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To prime ROSINA for the Rosetta Encounter with Comet 67P/Churyumov-Gerasimenko

M. Rubin (1), K. Altwegg (1,2), L. Le Roy (2), B. Schläppi (3), and V. M. Tenishev (4)
(1) Space Research and Planetary Sciences, University of Bern, Switzerland, (2) Center for Space and Habitability, University of Bern, Switzerland, (3) Aerosols and Nanoscience, Swiss Federal Institute of Technology Zürich, Switzerland, (4) Atmospheric, Oceanic and Space Sciences, University of Michigan, USA (martin.rubin@space.unibe.ch)

Abstract

ESA's Rosetta spacecraft is currently on its way to rendezvous comet 67P/Churyumov-Gerasimenko (67P/C-G). It carries with it the Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (ROSINA) instrument suite that consists of two mass spectrometers and a pressure sensor.

In order to prepare ROSINA for the cometary environment we perform various studies including laboratory measurements of expected species, modeling of the environment including revisiting observations obtained during previous missions to comets, and data analysis of measurements already obtained in space. Here we will report on the findings obtained by ROSINA before reaching the comet, we will touch on the expected environment at 67P/C-G, and briefly discuss the difficulties we expect to face at the comet.

1. The ROSINA instrument

ROSINA consists of the COmet Pressure Sensor (COPS), the Double Focusing Mass Spectrometer (DFMS), and the Reflectron-type Time-Of-Flight (RTOF) mass spectrometer. ROSINA is designed to detect and monitor the neutral gas and plasma environment in the comet's coma [1]. Rosetta will orbit and fly-by the comet in order to monitor the spatial and temporal variability of the coma as it follows the comet to and past perihelion. COPS is able to derive total gas densities as well as gas velocities. The two mass spectrometers are built to complement each other with high resolution to derive isotopic ratios and separate components (DFMS) and increased mass range for the detection of larger molecules (RTOF).

2. Spacecraft background

Right from the beginning after launch ROSINA detected an atmosphere around the Rosetta spacecraft itself. Over the course of the cruise phase the temporal behavior of this background atmosphere has been monitored. ROSINA observes three major processes acting on increasing time scales, first desorption of material sticking to the surface of the spacecraft, second the diffusion of volatiles from the inside structure of the spacecraft (e.g. trapped particles in the multi layer insulation foil), and third the decomposition of some of the used materials [2]. The composition of the background shows evidence of polycarbonates and fluorocarbons (spacecraft structure, tapes, etc.), solvents, lubricants, fragments of the propellant and its oxidizer, etc. These findings do impact the capability of ROSINA to detect minor species but are also interesting for other missions where spacecraft contamination can affect the performance of telescopes and particle instruments. For instance the background of Rosetta was much more prominent compared to the atmosphere of asteroid Lutetia, at least for the given geometry of the fly-by, and only an upper limit for asteroid's exosphere could be derived [3]. Furthermore we also find that spacecraft outgassing can explain at least a part of the Pioneer anomaly, i.e. the anomalous deceleration of the Pioneer spacecraft observed over the course of the last few decades [4].

3. Preparations for the rendezvous with comet 67P/C-G

For the purpose of preparing instrument operations we engage in modeling of the expected fluxes and abundances of neutral gas and plasma at the comet as well as joint lab experiments with components which might be encountered at the comet.

The models contain neutral gas and dust as well as the plasma phase ([5], [6]). Based on the cometocentric and heliocentric distance the composition and abundance of individual species varies greatly and during the early part of the mission we have to worry about the background signal of Rosetta itself.

Chemical components already detected in comets ([7]) and in the spacecraft background ([2]), are currently being analyzed in our lab with the flight spare instrument (if possible based on their corrosiveness and toxicity). We will discuss briefly some of the results of the expected environment to be encountered at the comet and discuss some of the problems that might arise during the course of the mission.

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References

[1] Balsiger, H., Altwegg, K., Bochsler, P., Eberhardt, P., Fischer, J., Graf, S., Jäckel, A., Kopp, E., Langer, U., Mildner, M., Müller, J., Riesen, T., **Rubin**, **M.**, Scherer, S., Wurz, P., Wüthrich, S., Arijs, E., Delanoye, S., DeKeyser, J., Neefs, E., Nevejans, D., Rème, H., Aoustin, C., Mazelle, C., Mèdale, J.-L., Sauvaud, J. A., Berthelier, J.-J., Bertaux, J.-L., Duvet, L., Illiano, J.-M., Fuselier, S. A., Ghielmetti, A. G., Magoncelli, T., Shelley, E. G., Korth, A., Heerlein, K., Lauche, H., Livi, S., Loose, A., Mall, U. A., Wilken, B., Gliem, F., Fiethe, B., Gombosi, T. I., Block, B., Carignan, G. R., Fisk, L. A., Waite, J. H., Young, D. T., and Wollnik, H., ROSINA -Rosetta Orbiter Spectrometer for Ion and Neutral Analysis, Space Science Review, Space Science Reviews, Volume 128, Issue 1-4, pp. 745-801, 02/2007.

[2] Schläppi, B., Altwegg, K., Balsiger, H., Hässig, M., Jäckel, A., Wurz, P., Fiethe, B., Rubin, M., Fuselier, S. A., Berthelier, J.-J., DeKeyser, J., Rème, H., and Mall, U. A., Influence of spacecraft outgassing on the exploration of tenuous atmospheres within situ mass spectrometry, J. Geophys. Res., Vol. 115, A12313, 12/2010.

[3] Altwegg, K., Balsiger, H., Calmonte, U., Hässig, M., Hofer, L., Jäckel, A., Schläppi, B., Wurz, P., Berthelier, J.-J., DeKeyser, J., Fiethe, B., Fuselier, S. A., Mall, U., Rème, H., and Rubin, M., In situ mass spectrometry during the Lutetia flyby, Plan. and Sp. Sci., Vol. 66, Issue 1, 173-178, 06/2012.

[4] Schläppi, B., Altwegg, K., Riesen, T., Rubin, M., An underestimated onboard generated recoil force to contribute to the Pioneer anomaly, Adv. Sp. Res., Vol. 49, Issue 3, pp. 579-585, 02/2012

[5] Tenishev, V. M., Combi, M. R., and Rubin, M., Numerical Simulation of Dust in a Cometary Coma: Application to Comet 67P/Churyumov-Gerasimenko, Astrophys. J., Vol. 732, pp. 104-121, 05/2011.

[6] Rubin, M., Hansen, K. C., Gombosi, T. I., Combi M. R., Altwegg, K., and Balsiger, H., Ion composition and chemistry in the coma of comet 1P/Halley: A comparison between Giotto's Ion Mass Spectrometer and our Ion-Chemical Network, Icarus, Vol. 199, Issue 2, pp. 505-519, 02/2009.

[7] Bockelée-Morvan, D., Crovisier J., Mumma, M. J., and Weaver, H. A., The composition of cometary volatiles. Comets II. Festou, M. C., Keller, H. U., and Weaver, H. A., Tucson, USA, the University of Arizona Press, 391 – 423, 2004.