Analysis of a 67P/CG night side outburst observed by VIRTIS-M: A new method to constraint the surface thermal inertia

G. Rinaldi[1,2], M. Formisano[1], D. Kappel[3], F. Capaccioni,[1], D. Bockelée-Morvan[4], M.T. Capria[1], M. Ciarniello [1], E. D'Aversa[1], M.C. De Sanctis[1], L. Doose[5], S. Erard[4], C. Federico[1], G. Filacchione[1], U. Fink[5], C. Leyrat[4], A. Longobardo[1;2], G. Magni[1], A. Raponi[1], F. Taylor[6], G.P. Tozzi[7], and M. Salatti [8]

[1] Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Rome, Italy
[2] Universita' degli Studi di Napoli Parthenope, Dip. di Scienze e Tecnologie, CDN IC4, 80143 Naples, Italy
[3] Institute of Planetary Research, DLR,12489 Berlin, Germany
[4] LESIA, Observatoire de Paris, LESIA/CNRS, UPMC, Universite Paris-Diderot, 92195, Meudon, France;
[5] Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, USA
[6] Departement of Physics, Oxford University, Oxford, UK
[7] INAF - Osservatorio Astrofisico di Arcetri, Firenze, Italy
[8] ASI, Via del Politecnico snc, I- 00133, Rome, Italy

On July 2015, during the perihelion period at heliocentric distance of 1.28 au, the Visible InfraRed Thermal Imaging Spectrometer (VIRTIS-M) onboard Rosetta spacecraft had the opportunity to monitor dust activity in the inner coma with a view from the night (shadowed) side of the comet 67P/Churyumov-Gerasimenko. At the time of the measurements presented in this work, we observed an outburst, which was identified as being generated on the opposite side of the nucleus. The first task has been to identify the originating spot. The analysis of the illumination conditions at the time of the observations revealed that identified spot was not directly illuminated, but only up to 2 hours before. We had then to investigate, by modeling, the subsurface temperature distribution to identify conditions for an outburst event to take place two hours after illumination. We applied a 3-D thermophysical model, based on a finite-element method (FEM), in order to evaluate the surface/subsurface temperature of the emitting region and to identify at which depth water ice sublimation temperature is reached. We explored three different initial configurations: 1) a layering with water ice mixed with dust (dust to ice ratio equal to 6) beneath a dust cover of 5 mm and thermal conductivity of the order of 10^-3 W/(m K); 2) the same layering but thermal conductivity of the order of 10^-2 W (m K); 3) no dust cover and ice-dust mixture directly exposed. The numerical model solves the heat equation coupled with a diffusion equation for the treatment of the water vapor emission. Self-heating computation is included in energy balance. The active layer has been identified at 5mm depth for a thermal inertia between 27-35W m^{-2} K^{-1} $s^{1\backslash 2}$.

The spectral properties show that the visible dust color range from red, 16±4.8 %/100 nm to 13± 2.6 %/100 nm indicating that inside this outburst is not present an evident color gradient. The outburst morphology can be classified as a narrow jet with a life-times of 12 minutes. The total ejected mass during this outburst event is estimated to be between 6 and 19 tons assuming size distribution indices between -2.5 and -3. Our analysis suggests that this transient event is a day-side dust activities that continued after the illumination. The specific observational conditions for these night (shadowed) side dust activities constrain their possible sources to a dusty terrains and their irregular distribution is possibly related to subsurface inhomogeneities in the dusty area.