

**GROUND-BASED OBSERVATIONAL CAMPAIGN FOR ASTEROID 162173 1999 JU3.** M. Abe<sup>1</sup>, K. Kawakami<sup>2</sup>, S. Hasegawa<sup>3</sup>, D. Kuroda<sup>4</sup>, M. Yoshikawa<sup>1</sup>, T. Kasuga<sup>5</sup>, K. Kitazato<sup>2</sup>, Y. Sarugaku<sup>2</sup>, D. Kinoshita<sup>6</sup>, S. Miyasaka<sup>7</sup>, S. Urakawa<sup>8</sup>, S. Okumura<sup>8</sup>, Y. Takagi<sup>9</sup>, N. Takato<sup>4</sup>, T. Fujiyoshi<sup>4</sup>, H. Terada<sup>4</sup>, T. Wada<sup>1</sup>, Y. Ita<sup>4</sup>, F. Vilas<sup>10</sup>, P. R. Weissman<sup>11</sup>, Y.-J. Choi<sup>11,12</sup>, S. Larson<sup>13</sup>, S. J. Bus<sup>5</sup>, A. Tokunaga<sup>5</sup>, T. G. Muller<sup>14</sup>, <sup>1</sup>Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagami-hara, Kanagawa 229-8510, Japan ([abe@planeta.sci.isas.jaxa.jp](mailto:abe@planeta.sci.isas.jaxa.jp)), <sup>2</sup>The University of Tokyo, <sup>3</sup>Japan Space Exploration Center, Japan Aerospace Exploration Agency, <sup>4</sup>National Astronomical Observatory Japan, <sup>5</sup>University of Hawaii, <sup>6</sup>National Central University, <sup>7</sup>Tokyo Metropolitan Government, <sup>8</sup>Japan Spaceguard Association, <sup>9</sup>Aichi Toho University, <sup>10</sup>MMT observatory, <sup>11</sup>Jet Propulsion Laboratory, <sup>12</sup>Korea Astronomy and Space Science Institute, <sup>13</sup>Lunar and Planetary Laboratory, <sup>14</sup>Max Planck Institute.

**Introduction:** Asteroid 162173 1999 JU3 is an Apollo-type near-Earth asteroid, which is one of the most accessible asteroids by spacecraft. It has been selected as a target for the Japanese sample return mission, Hayabusa-2 [1]. This asteroid was observable in 2007. We conducted an observational campaign of this asteroid. We summarize the observations of 1999 JU3, which were executed last year, in Table 1.

**Visible photometry and lightcurve data:** The rotational period of this asteroid was unknown before our campaign. If this asteroid is a fast rotator, it will be difficult for the spacecraft to land on the surface for sampling. Therefore, the rotational period is important information for assessment of the mission feasibility. Lightcurve data were obtained from July to December in 2007. Using the Fourier analysis of the Lomb method, we found two peaks,  $P = 0.2750$  day and  $P = 0.3178$  day, as shown in Fig. 1. The two periods differ by a half revolution over the one-day interval between observations. To identify the right period, we use continuous observational data obtained at Steward observatory and Ishigaki observatory on September 10-11, and 12-13. As shown in Fig. 2, we found that  $P = 0.3178$  ( $\pm 0.0003$ ) day is the correct rotational period for 1999 JU3. The lightcurve of 1999 JU3 phased against 0.3178 days is shown in Fig. 3. The amplitude of the lightcurve is small, about 0.1 magnitudes. It means that the spin axis was oriented toward the observational line of sight or the axial ratio,  $a/b$ , is almost 1.

We also obtained colorimetric data shown in Fig. 4. The spectral slope of 1999 JU3 is flat and BVRI color indices plot in the C-type region. This result is consistent with previous results from visible spectroscopic data [2].

**Near-infrared and mid-infrared photometry:** YJHKs-band photometric observations were conducted using the CFHT 3.6 m telescope with WIRCam. These observations were conducted as service observations. Data reduction has not yet finished.

