EPSC Abstracts
Vol. 10, EPSC2015-591, 2015
European Planetary Science Congress 2015

Typology of dust particles collected by the COSIMA mass spectrometer in the inner coma of 67P/Churyumov Gerasimenko from Rendez-Vous to perihelion.

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Introduction: COSIMA is a TOF/SIMS spectrometer dedicated to the analysis of cometary grains collected in-situ on the the Rosetta orbiter. The grains are collected on targets 10 mm x 10 mm in area exposed by sets of 3 ("target assembly") in front of a funnel providing a 20° x 40° FOV to the outside environment of the spacecraft. 4 target assemblies have been exposed from August 8th 2014 (distant approach phase) to April 29th, 2015 on a weekly basis, except during near comet passages (daily basis). 10 of the 12 targets exposed up to now are covered by "metal black" layers (gold or silver) so as to maximize grain collection efficiency [1], the other two targets being silver foils. The collected grains are detected by a microscope, COSISCOPE, using two LED's at grazing incidence and a 14 µm pixel size (714 pixels across the target). This set up was designed so as not to miss the small particles expected to dominate the distribution of collected dust as well as the imprints resulting from rebounding particles when simulating impacts at speeds of up to 300 m/s as predicted by models of the inner coma [2]. The number and size of collected particles far exceeded expectations, with more than 10000 identified particles, including more than 80 collected dust particles with sizes of 7 pixels (100 µm) or more, making it possible to characterize the diversity of cometary grains collected in-situ at very low velocities in the inner coma of 67P/Churyumov-Gerasimenko. The first results demonstrated that cometary dust close to the nucleus is dominated by fluffy aggregates [3]. At EPSC, we will present the results on the pre-perihelion phase (August 2014 to August 2015).

Dust collection characteristics: The collection rate is extremely irregular, from a few particles on all three targets during a week to more than 2000 particles over a few days. For such a high collection rate period, there are also large variations between targets, as demonstrated by Fig. 1a and Fig. 1b.

These large variations in time and between targets, as well as the spatial correlations observed for the largest collections, demonstrate that most of the observed dust particles during a high collection episode originate from a single large parent particle, which disintegrated close to the spacecraft or within the COSIMA entry funnel. In such cases, fluffy particles dominate the typology. These observations by COSIMA are fully consistent with those of

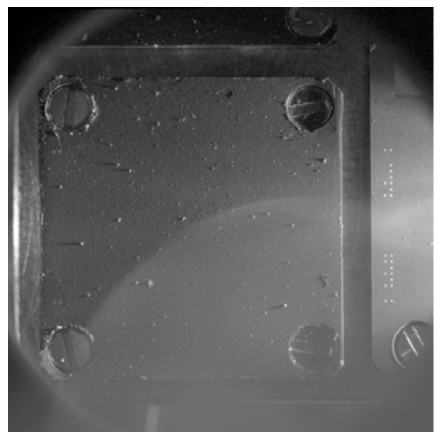

Fig. 1a: Target 3CF after a high collection week, displayed with a log scale. The bright spots indicate grains illuminated from the right)

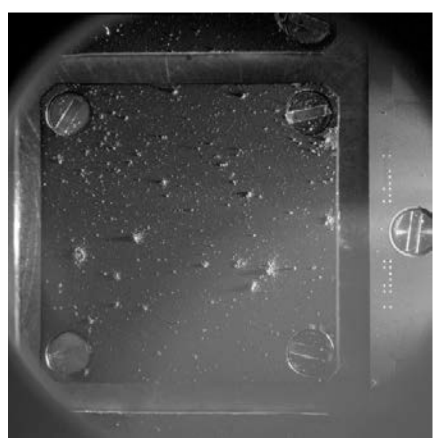

Fig. 1b: Target 2CF after the same week. The number and typology of collected grains markedly differs from that of grains collected on the neighbour target.

GIADA, which detects dust optically and with an impact sensor, a large fraction of the detections having been observed in clusters [4].

