

LO GEM : PERIOD AND MAGNITUDESUMMARY

LO Gem is an eclipsing star of EA type, varying from magnitude 11.00 (V) to 11.60 (V) with a secondary minimum at perhaps 11.53 (V) and a mean B-V index of + 0.545. The eclipses duration is 11.5 % period. Its period elements correspond to : $HJD\ 2427368.371 + 2.2377824\ d \times E$.

RESUME

LO Gem est une étoile à éclipses du type EA, variant de la magnitude 11.00 (V) à 11.60 (V) avec un minimum secondaire atteignant peut-être 11.53 (V) et un indice B-V moyen de + 0.545. La durée des éclipses est de 11.5 % de la période. Les éléments de sa période correspondent à : $JJH\ 2427368.371 + 2.2377824\ j \times E$.

1. INTRODUCTION

LO Gem (6h 4min 8s + 25° 20.9') (2000) is listed in the fourth edition of the GCVS (P.N.Kholopov et al, 1985) as an E star varying from magnitude 11.5 to 12.0 (p). It is first mentioned as an Algol eclipsing star in a posthumous list from C. Hoffmeister (1968) with 3 minima instants. A few years later, after the reduction of the C. Hoffmeister discoveries, H. Gessner and I. Meinunger (1973) gave a new estimation of the LO Gem brightness (magnitude 11.5 to 12.0) and raised the number of minima instants to 10. All the timings were from Sonneberg photographic plates taken between 1933 and 1967. No period was found.

2. OBSERVATIONS

I began the visual monitoring of LO Gem in April 1990 and at the end of 1992 (Vandenbroere J., 1993), period searches on my estimates displayed a value of 1.1189 day. This finding allowed guiding the observations and determining 13 new minima instants from the author and two other GEOS members R. Boninsegna and A. Manna. Furthermore, during several GEOS missions from 1992 to 1997, 128 photoelectric measurements of LO Gem were obtained with the 76-cm telescope of the Jungfrauoch's observatory using the B and V filters of the Geneva system (see table 1). They permitted to determine 3 minima instants and gave a first good idea of the star's light curve.

3. PERIOD ELEMENTS AND OTHER PARTICULARS OF LO GEM

To determine LO Gem's period as accurately as possible, I used the 3 photoelectric minima from Jungfrauoch's measurements with 13 visual minima from three GEOS observers. The result allowed me to propose cycle numbers for the photographic instants published by C. Hoffmeister (1968) and by H. Gessner and I. Meinunger (1973). Two of these instants have to be rejected from the calculations because of their large O-C's. A triple weight was given to the photoelectric instants.

Table 2 : minimum instants of LO Gem

OBSERV.	MODE	HJD	E	O-C
GES	phot	27369.45	0.5	- 0.0399
GES	phot	27415.33	21	- 0.0344
GES	phot	27424.33	25	+ 0.0145
HOF	phot	31443.40	1821	+ 0.0272
HOF	phot	31462.421	1829.5	+ 0.0261
GES	phot	31470.49		
GES	phot	38322.55		
HOF	phot	38397.27	4928.5	- 0.0117
GES	phot	38472.30	4962	+ 0.0526

