

# Hayabusa and its adventure around the tiny asteroid Itokawa

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**Abstract.** Results of the *Hayabusa* mission to image and sample the asteroid Itokawa are summarized.

**Keywords.** minor planets, asteroids, space vehicles

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## 1. Results

The *Hayabusa* spacecraft, which was launched in May 2003, arrived at asteroid Itokawa in September, 2005. The size of Itokawa is about 540 m in length, so it is the smallest celestial object that manmade spacecraft has ever visited.

The view of Itokawa was totally unexpected. The surface of Itokawa is covered with numerous boulders and we could see only a few craters on it.

*Hayabusa* carried out scientific observations of Itokawa in detail for about two months by using four instruments; AMICA (Asteroid Multiband Imaging Camera), NIRS (Near-Infrared Spectrometer), XRS (X-ray fluorescence Spectrometer), and LIDAR (Light Detection and Ranging instrument).

The surface of Itokawa is basically divided into two parts, smooth terrain and rough terrain, and we found many geographical and geological features from the images of AMICA with a resolution of less than 1 cm at the most. Also we found from the data of NIRS and XRS that the surface material of Itokawa is similar to LL-chondrite, ordinary chondrite meteorites.

The mass of Itokawa was estimated by the orbit analysis of *Hayabusa* using the optical navigation cameras, LIDAR, and radiometric data. Then the bulk density was calculated as  $1.9 \text{ g/cm}^3$  using the obtained shape model of Itokawa. This low density indicates a macroporosity of about 40%. From these results, we have concluded that Itokawa is a rubble pile asteroid.

After these scientific observations, *Hayabusa* tried to approach Itokawa closely several times in November 2005, and finally *Hayabusa* executed a touchdown on the surface of Itokawa twice. The second touchdown was executed as scheduled but after that we had troubles in the operation of *Hayabusa*. We are not sure if some surface materials were taken or not. However, expecting to have some samples, we are now attempting to return *Hayabusa* to the Earth in June 2010.

## 2. Mission details

Launch date: 9 May 2003

Arrival at Itokawa: 12 September 2005

Dry mass: 374 kg, wet mass: 502 kg

Primary science instruments:

*Hayabusa*-AMICA: collects scientific images with seven filters in the ECAS system bands: *ul*, *b*, *v*, *w*, *x*, *p*, and *zs*.

*Hayabusa*-LIDAR: uses time-of-flight measurement of a laser pulse reflected from the surface to determine the surface topography, with a footprint at 7 km altitude of about  $5 \times 12$  m.

*Hayabusa*-NIRS: studies the mineralogy and physical properties of the surface with a 64 channel InGaAs photodiode array detector and a diffraction grating combined with a prism, covering wavelengths from 0.76 to  $2.1 \mu\text{m}$  with a dispersion per pixel of 23.6 nm.

*Hayabusa*-XRS: studies the elemental composition of the surface using a CCD X-ray detector with an energy resolution of 160 eV at 5.9 keV.

### 3. In the literature

A detailed description of the *Hayabusa* mission and the first results from the mission were published in the 2 June 2006 issue of *Science*. Fujiwara *et al.* (2006) give an overview of the rubble-pile asteroid Itokawa as observed by *Hayabusa*. M. Abe *et al.* (2006) discuss the near-infrared spectral results from the *Hayabusa* spacecraft. Okada *et al.* (2006) report on the X-ray fluorescence spectrometry by *Hayabusa*. Saito *et al.* (2006) present detailed images of asteroid 25143 Itokawa from *Hayabusa*. S. Abe *et al.* (2006) discuss mass and local topography measurements of Itokawa. Demura *et al.* (2006) report the pole and global shape of asteroid 25143 Itokawa. And Yano *et al.* (2006) describe the touchdown of the *Hayabusa* spacecraft at the Muses Sea on Itokawa.

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