THE $^{18}\text{O}/^{16}\text{O}$ RATIO IN COMETARY DUST AND OTHER NEW RESULTS FROM COSIMA. J. A. Paquette$^1$, N. Fray$^2$, H. Cottin$^2$, A. Bardin$^2$, and M. Hilchenbach$^2$, $^1$Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany, $^2$Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA), UMR CNRS 7583, Université Paris Est Créteil et Université Paris Diderot, Institut Pierre Simon Laplace, 94000 Créteil, France

Introduction: The oxygen isotopic ratio $^{18}\text{O}/^{16}\text{O}$ has been measured many times in cometary gas. For comet 1P/Halley mass spectrometry was used to determine the oxygen isotopic ratio in hydronium ions and in neutral water [1], [2] giving values consistent with the value for VSMOW (Vienna Standard Mean Ocean Water). This is also true for submillimeter astronomy measurements of the oxygen isotopic ratios for comets 153P/Ikeya–Zhang, C/2001 Q4 (NEAT), C/2002 T7 (LINEAR), and C/2004 Q2 (Machholz) [3], and for far infrared measurements which determined the isotopic ratio in water from Comet Garrad [4]. Ground-based ultraviolet spectroscopy produced a ratio that was marginally higher than VSMOW for Comet C/2002 T7 [5] and significantly higher than VSMOW for comet C/2012 F6 (Lemmon) [6].

More recently, measurements conducted on comet C/2014 Q2 (Lovejoy) using submillimeter astronomy showed an oxygen isotopic ratio in agreement with the terrestrial value [7]. ROSINA measurements on water vapor from Comet 67P/Churyumov-Gerasimenko gave a ratio which was lower than the VSMOW value, but with large enough error bars that agreement cannot be precluded [8]. Of course, depending on the mechanism that fractionates the oxygen isotopes, there is no requirement for isotopic ratios measured in the gas to agree with a ratio measured in the dust.

Measurements of $^{18}\text{O}/^{16}\text{O}$ in cometary dust are much less common. The Stardust measurements of cometary dust from comet 81P/Wild 2 found most samples to have oxygen isotopic ratios in agreement with those typically measured in constituents of primitive meteorites [9], [10], [11]. Calcium-aluminum-rich inclusions (CAIs) found in Stardust samples show the typical $^{16}\text{O}$ enrichment observed in primitive extraterrestrial material with regard to the terrestrial value [10], [12], [13]. Considerable variation in the oxygen isotopic ratios of fine-grained material encased in the walls of the Stardust sample tracks have been reported [11], ranging from values enriched in $^{16}\text{O}$ close to the Sun value [14] to heavy isotope enriched values similar to those measured in cosmic symplectite [15].

The value of the oxygen isotopic ratio is of interest, because (as is well known) oxygen isotopes in a variety of solar system solids are distributed along a line with a slope of 1. CAIs and the sun are enriched in $^{16}\text{O}$ compared with the chondrites and with the earth, the moon, and similar bodies [12].

**COSIMA:** COSIMA was an instrument aboard the Rosetta orbiter designed to capture, image, and measure the composition of cometary dust particles using Time of Flight Secondary Ion Mass Spectrometry (ToF-SIMS) [16]. Because of Rosetta’s months-long proximity to comet 67P/Churyumov-Gerasimenko cometary dust particles were collected within the coma, and with velocities orders of magnitude lower than in previous cometary flyby missions.

**Measuring Oxygen With COSIMA:** The oxygen isotopic ratio is a challenging measurement to make with COSIMA. The measurement must be done in negative mode, as secondary oxygen ions are very likely to be negatively charged. While $^{16}\text{O}$ is very easy to measure and provides abundant counts, a very long measurement is needed to get sufficient counts of $^{18}\text{O}$. Just such a long measurement was undertaken on the comet dust particle Jessica Lummene.2 as shown in Figure 1. The measurement lasted almost 48 hours.

![Figure 1](https://example.com/image1.png)  
*Figure 1:* The particle Jessica Lummene.2 on Target 2CF is about 450 microns x 550 microns, and is roughly 40 microns tall. The long measurement was taken at 4 locations - the corners of the blue square.
must be corrected for interferences and an instrumental effect.

Figure 2: Panels a, b, and c show sections of mass spectra around 16, 17, and 18. The red points are the data, the blue lines a fit. Note the different scales in the 3 panels.

The unusual peak shape is characteristic of negative mode spectra, which were used for the measurement.

We will present the $^{18}\text{O}/^{16}\text{O}$ ratio measured with COSIMA, together with other new results.