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RESEARCH ARTICLE

Monitoring the Period Variation of KR Cyg Eclipsing Binary

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ABSTRACT
This study examines the period variation of the eclipsing binary system KR Cyg, a near-contact binary characterized by its short orbital period and significant stellar interactions. The precise orbital parameters of the system have been determined through light curve data collected periodically since 1999 and were published in our previous studies. Additionally, minimum light observations have been continuously monitored to analyze the period variation of the system. In our earlier work, the masses of the primary and secondary components were determined as $2.88 \pm 0.20 M_\odot$ and $1.26 \pm 0.07 M_\odot$, with corresponding radii of $2.59 \pm 0.06 R_\odot$ and $1.80 \pm 0.04 R_\odot$. The bolometric albedo and effective temperature of the less massive star were also investigated, and deviations caused by mutual illumination effects were identified. These results provide valuable insights into the evolutionary status of KR Cyg and shed light on the dynamic processes that occur in near-contact binary systems. Using updated eclipse timings, an (O-C) diagram was constructed, revealing both long-term trends and periodic oscillations. These cyclical variations are thought to indicate the presence of a tertiary component affecting the system via the light-time effect. Additional observations and modeling are recommended to confirm the tertiary hypothesis and further refine the parameters of the system.

Keywords: Techniques: CCD photometry; stars: KR Cyg; period variation

1. INTRODUCTION

Near-contact binary systems (NCBs) represent a fascinating class of stellar binaries where at least one component is close to filling its Roche lobe, often leading to significant tidal interactions and mutual distortion. These systems are typically characterized by short orbital periods and exhibit complex light curve variations due to effects such as ellipsoidal modulation, reflection, and sometimes partial eclipses. NCBs serve as crucial laboratories for studying stellar evolution, mass transfer processes, and the influence of proximity on stellar structure and behavior. Their diverse configurations often position them as precursors to more evolved systems, such as contact binaries or cataclysmic variables. Understanding the physical and dynamical properties of NCBs provides valuable insights into binary evolution scenarios and their role in broader astrophysical contexts.

KR Cyg is an EB-type eclipsing binary system initially identified by Schneller (1931) and Schneller (1932) in the early 1930s. Visual light curves were later documented by Lassovszky (1936), Gaposchkin (1953), and Tsesevich (1954). Photographic light curves were produced by Wachmann (1948) and Nekrasova (1945), whose studies indicated that KR Cyg is an Algol-type binary. Subsequent observations by Vetesnik (1965) introduced the first photoelectric light curves for the system, determining an orbital period of 0.8451538 days. Based on these light curves, Vetešnik categorized the system as β Lyrae-type, comprising a B9-type primary star and an F5-type secondary star. However, Koch (1973) assigned the secondary star a spectral type of G4, while Hill et al. (1975) conducted the first spectroscopic analysis, suggesting the system is closer to type A3. In 1980, Wilson & Rafert (1980) analyzed Vetešnik's light curves and calculated the first photometric solution, yielding a mass ratio of $q = 0.478$. A statistical analysis by Giuricin et al. (1983) grouped KR Cyg among 'a' class Algol systems, which includes classical semi-detached binaries and Algols with subgiant secondaries. Al-Naimiy et al. (1985) applied Fourier analysis to derive the geometric and physical properties of the system, reporting a slightly adjusted photometric mass ratio of $q = 0.51$. Later, Kholopov (1985) classified the system as A2V. In 2004, Sipahi & Gülmen (2004) presented three-colour photometric data, further refining the system's parameters. Their WD-based analysis revealed a photometric mass ratio of $q = 0.43$, suggesting that the cooler, less massive secondary nearly fills its Roche lobe. Shaw (1990) classified KR Cyg as a near-contact binary (NCB), a group where both stars either fill or nearly fill their Roche lobes. At a later time, Sipahi (2012) compiled all known light minimum times and analysed the system's orbital period. Her findings revealed periodic oscillations in the (O-C) data, with an amplitude of 0.001 days and a cycle lasting approximately 76 years,

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Table 1. Basic parameters of the observed stars.

Star	α_{2025} (hh:mm:ss.ss)	δ_{2025} (dd:mm:ss.ss)	V (mag)	Spt Typ
KR Cyg	20:10:05.83	+30:37:29.60	9.34	A0
HD 191398	20:09:39.73	+30:24:42.96	9.00	A0V
HD 333664	20:10:18.54	+30:18:07.56	9.63	A0

which she attributed to a hypothetical third component. Shortly after Sipahi et al. (2013) presented multi-colour, five-year photometric light curves and radial velocity measurements for the near-contact binary system KR Cyg.

In this study, the component masses were determined as $2.88 \pm 0.20 M_{\odot}$ and $1.26 \pm 0.07 M_{\odot}$, with corresponding radii of $2.59 \pm 0.06 R_{\odot}$ and $1.80 \pm 0.04 R_{\odot}$. Additionally, they investigated the empirical determination of the albedo and effective temperature of the cooler, less massive star in KR Cyg, alongside a comparison with two similar near-contact binaries, AK CMi and DO Cas. Discrepancies between the observed and computed fluxes are attributed to mutual illumination effects, where the heated surface layers of the illuminated star experience variations in bolometric albedo, limb-darkening coefficients, and gravity-brightening exponents. Interestingly, the derived effective albedos are generally lower than those predicted for stars with convective envelopes. It is important to note that these findings are preliminary and warrant further investigation. Tvardovskyi & Marsakova (2015) have also published a study on the period variation of the system. In this study, the light curve variations and period changes of the KR Cyg eclipsing binary system were analysed using the photometric observations from 2024 and the updated minimum time. This study aims to investigate the presence of the third component in the system through (O-C) analysis using approximately 95 years of minimum time data.

2. OBSERVATIONS

Observations were acquired with a thermoelectrically cooled ALTA U +47 1024 × 1024 pixel CCD camera attached to a 40 cm Schmidt-Cassegrains type MEADE telescope at Ege University Observatory. The observations made in the V band were continued on September 27, 28, and 29, in the season of 2024. In Table 1, the coordinates, apparent visual magnitudes, and spectral types of the variable and the comparison stars are given. Although the variable and comparison stars are very close in the sky, differential atmospheric extinction corrections were applied. The atmospheric extinction coefficients were obtained from observations of the comparison stars on each night. Heliocentric corrections were also applied to the times of the observations. The mean averages of the standard deviations are 0.025 mag for observations acquired in the V band. To compute the standard deviations of observations, we used the standard deviations of the reduced differential magnitudes in the sense comparisons minus the check stars for each night. All KR Cyg data was phased using the minimum time and period taken from Sipahi (2012). Then, the V-band light curve shown in Figure 1 was derived.

KR Cyg eclipsing binary has been observed at different intervals over 26 years at the Ege University Observatory. Discussions on the light variations of the KR Cyg system obtained in different years have been provided by Sipahi & Gülmen (2004), Sipahi & Tas (2006), Sipahi (2012), and Sipahi et al. (2013). Observations obtained in the V band in 2024 demonstrated that the system's light curves exhibit similar variations. The depths of the minima do not change. Both minima are sufficiently symmetrical. The secondary minimum lies just at the phase 0.5. Since the radial velocity of the system, the solution of the light curve, and the absolute parameters are provided in Sipahi et al. (2013), the parameters of that study have been adopted in this work.

