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The electron-to-neutral number density ratio in the inner coma of 67P at different stages of the Rosetta mission

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The ESA Rosetta spacecraft has followed comet 67P/Churyumov-Gerasimenko closely (typically at tens to hundreds of km) since early August 2014 covering heliocentric distances from $\sim$3.6 AU to $\sim$1.25 AU at perihelion in August 2015.
Since arrival at the comet the neutral number density, nN, at the spacecraft location, has been probed by the Rosetta Orbiter Spectrometer for Ion and Neutral Analysis/Comet Pressure Sensor (ROSINA/COPS [1]). Likewise, the dual Langmuir Probe (LAP [2]) and the Mutual Impedance Probe (MIP [3]), both being subsystems of the Rosetta Plasma Consortium (RPC [4]), have operated allowing for the retrieval of the electron number density, ne. Arguably, the electron-to-neutral number density ratio, ne/nN, accessible from these observations, is key to gain insights into the processes dictating the ionization balance within the inner coma of 67P [5].
In January 2015, at a heliocentric distance of $\sim$2.4-2.6 AU (and when not being disturbed by by-passing co-rotating interaction regions [6]) we find that a Field Free Chemistry Free (FFCF) solar EUV deposition model reasonably well captures the observed ne/nN ratio in the H_2O dominated summer hemisphere of 67P. For the same period we find ratios often elevated by more than a factor of 2 (with respect to modeled values) in the winter hemisphere and argue that this partly could be caused by high mixing ratios of CO_2 [see 7].
We are currently conducting a study of ne/nN ratios in the coma of 67P when close to perihelion, which includes time-intervals when within the diamagnetic cavity as attested from observations [8] by the RPC/Fluxgate Magnetometer (MAG, [9]). Results of these investigations will be presented at the meeting. The closer distance to the sun and the enhanced activity bring about several effects that are anticipated to at least somewhat reduce ne/nN ratios from values predicted by the FFCF-model. As an example one may expect an increased influence of dissociative recombination on the ionization balance. This is not only due to the increased ion-electron pair formation from photoionization but also because the enhanced outgassing makes collisional electron cooling more efficient, reducing the electron temperature, in turn giving higher recombination coefficients.

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