

First results at comet 67P/Churyumov-Gerasimenko from the high resolution mass spectrometer ROSINA DFMS on-board the Rosetta spacecraft

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Abstract

The ROSINA experiment will be the first experiment since the Giotto mission to probe the composition and dynamics of a cometary atmosphere using in situ mass spectrometry. We will present the first results of the high-resolution mass spectrometer of ROSINA at comet 67P/Churyumov-Gerasimenko.

1. Introduction

Since the end of the Giotto mission, no in situ mass spectrometer measurements of cometary atmospheres have been performed. The European Space Agency's Rosetta spacecraft, which carries the ROSINA (Rosetta Orbiter Sensor for Ion and Neutral Analysis) experiment, will give us the next chance to probe and study the composition and the dynamics of a comet's coma.

2. ROSINA and DFMS

The ROSINA experiment consists of a suite of three instruments: a pressure sensor (COPS: COmetary Pressure Sensor) and two mass spectrometers: the Reflectron Time of Flight mass spectrometer (RTOF) and the Double Focusing Mass Spectrometer (DFMS). The two sensors are complementary. RTOF has a larger mass range and can record mass spectra at higher time resolution than DFMS; whereas, DFMS has better mass resolution ($m/\Delta m = 9000$ at FWHM at 28 amu/q) than RTOF.

Here we will focus on the high-resolution mass spectrometer of ROSINA. DFMS is a traditional magnetic mass spectrometer that combines an electrostatic analyzer for energy analysis with a magnet for momentum analysis. To date, DFMS is the highest mass resolution mass spectrometer in space. It will be able to resolve CO from N₂ at $m/z = 28$ amu/q or ¹²CH and ¹³C at $m/z = 13$ amu/q [1]. This will allow to measure many isotopes in different molecules, from Deuterium to Oxygen isotopes and ¹⁵N.

3. Objective

Starting from May 2014, the ROSINA experiment will take measurements. At this date the Rosetta spacecraft will still be far from the comet, therefore the three sensors will characterize the probe's outgassing. These first measurements will be very important for the early phase of the mission where the activity of the comet will be low [2]. ROSINA will then monitor the gaseous composition during the comet approach phase and we expect the first results of 67P/CG's coma in early August. We will present the first results of DFMS on elemental and isotopic composition from the high resolution mass spectra obtained at 67P/CG.

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., Arijis, E., Delanoye, S., de Keyser, J., Neefs, E., Nevejans, D., Rème, H., Aoustin, C., Mazelle,

C., Médale, 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., 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 Reviews 128, pp745-801, 2007.

[2] Schläppi, B., Altwegg, K., Balsiger, H., Hässig, M., Jäckel, A., Wurz, P., Fiethe, B., Fuselier, S. A., Berthelier, J. J., De Keyser, J. Rème, H. and Mall, U., Influence of spacecraft outgassing on the exploration of tenuous atmospheres with in situ mass spectrometry, Journal of geophysical research, Vol. 115, pp 2156-2202, 2010