3. ORBITAL PERIOD VARIATION

To investigate the orbital period variation of KR Cyg, all accessible minimum times were gathered from the literature. In addition, the system was observed for three nights in 2024. From these observations, a primary minimum time was determined. Additionally, the primary and secondary minimum times of the system have been determined from the Transiting Exoplanet Survey Satellite (*TESS*) data (Ricker et al. 2015). All other minimum times were obtained from the database of (O-C) Gateway (Paschke & Brat 2006). All minimum timings of KR Cyg eclipsing binary are provided in the appendix. In total, 179 visual, 29 photographic, and 219 photoelectric minimum times of KR Cyg were used in the period analysis. The (O-C) residuals of KR Cyg were calculated using the following linear ephemeris and plotted in Figure 2.

$$JD\,(\mathrm{Hel.}) = 2455036.5310(14) + 0^{d}.84515279(6) \times E. \quad (1)$$

Subsequently, the (O-C)I values and (O-C)II residuals were plotted against the epoch number (E) in Figure 2 and Figure 3, respectively. The residuals (O-C) II suggest that the orbital period of KR Cyg exhibits a long-term sinusoidal variation. It is hypothesized that the most plausible explanation for the cyclic variation in the (O-C)II residuals is the light-travel-time effect (LTTE) caused by an undetected third body in the system. To model this effect, the LTTE equation, presented as expression (2) by Irwin (1959), was applied to the (O-C)II residuals of the system's eclipse timings.

$$\Delta t = \frac{a_{12}\sin i'}{c}\left\{\frac{1-e'^2}{1+e'\cos\nu'}\sin(\nu'+\omega') + e'\cos\omega'\right\}. \quad (2)$$

Here, Δt represents the time shift caused by the LTTE, c is the speed of light, and a_{12}, i', $e'$and ω' denote the semi-major axis, inclination, eccentricity, and longitude of periastron of the absolute orbit of the eclipsing binary's center of mass around the triple system's center of mass. Additionally, ν' refers to the true anomaly of the eclipsing binary's center of mass along this orbit.

A weighted least-squares analysis was performed to determine two parameters (T_0 and P) for the linear ephemeris of KR Cyg, along with five parameters ($a_{12}\sin i'$, e', ω', T' and P') for the LTTE. The results of this analysis are summarized in Table 2. The observed data points, along with the theoretical curve providing the best fit, are plotted against the epoch number in Figure 3. Assuming that the orbit of the presumed third body is

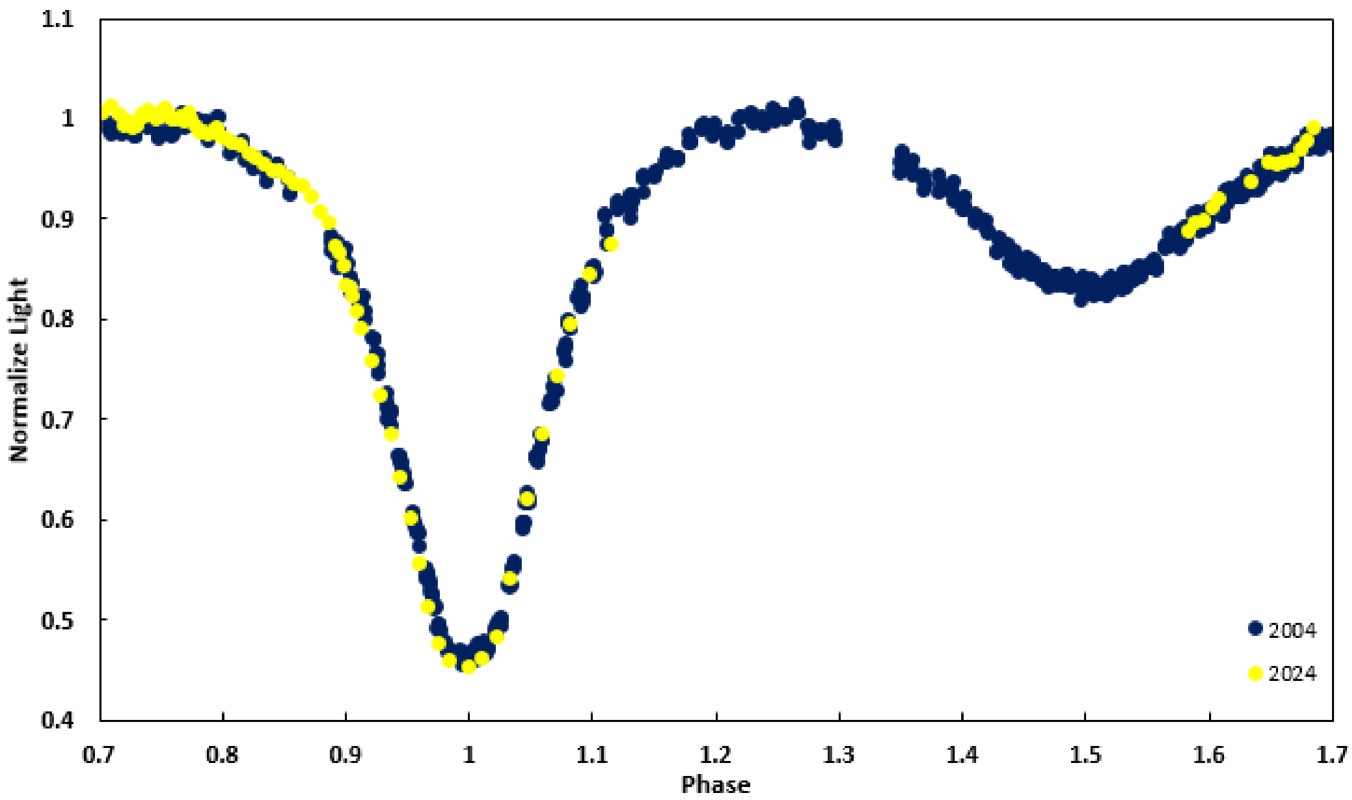

Figure 1. The V-band normalized light curves of the KR Cyg from 2004 (blue-coloured points) and 2024 (yellow-coloured points) are presented (brightness values were converted to intensity to compare the light curve variations over a 20-year time interval).

Table 2. The parameters derived from (O-C) analysis of KR Cyg.

Parameter	Value
T_0 (HJD)	2455036.5310±0.0014
P (day)	0.84515279±0.00000006
K (day)	0.012±0.006
P' (year)	70.9±1.9
e'	0.93±0.12
ω' (deg)	26.70±0.02
$a_{12} \sin i'$ (AU)	1.99±0.22
$f(m)$ ($M_\odot$)	0.00157±0.00010
M_3 (i'=15°)	1.41$M_\odot$
M_3 (i'=30°)	0.66$M_\odot$
M_3 (i'=45°)	0.45$M_\odot$
M_3 (i'=60°)	0.36$M_\odot$
M_3 (i'=75°)	0.33$M_\odot$
M_3 (i'=90°)	0.32$M_\odot$

circular, we obtained the mass function as $f(m) = 0.00157M_\odot$ for the third body, using the Equation:

$$f(m) = \frac{4\pi^2}{GT^2} \times (a_{12} \sin i')^3 = \frac{(M_3 \ \sin i')^3}{(M_1 + M_2 + M_3)^2}. \qquad (3)$$

where M_1, M_2, and M_3 are the masses of the binary's components and the third body, respectively.

The mass of the third component can be determined using Equation (3), which varies based on the orbital inclination. For instance, when $i' = 90°$, the minimum mass $M_{3,\min}$ is calculated to be 0.32 $M_\odot$. In this calculation, the total mass of the eclipsing binary system is assumed to be 4.14 $M_\odot$. The masses of the third body for various inclination angles i' have been computed and are presented in Table 3. The data in Table 3 also indicate that KR Cyg follows an eccentric orbit around the center of mass of the triple system, with a period of approximately ~71 years.

