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DOES V694 Mon ENTER AN INACTIVE PHASE?

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MWC 560 ≡V694 Mon is a very peculiar member of the symbiotic variables. The system consists of an M4.5 red giant and probably a magnetic white dwarf. The lack of evidence of orbital motion suggests a very low orbital inclination: the *face-on* orientation is quite probable. The same is suggested by the most intriguing feature of MWC 560 fast (1000–6000 km s^{-1}) and collimated jet along the line of sight, seen in the spectrum as a very broad and variable blue-shifted absorption of Balmer and singly ionized metal lines (Tomov et al. 1990, Shore et al. 1994). The star is supposed to be one of the prototypes of a possible new subclass of the symbiotic binaries, *propellers* (Mikołajewski et al. 1996). The luminosity of the hot component in these systems is partially derived from the stellar wind accretion and partially from the rotation of a white dwarf transferred into the accreted matter *via* the magnetic field (oblique rotator).

In this paper we present spectroscopic and photometric results for the last year. The spectra were obtained with the echelle spectrograph mounted on the 1.82m telescope of the Asiago Observatory. Photometric data were collected with the single channel UBVRI photometer mounted on 60 cm telescope at Toruń Centre for Astronomy (Poland) and UBV photometers at Belogradchik Observatory and Rozhen National Astronomical Observatory (Bulgaria), also attached to 60 cm reflectors.

In an earlier paper about MWC 560 (Mikołajewski et al. 1997) we presented the photometric behaviour of the star after its highest maximum in 1990, when it reached $B \approx 9\overset{m}{.}4$. Since then we have observed a systematic decrease until April 1997 when B dropped to about $12^{\rm m}$. During this period, brightness in UBVR bands varied in a very similar way. The changes of the I magnitudes were different and probably reflected variations of the red giant. In 1995 the system had a weak maximum that is consistent with $1930^{\rm d}$ orbital period (Doroshenko et al. 1993) and may correspond to the periastron passage. The spectra showed wide, variable rectangular-shaped, jet-origin blue-shifted absorption components during the whole 1990–97 period (see also Tomov & Kolev 1997).

The significant drop in brightness in April 1997 (Mikołajewski et al. 1997) appeared to be only a temporary change because at the beginning of 1997/98 observational season (from October 1997 to April 1998) MWC 560 was slightly brighter again. However, there is a substantial difference in the character of the light curve. The scatter of colours has

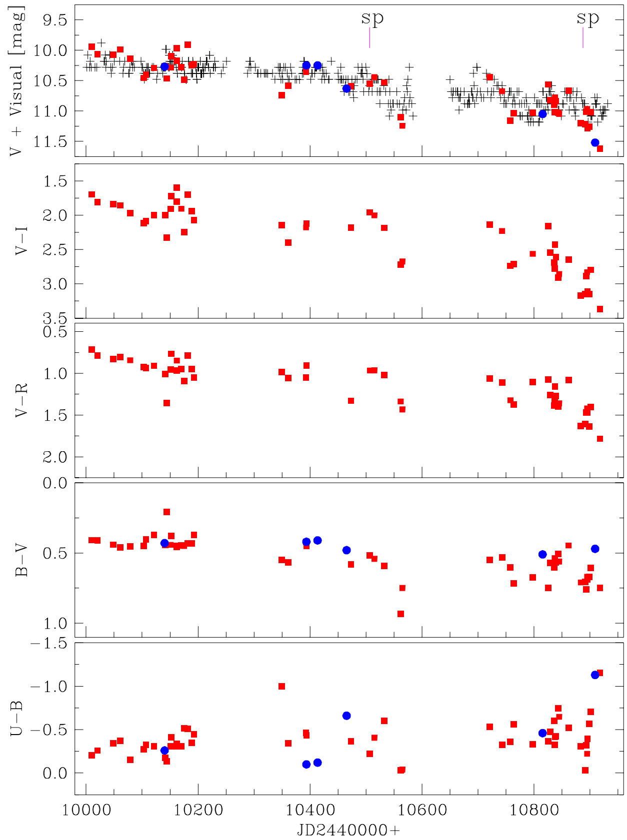

Figure 1. The colour light curves of MWC 560 during last three seasons (Oct 1995 – Apr 1998): Toruń UBVRI data (*filled squares*), Rozhen and Belogradchik UBV data (*filled circles*) and visual estimates by A.J. (*crosses*). The visual magnitudes are corrected by $-0\overset{m}{.}22$ as in Mikołajewski et al. (1997) and vertical lines mark the dates of spectroscopic observations shown in Fig. 3

