

Properties of 25143 Itokawa observed by Hayabusa

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Mission Outline: The Hayabusa (MUSES-C) spacecraft designed for the asteroid sample return[1] was launched on 9 May 2003 (JST). After cruising with successful operation of the ion engines, the spacecraft arrived at the position of an altitude of about 20 km near the sub-earth point of the near-Earth asteroid 25143 Itokawa (1998 SF36) on 12 September 2005, and transferred to the nominal hovering position at an altitude about 7km on 30 September 2005. During 8 - 28 October, the spacecraft moved to several various altitudes and solar phase angles to acquire images of the polar regions, finer surface topography and with different light conditions. The spacecraft made touch downs onto the asteroid's smooth area "Muses Sea" on November 20 and 26. Observational instruments onboard the Hayabusa spacecraft included a telescopic multi-band imager with filters, a near-infrared spectrometer, a laser ranging instrument, and a X-ray fluorescence spectrometer . Sampling during each touch down should have been made by shooting small projectiles onto the asteroid surface and catching their ejecta, but it was found that the projectile firing had not been made. It is plausible that some surface samples reached in the sample canister during the stay on the asteroid's surface. After the ascent from the second touch down, the spacecraft started to lose its attitude control capability, and the return of the spacecraft to the earth has been to June 2010.

Properties of Itokawa: Itokawa is an Apollo type asteroid of orbital elements $a=1.324$ AU, $e=0.280$, $i=1.622$ deg., $q=0.953$ AU, $Q=1.695$ AU, and the rotational period is 12.132 hours. The spectroscopic type is S(IV) [2]. The longest dimension of Itokawa found by Hayabusa is 548m, which is consistent with that found by radar observation [3]. Pre-arrival, predicted values[4] were confirmed by Hayabusa for the rotation period, its retrograde rotation and the spin pole orientation being approximately normal to the ecliptic. The bulk density was estimated to be ~ 1.9 g/cm³, considerably lower than Eros. Itokawa's global shape appears to be a contact-binary. The surface of Itokawa is divided into two distinct types of terrain: "the rough terrain", which exhibits rough topography mostly due to the existence of numerous, large boulders, and

“the smooth terrain”, which is mainly comprised of flat regolith region. The smooth, regolith region is distributed in two distinct parts: the “Muses Sea” located between the head and the body and the “Sagamihara” area surrounding the north polar region. Large impact craters with typical bowl shapes are far less than any other asteroids observed in the similar spatial resolutions. The near infrared spectra and X-ray spectrometer data shows that there is not much difference in the constituent material as a function of location. Several very large boulders were found particularly on one side, and the maximum boulder size is about 50m. Large pinnacles were also found in the “neck” region on the western side. The 3-dimensional numerical shape models, the slope and gravity potential models have been developed. These models show that the gravity potential is high near the ends of the asteroid while the potential minima exist around the “neck” region between the head and the body.. These potential minima regions and the regolith regions are strongly correlated suggesting regolith particles moved to these regions through seismic shaking due to impacts.

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