Using MSTM to model geometrically complex space weathered particles

Carey Legett IV[a,*], Timothy D. Glotch[a], and Paul G. Lucey[b]

[a]*Stony Brook University, 255 Earth and Space Sciences Building, Stony Brook, NY 11794-2100, USA*
[b]*Hawaii Institute of Geophysics and Planetology, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96822, USA*

[*]*Presenting author (carey.legett@stonybrook.edu)*

Space weathering can be defined as the gradual changes experienced by the surfaces of airless planetary bodies due to exposure to the vacuum of space, radiation, and micrometeoroid bombardment [1]. Characteristic visible/near-IR spectral changes due to space weathering include a decrease in albedo and a general "reddening" of spectra (increasing reflectance with increasing wavelength). Apollo-returned lunar soils contain grains hosting amorphous rims with nanophase metallic-iron particles ($npFe^0$) dispersed throughout. Absorbing particles of this scale (tens of nm) have very strong optical effects relative to their abundance. The size of the $npFe^0$ particles determines the amount of reddening observed with smaller particles being associated with redder spectra than larger particles. In laboratory data, a transition occurs at a particle size of ~30–50 nm, above which the spectra darken without reddening. Previous modeling work has failed to robustly reproduce this transition at the observed iron particle size, instead requiring larger particles [2].

We present work using the Multiple Sphere T-Matrix method [3] to model space weathered olivine particles. We construct each particle out of a host grain of olivine, a thin (tens to hundreds of nm) amorphous silica rim, and a number of iron particle inclusions outside the host, but within the rim. We then explore the dependence of the modeled reflectance on the abundance and size of iron nanoparticles. Additionally, we construct small clusters of these grains in order to model more realistic multiple scattering cases that are more comparable to remote sensing and laboratory data.

References

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