EPSC Abstracts
Vol. 12, EPSC2018-724, 2018
European Planetary Science Congress 2018

Inbound to perihelion dust activity of 67P/Churyumov-Gerasimenko's Northern hemisphere

A. Longobardo (1,2), V. Della Corte (1,2), S. Ivanovski (1,2), G. Rinaldi (1,2), A. Rotundi (1,2), M. Fulle (3), F. Capaccioni (1), E. Palomba (1,4), P. Palumbo (1), F. Tosi (1), M.T. Capria (1,4), G. Filacchione (1), A. Raponi (1), M. Ciarniello (1), D. Bockelee-Morvan (5), S. Erard (5), C. Leyrat (5) and the GIADA and VIRTIS teams
(1) INAF-IAPS, via Fosso del Cavaliere 100, 00133 Rome, Italy (andrea.longobardo@iaps.inaf.it); (2) DIST, Università Parthenope, Naples, Italy; (3) INAF-OATS, Trieste, Italy; (4) ASI-SSDC, Rome, Italy; (5) LESIA, Meudon, France

Abstract

We studied dust activity of comet 67P/Churyumov-Gerasimenko (67P) inbound to perihelion, from August 2014 to January 2015, by means of the GIADA dust detector and the VIRTIS imaging spectrometer, on board the ESA Rosetta spacecraft. We found that illumination is the main driver for both fluffy and compact dust particles ejection and leads to exposition of water ice on 67P surface. We derive a spatial correlation between fluffy and compact particles that we derive on the nucleus, which is not observed in the coma, where the two types of particles disperse due to their different velocity.

1. Introduction

The ESA/Rosetta spacecraft orbited comet 67P/Churyumov-Gerasimenko (hereafter 67P) from August 2014 until September 2016, escorting it through perihelion, occurred on 13th August 2015. The VIRTIS (Visual InfraRed and Thermal Imaging Spectrometer) imaging spectrometer [1] revealed a dark surface, composed mainly of a opaque, spectrally featureless material, and organics, producing the absorption band at about 3.2 μm [2]. Water ice is also observed as the result of a water diurnal cycle [3], and can be detected by deepening and shortward shift of the 3.2 μm band [3], as well as flattening of the infrared spectral slope between 1.1 and 1.9 μm (e.g. [4]). These spectral signatures are more evident in regions at high temperature, supposing that increasing temperature leads to cometary activity and consequent water ice exposition on the surface [5].
The GIADA (Grain Impact Analyser and Dust Accumulator) dust detector [6] detected compact particles (high density) and fluffy aggregates (high porosity), which distribute differently in the coma [7]. the association with the type of particle was based on results obtained by previous instrument calibrations.
This work combines GIADA and VIRTIS datasets to give further insights on 67P's cometary activity inbound to perihelion (from August 2014 to January 2015). We studied a possible correlation between dust emission and nucleus compositional variations in each geomorphological region (as defined by [8]) of 67P's Northern hemisphere, i.e. the hemisphere observed during the inbound orbit.

2. Method

We defined and retrieved for each geomorphological region the following indicators of cometary activity:

- for VIRTIS, the decrease of the 3.2 μm band centre (BC) and of the spectral infrared slope (S) between the lowest and the highest temperature;
- for GIADA, the number of fluffy and compact particles ejected.

To retrieve the latter, we defined an algorithm to trace the motion of each dust particle detected by GIADA in the coma back to the nucleus. The algorithm combines the velocities measured by GIADA, the rotation of the comet, as well as assumptions derived from dust models [9], i.e. a radial trajectory with a constant acceleration up to 11 km from the nucleus surface and then a constant velocity.

3. Results and conclusions

VIRTIS. We observed a strong correlation between BC and S shifts with temperature, suggesting that the reason of the two shifts is the same, i.e. exposition of water ice.

GIADA. Whereas the correlation between fluffy (parent) and compact particles is low in the coma, we found a strong correlation on the nucleus, after the

application of the traceback procedure, (Figure 1). This indicates that the two types of particles are emitted together and then spread in the coma due to their different velocity.

