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The Dynamic Plasma of Comet 67P

Anders I. Eriksson (1), Niklas Edberg (1), Fredrik L. Johansson (1,2), Erik Vigren (1), Jan Deca (3), Andrey Divin (4), Marina Galand (5), Charlotte Goetz (6), Pierre Henri (7), Kristie Llera (8), Hadi Madanian (9), Hans Nilsson (10), Elias Odelstad (11), Martin Rubin(12), Gabriella Stenberg Wieser (10), and Martin Volwerk (13).
(1) Swedish Institute of Space Physics, Uppsala (anders.eriksson@irfu.se), (2) Uppsala University, Sweden, (3) University of Colorado, Boulder, USA, (4) St. Petersburg State University, Russia, (5) Imperial College London, UK, (6) Technische Universität Braunschweig, Germany, (7) LPC2E, Orléans, France, (8) Southwest Research Institute, San Antonio, TX, USA, (9) University of Iowa, Iowa City, USA, (10) Swedish Institute of Space Physics, Kiruna, (11) Royal Institute of Technology, Stockholm, Sweden, (12) University of Bern, Switzerland, (13) Space Research Institute, Austrian Academy of Science, Graz.

Abstract

The inner coma plasma observed by Rosetta at comet 67P/Churyumov-Gerasimenko was very dynamic at all outgassing rates (10^{26}-10^{29} s^{-1}) and all heliocentric (1.25-3.8 AU) and cometocentric (0.25 - 1500 km) distances covered. On a time scale of tens of seconds to a few minutes, the relative variations in plasma density sometimes reached the 100% level. Variations in the magnetic field and particle fluxes were often equally dramatic and abrupt. The plasma density fluctuations (in per cent) were several orders of magnitude higher than the corresponding neutral gas and solar wind variations. This shows they are due mainly to the internal dynamics of the cometary plasma, though external drivers like space weather events can at times dominate. We show statistics and examples from Rosetta, establish time scales of the dynamics and discuss physical interpretations. While the plasma variations on a time scale of the nucleus spin (12 h) mainly are dictated by the neutral gas density, the marginal effect of collisionality becomes clear when comparing the rich plasma dynamics on shorter time scales to the relatively smooth neutral gas density. A particularly interesting question is how different Rosetta plasma observations from 67P really are to previous findings from rapid cometary flybys. We find that while some of the apparent differences are due to real differences between the environments of the comets visited, determined mainly by their outgassing activity, others may more be due to the disparate measurement situations. One such difference is Rosetta going much closer to its nucleus, but also the slow motion of Rosetta (~1 m/s) favours detection of temporal phenomena, while the fast flybys (~70 km/s for Giotto at 1P/Halley) invited interpretations in terms of spatial structures (regions, boundaries). We also discuss the impact for future investigations by single- and multi-spacecraft comet flyby and escort missions.