Table 1 : photoelectric measurements of LO Gem

HDJ + 2400000	Mag. V	(B-V)G	HDJ + 2400000	Mag. V	(B-V)G	HDJ + 2400000	Mag. V	(B-V)G
48978.5175	11.105	- 0.314	49721.4083	11.103	- 0.309	50461.3039	11.033	- 0.306
48978.5473	11.194	- 0.311	49721.5479	11.421	- 0.325	50461.3178	11.012	- 0.309
48978.5654	11.279	- 0.335	49721.5958	11.605	- 0.327	50461.3629	11.021	- 0.311
48978.5814	11.342	- 0.326	49721.6178	11.517	- 0.297	50461.3851	11.008	- 0.295
48978.5994	11.436	- 0.311	49721.6430	11.345	- 0.305	50461.4067	11.008	- 0.294
48978.6251	11.593	- 0.322	49722.3722	11.032	- 0.322	50461.4497	11.020	- 0.307
48978.6522	11.643	- 0.330	49722.4416	11.055	- 0.301	50461.4657	11.027	- 0.296
48978.6682	11.558	- 0.297	50336.6264	11.010	- 0.287	50461.4886	11.025	- 0.304
48981.3258	11.026	- 0.301	50342.5430	11.416	- 0.271	50461.5212	11.023	- 0.302
48981.3772	11.044	- 0.298	50342.5451	11.427	- 0.267	50461.5393	11.026	- 0.295
48981.3953	11.006	- 0.325	50342.5492	11.477	- 0.282	50461.5601	11.030	- 0.304
48981.4119	11.027	- 0.302	50342.5506	11.499	- 0.281	50461.5941	11.011	- 0.296
48981.4223	11.023	- 0.310	50342.5520	11.505	- 0.283	50462.2684	11.486	- 0.321
48981.4425	11.025	- 0.286	50342.5562	11.521	- 0.296	50462.2733	11.505	- 0.301
48981.4508	11.017	- 0.292	50342.5576	11.495	- 0.272	50462.2754	11.513	- 0.312
48981.4598	11.023	- 0.306	50342.5617	11.489	- 0.246	50462.2795	11.529	- 0.309
48981.4668	11.027	- 0.315	50342.5631	11.511	- 0.264	50462.2809	11.536	- 0.312
48981.4751	11.021	- 0.314	50342.5645	11.522	- 0.268	50462.2858	11.545	- 0.309
48981.5001	11.054	- 0.315	50342.5687	11.517	- 0.269	50462.2872	11.541	- 0.291
48981.5355	11.041	- 0.301	50342.5701	11.517	- 0.264	50462.2913	11.549	- 0.302
48981.5529	11.025	- 0.305	50342.5715	11.529	- 0.279	50462.2927	11.572	- 0.304
48981.5619	11.041	- 0.313	50342.5756	11.520	- 0.274	50462.2969	11.557	- 0.291
48981.5765	11.047	- 0.315	50342.5770	11.526	- 0.256	50462.2983	11.551	- 0.297
48981.5883	11.032	- 0.312	50342.5784	11.506	- 0.250	50462.3025	11.543	- 0.281
48981.6133	11.045	- 0.301	50342.5819	11.487	- 0.236	50462.3038	11.543	- 0.301
48981.6446	11.033	- 0.285	50342.5833	11.486	- 0.257	50462.3073	11.541	- 0.317
48981.3612	11.043	- 0.305	50342.5847	11.491	- 0.280	50462.3101	11.532	- 0.296
48982.4293	11.048	- 0.306	50342.5916	11.464	- 0.271	50462.3150	11.511	- 0.282
48982.4466	11.054	- 0.307	50342.5930	11.467	- 0.275	50462.3170	11.492	- 0.280
48982.4682	11.057	- 0.315	50342.5944	11.457	- 0.259	50462.3295	11.429	- 0.281
48982.5390	11.036	- 0.311	50342.6055	11.441	- 0.297	50462.3386	11.395	- 0.296
48982.5619	11.035	- 0.315	50342.6277	11.332	- 0.312	50462.3469	11.348	- 0.292
48982.5772	11.040	- 0.319	50342.6361	11.277	- 0.292	50462.3538	11.319	- 0.299
48982.6251	11.043	- 0.310	50342.6375	11.261	- 0.289	50462.3629	11.280	- 0.303
48983.3411	11.046	- 0.310	50456.3679	11.018	- 0.299	50462.3677	11.212	- 0.314
48983.3619	11.051	- 0.298	50456.3929	11.016	- 0.275	50462.3809	11.192	- 0.295
48983.3959	11.049	- 0.303	50456.4207	11.019	- 0.294	50462.3900	11.155	- 0.301
48983.4182	11.023	- 0.309	50456.4360	11.018	- 0.280	50462.4045	11.109	- 0.303
48983.4577	11.051	- 0.316	50456.5089	11.029	- 0.302	50462.4205	11.071	- 0.294
48983.4800	11.048	- 0.317	50456.5610	11.035	- 0.305	50462.4462	11.059	- 0.307
48984.4425	11.022	- 0.310	50456.5950	11.100	- 0.310	50462.4691	11.062	- 0.316
48984.4584	11.045	- 0.306	50456.6276	11.231	- 0.304	50462.4844	11.055	- 0.299
48984.4779	11.056	- 0.315	50461.2893	11.069	- 0.297			

