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PHOTOELECTRIC OBSERVATIONS OF SZ LYNCIS

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ABSTRACT

1018 photoelectric observations of SZ Lyn obtained at Kottamia and Konkoly Observatories between 1984 and 1986 are reported. The long-period variation in time of maximum light discovered by van Genderen was investigated and the value of its period (P_B=1173.5 days = 3.213 years) and semiamplitude (A=0.00569 day = 491.6 sec) have been improved, and a secular change in the pulsation period ($\beta = 3 \cdot 10^{-12}$ day$\cdot$cycle^{-1}) has been found.

INTRODUCTION

SZ Lyncis (=BD+44°1718 = HD 67 390) is one of the most interesting high amplitude δ Scuti type variables. It is definitely a member of a binary system, and the duplicity is well reflected by the periodic variation in its period.

Its light variability was discovered by *Hoffmeister* (1949a,b), and since 1961 a great number of photoelectric observations have been carried out (see *Szeidl*, 1983 and references therein; *Braune* et al., 1983; *Fernley* et al., 1984; and *Jiang Shi-yang* et al., 1985).

Van Genderen (1967) was the first to point out that the O-C's produced by a linear ephemeris appeared to follow a sine-curve relation with a period of $P_B = 3.091 \pm 0.051$ years. *Barnes* and *Moffett* (1975) improved the parameters of the long-period variation from a linear element ($P_B = 3.138 \pm 0.028$ years) and interpreted this long-period variation as light travel time effect supposing SZ Lyn to be a member of a binary system with P_B the orbital period. *Garrido* et al. (1979) confirmed that the residuals from a constant period fitted a sine-wave well with a cycle length $P_B = 3.149 \pm 0.028$ years. *Szeidl* (1983) discussed all the photoelectric maxima available up to 1980 and came to the conclusion that the orbital period was longer (P_B=3.203$\pm$0.009 years) allowing that the pulsation period of the star might change linearly.

Bardin and *Imbert* (1984) carried out radial velocity measurements of high accuracy. They took into account the previous radial velocity observations of less accuracy and they then derived an even longer orbital period ($P_B = 3.235 \pm 0.004$ years) than was obtained previously.

Szeidl (1983) was the first to try to determine the intrinsic, secular change in the pulsation period (P_o) of SZ Lyn and he obtained $\beta = (+10 \pm 7) \cdot 10^{-13}$ day$\cdot$cycle^{-1} by a least squares solution. Later, *Jiang Shi-yang* et al. (1985)

supposed that *Barnes* and *Moffett*'s (1975) solution for the periodic long term (sinusoidal) variation had been accurately determined and they corrected the O-C's for this variation; the residual O-C's yielded $\beta=(+6.32\pm0.72)\cdot 10^{-12}$ day·cycle^{-1} by a second order least squares solution.

Although the photoelectric observations of SZ Lyn have covered almost a quarter of a century there are still some uncertainties in the period determinations by the radial velocity measurements and by the light time effect. In an attempt to determine a more accurate value for the periods and the variation in the pulsation period we put the star on our observational programme again for three observational seasons.

THE OBSERVATIONS

The photoelectric observations were carried out at Helwan Institute's Kottamia Observatory and the mountain station of Konkoly Observatory.

The 347 photoelectric observations of Kottamia Observatory were made by the 74 inch telescope on the nights 27/28, 28/29 February and 1/2 March 1984 (J.D. 244 5758, 244 5759, and 244 5761). The photoelectric photometer attached to the f/18 Cassegrain focus had an EMI 9558 B tube with an S-20 photocathode. The amplified output of the tube was fed into a Brown recorder. The time of the observations was estimated from the starting point and the mean moving speed of the strip chart recorder. The U,B and V filters used were very close to the standard system of Johnson and Morgan. BD+44°1714 served as the comparison star: its brightness and colours were determined as follows: V = 9.64 , B–V = +0.63 and U–B = +0.14 . The observations in the natural system obtained at Kottamia Observatory are given in Table 3a,b,c.

During the nights 3/4, 4/5 December 1984 and 4/5, 5/6 February 1986 (J.D. 244 6038, 244 6039, and 244 6466, 244 6467), 671 three-colour photoelectric observations were obtained at the mountain station of Konkoly Observatory. The observations were carried out with the 20 inch Cassegrain telescope equipped with an unrefrigerated photometer. This photometer contained an EMI 9058 QB multiplier tube and the colour filters were nearly on the UBV system: in ultraviolet light UG2, in blue light BG12 + GG13, and in yellow light GG11 Schott filters were used. The observations of Konkoly Observatory were made differentially with respect to the comparison star BD + 45°1544 whose brightness and colours measured by different authors are given in the paper of *Szeidl* (1983). (The accepted values for the comparison star are: V = 9.44 , B–V = +0.45 , U–B = +0.03 .) The individual observations of SZ Lyn have been converted to the standard UBV system and are presented in

Table 4a,b,c. As the comparison star was close to the variable, no correction has been made for differential extinction.

The light variation of SZ Lyn is very regular. The small deviations between the light curves of different observers can be attributed to errors in the transformation from the instrumental system into the UBV system. Apart from these deviations small cycle-to-cycle variations are also present.

An unusual feature in the colour loop during the phase interval 0.32-0.44 was found by *Barnes* and *Moffett* (1975). We examined this part of our light curves but no unusual feature was found. It seems that this behaviour does not reproduce each cycle.

PERIOD ANALYSIS

The early investigation of the period of SZ Lyn carried out by *van Genderen* (1967) revealed that the linear ephemeris produced (O-C)'s which appeared to follow a sine-curve relation with a cycle length of 1129 days. The observations used by *van Genderen* covered only $1.6P_B$=5 years whereas the baseline of coverage was extended to $3.8P_B$= 12 years by *Barnes* and *Moffett* (1975) who obtained a period of 1146 days. This long-period variation in the time of maximum light first found by *van Genderen* was interpreted by *Barnes* and *Moffett* as a modulation of the phase of maximum light by binary motion.

