COMMISSION 27 OF THE I. A. U.
NFORMATION BULLETIN ON VARIABLE STARS

Number 2902

Konkoly Observatory
Budapest
4 June 1986

HU ISSN 0374-0676

SPECTRAL ESTIMATION OF LUMINOSITY AND OTHER CHARACTERISTICS OF THE DELTA SCUTI STARS AI CVn (= 4 CVn) AND δ Ser

In June 1976 we obtained a series of spectrograms of two Delta Scuti variables - AI CVn (4 CVn, HD 107 904, HR 4715) and δ Ser (HD 138 917, HR 5788) - with a reciprocal dispersion of 37 Å/mm and 15 Å/mm, respectively; the spectral range was 3600 - 4900 Å. The observations were performed by means of a diffraction spectrograph ASP-11 attached to the 122-cm telescope of the Crimean Astrophysical Observatory (USSR). More details of observations as well as results obtained from the spectroscopic investigation of these stars are given in Tsvetkov (1977a, b).

In the present note we apply a method based on spectral observations only, in order to estimate the luminosities of the both stars. Our results are listed in Table I. The spectral types of the stars were determined by means of calibrations connecting equivalent widths or ratio of equivalent widths of chosen spectral lines with the spectral type according to the two-dimensional spectral classification (based on the MKK classification) developed and elaborated in the Crimean Astrophysical Observatory. We measured and used equivalent widths of hydrogen, calcium, and iron lines (H_γ, H_δ, Ca II K Ca I λ 4227, Fe I λ 4046, Fe II λ4385) and derived the same estimations of spectral type, for a given star (Table I). We found, furthermore, the last hydrogen line (of Balmer series) observed in the spectrograms: $n_m = 21$ for both stars. Then, we estimated their absolute visual magnitudes:

$$M_v = (M_v)_{A0} + \Delta M_v.$$

$(M_v)_{A0}$ was derived from a $n_m - (M_v)_{A0}$ calibration for stars of spectral type A0 (Gerashchenko, 1970); this calibration is mainly based on trigonometric parallaxes for $(M_v)_{A0}$ determinations. ΔM_v is a correction to $(M_v)_{A0}$ for estimating M_v of a star of another (O9-F2) spectral type, by using a Sp-ΔM_v calibration (Gerashchenko, 1970) based also on trigonometric parallaxes.

Table I

M_v estimates of AI CVn and δ Ser

Star	Sp	n_m	$(M_\Delta)_{AO}$	ΔM_Δ	M_Δ
AI CVn	F2	21	$-0^m.6$	$+1^m.6$	$+1^m.0$
δ Ser	F0	21	-0.6	+1.4	+0.8

Table II

Several characteristics of AI CVn and δ Ser

Star	P (days)	V	$\log \frac{L}{L_\odot}$	T_e (K)	$\frac{R}{R_\odot}$	r (pc)	Iben M_e	Iben t	Paczynski M_e	Paczynski t	M_Q	Mode
AI CVn	0.209	$5^m.90$	1.50	6950	3.88	95.5	1.98	8.21	2.13	5.95	1.50	F
δ Ser	0.134	4.23	1.58	7500	3.65	48.5	2.06	7.21	2.21	5.29	1.88	1H

The M_v estimations in Table I may be compared with those derived in other ways: $0^m.95$ (Baglin et al., 1973), $0^m.71$ (Breger and Bregman, 1975), $0^m.62$ (Breger 1975), $0^m.62$ (Breger, 1979) for AI CVn; $0^m.8$ (Eggen, 1970) for δ Ser. There is a relatively good agreement between our and other M_v values, bearing in mind that the mean observational error in M_v is $\pm$ 0.2 for dwarfs (Breger, 1979) and, probably, up to $\pm$ $0^m.5$for giants (Baglin et al., 1973). Hence, the method used in the present note gives an independent and relatively accurate luminosity estimation, provided that spectrograms with a sufficiently high dispersion are available.

Table II lists a number of physical characteristics of the stars studied. The periods P and the mean visual magnitudes $\bar{V}$ are taken from Breger (1979). The luminosities L are derived from the M_v values in Table I neglecting the very small ($|B.C.| \lesssim 0^m.04$) bolometric corrections for Delta Scuti stars. The effective temperature T_e of AI CVn is taken from Tsvetkov (1985); T_e of δ Ser is estimated by comparing the observed profile of the line H_γ in our spectrograms with a set of theoretical profiles of this line, which are computed for various effective temperatures (Mihalas, 1965).

The radii R are derived from these L and T_e estimates. The distances r (in parsecs) to the stars are evaluated from $\bar{V}$ and M_V, neglecting the small interstellar absorption of light. Using T_e and L, the evolutionary masses M_e (in units of the solar mass) and the ages t (in units of 10^8 years) are interpolated from Iben's (1967) and Paczynski's (1970) evolutionary tracks; both stars are in the phase of shell hydrogen burning. Adopting the P, L, T_e and R values in Table II, pulsation masses M_Q (expressed also in solar masses) are calculated by means of Faulkner's (1977) fitting formulae for a chemical composition (X,Y,Z) = (0.70,0.28,0.02). In Table II, the pulsation mass of each star is listed for this radial pulsation mode (F for AI CVn, 1H for δ Ser), for which M_Q is closest to the evolutionary mass M_e.

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