ELS-XV-2015 Abstracts
ELS-XV-2015-72
Electromagnetic & Light Scattering XV 2015, Leipzig

Numerical rough-surface scattering model for the photometry of atmosphereless Solar System bodies

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We present a scattering model for regolith-covered Solar System bodies. It is used to compute the intensity of light scattered by a surface consisting of packed, mutually shadowing particles.

Our model is a Lommel-Seeliger type model, representing a medium composed of individual scatterers with small single-scattering albedo. This means that it is suitable for dark regolith surfaces such as the Moon and many classes of asteroids. Our model adds an additional term which takes into account the mutual shadowing between the scatterers. The scatterers can have an arbitrary phase function. We use a numerical ray-tracing simulation to compute the shadowing contribution.

We present the model in a form which makes impelementing it in existing software straightforward. The model in practice is implemented as files containing pre-computed values of the surface reflection coefficient, which can be loaded into a user's program and used to compute the scattering in the desired illumination geometries. We have used the model to fit disk-resolved photometry of the lunar surface, as well as to produce simulated asteroid lightcurves for the testing of lightcurve inversion software.