Later on, the value of the long period was improved by *Garrido* et al. (1979) using observations which covered $5.0P_B$=16 years.

Szeidl (1983) used all the photoelectric observations available up to 1980; the baseline of coverage was $6.0P_B$= 19 years. He supposed that the pulsational period underwent intrinsic, secular (evolutionary) changes, therefore he tried to fit the epochs of maximum light of SZ Lyn to the following relation:

$$T_{max} = T_o + P_o \cdot E + \frac{\beta}{2}E^2 - A \cdot \cos 2\pi \left(\frac{P_o}{P_B}E - \phi_o\right) \qquad (1)$$

where T_o is the initial epoch of maximum corresponding to E = 0 ; P_o is the pulsation period of SZ Lyn; P_B is the period of the sinusoid; β is the secular change of the pulsation period during one pulsation cycle; A is the semiamplitude of the sine-curve; and ϕ_o is the phase shift. From a least squares solution of Eq.(1), *Szeidl* (1983) derived an essentially larger value for P_B (=1170 days) than was obtained previously.

Bardin and *Imbert* (1984) using only radial velocity measurements derived an even longer period of the orbital motion: P_B= 1181.5 days.

Table 1

Parameters of ephemerides

T_o	P_o	P_B	A	ϕ_o	$10^{12}\beta$	coverage	ref.
2438124.39849 ±21	$0^d.12053493$ ±05	1129^d ±18	$0^d.00569$ ±18	-0.019 ±11	0***	5.0 years	[1]
38124.39828 ±17	0.120534906 ±20	1146 ±10	0.00572 ±19	-0.010 ±08	0***	11.8 years	[2]
38124.39824 ±17	0.120534920 ±13	1150 ±10	0.00573 ±20	-0.007 ±08	0***	16.2 years	[3]
38124.39801 ±12	0.120534934 ±18	1170 ±03	0.00540 ±11	-0.015 ±05	1.0 ±.7	18.9 years	[4]
38124.39828*	0.120534906*	1146*	0.00572*	-0.010*	6.32 ±.62	23.0 years	[5]
-	-	1181.5** ±1.4	-	-	-	19.0 years**	[6]
38124.39811 ±13	0.120534896 ±7	1173.5 ±2.0	0.00569 ±13	-0.017 ±06	2.96 ±.15	24.9 years	[7]

* Barnes and Moffett's parameters were accepted
** From radial velocity measurements
*** Pulsation period assumed to be constant
ref.: [1]: van Genderen (1967); [2]: Barnes and Moffett (1975); [3]: Garrido et al. (1979); [4]: Szeidl (1983); [5]: Jiang et al. (1985); [6]: Bardin and Imbert (1984); [7]: present paper

For comparison, the parameters of the sine-curve relation obtained by different authors are given in Table 1.

In order to determine a more accurate value of the parameters in Eq.(1), we collected all the published times of photoelectric maxima in Table 2. Five maxima have been excluded from the fit to Eq.(1). Four of these maxima (E = 2919 and 2977 observed by *Joshi* and *Srivastava* (1967); E = 18459 by *Wisse* and *Wisse* (1969); and E = 21073 by *Popovici* (1971)) were already reported to deviate significantly from the non-linear ephemeris. The time of the fifth maximum (E=57701), observed by *F. Agerer* (*Braune* and *Mundry*, 1982), is probably given erroneously.

Values of the six parameters in Eq.(1) were determined by the method of least squares giving the same weight to all observations:

$$T_o = 2438124.39811 \pm .00013 \qquad A = 0.00569 \text{ day} \pm .00013$$

$$P_o = 0.120534896 \text{ day} \pm 7 \qquad \beta = +2.96\cdot 10^{-12} \text{ day}\cdot\text{cycle}^{-1} \pm .15$$

$$P_B = 1173.5 \text{ days} \pm 2.0 \qquad \phi_o = -0.017 \pm .006$$

These new values are also given in Table 1 for comparison purposes. The 145 observed maxima used in this discussion cover almost $8P_B \approx 25$ years.

