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UBVRI PHOTOMETRY OF DX And: THE 2006 OUTBURST

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The dwarf nova DX And is one of the few cataclysmic variables with the orbital period length near the upper limit of the range (10.6 hours), together with an exceptional long cycle length (270-330 days), a secondary star probably evolved off the main sequence, and a very low mass–transfer rate (Šimon, 2000). For all these reasons, DX And can be considered representative of the upper limit of the distribution of dwarf novae, and a detailed study of its activity can help to constrain theoretical models. Nevertheless, only a few outbursts have been studied in detail, and rarely with multi–colors photometry (see Šimon 2000 for an overview of the scarce database available in literature).

In the contest of a long-term variability study of a sample of dwarf novae, we are monitoring DX And since 1994 and we have already obtained photometric data in the BVR_CI_C bands during two outbursts, in 1994 and 2005 (Spogli et al., 1998, 2006). In this brief paper we present the results of our observations done in 2006, that includes also the U broad band together with the usual BVR_CI_c Johnson-Cousins filters. These are the firsts U data during the rise and the maximum of the outburst, since we know only two other data reported in literature obtained during the descending phase (Echevarria, 1984). The telescope we used was a 0.30-m f/6.5 Schmidt-Cassegrain reflector, equipped with an AP-32ME CCD camera (Kodak 3200-ME, 2184×1470 pixels) and Schuler $UBVR_CI_C$ filters, located on Mt. Subasio, Assisi (PG), Italy. The exposure time was 120–600 s depending on the brightness of the object and the filter used. The frames were first corrected for bias and flat-field, and then processed by a PC-based aperture photometry package developed by one of the authors using DAOPHOT routines (Stetson, 1987).

All the data here reported were obtained in differential photometry using the photometric comparison sequence around DX And tabulated in Table 1. The $UBVR_CI_C$ magnitudes have been calibrated with CCD observations obtained in July-August 2006 during three different photometric nights with respect to a selected sample of standard stars (Landolt 1983, 1992). Color transformation equations were characterized by slopes always within the margins 0.9–1.1. The photometric stability of the comparison stars can be guaranteed for C1 and C2 because they have been checked by repeated observations since 1994 (Spogli et al., 1998), while for the other stars we can only say that they were stable during the four months reported in this paper.

DX And has been monitored from July 23 to November 15, for a total of 40 different nights (Table 2). During the minimum we used only the R_C broad-band, because we already knew that in quiescence the emission of DX And is dominated by the secondary

star (Spogli et al., 2006). Our data confirm that in this phase of activity the R_C magnitude oscillate between 14.4 and 14.6, probably ellipsoidal variations superimposed to additional variability, a typical pattern for long–period cataclysmic binaries (Hilditch, 1995). The precedent outburst occurred at the end of September 2005 (Spogli et al., 2006), so our aim was to observe the rise to the new outburst with the $UBVR_CI_C$ filters, and the outburst effectively went up at the middle of September 2006 (Fig. 1). We obtained data in all the photometric range during the rise up to the maximum, observed in the night of September 23. Unfortunately, soon after the outburst we were not able to use the U filter for technical problems, so we followed the decline with the BVR_CI_C bands.

Fig. 2 shows the spectral flux distribution of DX And during the rise. The magnitudes have been converted in $f(\lambda)$ using the flux calibrations reported by Bessell (2000). The increasing rate is more or less the same in all the filters, with the remarkable exception in the U, where the brightness continues to increase when in the other bands the maximum is already reached. This feature is quite common in outside–in outbursts, i.e. when the thermal instability (that gives rise to the outburst) starts in the outer part of the accretion disk and propagates inwards, producing an asymmetric light curve with a rapid rise and slow decay. The figure shows the progressive increase of the disk emission, theoretically represented - in a first approximation - as a power–law $f(\lambda) \propto \lambda^{-7/3}$, during the final steps of the outburst.

