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Search for Pulsating Stars in the Open Cluster NGC 1502

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Abstract. We present results of a variability search in the field of the young open cluster NGC 1502. We confirm that a β Cephei suspect WEBDA 26 is indeed pulsating with a period of 0.09612 d and semi-amplitude of about 3 mmag in V. A new $VI_{\rm C}$ light curve of the bright eclipsing binary and cluster member SZ Cam was obtained. In addition, we found two new variable stars. One is an interesting eclipsing binary showing total eclipses, which can be used to derive the distance to the cluster once radial velocities of the components will be obtained.

1. Introduction

NGC 1502 is a very young open cluster in Camelopardalis which contains about 20 B-type stars. This cluster was subject of a few photometric and spectroscopic studies. The *uvby* photometry was published by Reimann & Pfau (1987), Tapia et al. (1991), Delgado et al. (1992) and Crawford (1994). The most extensive *UBV* data are available from Hoag et al. (1961), Purgathofer (1964) and Reimann & Pfau (1987). The MK spectral types are available for 9 stars.

2. Observations and Reductions

Observations of NGC 1502 were carried out in Białków Observatory, Wrocław University, during 21 nights between 2004 September 22 and 2005 April 2. We used the 60-cm Cassegrain reflector equipped with a CCD camera. A set of standard $VI_{\rm C}$ filters and a pair of filters, centered at the Hα line, narrow and wide, were used. To expand the magnitude range, the observations were obtained with short and long exposure times. We took 5700 V frames, 1670 $I_{\rm C}$ frames and additionally 250 and 125 through Hα wide and narrow filters. The observations were made in two overlapping fields and the whole observed field covered an area of $6' \times 6'$. All frames were calibrated in a way similar to described by Jerzykiewicz et al. (1996), and reduced using the DAOPHOT II package (Stetson 1987). Both point-spread-function and aperture magnitudes derived by means of the NEDA/DAOGROW routines (Stetson 1990), were analyzed.

The Hα photometry which we made, was used to find stars showing Hα emission. This was done by means of an α index, defined as the difference between the magnitudes of a star through a narrow and wide Hα filter. We calculated this index for a bright stars in the field (Fig. 1). Only one star, WEBDA 1, shows Hα emission. Figure 1 also shows that all bright stars are cluster members.

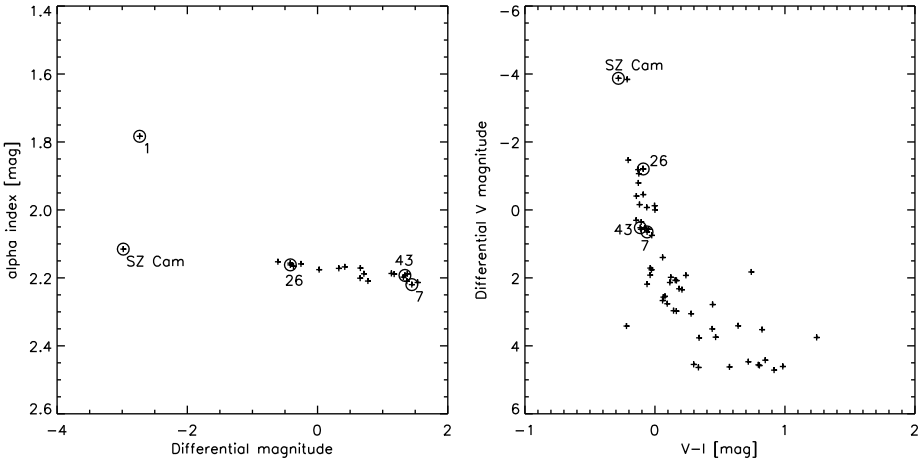

Figure 1. *Left:* The α index plotted as a function of differential magnitude in Hα wide. *Right:* Color-magnitude diagram for the bright stars in the field.

