THE OPPOSITION PHASE CURVE IN LOW ALBEDO MEDIA

R. M. Nelson(1). B. W. Hapke(2), W. D. Smythe(1), A. S. Hale(1), J. L. Piatek(2), (1)Jet Propulsion Laboratory,Pasadena CA 91109, (2)Department of Geology and Planetary Science, 321 OEH, University of Pittsburgh, Pittsburgh PA 15260. Robert.M.Nelson@jpl.nasa.gov, FAX 818-354-0966

Introduction: We report the results of an investigation into the opposition surge of low albedo particulate materials of varying particle size and packing density. These very low albedo materials exhibit nearly constant circular polarization ratio with decreasing phase angle consistent with the elimination of shadows being the overwhelming contributitor to the phase curve.

The Experiment: The measurements were made on the long arm goniometer at NASA's Jet Propulsion Laboratory The samples of were presented with linearly and circularly polarized light from a laser of wavelength 0.633 μm. The samples (SiC, B_4C, Fe_3O_4 and $Co_2O_{3)}$ differed in reflectance from 13% to 1.6 %. The reflectance of each sample measured at 5° phase angle relative to Spectralon™ was, 13%, 5%, 2.3% and 1.7% for the SiC and B_4C, Fe_3O_4 and Co_2O_3 respectively. They were presented with light that was polarized in and perpendicular to the scattering plane. A quarter wave plate was inserted into the optical train at appropriate places to permit the samples to be presented with both senses of circular polarization. The scattered beam was analyzed in both senses of linear and circular polarization. We combined the data from all of the polarization configurations and these are shown as integrated phase curves.

The Results: The phase curves all exhibit an increase in reflectance as phase angle decreases. From 5 to 0°.05 SiC exhibits a non-linear increase in circular polarization ratio (CPR) compared to the more absorbing media. The increase in CPR with decreasing phase angle can only be caused by significant multiple scattering in the medium. This is consistent with coherent backscattering.

Discussion: We have previously shown that significant multiple scattering is observed in materials of high reflectance (70-90%) We found the result for SiC to be unusual given that is it so much more absorbing. However, if the reflectance of a material decreases still further (below (10%) the contribution of multiply scattered light to the reflectance phase curve diminishes significantly. This causes the phase curve to become nearly linear as in the case of B_4C, Fe_3O_4 and Co_2O_3.

Conclusion: We find a significant contribution of multiply scattered radiation in the reflectance phase curve of materials of fairly low albedo even for some materials as with reflectance as low as 13%. The contribution of multiple scattering only becomes insignificant (although still measurable) when the reflectance approaches 5%. Low albedo planetary regoliths such as the Moon and Marcury can be expected to exhibit appreciable multiple scattering.