

PHOTOELECTRIC PHOTOMETRY OF ASTEROID 15 EUNOMIA

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Photoelectric photometry of asteroid 15 Eunomia was performed during two nights in October 1985. Eunomia's rotation period was well established as 6.085 ± 0.002 hours with an amplitude of 0.48 mag.

Observations

During October and much of November, 1985, the asteroid 15 Eunomia was in a favorable position for observers in the northern hemisphere. The opposition date was October 13 and the predicted B magnitude was 8.8. The photometric observations described here were from North Valley Stream Observatory located on Long Island approximately 20 miles east of New York City.

The observations were made using an Optec SSP-3 solid state photometer coupled to a 20-cm Schmidt-Cassegrain telescope with digital readouts. On October 7 and 17 UT, Eunomia was observed photometrically using a V filter. Observational circumstances for the two nights are given in Table I.

A nearby star, SAO 54580, $m_V=6.9$, spectral type K0, was used as a photometric comparison. At the time of the observations on October 7, Eunomia and the comparison star were separated by approximately 1 degree. On October 17, this separation was only about one-fourth degree. Due to the proximity of the asteroid and the comparison star, differential extinction was negligible.

On October 7 UT, 37 photometric measurements were made at 10 minute intervals during six hours. On October 17 UT, again 37 photometric measurements were made at 10 minute intervals during six hours. The resulting lightcurves are presented in Figures 1 and 2 where the vertical scale represents the differential V magnitude with respect to SAO 54580.

Results

Eunomia is listed by *Bowell et al. (1979)* as an S-type asteroid with a diameter of 259-km. It has been previously well observed, but additional observations are needed to resolve any ambiguities in its rotational period and to determine the direction of its polar axis.

Eunomia is a rewarding object for photoelectric photometry. The photometric data showed two maxima and minima per rotation. On October 7, the first maximum and minimum showed an amplitude of 0.46 ± 0.05 mag. The second pair of extrema showed a slightly deeper amplitude. The rotational period is just over 6 hours and it seems like about 6.1 hours is correct. The two observed maxima appear to be separated by an interval just under 3.1 hours for one-half rotation.

On October 17, the first maximum and minimum showed an amplitude of 0.43 ± 0.01 mag. The second pair of extrema showed a 0.46 ± 0.02 mag amplitude. Note that

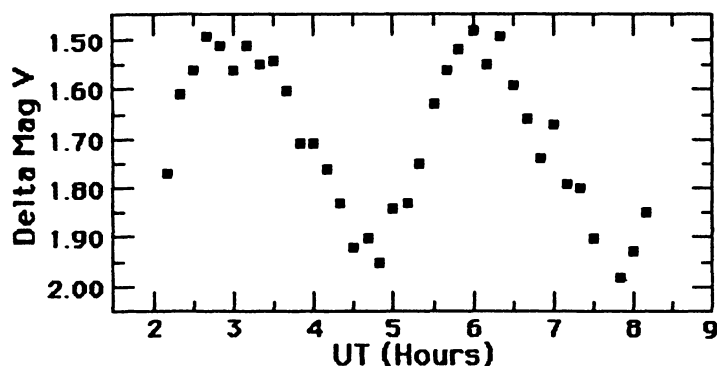


Figure 1. Photoelectric Lightcurve of 15 Eunomia on 7 October 1985 UT.

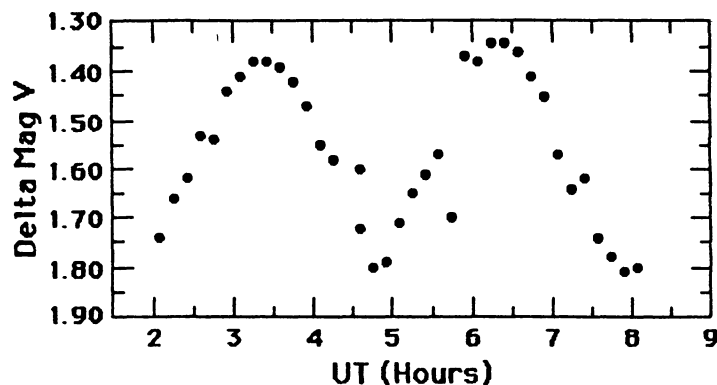


Figure 2. Photoelectric Lightcurve of 15 Eunomia on 17 October 1985 UT.