Table 2

Photoelectrically observed maxima

Epoch of maximum	Rem.	E	$(O-C)_{lin}$	O-C	φ
2437367.441	Sc	-6280	+0.0020	-0.0020	0.372
368.407	Sc	-6272	+0.0038	-0.0003	0.373
642.021	Eg	-4002	+0.0035	-0.0010	0.606
706.2645	Sz	-3469	+0.0019	-0.0011	0.661
707.4695	Sz	-3459	+0.0016	-0.0014	0.662
.5908	Sz	-3458	+0.0024	-0.0007	0.662
718.5587	Sz	-3367	+0.0016	-0.0011	0.671
726.5141	Sz	-3301	+0.0017	-0.0008	0.678
744.3535	Sz	-3153	+0.0019	-0.0001	0.693
780.031	HX	-2857	+0.0011	+0.0001	0.723
.152	HX	-2856	+0.0016	+0.0006	0.724
977.343	HX	-1220	-0.0025	+0.0019	0.892
997.351	HX	-1054	-0.0033	+0.0015	0.909
38001.568	vG	-1019	-0.0051	-0.0002	0.912
.689	vG	-1018	-0.0046	+0.0003	0.912
003.378	HX	-1004	-0.0031	+0.0018	0.914
021.576	vG	-853	-0.0058	-0.0007	0.929
.699	vG	-852	-0.0034	+0.0018	0.929
032.305	HX	-764	-0.0044	+0.0008	0.939
052.4333	Sz	-597	-0.0055	0.0000	0.956
.5545	Sz	-596	-0.0048	+0.0007	0.956
053.276	HX	-590	-0.0065	-0.0010	0.956
055.205	HX	-574	-0.0061	-0.0006	0.958
.3268	Br	-573	-0.0048	+0.0007	0.958
.4463	Br	-572	-0.0058	-0.0004	0.958
.5681	Br	-571	-0.0046	+0.0009	0.958
057.3752	Br	-556	-0.0055	0.0000	0.960
.4964	Br	-555	-0.0048	+0.0007	0.960
.6172	Br	-554	-0.0046	+0.0009	0.960
082.4464	Sz	-348	-0.0056	+0.0001	0.981
114.3880	Br	-83	-0.0057	0.0000	0.008
118.367	vG	-50	-0.0044	+0.0013	0.012
.485	vG	-49	-0.0069	-0.0012	0.012
124.393	vG	0	-0.0051	+0.0006	0.017
140.423	Br	+133	-0.0063	-0.0007	0.031
439.3565	Sz	2613	+0.0007	-0.0006	0.285
.4772	Sz	2614	+0.0009	-0.0004	0.285
457.3173	Sz	2762	+0.0018	0.0000	0.301
.4376	Sz	2763	+0.0016	-0.0002	0.301
460.210	JS	2786	+0.0017	-0.0002	0.303
463.342	JS	2812	-0.0002	-0.0022	0.306
464.189	JS	2819	+0.0030	+0.0010	0.307
465.276	JS	2828	+0.0052	+0.0032	0.308
466.238	JS	2836	+0.0029	+0.0009	0.308
467.200	JS	2844	+0.0006	-0.0014	0.309
471.297	JS	2878	-0.0005	-0.0027	0.313
(476.249	JS	2919	+0.0095	+0.0072	0.317)
(483.241	JS	2977	+0.0105	+0.0080	0.323)
701.8866	Bi	4791	+0.0058	+0.0001	0.509
708.6377	vG	4847	+0.0069	+0.0013	0.515
709.6014	vG	4855	+0.0064	+0.0007	0.516
712.6148	vG	4880	+0.0064	+0.0007	0.518
725.5117	vG	+4987	+0.0061	+0.0004	0.529

Table 2 (cont.)

Epoch of maximum	Rem.	E	$(O-C)_{lin}$	O-C	ψ
2438752.5114	vG	+5211	+0.0059	+0.0005	0.552
788.5505	vG	5510	+0.0051	+0.0001	0.583
809.4022	vG	5683	+0.0043	-0.0004	0.601
830.4949	vG	5858	+0.0034	-0.0009	0.619
834.234	JS	5889	+0.0059	+0.0017	0.622
844.4771	vG	5974	+0.0035	-0.0004	0.631
849.5396	vG	6016	+0.0036	-0.0003	0.635
850.3839	vG	6023	+0.0041	+0.0003	0.636
.5034	vG	6024	+0.0031	-0.0007	0.636
871.3567	vG	6197	+0.0038	+0.0005	0.654
39052.5129	vG	7700	-0.0039	-0.0020	0.808
.6355	vG	7701	-0.0018	+0.0001	0.808
054.5631	vG	7717	-0.0028	-0.0008	0.810
.6846	vG	7718	-0.0018	+0.0002	0.810
092.7726	Bi	8034	-0.0029	+0.0002	0.842
121.7007	Bi	8274	-0.0031	+0.0006	0.867
130.4981	vG	8347	-0.0048	-0.0009	0.874
145.4461	vG	8471	-0.0031	+0.0011	0.887
.5642	vG	8472	-0.0055	-0.0013	0.887
205.4706	vG	8969	-0.0050	+0.0002	0.938
527.5441	Sz	11641	-0.0007	+0.0004	0.213
528.6288	Sz	11650	-0.0008	+0.0002	0.214
531.401	JS	11673	-0.0010	+0.0001	0.216
905.3070	Sz	14775	+0.0058	-0.0001	0.535
40243.3996	Sz	17580	-0.0020	+0.0001	0.823
(349.3521	WW	18459	+0.0003	+0.0047	0.913)
(664.4239	Po	21073	-0.0061	-0.0044	0.181)
41035.443	Sz	24151	+0.0066	+0.0001	0.498
312.4276	Sz	26449	+0.0020	+0.0004	0.734
390.4113	Sz	27096	-0.0004	+0.0003	0.800
678.8475	BM	29489	-0.0042	0.0000	0.046
679.5714	Sz	29495	-0.0035	+0.0007	0.047
.6913	Sz	29496	-0.0041	+0.0001	0.047
683.7909	BM	29530	-0.0027	+0.0014	0.050
.9096	BM	29531	-0.0045	-0.0004	0.050
684.0312	BM	29532	-0.0035	+0.0007	0.050
42106.3947	Sz	33036	+0.0058	-0.0007	0.410
129.5391	KM	33228	+0.0075	+0.0007	0.430
136.2887	KM	33284	+0.0071	+0.0002	0.436
.4091	KM	33285	+0.0070	+0.0001	0.436
.5294	KM	33286	+0.0067	-0.0001	0.436
162.4450	KM	33501	+0.0073	+0.0002	0.458
451.4834	Sz	35899	+0.0031	-0.0005	0.704
454.4971	Sz	35924	+0.0034	-0.0001	0.707
531.7560	Af	36565	-0.0006	-0.0018	0.773
532.7210	Af	36573	+0.0001	-0.0010	0.774
533.6852	Af	36581	+0.0001	-0.0011	0.774
837.3091	Du	39100	-0.0034	-0.0001	0.033
841.2875	Du	39133	-0.0027	+0.0006	0.037
871.4218	KM	39383	-0.0021	+0.0009	0.062
872.3861	KM	39391	-0.0021	+0.0009	0.063
874.3152	KM	39407	-0.0016	+0.0014	0.065
.4352	KM	39408	-0.0021	+0.0008	0.065
43232.4309	HW	42378	+0.0050	-0.0016	0.370
257.3835	GE	+42585	+0.0068	-0.0003	0.391

Table 2 (cont.)

