

DZ Andromedae : A search for the spectral evidence of its possible RCB nature

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Abstract. The analysis of high-resolution spectra of DZ Andromedae, a suspected R Coronae Borealis variable, is presented here. The spectra of DZ And show the characteristics of a normal K2 III star, indicating that the star was earlier misclassified. A detailed abundance analysis also indicates that the star's composition is not consistent with its membership in the RCB class.

1. Observations and data reduction

The spectra were obtained on 1996 July 24 using '2dcoude', a cross-dispersed echelle spectrograph, at the coudé focus of the McDonald Observatory's 2.7m telescope (Tull et al. 1995). The wavelength coverage is from 3800 to 10000 Å and the spectral resolution is about 60,000. The CCD data were reduced using spectroscopic reduction package ECHELLE of IRAF software package.

2. The spectrum description

DZ And's spectrum resembles that of a K giant, as a comparison with the spectrum of Arcturus (Griffin 1968) clearly shows. Strong lines of C I which are primary spectral characteristics of RCB stars are weak or absent in the spectrum of DZ And. Figure 1 shows the H_{α} profile. In Figure 2, the upper panel shows the presence of the leading C2 Swan bandhead at 5165 Å in the cool RCB star Z UMi and the lower panel shows its weak presence in DZ And's spectrum. The Balmer lines of hydrogen are weak or absent in RCB stars spectra. In DZ And H_{α} profiles have a distinct core and broad wings in absorption (equivalent width = 1.117 Å). On correction for the instrumental profile, the full width at half maximum of the H_{α} line is found to be 59 ± 4 km s⁻¹. From the width - luminosity calibration offered by Kraft et al. (1964) we derived the luminosity class of DZ And to be III and K2 III as a possible spectral classification.

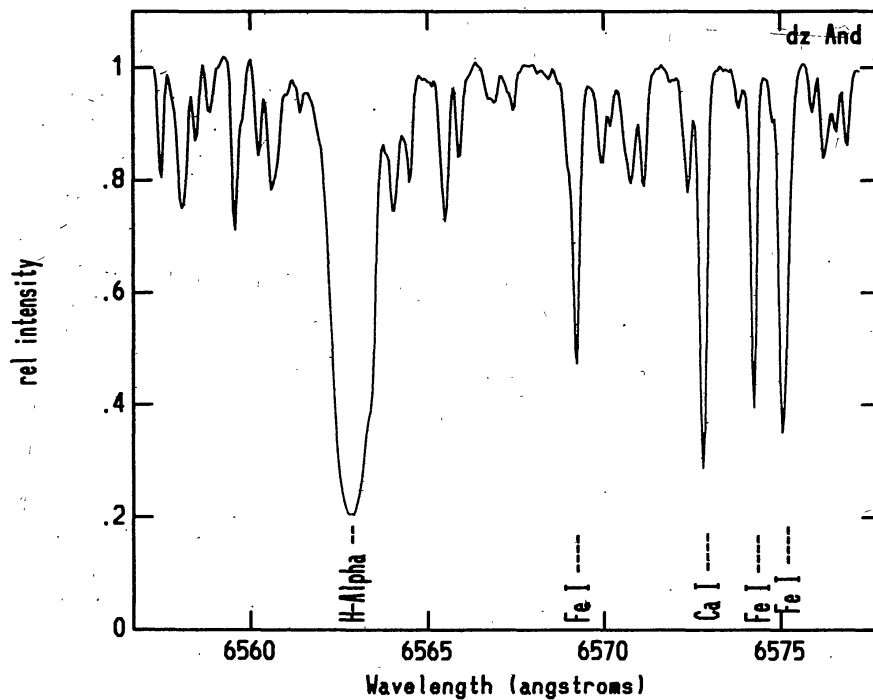


Figure 1. The H_{α} profile in DZ And.

