COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5930

Konkoly Observatory
Budapest
12 March 2010

HU ISSN 0374 – 0676

BVR$_C$I$_C$ PHOTOMETRIC EVOLUTION AND FLICKERING DURING THE 2010 OUTBURST OF THE RECURRENT NOVA U SCORPII

MUNARI, U.[1]; DALLAPORTA, S.[2]; CASTELLANI, F.[2]

[1] INAF Osservatorio Astronomico di Padova, Sede di Asiago, I-36032 Asiago (VI), Italy

[2] ANS Collaboration, c/o Astronomical Observatory, 36012 Asiago (VI), Italy

The 2010 outburst of the recurrent nova U Scorpii was discovered by B.G. Harris (New Smyrna Beach, FL, USA) on Jan. 28.4385 UT, when the star was measured at $V = 8.05$ (cf Schaefer, 2010). On Jan 27.63 UT, i.e. 0.80 days earlier, the nova was still at quiescence brightness ($V \geq 16.5$ mag, Linnolt, 2010).

This is the 10th recorded outburst of U Scorpii. Previous ones occurred on 1863, 1906, 1917, 1936, 1945, 1969, 1979, 1987 and 1999 according to the recent summary by Schaefer (2009). The last outburst has been the best observed one, with detailed reports being provided by Munari U. et al. (1999), Kiyota (1999), Lépine et al. (1999), Anupama and Dewangan (2000), Hachisu et al. (2000), Evans et al. (2001) and Iijima (2002).

We obtained accurate BVR_CI_C of U Sco with a 0.30-m Meade RCX-400 f/8 Schmidt-Cassegrain telescope equipped with a SBIG ST-9 CCD camera. The photometry was accurately corrected for color equations using nightly calibration on Landolt (1992) standard stars. The data are presented in Table 1, and plotted in Figure 1. The external errors (always less than 0.02 mag) do not exceed the dimension of the symbols in Figure 1.

In Figure 1 the time is counted from the discovery of U Sco in outburst on Jan. 28.4385 UT (t=0.00 days), that we assume as the time of actual maximum, there being no earlier observations of U Sco or reporting it brighter than V=8.05. The light curve in Figure 1 is characterized by a smooth decline, similar to that of previous outbursts (cf Munari et al. 1999; Kiyota 1999). The decline times (±0.1 days) are:

$$t_2^V = 1.8 \qquad t_3^V = 4.1 \text{ days} \tag{1}$$

that are significantly slower than t_2=1.2, t_3=2.6 days reported by Schaefer (2009) as typical values for previous outbursts, and instead much closer to the t_2=2.2, t_3=4.3 days derived by Munari et al. (1999) for the 1999 outburst. The light-curve in Figure 1 exhibits a plateau phase extending from day +12 to day +20, during which the mean colors are

$$< V >= 14.25 \quad < B-V >= +0.16 \quad < V-R_C >= +0.35 \quad < V-I_C >= +0.41 \tag{2}$$

This phase corresponds to the white dwarf still burning hydrogen in the envelope and the ejecta being transparent to soft X-rays. In fact, on day +12, Schlegel et al. (2010) found U Sco to have become a super-soft X-ray source with a brightness 100 time larger