Epoch of maximum	Rem.	E	$(O-C)_{lin}$	O-C	ϕ
2443258.4685	GE	+42594	+0.0070	-0.0001	0.392
287.3985	GE	42834	+0.0087	+0.0010	0.417
288.3600	GE	42842	+0.0059	-0.0018	0.417
578.3668	Sz	45248	+0.0057	-0.0002	0.665
879.5758	Sz	47747	-0.0020	-0.0004	0.921
931.4059	Sz	48177	-0.0019	+0.0002	0.965
44222.3817	Ga	50591	+0.0027	+0.0002	0.213
257.4574	Ga	50882	+0.0027	-0.0009	0.243
261.3156	Ga	50914	+0.0038	+0.0001	0.247
.4359	Ga	50915	+0.0036	-0.0002	0.247
262.2787	Ga	50922	+0.0026	-0.0011	0.247
269.2711	Ga	50980	+0.0040	0.0000	0.253
578.2099	JE	53543	+0.0119	+0.0020	0.517
590.1415	JE	53642	+0.0105	+0.0006	0.527
591.3465	JE	53652	+0.0102	+0.0003	0.528
592.1907	JE	53659	+0.0106	+0.0008	0.529
606.2899	JE	53776	+0.0072	-0.0026	0.541
607.1374	JE	53783	+0.0110	+0.0012	0.541
.2570	JE	53784	+0.0100	+0.0003	0.541
610.2709	JE	53809	+0.0106	+0.0008	0.544
611.1149	JE	53816	+0.0108	+0.0011	0.545
999.2205	JE	57036	-0.0059	-0.0067	0.875
45001.1553	JE	57052	+0.0003	-0.0004	0.877
.2758	JE	57053	+0.0003	-0.0005	0.877
002.1192	JE	57060	-0.0001	-0.0008	0.878
.2398	JE	57061	0.0000	-0.0007	0.878
(079.3405	BY	57701	-0.0416	-0.0412	0.944)
390.3636	BE	60281	+0.0014	-0.0025	0.209
739.2014	JE	63175	+0.0112	-0.0004	0.506
740.0449	JE	63182	+0.0110	-0.0006	0.507
.1672	JE	63183	+0.0128	+0.0012	0.507
.2870	JE	63184	+0.0120	+0.0004	0.507
758.3670	Pp	63334	+0.0118	+0.0002	0.522
759.3310	Pp	63342	+0.0115	-0.0001	0.523
761.2612	Pp	63358	+0.0131	+0.0016	0.525
.3813	Pp	63359	+0.0127	+0.0012	0.525
767.0468	JE	63406	+0.0131	+0.0015	0.530
46038.4852	Pp	65658	+0.0069	+0.0009	0.761
.6061	Pp	65659	+0.0073	+0.0013	0.761
039.4493	Pp	65666	+0.0067	+0.0008	0.762
466.5001	Pp	69209	+0.0024	-0.0007	0.126
467.4653	Pp	69217	+0.0033	+0.0002	0.127

Remarks to Table 2: Sc = Schneller (1961); Eg = Eggen (1962); Sz = Szeidl (1983); HX = He Tian-Jian and Xiong Da-run (1964); vG = van Genderen (1963, 1967); Br= Broglia (1963); JS = Joshi and Srivastava (1967); Bi = Binnendijk (1968); WW = Wisse and Wisse (1969); Po = Popovici (1971); BM = Barnes and Moffett (1975); KM = Karetnikov and Medvedev (1977, 1978); Af = Africano (1978); Du = Duerbeck (1976); HW = Hopp and Witzigmann (1979); GE = Garrido et al. (1979); Ga = Garbusov (1980); JE = Jiang Shi-yang et al. (1985); BY = Braune and Mundry (1982); BE = Braune et al. (1983); Pp = Present paper.

In columns 4 and 5 of Table 2 the $(O-C)_{lin}$ residuals from the linear portion of Eq.(1) and the O-C residuals determined by Eq.(1) are given. The

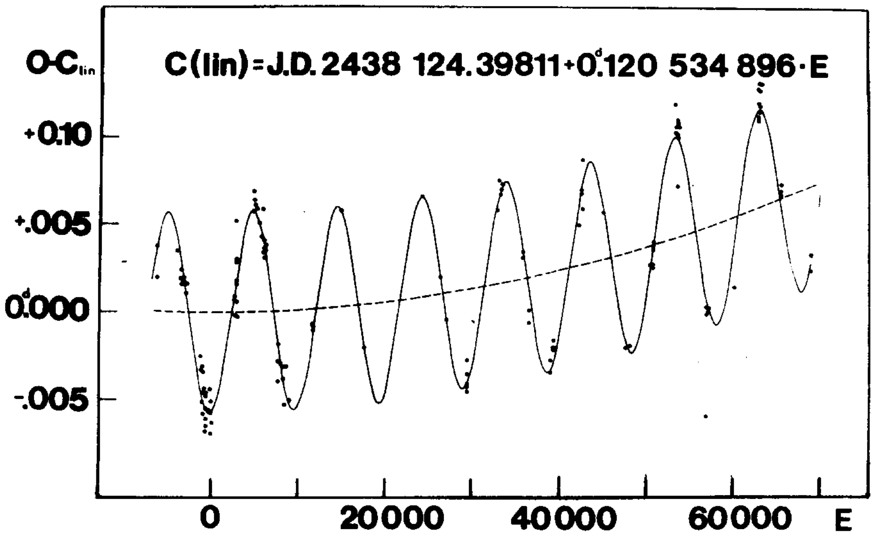

Figure 1. $(O-C)_{lin}$ versus E. The solid line indicates the goodness of fit for the non-linear ephemeris Eq.(1); the dashed line shows the secular variation in the pulsation period.

phases of the sinusoid are also given in column 6 of Table 2. Figure 1 indicates the goodness of the fit for the non-linear ephemeris. It shows the residuals from the linear part in Eq.(1) versus epoch number E and the non-linear fit is drawn in.

