EXTENDED CALCULATION OF POLARIZATION OF FRACTAL AGGREGATES BASED ON NUMERICAL LIGHT SCATTERING SIMULATIONS. Y. Okada[1], T. Mukai[2], I. Mann[1] and M. Koehler[3], [1]Kinki University, Graduate School of Science and Engineering (3-4-1 Kowakae Higashi-Osaka, 577-8502 Japan; yasokada@gmail.com); [2]Kobe University, Department of Science; [3]Meunster University.

Introduction: Light scattering properties of fractal aggregates are important to analyze observational data, such as polarization by cometary dust.

Studies for the light scattering properties of aggregates have been carried out with methods for numerical light scattering simulations. Among various methods, T-matrix method for clusters of spheres introduced in [1] has been widely used as a rigorous method. Their widely used code is based on exploitation of T-matrix for clusters of spheres, together with analytical orientation averaging method for random orientation averaging.

With the T-matrix method and other methods for numerical light scattering simulations such as Discrete Dipole Approximation [2,3] and Generalized Multiparticle Mie solution [4], researchers have been carrying out studies of light scattering properties of aggregates. However, those previous studies were limited in the number of particles N (e.g., less than 200), and the size parameter of monomers x_m (e.g., x_m<=1.7 for N around 200) (see Figure 1 of [5] and references therein).

Proposal of extended calculations: We have investigated the possibility of expansion of parameter space by using other approaches not widely used in previous studies. When random orientation averaging properties are considered, there are two approaches for the averaging; analytical orientation averaging and numerical one.

The former is widely used with the advantage of efficiency in the computation as proposed in [6]. However, it is found by our investigation that with the fixed orientation code provided by Prof. Mackowski and Prof. Mishchenko in [7], the size and the number of monomers of fractal aggregates in the numerical light scattering simulations can be expanded compared with the code for analytical orientation averaging (see Figure 3 of [5]).

Therefore, we propose to carry out numerical light scattering simulations of fractal aggregates by a combination of 1) light scattering simulation code for a fixed orientation, and 2) numerical orientation averaging.

The numerical orientation averaging was considered to be inefficient compared with analytical one. However, traditional method for numerical orientation averaging was based on a selection of orientations in a grid like a lattice (hereafter, lattice-grid). Instead of the conventional selection of orientations in the lattice-grid, Okada (2008) proposed an efficient selection of orientations based on Quasi-Monte-Carlo (QMC) method [8]. With the QMC method, number of orientations required to have accurate averaging results can be reduced by a factor of around 17 (see Figures in [8]), which makes the numerical averaging comparably efficient to the analytical averaging.

Results of numerical simulations: As a sample result of numerical light scattering simulations of fractal aggregates extended with our approach, we show polarization of fractal aggregate composed of up to 1024 monomers.

We treat ballistic particle-cluster aggregate (BPCA) as a shape model of the aggregate [9]. As an optical constant of the aggregate, we used that of silicate (m=1.68+0.03i) at the wavelength of 0.6 micron [10]. The radius of the monomer is considered as 0.15 micron, which corresponds to monomer size parameter of 1.57 for the selected wavelength. Figure 1 shows 3D image of BPCA composed of 1024 monomers.

Figure 2 shows degree of linear polarization of BPCA. In order to study the dependence of number of monomers, we have carried out numerical simulations with number of monomers N=16, 32, 64, and 128 in the upper panel of Figure 2. We also show results with N=128, 256, 512 and 1024 in the lower panel of Figure 2.

Two panels of Figure 2 show that the interpretation of a dependence of the number of monomers on the polarization becomes different for smaller and larger numbers of monomers.

It is considered that for smaller numbers of monomers, several factors causes misleading interpretation of numerical results, which will become negligible by increasing numbers of monomers. These factors should be considered with caution when we treat smaller numbers of monomers in future systematic studies.

Summary: We have introduced our approach for extended numerical light scattering simulations for fractal aggregates. Our approach enables us to treat aggregates composed of 1024 monomers for monomer size parameter of 1.57. Numerical simulations for different numbers of monomers show that dependences of number of monomers are different for smaller and larger numbers of monomers, which should be treated with caution.

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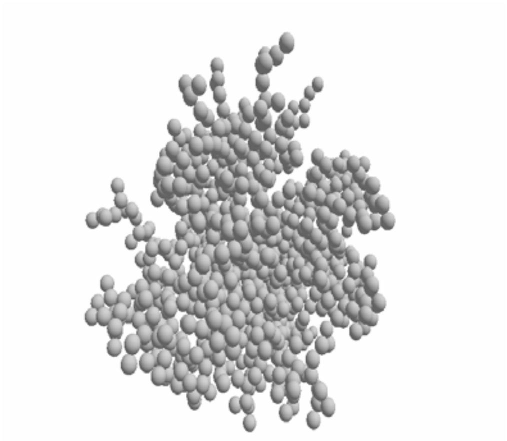

Figure 1. BPCA composed of 1024 monomers

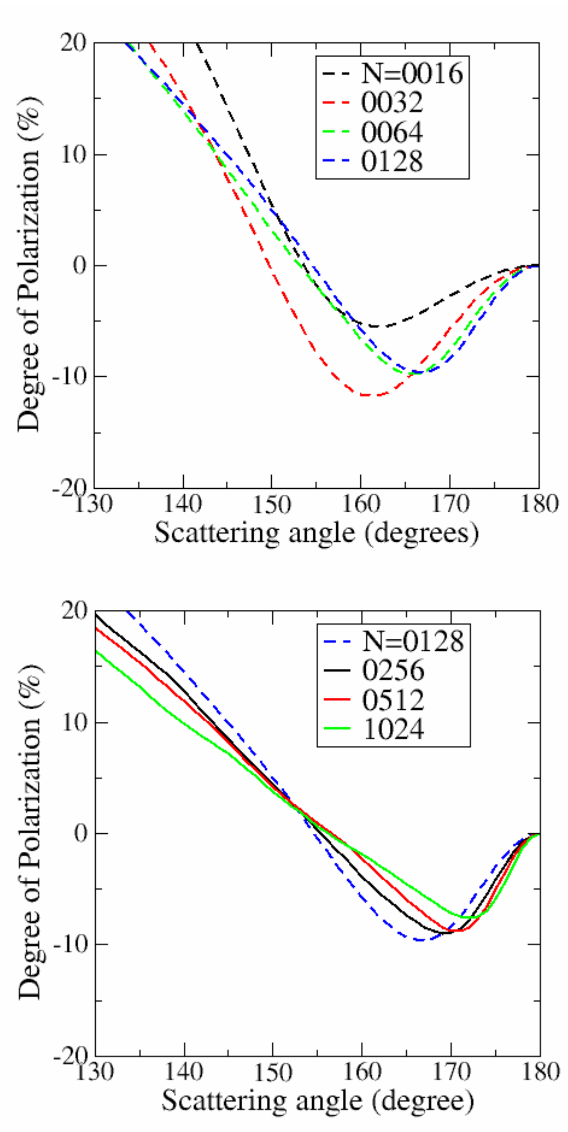

Fig.2 Degree of linear polarization of BPCA. Monomer size parameter of 1.57, optical constant *m*=1.68+0.03*i*[10] for smaller (upper panel) and larger numbers (lower panel) of monomers.