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Period Changes in the Algol-type Eclipsing Binary System TYC 1744 2329 1

K.V. Sokolovsky[1,2], S.V. Antipin[1,3], S.A. Korotkiy[4]

[1] Sternberg Astronomical Institute, 13, University Ave., Moscow 119992, Russia

[2] Astro-Space Center, Lebedev Physical Institute, Russian Academy of Sciences, Profsoyuznaya str., 84/32, Moscow 117997, Russia

[3] Institute of Astronomy, Russian Academy of Sciences, 48, Pyatnitskaya str., Moscow 119017, Russia

[4] Ka-Dar Public Observatory, Barybino, Domodedovo District, Moscow Region, Russia

We present the discovery and the times of primary minima for the eclipsing binary TYC 1744 2329 1 = ASAS 003933+2730.5. Our CCD observations compared to times of minima derived from the archival photographic plates and from the NSVS and ASAS-3 data clearly show that the orbital period of the system is variable.

The eclipsing binary TYC 1744 2329 1 = USNO-A2.0 1125-00240848 = ASAS 003933+2730.5 ($\alpha = 0^{\rm h}39^{\rm m}33\overset{\rm s}{.}03$, $\delta = +27°30'29\overset{''}{.}3$ (J2000.0)) was discovered by one of the authors (K. Sokolovsky) on the plates of Moscow collection taken with the 40-cm astrograph in Crimea. The star was estimated by eye on 112 plates for the interval JD2436077–2447835. The phased light curve for the light elements

$$\mathrm{Min} = \mathrm{HJD}\,2446313.993 + 4\overset{\rm d}{.}40292 \times E$$

is given in Fig. 1. Later, the variable was independently discovered by ASAS-3 (Pojmanski, 2005). Comparison of our photographic observations to ASAS-3 and NSVS (Woźniak et al., 2004) times of minima led us to the conclusion that the $O - C$ behavior cannot be expressed in form of linear light elements (see the $O - C$ diagram in Fig. 2). To verify this inference, we undertook additional CCD observations.

Our first CCD photometry session was carried out in 2004 July at the 50-cm Maksutov telescope of the Crimean Laboratory (Sternberg Astronomical Institute) equipped with a Pictor 416XTE CCD camera with a Johnson V filter. The images were dark subtracted, flat-fielded and analyzed with the aperture photometry software *Winfits* developed by V.P. Goranskij, *MaxIm DL* and *VAST* (Sokolovsky & Lebedev, 2005). Unfortunately, both night-time minima during our observation set could be observed only partially (Fig. 3). We combined the two incomplete light curves taken on July 17 and 30 to determine a single epoch of the primary minimum.

In 2005 July, we could not observe this star in Crimea because of bad weather, so in 2005 October, we carried out one more set of observations of the variable with the instruments of the Ka-Dar Public Observatory located in the Moscow Region. The light minima were observed on October 10 (the 14″ MEADE LX200GPS Schmidt-Cassegrain Telescope and SBIG STL-6303 CCD camera with an IR-cut filter) and on October 31 (simultaneously at the 8″ MEADE LX200GPS Schmidt-Cassegrain Telescope equipped with an unfilterred SBIG ST-2000XM CCD camera and at the Vixen (D = 103 mm)

refractor with an unfiltered SBIG STL-6303 CCD). The corresponding light curves are shown in Fig. 4.

Table 1. Times of primary minima and $O-C$ residuals.

HJD 24...	Error, d	E_1	$(O-C)_1$, d	E_2	$(O-C)_2$, d	Source
45948.531	0.06	-1651	-0.0608	-1755	-0.3028	pg
46679.469	0.06	-1485	0.0173	-1589	-0.1997	pg
51403.6806	0.015	-412	0.0567	-516	0.0006	NSVS
52966.5451	0.06	-57	-0.0621	-161	-0.0650	ASAS-3
53217.5651	0.004	0	0	-104	0.0057	CCD, Crimea
53653.4149	0.004	99	-0.0244	-5	-0.0039	CCD, Moscow
53675.4319	0.004	104	-0.0213	0	0	CCD, Moscow

