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Photometry and Spectroscopy of X Per During the Years 1996-1999

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Abstract.
UBVRI photoelectric monitoring of the Be star X Per, a transient X-ray binary, during the last four years, along with some optical spectra are presented and briefly discussed in the context of the long term behaviour of the system.

1. Introduction

The Be star X Persei = HD 24534 is the optical counterpart of a binary system together with a neutron star 4U0352+30 (Braes & Miley 1972; Van Den Bergh 1972; Brucato & Kristian 1972; Weisskopf et al. 1984) slowly rotating in 837 s (Nagase 1989). There is no obvious relation between the X-ray activity and the optical brightness. The light curve is complex presenting extended low states in which $V \sim 6.9$, interrupted by maxima remarkably varying in luminosity (up to V=6.0) and duration. The time scale of the long term variability is 300-500 days; but X Per often undergoes fast and irregular outburst or fading in few seconds or minutes. The problem of the orbital period is still open. The amplitude of the light variations depends on the wavelength: in IR (K band) it is larger than in the optical one; this fact is interpreted as due to the IR excess emitted by the equatorial envelope. Therefore *UBVRI* photometry could give significant information on the system.

2. Photometric and spectroscopic observations

X Per was observed photoelectrically with the *UBVRI* photon counting photometer with HAMAMATSU R943-02 PMT (Piccioni et al. 1992) mounted on the Cassegrain focus of the 62 cm ZEISS photometer of the University of Bologna in 41 nights since October 29, 1996 to March 24, 1999. Near the beginning and the end of this time interval the star showed two maxima of luminosity at JD 2450530 and 2451250, respectively (Fig. 1). In the U, R and I bands the two maxima are nearly equal, whereas in the B and V band the second maximum is brighter. The color indices show an unexpected result (Fig. 2): according to all of them but the $U-B$ the star is bluer when it is fainter; the $U-B$ instead reaches its most negative value (-0.9) at maximum, indicating that the star

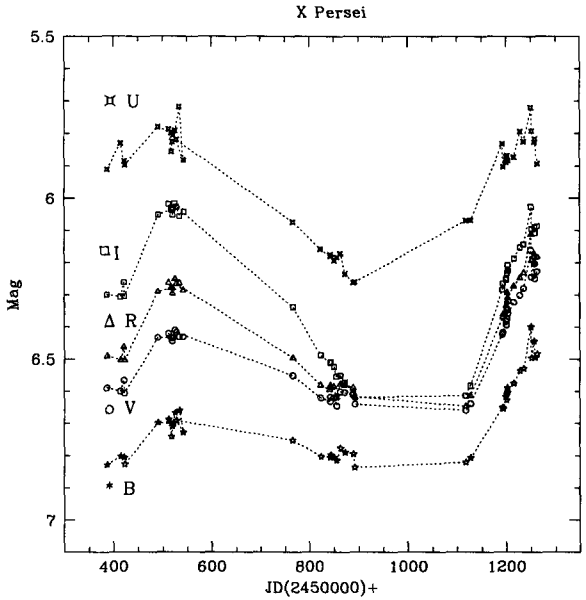

Figure 1. *UBVRI* photometrical light curve during the period 1996-1999.

at the maximum presents a strong emission of UV radiation. Besides luminosity variations X Per presents a spectral variability. We obtained some optical spectra in the period 1997-99 with the BFOSC spectrograph, mounted on the 152 cm telescope at Loiano. $H\alpha$, Hβ, He I 5876, 6678, 7065 were in emission during the whole period (Fig 3); however their equivalent width was decreasing (in absolute value).

3. Concluding remarks

As all Be stars, X Per presents light and spectral variations on many time scales. In Fig. 4 we prepared a synoptic picture of V light behaviour and Hα EW evolution during the last twenty years. The data were taken from the literature (Roche et al. 1993, 1997; Zamanov, 1995; Engin, 1997; Lyubimkov, 1997) updated by those presented in this work. A fairly good correlation between the overall trend of the luminosity of the system and the Hα EW can be noted, in agreement with the current models for circumstellar disks. However the latest data in the figure seem to contradict this behaviour (while the luminosity increases, the Hα emission is fading). Future observations should clarify this important point.

