Structure of cometary dust particles revealed through light scattering observations and simulations, together with sample analysis

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Comet nuclei are considered as among the most pristine bodies in the solar system. When they approach the Sun, cometary particles are released from the surface or from inner layers allowing studying particles, which are not processed with properties probably representative of their origin.
Remote observations of solar light scattered by cometary dust particles provide information on their properties for a large variety of comets, in complement to the exceptional in-situ observations (with or without sample returns). The scattered light is partially linearly polarized. Differences in polarization have been found in cometary comae, pointing to different physical properties of the dust (e.g. sizes of the grains, of the aggregates, morphologies, complex refractive indices) [1,2].
High polarization regions are found: (1) in the 'focused' jets of active comets, (2) in some circumnucleus regions in restricted areas (or around fragments) for other comets [1]. When not hidden by jets, the polarization in the circumnucleus region may be lower with an eventual different spectral gradient than in the surrounding coma [3,4]. The polarization values are not sufficient to conclude and it is necessary to study the variation of polarization and intensity inside the coma and/or the spectral variations [5, 6].
We use experimental and numerical simulations in different wavelengths, which tend to show that large aggregates made of submicron-sized grains and more compact particles are present in various ratios in the different coma regions and/or comets. The fluffy aggregates population being in larger amounts in some regions (e.g. jets) or comets [1,3].
These results are confirmed by the analysis of particles captured by the Stardust mission at comet 81P/Wild 2, which are mainly made of silicates and carbonaceous compounds. The structure of tracks in the aerogel and of the impacts on the aluminium foils suggest mixtures of aggregates and compact grains in a large range of sizes from tenth up to hundreds of micrometers [7,8].
On the images of comet 9P/Tempel 1 some hours after the Deep Impact, two kinds of dust particles were detected: more compact particles with small velocities and fluffy particles ejected by the impact with large velocities, the two morphologies pre-existing in the nucleus [9].
Combining numerical [6,10,11] and experimental simulations [12,13], the polarization and its variation for different particles and composition will be presented and examples chosen among representative comets discussed.

Keywords: comets, dust, polarization, observations

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