3. Variable Stars

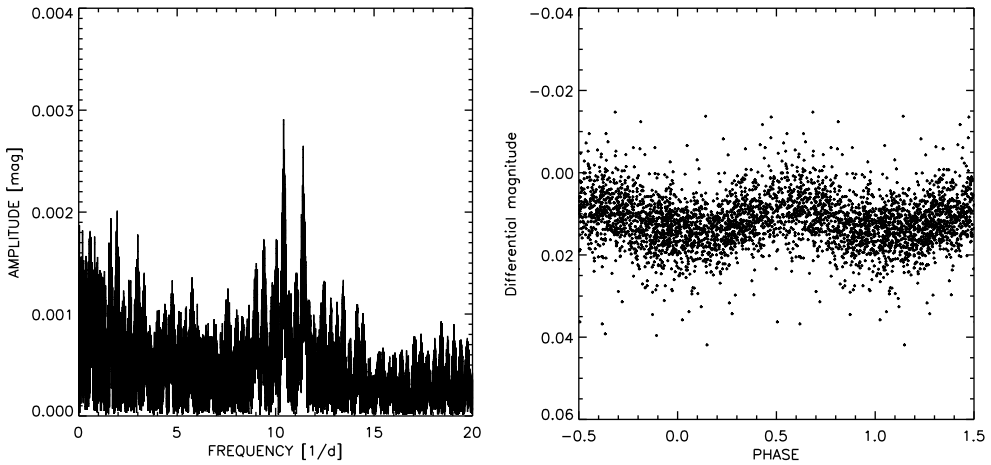

Figure 2. *Left:* Fourier frequency spectrum of the V magnitudes of WEBDA 26. *Right:* Phase diagram of WEBDA 26 ($P = 0.^{\rm d}09612$).

In the search for variability we analyzed differential V magnitudes of 305 stars. This analysis consisted of the periodogram analysis and visual inspection of the light curves. Periodograms were calculated from 0 to 30 d^{-1}. Four stars turned out to be variable: the well-known multiple system SZ Cam (Harries et al. 1998), the suspected β Cephei-type pulsator WEBDA 26 (Delgado et al. 1992) and the new variable stars WEBDA 7 and WEBDA 43.

We confirm the β Cephei-type variability of WEBDA 26. It appeared to be a single-mode pulsator with frequency of 10.403662 d^{-1} ($P = 0.^{\rm d}09612$) and semi-amplitude of about 3 mmag in V (Fig. 2). In addition, we found that WEBDA 43 is a variable star with frequency of 2.38750 d^{-1} ($P = 0.^{\rm d}41885$) and

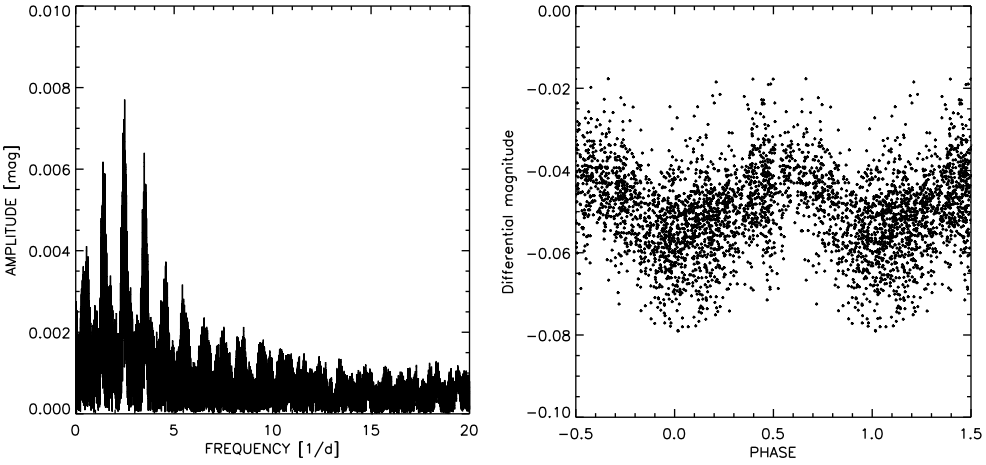

Figure 3. *Left:* Fourier frequency spectrum of the V magnitudes of WEBDA 43. *Right:* Phase diagram of WEBDA 43 ($P = 0.^{\rm d}41885$).