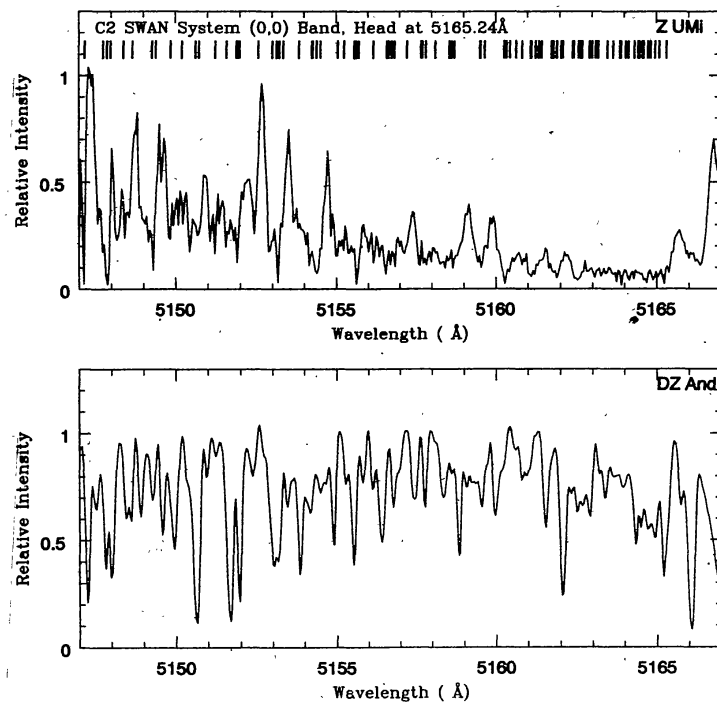


Figure 2. The upper panel shows the presence of strong C_2 Swan bandhead at 5165 \AA in the cool RCB star Z UMi. The lower panel shows its weak presence in DZ And's spectrum.

Radial velocities of the star have been measured using several unblended lines. The mean radial velocity after applying heliocentric correction $v_r = 13.3 \text{ km s}^{-1} \pm 1.5 \text{ km s}^{-1}$.

3. Analysis

A selection of Fe I and Fe II lines from the analysis of Arcturus by Mackle et al. (1975) was used in a routine procedure to determine the stellar parameters : the effective temperature T_{eff} , surface gravity $\log g$, microturbulence v_t , and the metallicity. Throughout our analysis we have assumed local thermodynamic equilibrium (LTE). Model atmospheres were selected from a grid computed using the MARCS code of Gustafsson et al. (1975). We assumed that DZ And has the standard He abundance of the MARCS grid ($\text{He}/\text{H}=0.1$) and used the model atmosphere computed for $[\text{M}/\text{H}]=0.0$. We determined the parameters for DZ And to be $T_{\text{eff}}=4400 \text{ K}$, $\log g=2.0$ and $v_t \sim 1.75 \text{ km s}^{-1}$. The observed colours, U-B and B-V (Rao 1980), indicate that the star is not affected by interstellar reddening. Based on Johnson's (1966) calibration, from the photometric colours (Rao 1980), we estimated its effective temperature as $\sim 4350 \text{ K}$. The uncertainties in T_{eff} , $\log g$ and v_t are $\Delta T_{\text{eff}} \sim \pm 200 \text{ K}$, $\log g \sim \pm 0.25$ and $\Delta v_t \sim \pm 0.5 \text{ km s}^{-1}$, respectively.

Our analysis suggests almost solar abundance for most of the elements including Fe. However, Na, Si and Zn show minor enhancements of ~ 0.5 dex. Sr and Zr show a deficiency of -0.3 dex but elements such as Mg, Al, Ca, Sc, Ti, Cr and Y show almost solar abundances. The s-process elements Ba, La and Nd show solar abundances along with Ce and Eu. Ni is marginally enhanced by 0.2 dex but Co is enhanced by ~ 0.6 dex.

4. Concluding remarks

DZ And shows the characteristics of a normal K2 III star and thus is not expected to vary. Its composition is nearly solar and is not consistent with that of the RCB class. However, the cause of the light variations, if real, as reported by Cragg (1961) appears to be a mystery. Perhaps, DZ And is a very long period binary in which the deep eclipse of the star occurred at the time of Cragg's observations.

The details of this work will be available in 'The Observatory' 1998.

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