Premise

The objective of our photometric study and shape analysis of the Vesta family of asteroids is to better understand the family's impact origin. In particular, we are collecting data to discern whether the Vesta chips are intact spall fragments (having thin, elongated shapes) or re-accumulated rubble piles (having roughly spherical, ellipsoidal, or lumpy shapes). This information will contribute to constraining numerical models of family formation, and uncovering the basic principles of asteroid evolution. In this analysis we report on data derived for 2511 Patterson.

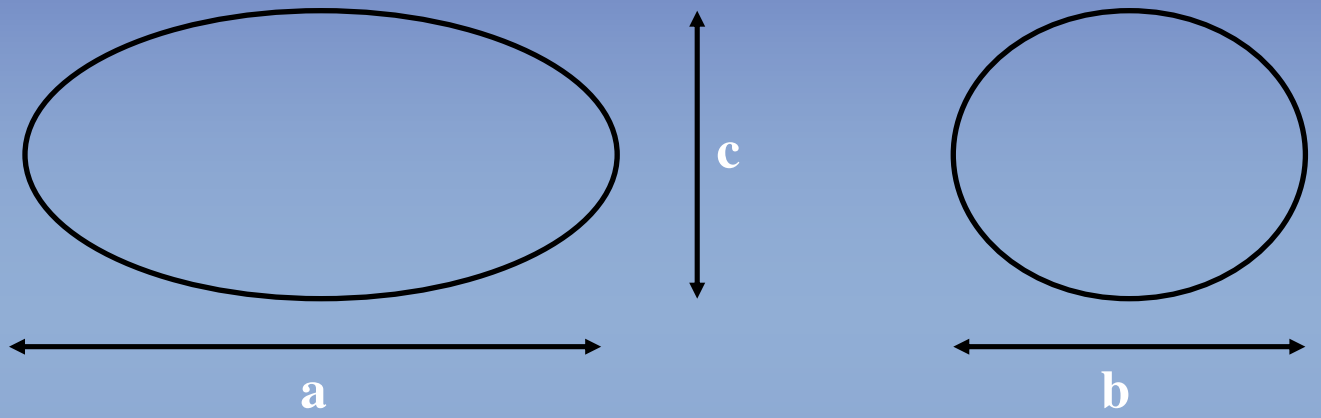
Data Table

Run Date	Solar Phase Angle °	Geocentric Eclip Long, Lat °	R_{mean} (mag)	Amplitude (mag)	Observers	Facility
Dec 11, 2002	7.0	61.5, -3.9	12.946	0.74/0.63	WHR,EVR, LS	VATT
Jan 19, 2004	23.0	188.2, 10.3	13.397	0.93/0.75	WHR,RAJ, EVR,	VATT
Mar 16, 2004	6.9	184.3, 14.0	12.953	0.69/0.67	WHR,CTM	VATT
Mar 17, 2004	6.7	184.0, 14.0	12.946		WHR, CTM	VATT
Apr 10, 2004	11.4	177.9, 13.6	13.080	0.79/0.73	WHR,RAJ, EVR	VATT
Apr 12, 2004	12.2	177.5, 13.5	13.122 ??		WHR,RAJ, EVR	VATT
Apr 13, 2004	12.6	177.3, 13.4	13.118		WHR,QJ	VATT
Apr 14, 2004	13.0	177.1, 13.3	13.135		WHR,QJ	VATT
May 25, 2004	25.2	175.8, 9.9	13.483	1.06/0.80	WHR	CTIO
May 26, 2004	25.4	176.0, 9.8	13.478		WHR	VATT
Sept 26, 2005	6.3	1.9, -14.3	N/C	0.69/0.66	WHR,CTM, RAJ	VATT
Sept 27, 2005	6.4	1.7, 14.2	N/C		WHR,CTM, RAJ	VATT

This table shows the observational data taken over several runs, for 2511 Patterson. The trends that we noticed are illustrated in the graphs that follow. This research database serves as a source for our analysis and a guide to future analysis goals.

