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NZ Ser: the results of the analysis of the 25 years photometric activity

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Abstract. We present the analysis of the long-term photometric variability of NZ Ser. The object shows both large-scale cyclic variability and low-amplitude Algol-like, fading typical for UX Ori stars. The variations of the stellar brightness are accompanied by variations of the B-V and V -R colors: when the brightness decreases, B-V decreases, while V-R increases.
Key words: young stars – photometry – circumstellar disk

1. Introduction

NZ Ser (MWC 297) belongs to the family of young, hot Herbig Be stars. It has a strong infrared excess (Pezzuto et al., 1997), providing evidence for the presence of a circumstellar (CS) gas-dust disk, and strong emission in its spectrum (Drew et al., 1997). According to the different sources the disk is viewed both almost along its equatorial plane (Drew et al., 1997) and nearly pole-on (Acke et al., 2008; Weigelt et al., 2011). These investigations mainly used the spectroscopic and spectro-interferometric methods. This makes an analysis of the photometric behavior of the star of interest. The reason is that one of the main mechanisms for the variability of Herbig Ae/Be stars is variable CS extinction, which depends sensitively on the inclination of the CS disk to the line of sight. If the star is observed near edge-on, we can expect the strong photometric activity similar to that observed in UX Ori stars (Grinin et al., 1991).

2. Peculiarities of the photometric activity of NZ Ser

For our analysis we used the long-term photometrical observations carried out by ourselves, and other authors (Mel'nikov, 1997; Pojmanski, 1997). The series of photometric observations of NZ Ser used in this article covers about 25 yr. We see from Figure 1 that the brightness of the star varies within a small range ($\Delta V \approx 0.4^m$), both during a single observing season and over longer time scales. The amplitude of the slow V-band variations is about 0.2^m. The detailed analysis of the light curves is described in the paper by Barsunova et al. (2013).

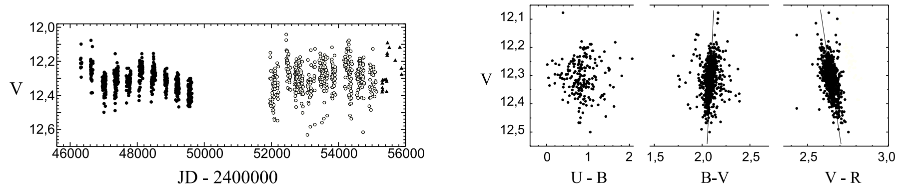

Figure 1. Left: the light curve of NZ Ser. The figure legend: filled circles by Mel'nikov (1997), open circles by Pojmanski (1997), triangles - our data. Right: the color-magnitude diagram for NZ Ser.

Analysis of the photometric series for NZ Ser from Mel'nikov (1997) for separate observing seasons showed that the light curve has features which are typical for both flared UV Ceti stars and UX Ori stars. As an example, Fig. 2 shows the light curves of NZ Ser for two different observing seasons. The algol-like minima with an amplitude of $\simeq 0.2^m$ lasting for several days are visible. A small-amplitude flare observed in the V and R bands at the end of 1990 observing season can also be seen (Fig. 2 right). It had a steep rise and shallower decline, and resembles (in terms of the shape of the light curve) the flares observed for flare stars (see, e.g., Gershberg, 1978).

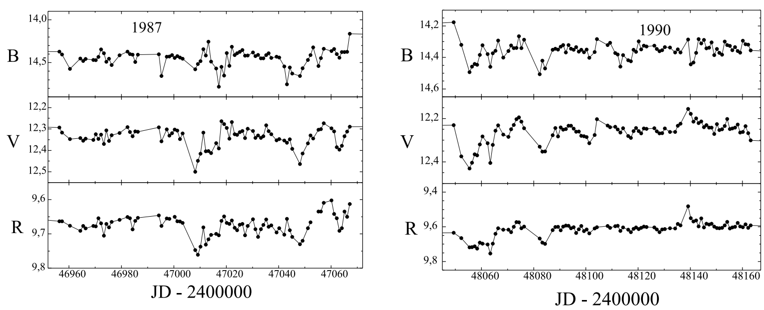

Figure 2. Fragments of the NZ Ser B, V and R light curves for two observing seasons: (left) 1987, (right) 1990.

Figure 1 shows color-magnitude diagrams for NZ Ser based on the data of Mel'nikov (1997). A weak effect is observed only in *(B-V)/V* and *(V-R)/V* diagrams and has a different character. Earlier the behavior of the *(B-V)/V* diagram was analyzed in the paper by de Wit et al. (2005). De Wit et al.

suggested that the variations of the visual brightness are due to fluctuations of the radiation flux of hot CS gas, not to variations of the CS extinction. They did not consider the *(B-V)/V* diagram. Given that a strong Hα line is located in the *R*-band in the spectrum of NZ Ser, this variation of *V -R* could be related to strengthening of the line emission of the star. However, this would imply that strengthening of line emission is accompanied by fading of the star's brightness. This is, in principle, possible and observed during the minima of UX Ori stars, and is explained by a coronagraphic effect caused by CS gas-dust clouds. However, in this case, the star's reddening itself may be explained by selective absorption by CS dust, but not by the enhanced input of the emission to the Hα line.

3. Conclusion

The low-amplitude photometric activity of NZ Ser and the absence of deep brightness minima are not typical for young stars with CS disks observed near to edge-on. Instead, it is typical for stars observed near to pole-on. The analysis of the color-magnitude diagrams of NZ Ser showed that the two mechanisms can be responsible for the star's brightness variations: the non-stationary processes in the CS gas and the variable CS extinction. On the other hand, under certain conditions, CS extinction may depend on the wavelength such that the color-indexes in different parts of the spectrum vary with the brightness changes in opposite directions (Grady et al., 1995). Therefore, the unusual behavior of the *B-V* and *V -R* colors of NZ Ser in color-magnitude diagrams requires additional investigation.

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