4. CONCLUSION

In this study, the orbital period variation of the KR Cyg system was reanalysed using data based on its 2024 photometry. The system has been observed at Ege University observatory during certain years and monitored for approximately 26 years. During this time, photometric and spectroscopic studies of the system were obtained, and the absolute parameters of the components were determined by Sipahi et al. (2013). The orbital period variation caused by a third body was proposed by Sipahi (2012). All minimum time observations conducted after the period variation study proposed by Sipahi (2012) have supported this suggestion. The (O-C) variation of the KR Cyg appears scattered. Both the primary and secondary minima exhibit the same variation in the (O-C) diagram. With our 2024 observations, the system's period variation has been updated under the assumption that the orbital period change is caused by a third body. Tvardovskyi & Marsakova (2015) also examined the period variation of the KR Cyg system and determined the orbital period of the third body to be approximately 80 years. The minimum timings to be obtained in the next approximately five years are crucial for refining the orbital parameters of the third body of the system.

Table 3. Times of minima of KR Cyg.

HJD (+24 00000)	Year	Cycle	(O-C)	Method	References
25700.4230	1929.3	-34711.0	-0.04594	pg	O-C Gateway
26120.4860	1930.5	-34214.0	-0.02334	pg	O-C Gateway
26298.7740	1931.0	-34003.0	-0.06234	pg	O-C Gateway
26447.5310	1931.4	-33827.0	-0.05204	pg	O-C Gateway
26586.1400	1931.8	-33663.0	-0.04792	vis	O-C Gateway
26590.3700	1931.8	-33658.0	-0.04368	vis	O-C Gateway
26591.2090	1931.8	-33657.0	-0.04983	vis	O-C Gateway
26596.2800	1931.8	-33651.0	-0.04974	vis	O-C Gateway
26601.3550	1931.8	-33645.0	-0.04565	vis	O-C Gateway
26602.1910	1931.8	-33644.0	-0.05481	vis	O-C Gateway
26607.2700	1931.8	-33638.0	-0.04672	vis	O-C Gateway
27245.3740	1933.6	-32883.0	-0.03225	vis	O-C Gateway
27553.0000	1934.4	-32519.0	-0.04147	V	O-C Gateway
28074.4660	1935.8	-31902.0	-0.03407	pg	O-C Gateway
28333.9050	1936.5	-31595.0	-0.05664	V	O-C Gateway
28380.4170	1936.7	-31540.0	-0.02798	pg	O-C Gateway
28545.2100	1937.1	-31345.0	-0.03956	pg	O-C Gateway
28773.3910	1937.7	-31075.0	-0.04952	pg	O-C Gateway
28806.3640	1937.8	-31036.0	-0.03744	pg	O-C Gateway
28811.4430	1937.8	-31030.0	-0.02935	pg	O-C Gateway
29106.4027	1938.7	-30681.0	-0.02759	pg	O-C Gateway
29106.4130	1938.7	-30681.0	-0.01729	pg	O-C Gateway
29143.5780	1938.8	-30637.0	-0.03897	pg	O-C Gateway
29230.6040	1939.0	-30534.0	-0.06359	pg	O-C Gateway
30259.2040	1941.8	-29317.0	-0.01321	pg	O-C Gateway
30531.3270	1942.6	-28995.0	-0.02906	pg	O-C Gateway
32296.8470	1947.4	-26906.0	-0.03096	pg	O-C Gateway
32821.6840	1948.8	-26285.0	-0.03317	pg	O-C Gateway
33220.6060	1949.9	-25813.0	-0.02277	pg	O-C Gateway
33226.5160	1949.9	-25806.0	-0.02883	pg	O-C Gateway
33536.6850	1950.8	-25439.0	-0.03050	pg	O-C Gateway
33567.9700	1950.9	-25402.0	-0.01612	pg	O-C Gateway
33923.7660	1951.8	-24981.0	-0.02898	pg	O-C Gateway
34213.6610	1952.6	-24638.0	-0.02102	pg	O-C Gateway
34512.8460	1953.5	-24284.0	-0.01972	pe	O-C Gateway
34596.5280	1953.7	-24185.0	-0.00774	vis	O-C Gateway
34602.4390	1953.7	-24178.0	-0.01280	vis	O-C Gateway
34607.5150	1953.7	-24172.0	-0.00771	vis	O-C Gateway
34650.6050	1953.8	-24121.0	-0.02044	pg	O-C Gateway
35221.9170	1955.4	-23445.0	-0.03099	pg	O-C Gateway
35774.6500	1956.9	-22791.0	-0.02721	pg	O-C Gateway
36818.4010	1959.8	-21556.0	-0.03855	pg	O-C Gateway
36868.3020	1959.9	-21497.0	-0.00151	pg	O-C Gateway
38336.3120	1963.9	-19760.0	-0.02001	vis	O-C Gateway
38558.5900	1964.5	-19497.0	-0.01691	pe	O-C Gateway
38559.4352	1964.5	-19496.0	-0.01686	pe	O-C Gateway
38559.4360	1964.5	-19496.0	-0.01606	pe	O-C Gateway
38580.5649	1964.6	-19471.0	-0.01595	pe	O-C Gateway
38580.5657	1964.6	-19471.0	-0.01515	pe	O-C Gateway
38597.4671	1964.6	-19451.0	-0.01678	pe	O-C Gateway
38608.4535	1964.7	-19438.0	-0.01736	pe	O-C Gateway
38614.3693	1964.7	-19431.0	-0.01762	pe	O-C Gateway
38614.3702	1964.7	-19431.0	-0.01672	pe	O-C Gateway
38652.4050	1964.8	-19386.0	-0.01374	vis	O-C Gateway
38675.2210	1964.9	-19359.0	-0.01684	pe	O-C Gateway
38675.2229	1964.9	-19359.0	-0.01494	pe	O-C Gateway
38941.4520	1965.6	-19044.0	-0.00863	vis	O-C Gateway
39040.3170	1965.9	-18927.0	-0.02637	vis	O-C Gateway
39040.3300	1965.9	-18927.0	-0.01337	vis	O-C Gateway
39051.3050	1965.9	-18914.0	-0.02535	vis	O-C Gateway
39051.3060	1965.9	-18914.0	-0.02435	vis	O-C Gateway
39389.3770	1966.8	-18514.0	-0.01403	vis	O-C Gateway
40420.4578	1969.6	-17294.0	-0.01830	vis	O-C Gateway
40725.5590	1970.5	-16933.0	-0.01686	vis	O-C Gateway
40731.4690	1970.5	-16926.0	-0.02293	vis	O-C Gateway
40753.4590	1970.5	-16900.0	-0.00687	vis	O-C Gateway
40759.3740	1970.6	-16893.0	-0.00793	vis	O-C Gateway
40780.5000	1970.6	-16868.0	-0.01072	vis	O-C Gateway
40785.5700	1970.6	-16862.0	-0.01163	vis	O-C Gateway
40786.4100	1970.6	-16861.0	-0.01679	vis	O-C Gateway
40791.4800	1970.7	-16855.0	-0.01770	vis	O-C Gateway
