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The DFMS sensor of ROSINA onboard Rosetta: how to account for instrumental effects?

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In 2014, Rosetta will finally meet comet 67P/Churyumov-Gerasimenko. The Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (ROSINA) consists of three sensors, each of which addresses a subset of the scientific objectives. The DFMS sensor is a double focusing magnetic mass spectrometer developed in cooperation with the Belgian institute for space aeronomy (BISA) and is optimized for very high mass resolution and large dynamic range.

The DFMS consists of three major parts: an ion source, a mass analyzer and a detector package containing three detectors. The ion source allows two basic operational modes: an ion mode, in which cometary ions are directly sampled in the mass spectrometer, and a neutral gas mode in which cometary gases undergo electron ionization (EI) before analysis. The DFMS analyzer can be operated in both a low mass resolution (LR) and high resolution (HR) mode and is provided with an electrostatic zoom lens system to allow the high mass dispersion needed for use with the position-sensitive microchannel plate (MCP) detector, which is the main detector. Ions that hit the MCP release electrons, and these are recorded by a linear electron detector array with 512 anodes (LEDA512). To increase sensitivity and facilitate the detection of heavier ions, a post-acceleration voltage can be applied on the front face of the MCP.

Raw data for a certain commanded mass (m0) within a given measuring time is obtained under the form of detector counts as a function of MCP pixel number. Several corrections need to be applied to obtain a mass spectrum with ion counts per second (cps) as a function of m/Z value.

Establishing the mass scale: the mass scale is mainly dependent on the dispersion constant D, the zoom factor z (which is different between LR and HR) and the pixel (p0) associated with the commanded mass. In HR, a high post-acceleration is applied for commanded masses > 70. Because p0 also depends on m0, p0 needs to be determined as a function of m0. To assist in this effort, ROSINA is equipped with a gas calibration unit (GCU) that allows to inject well-defined quantities of a known gas mixture of He, CO_2 and Kr into the instrument.

Establishing the intensity: the intensity for a certain ion is dependent on the gain of the individual MCP pixels, the detector yield, and the overall gain of the instrument optics.

Finally, to obtain instrument-independent gas number densities and compositions, fragmentation caused by EI needs to be taken into account, as well as the ionization cross sections, the ion transmission through the instrument, and the detector yield.

This contribution focuses on the data treatment process and presents the remaining challenges.