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[U-06_28AM1]New Progress toward the Understanding of Small Solar System Bodies

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Mon. Apr 28, 2014 9:00 AM - 10:45 AM 503 (5F)

This session is aimed at setting up a forum to discuss how we can make progresses in our understanding of the solar system evolution with our hands on data. Presentations related to the science of the small bodies in the solar system (satellites, asteroids, comets, interplanetary dust particles, trans-Neptunian objects, and planetesimals) are invited. In addition to the extensive astronomical/remote-sensing observations and theoretical works, Hayabusa has brought us samples back from Itokawa (S-type asteroid) for unprecedentedly detailed analysis. The results of the Hayabusa sample initial analysis do prove that analysis of returned samples will play a key role in our future study of the solar system evolution. While the mission preparation of Hayabusa2, which is targeted at a more primordial asteroid than Itokawa (1999JU3, C-type), is being matured, expectation of building a new gateway to biology-flavored topics via organic material and aqueous alteration analysis is ramping up. In this session, after summarizing the cutting-edge results obtained by various studies, including the impact physics important for the asteroid evolution, we will discuss the future shape of the study of the solar system evolution.

10:30 AM - 10:45 AM

[U06-P05_PG]Relationship between Regolith Particle Size and Porosity on Small Bodies

3-min talk in an oral session

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Keywords:asteroid, regolith, porosity

Planetary small bodies are covered by a particulate layer called regolith. The particle size and porosity of the regolith surface of small bodies are important physical properties. The responses of the surface to solar irradiation are dependent on the particle size and porosity. The particle size and porosity have influences on the dynamic responses of the surface, such as cratering efficiency. By Apollo missions, the particle size was directly measured and estimated the mean porosity of the regolith 51% (Mitchell et al., 1974). The near-surface bulk porosity of asteroid was estimated using ground-based radar data to have a mean of 51∓14% (Magri et al., 2001). The angular width of opposition surge in optical reflectance was interpreted in terms of porosity and particle size distribution : surface porosities of S-class asteroidswere ranging from 40 to 80 % (Hapke, 1986; Domingue et al., 2002). An empirical relationship between porosity and the ratio of the magnitudes of the interparticle force that was estimated as the capillary force and gravity which act on a particle was presented by Yu et al. (2003). The porosity was measured for the particles in the loose packing state and different porosities were interpreted as due to the difference of particle size. In this study we assume that the van der Waals force is predominant in the interparticle forces. A model formula of the van der Waals force in which the effect of adsorbate molecules is taken into account by a parameter is defined as $Fv=AS^2r/48\Omega^2$ (1)where A is Hamaker constant, r is particle radius, Ω is diameter of an O^{-2} ion, S is cleanliness ratio which shows the smallness

of a number of the adsorbate molecules (Perko et al., 2001). It was shown that cleanliness ratio, S, is approximately 0.1 on the Earth, and is almost unity in the interplanetary space. In addition to the data of the several past studies, our own measurement result of micron-size fly ash particles in atmospheric condition. We calculate Fv of all data using Eq.2, and obtain a revised relationship between porosity and the ratio RF of the magnitudes of the van der Waals force and gravity Fg , $R_F = F_V/F_g$. An empirical formula used in the previous study (Yu et al., 2003) ,$p=p_0+(1-p_0)\exp(-mR_F^{-2})$ (2)is applied to fit the data, where p_0, m and n are constants. Substituting Eq.1 to Eq.2 yields,$p=p_0+(1-p_0)\exp\{-m(AS^2/64\pi\Omega^2\rho\, gr^2)^{-n}\}$ (3)where ρ is particle density and g is gravitational acceleration. We apply Eq. 3 to the conditions of small bodies' surfaces to derive the relationship between particle radius and porosity. For example, we obtained the relationship for asteroid 25143 Itokawa surface. The particle size of Itokawa is ranging from millimeter to centimeter in the area of fine particles, smooth terrain of the Muses Sea (Yano et al., 2006). The result shows the range of porosity would be 0.55-0.8. Similarly, we can calculate the above relationships for other small bodies. Gundlach and Blum (2013) estimated the particle size of small bodies by using the thermal inertia data and a heat conductivity model for regolith. By combining the relationship described for Eq.3 with those of Gundlach and Blum (2013), we can estimate the particle size and the porosity of regolith for the small bodies simultaneously.