CONCLUSIONS

Taking into account all the photoelectric maxima available up to 1986 has led unambiguously to the conclusion that the orbital period of the system is 1173.5 ± 2.0 days. *Bardin* and *Imbert* (1984) obtained a slightly longer period (1181.5 days) probably because they took into account the early radial velocity measurements of low accuracy in their period determination. The difference cannot be explained by the fact that we assumed a circular orbit.

Using our solution for Eq.(1) we can deduce the following characteristics of the binary system if we assume that the orbit is circular:

$$a_{SZ} \cdot \sin i = cA = (147.4 \pm 3.4) \cdot 10^6 \text{km} = 0.99 \pm 0.03 \text{ AU}$$

$$K_{SZ} = cA\frac{2\pi}{P_B} = 9.13 \pm 0.21 \text{ km} \cdot \text{s}^{-1}$$

$$f(M_2) = (0.093 \pm 0.006) M_\odot$$

As *Bardin* and *Imbert* (1984) derived a large value for the eccentricity (e=0.19) of the orbit from the radial velocity observations, our results can only be regarded as tentative. An attempt to derive the orbital elements from the O-C residuals of light maxima of SZ Lyn allowing non-circular orbit is planned in a forthcoming paper.

We were able to determine an intrinsic secular change of $\beta=(+2.96\pm0.15)\cdot 10^{-12}$ day·cycle^{-1} in the pulsation period of SZ Lyn. This change is in agreement with the evolutionary theories: the high amplitude δ Scuti star SZ Lyn is evolving off from the main sequence (see, for example, the evolutionary track of the star with a mass of 1.7 $M_\odot$ in *Percy* et al., 1980).

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Table 3a

Yellow observations obtained at Kottamia Observatory
(SZ Lyn - BD+ 44°1714)

J.D.	Δv	J.D.	Δv	J.D.	Δv	J.D.	Δv
2445758		2445758		2445759		2445761	
.2694	-0.334	.4044	-0.229	.3446	-0.463	.3153	-0.120
.2722	.294	.4098	.186	.3477	.433	.3179	.093
.2767	.260	.4127	.169	.3510	.433	.3209	.091
.2797	.234	.4159	.152	.3542	.409	.3243	.083
.2823	.223	.4189	.125	.3554	.385	.3269	.074
.2853	.212	.4239	.093	.3582	.335	.3299	.066
.2882	.193	.4266	.091	.3613	.352	.3345	.051
.2898	.168	.4295	.080	.3644	.327	.3373	.029
.2928	.157	.4323	.059	.3658	-0.301	.3405	.014
.2958	.137	.4350	.067			.3440	.024
.2985	.134	.4377	.055	2445761		.3471	.041
.3017	.114	.4402	.053	.2516	-0.415	.3501	.045
.3121	.060	.4427	.039	.2545	.476	.3644	.198
.3325	.029	.4452	.037	.2574	.511	.3670	.245
.3354	.039	.4619	.034	.2603	.519	.3698	.333
.3386	.049	.4652	.067	.2627	.518	.3728	.419
.3418	.076	.4678	-0.099	.2655	.515	.3765	.493
.3459	.120			.2794	.376	.3799	.534
.3493	.185	2445759		.2821	.343	.3830	.534
.3529	.269	.2905	-0.038	.2847	.319	.3860	.511
.3565	.361	.2940	.053	.2873	.303	.4006	.355
.3604	.493	.2971	.047	.2902	.291	.4034	.345
.3633	.552	.3004	.062	.2930	.264	.4061	.305
.3663	.572	.3037	.087	.2956	.261	.4096	.290
.3690	.573	.3069	.122	.2984	.236	.4124	.262
.3853	.383	.3109	.166	.3014	.217	.4152	.245
.3883	.369	.3143	.227	.3039	.205	.4235	.189
.3914	.330	.3178	.319	.3065	.190	.4259	.182
.3942	.313	.3211	.404	.3090	.174	.4291	.160
.3983	.274	.3244	.512	.3116	.155	.4317	-0.145
.4014	-0.252	.3276	-0.551	.3125	-0.133		

Table 3b

Blue observations obtained at Kottamia Observatory
(SZ Lyn - BD+ 44°1714)

J.D.	Δb	J.D.	Δb	J.D.	Δb	J.D.	Δb
2445758		2445758		2445758		2445758	
.2697	-0.658	.2994	-0.395	.3542	-0.623	.3951	-0.609
.2735	.614	.3025	.359	.3586	.799	.3991	.572
.2776	.569	.3128	.322	.3613	.903	.4023	.541
.2808	.537	.3332	.281	.3642	.953	.4053	.514
.2839	.519	.3363	.299	.3672	.970	.4105	.463
.2862	.502	.3393	.317	.3701	.955	.4136	.441
.2907	.452	.3427	.343	.3862	.747	.4168	.410
.2937	.433	.3468	.415	.3892	.698	.4220	.377
.2966	-0.414	.3506	-0.517	.3923	-0.666	.4246	-0.359

Table 3b (cont)

