

LIGHTCURVE OBSERVATIONS OF MINOR PLANET #141 LUMEN

Bill Holliday
4538 Hogan
Corpus Christi, Tx. 78413
bholliday@mail.interconnect.net

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Photometric observations of asteroid 141 Lumen were made in November 1995 to determine its rotational period and amplitude. The amplitude was found to be 0.13 magnitude. The period was determined to be most likely 19.67 ± 0.01 hours.

Introduction

The asteroid 141 was recommended for study in the *Minor Planet Bulletin* 22-4 by Harris and Zappalà (1995). The period was thought to be greater than 18 hours.

Observations

The minor planet was observed on seven evenings between 11/14 and 11/25. All

images were taken through a V filter with an SBIG ST6 CCD through a 25 cm newtonian scope located in Corpus Christi Texas. All images were calibrated with Hubble guide stars within the images. The same guide stars were used as comparison stars for differential photometry. Integration times were 120 seconds for all images. Dark subtraction and flat fielding were done immediately. After light time correction and conversion to reduced magnitudes, a magnitude versus time curve was made for each observing run to check for data entry errors. The reduced magnitude was plotted against the phase angle to choose a phase coefficient. The data appeared to plot best using a phase coefficient of about +0.35. This coefficient was used to reduce the magnitudes further to zero phase angle. The composite lightcurve shown in Figure 1 was then constructed. Table I summarizes the position and other data on the dates the observations were made.

Although the coverage was nearly complete, there is still some possibility the period is

Table I: Observational Circumstances

DATE	RA (2000)	DEC	D	R	Phase
11/14/95	2 ^h 13 ^m 49 ^s	+36°24'53"	1.201	2.147	10.4°
11/15/95	2 12 50	+36 17 37	1.203	2.148	10.5
11/20/95	2 8 50	+35 42 18	1.221	2.154	11.0
11/21/95	2 8 6	+35 34 37	1.226	2.156	11.8
11/22/95	2 7 23	+35 26 35	1.231	2.157	12.1
11/23/95	2 6 42	+35 18 24	1.235	2.158	12.4
11/25/95	2 5 32	+35 3 8	1.245	2.161	13.0

not correctly determined. The data does not fit well on the composite curve during the first hour. The data from 11/20 does not fit at all. On 11/20 clouds cut the observations short. It is believed the clouds caused poorer quality data than was expected at the time that data was entered.

Results

Two period solutions of 19.63 and 19.67 ± 0.01 hours fit the data considerably better than any other solution. The nearly complete coverage provides an amplitude estimate of 0.13 magnitudes.

References

Harris, A. W. and Zappalà, V (1995). "Asteroid Photometry Opportunities for November-January." *Minor Planet Bulletin* 22-4

COMPOSITE LIGHTCURVE

141 LUMEN 11/95

PERIOD: 19.67 ± 0.01

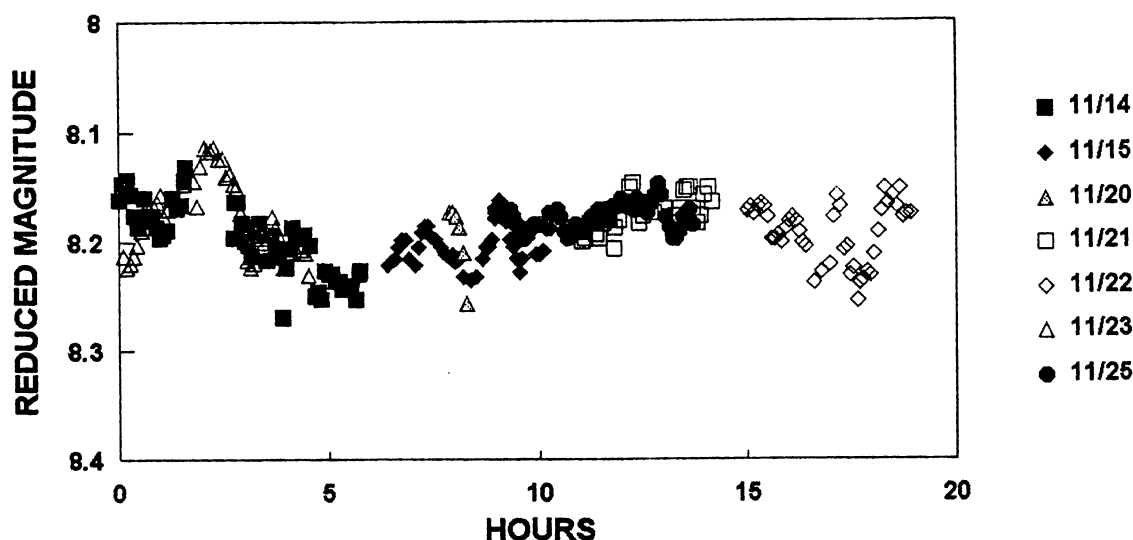


Figure 1: Composite lightcurve for asteroid 141 Lumen based on a 19.67 hour period. The Y axis is the reduced V magnitude for zero phase angle using a +0.35 value for G.

THE CRITICAL LIST OF POORLY OBSERVED MINOR PLANETS: PROSPECTS FOR REOBSERVATION

Frederick Pilcher
Illinois College
Jacksonville, IL 62650 USA

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For the most poorly observed of the numbered minor planets opportunities for future observation are described and a plea for observations is made.

The "Ephemerides of Minor Planets for 1995," published in 1994 by the Institute for Theoretical Astronomy, St. Petersburg, Russia, contains a list of 134 numbered minor planets not observed for 10 years or observed in less than four oppositions, as of 1993 Nov. 29. Minor Planet Circular 25993 with the most recent version of the critical list published 1995 Dec. 7, shows only 48 planets still in these categories, although it lists 183 others as observed within the past 10 years but poorly observed and needing additional observation, a category not yet included in the "Ephemerides of Minor Planets for 1996."

