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Possible pulsations of the M giant in MWC560

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Abstract. MWC 560 and other peculiar symbiotic binary, CH Cyg, have been classified as the prototypes of the new subclass of symbiotic systems—propellers with accretion onto a magnetic white dwarf being the source of activity (Mikołajewski, Mikołajewska & Tomov, 1996). The companion of the hot component in this model should demonstrate stellar wind with relatively high mass-loss $10^{-5}$ – $10^{-7} M_{\odot}$/year. It can be expected rather a late AGB, Mira or semiregular variable (SR) than any normal red giant. Our analysis performed for the $i$ band shows that the M giant probably belongs to such kind of stars and pulsates with a period of about 5 months.

Unfortunately, the nature of the M giant in MWC 560 is uncertain. No significant variability has been observed yet. The spectral classification from the optical is affected by the veiling blue continuum and gives probably to high, M3-4 spectral class (e.g. Allen, 1978). In the infrared the M giant spectrum seems to be free from the hot component, it is however affected by the dust emission. The spectral type estimations give rather a later M4-5 giant (Thakar & Wing, 1992). The mean values of the infrared indices $J - H = 1.00$ and $H - K = 0.33$ (Zhekov et al., 1996) also can indicate almost the latest spectral types between unreddened M6 and M5 with reasonable reddening $E_{B-V} = 0.25$. These estimations have been very good confirmed by spectral classification carried out using five TiO bands in the infrared (Mürset & Schmid, 1999). Their results were M5.5 and M6 obtained in two different dates.

We have observed MWC 560 during 1992—1999 for looking of the long-term variability with $UBVri$ filters. The observations were carried out with 60cm telescope at Toruń Observatory, equipped with the one-channel diaphragm photometer and unrefrigerated EMI 9558B photomultiplier. $UBV$ bands are very close to the standard Johnson system whereas our instrumental $ri$ band were significantly blueshifted until 6390Å and 7420Å mean (effective) wavelength respectively. Our $UBV$ observations were complemented by the large set of photometric data presented by Tomov, Kolev & Ivanov (1996) and references therein, and $ri$ data by few measurements presented by Feast (1990), Buckley et al. (1990), Wing & Landolt (1990).

We have carried out the Fourier analysis of all data using original Deeming (1975) and Lomb-Scargle (Lomb, 1976; Scargle, 1982) methods. Main trend in all $UBVr$ light curves shows two pronounced maxima around JD 2448000 in 1990 and JD 2450000 in 1995 and separated by about 2000 days. These maxima correspond to found by Doroshenko, Goanskij & Efimov (1993) 6-years period-
icity possibly reflected an orbital motion. The other year-scale variability has rather chaotic character. Availing of natural (every year) gaps in observations (caused by conjunction of MWC 560 with Sun) we have decided to remove the long-term trends in observations by means of the one-year (in fact one-season) averages. Only for very limited $RI$ data we used one average value calculated together for 1990 and 1990/91 observations. For other seasons were used our original $\Delta r$ and $\Delta i$ data in the instrumental system where HD 59380 was taken as the comparison star. The all obtained in such way residuals have been undergone the frequency analysis. The resulting power spectra are showed in Fig. 1.

During all period of observations (1990-99) the star varies in a very similar way in the $UBVr$ filter with amplitudes strongly decreased from $U$ to $r$. Also the periodograms (Fig. 1), especially for $B$ and $V$ light, are dominated be the presence of practically the same 7 components between 0.005 and 0.015 /day. Most of these frequencies can be identify in $U$ power spectrum, however they dramatically decrease or vanish in $r$. This behaviour indicates that the $UBVr$ brightnesses are dominated by the hot, active component which underwent any chaotic changes with time-scale of 6-2 months. Only the $i$ light curve and they power spectrum significantly differ from $UBVr$ light curves and their periodograms. It can be understand if the flux in our $i$ band is dominated mainly by the M giant.

Against to $UBVr$ the $i$ light power spectrum is dominated by one component around 0.062 /day. Its one-year aliases are also clearly visible (Fig. 1). This most pronounced peak corresponds to the period $P = 161.3$ days. It is very probably that there is the real periodicity belonging to the M giant in this system.

In Fig. 2 we present the mean $i$ light curve of MWC 560 binned with step of 0.1 phase of the 161.3 days period. Half-amplitude of this variability is about 0.08 mag i.e. on about 3 sigma level.

Another twin for MWC 560 symbiotic binary seems to be CH Cyg which has been discovered in 1924 and observed four decades as the semiregular (SR) M giant variable with pulsation period about 100 days Mikołajewski, Mikołajewska & Khudyakova (1990) and references therein. In the $V$ light this variations have average amplitude about 0.7 magnitude (Mikołajewski, Mikołajewska & Khudyakova, 1992). For the comparison to MWC we have found in our own observations of CH Cyg two periods JD 2448887-2449432 and JD 2449722-24450121 when pulsations were clearly visible in $i$ band. On the periodogram we have found the best period for this time: $P = 87.7$ days. The mean $i$ light curve of CH Cyg is shown in the right panel on Fig. 2. It is clear that both stars seem to pulsate in similar way. The lower amplitude in MWC 560 can be caused by additional veiling hot continuum. Such pulsations are characteristic for semiregular pulsating red giants similar to Miras but having significantly lesser amplitude (known as SRa stars in GCVS catalog). They are probably relatively young AGB stars with large mass loss.

It is very interesting that the same little shifted frequency-component also exists on all power spectra from $U$ to $r$ light. Moreover there is only one such component and its amplitude seems to be systematically decreasing from $U$ to $r$ (marked by arrow in Fig. 1). The $UBV$ fluxes in MWC 560 are dominated by a hot continuum which also significantly contributed in our instrumental blueshifted $r$ bands. It is possible that in 159 days periodicity in hot continuum
Figure 1. Power spectra of residuals of $UBVri$ observations of MWC 560. The most interesting component ($f_0$) around 0.0062 1/day is marked by an arrow and shown for $U$ and $i$ light together with the spectral window (dotted line) for the $UBV$ data and $ri$ data, respectively.
reflects variable accretion rate from the stellar wind modulated by the donor pulsations.

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