Expedition for Ground-Based Observation of HAYABUSA Spacecraft Re-Entry

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The HAYABUSA spacecraft re-entered the Earth's atmosphere on June 13, 2010 UT., together with the capsule for the sample return. This was the first trial of the re-entry experiment as a Japanese interplanetary spacecraft. We organized an expedition to South Australia for ground-based observations, and succeeded in obtaining valuable data of various phenomena occurring at this re-entry by using 17 instruments. Our data were widely used not only for scientific analysis, but also for outreach purposes [1].

We succeeded to monitor fragmentation of the main body of HAYABUSA spacecraft at the re-entry. The fragmentation started at 13 h 52 m 5.2 s UT at 83−84 km above the sea level, and the number of fragments increased with time. The maximum number is more than a few hundreds at around 13 h 52 m 20 s, and the fragments dispersed with more than 14 km in length, and 1 km in width along the re-entry trajectory. The number decreased after the maximum, and almost ended at 13 h 52 m 31.3 s at around the height of 45 km. Under some assumptions, we derived size distribution of the fragments, which shows small power low index within a range of −1.2 and −1.4, which is similar to −1.5 of the intrinsic size distribution of assembled parts of the spacecraft. This strongly indicates that in the fragmentation phenomena the size distribution of the fragments reflects the internal structure of the parent bodies [2].

A low resolution spectroscopic observation of the capsule were also performed. The altitude at the maximal flux was ocuurred at around 56 km (13 h 52 m 19.8 s UT), and thederived blackbody temperature was 3100 ± 300 K at the altitude of 50 km, and 2400 ± 300 K at the altitude of around 40 km, respectively [3].

The brightness variation of the main body during the ablation was derived by using ghost images instead of the direct ones due to heavy saturation. Among several peaks of flare up possibly due to the rapid increase of the total cross section of fragments, the maximum brightness obtained was −13.1 ± 0.1 which is apparent magnitude at 13 h 52 m 19.8 s UT, which corresponds to the height of 57.4 km. The corresponding absolute magnitude is −13.7 ± 0.1 [4].

References

[1] Watanabe, J.-I., et al.: 2011, *PASJ*, **63**, 941-946.
[2] Watanabe, J.-I., et al.: 2011, *PASJ*, **63**, 955-960.
[3] Ohnishi, K., et al.: 2011, *PASJ*, **63**, 987-993.
[4] Ohkawa, T., et al.: 2012, *PASJ*, **64**, 11-14.

Figure 1: Image of maximal phase of the fragmentation of the HAYABUSA spacecraft at 13 h 52 m 19.8 s. Hundreds of fragments are easily recognized. Taken by OLYMPUS E-30 with a ZUIKO DIGITAL ED 35−100 mm (F 2.0) lens which was set up for sequential shooting mode of 5 frames every second. The exposure time was 1/60 second. The focal length was fixed at 100 mm, which resulted in 12.3 degrees in the diagonal field of view. The ISO was set at 3200 to achieve high sensitivity.