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Similarity and diversity of the polarization opposition effects for high-albedo atmosphereless Solar System bodies

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Negative polarization has been observed near opposition for objects of quite different nature. The angular dependence of polarization can exhibit a wide, almost parabolically shaped negative polarization branch (NPB) with a minimum near 5°-12° (e.g., for regolith of moderate- and low-albedo asteroids, cometary dust) while some high-albedo atmosphereless Solar System bodies (ASSBs) display an asymmetric NPB with a sharp minimum centered at about 0.5°–2° called the polarization opposition effect (POE). The POE has been detected for some high-albedo objects, such as the bright Galilean satellites of Jupiter, Saturn's rings and E-type asteroids. These early observations showed some differences in the NPB for various high-albedo objects. What are these differences?

We present all available data as well as new results of near-opposition polarimetric observations of high-albedo asteroids 64 Angelina and 44 Nysa; the satellites of Jupiter Io, Europa, and Ganymede; the Saturnian satellites Enceladus and Rhea; and the bright trailing hemisphere of Iapetus obtained through June 2014. We found the following significant difference in the parameters of the NPB and POE for different objects:

- The sharp asymmetric POE with a minimum about -0.75% centered at about 1° is observed for the bright side of Iapetus (p_v=0.6) resembling a curve obtained for a particulate MgO sample by Lyot;
- Despite albedo differences, the polarization curves for Enceladus (p_v=1.04) and Rhea (p_v=0.7) are almost symmetrical and very similar, with a minimum $\sim -0.6\%$ centered at about 3°;
- The sharp asymmetric POE with a minimum $\sim -0.35\%$ centered at about 0.5° is observed for Europa (p_v=0.68). This minimum is superimposed on an almost flat NPB;
- The POE in the form of a secondary minimum of polarization $\sim -0.3\%$ centered at the phase angle about 1.5° is observed for the asteroids Angelina (p_v=0.48) and Nysa (p_v=0.55). The NPB for these asteroids is almost flat at phase angles from 4° up to 10°.

The coherent backscattering mechanism and near-field effects as well as multiple scattering between particles forming a regolith and the single-particle scattering of light by individual particles form the NPB as a whole. The shape of the NPB (bimodal or highly asymmetric) will depend on the relative contributions of these mechanisms, which, in turn, depends on the physical characteristics of the regolith layer and the scattering geometry. The similarities and diversity in the parameters of the POE and NPB for different ASSBs will be discussed in the framework of the mentioned mechanisms.