It is gratifying that observers have given so much attention to these minor planets. In nearly every case the discrepancy between prediction and observation was large enough that the new observations allowed for improvement in the orbital elements, but sufficiently small that the object lay within the field of view, even for a CCD. Lack of observation of these planets was due to preoccupation of observers with many thousands of other numbered and unnumbered minor planets, rather than an inability to find them.

MPC 25993 lists a residuum of 1 planet observed only at its discovery opposition, and 11 others observed at only 2 oppositions. Several of these are hard-core cases for which further observation will be possible only in the distant future and even then require considerable observer effort. Three other planets observed at 3 apparitions are also mentioned, because special circumstances delay or make further observations difficult. This paper predicts the opportunities for future observation. The planets are listed roughly in sequence of difficulty of reobservation, beginning with the most difficult.

Planet observed only at the discovery apparition:

719 Albert. Albert was observed for only two weeks at a close approach to Earth in

Table 1 Sources of minor planet elements

719 Albert	EMP 1995	4034 1986 PA	EMP 1992	5335 Damocles	MPC20799
3360 1981 VA	EMP 1992	4544 Xanthus	EMP 1993	5370 Taranis	MPC21090
3688 Navaajo	EMP 1992	4581 Asclepius	EMP 1993	5836 Tara	MPC23230
3757 1982 XB	EMP 1992	4688 1980 WF	MPC17609	6489 1991 JX	MPC25418
3908 1980 PA	EMP 1992	5324 Lyapunov	MPC20794	6491 1991 OA	MPC25420

Table 2 Discovery circumstances and years of observation of poorly observed planets.

	Date	Discoverer(s)	Place	Years of obs
719 Albert	1911 Oct 3	J. Palisa	Vienna	1911
3360 1981 VA	1981 Nov 4	E. F. Helin and R. S. Dunbar	Palomar	1981-85
3688 Navaajo	1981 Mar 30	E. Bowell	Flagstaff	1981-87
3757 1982 XB	1982 Dec 14	E. F. Helin	Palomar	1982-88
3908 1980 PA	1980 Aug 6	H.-E. Schuster	La Silla	1980-88
4034 1986 PA	1986 Aug 2	E. F. Helin	Palomar	1986-88
4544 Xanthus	1989 Mar 31	H. E. Holt and N. G. Thomas	Palomar	1989-91
4581 Asclepius	1989 Mar 31	H. E. Holt and N. G. Thomas	Palomar	1989-90
4688 1980 WF	1980 Nov 29	C. T. Kowal	Palomar	1980-91
5324 Lyapunov	1987 Sep 22	L. G. Karachkina	Nauchnyj	1987-92
5335 Damocles	1991 Feb 18	R. H. McNaught	Siding Spring	1991-92
5370 Taranis	1986 Sep 2	A. Maury	Palomar	1986-92
5863 Tara	1983 Sep 7	C. Shoemaker and E. Shoemaker	Palomar	1983-93
6489 1991 JX	1991 May 10	H. E. Holt	Palomar	1991-95
6491 1991 OA	1991 Jul 16	H. E. Holt	Palomar	1991-95

1911 October, and the available observations are discordant. Any orbit must include a purely subjective judgment of which observations are the ones of highest quality. One should not consider all the decimal places in the published semimajor axis of 2.5839 AU to be significant. For poorly observed objects the inclination and ascending node rather than semimajor axis are the best determined elements. A semimajor axis near 2.51 AU with Albert in a 3:1 resonance with Jupiter is well within reasonable limits of error. In this case close approaches to Earth may be separated by many decades.

The present position of Albert is completely unknown. It could be anywhere in the sky. Recovery will be entirely fortuitous at some unpredictable future close approach, and will require the skill of observers and orbit calculators to identify with 719 Albert the newly observed object.

For all of the other planets in this study the author has computed daily ephemerides until 2060 Dec. 7 with a Cowell's method numerical integration program courtesy of Dr. John Reed, positions of the major planets from the JPL DE-200 planetary ephemeris courtesy of Dr. E. Myles Standish. Orbital elements at all standard epochs 200 days apart have also been obtained. These daily positions have been searched for circumstances favorable for observation, specifically, maximum elongations from the Sun along with minimum magnitude and distance occurring near maximum elongation. Only a few of all the events found are reported here. For the

planets considered in this study magnitudes brighter than 20 occur for only a small minority of all maximum elongations. It is especially the purpose of this paper to list these data for future apparitions which are especially favorable for further observations. Circumstances relating to existing past observations are also stated.

Readers are warned that the data here assume the published elements are correct. Actually some of these are poorly known, and real positions will diverge progressively with time from these predictions. There is great need for observations at the earliest future opportunity, or the risk increases with passing time that these planets will become lost like 719 Albert.

The tabular listings are: Planet number, date of maximum elongation from the Sun in format yyyy/mm/dd, maximum elongation in degrees, right ascension on date of maximum elongation, declination on date of maximum elongation, both in J2000 coordinates, date of minimum magnitude in format yyyy/mm/dd, minimum magnitude (meaning the brightest occurring during the apparition), date of minimum distance in format yyyy/mm/dd, and minimum distance in AU.

Starting elements are from EMP or MPC sources listed in Table 1.

The discovery circumstances are from a listing maintained by the author for the NSSDC, and the years of observation are as provided in the computer program Ceres v. 2.31, published in 1995 by the Institute for Theoretical Astronomy.