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Optical properties of particles collected by COSIMA around 67P/Churyumov Gerasimenko

Yves Langevin (1), Martin Hilchenbach (2), Mathieu Vincendon (1), Sihane Merouane (2), Klaus Hornung (3), and Cosima team (2)

(1) Institut d'Astrophysique Spatiale, CNRS / Univ. Paris-Sud 11, Orsay, France (yves.langevin@ias.u-psud.fr), (2) Max-Planck Institut für Sonnensystemforschung, Göttingen, Germany, (3) Universität der Bundeswehr, Neubiberg, Germany

The COSIMA TOF-SIMS spectrometer aboard Rosetta has collected nearly 40,000 particles in orbit around 67P/Churyumov-Gerasimenko from August 2014 to September 2016. These particles have been identified using the COSISCOPE optical microscope, which imaged the 10 mm x 10 mm targets before and after exposure to the cometary environment with a resolution of $\sim$ 14 μm / pixel [1]]. Most of the particles in the smaller size ranges are fragments of larger parent particles [2}. 4000 particles are resolved, covering more than 2 pixels across, and 550 particles are more than 100 μm across (7 pixels), which made it possible to characterize their typology using sub-pixel sampling [1]. More than 90% of these large collected particles are aggregates, pointing towards a high porosity / low strength of the collected cometary material, as discussed in [3]. The optical properties of the collected particles provide supporting evidence that cometary material is dominated by high porosity / low strength material most likely dominated by complex organic matter [4].

Determining optical properties with COSISCOPE is a challenge as the LED's on opposite sides of the target are set for providing high incidence (70 – 85° from the near to the far edge), which means that relief / slope is the major parameter controlling the signal from a particle. Several complementary approaches have been implemented. A small fraction of particles,cover extended areas with low relief, making it possible to directly infer the albedo by comparing the light level with that of neighbor substrate areas (albedo measured in the lab: 1.85 % for "gold black" targets). For most particles, one has to rely on the crossover of the light profiles from the left and right LED's. With this approach, the albedo of aggregates ranges from 2% to at most 20%, and the relationship between the left and right profiles shows that photons penetrate 10's of μm into such particles, confirming a high porosity in line with the low strength.

[1] Langevin et al. (2016), Typology of dust particles. Icarus 271, p. 76.
[2] Merouane et al (2016), Dust particles flux and size distribution, A&A, doi : 10.1051/0004-6361/201527958
[3] Hornung et al (2016), first assesment of the strength of cometary particles Planet. Space Sci. 133, p. 63
[4] Fray et al (2016)., high-molecular weight organic matter in cometary particles, Nature 538, p. 72.