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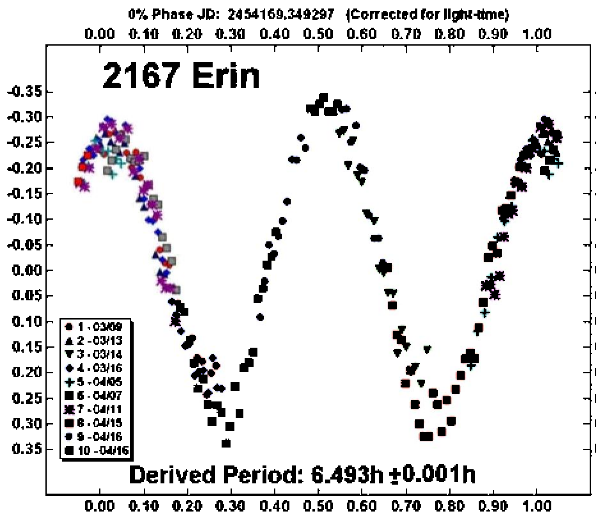

Figure 1: Composite lightcurve of asteroid 2167 Erin derived from 9 nights of observations and a rotation period of 6.493 hours.

LIGHTCURVE OF 7304 NAMIKI

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7304 Namiki was observed on 7 nights in May 2007. The synodic period was determined to be 8.8712 ± 0.0014 hr. The lightcurve amplitude was 0.74 ± 0.02 magnitudes, peak to peak.

Asteroid 7304 Namiki was observed at Teakdale Astrophysical Observatory (MPC Code H90) in suburban Ottawa during an unusual string of clear weather on seven nights in May 2007. This target was chosen as one of the most northerly asteroids on the MPB list of photometry opportunities (Warner et al. 2007).

On the first five nights, data were collected with a 9cm f/5.6 apochromatic refractor on a German equatorial mount with an SBIG ST2000XM CCD camera and Custom Scientific clear filter. Image scale was 3.07 arc-seconds per pixel. Photometric data from these 5 nights were too noisy to clearly discern whether the curve was monomodal or bimodal, so an additional two nights of data were collected using a recently repaired 200mm f/5.6 Newtonian with the same camera and filter at an image scale of 1.36 arc-seconds per pixel. Typical sessions were approximately 5.5 hours in duration, interrupted by a meridian flip near local midnight. Two nights were cut short by cloudy skies. Exposures throughout were 120 sec. All exposures were auto-guided. Camera temperature was maintained at -10C for all exposures. Maxim DL/CCD Version 4.59 was used for telescope and camera control, for image calibration (bias, dark, and flat-field), and for differential photometry using three comparison stars for each data series. Observations were light-time corrected based on distances indicated by the Earth Centred Universe Version 5.0 Pro planetarium program. In all, 499 observations were collected.

Data were analyzed using Period04 Version 1.0.1 (Lenz and Breger, 2005). A frequency of 5.41074 ± 0.0008 d^{-1} was found by Period04. By examination of the folded light curve, this was determined to be one half of the bimodal period of 8.8712 ± 0.0014 hr. Period04 found an amplitude of 0.74 ± 0.02 magnitudes. The period agrees well with previous results of 8.90 ± 0.02 hr (Brinsfield 2007), 8.8586 ± 0.0006 hr (Montigiana 2007), and 8.8754 ± 0.0001 hr (Sheridan 2007).

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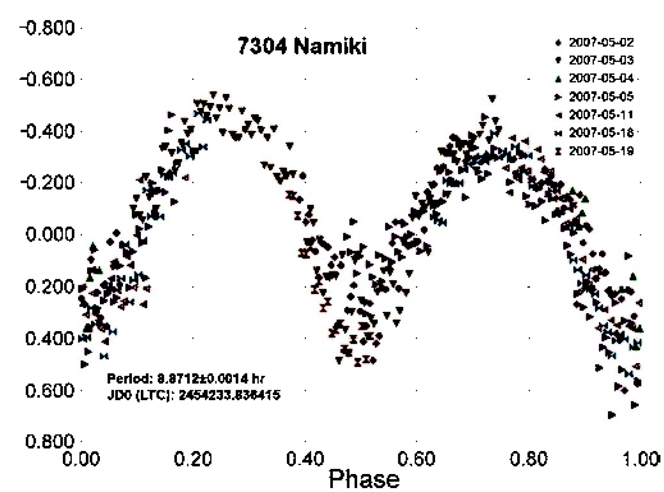

INITIAL RESULTS FROM A DEDICATED H-G PROJECT

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One of the main obstacles to studies of the asteroid population, NEAs in particular, is the lack of good H (absolute magnitude) and G (phase slope) values. Starting in early 2007, the Palmer Divide Observatory began a dedicated program for determining the H-G values for as many asteroids as possible. The initial efforts involved MBA asteroids as a control group where the results were compared to values given in the MPCORB file (MPC 2007). Subsequent observations will concentrate on brighter targets within the NEA and inner main-belt populations. A consequence of these observations is also the determination of the V-R color index for almost all targeted asteroids. This paper discusses the details of the project, from strategy to implementation, as well as reporting some initial findings.

