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Oxygen Isotopes in Water in the Coma of Comet 67P / Churyumov-Gerasimenko as measured with the Rosetta / ROSINA Double Focusing Mass Spectrometer

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Abstract

Comets are widely considered to contain some of the most pristine material in the Solar System [1]. The degree of isotopic fractionation – the enrichment or depletion of an isotope in a molecule, relative to its initial abundance – observed in a comet is sensitive to the environmental conditions at the time of the comet's formation [2]. Therefore, measurements of isotopic abundances in cometary ices reveal important information regarding the early Solar System's composition, density, temperature and the amount of radiation present before the accretion of solid bodies, when the molecules were being formed during the chemical evolution of the presolar cloud to the protosolar nebula and protoplanetary disc. They are therefore vital to understanding and reconstructing the history and origins of material in the Solar System [3].

The ^{16}O **/** ^{18}O ratio of CO_2 in the coma of the comet 67P **/** Churyumov-Gerasimenko was previously measured by Hässig et al. (2016) [2] with the ESA spacecraft Rosetta's ROSINA instrument package's Double Focusing Mass Spectrometer (DFMS) and found to be 494 ± 8, which is consistent within 1σ uncertainty with the terrestrial value of 499 calculated by Lodders (2003) [4], but not with the ratio of 530 ± 2 measured for the solar wind by McKeegan et al. (2011) [5].

In this study, the ^{16}O **/** ^{18}O ratio of H_2O in the coma of the comet 67P, as measured by the Rosetta **/** ROSINA DFMS, was found from the ratio of H_2O **/** $H_2{}^{18}O$ to be 445 ± 35, which represents a 12% enrichment of ^{18}O compared with the terrestrial value [4] of 499 and would be consistent with the comet containing primordial water, in accordance with leading self-shielding models, which hypothesise primordial water to be between 5% to 20% more enriched in the heavier oxygen isotopes than terrestrial water [6].

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