RE-CLASSIFICATION OF THE NEGLECTED VARIABLE V480 AQL

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ABSTRACT. We present the results of multicoloured photometric study of previously neglected variable star V480 Aql. Our VRI observations prove that this star belongs to classical Cepheids with the period of $P = 19^d.0016$. We also propose an empirical dependence between colour indices and temperature of supergiants, which, according to the nature of Cepheids, enabled us to determine minimum and maximum temperatures of V480 Aql.

Key words: Stars: variable: Cepheids; stars: individual: V480 Aql.

1. Introduction

V480 Aql = GSC 0460-0382 ($R.A._{J2000} = 18^h50^m34.885^s$, $Dec._{J2000} = +07°07'33.70''$) is a poorly studied variable star, discovered by C. Hoffmeister (1949) who classified it as a typical RW Aurigae variable. Then this star was mentioned in the list of coordinates and identifications for Sonneberg variables (Kinnunen & Skiff, 2000). But no photometric data have been published up till now. At present different types of variability are indicated for V480 Aql in various catalogues: Hoffman, Harrison and McNamara (2009) classified it as a rapid irregular variable; the variability type LB is indicated in GCVS (Kazarovets et al., 2013); in ASAS (Pojmanski, 2002) it is classified as a star of DCEP-FU type; and in AAVSO catalogue the variability type DCEP is indicated.

In order to clarify the classification of V480 Aql, we observed it in V, R and I bands.

2. Observations

We observed V480 Aql using two telescopes for over two years. One of them, BSM Takahashi FS-60CB, equipped with SBIG ST-8XME camera and photometric B, V, R_c, I_c filters, we used from February till May 2012. Another one, namely T5 Takahashi Epsilon ($D = 250mm$) of iTelescope.net observatory in New Mexico, USA, was used from July 2013 till June 2014. It was equipped with SBIG ST-10XME together with BVR or BVI photometric filters. As V480 Aql is rather faint in B-band, we observed it only with V, R and I filters for this study. Three constant stars were chosen as reference stars for ensemble photometry. The list of reference stars, their coordinates and magnitudes are given in Table 1. The BSM telescope was designed for rather bright stars; thus the photometric data, collected with that telescope, demonstrate a wide scattering. To improve the quality of phase curves, we binned the BSM data with bin size of 0.1 d. We applied the Lafler-Kinman method to combined light curves and determined the period $P = 19^d.0016(\pm 0^d.0851)$, which is in good agreement with the AAVSO period $P = 19^d.001597$. The initial epoch is $HJD_{\max} = 2456608.01 \pm 0.19$. The resulting curves from both telescopes in $V-$, $R-$ and $I-$bands are shown in Fig. 1. The amplitudes and phase curves are typical for classical Cepheids.

3. Classification

Multicoloured observations made it possible to evaluate the temperature variations of V480 Aql by analysing colour indices. Taking into account that V480 Aql is faint in B-band and rather bright in I-band, and assuming that this star is a supergiant that is typical for Cepheids, we used the dependence between colour indices $(V-R)$ and $(R-I)$ and temperature T, given in Allen's Astrophysical Quantities (Cox, 2000). We propose two empirical formulae, whose domain of validity extends from $2800K$ to $10000K$:

$$lg(T) = (-0.56\pm0.01)\cdot lg(V-R+0.2)+(3.654\pm0.003);$$

$$lg(T) = (-0.50\pm0.02)\cdot lg(R-I+0.1)+(3.573\pm0.009).$$

Table 1: Reference stars

USNO-B1.0	R.A.	Dec.	V	R	I
0971-0471757	$18^h51^m32.645^s$	$07°08'15.73''$	$11^m.279$	$10^m.797$	$10^m.347$
0972-0471843	$18^h50^m03.570^s$	$07°13'17.15''$	$11^m.591$	$10^m.750$	$9^m.970$
0971-0469055	$18^h49^m31.477^s$	$07°08'01.45''$	$11^m.033$	$10^m.481$	$9^m.967$

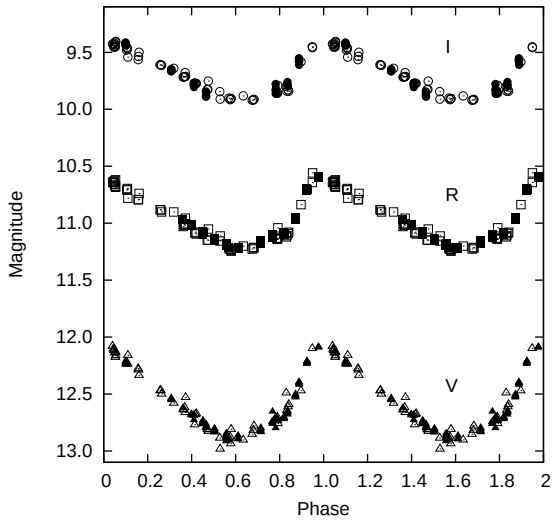

Figure 1: VRI phase curves of V480 Aql. Filled symbols correspond to T5 observations, while empty ones correspond to BSM data

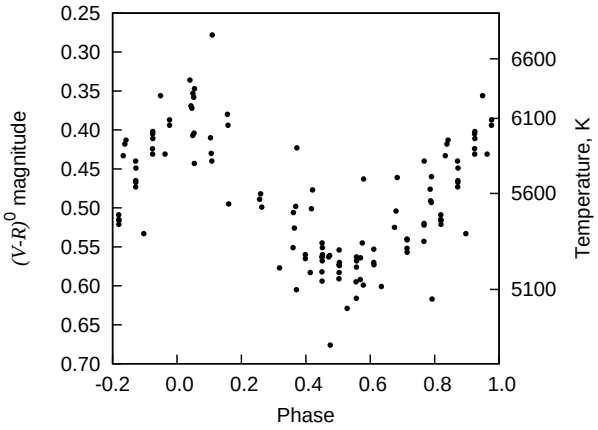

Figure 2: $(V\text{-}R)^0$ and temperature variations of V480 Aql.

We found that V480 Aql belongs to the Galactic thin disc; thus, to determine the real temperature we should take reddening into account. To calculate the intrinsic $(B-V)^0$, we adopted the empiric formula suggested by Tammann, Sandage and Reindl (2003):

$$(B-V)^0 = (0.366 \pm 0.015) \cdot lgP + (0.361 \pm 0.013).$$

By applying it to V480 Aql, we obtained the mean value $(B-V)^0 = 0^m.829$. To find the following dependence between colour indices: $(V-R) = 0.504 \cdot (B-V) + 0.085$, we also analysed the results of processing the photometric data given by Fouque et al. (2007) Thus, for V480 Aql the expected mean colour index is $(V-R)^0 = 0^m.503$. Adopting this value, we calculated the $V-R$ variability, which gave the minimum and maximum temperatures for V480 Aql: $(V-R)_{max} = 0^m.382(9)$ yields $T_{max} = 6120(\pm 64)K$, $(V-R)_{min} = 0^m.573(5)$ corresponds to $T_{min} = 5216(\pm 18)K$ (Fig. 2). The maximal temperature is reached near the phase $\varphi = 0$, together with maximal luminosity, which is typical for DCEP-type variables.

4. Conclusion

Due to the fact that the period, shape, phase curve amplitudes, temperature variation and position in the Galaxy are typical for those ones of DCEP-type variables, we may conclude that V480 Aql is a classical Cepheid indeed.

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