VATT = Vatican Advanced Technology Telescope (1.8- meter)
CTIO = Cerro Tololo International Observatory (1.0- meter)
WHR = Dr. William H. Ryan EVR = Dr. Eileen V. Ryan
CTM = Carlos T. Martinez RAJ = Ruth A. Juarez
N/C = no calibration

Axial Ratios

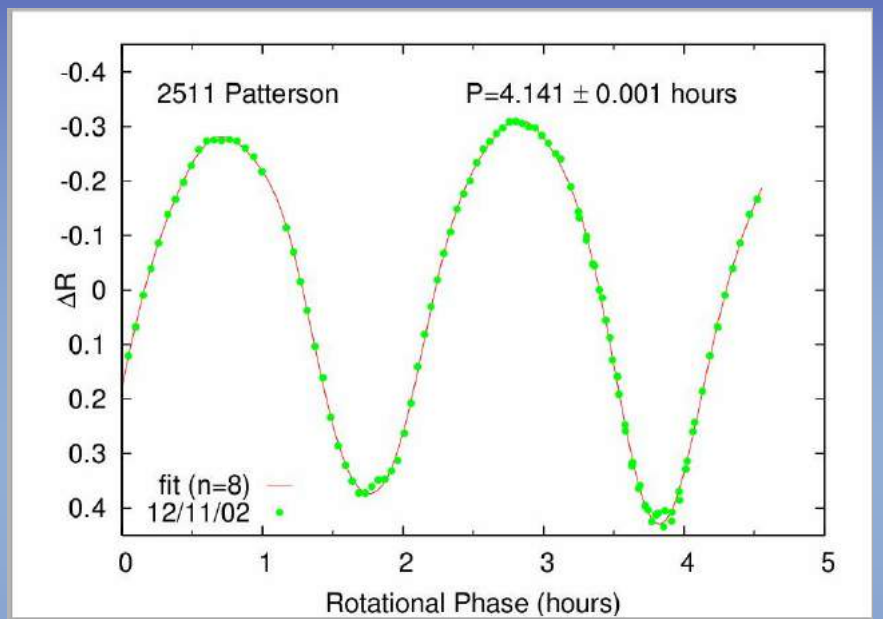


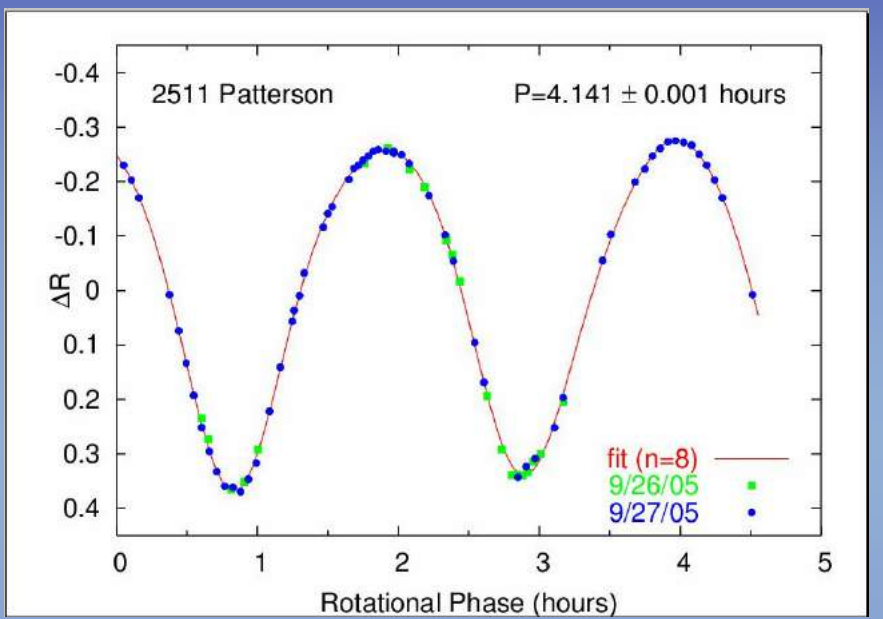
$S_{max} = \pi ac$

$S_{min} = \pi bc$

Lightcurve Amplitude = 2.5log Smax - 2.5log Smin = 2.5log(a/b)

