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Nano-to-micro dust environment monitored by GIADA during the entire ROSETTA scientific phase

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Abstract

Among the measurement subsystem of the GIADA instrument the MBBS is devoted to monitor the mass fluence and flux of the nano to micro meter size dust particles. This subsystem continuously operated along the whole scientific phase of the Rosetta mission, allowing a complete characterization of the finest part of the dust environment.

Introduction

The Micro Balance System (MBS) [1] is the GIADA [2,3] subsystem devoted to the flux and fluence of nano to micro dust particles measurement. The cumulative flux of particles/grains with diameters <10 μm is measured by a net of five Quartz Crystal Microbalances (QCMs) pointing towards different directions in order to characterize the dust flux within a solid angle of 180 deg.

Each QCM has an acceptance angle of about 40 deg, a collection area of about 12 mm2 and consists of a matched pair of quartz crystals resonating at ~15MHz. Each QCM is equipped with a heating device to: (1) check the frequency vs. temperature dependence, (2) perform thermo-gravimetric measurements on the accumulated dust, at temperatures < 100 °C, and (3) remove volatile materials from the sensitive surface. Starting from the July 2014, i.e. during the Rosetta/ESA space probe approach to comet 67P/Churyumov-Gerasimenko, the MBS was continuously operating to monitor the dust coma environment.

The QCMs' high sensitivity (0.2 [Hz ng−1]) allowed to detect nano-micron-sized dust dust flux variation events well constrained in time. Otherwise, the nano-to-micron-sized particle flux was constant over the entire Rosetta mission scientific phase.

1. Data

The MBS data analysis allowed us to characterize the nano-to-micron sized dust particles flux identifying: (1) the preferred dust flux directions [4]; (2) the flux time variation for particles with sizes smaller than 10 microns; 3) the presence of fine dust in dust "outbursts"; in Figure 1 are reported the data collected for the QCM1 (pointing to the solar direction for almost the whole scientific phase) and QCM5 (pointing the Nadir direction).

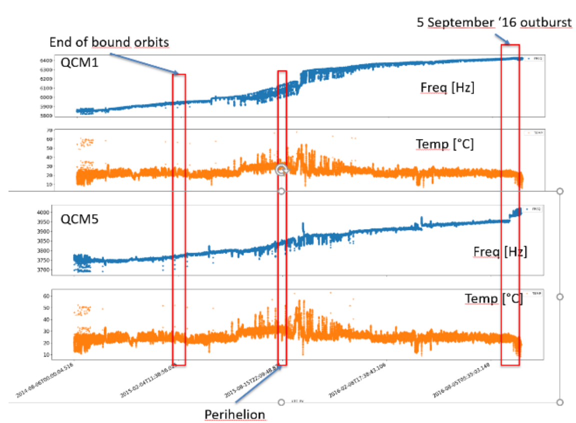

Figure 1: Raw data collected during the whole scientific phase by the QCM5 (nadir pointing) and QCM1 (roughly solar direction for most of the scientific phase).

2. Results

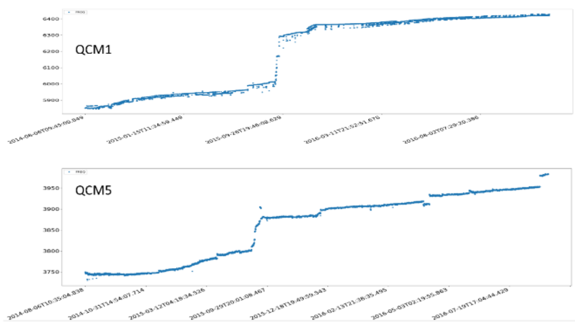

Figure 2: QCM1 (roughly solar direction for most of the scientific phase) QCM5 (nadir pointing) data, after removing the thermal effects.

In Figure 2 are reported the QCM1 and QCM5 measurements after removing the thermal effects. For both is evident the high enhancement of the nano to micro dust size flux during 67P perihelion passage. Despite the large distance from the comet (>300 km) a strong change in the trend of the data testifies a great increase of the dust mass cumulated on the QCM1 and QCM5 sensitive surfaces. The dust fluxes seem uncorrelated with respect to the comet surface illumination conditions. It is not trivial to identify a scaling factor that takes into account the detection distance from the comet. A simple $1/r^2$ scaling factor does not fit, probably because the nano to micron size fluxes are affected by the perihelion outburst activity.

Acknowledgements

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