Mem. S.A.It. Vol. 80, 184

Memorie della

Photometric monitoring of dwarf novae

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Abstract. BVR_CI_C photometric observations of a large sample of dwarf novae were obtained since 1993. In this brief paper we resume the significant variations in the colour indices during the outburst–cycle, and the main results of our monitoring. The main conclusion is that we have yet a poor knowledge of the true radiative transfer solution in accretion disk, and more efforts must be made to obtain multi-wavelength observations.

Key words. Stars: dwarf novae

1. Introduction

Dwarf novae (DNe) are a subclass of cataclysmic variables consisting of a close binary star system in which a white dwarf accretes matter from its companion. They are characterised by recurrent outbursts in the optical light curve. The luminosity of the outburst increases with the recurrence interval as well as the orbital period, and typical amplitudes are in the range of 2-5 mag.

Since the behaviour of most DNe is unpredictable, it is very difficult for astronomers to monitor these variables systematically. During DN outburst, the rise is very rapid (typically less than a day), the maximum stands for 2-3 days, and the decline has a typical duration of 4-5 days (Szkody & Mattei 1984), but it can be as long as a month or more (Warner 1995). Therefore, for the observation of DNe during all the outburst cycle, we need a total availability of the telescope for a considerable amount of time. For this reason most of the optical observations of DNe were carried out by amateur astronomers through visual estimations or, recently, with small telescopes equipped with CCD cameras and filters. Multi-band monitoring is of special interest in order to extend the work done by amateurs, to study the spectral behaviour of the optical continuum, and to explore the physics of the accretion disk.

2. Observations and results

For the above–mentioned reasons we are monitoring since 1993 (Spogli et al. 1993) a large sample of DNe in the BVR_CI_C Johnson-Cousins photometric bands, with sporadic observations in the U band (Spogli et al. 2007). The photometric data were mainly obtained with the 0.72m Teramo Normale Telescope (TNT[1]) of the INAF Teramo Astronomical Observatory, and the 0.40m

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[1] http://www.oa-teramo.inaf.it

Table 1. Example of photometric parameters for a sample of DNe.

Name	outburst		quiescence	
	V	$V - I_C$	V	$V - I_C$
DX And	11.91	0.24	15.20	1.16
RX And	11.17	0.16	13.70	1.14
SY CnC	11.22	0.10	13.12	0.62
EM Cyg	12.20	0.58	13.82	1.16
V503 Cyg	13.67	0.11	17.71	0.54
V516 Cyg	13.96	0.19	17.42	1.01
AH Her	11.71	0.17	14.52	0.87
X Leo	12.28	0.21	16.02	1.11
CN Ori	12.51	0.23	15.31	0.98
CZ Ori	12.42	0.34	16.35	0.99
KT Per	12.54	0.38	15.61	1.40
FY Vul	13.94	0.43	14.62	0.56
VW Vul	13.71	0.27	15.77	0.75

Automatic Imaging Telescope (AIT[2]) of the Perugia University Observatory (Tosti et al. 1996). The instruments used and the photometric techniques have already been described in Spogli et al. (1998, 2000). We are also using the 0.35m Schmidt-Cassegrain telescope equipped with an HISIS 23 CCD camera (Kodak 401-E, 762 × 512 pixels), and the 0.30m Schmidt-Cassegrain telescope equipped with an AP-32ME CCD camera (Kodak 3200-ME, 2184 × 1470 pixels) of the Subasio Astronomical Station[3] (Capezzali et al. 2007). A comparison among the results obtained with the different telescopes shows no relevant systematic difference within the typical standard deviation of each instrument.

Table 1 shows a synthetic example of photometric parameters that we can collect during the monitoring. Following the outburst-cycle, we are able to see the variations in the colour indices and, consequently, in the spectral flux distribution. Moreover, intra–night and night–to–night observations give us important information at different time–scales. Therefore, simultaneous BVR_CI_C observations of dwarf novae at the INAF-Teramo Observatory, Perugia University Observatory and the Subasio Astronomical Station, allow us to obtain important constrains to the theoretical models of DNe emission.

For example, during quiescence the emission is dominated by the late–type secondary star and, therefore, it is possible to estimate its temperature from the BVR_CI_C data (Spogli et al. 2003). Periodograms and other statistical tools can be used to analyse intra–night data to study ellipsoidal variations (Spogli et al. 2006). During the outburst the emission is dominated by the accretion disk, and the multi-colour monitoring is useful to calculate the power law index α of the optical continuum spectral energy distribution – $F(\nu) \propto \nu^{\alpha}$. The theoretical slope is $\alpha = 0.33$ for a stationary infinitely large accretion disk whose surface elements radiate as a black body (Warner 1995). Our data confirm that, for several sources and in some phases of the outburst, the steady-state accretion disk models do not provide a good representation of the optical continuum (Spogli et al. 1998). This is a clear evidence about our poor knowledge of the true radiative transfer solution in accretion disk, and more efforts must be made to obtain multi-wavelength observations of DNe.

[2] http://astro.fisica.unipg.it

[3] http://www.astrosubasio.it

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