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Numerical surface scattering laws for asteroid applications

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We present a database of numerically computed surface scattering laws for surfaces consisting of spherical particles.

1 Introduction

Simple analytical scattering laws such as the Lommel-Seeliger law is commonly used to model the scattering of sunlight by asteroid surfaces. In their simple form, however, they are only valid for smooth surfaces, while the surfaces of asteroids are covered by a loose regolith. The particulate surface structure causes subtle photometric features [1], but taking them into account is difficult with a simple analytic scattering law. Our intention is to allow a user to efficiently simulate light scattering from this type of surfaces by using pre-computed values.

2 Methods

We use a ray-tracing technique [2] to compute the scattering of light from a surface medium composed of opaque spherical particles with variable size distribution, packing density, and macroscale roughness. The scattering is discretized over the angles of incidence, emergence, and azimuth using an efficient and simple hemisphere discretization scheme.

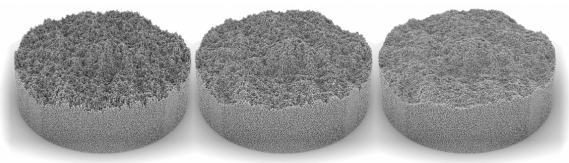

Figure 1: A visualization of the scattering medium.

3 The product

The numerical scattering laws are provided as data files containing the sky hemisphere and descriptive metadata. In practice, the user will load the hemisphere array from the file and compute the scattering law values in their software through interpolation between the array values, then multiplying by the desired phase function.

The first release of data contains scattering laws computed for media with packing densities in the range of 0.15 to 0.55 and a uniform size distribution.

Documentation and example source code is also provided to help users integrate our scattering law approach to their software.

4 Example

We are using this numerical scattering law to compute simulated asteroid lightcurves, for the purpose of testing shape inversion software. The shape inversion code assumes a plain Lommel-Seeliger scattering law, and using our more complex model avoids inverse crimes.

Acknowledgements

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References

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