40796.5540	1970.7	-16849.0	-0.01461	vis	O-C Gateway
40830.3670	1970.8	-16809.0	-0.00767	vis	O-C Gateway
40830.3860	1970.8	-16809.0	0.01133	vis	O-C Gateway
40841.3460	1970.8	-16796.0	-0.01565	pe	O-C Gateway
40890.3550	1970.9	-16738.0	-0.02545	vis	O-C Gateway
41080.5150	1971.4	-16513.0	-0.02458	vis	O-C Gateway
41135.4540	1971.6	-16448.0	-0.02044	vis	O-C Gateway
41146.4560	1971.6	-16435.0	-0.00541	vis	O-C Gateway
41162.4970	1971.7	-16416.0	-0.02229	vis	O-C Gateway
41168.4130	1971.7	-16409.0	-0.02235	vis	O-C Gateway
41173.4930	1971.7	-16403.0	-0.01326	vis	O-C Gateway
41174.3323	1971.7	-16402.0	-0.01912	pe	O-C Gateway
41201.3910	1971.8	-16370.0	-0.00527	vis	O-C Gateway
41234.3540	1971.9	-16331.0	-0.00319	vis	O-C Gateway
41490.4170	1972.6	-16028.0	-0.02115	vis	O-C Gateway
41490.4230	1972.6	-16028.0	-0.01515	vis	O-C Gateway
41506.4740	1972.6	-16009.0	-0.02203	vis	O-C Gateway
41511.5550	1972.6	-16003.0	-0.01194	vis	O-C Gateway
41522.5430	1972.7	-15990.0	-0.01092	vis	O-C Gateway
41528.4524	1972.7	-15983.0	-0.01758	vis	O-C Gateway
41556.3550	1972.7	-15950.0	-0.00499	vis	O-C Gateway
41583.3900	1972.8	-15918.0	-0.01484	vis	O-C Gateway
41589.3080	1972.8	-15911.0	-0.01290	vis	O-C Gateway
41594.4080	1972.8	-15905.0	0.01619	vis	O-C Gateway
41599.4410	1972.9	-15899.0	-0.02172	vis	O-C Gateway
41622.2820	1972.9	-15872.0	0.00018	vis	O-C Gateway
41627.3310	1972.9	-15866.0	-0.02173	B	O-C Gateway
41627.3330	1972.9	-15866.0	-0.01973	vis	O-C Gateway
41812.4120	1973.4	-15647.0	-0.02895	vis	O-C Gateway
41823.4030	1973.5	-15634.0	-0.02492	vis	O-C Gateway
41850.4440	1973.5	-15602.0	-0.02878	vis	O-C Gateway
41850.4510	1973.5	-15602.0	-0.02178	vis	O-C Gateway
41871.5850	1973.6	-15577.0	-0.01657	vis	O-C Gateway
41904.5430	1973.7	-15538.0	-0.01949	vis	O-C Gateway
41931.5820	1973.8	-15506.0	-0.02534	vis	O-C Gateway
41932.4330	1973.8	-15505.0	-0.01949	vis	O-C Gateway
41938.3480	1973.8	-15498.0	-0.02055	vis	O-C Gateway
41938.3510	1973.8	-15498.0	-0.01755	vis	O-C Gateway
41943.4220	1973.8	-15492.0	-0.01746	vis	O-C Gateway
42144.5560	1974.4	-15254.0	-0.02957	vis	O-C Gateway
42193.5810	1974.5	-15196.0	-0.02337	vis	O-C Gateway
42221.4741	1974.6	-15163.0	-0.02027	vis	O-C Gateway
42254.4490	1974.7	-15124.0	-0.00629	vis	O-C Gateway
42337.2410	1974.9	-15026.0	-0.03916	vis	O-C Gateway
42419.2410	1975.1	-14929.0	-0.01887	vis	O-C Gateway
42570.5200	1975.5	-14750.0	-0.02203	vis	O-C Gateway
42576.4480	1975.5	-14743.0	-0.01009	vis	O-C Gateway
42708.2930	1975.9	-14587.0	-0.00875	vis	O-C Gateway
42958.4560	1976.6	-14291.0	-0.01066	vis	O-C Gateway
42980.4260	1976.6	-14265.0	-0.01460	vis	O-C Gateway
42996.4850	1976.7	-14246.0	-0.01348	vis	O-C Gateway
43013.3900	1976.7	-14226.0	-0.01152	vis	O-C Gateway
43046.3560	1976.8	-14187.0	-0.00643	vis	O-C Gateway
43280.4500	1977.5	-13910.0	-0.01945	vis	O-C Gateway
43673.4540	1978.5	-13445.0	-0.01099	vis	O-C Gateway
43689.5150	1978.6	-13426.0	-0.00788	vis	O-C Gateway
43706.4260	1978.6	-13406.0	0.00009	vis	O-C Gateway
43739.3680	1978.7	-13367.0	-0.01883	vis	O-C Gateway
43744.4350	1978.7	-13361.0	-0.02274	vis	O-C Gateway
43766.4210	1978.8	-13335.0	-0.01068	vis	O-C Gateway
43777.4150	1978.8	-13322.0	-0.00365	vis	O-C Gateway
44165.3320	1979.9	-12863.0	-0.01128	vis	O-C Gateway
44426.4810	1980.6	-12554.0	-0.01416	vis	O-C Gateway
44437.4880	1980.6	-12541.0	0.00587	vis	O-C Gateway
44443.3700	1980.6	-12534.0	-0.02819	vis	O-C Gateway
44454.3700	1980.7	-12521.0	-0.01516	vis	O-C Gateway
44498.3490	1980.8	-12469.0	0.01595	vis	O-C Gateway
44503.3870	1980.8	-12463.0	-0.01696	vis	O-C Gateway
44514.3870	1980.8	-12450.0	-0.00394	vis	O-C Gateway
44569.2970	1981.0	-12385.0	-0.02880	vis	O-C Gateway
44569.2990	1981.0	-12385.0	-0.02680	vis	O-C Gateway
44913.2800	1981.9	-11978.0	-0.02254	vis	O-C Gateway
44913.2920	1981.9	-11978.0	-0.01054	vis	O-C Gateway
45130.4907	1982.5	-11721.0	-0.01582	vis	O-C Gateway
45600.3920	1983.8	-11165.0	-0.01887	vis	O-C Gateway
45644.3340	1983.9	-11113.0	-0.02476	vis	O-C Gateway
45878.4480	1984.6	-10836.0	-0.01778	vis	O-C Gateway
45889.4330	1984.6	-10823.0	-0.01975	vis	O-C Gateway
45911.3980	1984.7	-10797.0	-0.02870	vis	O-C Gateway
45933.3840	1984.7	-10771.0	-0.01664	vis	O-C Gateway
46004.3820	1984.9	-10687.0	-0.01138	vis	O-C Gateway
46271.4480	1985.7	-10371.0	-0.01332	vis	O-C Gateway
46271.4590	1985.7	-10371.0	-0.00232	vis	O-C Gateway
46326.3810	1985.8	-10306.0	-0.01518	vis	O-C Gateway
46331.4520	1985.8	-10300.0	-0.01509	vis	O-C Gateway
46917.5890	1987.4	-9606.5	0.00921	pe	O-C Gateway
46992.3660	1987.6	-9518.0	-0.00972	vis	O-C Gateway
47003.3520	1987.7	-9505.0	-0.01069	vis	O-C Gateway
47008.4070	1987.7	-9499.0	-0.02660	vis	O-C Gateway
47023.6300	1987.7	-9481.0	-0.01633	vis	O-C Gateway
47039.6920	1987.8	-9462.0	-0.01221	vis	O-C Gateway
47055.3250	1987.8	-9443.5	-0.01452	vis	O-C Gateway
47083.6410	1987.9	-9410.0	-0.01110	vis	O-C Gateway
47111.5250	1988.0	-9377.0	-0.01711	vis	O-C Gateway
47121.6700	1988.0	-9365.0	-0.01393	vis	O-C Gateway
47151.2420	1988.1	-9330.0	-0.02224	vis	O-C Gateway
47300.8430	1988.5	-9153.0	-0.01309	vis	O-C Gateway

