High-Precision Measurements of the Brightness Variation of Nereid

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Neptune II Nereid, the second largest Neptunian satellite, has a prograde orbit with a large semi-major axis (0.05 Hill radius) as well as high eccentricity (0.75) and is categorized as an irregular satellite. Irregular satellites are generally believed to have been captured from heliocentric orbits by the host planets in the early solar system. However, Goldreich et al. (1989) suggest that Nereid originally formed close to Neptune in the circum-planetary disk, and was then transported outward due to the perturbation by Neptune I Triton [1]. Each of previous photometric observations for Nereid reported different rotation period and brightness amplitude. Therefore, it is proposed that Nereid's rotation is on chaotic variation [2] or has long-term variability produced by precession of the spin axis [3], both of which support the in-situ formation model. In contrast, Grav et al. (2003) showed the rotation period of 11.5 hr and exclude the possibility of chaotic rotation [4]. The rotation state remains uncertain and the origin has been yet poorly understood.

We measured the brightness variation of Nereid with unprecedented precision using 3-night imaging data around Neptune obtained by Subaru/Suprime-Cam [5]. The resulting lightcurve (figure 1) shows the rotation period of 11.5 ± 0.1 hr and peak-to-peak amplitude of 0.031 ± 0.001 mag. These values agree well with Grav et al. (2003), indicating a constant rotation state. In addition, the rapid spin rate rejects a chaotic rotation. We also found the consistency of Nereid's rotation period based on the size-rotation and color distributions of trans-Neptunian objects (TNOs). It is likely that Nereid originated as an immigrant body captured from a heliocentric orbit. The source region could be same as TNOs, which is consistent with the outward transportation model of TNOs [6].

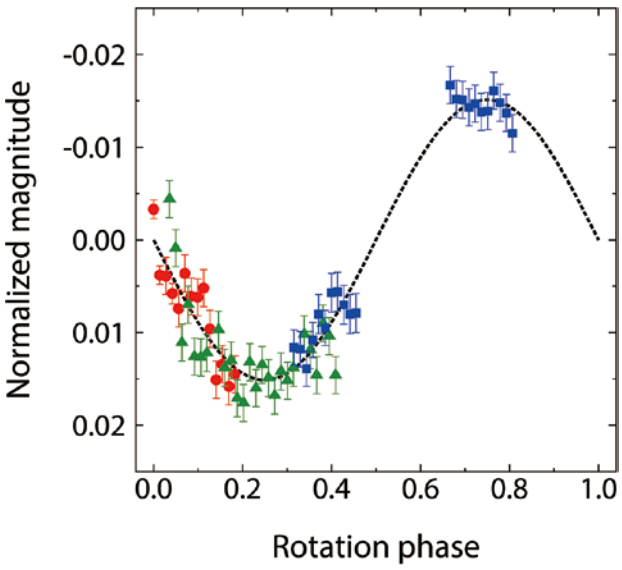

Figure 1: Lightcurve of Nereid with a period of 5.75 hr. The vertical axis shows the normalized magnitude corrected for the difference of heliocentric/geocentric distances and solar phase angle. The circles, triangles, and squares represent data obtained on 2008 September 1, 2, and 29, respectively. The dashed curve is the best-fit model with a peak-to-peak amplitude of 0.031 mag.

References

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[2] Dobrovolskis, A. R.: 1995 *Icarus*, **118**, 181.
[3] Schaefer, B. E., et al.: 2008, *Icarus*, **196**, 225.
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[5] Terai, T., Itoh, Y.: 2013, *PASJ*, **65**, 46.
[6] Gomes, R. S.: 2003, *Icarus*, **161**, 404.