LIGHTCURVE ANALYSIS OF 279 THULE

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A campaign involving asteroid observers from the US, Australia, and New Zealand was established to determine the rotation period of the outer main-belt asteroid, 279 Thule. Several conflicting periods had been reported as well as the possibility of the object being binary. Neither this campaign nor one conducted in 2008 by Pravec et al. found evidence of a satellite. We find a period of 15.962 ± 0.003 h. While there is good confidence in the result, despite it contradicting all previous periods, the matter of the asteroid's true rotation period may still be open.

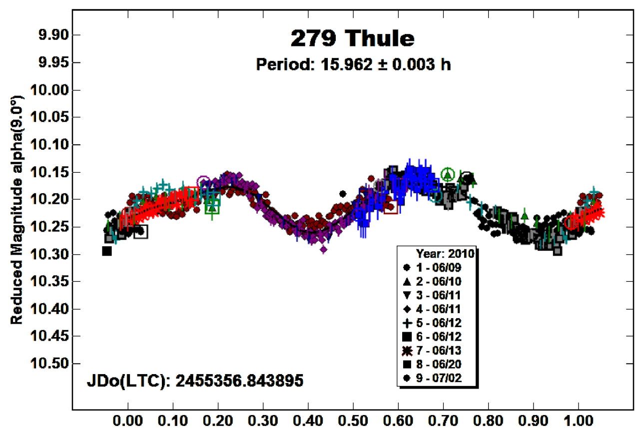
Despite what many might think, a large number of low-numbered asteroids, those below 1000, do not have well-determined rotation periods. In the Asteroid Lightcurve Database (LCDB; Warner et al., 2009), there are summary line entries for 944 of the first 1000 numbered objects. Of these only 683 have well-determined periods (U = 3 or 3- in the LCDB rating system); 177 have ratings that indicate a probable but still not certain period (U = 2+, 2, or 2–); while 46 have very poorly determined periods (U = 1 or 1+, "may be wrong"); and 10 have no periods at all, just an indication that some data have been obtained but not even a rough estimate of a period can be made. One of the 177 asteroids currently listed with a rating in the 2 range is 279 Thule.

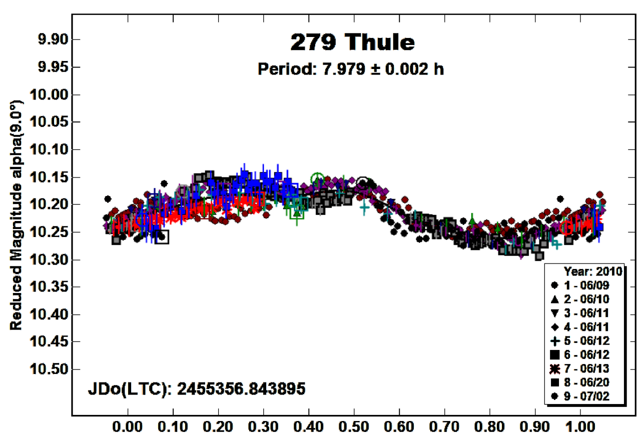
As a result of discussions via email regarding the uncertainty of the period and some suspicion of a satellite due to data from Hamanowa and Hamanowa (2010), an observing campaign was organized involving observers principally from Australia and New Zealand since the asteroid was well south of the equator and the Southern Hemisphere winter was approaching. This would allow prolonged observing runs that would be critical in resolving the asteroid's rotation period. Observers from the US (Coley and Stephens) provided additional observations. While these were shorter runs, they were from significantly different longitudes, thus helping further with resolving period ambiguities.

The campaign generated more than 1600 data points in 9 sessions from 2010 June 9 through July 2. Data were combined into a single set and analyzed by Warner using *MPO Canopus*, which employs the FALC Fourier analysis algorithm developed by Harris (Harris et al., 1989). The result was a synodic period of P = 15.962 ± 0.003 h and amplitude A = 0.10 ± 0.01 mag. The data were binned 3x in the plots below to make them easier to review.

