**FIRST RESULTS AT 67P/CHURYUMOV-GERASIMENKO WITH THE ROSETTA PLASMA CONSORTIUM.** K. E. Mandt[1], J. L. Burch[1], C. Carr[2], A. I. Eriksson[3], K.-H. Glassmeier[4], J.-P. Lebreton[5], H. Nilsson[6], C. Béghin[5], T. W. Broiles[1], G. Clark[7], E. Cupido[2], N. Edberg[3], M. Galand[2], R. Goldstein[1], P. Henri[5], C. Koenders[4], P. Mokashi[1], Z. Nemeth[8], C. Pollock[7], I. Richter[4], M. Samara[7], K. Szego[8], C. Vallat[9], X. Vallières[5], M. Volwerk[10], G. S. Wieser[6] and D. Winterhalter[11], [1]Southwest Research Institute, Space Science & Engineering, PO Drawer 28510, San Antonio, TX 78228 kmandt@swri.org, [2]Imperial College London, London, United Kingdom, [3]IRF Swedish Institute of Space Physics Uppsala, Uppsala, Sweden, [4]Technical University of Braunschweig, Braunschweig,Germany, [5]Laboratoire de Physique et Chimie de l'Environnement et de l'Espace, Orléans Cedex 2, France, [6]IRF Swedish Institute of Space Physics Kiruna, Kiruna, Sweden, [7]NASA/GSFC, Greenbelt, Maryland, USA, [8]Wigner Res. Inst. for Physics, Budapest, Hungary, [9]ESAC, Villanueva, Spain, [10]Space Research Institute, Austrian Academy of Sciences, Graz, Austria, [11]NASA Jet Propulsion Laboratory,Pasadena, CA, United States

**Introduction:** After more than ten years in space, the Rosetta spacecraft arrived at its target, comet 67P/Churyumov-Gerasimenko (CG) in early August 2014. Although the comet was expected to be in a state of relatively low activity, its interaction with the solar wind has been found to cause plasma conditions different from unperturbed solar wind characteristics. Since arrival at the comet the five plasma sensors of the Rosetta Plasma Consortium (RPC) [1] have been investigating these cometary activity driven perturbations.

Prior to arrival at the comet, the possible first signs of cometary activity that were expected include distributions of pick-up ions detected by the Ion and Electron Sensor (RPC-IES) [2] and the Ion Composition Analyzer (RPC-ICA) [3], ion cyclotron waves generated by the pick-up process and measured by the Fluxgate Magnetometer (RPC-MAG) [4], and electron density and temperature measurements, as well as electric-field and waves measurements in the range from DC up to 3.5 MHz obtained by the Langmuir probes (RPC-LAP) [5] and the Mutual Impedance Probe (RPC-MIP) [6]. RPC instruments have made not only these observations, but also several that were not expected prior to the Rosetta mission.

**Solar wind charge exchange:** Figure 1 illustrates the ion and electron counts measured by RPC-IES at a distance of 10 km from CG. This shows a clear signal of solar wind protons and alpha ($He^{++}$) particles as well as demonstrating the interaction of the solar wind with the cometary coma. The ion signal seen at four times the solar wind proton energy has been consistently observed since arrival at CG and is produced by charge exchange of solar wind $He^{++}$ in the coma, a process also observed at Halley by Giotto [7]. Furthermore, a signal at an energy slightly lower than the solar wind proton energy was observed in the RPC-IES electron energy spectra at a flux that was ~20% of the solar wind proton flux. This is interpreted to be negative hydrogen ions produced as a result of double charge exchange between solar-wind protons and the coma. This was an unexpected observation and to our knowledge there have been no previous measurements of negative ions in the solar wind or negative hydrogen in a cometary coma.

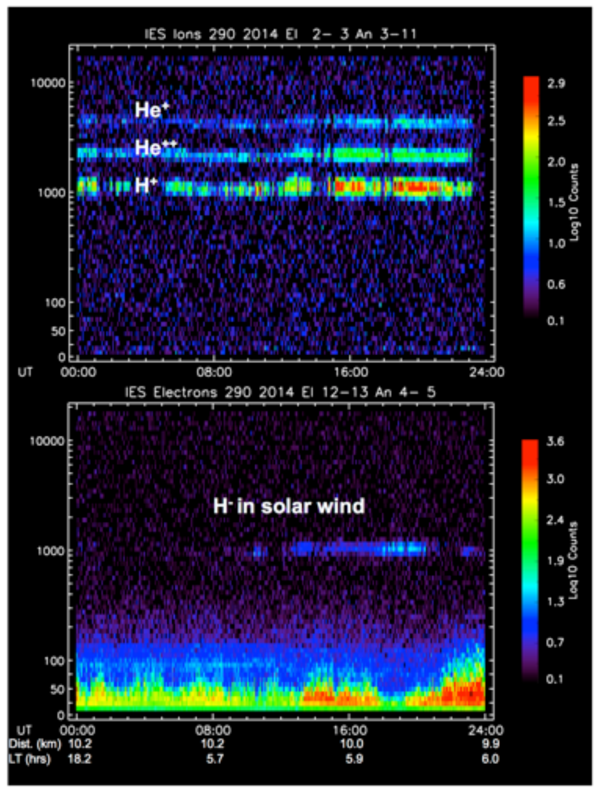


**Figure 1: Charge exchange of the solar wind observed by RPC-IES.**

**Pick up ions:** Since arrival at CG, RPC-ICA and RPC-IES have regularly observed locally produced newborn water ions and ions accelerated up to ~1 keV as illustrated in Figure 2. These ions are a signature of the neutral atmosphere through which the solar wind has passed prior to reaching Rosetta.

