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# GIADA (Grain Impact Analyzer and Dust Accumulator): Rosetta Escort Phase Simulations (2 AU)

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## Abstract

We simulated GIADA performances along various SpaceCraft (S/C) trajectories and during distinct mission phases. Our aim was to evaluate the GIADA scenario in terms of scientific return: coupling dust coma modeling with GIADA performances. This work supports the evaluation of S/C orbits with respect to the scientific data collectable by GIADA. It contributes to forecast the dust environment in which the S/C will navigate during the pre- and post-landing phase. It can also predict payloads components performance degradation (e.g. optics) due to dust deposition for certain orbits scenarios. For the simulations at 2 AU we used GIPSI (GIADA Performance Simulator) that simulates GIADA performances having as in-puts: 1) the output of 3D evolutionary coma model and 2) the S/C orbits. GIPSI simulations, in terms of scientific predictions provide the number of collected grains per hour, their cumulative values and information on their velocities; in terms of technical response, the data volume.

## 1. Introduction

The short-period comet 67P/Churyumov-Gerasimenko (hereafter 67P/C-G) is the target of the ESA Rosetta probe launched in 2004. After almost a decade of flight, Rosetta will reach 67P/C-G and will explore its coma environment as well as its nucleus releasing a Lander on it. GIADA [1] is one of the payload on-board the orbiter designed to monitor the cometary dust activity. Cometary coma models together with GIADA performances evaluations play a key role in the prediction of the environment that Rosetta will encounter.

## 2. GIPSI and Simulated comet Environment

The GIPSI tool is a Java client software able to simulate along a specific orbit and for a defined time interval: 1) the performances of payloads devoted to dust measurements; 2) the interaction of sensitive surfaces deployed on the Spacecraft with the dusty environment it will encounter. The instrument definition must contain: lower limit and saturation limit for each sensor; field of view of each sensor.
In the absence of 67P/C-G flyby observations, the distribution of gas and dust around a nucleus, and the nucleus itself, remain inaccessible. Any dust model output can be an input for GIPSI.

**Fulle model**: Presently, only ground-based images of the distribution of the emitted cometary dust are available. These images involve grains flying times huge compared to nucleus rotation periods. The observations blend all sizes together. The grains motion in these regions is relatively well understood (Keplerian orbits) so that it is possible, by trial and error fits, to derive "effective" mass spectra and initial velocities fitting the astronomical images with models [2]. These are averages over the rotation of the real velocities, real fluxes, real mass spectra and real velocity distributions (at each mass).

**Rodionov-Zakharov-Crifo model**: Ab-initio physical modeling can derive dust velocity vectors and numerical density taking into account: the nucleus shape and rotation; a mechanism for gas production from the nucleus. By means of physical methods the resulting 3D+t structure of the near nucleus gas outflow can be obtained. The dust is seeded in the flow and the velocity vectors, acquired by the grains at some distance, are computed [3].

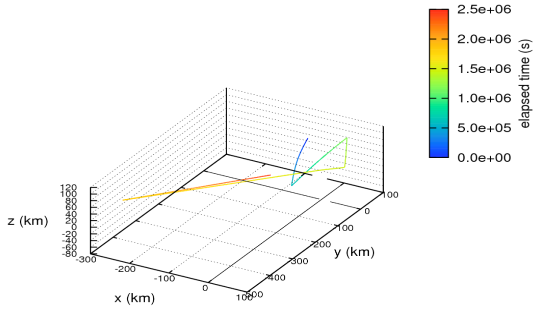


Figure 1: Rosetta Orbit foreseen for the mission phase at 2AU plotted in the J2000 frame.

The S/C trajectory used to evaluate the dust grains collected by GIADA is reported in Fig. 1. The S/C trajectory during this phase consists of two icosahedral legs around the nucleus followed by a fly-by.

## 3. Simulations Results

We report in Fig. 2 the simulations results for two sizes of grains (200 micron and 100 micron, in radius) considering as lower and upper limits the values reported for Compact Grains (table 3) and Fluffy Grains (table 4) of Fulle et al. 2010.

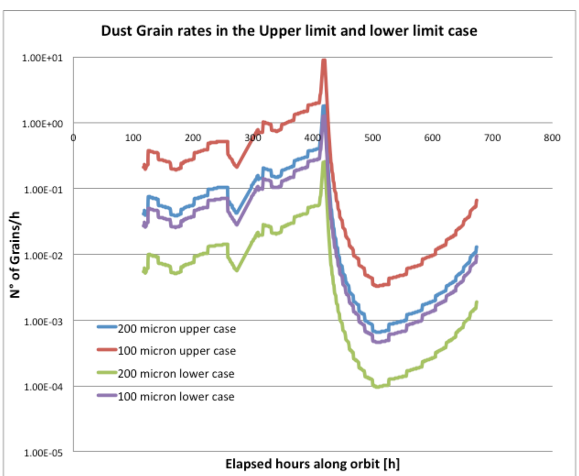


Figure 2: Dust rates obtained along the trajectory for the upper and lower limits of the dust environment described in [2].

The values for the cumulative grains collected along the considered trajectory are reported in Table 1.

Table 1: Cumulated Dust grains by GIADA along the trajectories foreseen for the 2AU phase

| Dust Grains size bin | N° of collected particles lower limit | N° of collected particles upper limit |
|---|---|---|
| 100 micron | 35 | 251 |
| 200 micron | 7 | 50 |

The reported results refer to Fulle model. Similar simulation will be performed with the dust environment described by the RZC model.

## 5. Summary and Conclusions

Due to the very large distance during the icosahedral legs, part of Escort Phase trajectory, the rate of dust grains collection doesn't allow a statistical meaningful cumulative number to exhaustively describe the dust environment, especially in the lower limit case. During the fly-by for a very short period of time it is possible to make a more accurate description of the dust environment in the nucleus proximity, although for a very localized portion of the coma.

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## References

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