

Remote Sensing of a Bow Shock at Comet 67P: ICA and Hybrid Modelling

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No direct observational evidence of the cometary bow shock around comet 67P/Churyumov-Gerasimenko has been presented during the ESA/Rosetta mission. The Rosetta probe, during its escort phase, performed a lengthy dayside excursion up to a cometocentric distance of approximately 1500 kilometers, but no bow shock crossing was observed, implying either a distant bow shock or no bow shock formation at all. However, modelling studies at low heliocentric distances and high outgassing rates consistently predict the formation of a cometary bow shock within several thousands of kilometres of 67P's nucleus.

The Ion Composition Analyzer ICA, of the Rosetta Plasma Consortium, a top-hat ion spectrometer aboard Rosetta, measured solar wind and cometary ion distribution functions during the escort phase. As the length scales of the heavy cometary pickup ions exceed those of the predicted bow shock standoff distance by a factor of two up to an order of magnitude, the pickup ions could provide a remote sensing diagnostic of the cometary environment. A bow shock would present a significant increase in plasma heating and turbulence, leading to a modified acceleration environment for freshly ionized cometary particles and a modulation of the pickup ion energy spectra at the nucleus.

In this work, we summarily present a potential bow shock observation using the energy dispersion of cometary ions observed by ICA and provide an interpretation of the observations with a self-consistent, numerical hybrid plasma model. We describe simulated observations of ions from two cometary plasma environments, one shock-producing and one non-shocked, and give guidelines on how the bow shock could be inferred remotely from in-situ observations.