This differs from the period by Pravec et al. (2010) of P = 11.942 h based on observations from 2008 that had A = 0.04 mag and is about double the period found by Zappala et al. (1989). Behrend (2010) found a period of 5.75 h using the Hamanowa data. We checked the fit of the 2010 data to the other periods. While the differences are subtle, the long sessions from the Southern Hemisphere observers allowed us to exclude the previously reported periods. A plot using the 2010 data phased to the half-period of ~7.9 h shows the subtlety involved in discriminating among solutions.

While we are confident in our solution of 15.96 h, the fact that the lightcurve amplitude is always very small (< 0.1 mag) means that a protracted campaign with all data put onto a common system to within 0.01 mag may be needed to remove all doubt.





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LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2010 OCTOBER - DECEMBER

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Once again the spotlight is on several near-Earth asteroids (NEAs) for radar support that may present some challenges given their fast sky motion, faintness, and/or proximity to the Sun. For more background on the program details for each of the opportunity lists, refer to previous issues, e.g., *Minor Planet Bulletin* **36**, 188.

As always, we urge observations of asteroids even if they have well-established lightcurve parameters, especially if they do not yet have good spin axis or shape models. Every lightcurve of sufficient quality provides valuable information in support of such efforts, which are needed to resolve a number of questions about the evolution of individual asteroids and the general population. Furthermore, data over many apparitions can help determine if an asteroid's rotation rate is being affected by the YORP effect, a thermal effect that can cause a smaller, irregularly-shaped asteroid to speed up or slow down. This is done by seeing if a constant sidereal period fits all the data equally well or if a small linear change in the period produces better results. See Lowry et al. (2007) *Science* **316**, 272-274 and Kaasalainen et al. (2007) *Nature* **446**, 420-422.

Lightcurves, new or repeats, of NEAs are also important for solving spin axis models, specifically the orientation of the asteroid's axis of rotation. Pole directions are known for only about 30 NEAs out of a population of 6800. This is hardly sufficient to make even the most general of statements about pole alignments, including whether or not YORP is forcing pole orientations into a limited number of preferred directions (see La Spina et al., 2004, *Nature* **428**, 400-401).

The Opportunities Lists

We present four lists of "targets of opportunity" for the period 2010 October-December. In the first three sets of tables, Dec is the declination, U is the quality code of the lightcurve, and α is the solar phase angle. See the asteroid lightcurve data base (LCDB) documentation for an explanation of the U code:

www.minorplanetobserver.com/astlc/LightcurveParameters.htm

Note that the lightcurve amplitude in the tables could be more, or less, than what's given. Use the listing only as a guide.

Objects with no U rating or $U = 1$ should be given higher priority when possible. *We urge that you do not overlook asteroids with U = 2 on the assumption that the period is sufficiently established.* Regardless, do not let the existing period influence your analysis since even high quality ratings have been proven wrong at times.

The first list is an *abbreviated list* of those asteroids reaching V < 14.5 at brightest during the period and have either no or poorly constrained lightcurve parameters. The goal for these asteroids is to find a well-determined rotation rate. More completed lists, including objects V < 16.0 can be found on the CALL web site.

http://www.minorplanetobserver.com/astlc/targets_3q_2010.htm

The Low Phase Angle list includes asteroids that reach very low phase angles. Getting accurate, calibrated measurements (usually V band) at or very near the day of opposition can provide important information for those studying the "opposition effect."

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. Those doing work for modeling should contact Josef Durech at the email address above and visit the Database of Asteroid Models from Inversion Techniques (DAMIT) web site for existing data and models: *http://astro.troja.mff.cuni.cz/projects/asteroids3D.*

The fourth list gives a brief ephemeris for planned radar targets. Supporting optical observations made to determine the lightcurve period, amplitude, and shape are needed to supplement the radar data. High-precision work, 0.01-0.03 mag, is preferred. Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

Future radar targets:
http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html