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ROSINA measurements and interpretations during (2867) Steins and (21) Lutetia flyby

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Abstract

The asteroid (2867) Steins flyby of Europe's comet chaser Rosetta took place on Sep 05, 2008. The second flyby at (21) Lutetia will take place on Jul 10, 2010. These two flybys, as well as the rehearsals for the flybys are an important opportunity for the payload instruments to perform measurements as a function of the location of the spacecraft, the spacecraft attitude and the payload activity. In this paper we discuss these different influences during the asteroid flybys to the ROSINA instruments.

1. ROSINA Instruments

The ROSINA (Rosetta Orbiter Sensor for Ion and Neutral Analysis) instrument package onboard Rosetta consists of two mass spectrometers, ROSINA-DFMS and ROSINA-RTOF, and a pressure sensor ROSINA-COPS. They are designed to measure the neutral and ionized volatile material in the coma of a comet. Due to their high sensitivities, measurements of very low particle densities are possible. ROSINA-DFMS and ROSINA-COPS performed regular measurements since launch. Since Mar 2010 the ROSINA-RTOF sensor complements the data of DFMS and COPS.

1.1 ROSINA-DFMS

The DFMS sensor is a classical Double-Focusing Mass-Spectrometer designed in Nier-Johnson configuration. It is characterized by very high mass resolution and good sensitivity. It covers a mass range of 12 – 140 amu/e and has a mass resolution of $m/\Delta m > 3000$ at the 1% peak height which corresponds to a mass resolution of $m/\Delta m > 7000$ at the 50% level [1].

1.2 ROSINA-RTOF

The Reflectron-type Time Of Flight sensor (RTOF) has an extended mass range from 1 to > 300 amu/e and a higher sensitivity. An advantage of the RTOF sensor is that a full mass spectrum of the entire mass range is recorded within 100 µs. The mass resolution is $m/\Delta m > 1200$ at the 50% peak height [1].

1.3 ROSINA-COPS

The COmetary Pressure Sensor (COPS) consists of two gauges based on the extractor-type ionization gauge principle. The first gauge (nude gauge) is able to measure the total neutral particle density of the cometary gas, the total pressure. The second gauge (ram gauge) is able to analyze the cometary gas flux. Combining the results from both gauges and the known spacecraft orientation relative to the comet nucleus the gas velocity can be calculated [2].

2. (2867) Steins flyby

During the Steins flyby only ROSINA-DFMS and ROSINA-COPS were switched on. The measurements were intended to contribute to the exploration of the asteroid's environment, in particular to the search for a low level gaseous envelope [3]. The strategy for the flyby was to use COPS to monitor the total neutral particle density while DFMS would monitor one single mass in order to avoid time consuming adjustments of the ion optical potentials so that the risk of missing interesting data was minimized. Since (2867) Steins is a thermally evolved object, the monitored mass to charge ratio was set to m/q=15.5 amu/e, which allows the simultaneous detection of several species: O, CH_4, NH_2 as well as CH_3 and NH [4]. The Steins flyby, however, revealed that spacecraft outgassing plays an important role, mainly due to the changing attitude during the flyby.

3. (21) Lutetia flyby

During the Lutetia flyby in July 2010 all three ROSINA sensors will be switched on and will perform measurements from few days before closest approach until few hours after closest approach. A rehearsal of the Lutetia flyby serves this time as a baseline in order to assess the spacecraft background.

4. Summary and Conclusions

The ROSINA results from the Steins flyby clearly show the correlation between spacecraft attitude and instrument background. This led to our hypothesis that the illumination of cold panels exposed to sunlight after years in darkness causes evaporation of gases condensed on these panels. The outgassing of the spacecraft leads to different problems for scientific in situ mass spectrometers. Although the performance of the instrument is not affected as such, a limit of detectability for neutral and charged particles in the target atmospheres is set by the gaseous spacecraft environment.

References

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