Physical Properties of Cosmic Dust Particles From Light Scattering

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Two ubiquitous phenomena are observed for atmosphereless solar-system objects near opposition: negative linear polarization and nonlinear surge of brightness (opposition effect). The phenomena are confined to Sun-object-observer angles (phase angles) of less than 30 and 10 degrees, respectively. The coherent-backscattering and shadowing mechanisms have been introduced to explain the phenomena sometimes showing up at extremely small phase angles. Coherent backscattering has been shown to contribute to both brightness and polarization, whereas shadowing has been shown to contribute to the opposition effect only. Recently, a single-scatterer mechanism has been introduced to explain the considerable angular widths of the observed negative polarization branches.

The single-scatterer mechanism consists of two parts and is related to the internal electric fields of wavelength-scale scatterers. First, a longitudinal internal-field component parallel to the wave vector of the incident wave results in negative polarization at intermediate phase angles with decreasing contribution towards the backward and forward-scattering directions. Second, interference among transverse internal-field components parallel to the incident electric field vector gives rise to negative polarization near backward-scattering directions, in resemblance to the multiple-scattering mechanism of coherent backscattering. The mechanism has been verified for both spherical and nonspherical single scatterers with wavelength-scale sizes.

We utilize the novel modeling in the interpretation of the polarimetric and photometric observations of near-Earth objects, asteroids, cometary comae and nuclei, transneptunian objects, and atmosphereless solar-system objects at large. We pay special attention to the observations of near-Earth cometary nuclei and transneptunian objects currently ongoing at the Very Large Telescope of the European Southern Observatory (ESO/VLT).