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Measuring the $^{13}C/^{12}C$ Ratio in the Dust of Comet 67P Using COSIMA

John Paquette (1), Martin Hilchenbach (1), Nicolas Fray (2), Cecile Engrand (3), Martin Hilchenbach (1), Hervé Cottin (2), and the COSIMA Team.
(1) Max Planck Institute for Solar System Research, Göttingen, Germany, (2) Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA), UMR CNRS 7583, Université Paris Est Créteil et Institut Pierre Simon Laplace Créteil, France, (3) Centre de Sciences Nucléaires et de Sciences de la Matière - CSNSM, CNRS/IN2P3-Univ. Paris Sud (UMR8609), Université Paris-Saclay, Orsay, France.
(paquette@mps.mpg.de)

Abstract

The isotopic ratio $^{13}C/^{12}C$ measured in the dust of comet 67P Churyumov-Gerasimenko (hereafter 67P) using the COSIMA (COmetary Secondary Ion Mass Analyzer, [1]) instrument on board Rosetta will be compared to previous measurements of this ratio in comets and in other extraterrestrial materials.

1. Introduction

The isotopic composition of extraterrestrial matter can provide important information about that matter's history, because isotopic fractionation is affected by many conditions such as chemistry, temperature, and radiation. The $^{13}C/^{12}C$ ratio has been measured in a fair number of comets, in the gas phase for C_2, CN, HCN, C_2H_4, C_2H_5, CO, and CO_2 [2, 3, 4] mostly by remote sensing techniques, but also in situ with the ROSINA instrument on board Rosetta. Here we present measurements of the carbon isotopic composition measured in cometary dust collected by the COSIMA instrument, which collected tens of thousands of dust particles from within the coma of comet 67P, and subjected a number of dust particles to ToF-SIMS (Time-of-Flight-Secondary Ion Mass Spectrometry) analysis allowing composition to be determined.

2. Measurement Technique

While the simplest technique to measure the $^{13}C/^{12}C$ ratio would be to compare the mass peaks at masses 12 and 13, that is impractical due to interference from ^{12}CH at mass 13 that is not resolved by the intrinsic mass resolution of COSIMA. Instead masses 15 ($^{12}CH_3$; see Figure 1) and 16 ($^{13}CH_3$; see Figure 2) are used. All peaks at these masses are fit, allowing the evaluation of the desired species. Background contribution is subtracted using a previously established technique (described in, e.g. [5]).

This method is then applied to a selection of spectra from cometary particles (chosen by the criterion that the mass 12 peak is of greater amplitude than the highest peak at mass 15. This is an indicator of spectra arising from a cometary particle rather than from the target substrate [6].

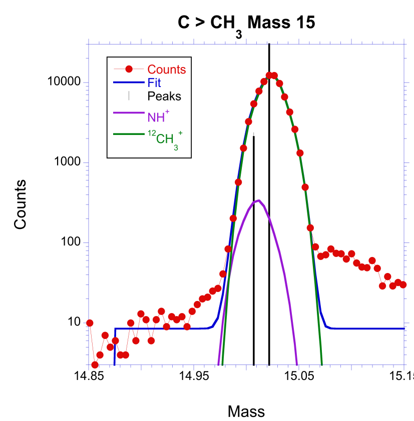

Figure 1: Section of a summed mass spectrum from cometary dust near mass 15. The total fit includes a contribution from NH^+, $^{12}CH_3^+$, and a baseline. The unfit "wings" represent less than 1% of the counts in the main peak.

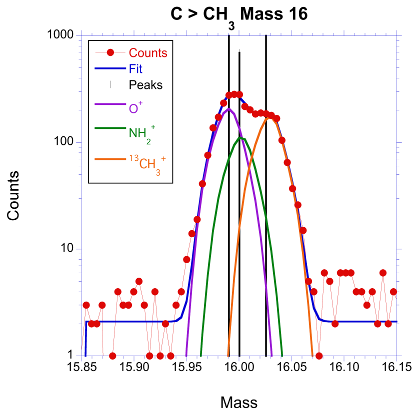

Figure 2: Section of a summed mass spectrum from cometary dust near mass 16. The total fit includes a contribution from O^+, NH_2^+, $^{13}CH_3^+$, and a baseline.

To convert the ionic, which are measured, to atomic ratios, the instrument mass fractionation (IMF) must be considered. Insoluble organic matter (IOM) samples extracted from meteorites (provided by the Carnegie institution) have been analyzed with the ground model of COSIMA at the MPS Göttingen. These measurements be used to estimate the IMF of COSIMA for carbon isotopes. The resulting carbon isotopic composition of cometary dust particles from 67P will be compared with that of other types of extraterrestrial objects, meteorites, micrometeorites, IDPs and comets.

References

[1] Kissel, J. et al.: Sp. Sci. Rev., Vol. 128, p. 823, 2007.

[2] Rubin, M. et al.: A&A Vol. 601 p. A123, 2017.

[3] Hässig, M. et al.: A&A Vol. 605 p. A50, 2018.

[4] Cordiner, M. A. et al.: ApJ. Lett. Vol. 870, p. L26, 2019.

[5] Paquette, J.A., et al.: MNRAS, Vol. 469 p. S230, 2017.

[6] Fray, N.,et al.: Nature Vol. 538, p. 72, 2016.