The times of minima derived from all available observations are listed in Table 1. The times of minima that were obtained not from continuous observations but are individual faint points on the phased light curve (as in the cases of photographic or ASAS-3 observations) should be considered to have an uncertainty slightly larger than half-duration of the total eclipse (2.4 hours). The $O-C$ residuals in the Table were calculated for the average light elements (linear elements for all available observations, which are not good because of the period changes):

$$\mathrm{Min} = \mathrm{HJD}\,2453217.5651 + 4\overset{\mathrm{d}}{.}40277 \times E \quad (1),$$

and for the current linear light elements (in excellent agreement with the NSVS, ASAS, and our CCD observations):

$$\mathrm{Min} = \mathrm{HJD}\,2453675.4319 + 4\overset{\mathrm{d}}{.}40262 \times E \quad (2).$$

The $O-C$ diagram shown in Fig. 2 is plotted for the averaged elements. The current linear elements are shown in Fig 2 as a solid line and the photographic elements, as a dashed line. The variations of the orbital period in the binary system are unquestionable. However, for the moment we are not ready to say anything about the real shape of the $O-C$ diagram (a sine curve or a broken line) or about the nature of the period changes.

The phased light curves for the NSVS and ASAS-3 observations plotted using the current light elements are given in Fig. 5.

Finally, note that the minima observed on October 9, 2005 and in July, 2004 show weak trends (decreases of brightness) during the total eclipse, while the data taken at the two Ka-Dar telescopes simultaneously on October 31, 2005 show the total eclipse to be nearly flat.

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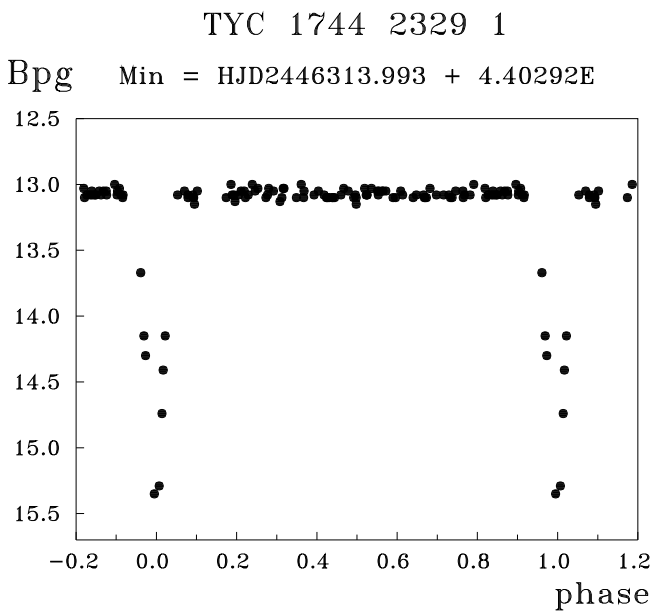

Figure 1. The photographic phased light curve.

References:

Pojmanski, G., Pilecki, B., Szczygiel, D., 2005, *AcA*, **55**, 275

Sokolovsky, K., Lebedev, A., 2005, in *12th Young Scientists' Conference on Astronomy and Space Physics*, Kyiv, Ukraine, April 19–23, 2005, eds.: Simon, A., Golovin, A., p.79 (VAST: `http://saistud.sai.msu.ru/poisk`)

Woźniak, P.R., Vestrand, W.T., Akerlof, C.W. et al., 2004, *Astron. J.*, **127**, 2436

