The Spacecraft Potential’s Influence on the FOV of Rosetta-ICA at Low Ion Energies

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Low-energy ions play important roles in many processes in the environments around various bodies in the solar system. At comets, they are, for example, important for the understanding of the interaction of the cometary particles with the solar wind, including the formation of the diamagnetic cavity.

Unfortunately, spacecraft charging makes low-energy ions difficult to measure using in-situ techniques. The charged spacecraft surface will attract or repel the ions prior to detection, affecting both their trajectories and energy. The affected trajectories will change the effective FOV of the instrument. A negatively charged spacecraft will focus incoming positive ions, enlarging and distorting the FOV.

We model the low-energy FOV distortion of the Ion Composition Analyzer (ICA) on board Rosetta. ICA is an ion spectrometer measuring positive ions with an energy range of a few eV to 40 keV. Rosetta was commonly charged to a negative potential throughout the mission, and consequently the positive ions were accelerated towards the spacecraft before detection. This distorted the low-energy part of the data. We use the Spacecraft Plasma Interaction Software (SPIS) to simulate the environment around the spacecraft and backtrace particles from the instrument. We then compare the travel direction of the ions at detection and infinity, and draw conclusions about the resulting FOV distortion. We investigate the distortion for different spacecraft potentials and Debye lengths of the surrounding plasma.

The results show that the effective FOV of ICA is severely distorted at low energies, but the distortion varies between different viewing directions of the instrument. It is furthermore sensitive to changes in the Debye length and we observe a small non-linearity in the relation between FOV distortion, ion energy and spacecraft potential. Generally, the FOV is not significantly affected when the energy of the ions is above twice the spacecraft potential.