Table 2 : minimum instants of LO Gem (continuation)

OBSERV.	MODE	HJD	E	O-C
GES	phot	39583.31	5458.5	+ 0.0036
VBR	vis	48226.7046	9321	- 0.0364
VBR	vis	48271.4524	9341	- 0.0442
VBR	vis	48345.3367	9374	- 0.0068
VBR	vis	48600.4618	9488	+ 0.0111
VBR	vis	48958.4984	9648	+ 0.0026
JUV	p.e.	48978.6439	9657	+ 0.0080
VBR	vis	49004.3641	9668.5	- 0.0063
BNN	vis	49390.3740	9841	- 0.0139
VBR	vis	49636.5162	9951	- 0.0277
VBR	vis	49701.4480	9980	+ 0.0084
MAA	vis	49776.4209	10013.5	+ 0.0156
VBR	vis	50050.5260	10136	- 0.0077
JUV	p.e.	50342.5687	10266.5	+ 0.0044
JUV	p.e.	50462.2948	10320	+0.0092
VBR	vis	50519.3468	1045.5	- 0.0023
VBR	vis	50538.3748	10354	+ 0.0046

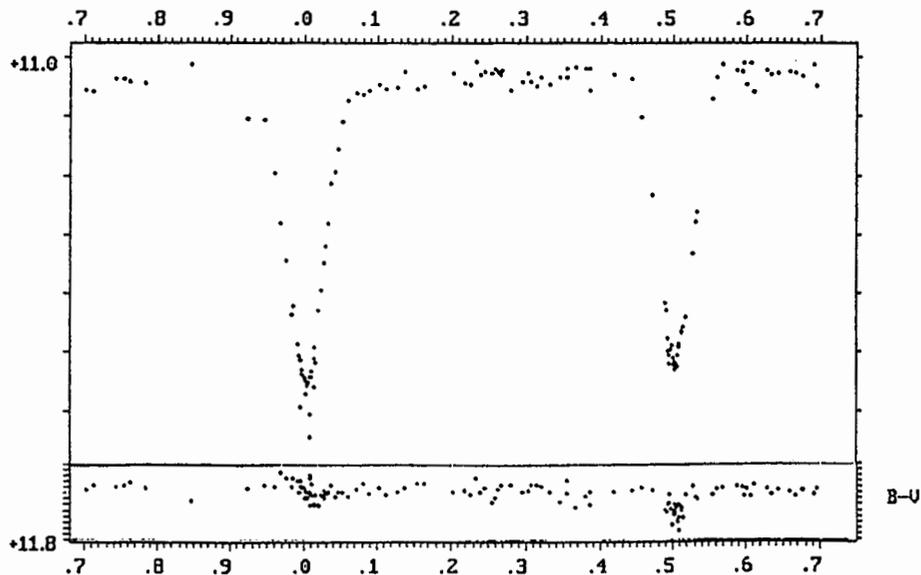
BNN = R. Boninsegna ; GES = instants published in H. Gessner and I. Meinunger (1973) ; HOF = instants published in C. Hoffmeister (1968) ; JUV = measurements at Jungfraujoch ; MAA = A. Man-
na ; VBR = J. Vandenbroere
phot = photographic plates ; vis = visual estimates ; p.e. = V photoelectric measurements

The period elements of LO Gem, calculated by linear regression with the instants listed in table 2, follows the formula :

