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Chlorine-bearing species and the $^{37}Cl/^{35}Cl$ isotope ratio in the coma of comet 67P/Churyumov-Gerasimenko

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A full-mission analysis of Cl-bearing species in the coma of comet 67P/Churyumov-Gerasimenko has been conducted using data from the Rosetta ROSINA/DFMS mass spectrometer. This contribution will focus on the challenges encountered to relate DFMS data on Cl-bearing species to the neutral abundances at the comet.

DFMS was operated in neutral mode, in which electron impact ionizes a fraction of the incoming neutral gas in the ion source. Only ions in a narrow range around a certain commanded mass-over-charge ratio (m/z) pass through the mass analyser at a time and impact on a micro-channel plate (MCP), creating an electron avalanche that is recorded by a Linear Electron Detector Array chip with two rows of 512 pixels each (LEDA A and LEDA B). Data are obtained as Analog-to-Digital Converter (ADC) counts as a function of LEDA pixel number. The instrument scans over a sequence of m/z values.

A well-defined approach exists to convert ADC counts as a function of pixel number to the number of ions that were detected on the MCP. However, to relate the number of ions detected this way to the abundance of neutrals in the coma gas, the sensitivity for each neutral needs to be known. The sensitivity for a certain neutral takes into account the total ionization cross section for the neutral and product ion fraction, instrument transmission and secondary electron yield for each product ion. Sensitivities can be determined experimentally by introducing the neutrals in the DFMS instrument copy in the laboratory, but such data are not available for Cl-bearing species and an alternative approach needs to be used. Fortunately, the use of ratios cancels out some of the factors that play a role in the sensitivity. As an example, for the $^{37}Cl/^{35}Cl$ ratio, total ionization cross sections and product ion fractions can be considered identical. In the case of $^{37}Cl/^{35}Cl$, taking into account the sensitivity results in a correction of more than 15%, mainly due to the secondary electron yield.

The $^{37}Cl/^{35}Cl$ ratio does not appear to change appreciably throughout the mission and is compared with known values from other solar system objects. The Cl/HCl ratio obtained with DFMS indicates

that there must be at least one additional chlorine-bearing species on the comet next to HCl, CH_3Cl and NH_4Cl, the identity of which is unknown at this time.