Table 3. Continue

HJD (+24 00000)	Year	Cycle	(O-C)	Method	References
47362.5360	1988.6	-9080.0	-0.01616	pe	O-C Gateway
47368.4310	1988.7	-9073.0	-0.03723	vis	O-C Gateway
47374.3630	1988.7	-9066.0	-0.02129	vis	O-C Gateway
47374.3820	1988.7	-9066.0	-0.00229	vis	O-C Gateway
47385.3800	1988.7	-9053.0	0.00874	vis	O-C Gateway
47407.3400	1988.8	-9027.0	-0.00520	vis	O-C Gateway
47410.7090	1988.8	-9023.0	-0.01681	vis	O-C Gateway
47412.3997	1988.8	-9021.0	-0.01641	vis	O-C Gateway
47423.3970	1988.8	-9008.0	-0.00609	vis	O-C Gateway
47448.7340	1988.9	-8978.0	-0.02364	vis	O-C Gateway
47460.5750	1988.9	-8964.0	-0.01476	vis	O-C Gateway
47462.2650	1988.9	-8962.0	-0.01506	vis	O-C Gateway
47498.6030	1989.0	-8919.0	-0.01859	vis	O-C Gateway
47522.2880	1989.1	-8891.0	0.00216	vis	O-C Gateway
47712.4325	1989.6	-8666.0	-0.01244	U	O-C Gateway
47721.7200	1989.6	-8655.0	-0.02164	vis	O-C Gateway
47734.4230	1989.7	-8640.0	0.00409	vis	O-C Gateway
47805.3980	1989.9	-8556.0	-0.01365	vis	O-C Gateway
48012.4530	1990.4	-8311.0	-0.02082	vis	O-C Gateway
48043.7340	1990.5	-8274.0	-0.01043	vis	O-C Gateway
48065.7040	1990.6	-8248.0	-0.01438	vis	O-C Gateway
48127.4040	1990.7	-8175.0	-0.01045	vis	O-C Gateway
48143.4660	1990.8	-8156.0	-0.00633	vis	O-C Gateway
48158.6620	1990.8	-8138.0	-0.02307	vis	O-C Gateway
48180.6430	1990.9	-8112.0	-0.01601	vis	O-C Gateway
48191.6310	1990.9	-8099.0	-0.01498	vis	O-C Gateway
48202.6110	1990.9	-8086.0	-0.02195	vis	O-C Gateway
48208.5410	1991.0	-8079.0	-0.00802	vis	O-C Gateway
48235.5820	1991.0	-8047.0	-0.01187	vis	O-C Gateway
48469.6810	1991.7	-7770.0	-0.01989	vis	O-C Gateway
48491.6460	1991.7	-7744.0	-0.02884	vis	O-C Gateway
48507.7090	1991.8	-7725.0	-0.02372	vis	O-C Gateway
48535.6160	1991.9	-7692.0	-0.00672	vis	O-C Gateway
48546.5950	1991.9	-7679.0	-0.01470	vis	O-C Gateway
48820.4400	1992.6	-7355.0	0.00115	vis	O-C Gateway
48853.3960	1992.7	-7316.0	-0.00376	vis	O-C Gateway
48983.5410	1993.1	-7162.0	-0.01212	vis	O-C Gateway
49164.4000	1993.6	-6948.0	-0.01559	vis	O-C Gateway
49195.6680	1993.7	-6911.0	-0.01820	vis	O-C Gateway
49238.7720	1993.8	-6860.0	-0.01694	vis	O-C Gateway
49266.6650	1993.9	-6827.0	-0.01394	vis	O-C Gateway
49271.7350	1993.9	-6821.0	-0.01485	vis	O-C Gateway
49562.4500	1994.7	-6477.0	-0.03204	vis	O-C Gateway
49687.5530	1995.0	-6329.0	-0.01149	vis	O-C Gateway
49926.7130	1995.7	-6046.0	-0.02942	vis	O-C Gateway
49948.6950	1995.7	-6020.0	-0.02137	CCD	O-C Gateway
49953.7740	1995.7	-6014.0	-0.01328	vis	O-C Gateway
49958.8400	1995.8	-6008.0	-0.01819	pe	O-C Gateway
49965.5960	1995.8	-6000.0	-0.02340	pe	O-C Gateway
50226.7610	1996.5	-5691.0	-0.01028	pe	O-C Gateway
50266.4764	1996.6	-5644.0	-0.01701	CCD	O-C Gateway
50308.7380	1996.7	-5594.0	-0.01299	vis	O-C Gateway
50325.6340	1996.8	-5574.0	-0.02002	CCD	O-C Gateway
50336.6320	1996.8	-5561.0	-0.00900	vis	O-C Gateway
50402.5540	1997.0	-5483.0	-0.00883	vis	O-C Gateway
50542.8470	1997.3	-5317.0	-0.01101	vis	O-C Gateway
50553.8430	1997.4	-5304.0	-0.00198	vis	O-C Gateway
50668.7750	1997.7	-5168.0	-0.01061	vis	O-C Gateway
50690.7400	1997.8	-5142.0	-0.01956	vis	O-C Gateway
50695.8200	1997.8	-5136.0	-0.01047	vis	O-C Gateway
50696.6600	1997.8	-5135.0	-0.01562	vis	O-C Gateway
50700.4609	1997.8	-5130.5	-0.01790	CCD	O-C Gateway
50703.4230	1997.8	-5127.0	-0.01383	CCD	O-C Gateway
50750.3193	1997.9	-5071.5	-0.02345	CCD	O-C Gateway
50753.2828	1997.9	-5068.0	-0.01798	CCD	O-C Gateway
50755.3856	1997.9	-5065.5	-0.02806	CCD	O-C Gateway
50772.3013	1998.0	-5045.5	-0.01540	CCD	O-C Gateway
50948.5166	1998.5	-4837.0	-0.01423	CCD	O-C Gateway
51007.6870	1998.6	-4767.0	-0.00445	vis	O-C Gateway
51033.4436	1998.7	-4736.5	-0.02497	CCD	O-C Gateway
51036.4121	1998.7	-4733.0	-0.01450	CCD	O-C Gateway
51040.6410	1998.7	-4728.0	-0.01136	vis	O-C Gateway
51083.7520	1998.8	-4677.0	-0.00310	vis	O-C Gateway
51133.6100	1999.0	-4618.0	-0.00905	vis	O-C Gateway
51325.4531	1999.5	-4391.0	-0.01539	CCD	O-C Gateway
51363.4866	1999.6	-4346.0	-0.01371	BV	Sipahi & Gülmen (2004)
51391.3746	1999.7	-4313.0	-0.01572	CCD	O-C Gateway
51393.4932	1999.7	-4310.5	-0.01000	CCD	O-C Gateway
51429.4095	1999.8	-4268.0	-0.01264	BV	Sipahi & Gülmen (2004)
51434.4798	1999.8	-4262.0	-0.01325	B	O-C Gateway
51443.3488	1999.8	-4251.5	-0.01835	CCD	O-C Gateway
51454.3437	1999.8	-4238.5	-0.01042	BV	Sipahi & Gülmen (2004)