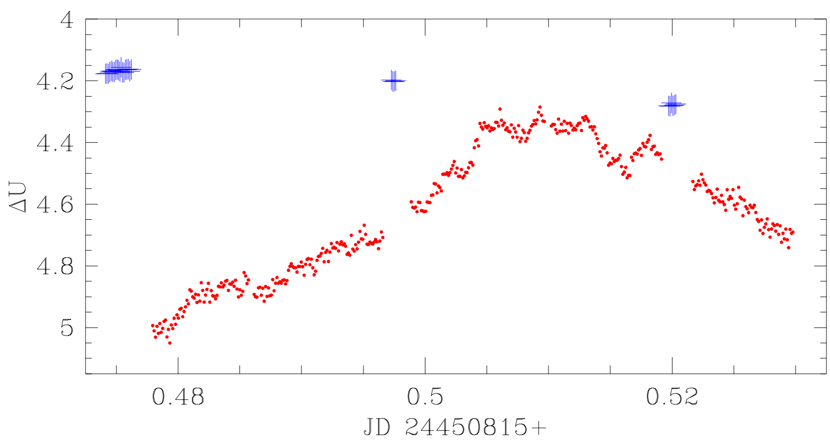

Figure 2. Flickering in U band on 1st January 1998. Crosses show the U magnitude of the comparison star (HD 59380) during the observation run shifted by a constant

significantly increased on a time scale of days to weeks (Fig. 1.) and more rapid decrease of the hot continuum, especially since January 1998, has been observed in BV bands. In April 1998 the V–R and V–I indices reached values typical for an M–type giant.

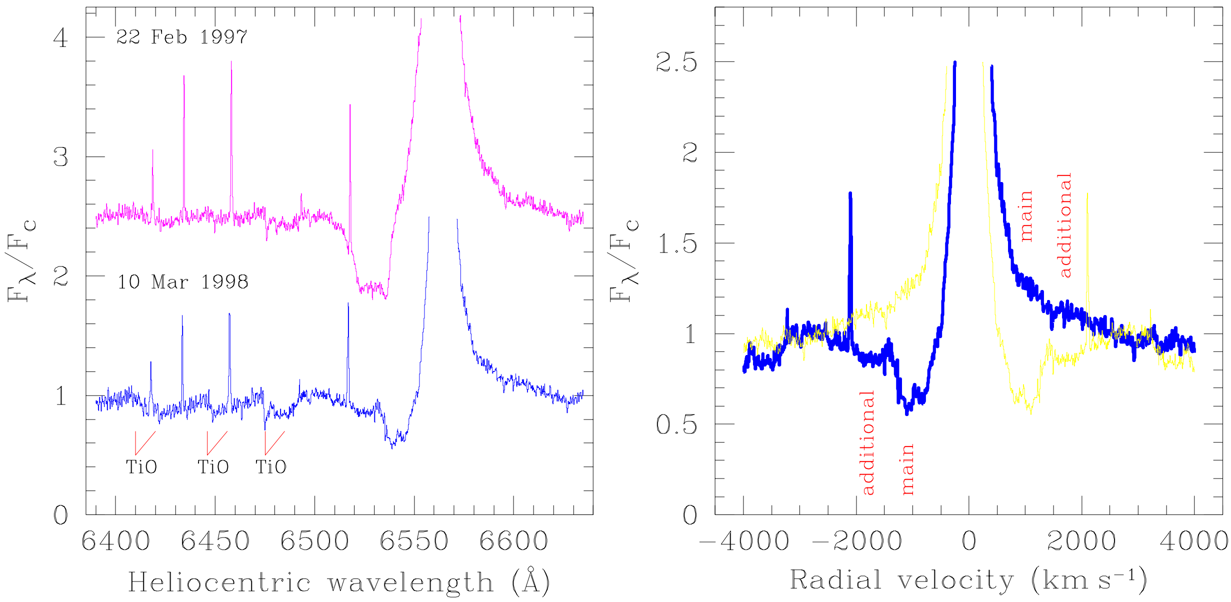

Figure 3. Left: the H_α spectral region. The H_α emission peaks are truncated and the February 1997 spectrum is shifted by 1.5 for plot clarity. Right: enlarged H_α profile of the 10 March 1998. For a better demonstration of the red-shifted jet a mirror profile with respect to central emission was plotted as a thin line

