Comet 67P: utilizing fully kinetic simulations to study its interaction with the solar wind plasma

Andrey V Divin (Swedish Inst of Space Physics)
Jan Deca (University of Colorado Boulder)
Mihaly Horanyi (University of Colorado Boulder)
Pierre Henri (LPC2E/CNRS - Université d'Orléans)

We present preliminary results of the first 3-D fully kinetic and electromagnetic simulations of the solar wind interaction with 67P/Churyumov–Gerasimenko at ~3 AU, before the comet transitions into its high-activity phase.
We focus on the global cometary environment and the electron-kinetic activity of the interaction. In addition to the background solar wind plasma flow, our model includes also plasma-driven ionization of cometary neutrals and collisional effects. We approximate mass loading of cold cometary oxygen and hydrogen using a hyperbolic relation with distance to the comet. We consider two primary cases: a weak outgassing comet (with the peak ion density ~10x the solar wind density) and a moderately outgassing comet (with the peak ion density ~50x the solar wind density).

The weak comet is characterized by the formation of a narrow region containing a compressed solar wind (the density of the solar wind ion population is ~3x the value far upstream of the comet) and a magnetic barrier (~2x to 4x the interplanetary magnetic field). Blobs of plasma are detached continuously from this sheath region. Standing electromagnetic waves are excited in the cometary wake due to a strong anisotropy in the plasma pressure, as the density and the magnetic field magnitude are anti-correlated.
The moderate mass-loading case shows more dynamics at the dayside region. The stagnation of the solar wind flow is accompanied by the formation of elongated density stripes, indicating the presence of a Rayleigh-Taylor instability. These density cavities are elongated in the direction of the magnetic field and encompass the dayside ionopause.

To conclude, we believe that our results provide vital information to disentangle the observations made by the Rosetta spacecraft and compose a global solar wind - comet interaction model.