J.D.	Δb	J.D.	Δb	J.D.	Δb	J.D.	Δb
2445758		2445759		2445761		2445761	
.4275	−0.342	.3187	−0.667	.2829	−0.678	.3447	−0.282
.4304	.324	.3222	.793	.2854	.645	.3480	.304
.4330	.314	.3253	.900	.2880	.619	.3510	.308
.4359	.305	.3283	.914	.2910	.596	.3651	.519
.4384	.304	.3302	.934	.2937	.572	.3677	.609
.4409	.283	.3455	.812	.2965	.553	.3707	.714
.4434	.283	.3488	.779	.2989	.532	.3737	.818
.4459	.282	.3519	.746	.3021	.506	.3774	.893
.4626	.301	.3561	.675	.3046	.490	.3807	.939
.4660	.355	.3592	.623	.3072	.467	.3837	.928
.4686	−0.386	.3623	.631	.3099	.445	.3878	.885
		.3667	−0.568	.3134	.407	.4013	.707
2445759				.3160	.389	.4043	.677
.2919	−0.307	2445761		.3188	.363	.4073	.646
.2949	.310	.2525	−0.802	.3218	.350	.4103	.614
.2984	.303	.2553	.867	.3250	.423	.4133	.576
.3017	.326	.2583	.906	.3276	.320	.4159	.555
.3046	.367	.2610	.911	.3313	.315	.4240	.487
.3076	.398	.2636	.904	.3354	.303	.4266	.468
.3117	.464	.2662	.891	.3380	.266	.4298	.447
.3154	−0.558	.2801	−0.710	.3417	−0.259	.4326	−0.435

Table 3c

Ultraviolet observations obtained at Kottamia Observatory
(SZ Lyn − BD + 44^{o}1714)

J.D.	Δu	J.D.	Δu	J.D.	Δu	J.D.	Δu
2445758		2445758		2445758		2445761	
.2710	−0.537	.3874	−0.594	.4697	−0.327	.2536	−0.727
.2753	.512	.3905	.576			.2564	.767
.2819	.453	.3933	.525	2445759		.2594	.782
.2846	.449	.3962	.505	.2931	−0.220	.2620	.771
.2919	.382	.4005	.499	.2963	.211	.2648	.769
.2950	.358	.4035	.471	.2996	.229	.2675	.757
.2976	.333	.4089	.419	.3029	.246	.2814	.594
.3009	.318	.4120	.399	.3060	.300	.2840	.565
.3037	.303	.4150	.366	.3091	.352	.2865	.542
.3141	.279	.4180	.331	.3133	.437	.2895	.517
.3347	.253	.4230	.315	.3168	.515	.2923	.493
.3375	.268	.4259	.302	.3201	.626	.2949	.486
.3408	.303	.4286	.288	.3236	.710	.2977	.463
.3441	.317	.4314	.260	.3267	.781	.3000	.450
.3483	.422	.4341	.259	.3317	.804	.3032	.430
.3520	.509	.4368	.257	.3467	.681	.3056	.406
.3556	.599	.4393	.240	.3502	.644	.3081	.403
.3597	.715	.4418	.237	.3533	.634	.3109	.370
.3620	.792	.4443	.264	.3575	.585	.3144	.345
.3653	.841	.4470	.248	.3606	.565	.3172	.328
.3681	.821	.4635	.266	.3636	−0.534	.3201	.304
.3710	−0.752	.4669	−0.297			.3229	−0.279

Table 3c (cont)

J.D.	Δu	J.D.	Δu	J.D.	Δu	J.D.	Δu
2445761		2445761		2445761		2445761	
.3260	−0.258	.3492	−0.263	.3820	−0.800	.4143	−0.467
.3287	.277	.3522	.267	.3851	.784	.4168	.426
.3329	.259	.3663	.482	.3890	.755	.4252	.377
.3362	.260	.3689	.567	.4025	.586	.4280	.358
.3392	.200	.3719	.643	.4055	.559	.4310	.341
.3433	.242	.3753	.742	.4085	.531	.4337	−0.327
.3461	−0.249	.3786	−0.799	.4108	−0.493		

Table 4a

Yellow observations obtained at Konkoly Observatory
(SZ Lyn − BD+45°1544)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2446038		2446038		2446038		2446466	
.4447	+0.169	.5270	+0.008	.6052	−0.357	.4379	+0.098
.4460	.168	.5283	.020	.6065	.362	.4389	.089
.4473	.162	.5297	.028	.6117	.330	.4398	.098
.4487	.153	.5350	.065	.6130	.304	.4407	.107
.4500	.158	.5364	.072	.6143	.295	.4456	.120
.4558	.141	.5377	.079	.6156	.282	.4465	.122
.4571	.136	.5390	.093	.6170	.266	.4474	.125
.4585	.128	.5404	.091	.6223	.198	.4484	.124
.4598	.114	.5462	.119	.6237	.180	.4496	.116
.4611	+0.111	.5476	.120	.6251	.170	.4590	.162
.4705	−0.056	.5488	.125	.6264	.160	.4599	.159
.4718	.097	.5502	.135	.6278	.138	.4609	.159
.4731	.134	.5516	.130	.6334	.111	.4652	.155
.4744	.183	.5571	.160	.6348	.098	.4661	.151
.4758	.229	.5584	.166	.6361	.076	.4671	.159
.4813	.332	.5597	.172	.6374	.071	.4680	.164
.4827	.336	.5611	.171	.6388	−0.062	.4690	.161
.4840	.347	.5624	.194			.4729	.159
.4853	.352	.5679	.204	2446039		.4738	.192
.4867	.341	.5692	.192	.4338	−0.044	.4747	.154
.4918	.311	.5706	.195	.4352	.069	.4757	.164
.4931	.301	.5719	.191	.4365	.107	.4820	.056
.4944	.292	.5733	.176	.4378	.156	.4830	.012
.4958	.283	.5793	.138	.4391	.194	.4840	+0.001
.4971	.279	.5806	.134	.4405	.212	.4849	−0.004
.5030	.193	.5819	.115	.4418	.246	.4888	.140
.5044	.179	.5832	.099	.4432	.246	.4897	.163
.5057	.164	.5846	+0.078	.4487	.354	.4906	.200
.5070	.142	.5901	−0.041	.4501	.353	.4915	.219
.5084	.139	.5915	.064	.4515	.324	.4925	.252
.5137	.071	.5928	.109	.4528	.325	.4964	.334
.5164	.043	.5941	.155	.4581	.283	.4974	.351
.5177	.029	.5955	.186	.4638	−0.252	.4983	.358
.5191	−0.036	.6012	.317			.4993	.363
.5243	+0.021	.6025	.330	2446466		.5002	.358
.5256	+0.001	.6038	−0.348	.4370	+0.093	.5041	−0.347