UT Date	R.A. (1950)	Dec. (1950)	Ecliptic Long	Lat	r (AU)	Δ (AU)	Phase Angle
Oct. 7	1 19	+31 14	30	21	2.15	1.21	12
Oct. 17	1 09	+30 43	28	21	2.15	1.19	10

Table I.
Observational Circumstances

this lightcurve was much more stable than 7 October, so the observational errors were much smaller. Again, a full rotation appears to occur in about 6.1 hours.

Writing more specifically about Eunomia's rotation, it rotated 39.5 times between the two nights (the first maximum on each night). The computation of the derived period is given in Table II.

The lightcurves from October 7 and 17 appear very similar. However, a closer look indicates that the amplitude on October 7 was slightly larger. The photometric observations cannot show whether this effect is caused by phase angle effects, the orientation of Eunomia's polar axis, atmospheric conditions, or other sources of noise in the data.

Reference

Bowell, E., Gehrels, T., and Zellner, B. (1979). "Magnitudes, Colors, Types, and Adopted Diameters of the Asteroids." In *Asteroids*, (T. Gehrels, Ed.), pp.1108-1129. University of Arizona Press, Tucson.

UT d		Rotation Cycle	Residual d
1985 Oct. 7.127	Maximum	0.00	-0.003
Oct. 7.199	minimum	0.25	+0.005
Oct. 7.257	Maximum	0.50	-0.000
Oct. 7.319	minimum	0.75	-0.002
Oct. 17.149	Maximum	39.50	+0.003
Oct. 17.205	minimum	39.75	-0.004
Oct. 17.276	Maximum	40.00	+0.004
Oct. 17.333	minimum	40.25	-0.003

$$\begin{aligned} \text{Period} &= \frac{d}{h} = 0.25355 \pm 0.00007 \\ &= 6.085 \pm 0.002 \end{aligned}$$

$$\text{Rotational cycle } 0.00 = \text{Oct. 7.130} \pm 0.002$$

Table II.
Period Solution for 15 Eunomia

PHOTOELECTRIC PHOTOMETRY OPPORTUNITIES MAY-JULY

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The table below lists asteroids which come to opposition during the months of May-July that represent useful targets for photoelectric photometry observations. Observations are needed because the asteroid has either an unknown or ambiguous rotational period or because the asteroid will be observable at a very low phase angle. The table also includes asteroids which are candidates for pole determinations (see the article by Di Martino and Zappalá in issue 12, No. 1) or are targets for radar observations (see the article by Ostro in *MPB* 10, No. 4). The table gives (in order of opposition dates) the asteroid number and name, opposition date, opposition B magnitude (the V magnitude is about 0.8 brighter), the rotational period (in hours), the estimated lightcurve amplitude (in magnitudes), and the designation PER if observations are needed to determine the rotational period. AMB implies that previous period determinations have given ambiguous results and these alternate periods are listed in the table. PHA indicates observations of the phase curve are desired because the asteroid will be at an unusually low phase angle, POL indicates the asteroid is a pole position candidate, and RAD indicates the asteroid is a planned radar target. Question marks are used to denote uncertain or unknown values. An outline of recommended observing procedures is given in *MPB* 11, No. 1, page 7. Also recommended is the book *Solar System Photometry Handbook* (see the review by Tholen in *MPB* 11, No. 4). Ephemerides for all of the asteroids in the table are included in this issue. Some of these may appear on finding charts prepared by Dr. J. U. Gunter, 1411 N. Mangum St., Durham, NC 27701 USA. These charts are free for a self-addressed stamped envelope.

