RADIATIVE-TRANSFER MODELING OF SPECTRA OF PLANETARY REGOLITHS USING CLUSTER-BASED DENSE PACKING MODIFICATIONS. G. Ito[1], M. I. Mishchenko[2], and T. D. Glotch[1], [1]Stony Brook University, [2]NASA Goddard Institute for Space Studies (gen.ito@stonybrook.edu).

Introduction: Light scattering and radiative transfer models are important tools in optical characterization of particulate media and have been an integral part in analyses of atmospheres and surfaces of solar system bodies from various remote sensing measurements. In the strictest sense, the radiative transfer theory (RTT) can only be applied to sparse particulate media in which individual particles are separated enough from each other that the far-field approximation can be assumed. However, the RTT has still been applied to densely packed media, such as regoliths and snow surfaces, with a variety of assumptions and modifications. Here we continue to improve theoretical modeling of spectra of densely packed particulate media using the RTT.

Methods: We use the superposition T-matrix method to compute the scattering properties of an elementary volume entering the radiative transfer equation (Fig. 1) by modeling it as a cluster of particles (Fig. 2) and thereby capture the near-field effects important for dense packing. Then, these scattering parameters are modified with the static structure factor correction to suppress the irrelevant far-field diffraction peak rendered by the T-matrix procedure. Using the corrected single-scattering parameters, reflectance (and emissivity) is computed via the invariant-imbedding solution to the scalar radiative transfer equation. We modeled the emissivity spectrum of the 3.3 µm particle size fraction of enstatite, representing a common regolith component, in the mid-infrared (~5 – 50 µm).

Results: The use of the static structure factor correction coupled with the superposition T-matrix method produced better agreement with the corresponding laboratory spectrum than the sole use of the T-matrix method, particularly for volume scattering wavelengths (transparency features). The static structure factor correction is best suited for relatively low packing densities. For a low packing density (0.2), the spectrum is modeled well at many frequencies, particularly at the transparency feature. This is important for studies of a number of solar system bodies as the regolith particles are thought to be gently deposited on surfaces with packing densities close to 0.2, as for the case of lunar regolith. For higher packing densities, the static structure factor correction leads to an overcorrection of spectral contrast at all wavelengths

Conclusions: This work demonstrates the importance of proper treatment of the packing effects when modeling semi-infinite densely packed particulate media using finite, cluster-based light scattering models. Particularly, spectral features arising from volume scattering, which has been difficult to model in the past, will benefit from our model whereas reststrahlen features are more difficult to correctly model.

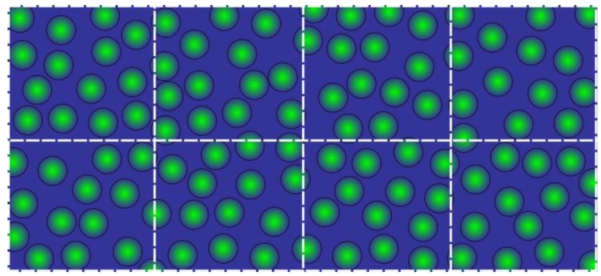

Figure 1. The scattering media considered in the model. White dashed boxes indicate the "elementary volume" in classical RTT.

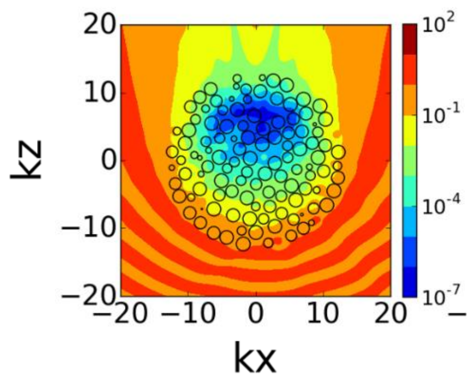

Figure 2. Electric field intensity of the scattered light in one of the "elementary volumes" represented by a cluster in the superposition T-matrix procedure.