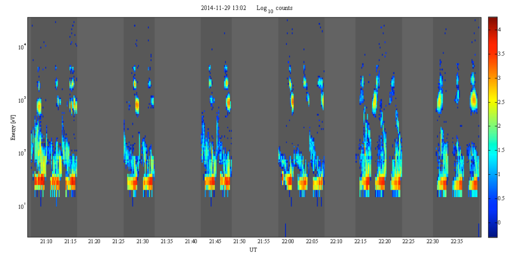


**Figure 2: RPC-ICA observations of newborn water ions accelerated by a spacecraft potential of approx. –20 V as well as pick up ions accelerated to energies up to ~1 keV. Also shown are solar wind protons, $He^{++}$ and $He^{+}$ resulting from charge exchange.**

**Charged grains:** The RPC-IES electron sensor has observed high energy particles extending between a few hundred eV/q and 20 keV/q that are interpreted to be negatively charged nanograins [8] because they have energies much higher than can be attributed to either solar wind or cometary electrons.

**The "singing" comet:** The RPC-MAG observed the generation of low frequency waves (~ 50 mHz) within 100 km of CG at a level that was two orders of magnitude greater than the quiet solar wind spectrum measured in May 2014 (Figure 3). Observllations showed broad band excitation in the 10-200 mHz band as well as time varying discrete monofrequent excitations in the 50 mHz region which have been described as the "singing comet".

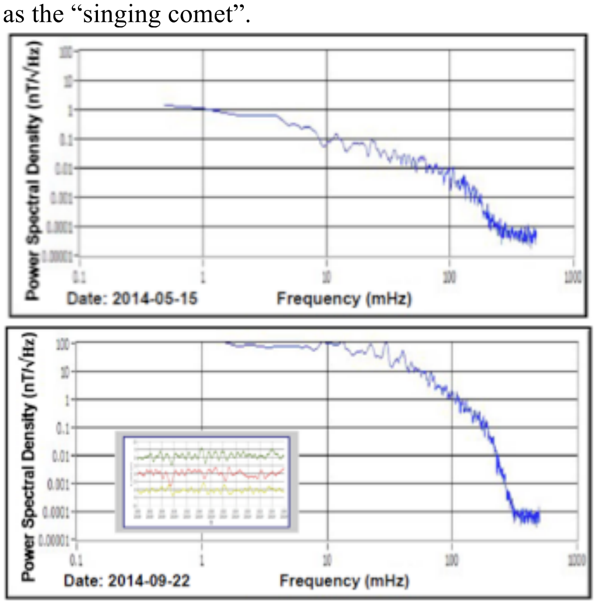


**Figure 3: Reference wave spectrum measured by RPC-MAG of the quiet solar wind (top) compared with strong wave activitiy in the vicinity of CG (bottom).**

**Spatial variability of ion and electron density:** RPC-MIP and RPC-LAP have monitored the local ion and electron density since arriving at CG and are evaluating the spatial and temporal variability of these densities. Figures 4 & 5 provide preliminary estimates of density subject to further cross-calibration.

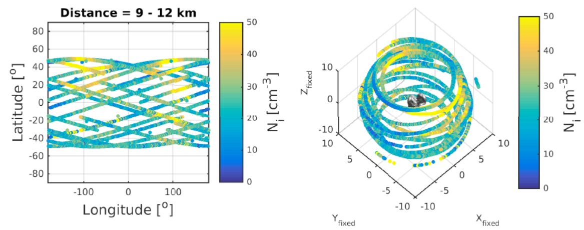


**Figure 4: Cometary ion density (in $cm^{-3}$ with a factor up 5 uncertainty) measured by RPC-LAP within the comet reference frame.**

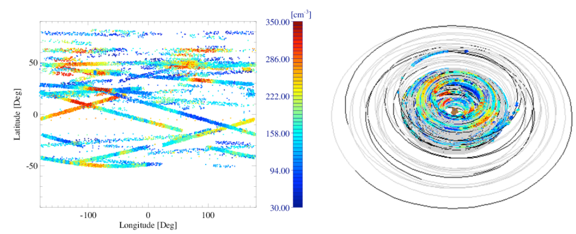


**Figure 5: Electron density (in $cm^{-3}$ with a factor up 5 uncertainty) measured by RPC-MIP within the comet reference frame.**

Clearly, the plasma density observed is determined over which position on the comet Rosetta is located, showing that the plasma at these close distances is determined by the outgassing from the nucleus and not by the solar wind. Even a rather unactive comet at 3 AU, hence does not show an asteroid-like solar wind dominated plasma environment at close distance.

**Conclusion:** In summary, plasma observations by Rosetta at CG have been exciting, providing unexpected findings. More is expected to come as CG approaches perihelion and the outgassing rate increases.

**References:** [1] Carr C. et al. (2007) *SSRv, 128,* 629–647. [2] Burch J. et al. (2007) *SSRv, 128*, 697–712. [3] Nilsson H. et al. (2007) *SSRv, 128*, 671–695. [4] Glassmeier et al. (2007) *SSRv, 128*, 649–470. [5] Trotignon J. G. et al. (2007) *SSRv, 128*, 713–728. [6] Eriksson A. I. et al. (2007) *SSRv, 128*, 729–744. [7] Shelley et al. (1987) *A&A, 187*, 304-306. [8] Horanyi & Mendis (1985) *ApJ, 294*, 357-368.