Opposition surge from surfaces of chips and powders of ordinary condrite meteorites

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Surfaces of small bodies such as asteroids are covered with particles called regoliths. The intensity of the scattered light from such surface nonlinearly increases at small solar phase angles, the angle between the light source and the detector as seen from the target. The degree and the sharpness of the phenomena, opposition surge, are considered to depend on the physical state of the surface. It was also shown that the opposition surge appears in scattered light from surface of bare rocks (Shepard and Arvidson 1999).

In September 2005, the Hayabusa spacecraft rendezvoused with an S-type asteroid Itokawa. One notable result is existence of opposition surge not only on the smooth terrain of Itokawa but also on the rough terrain, although existence of regolith is not clear (Yokota et al. 2006).

In this study, we performed measurements of the light scattered by simulated surfaces of asteroids at low phase angles. We measured the photometric phase curves of both bulk surface and powdery surface of the same materials, such as ordinary chondrite meteorites, dunite, mortar, and gypsum. Our focus was put on how the opposition surge depends on different factors of the surface. For example, the albedo, surface roughness and porosity.

The scattering intensity of the light from the different surfaces at different phase angles was measured using a newly developed multi-phase angle near infrared spectrometer at Kobe University with the incident angle fixed at 2 degree and the phase angle varied within 0-25 degrees. The reflectance data relative to those of Spectralon surface were used for analyses. In order to measure the surface roughness of the sample, we used a laser displacement mater. The elevation of the surface was measured for 101 x 101 points, with 1 micrometer or 10 micrometer pitch or spacing.

In order to compare the shape of the phase curves and the opposition surge, we use four fitting parameters in a functional form of $I(g) = A - Bg + Cexp(-g/D)$, where A, B, C, and D are the parameters of the reflectivity at g=0 (without the surge), the slope of the phase curve, the surge amplitude and the surge width, respectively. I is the relative intensity to the Spectralon and g is the phase angle in degree. The value of A+C denotes the total relative intensity of the scattered light at g=0.

The results show that amplitude (C) increases as reflectivity of the surface (A+C) increases, but reaches a peak at some albedo. The slope of the phase curve (B) decreases as reflectivity increases. These tendencies are similar to a result of observation of asteroids (Belskaya & Shevchenko 2000). We will show the results of comparison of parameters of phase curve with surface roughness and porosity.