Mid-infrared photometry was obtained using the AKARI/IRC, Japanese infrared space telescope, and

Subaru/COMICS. Observed wavelengths were 15 and 24 microns by AKARI, and 8.8, 9.7, 10.5, 11.7, and 12.4 microns by Subaru. At these wavelengths, thermal emission from the asteroid surface dominates. Observed results are shown in Fig. 5. Using the absolute magnitude  $H=19.2$  and NEATM [3], we estimated the geometric albedo  $p_v=0.037$  ( $\pm 0.002$ ) and the diameter  $D=980$  ( $\pm 29$ ) m. The albedo of 1999 JU3 is a typical value for C-type asteroids.

**Visible and near-infrared spectroscopy:** Spectroscopic data were obtained using the MMT at visible wavelengths, and using the IRTF at near-infrared wavelengths. The obtained reflectance spectra at visible and near-infrared wavelengths are shown in Fig. 6. The reflectance spectra of 1999 JU3 are featureless at visible and near-infrared wavelengths. The spectral slope is flat or slightly red. These characteristics identify the asteroid as C-type.

**References:** [1] Abe et al. (2007) *LPS XXXVIII*, Abstract #1638. [2] Binzel et al. (2001) *Icarus* 151, 139-149. [3] Harris (1998) *Icarus* 131, 291-301.

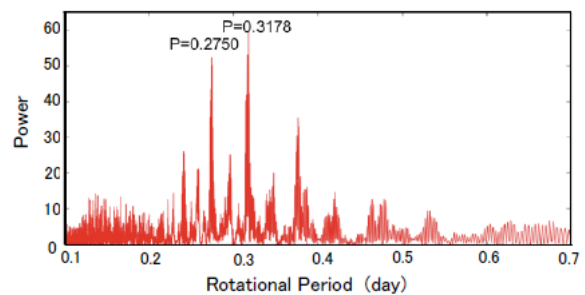


Fig.1 Spectral power vs. rotational period for 1999 JU3

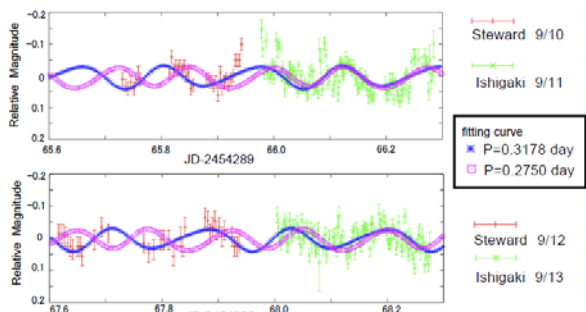


Fig. 2. Comparison between two model curves and obtained lightcurve data.

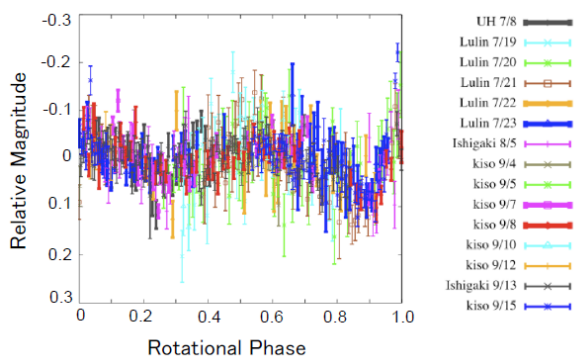


Fig. 3. The lightcurve of 1999 JU3 phased against 0.3178 days.

