GROUND-BASED OBSERVATION OF ASTEROID SAMPLE RETURN MISSION TARGET.

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Introduction: One of the important goals in the study of compositional characterization of asteroids is to understand the relationship between asteroids and meteorites. The asteroids are classified into some groups with similar spectral characteristics. The Japanese sample return mission, HAYABUSA, the spacecraft arrived at its exploration target, near Earth asteroid (25143) Itokawa this fall. The taxonomic type of Itokawa is S-type, and the spectrum of this type asteroid is similar to that of the ordinary chondrites[1].

The purpose of our observation is to obtain the information about taxonomic type and rotational status of the candidate target of the next asteroid sample return mission (post-HAYABUSA mission). This information is useful for mission targets selection and helpful for raising the technical feasibility of the exploration. Our goal is to find some primordial type asteroid, C-type and D-type, in our candidate objects. Considering several mission plans, we chose 287 asteroids from about 3700 NEAs as the candidate objects of the post-HAYABUSA mission. As the taxonomic types of 238 candidates are unknown, we have performed the colorimetric observations in order to obtain its taxonomic type information.

Observations and Data reductions: We have observed 23 near-Earth asteroids (NEAs) during 2003-2005, using the 1.05-m Kiso Schmidt telescope with 2kCCD in Japan, and the Lulin One-meter Telescope with PI1300B or AP8 in Taiwan. The observational log is summarized in Table 1. We made multicolor photometry at clear-stable nights, using broadband filter, B, V, R, and I. Figure 1 is the transmission characteristics of each filters. As the filter systems of each observatory are slightly different, we have to convert our result from each instrumental system into the standard system, in order to compare them with those obtained at other instrumental system. For this purpose, we observed some standard stars listed in [2] Landolt (1992) for each photometric night. We define the transformation equations as

$$V = a_v v - b_v X - c_v r + d_v$$
$$B = a_b b - b_b X - c_b V + d_b$$
$$R = a_r r - b_r X - c_r V + d_r$$
$$I = a_i i - b_i X - c_i V + d_i$$

where *V, B, R, I* are the standard magnitudes, *v, b, r, I* are the instrumental magnitudes, a_{band}, b_{band}, c_{band}, d_{band} are the transmission coefficients.

Since the brightness of the asteroid changes with its spin rotation, we set the observation sequence as R-V-R-I-R-B-R in order to ensure color difference even where the brightness was changed. Furthermore, in some cases, we obtained the information of its spin status from the R-band lightcurves. Figure 2 is the example of (11284) Belenus taken on 2005 Nov. 25 at Lulin Observatory.

Classification: Our objects were classified by comparing with ECAS dataset[3] and SMASS dataset[4][5]. Only from our BVRI color information, we could not judge the delicate characteristics of asteroidal type. We classified our objects in broad groups, C-group, S-group, D-group, and X-group. We obtained BVRI photometry data for 15 mission candidates, and classified 14 objects in broad groups. Out of 14 candidates, 4 had previous classification, and 2 of them had also spectrum data[6][7].

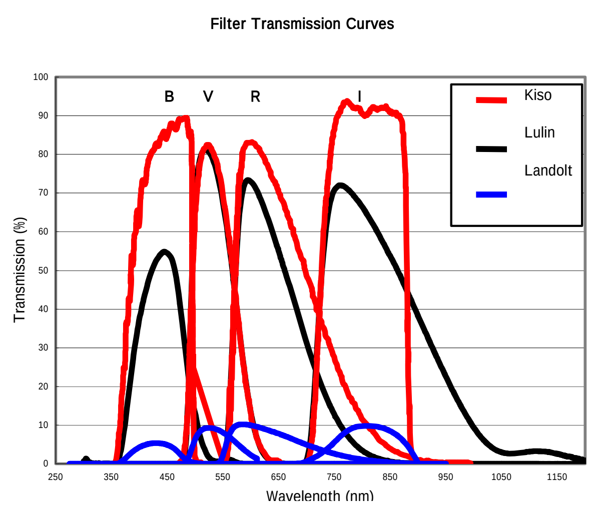

Figure 1: Filter transmission curve. The horizontal axis shows the wavelength[nm], the vertical axis gives transmission[%]. The red, black, blue lines are filter set of Kiso Observatory, Lulin Observatory, Landolt standard system, respectively.

