Emission, Absorption, and Scattering by Dust Particles: Synoptic Numerical Solution

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Physical properties of cometary and interplanetary dust particles can be constrained by combining the observed light scattering data to the observed thermal emission data. Using the same particle model for scattering and emission, i.e., the synoptic modeling, results in a more reliable estimate for the physical properties of particles than using only the scattering or emission data. For small particles, the radiative heat transfer solution can be found numerically via the exact electromagnetic techniques for scattering and absorption combined with the fluctuation driven electrodynamics for emission. This approach is computa- tionally heavy and cannot be applied to large particles. For large enough objects, absorption and emission sources can be assumed to be localized on the surfaces of a particle, and thus they can be coupled with the conductive/convective heat transfer equation by using a proper boundary condition to treat the heat flux in and out of the system. However, the gap in between the small and large objects cannot be treated rigorously with the existing simulation techniques due to the large computational time or inadequate approximations.

Recently, we have introduced a radiative transfer (RT) approach that extends the applicability of the RT to dense random media [1,2], and the method has been applied to compute scattering and absorption of porous cometary dust particles [3]. Currently, we are expanding the dense media RT for thermal emission allowing for simulations of the radiative heat transfer and thermal emission of such particles. Further, combining the radiative heat transfer model to the conductive and convective heat transfer equation together with the phase change physics allows us to simulate thermophysics of the cometary dust particles after they have being lifted off from the nucleus of a comet. In this talk, I will discuss the theoretical framework of our heat transfer model and show some preliminary simulation results.

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References:

[1] K. Muinonen, et al., Opt. Lett. 43(4), 683, 2018.
[2] J. Markkanen et al., Opt. Lett. 43(12), 2925, 2018.
[3] J. Markkanen, et al., ApJL. 868(1), L16 2018.