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V516 Cas, AN RRab STAR AT THE GALACTIC PLANE

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The variable star V516 Cas was discovered by Romano (1971) who classified it as an RR Lyrae type star. Although Simbad database includes this variable with an erroneous position due to the wrong coordinates given by the discoverer, on the base of Romano's finding chart it can be identified unambiguously and the electronic edition of the "GCVS with Improved Coordinates" (Samus et al., 2002) gives also the correct position: $\alpha_{2000} = 0^{\rm h}35^{\rm m}21\overset{\rm s}{.}75$, $\delta_{2000} = 52^\circ 59' 53\overset{''}{.}8$.

Since no observations were published on this star, we wanted to verify its variability and type. We observed it during 4 nights using two different CCD cameras attached to the 1m RCC telescope of the Konkoly Observatory mountain station at Piszkéstető. On three nights in December 2002 a camera was used which had been built by Photometrics Inc. containing a Thomson TH7896M 16 bits chip with 1024×1024 pixels. It yields a $5' \times 5'$ field of view (FOV). On the night in February 2003 we used a camera made by Wright Instruments including an EEV CCD05-20 16 bits chip with 800×1200 pixels. This equipment yields abut $4' \times 6'$ FOV. For detailed technical description of the CCDs we refer to the paper of Bakos (2000). The observational log is shown in Table 1. The filters used were standard Johnson B, V and Cousins $I_{\rm C}$, and the exposure times were between 4-6 minutes for all colours, the value of typical seeing was between $1\overset{''}{.}5$–$3\overset{''}{.}5$.

The basic reduction steps: flat fielding, overscan correction were carried out by IRAF[1], similarly to the aperture photometry. Since the stars in our field were well separated, an aperture photometry was done. A relative photometry to the comparison star (comp) GSC-2.2 N311030314105 (=1425-00833847 USNO-A2.0, Monet et al., 1998), and check star (check) GSC-2.2 N311030313722 (=1425-00838472 USNO-A2.0) were done and no variability was found in our data over $\sigma = 0.01$ for all three bands. Therefore we have used the relative magnitudes V516 Cas minus comp. The extinction was corrected in the usual way taking into account the first order extinction coefficients. To tie the comparisons into the standard photometric system, we observed the open cluster M52 on two nights (09/12/02 and 10/12/02). We used photometric results of ∼50 relatively bright and separated stars from the paper of Pandey et al. (2001) as reference magnitudes for all three colours. Applying the colour equations with the determined telescope constants and

[1]IRAF is distributed by the NOAO, operated by the Association of Universities for Research in Astronomy Inc., under contract with the NSF.

Table 1: Log of observations of V516 Cas

Date	No	Camera
	B V $I_{\rm C}$	
09/12/2002	20, 20, 20	Photometrics
10/12/2002	20, 20, 20	Photometrics
11/12/2002	14, 14, 13	Photometrics
02/02/2003	25	Wright

zero points, the magnitudes and colours for comparison and check stars are $V = 13\overset{\rm m}{.}82$, $(B-V) = 0\overset{\rm m}{.}516$, $(V-I_{\rm C}) = 0\overset{\rm m}{.}573$ and $V = 13\overset{\rm m}{.}63$, $(B-V) = 0\overset{\rm m}{.}775$, $(V-I_{\rm C}) = 0\overset{\rm m}{.}819$, respectively, where the estimated accuracies are ± 0.025.

A period search was done for V light curve using a Fourier-method realized by MUFRAN program package (Kolláth, 1990). The following ephemeris was obtained:

$$V_{\rm max}({\rm HJD}) = 2452618.460 + 0.403913E.$$

The B, V and $I_{\rm C}$-band light curves of the V516 Cas folded by the above period are shown in Fig. 1. The observational data are available by electronic form via the IBVS-website, as 5433-t2.txt, 5433-t3.txt, 5433-t4.txt The magnitude and intensity averaged mean magnitudes and colours are $\langle V\rangle = 14\overset{\rm m}{.}652$, $\langle B-V\rangle = 0.523$, $\langle V-I_{\rm C}\rangle = 0.721$, and $\overline{V} = 14\overset{\rm m}{.}576$, $\overline{B-V} = 0.474$, $\overline{V-I_{\rm C}} = 0.669$, respectively. Concerning the shape of the phase diagram and the period V516 Cas is truly an RR Lyrae star as it was suggested by Romano.

