Radiative-transfer modeling for measured scattering properties of a planetary-regolith analog sample

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Abstract

Multiple scattering by a planetary-regolith analog surface consisting of closely equisized silica spheres was studied with recently developed Radiative Transfer with Reciprocal Transactions (R^2T^2) and Radiative Transfer Coherent Backscattering with Incoherent interactions (RT-CB-ic). The computed results match the experimental results relatively well, considering that the computer modeling is in early stages.

1 Introduction

In order to do reliable inversion of the properties of the asteroid surface from spectral and polarimetric data, physics-based electromagnetic scattering programs, which work for large and dense media, are needed. The exact methods exist but these methods fail when the media is huge and thus approximate methods need to be developed. For this purpose we have been developing the radiative transfer codes R^2T^2 and RT-CB-ic [1]. To show the current progress of our work, we have modeled a planetary-regolith analog sample using them.

The analog sample is a low-density agglomerate produced by random ballistic deposition (RBP) of almost equisized SiO2 spheres (refractive index n=1.5 and diameter 1.45 ±0.06 µm with Gaussian size distribution). The volume fraction of the sample was 0.15 ±0.03 and the size of the diameter of the cake was about 20 mm and depth 5 mm. The experimental setup and more about the sample can be found in [2] and [3].

The light-scattering properties of the sample were studied using the PROGRA^2-surf experiment which has been developed to provide polarization phase curves which can be compared to remote sensing observations [4].

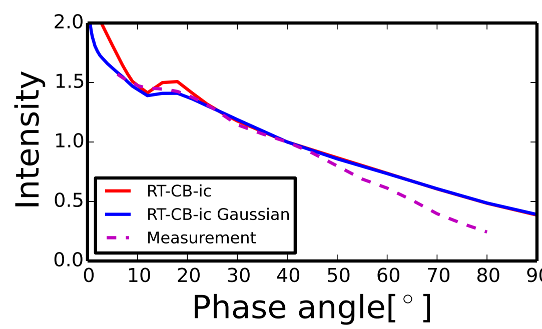

Figure 1: Intensity. Normalized to unity at 40 °

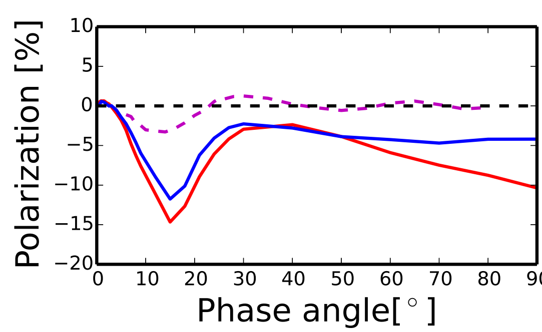

Figure 2: Degree of linear polarization

2 Computational Methods

The computational modeling was done by using radiative transfer codes the RT-CB-ic and the R^2T^2, which use the so the so-called incoherent fields [5], and include the coherent backscattering effect. We have shown that the incoherent field treatment can make the radiative transfer applicable to dense media [1]. The RT-CB-ic is not compute intensive and thus can be run on a personal computer whereas the R^2T^2 can require a supercomputer if the studied medium and scatterers are large. These methods are work in progress so improvements in the near future are expected.

3 Results

We have computed scattering from a macroscopic spherical medium (volume fraction 0.15) with RT-CB-ic [see Figs. 1 and 2] using single particle size (diameter 1.45 μm, red curve) and Gaussian distribution for the size (mean 1.45 μm with σ=0.02 μm, blue curve), with the refractive index (n = 1.48+0.0001i) which is due to remarks made in [3].

4. Summary and Conclusions

The RT-CB-ic produces relatively well the measurement results although the system is modeled using simple assumptions. The results can get better by tweaking the size distribution of the scatterers and modeling the shape of the media better. Large sphere as a shape of the media was assumed in the computations. The low polarization peak near 15° is a challenge for our methods. The reason for this can be the clustering of the spheres in the sample which is not present in current computational models.

Acknowledgements

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