Progress in modeling polarization of cosmic dust using MSTM code

Ludmilla Kolokolova[1], Daniel Mackowski [2]

[1]*University of Maryland, USA,* [2]*Auburn University, USA*

Aggregated particles play a crucial role in the formation of observed characteristics of dust in interstellar medium, molecular clouds, circumstellar disks, comets, planetary atmospheres and on surfaces. Thus, modeling their interaction with radiation has a fundamental astrophysical value. Recent years have been marked by a significant development of one of the most popular codes to model light scattering by aggregates - Multi Sphere T-Matrix code (MSTM), and by its numerous applications to cosmic dust.

Parallelized version of the MSTM code [1]. It made computations possible for aggregates of thousands of constituent particles (monomers) comparable with wavelength. Such large aggregates played a crucial role in our analysis of near-infrared polarization and modeling spectral dependence of polarization in comets and debris disks.

MSTM code for optically active material [2]. This version has a significant astrobiological value; it allows consideration of dust that includes homochiral organics. We used this code to interpret cometary circular polarization and for exploring circular polarization as a biosignature. The most recent development of this version of MSTM code considers a system where any of the spheres can be located at points that are either internal or external to the other spheres [3], enabling consideration of inclusions or core-mantle particles. See the latest MSTM code at www.eng.auburn.edu/users/dmckwski/scatcodes/ .

A new version of the code, **MSTM4**, **considers large thick slabs of spheres** [4], i.e. it can model planetary regolith. MSTM4 is significantly different from the versions described above. It adopts a discrete Fourier convolution (DFC), implemented using a fast Fourier transform (FFT), for evaluation of the exciting field. This approach is similar to that used in DDA codes, but considers multipole nature of the translation operators and does not require the spheres to be located on a regular lattice. MSTM4 is capable to consider dozens of thousands of monomers and is also about 100 times faster than the original MSTM code. The code is in its testing stage now, however we have already successfully applied it to model polarization and spectra of icy bodies (satellites of giant planets and KBOs).

1. Mackowski, D., Mishchenko, M., 2011, A multiple sphere T-matrix FORTRAN code for use on parallel computer clusters, JQSRT, 112, 2182 - 2192.

2. Mackowski, D., Kolokolova, L., Sparks, W., 2011, T-matrix approach to calculating circular polarization of aggregates made of optically active materials, JQSRT, 112, 1726 - 1732.

3. Mackowski, D., 2014, A general superposition solution for electromagnetic scattering by multiple spherical domains of optically active media JQSRT, 133, 264 - 270.

4. Mackowski, D., 2014, Extension of the MSTM code to particles near a surface, Proceedings of the Workshop ``Scattering by aggregates``, Bremen, Germany, 24 - 25. March 2014 (Th. Wriedt, Yu. Eremin, Eds.), 6 - 9.