DATE	R.A. (1950) DEC.				MAG B	PHASE ANGLE
	HR	MIN	DEG	MIN		
Minor Planet 23 Thalia						
1986 Apr 15	15	5.9	- 9	8.	11.17	9.3
25	14	56.7	- 8	58.	10.97	5.1
May 5	14	46.5	- 8	51.	10.87	2.8
15	14	36.7	- 8	51.	11.13	5.8
25	14	28.3	- 8	59.	11.42	9.8
Jun 4	14	21.9	- 9	18.	11.69	13.3
14	14	18.1	- 9	47.	11.95	16.2
24	14	16.8	-10	26.	12.20	18.4
Jul 4	14	18.0	-11	14.	12.43	20.0

Minor Planet 40 Harmonia						
1986 Apr 15	15	48.7	-14	39.	11.37	14.0
25	15	42.1	-14	16.	11.10	9.7
May 5	15	33.1	-13	51.	10.81	5.1
15	15	22.8	-13	26.	10.99	2.3
25	15	12.6	-13	5.	10.86	6.2
Jun 4	15	3.6	-12	53.	11.11	10.9
14	14	56.9	-12	52.	11.36	15.2
24	14	53.1	-13	5.	11.61	18.7
Jul 4	14	52.3	-13	30.	11.84	21.5

Minor Planet 51 Nemausa						
1986 May 15	18	41.6	- 7	58.	12.05	19.0
25	18	38.4	- 7	11.	11.83	16.0
Jun 4	18	32.5	- 6	36.	11.61	12.6
14	18	24.3	- 6	17.	11.43	9.3
24	18	14.9	- 6	16.	11.34	7.3
Jul 4	18	5.4	- 6	34.	11.40	8.2
14	17	57.0	- 7	8.	11.59	11.1
24	17	50.6	- 7	55.	11.83	14.4
Aug 3	17	46.8	- 8	52.	12.07	17.4
13	17	45.9	- 9	53.	12.31	19.9

Minor Planet 80 Sappho						
1986 May 5	18	48.7	-13	37.	12.45	20.0
25	18	47.4	-12	30.	12.15	17.0
Jun 4	18	42.9	-11	27.	11.84	13.5
14	18	35.5	-10	31.	11.55	9.6
24	18	26.1	- 9	47.	11.33	6.7
Jul 4	18	15.8	- 9	17.	11.31	7.5
14	18	6.1	- 9	4.	11.44	11.3
24	17	58.2	- 9	8.	11.63	15.7
Aug 3	17	53.4	- 9	27.	11.85	19.8
13	17	51.9	- 9	57.	12.06	23.3
23	17	54.1	-10	35.	12.27	26.1
Sep 2	17	59.7	-11	16.	12.45	28.2

Minor Planet 306 Unitas						
1986 May 15	19	8.4	-12	44.	12.97	23.2
25	19	10.2	-12	24.	12.69	20.3
Jun 4	19	8.7	-12	18.	12.39	16.7
14	19	4.1	-12	27.	12.09	12.4
24	18	56.9	-12	54.	11.81	7.8
Jul 4	18	48.0	-13	37.	11.59	4.7
14	18	38.9	-14	33.	11.73	7.0
24	18	31.1	-15	38.	11.05	11.8
Aug 3	18	25.8	-16	46.	12.22	16.5
13	18	23.9	-17	53.	12.49	20.5
23	18	25.6	-18	55.	12.76	23.8

Asteroid	Opp'n Date	Opp'n B Mag	Per	Amp	
23 Thalia	May 3	11.4	9.768 or 12.308	0.15	AMB
40 Harmonia	May 14	10.8	9.136	0.2	POL
405 Thia	Jun 10	11.7	10.08	0.15	PHA
51 Nemausa	Jun 25	11.3	7.785	0.2	POL
80 Sappho	Jun 27	11.2	14.05	0.3	POL
306 Unitas	Jul 3	11.6	8.75	0.2	POL
393 Lampetia	Jul 23	11.8	38.7	0.1	RAD

Photoelectric Photometry Opportunities