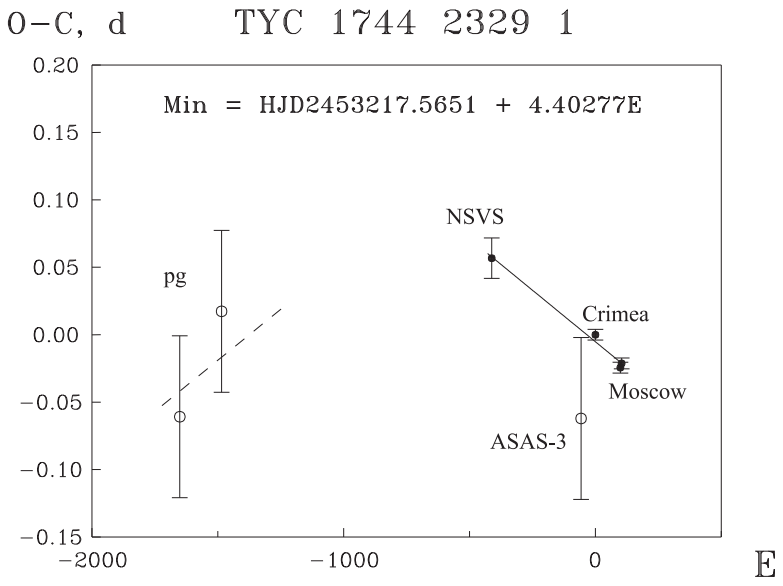

Figure 2. The $O-C$ diagram for the average linear light elements. The photographic light elements and the current ones are shown as dashed and solid lines respectively. The times of the faintest light (shown as open circles) were adopted as the times of primary minima for photographic and ASAS-3 observations.

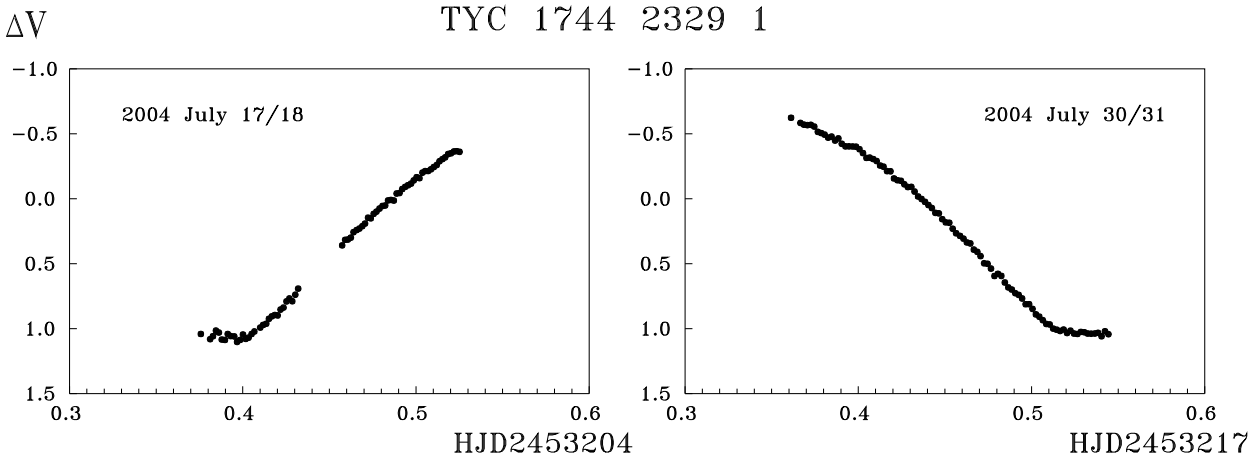

Figure 3. The two partially observed minima. Crimea, the 50-cm Maksutov telescope with a Pictor 416XTE CCD camera.

