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ROSINA/RTOF capabilities to detect polyoxymethylene in cometary gas

A. Jäckel (1), K. Altwegg (1), S. Gasc (1), M. Rubin (1), L. Le Roy (2), B. Fiethe (3), U. Mall (4) and H. Rème (5)
(1) Physics Institute, Space Research and Planetary Sciences, University of Bern, Switzerland, (2) Center for Space and Habitability, University of Bern, Switzerland, (3) Institute of Computer and Networking Engineering, TU Braunschweig, Germany, (4) Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, (5) Research Institute in Astrophysics and Planetology, Toulouse, France (annette.jaeckel@space.unibe.ch)

1. Introduction

One of the biggest surprises of the Giotto mission to comet 1P/Halley was the very low albedo of comets. Comet nuclei are probably the darkest bodies of our solar system. After several flybys at comets (Deep Space 1, Stardust, Deep Impact) it is still not clear what is responsible for the low albedo of cometary surfaces. Another surprise from the Giotto mission was the fact that there seem to be extended sources in the coma. Meier et al. [1] explained the formaldehyde and CO densities as a function of the distance from the nucleus as coming from dust grains which release the material slowly. Huebner [2] found in the Giotto/PICCA data the signature of organics which would be compatible with polyoxymethylene (POM; $(CH_2\text{-}O)_n$) which then could serve as parent for the observed formaldehyde and CO extended sources. Experimental work done on cometary analogues by Cottin et al. [3, 4] showed that POM can easily be synthesized in a cometary environment. However, Rubin et al. [5] showed that the distributed sources could also be explained by temporal variations in the outgassing rate of the comet. POM is solid for temperatures below 15°C, but decomposes at higher temperatures. The question therefore remains, if POM is an important part of cometary dust grains and the comet's surface and if they contribute to the observed density profiles.

2. ROSETTA

The Rosetta mission, currently on its way to comet 67P/Churyumov-Gerasimenko (C-G) contains beside other instruments, the dust mass spectrometer COSIMA (COmetary Secondary Ion Mass Analyzer) that will look at dust grain composition [6, 7] and the ROSINA (Rosetta Orbiter Spectrometer for Ion and Neutral Analysis) instrument, which measures the volatile compounds in the coma. The reflectron-type time of flight mass spectrometer, as part of ROSINA (ROSINA/RTOF), has a large mass range from 1 to > 300 amu/e. It has a mass resolution of $m/\Delta m \approx 1000$ at the 50% peak height and a sensitivity of 10^{-4} A/mbar [8]. RTOF is dedicated to analyze organic compounds in the coma of C-G.

3. Goal of this study

The goal of this work is to determine from lab measurements the expected fragmentation pattern of POM to test the hypothesis by Huebner et al. [2]. Furthermore, we will demonstrate from lab measurements of POM how ROSINA/RTOF will complement COSIMA dust composition observations in the coma of C-G. This paper will present RTOF spectra of POM measurements from our calibration chamber. With these essential laboratory measurements we are able to characterize the behavior of RTOF at the comet which is fundamental to interpret the measurements in space.

References

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