$$\text{Min I} = \text{HDJ } 2427368.3710 + 2.2377824 \times E$$

$$\pm 0.0080 \pm 0.0000022$$

Fig 1 : photoelectric light curves in V and (B-V)G of LO Gem

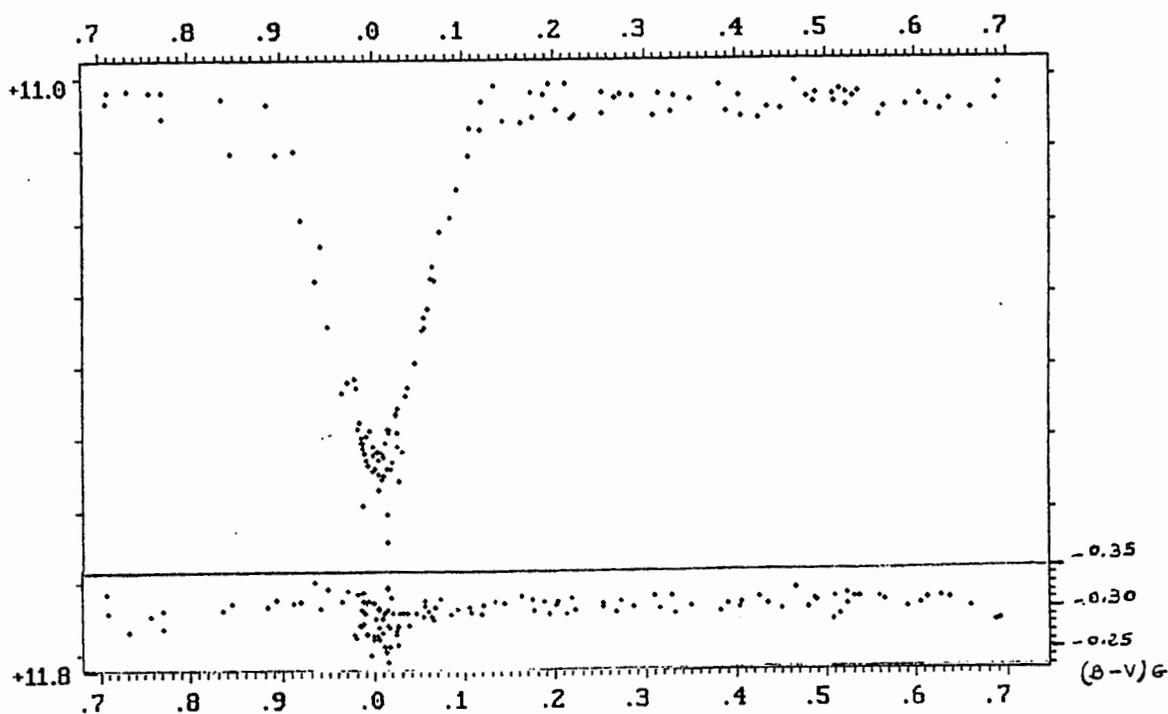


Using that ephemeris, the light curves composited with the photoelectric measurements in V and the (B-V)_G indices are shown in fig 1. We observe that outside eclipse LO Gem brightness fluctuates between 11.01 and 11.06 (V) and that the measurements during the primary minimum are still more scattered. Two layers appear around the zero phase : one around magnitude 11.55 for measurements from January 13, 1997 and the other around magnitude 11.60 for measurements from December 12, 1992 and January 3, 1995. The Jungfrauoch's measurements accuracy is generally around 0.03 magnitude. The observed fluctuations seem as if the LO Gem light curve shape does not recur exactly from cycle to cycle.

The B-V indices of LO Gem are at - 0.33 to - 0.24 in the Geneva system what corresponds to 0.51 to 0.55 after conversion using the formulae described by Meylan and Hauck (1981) considering LO Gem as a star of the luminosity class V. The LO Gem B-V index corresponds to a late F spectrum.

The possibility of a twice shorter period (1.1188912 day) for LO Gem was examined. In that case, the binary components would be of very different brightnesses and the secondary minimum undetected with the photoelectric measurements (see fig. 2). That solution is unlikely but cannot be rejected at the present time.

Fig 2 : LO Gem photoelectric light curves in V and (B-V)_G with a 1.1188912 day period



Now, considering that the period of LO Gem is really of 2.2377824 days, we have to examine more attentively the shape of the minima. The photoelectric measurements of January 1997 (see fig. 3) could suggested a stationary phase of an half hour, but the composited light curves of all the measurements in V between the phases 0.9 - 0.1 and 0.4 - 0.6 show rounded minima which could reflect incomplete occultations. That last solution is the more probable.