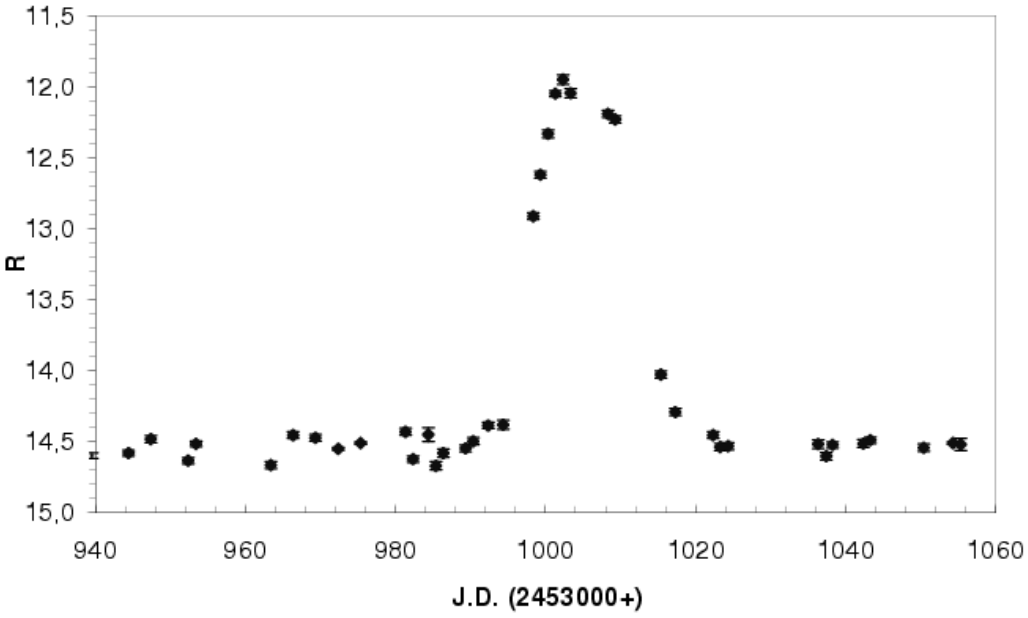

Figure 1. R_C light curve of DX And in July–October 2006. The maximum occurred in Sept.23

Table 1: Magnitudes and their errors for the stars in the photometric sequence.

Id	GSC id 03242-	RA (J2000)	DEC	U	B	V	R_C	I_C
C1	00510	23 29 42.7	+43 45 42	13.65±0.07	13.42±0.04	12.72±0.03	12.26±0.03	11.90±0.03
C2	00216	23 29 50.5	+43 44 49	13.98±0.07	13.90±0.04	13.33±0.03	12.95±0.03	12.64±0.03
C3	00856	23 30 01.2	+43 48 41	13.4±0.1	12.71±0.05	11.68±0.04	11.10±0.04	10.58±0.04
C4	00562	23 29 40.2	+43 50 04	13.2±0.1	12.21±0.05	11.03±0.04	10.36±0.04	9.84±0.04
C5	00990	23 29 24.5	+43 43 27	12.6±0.1	12.58±0.05	12.12±0.04	11.80±0.04	11.55±0.04

