Optical Properties of Porous Aggregates: Toward the Better and Simple Understanding

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Porosity evolution is a key process to overcome the radial drift barrier, which is a major problem of planet formation theory (e.g., Okuzumi et al. 2012, Kataoka et al. 2013 a,b). Since the optical properties of porous aggregates is not completely understood, the presence of such porous aggregates is not clearly shown by observation. Thus, our goal is to attain better understanding of optical properties of porous aggregates such as phase function, polarization, absorption and scattering cross-section and construct the model that is much easier to use than cost numerical method.

We calculated the absorption and scattering cross sections of porous aggregates with fractal dimension of two using the T-Matrix Method that is one of most rigorous method. Our results show that absorption cross-section of porous aggregates are same as monomer's absorption cross-section at the longer wavelength compare to the monomer radius. This is already shown by Kolokolova et al. (2007) and more recently by Kataoka et al. (submitted to A&A) using approximate method, Effective Medium Theory (EMT). We also find simple scaling relations for the scattering cross section in the limits of long and short wavelengths. If the wavelength is much longer than the characteristic radius of aggregates, scattered lights are coherently superposed, then $C_{\rm sca}(N) = N^2 C_{\rm sca}(N=1)$ where $C_{\rm sca}(N)$ is the scattering cross section of an aggregate consisting of N monomers. In the opposite limit, scattered lights are incoherently superposed then the scattering cross-section obeys $C_{\rm sca}(N) = N C_{\rm sca}(N=1)$. In the intermediate wavelength regime, the scattering cross-section can be described by the combination of coherent and incoherent scattering, and we derived the fitting formula that can reproduce the result obtained by T-Matrix Method. We also investigate its dependence on the fractal dimension of the aggregates. In addition, in the talk we compare these results with EMT and discuss the condition where the EMT approximation breaks down.