Introduction

The H-G system of absolute magnitude and phase slope parameter was developed by Bowell et al (1989). The H value took on the meaning of being the Johnson V magnitude of a given asteroid when moved to unity distance from the Sun and Earth and viewed at 0° phase angle. The phase slope parameter (G) was defined so that it is a continuous function, even through very small phase angles, and is valid for phase angles up to approximately 120°.

When phase angles are <7°, the so-called “opposition effect” comes into play, causing the asteroid to brighten in a manner different from what pure geometry would dictate. The value of G models the behavior of the asteroid's brightness both well away from and near opposition. The smaller the value of G, the steeper the slope of the phase curve line. It is even possible for G to be negative, e.g., –0.04 for 163 Erigone. The value of G along with the behavior of the curve near opposition can be used to develop models that explain the opposition effect and general scattering laws. The latter come into play when inverting lightcurves, i.e., generating a shape and spin axis model based on a number of lightcurves.

In order to establish a valid value for G, one must have observations near opposition, i.e., when the phase angle is near as possible to 0°. If such observations are not available, e.g., most observations are at phase angles >7°, then a value for G must be assumed. This still allows a value for H to be found. The adopted default value for G is 0.15, though it has been shown that this is merely a compromise and that the actual value can be dependent on taxonomic class (see pg. 553 of Bowell 1989).

The determination of the H value of an asteroid has many direct ramifications. Chief among them is the determination of the approximate size of the asteroid based on the formula

$$\log D\ (\mathrm{km}) = 3.1235 - 0.2H - (0.5 * \log(pv))$$

where H is the absolute magnitude of the asteroid and pv is the geometric albedo in the V band.

If not known directly, the albedo can be assumed based on the taxonomic class of the asteroid. A large number of such classifications are available using either the Tholen (1989) or SMASS II (Bus 2002) catalogs. Lacking a direct classification, the albedo can be assumed based on the orbit of the asteroid, e.g., following the method of Harris (2007) in which A and M orbit classes or main belt asteroids with a <2.6 AU are assumed to be Tholen "S" class with an albedo 0.18. Orbit classes C, T, K, or main-belt asteroids with a > 2.7 AU are assumed "C" or "D", with and albedo 0.058. Main-belt asteroids with a semi-major axis in the range 2.6-2.7 are classed "SC" and an albedo of 0.10 is assumed. Hungaria asteroids lacking any other taxonomic information are assumed to have an albedo of 0.30, intermediate between S and E classes.

Finding the H magnitude and value of G requires using the reduced magnitude of the asteroid at various phase angles. The reduced magnitude is the observed V magnitude converted to unity distance using

$$Vr = Vo - 5.0 \log(Rr)$$

where Vr is the reduced magnitude, Vo is the observed magnitude, R is the Sun-asteroid distance, and r is the Earth-asteroid distance, both in AU. The values for H and G are found using the algorithm described by Bowell and implemented in the FAZ program written by Alan Harris (see Bowell 1989). Figure 1 shows a plot of the reduced magnitude versus phase for 160 Una.

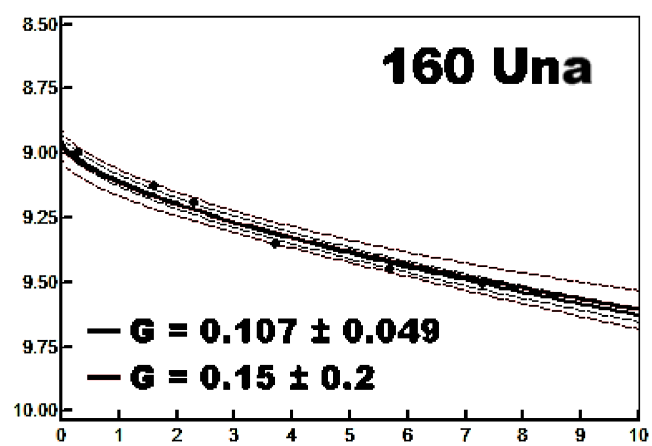

Figure 1. A plot of the reduced magnitude of 160 Una versus the phase angle. The slope of the line when the phase is >7° is the phase slope parameter, G. The value of H is the magnitude when the phase angle is 0°. Here H = 8.95 ± 0.02 and G = 0.11 ± 0.05.

The best results are achieved if, for a given night, the mean magnitude for the asteroid is used. This implies that the rotation period, amplitude, and phase at a given epoch are known. This is often not the case. It would be easy enough to follow an asteroid for several nights to obtain this information, but then the number of asteroids that could be covered during a given lunation would be reduced significantly. The problem can be overcome by getting numerous data points for the asteroid, e.g., every possible night over several weeks, and letting the amplitude variation “average out” over time (see pg. 550 of Bowell 1989).