



Metre-size bright spots at the surface of comet 67P/Churyumov-Gerasimenko: Interpretation of OSIRIS data using laboratory experiments

Antoine Pommerol (1), Nicolas Thomas (1), M. Antonella Barucci (2), Jean-Loup Bertaux (3), Björn Davidsson (4), Mohamed Ramy El-Maarry (1), Fiorenge La Forgia (5), Sonia Fornasier (2), Antonio Gracia (1), Olivier Groussin (6), Bernhard Jost (1), Horst Uwe Keller (7,8), Ekkehard Kuehrt (8), Raphael Marschall (1), Matteo Massironi (9), Stefano Motolla (8), Giampiero Naletto (10), Nilda Oklay (11), Maurizio Pajola (12), Olivier Poch (1), and the OSIRIS Team

(1) Universität Bern, Physikalisches Institut, Space Research and Planetary Sciences, Bern, Switzerland (antoine.pommerol@space.unibe.ch), (2) LESIA, Obs. de Paris, CNRS, Univ Paris 06, Univ. Paris-Diderot, 5 place J. Janssen, 92195, Meudon, France, (3) LATMOS, CNRS/UVSQ/IPSL, 11 boulevard d'Alembert, 78280, Guyancourt, France, (4) Department of Physics and Astronomy, Uppsala University, 75120 Uppsala, Sweden, (5) University of Padova, Department of Physics and Astronomy, Vicolo dell'Osservatorio 3, 35122 Padova, Italy, (6) Aix Marseille Université, CNRS, LAM, UMR 7326, 38 rue Frédéric Joliot-Curie, 13388 Marseille, France, (7) Institute for Geophysics and Extraterrestrial Physics, TU Braunschweig, 38106, Braunschweig, Germany, (8) Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Planetenforschung, Asteroiden und Kometen, Rutherfordstraße 2, 12489 Berlin, Germany, (9) INAF - Osservatorio Astronomico, Via Tiepolo 11, 34014 Trieste, Italy, (10) University of Padova, Department of Information Engineering, Via Gradenigo 6/B, 35131 Padova, Italy, (11) Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg, 3, 37077, Göttingen, Germany, (12) Centro di Ateneo di Studi ed Attività Spaziali, "Giuseppe Colombo" (CISAS), University of Padova, Via Venezia 15, 35131 Padova, Italy

Since the beginning of Rosetta's orbital observations, over a hundred small bright spots have been identified in images returned by its OSIRIS NAC camera, in all types of morphological regions on the nucleus. Bright spots are found as clusters of several tens of individuals in the vicinity of cliffs, or isolated without clear structural relation to the surrounding terrain. They are however mostly observed in the areas of the nucleus currently receiving the lowest amount of insolation and some of the best examples appear completely surrounded by shadows. Their typical sizes are of the order of a few metres and they are often observed at the surfaces of boulders of larger dimension. The brightness of these spots is up to ten times the average brightness of the surrounding terrain and multi-spectral analyses show a significantly bluer spectrum over the 0.3-1 μ m range. Comparisons of images taken in September and November 2014 under similar illumination conditions do not show any significant change of these features. Analysis of the results of past and present laboratory experiments with H₂O-ice/dust mixtures provide interesting insights about the nature and origin of the bright spots. In particular, recent sublimation experiments conducted at the University of Bern reproduce the spectro-photometric variability observed at the surface of the nucleus by sequences of formation and ejection of a mantle of refractory organic-rich dust at the surface of the icy material. The formation of hardened layers of ice by sintering/re-condensation below the uppermost dust layer can also have strong implications for both the photometric and mechanical properties of the subsurface layer. Based on the comparison between OSIRIS observations and laboratory results, our favoured interpretation of the observed features is that the bright spots are exposures of water ice, resulting from the removal of the uppermost layer of refractory dust that covers the rest of the nucleus. Some of the observations of clusters of bright spots are very indicative of a formation process, which involves the breakage and collapse of brittle layers of ice to form fields of large boulders, some of them showing bright spots on part of their surface. Some of the isolated spots observed elsewhere on the nucleus might as well have been formed by similar processes and then have been transported over large distances by multiple bounces. These surface exposures of water ice must be more recent than the last passage at perihelion, as they would rapidly sublimate at short heliocentric distance. The hypothesis formulated here will thus easily be tested as the comet approaches the Sun, by checking if and how fast the bright spots vanish and disappear.