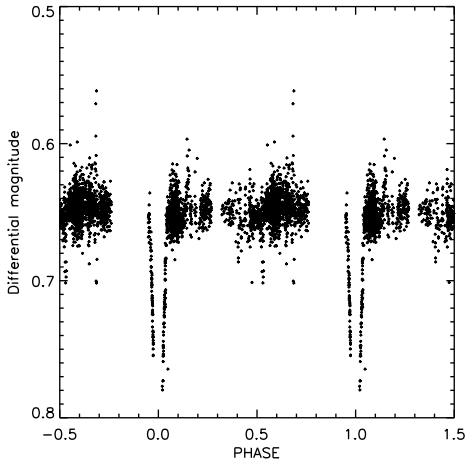

Figure 4. Phase diagram of SZ Cam ($P = 2.^{\rm d}698470$).

semi-amplitude of about 7 mmag in V (Fig. 3). The available UBV photometry, cluster membership, and the period suggest that it can be an SPB-type variable star. We do not confirm the variability of WEBDA 1 (Delgado et al. 1992). WEBDA 37, the β Cephei candidate of Hill (1967), does not present variability in our data. WEBDA 44, suspected to be variable by Purgathofer (1964), also appears to be constant.

SZ Cam is a well-studied eclipsing multiple system. Mayer et al. (1994) identified the system as a triple, composed of a close binary ($P_{\rm orb} = 2.^{\rm d}7$) and a massive companion orbiting the binary in a wide orbit with a period of 50.7 years. The same authors found that the mass of the tertiary amounts to at least 18.6 $M_\odot$. Harries et al. (1998) and Mayer et al. (1994) proposed that the tertiary component was itself a close binary. Figure 4 shows the light curve of SZ Cam phased with the period $P = 2.^{\rm d}698470$ (Mayer et al. 1994).

In addition to SZ Cam, we found WEBDA 7 to be an eclipsing binary (Fig. 5). Two total eclipses separated by 1.9839 days are present in our data. This separation seems to be equal to the orbital period, because shorter commensurable periods do not fit our data. The ephemeris of this system is, the following:

$$\mathrm{HJD_{min}I} = 2453408.3027(2) + 1.9839(3)\,\mathrm{E} \qquad (1)$$

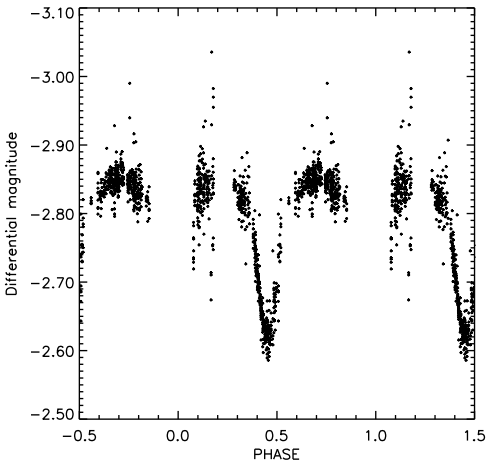

Figure 5. Phase diagram of WEBDA 7 ($P = 1.^{\mathrm{d}}9839$).

References

Crawford, D. L. 1994, PASP 106, 379
Delgado, A. J., Alfaro, E. J., Garcia-Pelayo, J. M., Garrido, R. 1992, AJ 75, 891
Harries, T. J., Hilditch, R. W., and Hill, G. 1998, MNRAS 295, 386
Hill, G. 1967, ApJS 14, 263
Hoag, A. A., Johnson, H. L., Iriarte, B., et al. 1961, Publ. US Naval Obs., 17, 349 106, 379
Jerzykiewicz, M., Pigulski, A., Kopacki, et al. 1996, Acta Astron., 46, 253
Mayer, P., Lorenz, R., Chochol, D., & Irsmambetova, T. R. 1994, A&A 288, 13
Purgathofer, A. 1964, Ann. Univ. Sternw. Wien, 26, 36
Reimann, H. G., & Pfau, W. 1987, ANac 308, 111
Stetson, P. B. 1987, PASP 99, 191
Stetson, P. B. 1990, PASP 102, 932
Tapia, M., Costero, R., Echevarria, J., & Roth, M. 1991, MNRAS 253, 649