AOGS 2006

Lunar Polarimetry at Large Phase Angles for Remote Sensing of Regolith Particles

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We present results of polarimetric investigations of the Moon at large phase angles and suggest characterizing the lunar regolith with the parameter (Pmax)^aA, where Pmax, A, and a are the degree of maximum polarization, albedo, and a parameter describing the linear regression of the correlation Pmax–A, respectively. This parameter contains significant information on the characteristic size and microporosity of lunar regolith particles. We also show that color-ratio images obtained with a polarization filter at large phase angles suggest a new and effective tool to study the lunar surface, since the color-ratios Cpar(0.65/0.42 um) and Cper(0.65/0.42 um) are sensitive to somewhat different thickness of the regolith surfaces. The perpendicular polarization component is produced mainly from small scatterers and quasi-Fresnel reflections from smooth facets of lunar grains. In the latter case a thin slab of the grain surface is responsible for the reflections, practically independently of the use of red or blue light. The parallel polarization component is formed primarily by internal scattering in rather large particles and depends strongly on their absorbing properties. To illustrate this, we model light scattering by an ensemble of independent scatterers, applying the DDA technique to irregular particles whose size is comparable with the wavelength. Thus the Cper(0.65/0.42 um) image acquired at large phase angles provides information on the composition of superficial slabs of regolith grains. These layers usually contain a surplus of nanophase metallic iron (npFe0) that is an indicator of the maturity of the lunar regolith. Agglutinate particles of the mature lunar regolith include the npFe0 in the surface layers as well as in their volume; whereas particles of the immature lunar regolith contain npFe0 only in superficial zones. This means that the parameter Cper(0.65/0.42 um) should not be as sensitive to the mature effects as the Cpar(0.65/0.42 um). Thus, color-ratio images obtained with a polarization filter suggest a new and effective tool to study the lunar surface, since the Cpar(0.65/0.42 um) and Cper(0.65/0.42 um) images are sensitive to different thicknesses of the regolith grain surfaces.