THE LINEAR POLARIZATION OF LIGHT SCATTERED FROM ICY SATELLITE SURFACES: THE DIAGNOSTIC POTENTIAL OF GALILEO PPR MEASUREMENTS

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Goguen (1993, 1994) shows that for high albedo particulate surfaces, calculations combining Mie scattering with the doubling method give excellent agreement with laboratory measurements of the linear polarization of a carefully controlled sample of glass spheres. This approach is applied to investigate the expected linear polarization dependence on phase angle for water-ice regoliths at visible wavelengths. The Galileo Photopolarimeter/Radiometer (PPR) instrument (Russell et al., 1992) can accurately measure +/-0.1% polarization in 3 bandpasses centered at 0.410, 0.678, and 0.945μm. This study will examine the dependence of the linear polarization at these wavelengths, where water-ice is transparent ($k < 1.e-6$), on the mean particle size and width of the particle size distribution. The intended application is to anticipate which subset of the possible PPR icy satellite measurements will be most diagnostic of the physical state of the icy satellite regoliths. The results are applicable to Europa's relatively pure water-ice surface and should give valuable clues to features that may also be present in polarization measurements of Ganymede and Callisto.

Fig. 1 (opposite page) shows the approximate, modelling multiple scattering as isotropic (Goguen, 1994), linear polarization as a function of phase angle for 3 size distributions of water-ice spheres: small, $r \sim 0.07\mu m$ (top); medium, $r \sim 0.7\mu m$ (middle); and large, $r \sim 7.0\mu m$ (bottom). Calculations for the 3 wavelengths of the PPR instrument are shown: solid line, $\lambda=0.410\mu m$; dotted line, $\lambda=0.678\mu m$; and dashed line, $\lambda=0.945\mu m$ in each panel. In each case, the width of the log-normal size distribution is the same, $\sigma g=0.47$ (Hansen and Travis, 1974) which corresponds to $\delta r/r \sim 0.5$. For small particles (top), the polarization approaches that due to rayleigh scattering with large positive polarizations near g=100 degrees. For the wavelength sized particles (middle), the polarization is very different with neutral polarization near g=90 degrees. Large particles (bottom) rapidly develop the expected "rainbow" feature near g=40 degrees, show neutral polarization near g=90 degrees, and large, negative polarization g=150 degrees. Galileo PPR measurements in the phase angle ranges $g < 50$ degrees and $120 < g < 150$ degrees would easily discriminate between these surface models.

References

Goguen, J.D. (1993). A Test of the Applicability of Independent Scattering to High Albedo Planetary Regoliths. *Lunar and Plan. Sci. Conf.* **XXIV**, 541-542.

Goguen, J.D. (1994). A Quantitative Test of the Applicability of Independent Scattering to High Albedo Planetary Regoliths. *Icarus*, submitted.

Hansen, J.E., and L. Travis (1974). Light Scattering in Planetary Atmospheres. *Space Sci. Rev.* **16**, 527-610.

Russell, E.E., F.G. Brown, R.A. Chandos, W.C/ Fincher, L.F. Kubel (1992). Galileo Photopolarimeter/Radiometer Experiment. *Space. Sci. Rev.* **60**, 531-563.

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