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Light scattering from densely packed irregular particle clusters in the geometric optics regime using inhomogeneous waves

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Abstract

We simulate huge discrete random media composed of Gaussian random particles of different sizes and shapes in the geometric optics (GO) regime. The code used is an extended version of the SIRIS4, and supports multiparticle systems and inhomogeneous waves. This helps us to understand how the properties of the particles affect the output of the simulation, e.g. is there any size dependency, and helps us to improve shadowing functions and thus asteroid phase curve models.

1. Introduction

Simulating light scattering from a huge discrete random medium with exact methods such as the Volume integral equation solver or the Superposition T-matrix method is a challenge [1]. The required computational resources are even more tremendous, if the particles are larger than the wavelength ($\lambda \gg r$), but fortunately, in this region, geometric optics (GO) can be applied.

In the GO, electromagnetic waves are treated as rays, which can be traced individually in the studied system. SIRIS4 [2, 3] is an GO code, which has been successfully applied to spectral modeling [4]. The problem is that the code does not support multiparticle systems, but this will be fixed in the SIRIS4.1.

The new version can be applied to the discrete random media composed of Gaussian random particles such as shown in Fig. 1. The intensity and polarization curves from these simulations will help us to develop better understanding of how the geometry of the single particles will affect the overall light-scattering characteristics of the system.

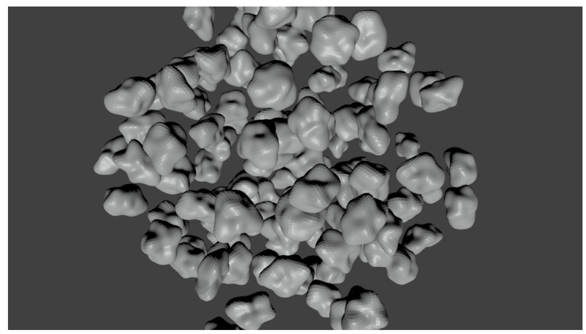

Figure 1: A discrete random medium composed of Gaussian random particles.

2. SIRIS4.1

SIRIS4.1 is a spin-off project from the original SIRIS4, which computed light-scattering characteristics of single particles by generating Gaussian random particles and tracing rays inside the particle. SIRIS4.1 supports ray tracing in dense random media with a huge number of particles.

As a preliminary result, Figs. 2 and 3 are shown. In these figures the GO and the radiative transfer (RT) were compared by simulating spherical discrete random media of packing density 10% and size parameter $kR = 5100$ made of $kr = 100$ particles. Both intensity (Fig 2) and polarization (Fig 3) were studied. These results were computed with a single computing core so there is a possibility to simulate even larger systems.

3. Summary

We will study discrete random media made of Gaussian random particles of different sizes and shapes in the geometric optics regime. In order to be able to do this, SIRIS4.1 needs to be finished with a proper

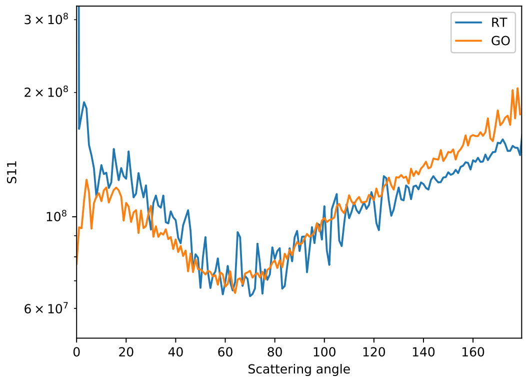

Figure 2: Intensity as a function of scattering angle.

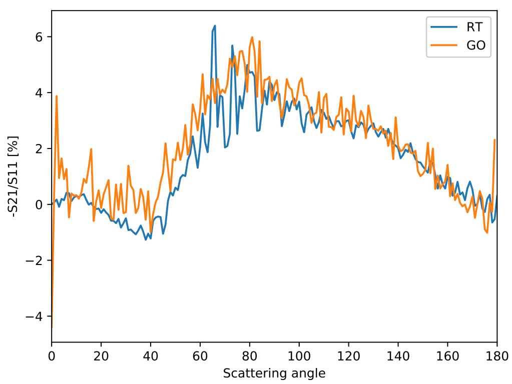

Figure 3: Degree of linear polarization as a function of scattering angle.

packing algorithm, which can support multiple irregular particles. The results will help us to understand how the features of a single particle can affect the output of the light scattering simulation. This knowledge can be then applied to improve asteroid phase curve models.

Acknowledgements

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References

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