Table 2: $UBVR_CI_C$ magnitudes of DX And during the 2006 outburst

UT date	J.D. 2453000+	U	B	V	R_C	I_C
23/07/2006	939.534				14.60±0.02	
27/07/2006	944.401				14.58±0.02	
30/07/2006	947.378				14.48±0.03	
04/08/2006	952.359				14.63±0.02	
05/08/2006	953.391				14.52±0.02	
15/08/2006	963.369				14.67±0.03	
18/08/2006	966.354				14.45±0.02	
21/08/2006	969.335				14.47±0.02	
24/08/2006	972.353				14.55±0.01	
27/08/2006	975.329				14.51±0.01	
02/09/2006	981.325				14.43±0.02	
03/09/2006	982.327				14.62±0.02	
05/09/2006	984.352				14.45±0.05	
06/09/2006	985.375				14.67±0.03	
07/09/2006	986.343				14.58±0.03	
10/09/2006	989.316				14.55±0.02	
11/09/2006	990.335				14.50±0.02	
13/09/2006	992.342				14.39±0.02	
15/09/2006	994.345				14.38±0.03	
19/09/2006	998.371	12.70±0.10	13.31±0.03	13.12±0.03	12.91±0.02	12.80±0.06
20/09/2006	999.305	12.38±0.08	12.94±0.03	12.79±0.02	12.62±0.02	12.49±0.03
21/09/2006	1000.304	12.05±0.03	12.60±0.08	12.53±0.03	12.33±0.03	12.23±0.02
22/09/2006	1001.309	11.75±0.05	12.28±0.04	12.21±0.02	12.05±0.02	11.97±0.03
23/09/2006	1002.309	11.58±0.10	12.23±0.03	12.14±0.03	11.95±0.03	11.85±0.02
24/09/2006	1003.336		12.40±0.04	12.21±0.04	12.05±0.03	11.92±0.02
29/09/2006	1008.306		12.54±0.03	12.39±0.02	12.19±0.02	12.00±0.03
30/09/2006	1009.284		12.66±0.05	12.45±0.02	12.23±0.03	12.09±0.03
06/10/2006	1015.376		14.73±0.03	14.33±0.02	14.03±0.02	13.68±0.01
08/10/2006	1017.288		15.59±0.03	14.77±0.02	14.29±0.02	13.77±0.03
13/10/2006	1022.321				14.45±0.02	
14/10/2006	1023.278				14.54±0.02	
15/10/2006	1024.298				14.53±0.03	
27/10/2006	1036.305				14.52±0.03	
28/10/2006	1037.391				14.60±0.03	
29/10/2006	1038.227				14.52±0.02	
02/11/2006	1042.337				14.51±0.03	
03/11/2006	1043.267				14.49±0.02	
10/11/2006	1050.383				14.54±0.03	
14/11/2006	1054.302				14.51±0.01	
15/11/2006	1055.295				14.52±0.04	

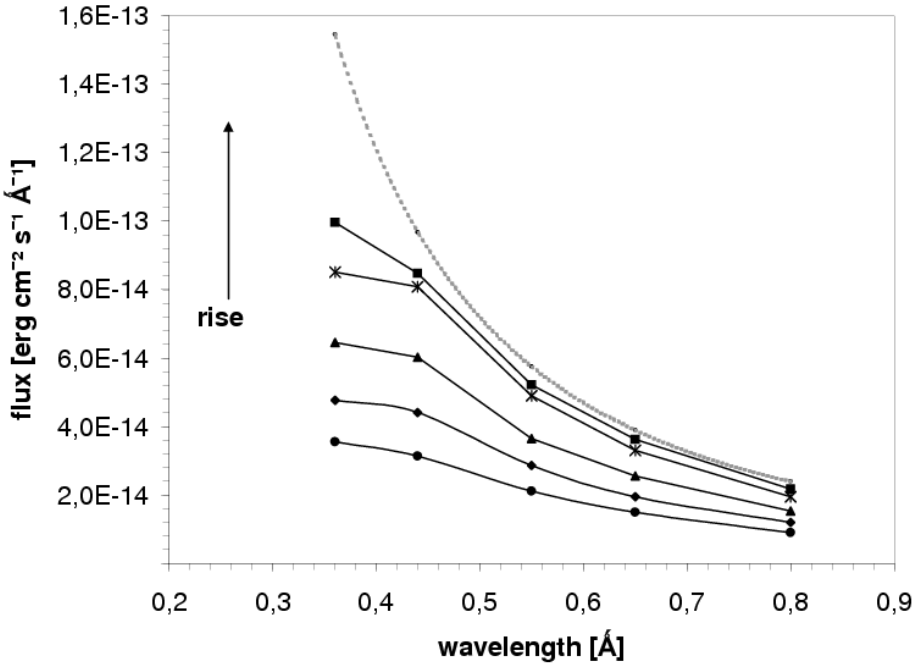

Figure 2. Spectral flux distribution of DX And during the rise to the outburst. The data have been obtained during the nights of September 19 (circle), 20 (diamond), 21 (triangle), 22 (cross) and 23 (box). The dotted line represents a generic power-law function $f(\lambda) \propto \lambda^{-7/3}$.

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