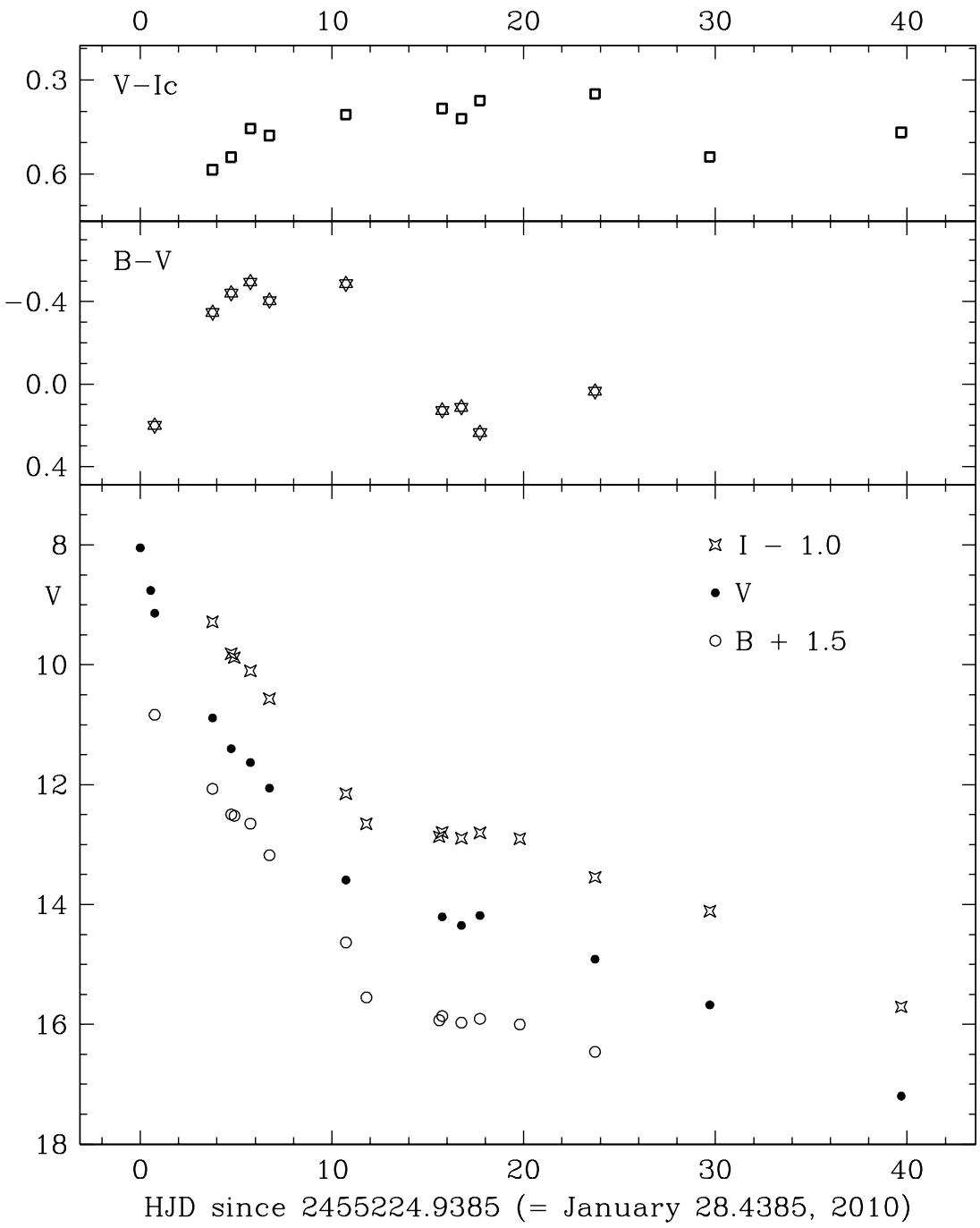

Figure 1. BVR_CI_C photometric evolution of the 2010 outburst of the recurrent nova U Scorpii according to our observations listed in Table 1. The point at t=0.0 days, V=8.05 is taken from IAUC 9111, that at t=0.54 days, V=8.76 from ATel 2412.

than a previous observation on day +8. Osborne et al. (2010) found U Sco still in super-soft conditions at day +17.5. A plateau was observed also during the 1999 outburst (Kiyota 1999, and Hachisu et al. 2000), but at a fainter mean magnitude ($< V >= 14.75$), lasting slightly longer (11 days) and starting appreciably later, on day +17.

With a 0.40-m f/8 Ritchey-Chrétien telescope located on Monte Baldo (Verona, Italy), and equipped with a Finger Lake Instruments ML1001E CCD camera, we carried out three runs in B and I_C filters looking for short time variations in U Sco. The results are presented in Figure 2.