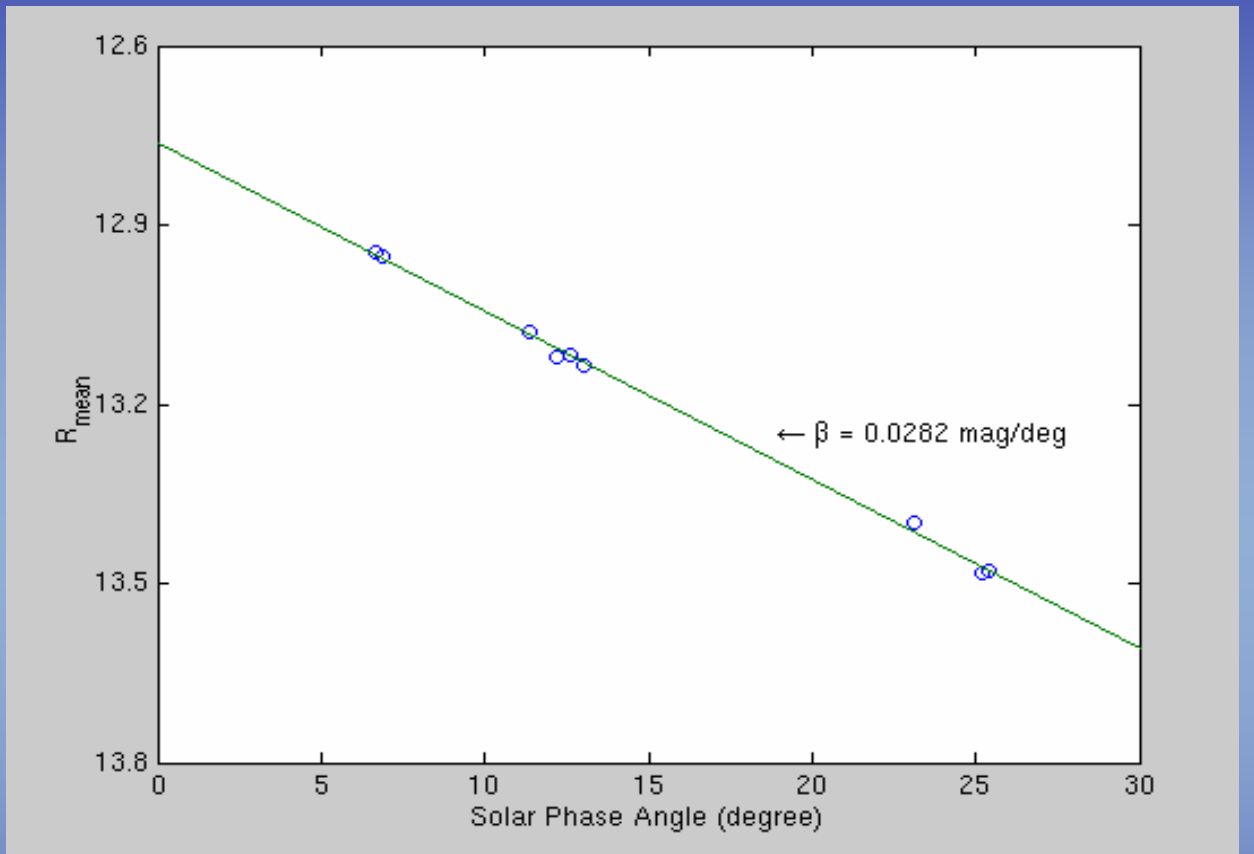
Composite Lightcurve





Two composite lightcurves for 2511 Patterson are shown above. The derived rotational period is 4.141 ± 0.001 hrs. Despite the fact that the data were taken at a 60° separation in ecliptic longitude, the ΔR measurements are very close. For December 2002, a/b = 1.91, and for September 2005, a/b = 1.85. This result indicates that 2511 Patterson might have an axis of rotation aligned nearly perpendicular to the ecliptic plane, making a derivation of the b/c axial ratio difficult.

