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## Abstract

GIADA (Grain Impact Analyzer and Dust Accumulator), an in-situ instrument onboard Rosetta [1], monitored the dust environment of comet 67P/Churyumov-Gerasimenko. GIADA is composed of 3 sub-systems: 1) the Grain Detection System (GDS), based on particle detection through light scattering; 2) the Impact Sensor (IS), measuring particles momentum; 3) the Micro-Balances System (MBS), constituted of 5 Quartz Crystal Microbalances (QCMs), giving cumulative deposited dust. The combination of the measurements performed by these 3 subsystems provides: number, mass, momentum and speed distribution of dust particles ejected from the comet nucleus. We present the coma dust environment as observed by GIADA during the outburst event occurred on the 5th of September 2016, few days before Rosetta landing on comet 67P/Churyumov-Gerasimenko. GIADA observed dust density temporal and spatial variation from a very close distance (<5km from the comet surface) during this brief and intense event. The three GIADA subsystems, MBS, GDS and IS recorded data with relevant statistics. In few hours, a very large number of dust particle detections allowed to characterize the dust environment in the size ranges from few microns to millimeters.

## 1. Introduction

One of the Rosetta mission target was to disentangle the normal cometary activity from specific active areas inducing peculiar high activity features in order to understand their origin. Rosetta observed sudden and transitory features characterized by high dust and gas loss defined as "outbursts" [2] [4]. Morning outbursts have been explained by thermal stresses while afternoon events have been associated to heat wave reaching buried volatiles, some events can result from the collapse of cliffs [4]. Additional stored energies prompting the outbursts are suggested to be pressurised sub-surface gas reservoirs or the crystallisation of amorphous water ice [2].

## 2. Data

At the end of the ROSETTA mission GIADA recorded a very low particle detection rate with the exception of the 5th September 2016 spike. From 17:40 to 20:30 UT, GIADA experienced an exceptional increase in the dust counts. The detected dust events and the MBS frequency shifts, convertible in dust mass deposited on the sensors, are reported in Table 1.

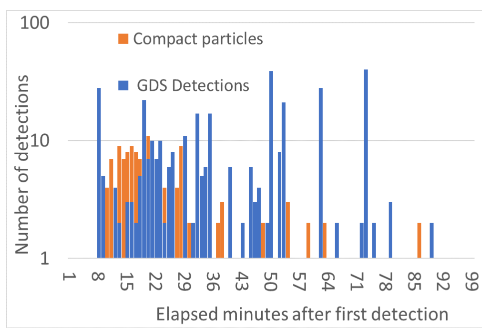


Figure 1: Dust particle detections per minute recorded by GIADA during the 2016 September 5 outburst. Compact (orange) and fluffy (blue) particle detections show different detection rates with respect to time: the compacts are present with high counts at the beginning of the event while the fluffy particle detections are spread along the whole event.

## 3. Results

GIADA observed two different types of particles in the 67P coma: compact particles [5] and fluffy porous aggregates [6]. During the outburst, GIADA detected both particle types but differently distributed in time, as shown in Fig. 1. The plot shows the number of detection per type as a function of the elapsed time since the initial GIADA detection of the outburst, which was at first detected by the MBS: as expected, the small particles reached GIADA before the larger ones, detected by the GDS and IS. Compact particles show a high rate during the first 30 minutes of the event. The GDS-only multiple detections ("dust showers" – [6]), i.e. fluffy aggregates, with isolated GDS detections, i.e. particles characterised by a highly non-radial velocity or with a momentum below the IS sensitivity, are spread over the outburst duration. The geometry of the detections shows that dust emitted during the outburst cover an angle of about 60 deg and are not correlated with the nucleus rotation. The masses and speeds of the compact particles show a clear temporal evolution after a rapid increase in the first minutes of the outburst both particle masses and speeds decrease. The smallest particles (<10 microns diameter) measured by the MBS show higher speeds and extremely collimated trajectories: the mass accumulated on the MBS during the first 10 minutes of the event.

Table 1: Dust counts obtained for each subsystem measurement.

| GDS-only | IS-only | GDS-IS | QCM4 | QCM5 |
|---|---|---|---|---|
| 759(*) | 136 | 74 | 25Hz(**) | 10Hz(**) |

## 4. Summary and Conclusions

The GIADA dust environment continuous monitoring allowed us to detect an outburst at the end of the Rosetta mission, when the dust activity was very low as 67P was at heliocentric distances greater than 3.5 au. Thanks to the close distance to the comet surface GIADA, providing the most complete dataset of the entire mission, allowed a complete physical and dynamical characterization of this peculiar dust event.


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