EPSC Abstracts
Vol. 13, EPSC-DPS2019-1932-3, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Dust composition in the innermost coma of comet 67P from VIRTIS-M spectra: Organic features detection

Giovanna Rinaldi (1,2), Emiliano D'Aversa (1), Dominique Bockelée-Morvan (3), Andrea Raponi (1), Fabrizio Capaccioni (1), Mauro Ciarniello (1), Gianrico Filacchione (1), Maria Cristina De Sanctis (1), Fabrizio Oliva (1), David Kappel (4,5), Andrea Longobardo (1,2), Federico Tosi (1), Maria Teresa Capria (1), Fred Taylor (6), and the VIRTIS Team

(1) INAF-IAPS, via Fosso del Cavaliere 100, 0133 Rome, Italy (giovanna.rinaldi@inaf.it); (2) DIST-Università Parthenope, Centro Direzionale, Isola C4, 80143, Naples, Italy; (3) LESIA, Observatoire de Paris, LESIA/CNRS, UPMC, Universite Paris-Diderot, 92195, Meudon, France; (4) Institute of Physics and Astronomy, Univ. of Potsdam, Germany, (5) Institute of Planetary Research, DLR, Berlin, Germany, (6) Department of Physics, Oxford University, Oxford, OX1 3PU, UK

1. Introduction

The Rosetta/ESA spacecraft followed the comet 67P/Churyumov-Gerasimenko from 2014 August (3.6 au pre-perihelion) to 2016 September (3.6 au post-perihelion). This offered a unique opportunity to analyze the time evolution of the dust properties in the inner coma. Onboard Rosetta, the Visual Infrared and Thermal Imaging Spectrometer (VIRTIS-M) [1,2] acquired spectra of the dust coma in the spectral range 0.25 to 5 μm.

We limited our analysis to the pre-perihelion period, due to the malfunction of the IR channel from May 2015 onward, and we present spectral maps of the inner coma collected on 2015 April 27, during the in-bound equinox. The 0.25-5 μm radiance spectra taken in the coma contain two contributions: the solar radiation scattered by the dust (0.25 - 3.5 μm) and the dust thermal emission (3.5 - 5 μm). The evolution in time of the dust properties are analyzed by fitting the radiance spectra by means of a single scattering radiative transfer model. In the current version of this model the dust spectra are modelled by assuming a fixed complex refractive index, a dust size distribution with power-law indexes from -4 to -0.1 and particle size intervals between 0.1 and 1000 μm. These quantities are needed to compute dust scattering and thermal emission properties, and a linear least square fitting algorithm to invert the observed spectra.

In [3] the application of the algorithm to the measured spectra has shown that the coma dust continuum radiationis sensitive to the dust size distribution. A power-law index of -4 fails in reproducing the observation, while all synthetic spectra computed by means of a differential size distribution with power-law index greater than −3.1 match the dust continuum very well. However, we have also identified some interesting peculiarities in the fits that we have analyzed in more detail in this work.

2. Results

In [3] we observed a mismatch between the observed and synthetic spectra in the range of 3.0 - 3.7 μm, suggesting the presence of organics in the dust particles (Fig. 1). The ratio spectrum, obtained by dividing the observed radiance spectra with the best fit (Fig.2), shows a well-defined absorption band centred near 3.2 - 3.3 μm roughly 1 μm wide, with a band depth of about 15 - 20 %. The band is fairly symmetrical and displays similarities, in band depth and shape, with that observed in VIRTIS-M nucleus spectra [4, 5, 6]. The presence of this band, attributed to organic compounds of various species, on the ejected dust coma reveals that dust particles maintain almost the same composition as that of the nucleus. A band of similar properties has been observed in the coma of other comets such as Hartley 2 [7].

Fitting the thermal part of the spectrumsuggests that the dust, which dominates the innermost coma of 67P, is at a temperature of (210 ± 11) K, by, and gives a superheat value of S = 1.0 ± 0.05 [8, 9]. This superheat value confirms that the coma of 67P during the inbound equinox is dominated by particles greater than 10 μm [3].

Starting from the analysis performed in [3] we have studied the band observed in the coma to identify the variability of the major band parameters (i.e. band depth, band shape, band centre position, etc.) as functions of the temporal and spatial evolution of the dust properties; thus we studied evolution as a function of solar illumination, distance from nucleus and dust composition. The results will be presented and discussed.

Acknowledgements

We thank the following institutions and agencies for support of this work: Italian Space Agency (ASI, Italy) Centre National d'Etudes Spatiales (CNES, France), 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. D.K. acknowledges DFG-grant KA 3757/2-1

References

[1] Coradini A. et al., 2007, Space Sci. Rev., 128, 529; [2] Filacchione G., 2006, PhD thesis; [3] Rinaldi et al. 2017 MNRSA 469, S598; [4] F. Capaccioni, et al., Science 347, 2015; [5] Raponi et al. 2018 EPSC 2018, 865; [6] Ciarniello M. et al., 2016, MNRAS, 462, 443; [7] Protopapa et al., 2014 Icarus 238, 191; [8] Gehrz R. D., Ney E. P., 1992, Icarus, 100, 162; [9] Bockelée-Morvan D. et al., 2017, MNRAS, 469, S443

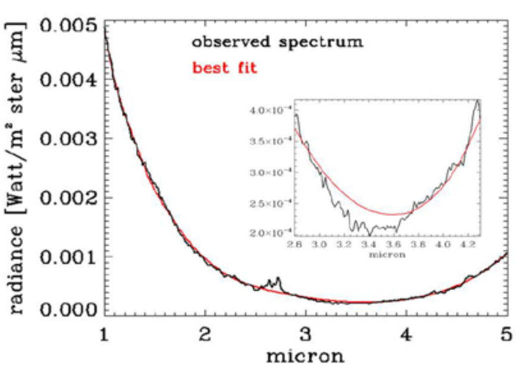

Figure 1: The figure shows the observed radiance spectrum in the infrared channel of 2015 April 27 in the infrared channel (black curve) and the best fit computed with a power law index of -3.1. The H_2O and CO_2 emissions at 2.67 μm and 4.27 μm are observed. The subplot displays the range between 3 and 3.8 μm where the mismatch between the observed and synthetic spectra occurs.

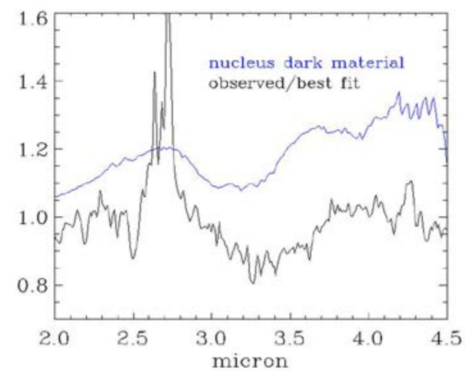

Figure 2: The black spectrum is the residual spectrum obtained by dividing the observed radiance spectrum with the best fit which is compared to the typical VIRTIS-M nucleus spectrum scaled by a factor (blue spectrum). In the black spectrum the H_2O emission band at 2.67 μm is observed.