Ion velocity and electron temperature inside and around the diamagnetic cavity of comet 67P

Abstract

A major point of interest in cometary plasma physics has been the diamagnetic cavity, an unmagnetised region in the inner-most part of the coma. Here, we combine Langmuir and Mutual Impedance Probe measurements to investigate ion velocities and electron temperatures in the diamagnetic cavity of comet 67P, probed by the Rosetta spacecraft. We find ion velocities generally in the range 2-4 km/s, significantly above the expected neutral velocity $\lesssim$1 km/s, showing that the ions are (partially) decoupled from the neutrals, indicating that ion-neutral drag was not responsible for balancing the outside magnetic pressure. Observations of clear wake effects on one of the Langmuir probes showed that the ion flow was close to radial and supersonic, at least w.r.t. the perpendicular temperature, inside the cavity and possibly in the surrounding region as well. We observed spacecraft potentials $\lesssim$-5 V throughout the cavity, showing that a population of warm ($\sim$5 eV) electrons was present throughout the parts of the cavity reached by Rosetta. Also, a population of cold ($\lesssim$ 0.1 eV) electrons was consistently observed throughout the cavity, but less consistently in the surrounding region, suggesting that while Rosetta never entered a region of collisionally coupled electrons, such a region was possibly not far away during the cavity crossings.