In the past years empirical relations have been found among the Fourier coefficients of V light curves and fundamental physical parameters of RRab stars. The calculated metal abundance of V516 Cas is [Fe/H]=-0.65 using the formula of Jurcsik & Kovács (1996), while the mean absolute magnitude is $\langle M_V\rangle = 0\overset{\rm m}{.}88$ by Kovács & Walker (2001) with the zero point of Kinman (2002). Using the three parameter formula for reddening free $B-V$ colour index by Kovács & Walker (2001) and comparing them with the measured value we can determined the colour excess along the line of sight as $E(B-V) = 0.23$. It agrees well with the value of $E(B-V) = 0.24$ from dust map of Schlegel et al. (1998) constructed from IRAS and COBE/DIRBE data.

There is no object in the Galactic position of V516 Cas ($l = 120\overset{\circ}{.}46$, $b = -9\overset{\circ}{.}8$) in the "Catalogue of dust clouds in the Galaxy" (Dutra & Bica, 2002), so this considerable reddening should be caused by the diffuse interstellar matter. Our light curves allow us to calculate the selective interstellar absorption coefficients $R_V = A_V/E(B-V)$. Following Kovács & Jurcsik (1997)=KJ97 we have applied the formula $I_0 = \langle I_{\rm C}\rangle - d - R_{I_{\rm c}}E(B-V)$, where I_0 is the calculated averaged magnitude from the Fourier coefficients and $R_{I_{\rm c}} = 0.751R_V - 0.485$. The distance modulus $d = X - X_0$, where $X = \langle I_{\rm C}\rangle - \beta\langle V - I_{\rm C}\rangle$, $\beta = R_{I_{\rm c}}/(R_V - R_{I_{\rm c}})$ and the reddening free quantity X_0 has also an expression containing Fourier parameters (see KJ97 for the details). The only unknown parameter is R_V which can be calculated from the above equations simply. We have found it as $R_V = 3.06 \pm 0.5$, which agrees with the widely used $R_V = 3.14$. The error given here is derived from the formal errors of the applied formulae so it may be overestimated. We have estimated the distance of V516 Cas from the previously obtained quantities: $r \approx 4.1$ kpc. All the above information shows that V516 Cas is a relatively young, metal rich RRab variable lying in the Galactic disk.

As we have seen, from BVI_C light curves of an RRab variable we can derive the colour excess and interstellar absorption coefficients, directly. In this manner we could scan the distribution of the interstellar matter at a much better angular resolution than that the known maps are yielded.

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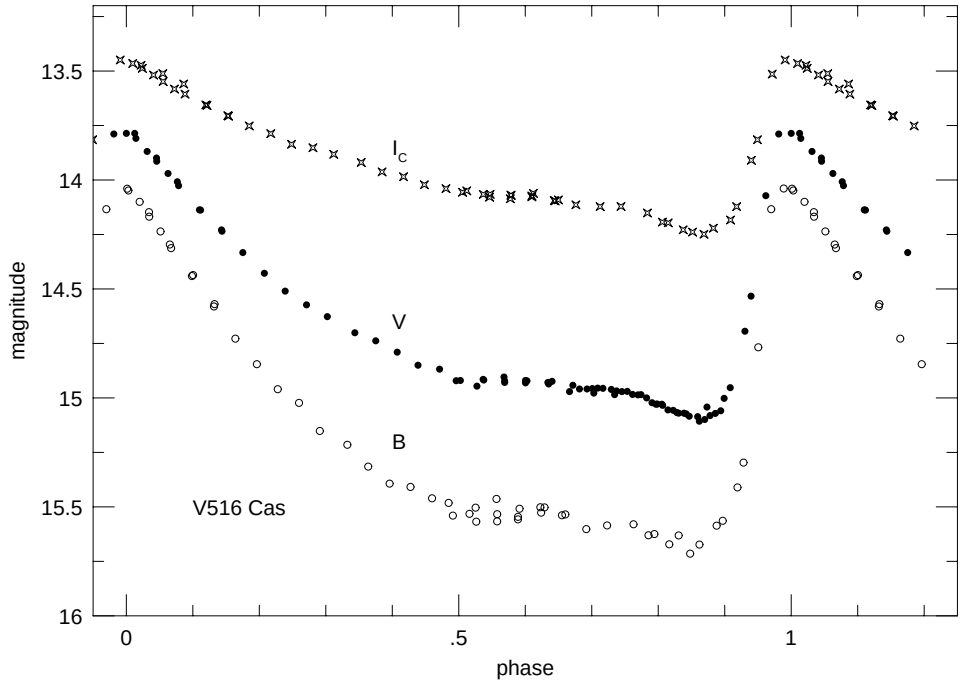

Figure 1. Phase diagrams of B, V and I_C-band photometric magnitudes of V516 Cas.

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