Light scattering by cometary dust: Evidence and speculations

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Dust particles ejected from cometary nuclei are expected to provide information on materials and processes prevailing in the early solar system. The sunlight they scatter in cometary comae is partially linearly polarized. As opposed to the intensity, the linear polarization P does not depend on the spatial density, but only on the phase angle α of the observations (between the directions of the Sun and of the observer, as seen from the dust particles, i.e., angle supplementary to the scattering angle), on the wavelength of the observations, and on the intrinsic properties of the dust particles, such as size and size distribution, morphology and porosity, complex refractive indices, and thus composition and albedo [e.g., 1,2].

Remote observations have established long ago that polarimetric phase curves present, as asteroidal phase curves, a shallow negative branch (dominant polarized intensity component in the scattering plane) for phase angles below about 20° and a wide positive branch (dominant polarized intensity component perpendicular to the scattering plane) above 20°, with a maximum in the 90°–100° range [e.g., 3, 4]. In situ observations (for $\alpha = 73°$) in comet Halley coma from the OPE-Giotto experiment have provided evidence for significant changes with the wavelength (through narrow interference filters) and for variations within different regions, such as jets and the innermost coma [e.g., 5,2].

Since then, numerous remote observations in visible and near-infrared domains (through filters blocking less polarized gaseous emissions) have provided clues, mostly through polarimetric imaging techniques, to heterogeneities in the dust properties within cometary comae. Although such approaches may miss sufficient resolution to study innermost comae, they establish that polarization increases in jet-like features [e.g., 6–10]. Besides, it has been noticed that the polarization increases after fragmentation events and that, for large enough phase angles (above 35°), P increases with the wavelength, at least up to about 1.5 µm. While an increase in polarization after a splitting event suggests the presence in the coma of 'fresh' dust particles from the inner parts of the nucleus, trends in the dependence of P on the phase angle and the wavelength may be interpreted in terms of dust properties through complementary numerical and experimental simulations [e.g., 11,12].

In this presentation, polarimetric observations of comets will be summarized, together with the main conclusions derived through simulations. The significance for the Rosetta mission, of polarimetric observations of 67P/Churyumov-Gerasimenko [13] and of expected high-resolution polarimetric observations [14] and future simulations, will be discussed.

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