Fig 3 : photoelectric primary minimum of January 13, 1997

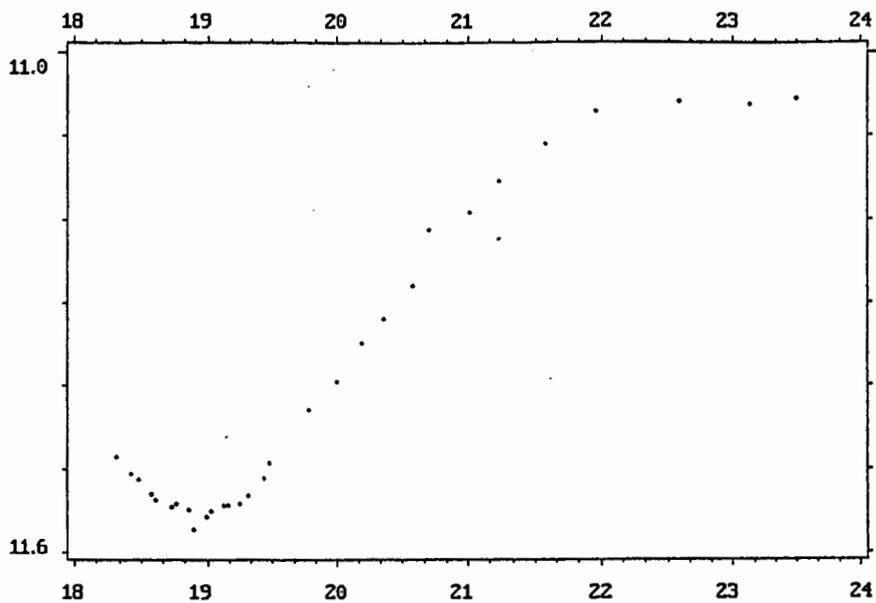
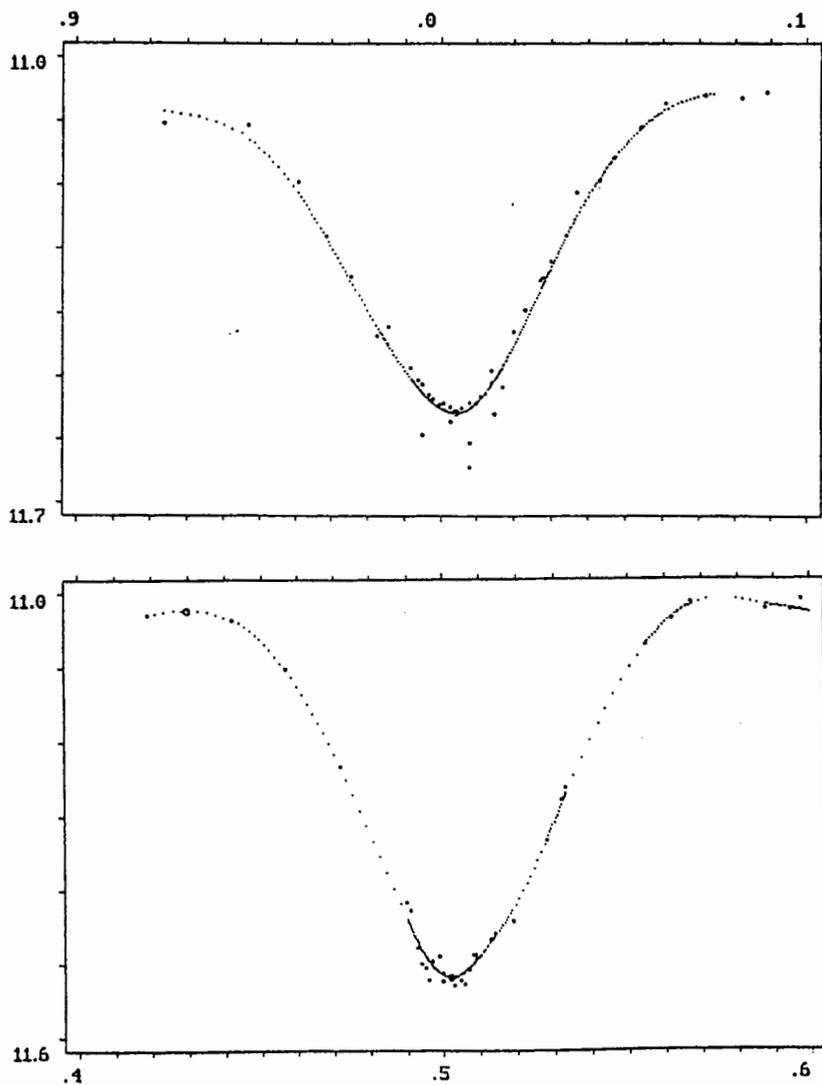


