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A simulated regolith medium for multi-wavelength studies

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Effects arising from the small-scale surface structure are significant in remote studies of regolith surfaces on atmosphereless solar system bodies, such as the Moon, Mercury and the asteroids. The important properties determining these effects are the porosity of the regolith and the roughness of the interface between the bulk material and empty space.

We concentrate on the regolith effects in visible light photometry and X-ray spectrometry. The fluorescent X-ray spectrum induced by solar X-rays contains information about the elemental abundances of the surface material, while the photometry can be used to constrain surface properties such as porosity.

We have developed a computer model simulating a regolith medium consisting of spherical particles with variable size distribution and properties. The bulk properties of the medium, such as porosity and surface roughness, can be varied. The model can then be used in ray-tracing simulations of the regolith effects in both visible light scattering and X-ray fluorescence. In photometric studies the scattering law of the constituent particles can be chosen to take into account scattering phenomena such as coherent backscattering. In the X-ray simulations, we can choose the elemental abundances of the material and the spectrum of the incident X-ray radiation. The ray-tracing simulations then allow us to determine the characteristics of the emitted radiation in different observational geometries.

We present results from various studies which have been based on our regolith model. The model has been used to simulate the regolith effects on X-ray fluorescence spectra under specific situations. These can be compared to laboratory measurements. The visible light simulations have been applied in a study of the shadowing effects in photometry.

The model was also used in a study of lunar photometry from SMART-1/AMIE data. Applications in the analysis of X-ray spectrometry from the BepiColombo MIXS/SIXS instruments are planned. An application of the model to produce a numerical scattering law for asteroid surfaces is currently in progress.

Because in real observations the actual surface properties are unknown, they must be estimated somehow in order to take their effect into account. The advantage of our approach is that we can use the same regolith model to simulate both light scattering processes and X-ray fluorescence. Combining photometry with X-ray spectroscopy can allow us to better constrain the surface properties inferred from the data.