POLARIZATION RATIOS AND RADAR ALBEDOS: INTERPRETATION IN TERMS OF NEAR-SURFACE PHYSICAL PROPERTIES OF ASTEROIDS.

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Introduction: A basic strategy for observing a small solar-system object using radar is to measure the distribution of echo power in time delay and the Doppler frequency for a circularly polarized wave in the same sense and opposite sense of circular polarization. The circular-polarization ratio μ is the ratio of the echo power in the same circular-polarization state (SC) to that in the opposite circular-polarization state (OC). The SC/OC ratio (μ) is often the most important physical observable when using the radar technique, as it provides the best indications for wavelength-scale complexity of the surface. Typical values of μ vary between 0 and 1. The maximum value observed using radar is $\mu = 1.48 \pm 0.4$ for the asteroid 2003 TH_2 [1]. Average observable values are to some extent taxonomical class dependent, and vary from $\mu = 0.10$ (G class) to $\mu = 0.83$ (E class), and radar albedos from $\sigma = 0.06$ (P class) to $\sigma = 0.27$ (M class). Typical transmitter frequencies are 2380 MHz and 8495 MHz.

Circular-polarization ratios and backscattering have been studied before in remote sensing (an overview of research in, e.g., [2]), and the fact that the surface complexity is not the only contributor has been acknowledged [3]. However, modeling of circular-polarization ratio dependency of similar range of parameters has not been carried out before, as well as presenting backscattering μ silmultaneously as a function of the size parameter and the refractive index.

Methods: We model electromagnetic scattering from closely-packed random aggregates of spheres mimicking the structure in asteroid's regolith. Both scattering and absorption of the electromagnetic wave are treated. The Multiple Sphere *T*-Matrix Method software (MSTM, [4]) is utilized to study how different parameters affect the SC/OC ratio, e.g., the size distribution and electric permittivities of the spherical particles forming the different aggregates. Our primary goal is to see if the computed circular-polarization ratios and radar albedos can be linked to the observational data of asteroids detected using radar. We model scattering from monodisperse and polydisperse sphere aggregates, both with absorption and without.

Results: The results of the simulations show striking interference structure for the circular-polarization ratio as a function of the size parameter (x) and the refractive index (m) of the medium for monodisperse aggregates (see Fig. 1).

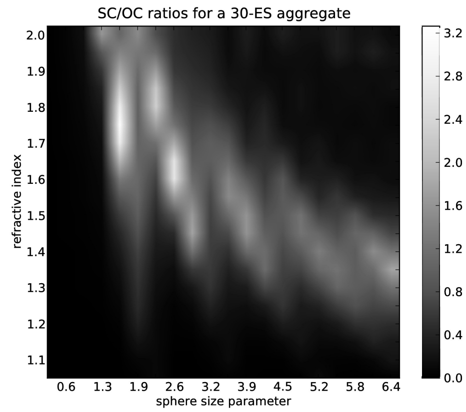

Figure 1. Circular-polarization ratios of an aggregate of thirty equal-size (ES) spheres.

Differences between aggregates of monodisperse and polydisperse spheres exist: the monodisperse aggregates may cause average SC/OC ratios of up to eight, whereas in case of the polydisperse aggregates, the maximum and minimum values approach unity at high values of m and x. Also, the vertical structure fades in case of polydisperse aggregates. Averaged over multiple polydisperse aggregates, the simulations for aggregates of spheres approach simulating realistic regolith, and hence, indicate reasons for the variations in the observed data.

Backscattering intensity (directly proportional to the radar albedo) seems to be inversely proportional to μ at high values of x and m. At small values both intensity and μ approach zero as scattering decreases.

References:

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