Measurement of the Light Scattering Properties of High-Porosity Dust Agglomerate at Low Phase Angle

Kensuke Hiraoka[1]; Akiko Nakamura[2]; Tadashi Mukai[3]

[1] Graduate School of Sci. & Tech., Kobe Univ.; [2] Grad. Sch. of Sci. and Tech., Kobe Univ.; [3] Earth and Planetary System Sciences, Kobe Univ

When phase angle (the angle between the light incident onto an observed object and the light reflected from object) is very small, a sharp surge in brightness is observed (so-called an opposition surge). The behavior of the opposition surge depends on particle size and porosity of the object. The opposition surge arises from two processes, shadow hiding (SH) and coherent backscattering (CB) (Hapke, 1993). The opposition surge due to CB is expected to be large when particle size is comparable to the observation wavelength. The half-width at half-maximum (HWHM) of the CB peak decreases with increasing porosity of the object (van der Mark et al., 1988). Mishchenko (1992) showed the dependence of the HWHM of the CB peak on the particle size and the porosity of the object. However, this dependence is not seen in the result of Nelson et al. (2002) who measured the reflectance of simulated planetary regoliths at low phase angles with varying particle sizes.

In order to study the dependence of the opposition surge on the porosity of the scattering medium, we measured the back-scattering intensity of reflected light from high-porosity dust agglomerate whose porosity was varied from about 85% to about 70% (Blum and Schrapler, 2004). A multi phase-angle near-infrared spectrometer installed at Kobe University was used for the measurements. The wavelength coverage of the spectrometer is from 0.97 to 1.7 micron.

The CB mechanism predicts the HWHM of the opposition surge of the medium with porosity of 70% to be about the twice of the HWHM of the sample with 85% porosity. However, the results of our measurements do not indicate any systematic dependence of the HWHM on the porosity of the dust agglomerate. On the other hand, the opposition surge seems more enhanced at the wavelength where the reflectance is higher. For a quantitative evaluation, we fit a function of the form I (g) = A + B g + C exp (-g) to the measurement result of the 70% porosity sample, where I and g (from 0 to 15 degree) are the reflectance normalized by a spectralon and the phase angle, and A, B and C are constants, respectively. The relation between A+C and C is shown in the figure: when A+C, that is the intensity at zero phase, is small, the opposition enhancement (C), is large.