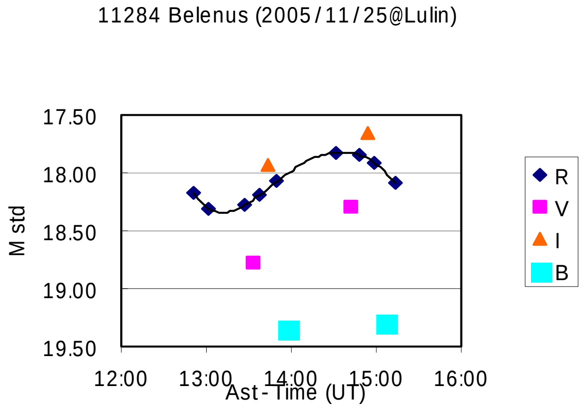

Figure 2: Observed magnitude of (11284) Belenus. The horizontal axis shows the Time (UT) in consideration of 1-way light time from the asteroid to the earth, the vertical axis gives magnitude converted to standard system. The solid line was fitted by polynomial approximation.

References: [1] Abe et al. (2002) Lunar & Planetary Science XXXIII, abstract #1666. [2] Landolt, A. U. (1992) AJ, 104, 340-371. [3] Tholen, D. J. (1984) Ph.D. thesis. [4] Bus, S. J., Binzel R. P. (2002) Icarus, 158, 146-177. [5] Binzel et al. (2004) Icarus, 170, 259-294. [6] Binzel et al. (2001) Icarus, 151, 139-149. [7] Wisniewski, W. Z. (1991) Icarus, 90, 117-122.

Table 1: Observation log. Observatory mark L: Lulin Observatory in Taiwan, K: Kiso Observatory in Japan, U: University of Hawaii 2.24-m telescope in Hawaii.

Asteroid	Date Observed (observatory)	Filter used
3361 Orpheus	2005/10/24 (K), 2005/11/28 (L)	BVRI
11284 Belenus	2005/11/25,26,27 (L)	BVRI
65803 Didymos	2003/12/1,3,4 (K), 2004/1/20 (K)	BVRI
85585 Mjolnir	2003/9/28,29,30 (K)	BVRI
98943 2001CC21	2003/9/29 (K), 2003/12/2 (K)	RVI
1989UQ	2003/926,29,30 (K)	BVRI
1999XO141	2005/8/31 (L), 2005/9/11 (L)	R
1999YB	2005/11/25,26,27 (L)	BVRI
2000QK25	2005/11/25,28 (L)	BVRI
2001FC7	2003/9/26,29,30 (K)	BVRI
2001US16	2004/4/10,11,12 (K)	RVI
2002CD	2004/4/10,11,12) (K)	RVI
2002CE10	2003/9/26,28 (K)	R
2002RX211	2005/8/29 (K), 2005/9/11 (L), 2005/11/25,26 (L)	BVRI
2002UC20	2003/12/3,4 (K), 2005/11/26 (L)	BVRI
2003AM31	2003/5/4 (U)	BVRI
2003CY18	2005/6/3 (K), 2005/9/11 (L), 2005/10/24 (K)	BVRI
2003RB	2003/9/28,29,30 (K)	BVRI
2003SD220	2003/12/1,2,3 (K)	BVRI
2004DK1	2004/4/11 (K)	RVI
2005ED318	2005/6/3 (K)	R
2005JU108	2005/8/29,31 (K)	R
2005TF	2005/11/28 (L)	BVRI