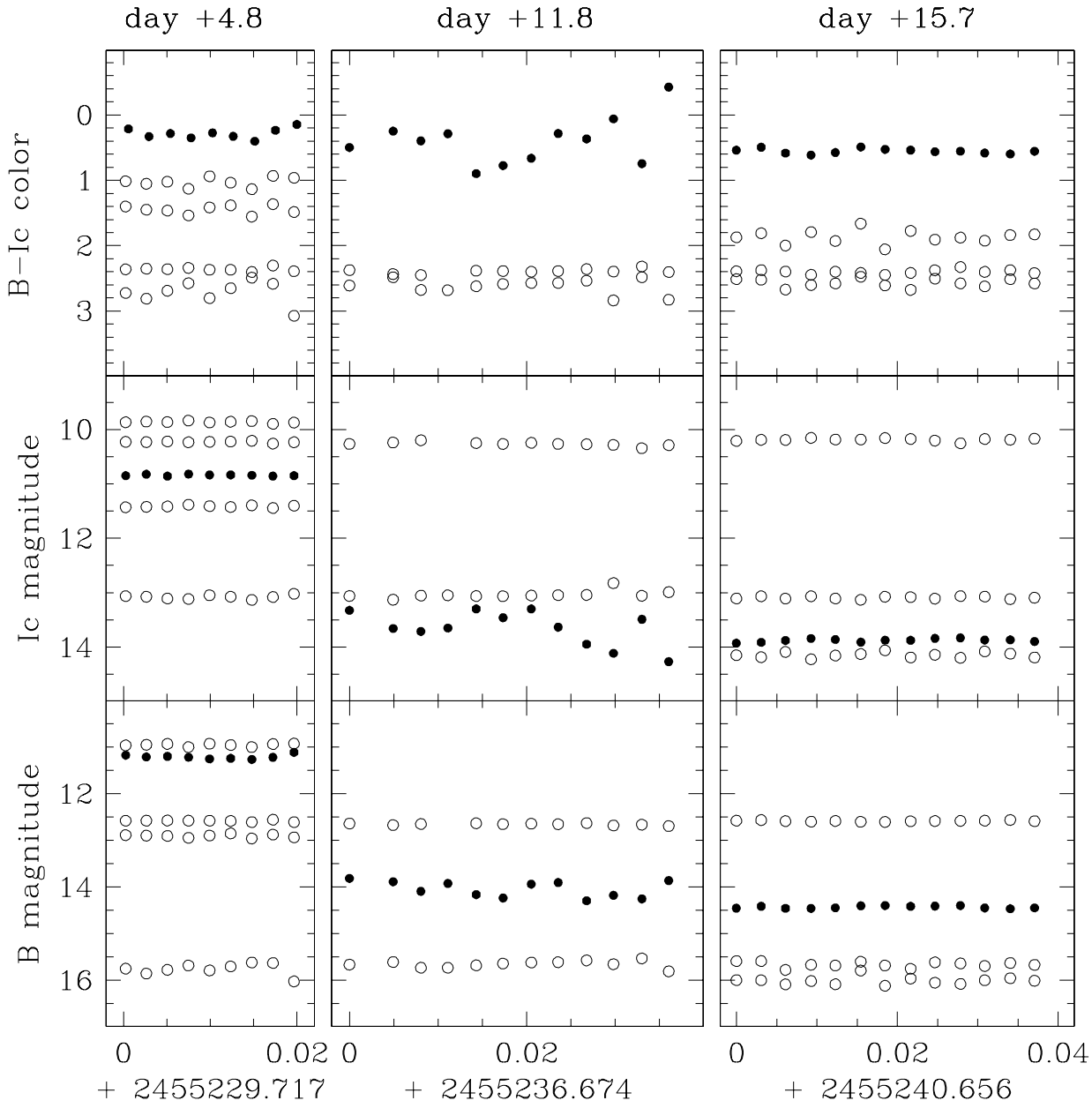

Figure 2. Results of searches for flickering carried out on days +4.8, +11.8 and +15.7 in the B and I_C bands. The dots represents measurements of U Sco, the circles those of nearby field stars to monitor photometric stability.

Table 1. Our $BVR_{\rm C}I_{\rm C}$ of U Scorpii

HJD	date HUT	V	$B-V$	$V-R_{\rm C}$	$V-I_{\rm C}$	$R_{\rm C}-I_{\rm C}$
225.6933	2010 01 29.19	9.140	0.201			
228.7090	2010 02 01.21	10.888	−0.347	0.831	0.586	−0.300
229.6861	2010 02 02.19	11.401	−0.441	0.751	0.546	−0.217
230.6817	2010 02 03.18	11.632	−0.495	0.582	0.455	−0.239
231.6799	2010 02 04.18	12.059	−0.405	0.572	0.477	−0.146
235.6682	2010 02 08.17	13.592	−0.487	0.365	0.410	0.022
240.6921	2010 02 13.19	14.207	0.128	0.347	0.391	0.038
241.6912	2010 02 14.19	14.349	0.113		0.423	
242.6575	2010 02 15.16	14.184	0.236	0.286	0.366	0.078
248.6599	2010 02 21.16	14.912	0.035	0.275	0.344	0.062
254.6492	2010 02 27.15	15.674		0.227	0.545	0.317
264.6344	2010 03 09.13	17.197			0.467	

No flickering was detected on day +4.8, while the short term variability was clearly present on day +11.8 (at the beginning of the plateau phase). Worters et al. (2010) reported that the flickering became visible on day +8, and they attributed it to an accretion disk that had already been re-established and was visible through optically thin ejecta. Our last observing run on day +15.7 (and additional three scattered points around day +19.8), at the center of the plateau phase, did not however show any short term variability, which cast doubts on the Worters et al. interpretation in terms of re-established accretion. The flickering we observed had a characteristic time scale of ∼half an hour, and a larger amplitude in $I_{\rm C}$ (Δm=1.0 mag) than in B band (Δm=0.5 mag).

References:

Anupama G. C., Dewangan G. C., 2000, *AJ*, **119**, 1359
Evans A., Krautter J., Vanzi L., Starrfield S., 2001, *A&A*, **378**, 132
Iijima T., 2002, *A&A*, **387**, 1013
Hachisu I., Kato M., Kato T., Matsumoto K., 2000, *ApJ*, **528**, L97
Kiyota S., 1999, *IBVS*, 4736, 1
Landolt, A.U., 1992, *AJ*, **104**, 340
Lépine S., Shara M. M., Livio M., Zurek D., 1999, *ApJ*, **522**, L121
Linnolt, M. 2010, *IAUC*, 9111
Munari U., Zwitter, T., Tomov, T. et al., 1999, *A&A*, **347**, L39
Osborne, J.P., Page, K.L., Wynn, W. et al., 2010, *ATel*, **2442**
Schaefer, B.E., 2009, arXiv:0912.4426
Schaefer, B.E., 2010, *IAUC*, **9111**
Schlegel, E.M., Schaefer, B.E., Pagnotta, A. et al., 2010, *ATel*, **2430**
Worters, H.L., Eyres, S.P.S., Rushton, M.T., 2010, *IAUC*, **9114**