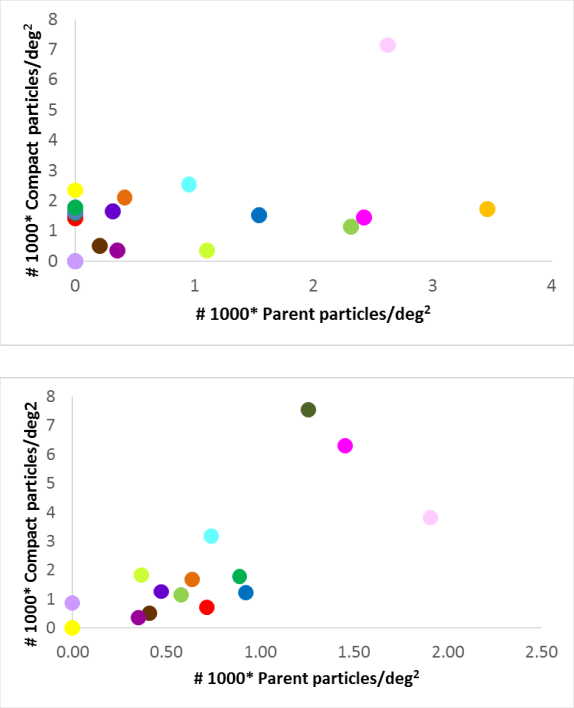

Figure 1. Number of compact and fluffy parent particles in the coma (top) and on the nucleus (bottom). Each dot corresponds to a geomorphological region.

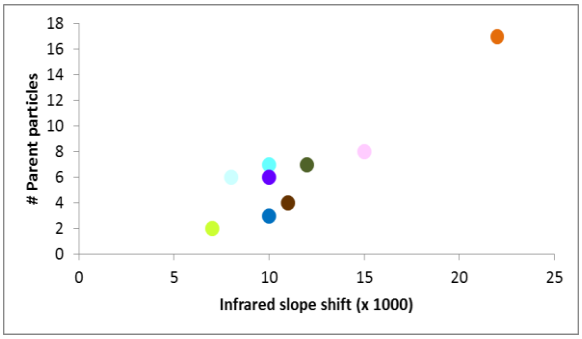

Figure 2. Correlation between number of fluffy parent particles measured by GIADA and spectral slope with temperature observed by VIRTIS. Each dot corresponds to a geomorphological region.

GIADA-VIRTIS data fusion. The VIRTIS and GIADA indicators correlate, indicating that dust ejection leads to water ice exposition on the nucleus surface (Figure 2). In addition, we related the number of dust particles emitted with the insolation period of each region, finding again a strong correlation (Figure 3). This lead to the conclusion that illumination is the main, if not the only, driver for dust cometary activity.

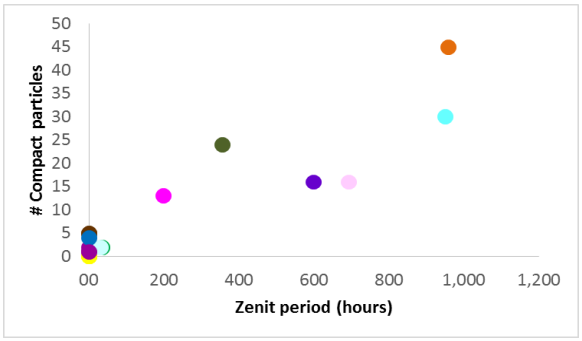

Figure 3. Number of compact particles emitted as a function of insolation time. Each dot corresponds to a geomorphological region.

Acknowledgements

GIADA was built by a consortium led by the Universitá degli Studi di Napoli 'Parthenope' and INAF – Osservatorio Astronomico di Capodimonte, in collaboration with the Instituto de Astrofisica de Andalucia, Selex-ES, FI and SENER. GIADA was managed and operated by IAPS-INAF. VIRTIS was built by a consortium formed by IAPS-INAF (Italy), which guides also the scientific operations. LESIA (France) and DLR (Germany).
This research was supported by the Italian Space Agency (ASI) within the ASI-INAF agreements I/032/05/0 and I/024/12/0.

References

[1] Coradini, A. et al. (2007), SSR 128, 1-4, 529-555; [2] Capaccioni, F. et al. (2015), Science 347, 6220; [3] De Sanctis, M.C. et al. (2015), Nature 525, 500-503; [4] Filacchione, G. et al. (2016), Icarus 274, 334-349; [5] Longobardo, A. et al. (2017), MNRAS 469, 2, S346-S356; [6] Colangeli, L. et al. (2007), ASR 39, 3, 446-450; [7] Della Corte, V. et al. (2016), MNRAS 462, 1, S210-S219; [8] El-Maarry, M.R. et al. (2015), A&A, 583, A26, 28pp.