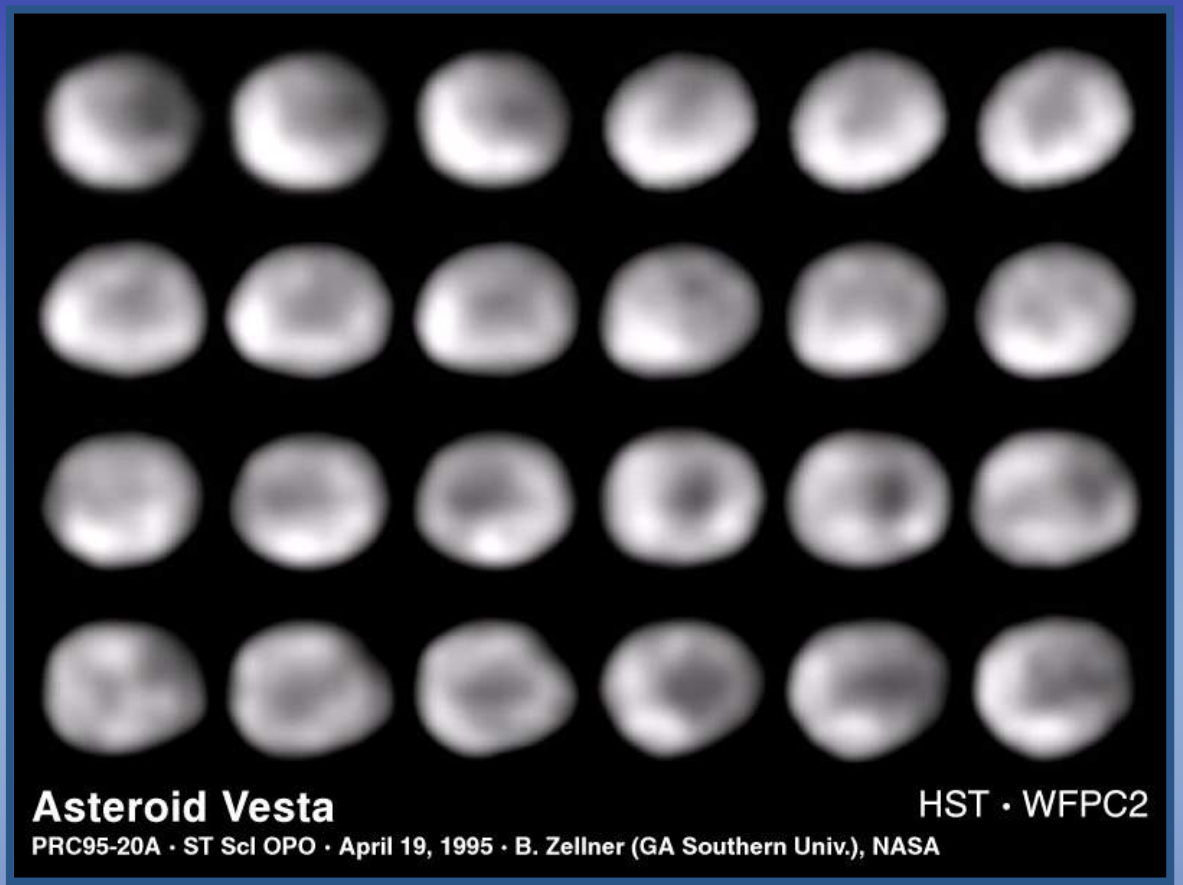
Magnitude-Phase Dependence



The magnitude-phase dependence is shown in this plot. The relation is only expected to be linear for phase angles >7° (applicable to our data). As solar phase angle increases, the magnitude increases (the asteroid becomes fainter). The slope of this plot, $\beta = 0.0282$ mag/deg, agrees well with that derived for Vesta (0.026 mag/deg, Gehrels et al., 1967), and for Vesta binary chip 3782 Celle (0.029 mag/deg, Ryan et al., 2004). This analysis is part of an ongoing compilation of Vesta chip phase-angle dependence.

Conclusion

The a/b axial ratios derived from the data (above) indicate that 2511Patterson has roughly a 2:1 elongated shape. Since it is quite possible that Patterson's spin axis appears to be aligned nearly perpendicular to the plane of the solar system, deriving the b/c axial ratio might not be readily possible using a purely photometric approach. Therefore, at this juncture, we cannot discern whether 2511 Patterson is a gravity ellipsoid or an intact spall fragment.



Asteroid 4 Vesta shown in a series of images taken by the HST on April 19, 1995. The visible dark area is presumable the crater that resulted in the smaller "vesta chips" that comprise this asteroid family.

Abstract

Photometric lightcurves were obtained during the 2002, 2004, and 2005 apparitions of the Vesta family asteroid 2511 Patterson using the 1.8-meter Vatican Advanced Technology Telescope (VATT) and the CTIO 1.0-meter. Analysis of these data yields a rotational period of 4.141 ± 0.001 hours and the following color indices: B-V = 0.91 ± 0.01, V-R = 0.50 ± 0.01, and V-I = 0.81 ± 0.04. In addition, from January-May 2004, photometric data were acquired over a range of solar phase angles where a linear trend of 0.028 ± 0.001 mag/deg was observed in the asteroid's mean R magnitude. At low phase angles during March 2004, Patterson's lightcurve displayed an amplitude of approximately 0.7 magnitudes. Assuming a triaxial (a>b>c) ellipsoid model for its shape, this implies a minimum a/b axial ratio of 1.89. This study helps place constraints on models for formation mechanisms of 2511 Patterson and other Vesta family asteroids.

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