EPSC Abstracts
Vol. 12, EPSC2018-910, 2018
European Planetary Science Congress 2018

VIRTIS and GIADA observations of summer outbursts on 67P/CG

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1.Introduction

During the period between July and September 2015, the Rosetta spacecraft had the opportunity to monitor the inner coma of comet 67P/Churyumov-Gerasimenko (67P/CG) along the most active part of its orbit. The Visible InfraRed Thermal Imaging Spectrometer (VIRTIS) [1] and the Grain Impact Analyzer and Dust Accumulator (GIADA) [2] onboard Rosetta observed and detected a series of transient events. Cometary outbursts are well-known but still poorly understood phenomena. GIADA is an in-situ instrument and detects outbursts pointing nadir, i.e. towards the nucleus. VIRTIS is a remote-sensing instrument and detects outbursts mainly during limb/off-nadir pointing, because the nucleus is always brighter than the coma events as jets and outbursts. Thus, the two instruments observed outburst material in remote-sensing mode (VIRTIS) or at the spacecraft location (GIADA) producing two independent but complementary outburst datasets. (Fig. 1 and 2). In this perspective, we combined the VIRTIS and GIADA outburst detections to fix some constraints for the physical properties of the outbursts.

2.Preliminary Results

Outburst lifetime: The two instruments observe different outburst lifetimes. For VIRTIS the outbursts are characteristically of short duration, the outbursts appear to decay away typically in tens of minutes, rarely lasting as much as an hour. For GIADA the outbursts are characterized by a slower decay ~~more slowly~~, being sometimes ~~being~~ observable for more than an hour.

Outburst locations: The GIADA and VIRTIS observations suggest that there are localized regions on the comet surface that are more prone to outbursts than the rest of the nucleus. All outburst sources are located in the main lobe, within the latitude range +30° to -60° and in ~~the~~ the eastern side of the body, around longitude 210° to 280° and latitude -20° to -55°, in areas characterized by steep scarps, cliffs, and pits with considerable talus deposits [4,6].

Dust outburst spectral properties. The outburst colour maps in the VIS show a colour gradient which seems to be associated to the level of the dust radiance within the outburst (Fig. 3) [6]. The same colour behaviour has been observed in the IR channel reaching the bluer values of -9.1±1.4 % /100 nm and returning to the pre-outburst value of about 2.5 % /100 nm [5]. The IR continuum emission is also characterised by high colour temperatures of about 600 K and a bolometric albedo of 0.6 [5]. The combination of VIS and IR dust properties thus reveals the presence of very small grains (less than 100 nm) in the outburst material. The bright grains in the ejecta could be silicate grains, implying the thermal degradation of the carbonaceous material, or icy grains. The rapid increase in radiance at the start of an outburst event is not due primarily to an increase in the number of existing dust particles, but rather to the release of small and bright icy particles with a high geometric albedo and a filling factor between 1.3 and 5.0 % [5,6].

Outburst particle dynamics: The dust particle velocities measured by GIADA during the outbursts are not different with respect to the velocities associated to the regular dust activity around perihelion, with values ranging between 10 to 60 m/s (Fig.1). VIRTIS found that the small particles in the dust ejecta expanded at speeds between 22.2 ±2.2 and 64.9 ±10.6 m/s [6].

Total dust mass ejected Assuming a typical size distribution taken from the 67P/CG literature, with indexes between -2.5 and -3, the observed total mass of ejected dust is estimated to be between 500 to 10000 kg [6].

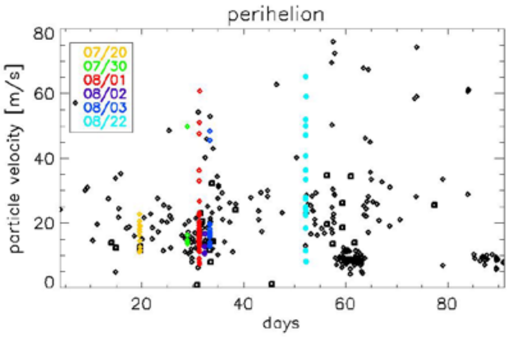

Figure 1: GIADA dataset of summer outburst. The outburst observed by GIADA are the result of a high dust particle detection rate (multicolor points).

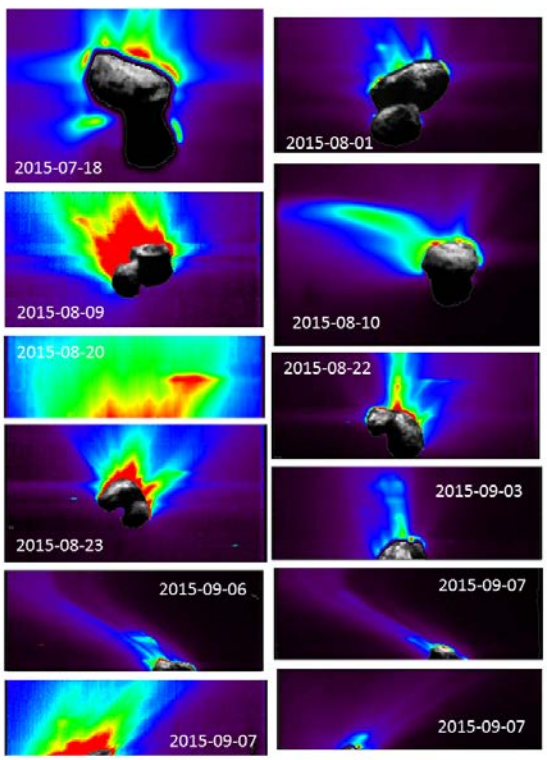

Fig. 2 VIRTIS dataset of some summer outbursts. Each image is an image at 0.55 µm, showing the nucleus, dust coma and outburst ejecta (collimated ejecta). A VIRTIS-M image of the nucleus at 0.55 µm is superimposed for better visualisation. The radiance has units of W/ m2/ sr/µm

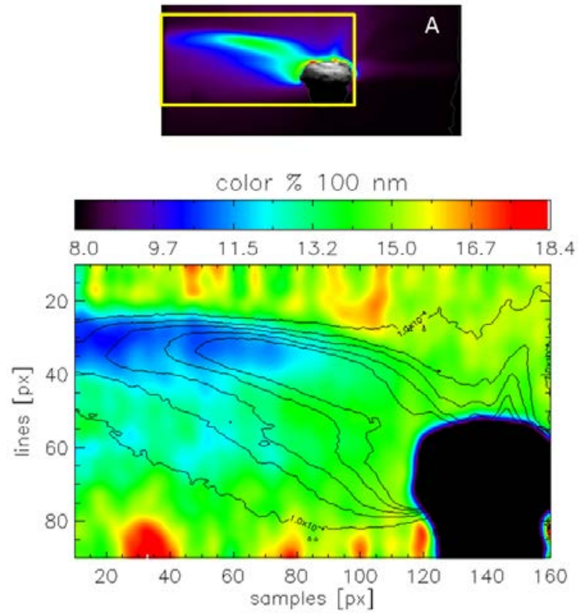

Figure 3: Dust continuum image of the 10 August 2015 outburst at 0.55 µm (upper plot) and the spatial distribution of the colour (lower plot) calculated in the yellow square of the dust image. The black contours are the radiance levels at 0.55 µm. The outburst ejecta display colours bluer than the background coma.

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.

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