**ROTATIONAL LIGHT CURVE AND ROTATION PERIOD OF 5535 ANNEFRANK.** B. E. Schmidt,[1] J. Bauer,[2] B. J. Buratti[2], and C. T. Russell[1], [1]UCLA-IGPP (britneys@ucla.edu, ctrussel@igpp.ucla.edu), [2]JPL (bauer@scn.jpl.nasa.gov, buratti@scn.jpl.nasa.gov).

**Introduction:** Main belt asteroid 5535 Annefrank was recently observed over a 26-minute window with the Stardust spacecraft. During this time, the first spacecraft images of this S-class NEA were taken over ~40% of the surface at resolution 185-300 m/pixel [1]. Stardust collected 72 images at varying phase angles, producing a phase curve to 134° and a geometric albedo of 0.24. Annefrank's orientation, shape and size were constrained by the encounter's imaging data[1], yielding a minimum triaxial ellipsoid size of 6.6 x 5.0 x 3.4 km, and the short axis within 7 degrees of normal to the orbital plain. Its shape is that of a triangular prism covered with possibly contact-accreted round bodies. Its topography is irregular, including a pointed end along its long axis and craters of order 0.5 km, indicating that brightness variations are likely due to shading and not albedo variation. The shape of the phase curve indicates that Annefrank does not have a Lambert surface, but instead its reflective properties "must be caused by some combination of changing cross section, shadowing, and a steep scattering law[2]."

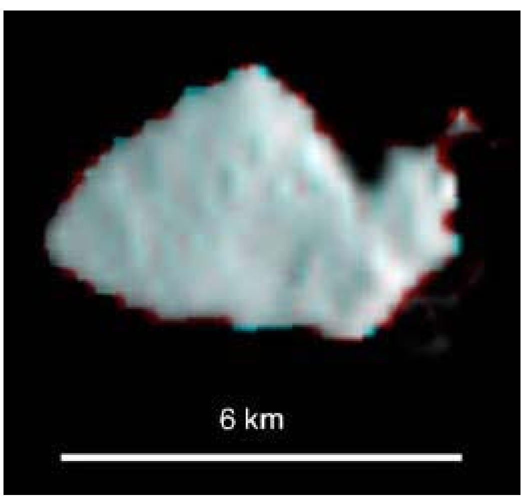


**Figure 1: Image of 5535 Annefrank taken by the Stardust spacecraft.** The image was taken on Nov 2, 2002 and printed in [1].

Due to a brief observing window, no rotational period, sense of rotation, or spin axis was constrained by Stardust observations. Annefrank is assumed to be a slow-rotator, so that all images were taken at relatively identical rotational phase. That no rotational information exists for Annefrank limits our understanding of the asteroid from telescope and spacecraft data. Thus, we began a campaign to observe Annefrank in May of 2005, using the 0.6m Table Mountain telescope. A total 14 nights of observations were taken over two oppositions between May 31, 2005 and Dec 9 2006, broken up into 5 runs of 3 nights each. Observations were chosen to cover the full rotation of Annefrank several times over the course of a year and half.

**Observations:** Images of Annefrank were taken using the TEK 1K CCD on the 0.6m Table Mountain Observatory telescope in Wrightwood, CA. Table Mountain Observatory is owned and operated by JPL. Observations were taken May 31-June 2 and June 13-15 of 2005 and Oct 26-28, Nov 17-19 and Dec 8-9 of 2006.

Images were taken in R band. Standard image cleaning, biasing and flat fielding with twilight flats were applied. Data were corrected for airmass and light travel time. Most of the images were taken on photometric nights with good seeing and were reduced using Landolt standards from the Mark A, PG 1657 and PG 2213 star fields. Data from other nights were reduced using relative photometry from standard stars common in the Annefrank frames across two or more nights.

**Results:** Photometry of Annefrank was used to create rotational light curves. Light curves plot surface brightness over the course of an object's rotation, and can be used to find rotational periods as well as to map brightness and albedo spatial variation.