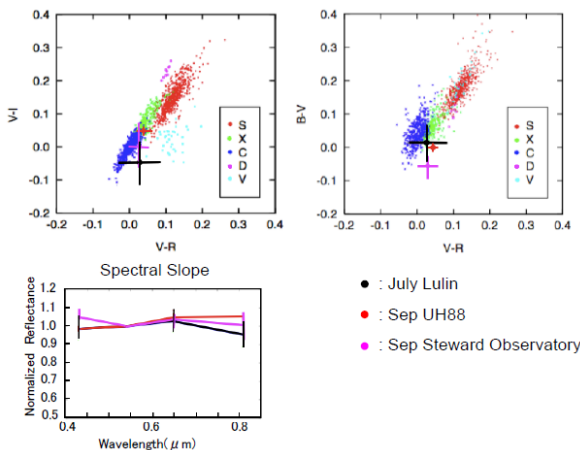


Fig. 4. BVRI color indices of 1999 JU3.

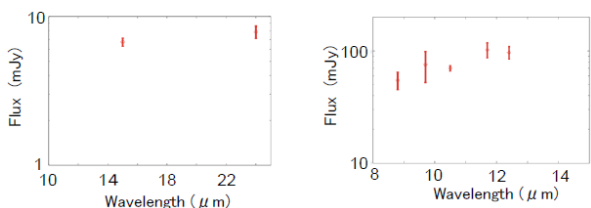


Fig. 5. Observed results by AKARI/IRC (left) and Subaru/COMICS (right).

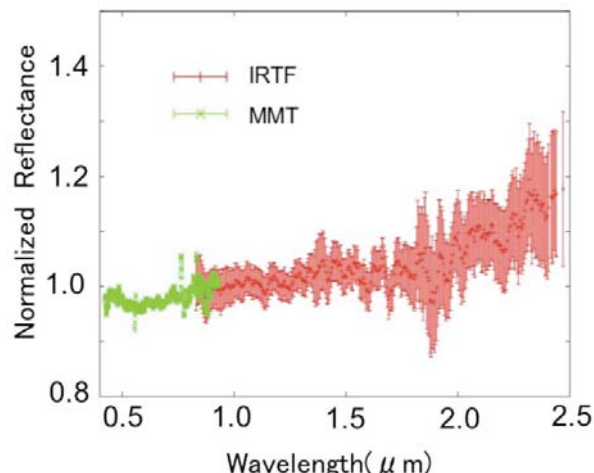


Fig. 6. Reflectance spectrum of 1999 JU3.

Table 1: Observational data

Telescope	Date	Observer
<Visible photometry & lightcurve data>		
UH 2.2 m	July 8, Sep 4	1
Lulin 1 m	July 19-23, Dec 3, 4, 6-8	2, 3, 4
Ishigaki 1 m	Aug 5, 15, Sep 6, 11, 13, 15, Oct 16, 18, Nov 13, 15	5
BSGC 1 m	Aug 9, 10, 17, 20, Sep 6, 10	6, 7
Kiso 1.05 m	Sep 4, 5, 7, 8, 10, 12, 14, 15, Nov 7-9, 11, 13	2, 3, 8, 9, 10
Steward 1.55 m	Sep 10-13	11, 12, 13
<Near infrared photometry>		
CFHT 3.6 m	Aug 28-30	4
<Thermal infrared photometry>		
AKARI	May 16	3, 14, 15, 16
Subaru/COMICS	Aug 27	1, 2, 3, 17, 18
<Visible spectroscopy>		
MMT 6.5 m	July 11, Sep 8, 9	19
<Near infrared spectroscopy>		
IRTF 3 m	Sep 18, 20	20

1:T.Kasuga, 2:M.Abe, 3:K.Kawakami, 4:D.Kinoshita, 5:D.Kuroda, 6:S.Urakawa, S.Okumura, 8:Y.Sarugaku, 9:S.Miyasaka, 10:Y.Takagi, 11:P. R.Weissman, 12:Y.-J.Choi, 13:S.Larson, 14:S.Hasegawa, 15:T.Wada, 16:Y.Ita, 17:N.Takato, 18:T.Fujiyoshi, 19:F.Vilas, 20: S.J.Bus