Table 4a (cont)

J.D.	ΔV	J.D.	ΔV	J.D.	ΔV	J.D.	ΔV
2446466		2446466		2446467		2446467	
.5051	-0.341	.5466	+0.035	.4566	-0.246	.4919	-0.111
.5060	.324	.5476	+0.046	.4575	.257	.4928	.097
.5069	.325			.4612	.322	.4937	.095
.5079	.308	2446467		.4621	.335	.4947	.089
.5120	.283	.4304	+0.180	.4630	.338	.4956	.076
.5129	.278	.4314	.185	.4640	.345	.4992	.040
.5138	.272	.4323	.172	.4649	.347	.5002	.028
.5148	.262	.4332	.165	.4688	.341	.5011	.026
.5211	.177	.4342	.168	.4698	.332	.5020	.018
.5220	.173	.4386	.128	.4707	.330	.5030	-0.010
.5229	.173	.4396	.126	.4717	.319	.5068	+0.019
.5276	.117	.4405	.115	.4726	.308	.5077	.021
.5286	.096	.4414	.102	.4765	.278	.5087	.023
.5304	.050	.4423	.085	.4775	.270	.5096	.052
.5356	.031	.4463	.023	.4784	.249	.5105	.046
.5365	.027	.4472	+0.009	.4794	.244	.5220	.121
.5375	.011	.4481	-0.017	.4803	.220	.5229	.124
.5384	.008	.4491	.026	.4843	.188	.5305	.144
.5393	-0.003	.4500	.049	.4853	.172	.5314	.149
.5438	+0.021	.4538	.170	.4862	.156	.5324	.141
.5447	.030	.4547	.202	.4871	.144	.5333	.149
.5457	+0.035	.4556	-0.221	.4881	-0.137	.5342	+0.145

Table 4b

Blue observations obtained at Konkoly Observatory
(SZ Lyn - BD + 45°1544)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2446038		2446038		2446038		2446038	
.4451	+0.071	.4935	-0.535	.5395	-0.020	.5850	-0.066
.4465	.073	.4949	.518	.5408	-0.022	.5905	.213
.4478	.063	.4962	.507	.5467	+0.029	.5919	.235
.4492	.067	.4976	.496	.5480	.031	.5932	.304
.4505	.053	.5034	.401	.5493	.044	.5946	.342
.4562	.021	.5048	.379	.5507	.052	.5959	.412
.4575	.016	.5061	.347	.5520	.061	.6016	.561
.4589	+0.001	.5075	.327	.5575	.077	.6030	.586
.4602	-0.008	.5088	.300	.5588	.086	.6043	.596
.4616	.016	.5142	.219	.5602	.086	.6056	.606
.4709	.235	.5155	.212	.5615	.111	.6070	.605
.4722	.285	.5182	.189	.5629	.095	.6121	.566
.4736	.337	.5195	.176	.5683	.104	.6134	.545
.4749	.388	.5248	.146	.5697	.099	.6148	.524
.4763	.436	.5261	.133	.5710	.097	.6161	.507
.4817	.568	.5274	.120	.5724	.089	.6174	.494
.4831	.583	.5288	.105	.5737	.077	.6228	.399
.4844	.581	.5301	.093	.5797	.022	.6242	.374
.4858	.590	.5354	.058	.5810	+0.011	.6255	.351
.4871	.585	.5368	.038	.5824	-0.002	.6268	.347
.4922	-0.537	.5381	-0.030	.5837	-0.032	.6282	-0.315

Table 4b (cont)

J.D.	ΔB	J.D.	ΔB	J.D.	ΔB	J.D.	ΔB
2446038		2446466		2446466		2446467	
.6339	−0.262	.4664	+0.073	.5359	−0.161	.4692	−0.596
.6352	.241	.4673	.076	.5368	.164	.4701	.578
.6365	.221	.4683	.084	.5377	.153	.4710	.571
.6379	.205	.4693	.084	.5387	.143	.4720	.556
.6392	−0.184	.4732	.079	.5396	.137	.4729	.529
		.4742	.097	.5441	.091	.4768	.483
2446039		.4751	.091	.5450	.085	.4778	.464
.4343	−0.252	.4760	+0.051	.5460	.084	.4787	.451
.4356	.303	.4815	−0.079	.5469	.070	.4797	.425
.4369	.344	.4824	.097	.5479	−0.057	.4806	.417
.4383	.393	.4833	.133			.4846	.360
.4396	.446	.4843	.162	2446467		.4856	.344
.4410	.496	.4891	.318	.4307	+0.101	.4865	.336
.4423	.519	.4900	.383	.4317	.096	.4874	.326
.4436	.535	.4909	.416	.4326	.093	.4884	.306
.4492	.616	.4919	.441	.4335	.092	.4922	.266
.4506	.606	.4928	.484	.4345	.081	.4931	.255
.4519	.593	.4968	.568	.4389	.048	.4940	.245
.4532	.554	.4977	.582	.4399	.032	.4950	.233
.4586	.526	.4986	.582	.4408	.021	.4959	.221
.4642	−0.390	.4995	.577	.4417	.019	.4995	.179
		.5004	.586	.4427	+0.002	.5005	.166
2446466		.5044	.565	.4466	−0.100	.5014	.181
.4373	+0.006	.5054	.559	.4475	.127	.5024	.173
.4382	.013	.5063	.550	.4484	.155	.5033	.146
.4392	.031	.5073	.530	.4494	.187	.5071	.124
.4401	.020	.5082	.521	.4503	.222	.5080	.116
.4410	.028	.5123	.488	.4541	.365	.5090	.114
.4459	.042	.5132	.475	.4549	.408	.5099	.064
.4468	.043	.5141	.474	.4559	.446	.5108	−0.066
.4477	.058	.5151	.444	.4569	.474	.5223	+0.041
.4487	.045	.5214	.353	.4578	.496	.5232	.056
.4499	.056	.5223	.347	.4614	.575	.5308	.045
.4593	.091	.5232	.334	.4624	.594	.5317	.051
.4603	.071	.5279	.259	.4633	.598	.5327	.048
.4612	.085	.5289	.230	.4643	.604	.5336	.060
.4655	+0.076	.5307	−0.214	.4652	−0.611	.5345	+0.053

