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The Rosetta spacecraft escorted comet 67P/Churyumov-Gerasimenko for two years along its orbit, from Aug 2014 to Sep 2016, observing the evolution of the comet from a close perspective. The Rosetta Plasma Consortium (RPC) monitored the plasma environment at the spacecraft throughout the escort phase.

Cometary electrons are produced by ionization of the neutral gas coma. This occurs through photoionization by extreme ultraviolet photons, and through electron-impact ionization (EII) by collisions of energetic electrons with the coma. Far from perihelion, EII is, at times, more prevalent than photoionization (Galand et al., 2016; Heritier et al., 2018), but the EII frequency has not been assessed across the whole mission. The source of the cometary electrons, and the origin of the ionizing electrons is still unclear.

We have calculated the electron impact ionization (EII) frequency throughout the Rosetta mission and at its location from measurements of RPC's Ion and Electron Sensor (RPC/IES). EII ionization is confirmed as the dominant source of cometary electrons and ions when far from perihelion but is much more variable than photoionization. We compare the EII frequency with properties of the neutral coma and cometary plasma to identify key drivers of the energetic electron population. The EII frequency is structured by outgassing rate and magnetic field strength.

The first 3D collision model of electrons at a comet (Stephenson et al. 2022) is also utilised to assess the origin of electrons within the coma. The model uses self-consistently calculated electric and magnetic fields from a fully-kinetic and collisionless Particle-in-Cell model (Deca et al. 2017, 2019)as an input. The modelling approach confirms cometary electrons are produced by impacts of energetic electrons at low outgassing. The ionizing electrons are identified as solar wind electrons

that have undergone acceleration in an ambipolar potential well, confirming the results of the data analysis.

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