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THE FIRST COMPLETE CCD LIGHT CURVES AND ORBITAL PERIOD CHANGE OF IK Per

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According to the 4th edition of the General Catalogue of Variable Stars (GCVS) (Kholopov et al., 1987), IK Per is a short-period eclipsing binary system with a period of $P = 0^{\rm d}.67603467$ and belongs to EB/KE type. Although some visual, photographic and photoelectric times of light minimum have been published, it was a neglected system for study. Up to now, no complete photoelectric and CCD light curves were obtained. For understanding the properties of light variation and studying the period change of the system, we choose it as our object to observe.

Observations of the eclipsing binary system IK Per in B and V bands were carried out on December 2, 3, and 4, 2002, with the PI1024 TKB CCD photometric system attached to the 1.0-meter Cassegrain reflector telescope at the Yunnan Observatory in P. R. China. The field of view of the CCD image at the Cassegrain focus is 6.5×6.5 square arc minutes. The B and V filters used approximate the standard Johnson UBV photometric system. During the observations, the integration time for each image was 120 seconds. A total of 273 images in V and 273 images in B were obtained. Image reductions were done by using IRAF packages. One of the CCD images is displayed in Figure 1.

Table 1: The coordinates of the variable, comparison star and check star

Stars	year	α	δ
Variable (star 1)	2000	04:29:27.46	42:03:10.7
Comparison (star 2)	2000	04:29:26.53	41:58:53.1
Check(star 3)	2000	04:29:02.4	42:01:12.4

The observations obtained in the three days are plotted in Figure 2, where the phases were calculated with a new period of $0^{\rm d}.67602324$ (Eq. 4). The light curves appear to exhibit a typical O'Connell effect, with Maximum I being 0.015 mag.(V) and 0.020 mag.(B) fainter than Maximum II. The light variation is continuous with a slightly large difference between the depths of the two minima. The secondary minimum is about 0.07 mag.(V) and 0.08 mag. (B) brighter than the primary minimum. With the observed data, one primary and two secondary times of light minimum are obtained by means of parabola fitting. The new determined times of light minimum and several recently published photoelectric minima times are given in Table 2.

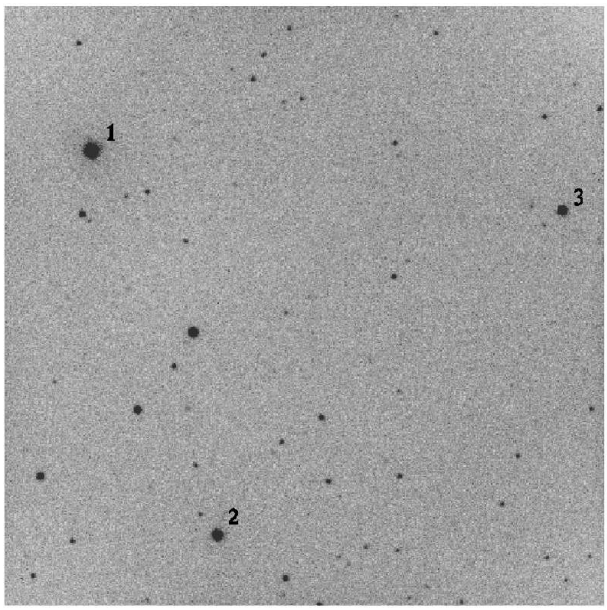

Figure 1. CCD image of IK Per, comparison and check stars.

The early times of light minimum for IK Per were compiled by Kreiner et al. (2000), which were kindly provided by Prof. Kim Chun-Hwey. The O–C curve calculated with the ephemeris given by Kreiner et al.,

$$\text{Min.I} = \text{HJD2427397.534} + 0^{\text{d}}.67603467 \times \text{E}, \quad (1)$$

is shown in Figure 3 where solid dots refer to photoelectric or CCD (PEC) observations, and open circles to visual or photographic (VP) data. As displayed in the figure, although O–C values of the VP observations show a slightly large scatter (up to $0^{\text{d}}.03$), the general O–C trend reveals that the period of IK Per is variable.

Since no data is available between E=17348.5 and 31962.5, the properties of the period change are not clear. By assuming a long-term period decrease, a weighted least-squares solution with weights 10 to PEC data and 1 to VP observations yields the following ephemeris,

$$\text{Min.I} = \text{HJD2427397.4934(51)} + 0^{\text{d}}.67604353(3) \times \text{E} - 2.48(1) \times 10^{-10} \times E^2. \quad (2)$$

With the quadratic term in the ephemeris, a secular period decrease rate of $\text{d}P/\text{d}t = -2.68 \times 10^{-7}$ days/year is derived. On the other hand, the period change may not vary continuously. With the data before E=17348.5, the linear ephemeris,

$$\text{Min.I} = \text{HJD2427397.5190(93)} + 0^{\text{d}}.67603280(108) \times \text{E}, \quad (3)$$

is determined by a least-squares solution. For the observations after E=17348.5, the ephemeris

$$\text{Min.I} = \text{HJD2427397.8995(149)} + 0^{\text{d}}.67602324(42) \times \text{E}, \quad (4)$$

is derived, which can be used to predict the epochs of light minimum. The $(O-C)'$ values of all the PEC times respect to this ephemeris are also listed in table 2. The two linear ephemeris reveal that a sudden period decrease, $\Delta P = 1.329 \times 10^{-5}$ days=1.15 s, might occur around E=28000. In order to check the period variation of the system, more times of light minimum are required.

