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Advances in Instrumental Techniques for Investigating Planetary Regolith Microstructure

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Introduction: The Opposition Effect (OE) is the non-linear increase in the intensity of light scattered from a surface as phase angle approaches 0^o. It is seen in laboratory experiments and in remote sensing observations of planetary surfaces. Understanding the OE is a requirement to fitting photometric models which will produce meaningful results about regolith texture. Previously we have reported measurements from the JPL long arm goniometer and we have shown that this instrument enables us to distinguish between two distinct processes which create the opposition surges, Shadow Hiding (SHOE) and Coherent Backscattering (CBOE)(Hapke et al., 1993; Nelson, et al. 2000; 2002). SHOE arises because, as phase angle approaches zero, shadows cast by regolith grains on other grains become invisible to the observer. CBOE results from constructive interference between rays traveling the same path but in opposite directions. Our instrument was able to measure the phase curve using linearly and circularly polarized light which enabled us to distinguish between the singly and multiply scattered components in the reflected radiation. We were able to measure to angles as small at 0.05 degrees but our results were limited to maximum measurements of only 5 degrees. In the last year, we have extensively renovated the instrument so that measurements can be made from phase angles as small at 0.05 degrees to 20 degrees. This permits us to study the reflectance phase curve and the linear and circular polarization phase curves for phase angles at which important changes occur depending principally on the albedo, the particle size and the single scattering phase function of the material under investigation. We report the results from the first series of measurements of the refurbished instrument.

The Experiment: We measured the angular scattering properties of 13 mixtures of

Aluminum Oxide powders of the different particle size (0.1 to 30microns). Along with the reflectance phase curve we measured the circular polarization ratio (CPR)- the ratio of the intensity of the light returned with the same helicity as the incident light to that with the opposite helicity. An increase in CPR with decreasing phase angle indicates increased multiple scattering and is consistent with CBOE (Hapke, 1993). Our results extended to a phase angle of 20 degrees are consistent with our earlier investigations which were limited to phase angles less than 5 degrees. We are also able to measure important parts of the linear and circular polarization phase curve which we had previously been unable to measure.

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