THE ROLE OF ELECTRON DYNAMICS IN THE SOLAR WIND INTERACTION WITH COMET 67P/CHURYUMOV-GERASIMENKO AT 3 AU

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ESA’s Rosetta orbiter spacecraft escorted comet 67P/Churyumov-Gerasimenko for almost two years, carrying 21 scientific instruments. Five of those were dedicated to plasma measurements. The mission revealed for the first time, and in unprecedented detail, the fascinating evolution of the former Kuiper Belt object as it races along its 6.45yr elliptical orbit around the Sun [1]. Using a self-consistent 3-D fully kinetic electromagnetic particle-in-cell approach [2-3], we focus on the global cometary environment and, in particular, on the collisionless electron-kinetic interaction. We include cometary ions and electrons produced by the ionization of the outgassing cometary atmosphere in addition to the solar wind ion and electron plasma flow. We approximate mass-loading of the cold cometary ion and electron populations using a 1/r relation with distance to the comet with a total neutral production rate of $Q = 10^{26}\ s^{-1}$ [4-5]. Our simulation results disentangle for the first time the kinetic ion and electron dynamics of the solar wind interaction with a weakly outgassing comet. The simulated global structure of the solar wind - comet interaction confirms the results reported in hybrid simulations of the induced cometary magnetosphere [6-8]. We show that cometary and solar wind electrons neutralize the solar wind protons and cometary ions, respectively, in the region of influence around the comet, representing to first order a four-fluid behavior [9]. Analyzing ion and electron energy distribution functions, and comparing with plasma measurements from ESA's Rosetta mission to comet 67P/Churyumov-Gerasimenko, we conclude that a detailed kinetic treatment of the electron dynamics is critical to fully capture the complex physics of mass-loading plasmas [10].

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