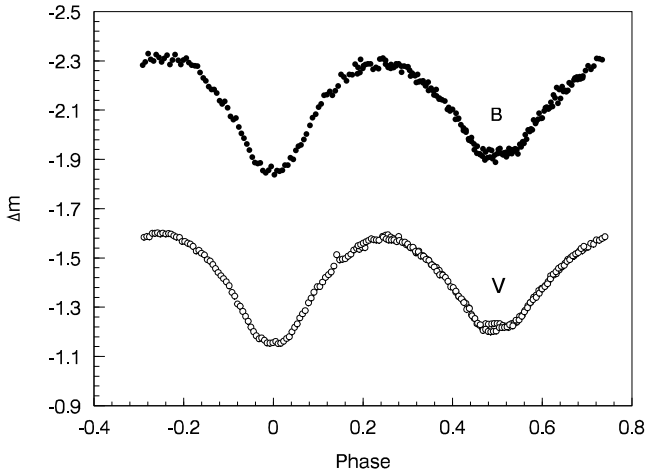

Figure 2. CCD light curves in V and B for IK Per, where the phases were calculated with the period ($p = 0\overset{d}{.}67602324$) given in the new linear ephemeris.

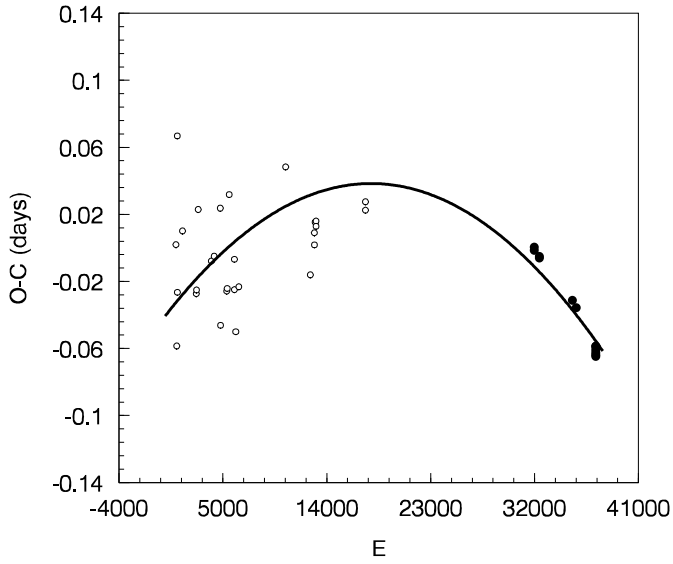

Figure 3. O-C plot in days for IK Per. Circles refers to the VP observations and solid dots to the PEC data. Also given in solid line is the quadratic fit.

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Table 2: CCD and photoelectric times of light minimum for IK Per.

JD (Hel.) +2400000	Error	Min.	Meth	Filter	E	$O-C$	$(O-C)'$	Ref.
49005.2917	±0.0015	II	pe	BV	31962.5	−0.0005	−0.0006	(1)
49310.5163	±0.0016	I	pe	BV	32414	−0.0056	−0.0005	(2)
51249.3580	±0.0012	I	pe		35282	−0.0312	+0.0065	(3)
51470.4169	±0.0070	I	pe		35609	−0.0357	+0.0058	(4)
52611.1995	±0.0009	II	CCD	BV	37296.5	−0.0616	−0.0008	(5)
52612.2164	±0.0004	I	CCD	BV	37298	−0.0587	+0.0021	(5)
52613.2250	±0.0007	II	CCD	BV	37299.5	−0.0642	−0.0033	(5)

References in Table 2: (1) Huebscher et al.(1993); (2) Huebscher et al. (1994); (3) Agerer & Huebscher (2000); (4) Agerer et al.(2001); (5) The present paper

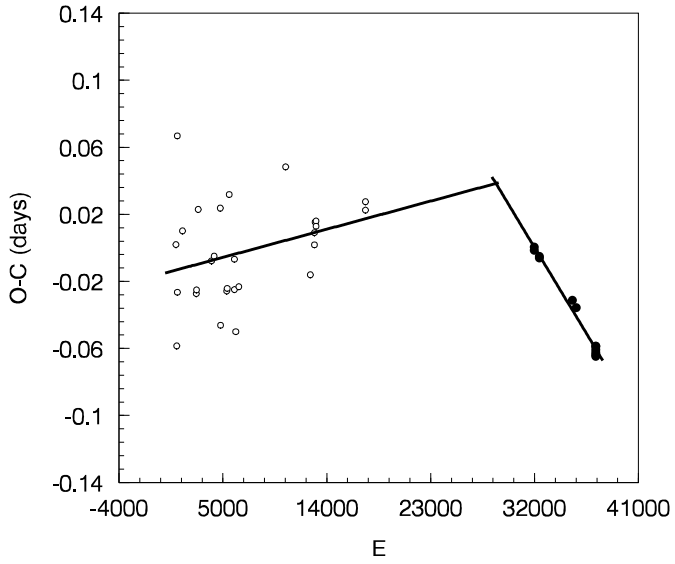

Figure 4. A possible sudden period decrease of IK Per occurred around E=28000. Symbols are the same as those in Figure 3.

References:

Agerer, F., Dahm, M., & Hubscher, J., 2001, *IBVS*, No. 5017

Agerer, F., & Hubscher, J., 2000, *IBVS*, No. 4912

Huebscher, J., et al., 1993, *B.A.V.Mitt.*, **No. 62**

Huebscher, J., et al., 1994, *B.A.V.Mitt.*, **No. 68**

Kholopov, P. N., et al., 1987, *The Fourth Edition of General Catalogue of Variable Stars*, Vol.III, Moscow, Nauka.

Kinnunen, T. & Skiff, B. A., 2000, *IBVS*, No. 4896

Kreiner, J. M., Kim, C.-H., and Nha, I.-S., 2000, *An Atlas of O–C Diagrams of Eclipsing Binary Stars*, Cracow, Poland: Wydawnictwo Naukowe Akademii Pedagogicznej, 2000.