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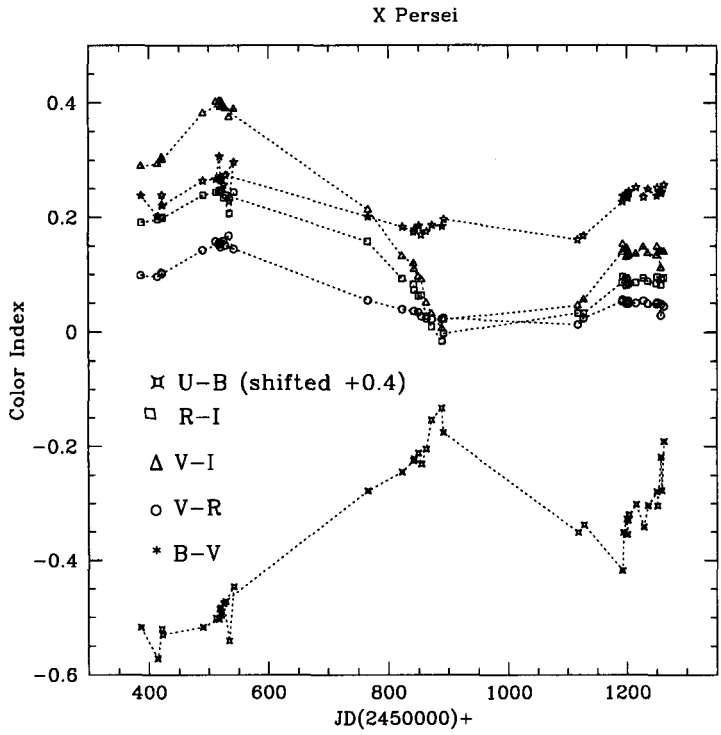

Figure 2. The colour index during the period 1996-1999.

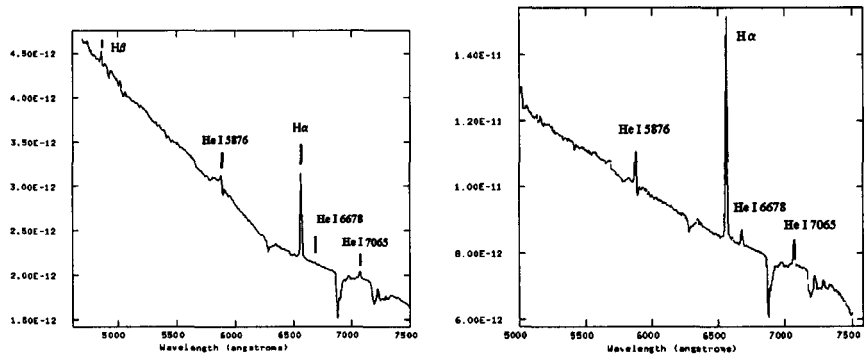

Figure 3. The spectra of X Per (13-12-97, left) showing Hα and He I line emissions (18-03-99, right). The intensities are in arbitrary scale.

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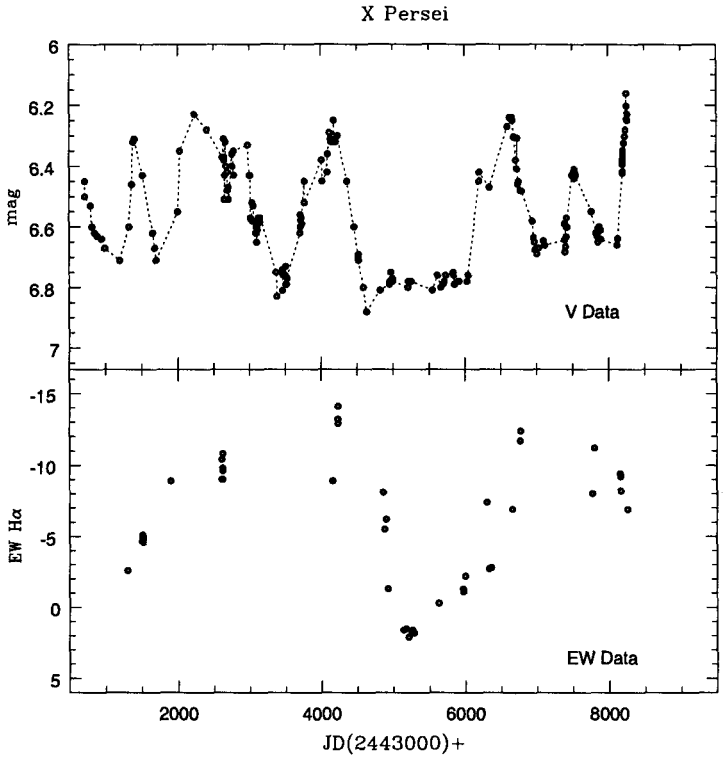

Figure 4. The V magnitude and the Hα equivalent widths variations during last twenty years.

References

Braes, L.L.E., Miley, G.K. 1972, Nature 235, 273.
Brucato, R.J., Kristian, J. 1972, ApJ 173, L105.
Engin, S. 1997, IBVS, 4454.
Kunjaya, C., Hirata, R. 1995, PASJ 47, 589.
Lyubimkov, L.S. et al. 1997, MNRAS 286, 549L.
Nagase, F. 1989, PASJ 41, 1.
Roche, P. et al 1993, A&A 270, 122.
Roche, P. et al 1997, A&A 322, 139.
Slettebak, A. 1982 ApJS 38, 205.
Tarasov, A.E., Roche, P. 1995, MNRAS 276, L19.
van den Bergh, S. 1972, Nature 235, 273.
Weisskopf, M.C., et al. 1984, ApJ 278,
Zamanov, P.K. 1995, IBVS 4189.

https://doi.org/10.1017/S0252921100056578 Published online by Cambridge University Press