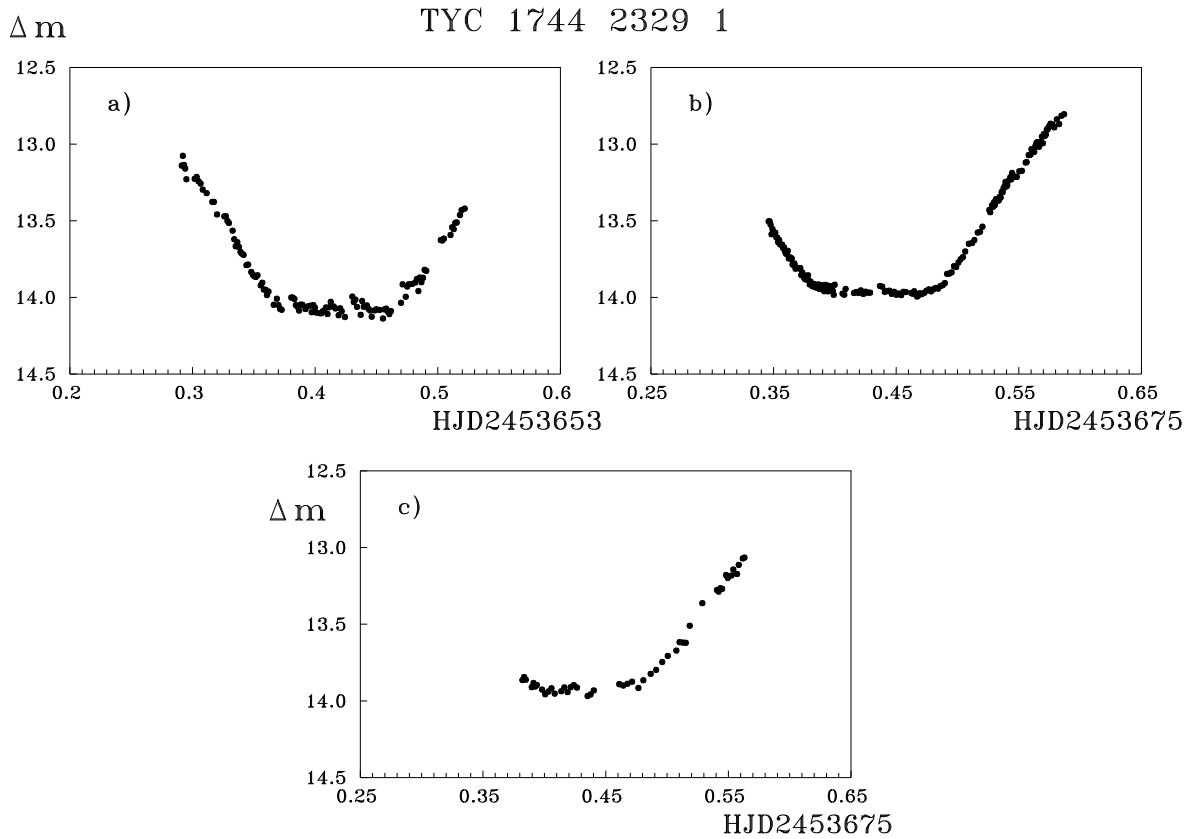

Figure 4. The two primary minima observed in 2005 at the telescopes of the Ka-Dar observatory, Moscow region. (a) October 10, the 14″ MEADE LX200GPS SCT and a SBIG STL-6303 CCD camera. (b) October 31, the 8″ MEADE LX200GPS SCT with a SBIG ST-2000XM CCD camera. (c) October 31, the Vixen (D = 103 mm) refractor with a SBIG STL-6303 CCD camera.

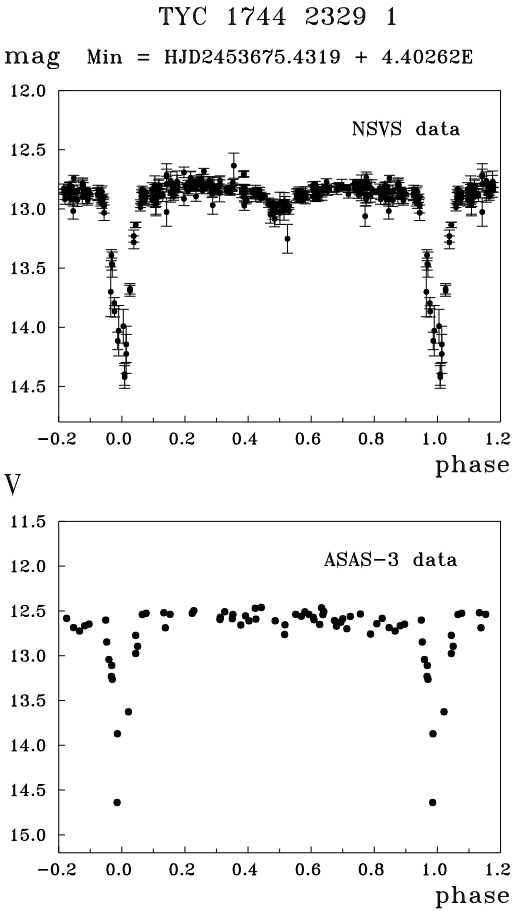

Figure 5. The NSVS and ASAS-3 phased light curve for the current linear light elements.