Dust typology: it ranges from very weak aggregates which shattered on the target even at the low velocities (1 to 12 m/s) measured by the GIADA instrument [4] to compact particles, some of which have been observed to move on the target from one week to the next while maintaining their shape.

The shattered clusters and more compact rubble piles dominate the dust collection. Examples of the different classes of grains are given in Fig. 2-4

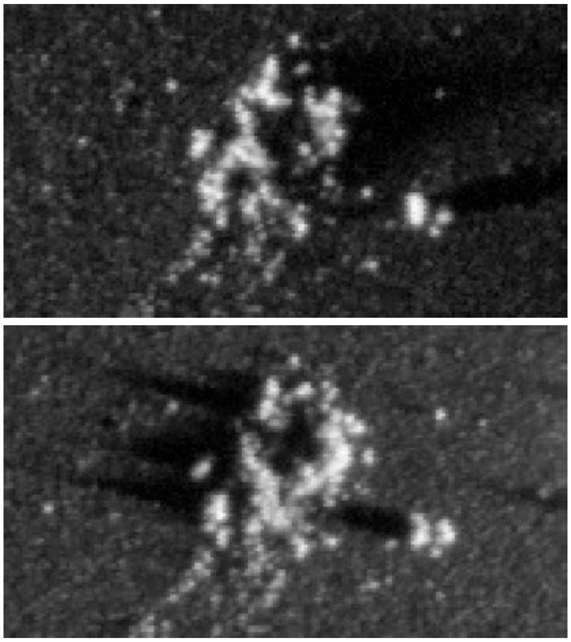

Fig. 2: Kamil (shattered cluster) as seen from the left LED (top) and the right LED (bottom)

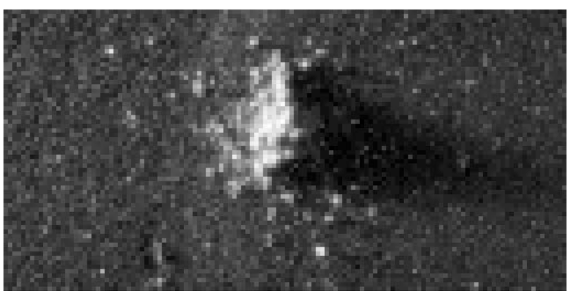

Fig. 3: Eloi (rubble pile), grain selected for reference [3]

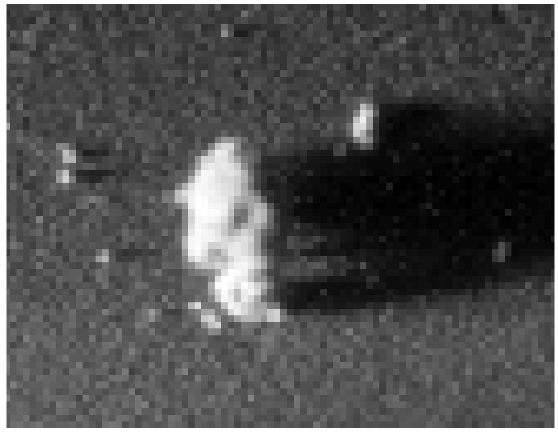

Fig. 3: Nick (compact grain). The shadow from the left LED demonstrates that the grain is not in contact with the target over its full length, as some light gets through.

Variations in typology have already been observed, but the relationship with heliocentric distance and the distance from the comet is not straightforward. Given the low velocity of dust particles, the orientation of the spacecraft with respect to the ram direction is likely to be critical.

Conclusion: Due to the very low collection velocities and the resulting high collection efficiencies of metal black targets, COSIMA/COSISCOPE provides the first optical characterization of an unbiased sampling of dust in the vicinity of an active cometary nucleus. The typology of the collected grains is dominated by aggregates extending to larger scales (100's of µm to millimeters for parent aggregates) the complex structure of IDP's and micrometeorites, in line with hierarchical dust accretion models [5]. A small fraction of compact grains which may be related to Stardust terminal particles [6] is also observed. A possible evolution of the typology of dust particles as the comet gets close to perihelion will likely be related to newly exposed areas after removal of the dust mantle.

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