51459.4121	1999.9	-4232.5	-0.01293	CCD	O-C Gateway
51468.2868	1999.9	-4222.0	-0.01232	CCD	O-C Gateway
51691.4093	2000.5	-3958.0	-0.00987	BV	Sipahi & Gülmen (2004)
51718.4518	2000.6	-3926.0	-0.01223	BV	Sipahi & Gülmen (2004)
51721.4147	2000.6	-3922.5	-0.00736	BV	Sipahi & Gülmen (2004)
51726.4804	2000.6	-3916.5	-0.01257	BV	Sipahi & Gülmen (2004)
51737.4680	2000.6	-3903.5	-0.01194	BV	Sipahi & Gülmen (2004)
51797.4700	2000.8	-3832.5	-0.01571	CCD	O-C Gateway
51816.4875	2000.8	-3810.0	-0.01412	CCD	O-C Gateway
51850.2932	2000.9	-3770.0	-0.01449	CCD	O-C Gateway
52411.4782	2002.5	-3106.0	-0.01022	-Ir	O-C Gateway
52427.5330	2002.5	-3087.0	-0.01330	V	O-C Gateway
52531.4839	2002.8	-2964.0	-0.01606	CCD	O-C Gateway
52576.2812	2002.9	-2911.0	-0.01180	CCD	O-C Gateway
52612.6234	2003.0	-2868.0	-0.01112	V	O-C Gateway
52613.0512	2003.0	-2867.5	-0.00590	V	O-C Gateway
52815.4619	2003.6	-2628.0	-0.00903	V	O-C Gateway
52832.3635	2003.6	-2608.0	-0.01047	pe	O-C Gateway
52840.3829	2003.6	-2598.5	-0.02001	-Ir	O-C Gateway
52859.4074	2003.7	-2576.0	-0.01142	pe	O-C Gateway
52864.4790	2003.7	-2570.0	-0.01073	CCD	O-C Gateway
52899.1337	2003.8	-2529.0	-0.00725	V	O-C Gateway
52951.5306	2003.9	-2467.0	-0.00976	CCD	O-C Gateway
52955.3517	2004.0	-2462.5	0.00816	CCD	O-C Gateway
53192.4000	2004.6	-2182.0	-0.00859	pe	O-C Gateway
53195.3598	2004.6	-2178.5	-0.00682	UBVR	O-C Gateway
53212.6832	2004.7	-2158.0	-0.00903	CCD	O-C Gateway
53225.3614	2004.7	-2143.0	-0.00811	pe	O-C Gateway
53267.6169	2004.8	-2093.0	-0.01019	CCD	O-C Gateway
53269.3084	2004.8	-2091.0	-0.00900	UBV	O-C Gateway
53289.5913	2004.9	-2067.0	-0.00974	CCD	O-C Gateway
53572.7160	2005.6	-1732.0	-0.01086	CCD	O-C Gateway
53585.3955	2005.7	-1717.0	-0.00863	UBVR	O-C Gateway
53593.4249	2005.7	-1707.5	-0.00817	UBVR	O-C Gateway
53601.4563	2005.7	-1698.0	-0.00571	-Ir	O-C Gateway
53639.4865	2005.8	-1653.0	-0.00734	-Ir	O-C Gateway
53891.3416	2006.5	-1355.0	-0.00745	uvby	O-C Gateway
53907.3985	2006.6	-1336.0	-0.00843	pe	O-C Gateway
53937.4060	2006.6	-1300.5	-0.00381	uvby	O-C Gateway
53978.3920	2006.8	-1252.0	-0.00767	BV	O-C Gateway
53984.3076	2006.8	-1245.0	-0.00813	CCD	O-C Gateway
53991.4921	2006.8	-1236.5	-0.00742	-Ir	O-C Gateway
54198.5565	2007.4	-991.5	-0.00519	BVRI	O-C Gateway
54270.8169	2007.6	-906.0	-0.00526	CCD	O-C Gateway
54282.2214	2007.6	-892.5	-0.01031	V	O-C Gateway
54313.4927	2007.7	-855.5	-0.00962	-Ir	O-C Gateway
54338.4286	2007.7	-826.0	-0.00570	V	O-C Gateway
54614.7946	2008.5	-499.0	-0.00430	CCD	O-C Gateway
54653.6721	2008.6	-453.0	-0.00378	CCD	O-C Gateway
54682.4095	2008.7	-419.0	-0.00156	BVR	O-C Gateway
54696.3480	2008.7	-402.5	-0.00804	B	O-C Gateway
54702.6904	2008.7	-395.0	-0.00428	CCD	O-C Gateway
54762.2706	2008.9	-324.5	-0.00727	BVR	O-C Gateway
55018.7782	2009.6	-21.0	-0.00321	CCD	O-C Gateway
55036.5296	2009.7	0.0	0.00000	BVR	O-C Gateway
55058.4980	2009.7	26.0	-0.00554	pe	O-C Gateway
55058.9206	2009.7	26.5	-0.00552	pe	O-C Gateway
55059.3432	2009.7	27.0	-0.00550	pe	O-C Gateway
55059.7658	2009.7	27.5	-0.00547	pe	O-C Gateway
55060.1884	2009.7	28.0	-0.00545	pe	O-C Gateway
55060.6109	2009.7	28.5	-0.00552	pe	O-C Gateway
55061.0335	2009.7	29.0	-0.00550	pe	O-C Gateway
55061.4561	2009.7	29.5	-0.00548	pe	O-C Gateway
55061.8787	2009.7	30.0	-0.00545	pe	O-C Gateway
55062.3012	2009.7	30.5	-0.00553	pe	O-C Gateway
55062.7238	2009.7	31.0	-0.00550	pe	O-C Gateway
55063.1464	2009.7	31.5	-0.00548	pe	O-C Gateway
55063.5690	2009.7	32.0	-0.00545	pe	O-C Gateway
55075.4040	2009.8	46.0	-0.00258	-Ir	O-C Gateway
55096.5329	2009.8	71.0	-0.00247	-Ir	O-C Gateway
55362.7581	2010.5	386.0	-0.00006	V	O-C Gateway
55379.6589	2010.6	406.0	-0.00229	CCD	O-C Gateway
55386.4356	2010.6	414.0	0.01320	BVR	Sipahi (2012)
55397.4081	2010.6	427.0	-0.00128	-Ir	O-C Gateway
55419.3832	2010.7	453.0	-0.00012	BV	Sipahi (2012)
55461.6389	2010.8	503.0	-0.00201	V	O-C Gateway
55465.0120	2010.8	507.0	-0.00951	V	O-C Gateway
55691.5220	2011.4	775.0	-0.00017	V	Sipahi (2012)
55801.3912	2011.7	905.0	-0.00069	-Ir	O-C Gateway
56147.0599	2012.7	1314.0	0.00097	V	O-C Gateway
56158.4718	2012.7	1327.5	0.00332	-I	O-C Gateway
56186.3665	2012.8	1360.5	0.00801	-I	O-C Gateway
56483.4310	2013.6	1712.0	0.00169	-I	O-C Gateway
56487.6559	2013.6	1717.0	0.00083	V	O-C Gateway
56494.4181	2013.6	1725.0	0.00182	-I	O-C Gateway
56496.5367	2013.7	1727.5	0.00754	-I	O-C Gateway