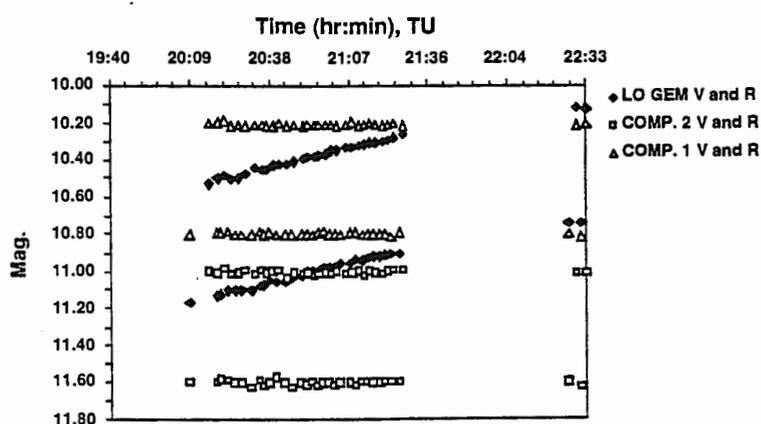
Fig 4 : the two enlarged photoelectric minima of LO Gem



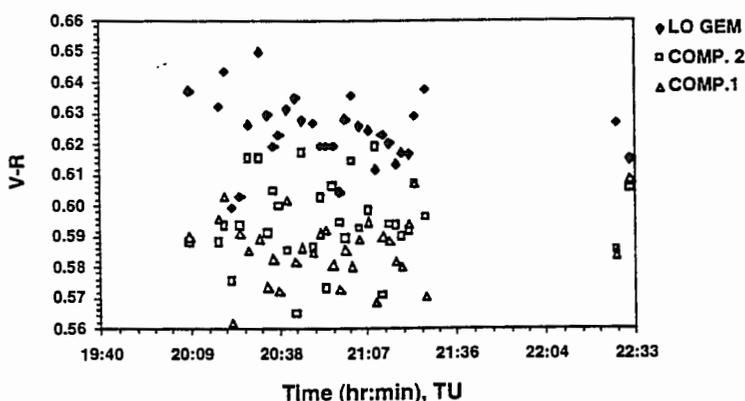
4. CCD MEASUREMENTS

Measurements of LO Gem were taken by Nicola Beltraminelli (BEL) and Andrea Manna (MAA) in the VR Johnson system with the CCD HI-SIS22. The images were taken with 30 s integration time in V and with 25 s integration time in R. Pre-treatment of the data was carried following the protocol suggested by C. Buil in the manual instructions of the CCD camera, which corresponds to standard procedures. The measured signal (see fig 5) is reported on the y-axis, as intensity in arbitrary units divided by the integration time. These data are still preliminar. Further work is needed to connect the system with the standard Morgan and Johnson system. The data reported show only an ascending part of a secondary minimum but further CCD measurements will be very useful especially during the eclipses faintest parts.

Fig 5 : CCD V and R measurements of LO GEM the 01-02-1997
BEL + MAA



CCD V-R Morgan and Johnson measurements of LO GEM the 01-02-1997



5. CONCLUSION

LO Gem is an eclipsing star of the EA type varying from magnitude 11.00 to 11.60 (V) ; secondary minimum is perhaps 11.53 (V). The eclipses duration is 11.5 % period with or without stationary phase.

Its period elements correspond to the following formula :

$$\text{Min I} = \text{HDJ } 2427368.371 + 2.2377824 \text{ d} \times \text{E.}$$

A twice shorter period is unlikely but not totally excluded.

The mean B-V colour index of LO Gem corresponds probably to late F spectra. The shape of the light curve is perhaps variable.

6. BIBLIOGRAPHY

- P.N. Kholopov et al, 1985, General Catalogue of Variable Stars, fourth edition.
- H. Gessner, I. Meinunger, 1973, Veröffentlichungen der Sternwarte in Sonneberg, 7, H6, 607.
- C. Hoffmeister, 1968, Astronomische Nachrichten, 290, H. 5/6, 277.
- G. Meylan and B. Hauck, 1981, Astronomy and Astrophysics Supplement Series, 46, 281.
- J. Vandenbroere, 1993, Note Circulaire GEOS 710, May 15.

Jacqueline Vandenbroere