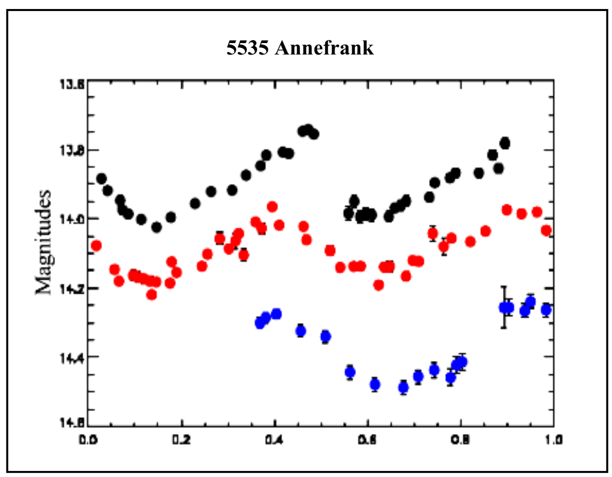


**Figure 2: Light curve of Annefrank for a rotational period of 0.63 days.** October data are black, November are red, and December are blue.

*Light curves.* Figure 2 shows the light curves of Annefrank for each of the October, November, and December 2006 observation runs rotationally phased to about 15 hrs. Offsets in the data are due primarily to telescopic and phase angle brightness variations. Using the widget program described below, this figure was selected as the best fit to the data due to the notable symmetry of the curves from each run. Some small scale variations are seen in each of the light curves, indicating a change in brightness likely consistent with topographic shading as per the Stardust analysis.

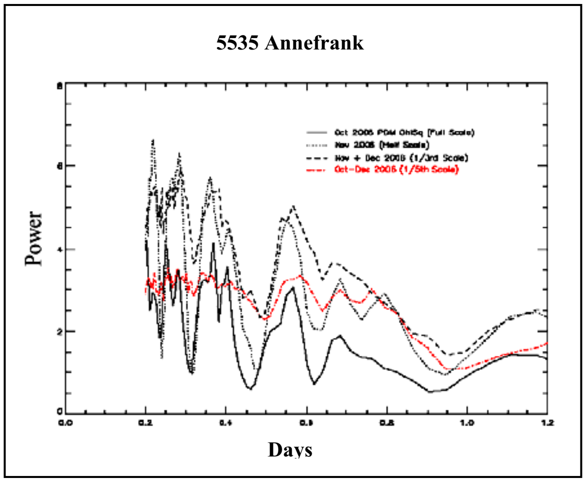


**Figure 3: PDM analysis for Annefrank for October-December 2006.** The red curve is the fit for all three data sets.

*Rotational Period.* We used 3 different methods to constrain possible values of the rotation period. First, we used two separate codes to analyze the data sets using a phase dispersion minimization technique (PDM [3]), producing $\chi^2$ plots with minima corresponding to the best periods. Figure 3 shows the PDM plots for Annefrank. The results from both programs were very similar, giving three strong candidate periods of ~0.5, 0.63, and 0.95 days. Finally, we used a widget program to "slide" the data sets relative to each other using periods from 0-1 days to investigate these three values and picked the best fits by eye. Three possible periods of ~0.48, 0.63, and 0.95 days were seen in this analysis. While ~0.5 or 0.95 days are possible, these are less visually convincing than values near 0.63 days. If the shape of the curve were due to airmass variation or changes in the telescope over the course of the night, the best fits should be at 1 day, which is not seen in any of our analyses.

**Conclusions:** From our observations, we see that three periods for Annefrank may exist for ~0.5, 0.63 or 0.95 days. The best fit to the light curve appears to be for 0.63 days. Other variations in brightness may be due to topographic shading. Further analysis of the two data sets from the 2005 opposition will be conducted to yield the best constraints of Annefrank's rotation period.

**References:** [1] Duxbury, T. C. et al. (2004) *JGR, 109,* E 2002. [2] Newman, R. L. et al. (2003) *JGR, 108(E11),* 5117. [3] Stellingworth, R. F. (1978) *Astrophys.J., 224*, 953.

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