Table 3. Continue

HJD (+24 00000)	Year	Cycle	(O-C)	Method	References
56535.4043	2013.8	1773.5	-0.00184	-I	O-C Gateway
56810.5034	2014.5	2099.0	0.00038	-I	O-C Gateway
56924.5950	2014.8	2234.0	-0.00350	vis	O-C Gateway
56924.5997	2014.8	2234.0	0.00120	V	O-C Gateway
57198.4295	2015.6	2558.0	0.00185	-I	O-C Gateway
57201.8101	2015.6	2562.0	0.00184	V	O-C Gateway
57206.4575	2015.6	2567.5	0.00095	Clear	O-C Gateway
57214.4880	2015.6	2577.0	0.00247	-I	O-C Gateway
57219.5606	2015.6	2583.0	0.00416	-I	O-C Gateway
57225.4742	2015.6	2590.0	0.00170	-I	O-C Gateway
57260.5559	2015.7	2631.5	0.00960	-Ir	O-C Gateway
57267.7314	2015.8	2640.0	0.00131	V	O-C Gateway
57574.5243	2016.6	3003.0	0.00414	-I	O-C Gateway
57657.3476	2016.8	3101.0	0.00254	Clear	O-C Gateway
57924.4177	2017.6	3417.0	0.00474	-Ir	O-C Gateway
57926.5294	2017.6	3419.5	0.00356	-Ir	O-C Gateway
57995.4110	2017.8	3501.0	0.00530	CCD	O-C Gateway
58265.8611	2018.5	3821.0	0.00685	V	O-C Gateway
58306.4286	2018.6	3869.0	0.00711	R	O-C Gateway
58327.5577	2018.7	3894.0	0.00738	-Ir	O-C Gateway
58344.4606	2018.7	3914.0	0.00722	BVRI	O-C Gateway
58414.6086	2018.9	3997.0	0.00766	V	O-C Gateway
58749.2881	2019.8	4393.0	0.00711	V	O-C Gateway
58749.2884	2019.8	4393.0	0.00733	V	O-C Gateway
58749.2884	2019.8	4393.0	0.00737	V	O-C Gateway
59035.7977	2020.6	4732.0	0.01026	V	O-C Gateway
59083.1224	2020.7	4788.0	0.00646	V	O-C Gateway
59337.5131	2021.4	5089.0	0.00647	V	O-C Gateway
59337.5148	2021.4	5089.0	0.00815	V	O-C Gateway
59381.4637	2021.5	5141.0	0.00921	-Ir	O-C Gateway
59770.2357(3)	2022.6	5601.0	0.01140		*TESS*
59770.6608(10)	2022.6	5601.5	0.01399		*TESS*
59771.0807(2)	2022.6	5602.0	0.01125		*TESS*
59771.5033(6)	2022.6	5602.5	0.01130		*TESS*
59771.9257(2)	2022.6	5603.0	0.01113		*TESS*
59772.3482(4)	2022.6	5603.5	0.01101		*TESS*
59772.7705(2)	2022.6	5604.0	0.01076		*TESS*
59773.1928(6)	2022.6	5604.5	0.01046		*TESS*
59773.6174(3)	2022.6	5605.0	0.01247		*TESS*
59774.0410(9)	2022.6	5605.5	0.01352		*TESS*
59774.4619(2)	2022.6	5606.0	0.01188		*TESS*
59774.8823(8)	2022.6	5606.5	0.00967		*TESS*
59775.3012(21)	2022.6	5607.0	0.00603		*TESS*
59775.7303(10)	2022.6	5607.5	0.01259		*TESS*
59776.1535(15)	2022.6	5608.0	0.01313		*TESS*
59776.5744(3)	2022.6	5608.5	0.01151		*TESS*
59779.5318(2)	2022.6	5612.0	0.01083		*TESS*
59779.9543(4)	2022.6	5612.5	0.01083		*TESS*
59780.3776(2)	2022.6	5613.0	0.01152		*TESS*
59780.8015(7)	2022.6	5613.5	0.01286		*TESS*
59781.2233(3)	2022.6	5614.0	0.01206		*TESS*
59781.6430(12)	2022.6	5614.5	0.00919		*TESS*
59782.0673(3)	2022.6	5615.0	0.01087		*TESS*
59783.7602(9)	2022.6	5617.0	0.01348		*TESS*
59784.1754(7)	2022.6	5617.5	0.00613		*TESS*
59784.6029(4)	2022.6	5618.0	0.01105		*TESS*
59785.0251(2)	2022.6	5618.5	0.01072		*TESS*
59785.4475	2022.7	5619.0	0.01054	V	O-C Gateway
59785.4519(16)	2022.6	5619.0	0.01486		*TESS*
59785.8711(3)	2022.7	5619.5	0.01151		*TESS*
59786.2934(2)	2022.7	5620.0	0.01128		*TESS*
59786.7153(10)	2022.7	5620.5	0.01061		*TESS*
59787.1391(3)	2022.7	5621.0	0.01183		*TESS*
59787.5603(6)	2022.7	5621.5	0.01047		*TESS*
59787.9834(2)	2022.7	5622.0	0.01090		*TESS*
59788.4073(10)	2022.7	5622.5	0.01225		*TESS*
59788.8293(3)	2022.7	5623.0	0.01165		*TESS*
59789.2493(8)	2022.7	5623.5	0.00916		*TESS*
59789.6756(3)	2022.7	5624.0	0.01284		*TESS*
59790.0968(1)	2022.7	5624.5	0.01147		*TESS*
59790.5193(17)	2022.7	5625.0	0.01137		*TESS*
59792.2097(4)	2022.7	5627.0	0.01145		*TESS*
59792.6323(4)	2022.7	5627.5	0.01150		*TESS*
59793.0543(1)	2022.7	5628.0	0.01092		*TESS*
59793.4782(7)	2022.7	5628.5	0.01222		*TESS*
59793.8999(2)	2022.7	5629.0	0.01135		*TESS*
59794.3236(7)	2022.7	5629.5	0.01255		*TESS*
59794.7446(3)	2022.7	5630.0	0.01091		*TESS*
59795.1693(8)	2022.7	5630.5	0.01301		*TESS*
59795.5905(2)	2022.7	5631.0	0.01164		*TESS*
59796.0130(1)	2022.7	5631.5	0.01162		*TESS*
59812.4930	2022.7	5651.0	0.01114	V	O-C Gateway
59839.5376	2022.8	5683.0	0.01089	V	O-C Gateway
60195.3471	2023.8	6104.0	0.01153	B	O-C Gateway
60195.3472	2023.8	6104.0	0.01158	B	O-C Gateway
60195.3472	2023.8	6104.0	0.01166	B	O-C Gateway
60195.3475	2023.8	6104.0	0.01195	B	O-C Gateway
60536.3619	2024.7	6507.5	0.00763	B	O-C Gateway
60583.2694(2)	2024.8	6563.0	0.00919	V	In this study

The latest data obtained for the eclipsing binary KR Cyg indicate that there is no significant change in the light curves. Detailed analyses of the characteristics of the light curves of the system have been provided by Sipahi (2012). According to these authors, comparison of the radii of the components with their corresponding Roche lobes suggests that the KR Cyg system is near-contact but not in contact. By combining the results of light curve and radial velocity analyses, they determined the absolute physical parameters of the system. Both components are located on the main sequence of the Hertzsprung-Russell diagram. The systematic behaviour of the residuals between the observed and fitted light curves is attributed to the mutual heating effect of the components, particularly in the case of the cooler star in this near-contact system. Analyses indicate that the effective albedo and effective temperature of the irradiated star are significantly altered. The empirically derived albedo value is smaller than expected for a convective star. As the albedo decreases, the effective temperature increases.

Near-contact binary systems are of significant interest in astrophysics due to their role in understanding mass transfer, angular momentum evolution, and stellar mergers. Just like KR Cyg eclipsing binary system, V994 Her, RZ Dra, and CN And illustrate the diversity among NCB systems with a third component. In V994 Her eclipsing binary system, the presence of a tertiary component has been confirmed through spectroscopic analysis, revealing a hierarchical triple system (Zasche et al. 2023). The third body of the system influences the orbital evolution of the binary and contributes to its mass-transfer dynamics. Similarly, RZ Dra, a well-studied eclipsing binary, shows evidence of long-term orbital period variations, attributed to a distant third companion (Erdem et al. 2011). Meanwhile, CN And stands out due to its compact tertiary component, which significantly perturbs the inner binary's orbit, creating detectable eclipsing light curve variations (Cai et al. 2019). These systems provide critical insights into the dynamical stability of multi-star systems and the mechanisms driving their evolution. Observations of such binaries with a third component challenge existing models of stellar evolution, particularly regarding angular momentum redistribution and the eventual fate of such systems, which may evolve into contact binaries or merge into single stars.