The decrease of brightness and large scatter of colour indices indicate that the pseudophotosphere around hot component has become optically thin and unstable. The A-B continuum is much weaker now or even completely absent. Probably only HII emission in the B band with a prominent Balmer jump in U are noticeable in March–April 1998. Flickering in the U band in January 1998 reached the largest amplitude ever observed, $0\overset{m}{.}7$ (Fig. 2.). From the analysis of the MWC 560 flickering given by Tomov et al. (1996, see their Fig. 6.) we conclude, that there is a possible correlation between the peak-to-valley amplitude of the MWC 560 U band flickering and the U brightness: when the star is fainter, the amplitude of flickering is greater. January results follow that rule. An amplitude of $0\overset{m}{.}7$ magnitude was observed when U brightness was about $11\overset{m}{.}1$. If this correlation is true, it means that the rapidly variable source of the flickering remains independent from the A–B pseudophotosphere brightness and varies with almost constant amplitude in flux units $\Delta F_u \approx 10^{-13}\, erg\, s^{-1}\, cm^{-2}\, \AA^{-1}$. The only visible source of the hot continuum now seems to be HII emission, so it would be identified with the flickering source.

All the photometric changes are confirmed by visual estimates made by A.J. in New Zealand with an outstanding time resolution. Only the last three photoelectric points lie $\sim 0\overset{m}{.}3$–$0\overset{m}{.}5$ below the visual light curve. We observed similar effect at the end of the previous season. The reason may be the very low position of the star above the horizon in Europe at this time, but independent UBV observations from Toruń and Belogradchik give similar results. Also, our spectral observations confirm that the significant fading of the veiling hot continuum in the optical and TiO bands of the M giant are stronger than before (Fig. 3. - left).

Generally, during 1997–98 MWC 560 was still ejecting matter in a quasi-stationary regime (see Tomov & Kolev 1997 for details). However, some changes are visible. In the last year's spectra the main blue-shifted rectangular absorption component was always visible. Occasionally an additional faster component appeared, but both were weaker than during the previous seven years (Fig. 3. - left). The typical velocity of the strongest absorption components was in the range from -1500 to $-1800\,\mathrm{km\,s^{-1}}$ till November 1997. At the end of 1997 the main absorption appeared slower (about $-1300\,\mathrm{km\,s^{-1}}$). In the spectrum from March 1998 the main, trapezoidal absorption of the H_α is significantly weaker and slower ($-1000\,\mathrm{km\,s^{-1}}$) than in 1997 and the shape of H_α looks like a P-Cyg profile. However, the emission and absorption are not physically connected. The emission probably arises close to the hot companion in a disk and/or envelope, while both absorptions originate in two separate jet-ejections. Additional faster ($\sim$2000 $\mathrm{km\,s^{-1}}$) absorption and emission (!) components are clearly visible. The red-shifted (+2000 $\mathrm{km\,s^{-1}}$) emission with the same shape and width as the blue-shifted absorption indicates the presence of a *counter*, receding jet (Fig. 3. - right). In the red wing of Hα, the emission equivalent of the main, trapezoidal absorption is probably also visible.

The photographic m_{pg} light curve from Sonneberg Sky Patrol plates which covered the period 1930–1990 (Luthardt, 1991) shows that MWC 560 spent most of that time varying between 12^{m} and 11^{m}. Only three times (1943–1954, 1958–61 and 1969–71) did the star drop to about $m_{pg} \approx 12\overset{\mathrm{m}}{.}5$ and remain relatively stable at this level for several years. This level seems to be the lowest m_{pg}/B brightness and probably indicates the non-active phase of the system, when the hot component remains inactive. Our data show that B brightness has fallen below 12^{m}, so we may expect a similar non-active phase that may last for a few years unless the behaviour of the star changes during its next possible periastron passage (in a year $\sim$ 2000). During such a quiescence phase we have a unique possibility to take a look at the close neighbourhood of a white dwarf, so additional optical, UV and X-ray observations are crucial.

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