THE $^{18}O/^{16}O$ RATIO IN COMETARY DUST AND OTHER NEW RESULTS FROM COSIMA. J. A. Paquette[1], N. Fray[2], H. Cottin[2], A. Bardyn[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 $^{18}O/^{16}O$ 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 $^{18}O/^{16}O$ 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}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}O close to the Sun value [14] to heavy isotope enriched values similar to those measured in cosmic symplectite [15].

The value of the oxyen 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}O compared with the chonrites 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 ration 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}O is very easy to measure and provides abundant counts, a very long measurement is needed to get sufficient counts of ^{18}O. Just such a long measurement was undertaken on the cometary dust particle Jessica Lummene.2 as shown in Figure 1. The measurement lasted almost 48 hours.

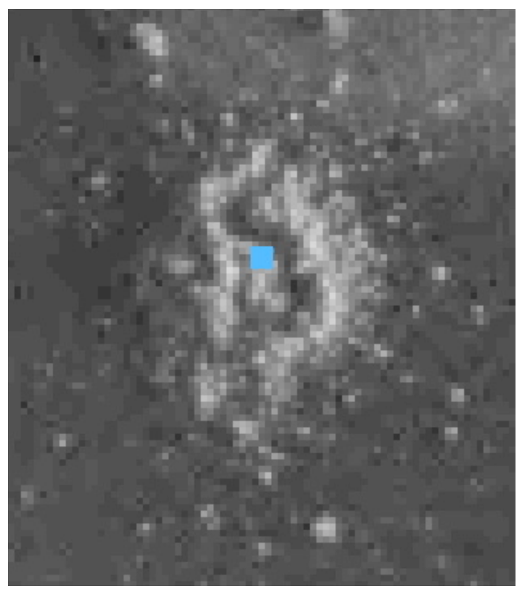

Figure 1: The particle Jessica Lummene.2 on Target 2CF is about 450 microns x 550 microns, and is roughly 40 microns tall. The long measurement was taken at 4 locations - the corners of the blue square.

Sections of the summed spectra near masses 16, 17, and 18 resulting from this long measurement are shown in Figure 2. The large peak at mass 17 is almost entirely due to ^{16}OH rather than ^{17}O, so the $^{17}O/^{16}O$ ratio cannot be measured. The peak at mass 16 is due to ^{16}O, and the peak at 18 is mainly due to ^{18}O, but must be corrected for interferences and an instrumental effect.

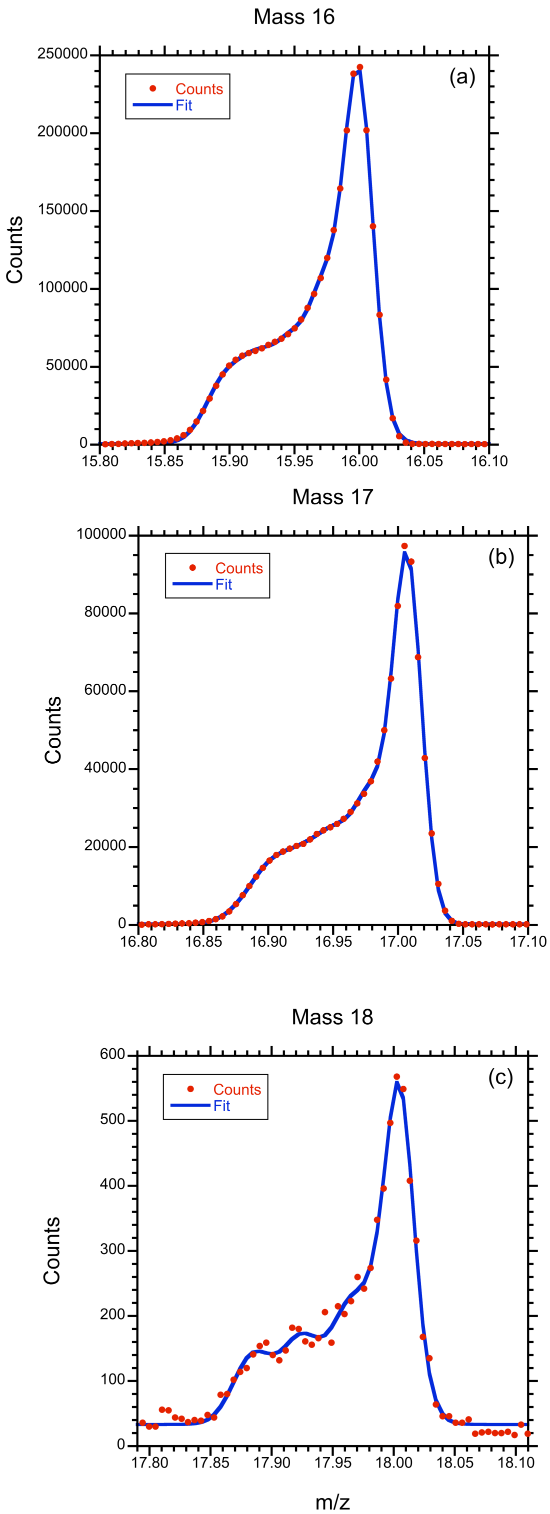

Figure 2: Panels a, b, and c show sections of mass spectra around 16, 17, and 18. The red points are the data, the blue lines a fit. Note the different scales in the 3 panels.

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

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

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