

OSIRIS-REx帰還試料のJAXAでの可視分光・ステレオ視計測装置の開発

Development of visible spectroscopy and stereo vision measurement system for OSIRIS-REx returned samples at JAXA

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Asteroid Bennu is a B-type near-Earth asteroid investigated by NASA's OSIRIS-REx launched in 2016¹. OSIRIS-REx observed Bennu with remote-sensing instruments and successfully collected samples from the asteroid surface². The Bennu samples will be returned to the Earth in September 2023, and some of the grains will be distributed to the JAXA Curation facility for comparative analysis with Ryugu samples (Yada+2023, JpGU). Remote-sensing observations have revealed the presence of two distinct boulder types. Bright boulders have bluish and rough surfaces, while dark boulders have reddish and smooth surfaces³, which were also observed for Ryugu⁴. It has been suggested that these differences are inherited from different depths of the parent body. Bennu is classified as B-type asteroid⁵ that has bluish spectrum in the visible region among C-complex group. Remote-sensing observations also revealed that the sampling site (Nightingale crater) has a redder spectrum and thus have a younger exposure age than its surroundings⁶. In addition, previous studies attribute the possible absorption at 550 nm to magnetite⁶, but its formation process (e.g., aqueous alteration in the parent body or space weathering) is not known.

Curation of such spectral and morphological properties of the returned samples require dedicated analytical instruments are necessary. In our previous study, we developed a multiband visible spectrum and shape measurement system for the curatorial work of the Ryugu samples⁷. However, this instrument could not measure the shape of the lower side of grains. To measure the shape and centers of absorption in the visible spectrum of the Bennu samples, measuring the spectrum with higher wavelength resolution is also required. To resolve these problems and compare properties of each sample, we develop a new instrument specifically designed for the Bennu samples, which will be installed in a glove box at the JAXA curation facility.

First, we update the stereo camera system that observes the surface texture and morphology of individual grains larger than 1 mm. This size range makes up more than half of the Ryugu returned samples⁸. We take pictures of a sample places on a rotating stage every few degrees, and a shape model is created using a Structure-from-Motion software. Our preliminary shape measurements of a 1-mm graphite grain showed that imaging the lower side of the particle with increased angular resolution improves the accuracy in volume measurements. We also found that using a grid-patterned calibration target can improve the accuracy by adding a reference for scaling the shape model. With this instrument we aim to compare the samples with those found by the remote-sensing observations as well as those of meteorite and Ryugu samples. We can associate stereo shape measurements to subsequent geochemical analyses because our measurement induces virtually no chemical alteration. In addition, the density and micro

porosity of each grain can be measured by dividing the measured volume with their weights.

Second, for the spectral measurement, the samples are irradiated by a panchromatic collimated light with an incidence angle of 30° and a spot diameter of 1 mm. The reflected light will be collected using a nadir-viewing objective lens. We measure the spectra in the 390 to 900 nm range with a wavelength resolution of 0.5 nm using a Czerny-Turner spectrometer. Using a prototype instrument, we measured the spectrum of a 2-mm Murchison meteorite chip.

Reference

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