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Ion-chemistry model of 67P/Churyomov-Gerasimenko

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Abstract

Rosetta will uniquely follow comet 67P/Churyumov-Gerasimenko (hereafter referred as 67P/CG) as it approaches the Sun and starts to develop its coma. When it reaches perihelion at ~1.3 AU in August 2015, the comet is expected to have an outgassing rate of ~$5x10^{27}$ molecules s^{-1} and to possess a well-developed ionosphere, which will be probed *in situ* by a full suite of instruments (e.g., plasma, dust, neutrals) on the Rosetta orbiter down to cometocentric distances of 5-20 km. Here we present an ion-chemistry model, the results of which will serve for comparison with the future Rosetta measurements of electron and ion number densities within the diamagnetic cavity of the comet.

We combine detailed solar energy deposition calculations with a gas-phase only ion-chemistry model including transport (the role of dust grains for the thermal electron balance and ion chemistry will be assessed at a later stage). At perihelion the electron number density is predicted to peak about 1 km above the surface at a value of ~10^5 cm^{-3}. The ion population there, and up to cometocentric distances of tens of km, may very well be largely dominated by ions such as NH_4^+ or $CH_3OH_2^+$, should NH_3 and/or CH_3OH prevail at volume mixing ratios only exceeding 0.5% or so. Note that NH_3 and CH_3OH, previously observed in cometary comae, are molecules with higher proton affinity than H_2O. While future observations may be used to update most of the input parameters of our model, we highlight also the need for new laboratory measurements of chemical reactions. Of particular importance is the assessment of rate coefficients at very low temperatures of some key ion-neutral reactions, addressed in this study.