From these investigations, we could draw out the following conclusions:

1. The orbital period variation of the system is caused by a third body. According to the results of the period variation analysis, the orbital period of the third body has been updated in ~71 years.

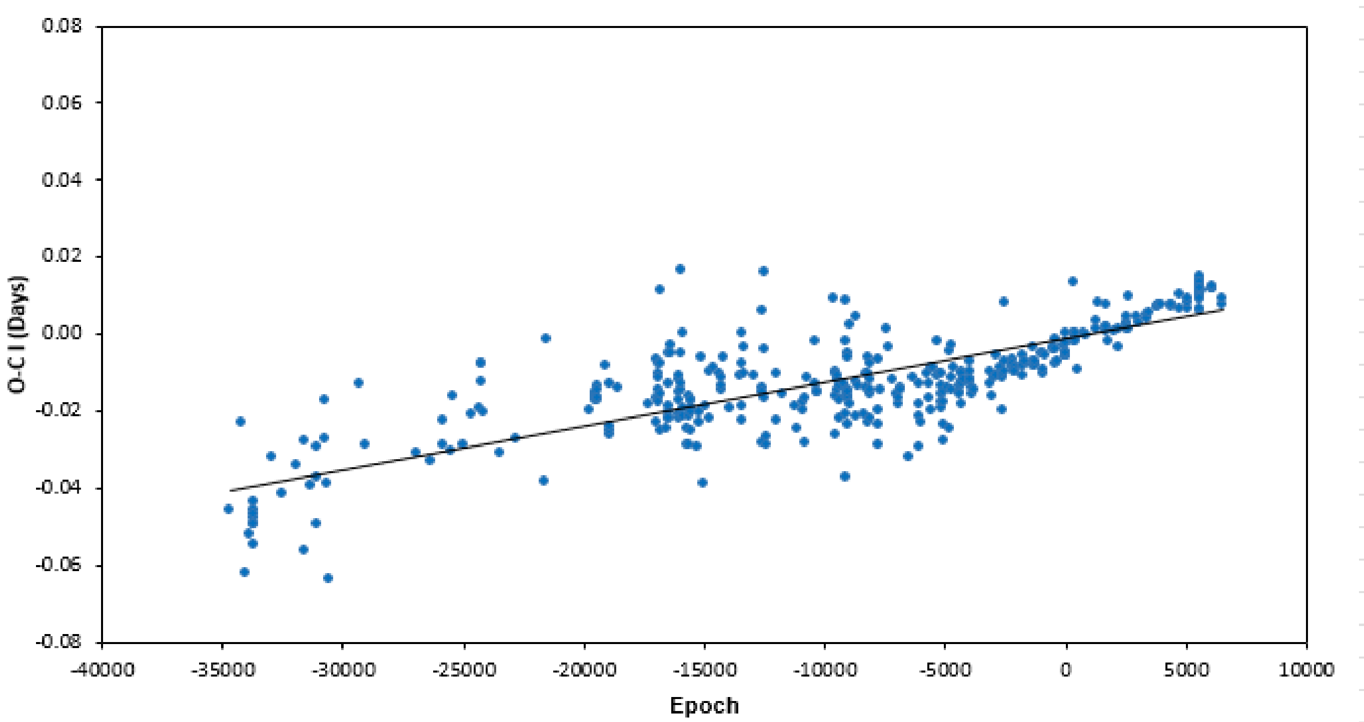

Figure 2. (O-C) diagram for KR Cyg.

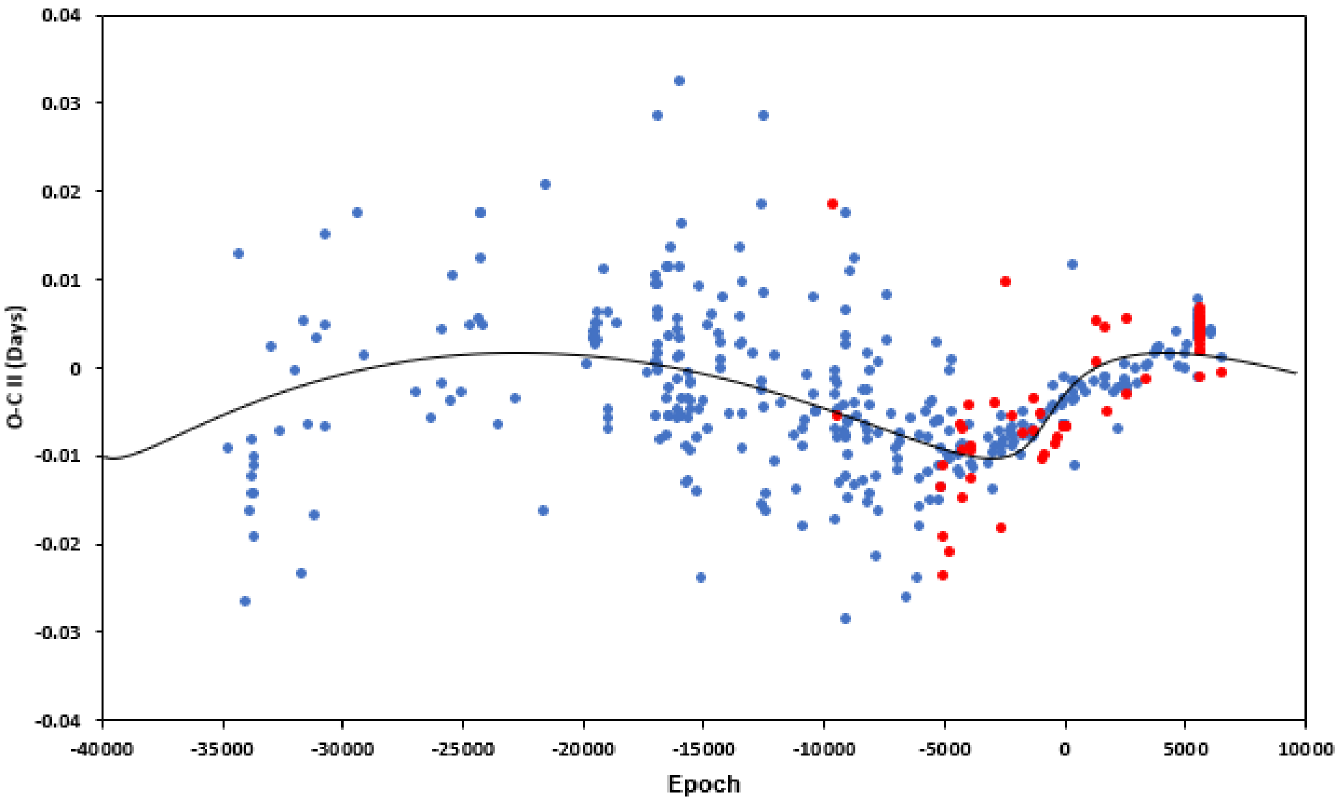

Figure 3. Residuals (O-C II) for KR Cyg. The filled blue and red circles represent the primary and secondary minima, respectively.

2. No significant changes have been observed in the light curves of the system over approximately 26 years of observations.

3. High-resolution spectroscopic observations are required to test the existence of the third body in the system.

4. Observations of minimum timings to be obtained in the coming years are crucial for determining the orbital parameters of the third body more precisely. Observations should continue.

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