraft, or the antenna itself. The dust impact is registered as a transient voltage signal (waveform) that is due to the charging of the spacecraft/antenna, and the induced charging from the part of the plasma cloud that is expanding from the impact location. Recent advancements provide the capability of obtaining the mass of the impacting particle from the measured waveforms. The new models are based on first principles and account for the parameters of the impact plasma (in terms of effective temperatures and the geometry of the expansion), the parameters of the ambient space environment, and the geometry of the spacecraft. The latter two allow for determining the approximate impact location on the spacecraft and thus constrain the incoming direction of the dust particle. Once the expansion of the transient impact plasma is over, the spacecraft and the antennas discharge through the ambient environment and relax back to their equilibrium potentials. The analysis of the measured waveforms thus also provides information on the density of the ambient plasma and its temperature. The numerical model is applied for the reanalysis of the measurements made by the STEREO spacecraft.