Table 4c

Ultraviolet observations obtained at Konkoly Observatory
(SZ Lyn − BD + 45^{o}1544)

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2446038		2446038		2446038		2446038	
.4456	+0.160	.4580	+0.112	.4740	−0.207	.4862	−0.417
.4469	.192	.4593	.111	.4754	.265	.4875	.414
.4483	.185	.4607	.105	.4767	.292	.4926	.374
.4496	.175	.4620	+0.110	.4822	.404	.4940	.363
.4509	.189	.4713	−0.127	.4835	.421	.4953	.349
.4567	+0.133	.4727	−0.174	.4848	−0.416	.4967	−0.347

Table 4c (cont)

J.D.	ΔU	J.D.	ΔU	J.D.	ΔU	J.D.	ΔU
2446038		2446038		2446466		2446467	
.4980	−0.347	.6139	−0.366	.4745	+0.185	.4487	−0.052
.5039	.238	.6152	.333	.4754	.167	.4497	.092
.5052	.217	.6166	.323	.4763	.137	.4506	.109
.5066	.201	.6179	.306	.4818	.027	.4544	.247
.5079	.173	.6233	.222	.4827	+0.004	.4553	.278
.5092	.157	.6246	.203	.4836	−0.027	.4562	.304
.5159	.040	.6259	.192	.4855	.077	.4572	.321
.5173	.022	.6273	.164	.4893	.187	.4581	.346
.5186	.024	.6286	.152	.4903	.241	.4618	.418
.5199	−0.023	.6343	.095	.4912	.256	.4627	.428
.5252	+0.003	.6356	.103	.4922	.296	.4636	.447
.5265	.018	.6369	.078	.4931	.324	.4646	.450
.5279	.048	.6383	.044	.4971	.381	.4655	.448
.5292	.053	.6397	−0.031	.4980	.395	.4695	.433
.5305	.049			.4989	.402	.4704	.413
.5359	.101	2446039		.4999	.401	.4714	.394
.5373	.093	.4347	−0.171	.5008	.418	.4723	.386
.5386	.100	.4360	.193	.5047	.385	.4732	.366
.5399	.115	.4374	.243	.5057	.383	.4772	.301
.5412	.115	.4387	.283	.5066	.356	.4781	.286
.5471	.164	.4401	.314	.5076	.343	.4790	.261
.5484	.161	.4414	.352	.5085	.347	.4800	.245
.5498	.166	.4427	.350	.5126	.314	.4809	.224
.5511	.174	.4441	.362	.5144	.309	.4849	.193
.5524	.181	.4496	.421	.5154	.285	.4859	.174
.5579	.227	.4510	.411	.5226	.181	.4868	.160
.5593	.205	.4523	.405	.5235	.173	.4877	.152
.5606	.210	.4537	.358	.5245	.157	.4887	.142
.5620	.220	.4590	.355	.5282	.112	.4925	.116
.5633	.220	.4646	−0.230	.5292	.092	.4934	.102
.5688	.223			.5310	.067	.4943	.112
.5701	.223	2446466		.5362	.025	.4953	.089
.5715	.215	.4376	+0.117	.5371	.026	.4962	.078
.5728	.214	.4385	.142	.5381	.025	.4999	.037
.5741	.202	.4394	.140	.5390	.021	.5008	.054
.5801	.137	.4404	.143	.5399	−0.009	.5017	.043
.5815	.144	.4414	.138			.5026	.036
.5828	.105	.4462	.161	2446467		.5036	.027
.5842	.071	.4471	.168	.4310	+0.222	.5074	−0.008
.5855	+0.054	.4480	.164	.4320	.223	.5083	+0.007
.5910	−0.086	.4489	.162	.4329	.205	.5093	.028
.5923	.133	.4596	.195	.4338	.208	.5102	.060
.5937	.184	.4606	.182	.4348	.195	.5111	.080
.5950	.223	.4615	.201	.4392	.133	.5226	.148
.5964	.279	.4658	.196	.4401	.131	.5235	.151
.6021	.389	.4668	.177	.4411	.121	.5311	.174
.6034	.420	.4677	.181	.4420	.104	.5320	.175
.6048	.436	.4686	.183	.4430	+0.078	.5330	.184
.6061	.440	.4696	.188	.4469	−0.005	.5339	.185
.6074	.435	.4735	+0.176	.4478	−0.010	.5349	+0.184
.6125	−0.376						