ABUNDANCE ANALYSIS OF R CrB VARIABLE UW CEN

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ABSTRACT: Burrell (1976) performed an abundance analysis of the southern R CrB star UW Cen and reported a metal deficiency by a factor of 660 compared to the sun. However, his analysis was made employing very uncertain gf values, which resulted in lower estimates for T_{exc} and T_{ion} etc. We have reanalysed his data using new values and model atmospheres calculated by Schönberner (1975). Our analysis shows that the star has nearly solar abundance.

1. INTRODUCTION

Among the group of R CrB stars which are hydrogen deficient stars with excess of helium and carbon, only very few have been studied in detail. The prototype of this group, R CrB was studied using high dispersion spectra by Searle (1961), Schönberner (1975), and Cottrell & Lambert (1982). Abundance analysis of R CrB, RY Sgr and UW Cen was done by Burrell (1976) who reported all the three stars to be metal deficient in general, but UW Cen to be deficient by a factor of 660. The metal deficiency of this order has not been observed in any other R CrB stars studied so far. Moreover, the observed radial velocity of UW Cen (34 km s^{-1} :Herbig 1985) and its galactic position do not support such extreme metal deficiency

An examination of the line data of Burrell (1976) revealed that the gf values used in his investigation (Corliss and Bozmann 1962, Corliss and Tech 1968, Tech 1972 etc) are highly uncertain.

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As pointed out by Foy (1972), these gf estimates suffered large errors, particularly for ionised lines. It is likely that these systematic errors in gf values might have led to an erroneous estimation of excitation temperature and consequently to very uncertain abundance estimates. We, therefore, undertook to reanalyse the line data of UW Cen.

2. EQUIVALENT WIDTHS AND EXCITATION

We have used equivalent width data of Burrell (1976) measured on spectrograms of 10 A mm^{-1} dispersion in 5400 A to 6400 A spectral region. We have applied a systematic correction as pointed out by Burrell (1976) of -0.16 in log $(W\lambda/\lambda)$ to the equivalent width of Burrell to bring these equivalent widths to the scale of Searle (1961) so that we could compare the derived abundance of UW Cen with R CrB.

Excitation Temperature: A preliminary curve of growth analysis of Fe I lines indicated an excitation temperature in the range 6500 K - 6800 K. These equivalent widths when plotted on theoretical curve of growth of Van der Held as computed by Powell (1969), gave a microturbulent velocity (V_t) of 3 kms^{-1} ± 1 kms^{-1} for Fe I lines. A higher value of V_t = 7 kms^{-1} ±1 kms^{-1} was obtained for Fe II lines. Burrell (1976) however had derived an excitation temperature. T_{exc} = 5040 K and V_t = 3.0 kms^{-1} for Fe I and 7.0 kms^{-1} for Fe II lines.

Atmospheric Parameters: We have summarized in Table 1 broad band colours for UW Cen at maximum light observed by different workers. After applying the correction for reddening adopted by Glass (1978) and Kilkenny and Whittete (1984) the observed colours of UW Cen are similar to those of R CrB indicating a similar temperature, thus the initial guess of T_{eff} is adopted as 6800 K ± 300 K which is same as the adopted value of R CrB.

Table 1.

	UW Cen			R CrB
	MW	Glass $A_\nu = 0.99$	KW $A_\nu = 0.44$	
V	9.2			
B-V	0.72	0.43	0.59	0.59
U-B	0.19	-0.03	0.10	0.10
R-I	0.26	0.01	0.15	

MW Moreno & Walker (1971)
KW Kilkenny & Whittete (1984)

We have used model atmospheres of Schönberner (1975) in the effective temperature range 6000 - 7200 K and log g = 0.0 to 1.0. We modified the spectrum synthesis code of Sneden (1974) to meet the requirements of R CrB type atmosphere by scaling the abundances to total number of H + He +C, instead of hydrogen alone. Also the opacities due to C I, C^-, Mg I, Al I and Si I are included. Details of our theoretical computations and also the adopted gf values for the lines, compiled from various sources have been described elsewhere.

The T_{eff} for UW Cen was derived by requiring the [Fe/H] from all the lines of the sample to be independent of their excitation potentials; the gravities were derived using ionization equilibrium for Fe II/Fe I, Si II/Si I and V II/V I. We arrived at following atmospheric parameters for UW Cen: T_{eff} = 6800 K, log g = 0.0 He=97%. Figures 1 and 2 demonstrate the fact that there is no dependence of derived [Fe/H] on excitation potentials and equivalent widths of the lines. We adopted V_t = 7.0 kms^{-1} although Fe I lines suggest V_t = 4.0 kms^{-1} whereas Fe II lines give V_t = 9.0 kms^{-1}.

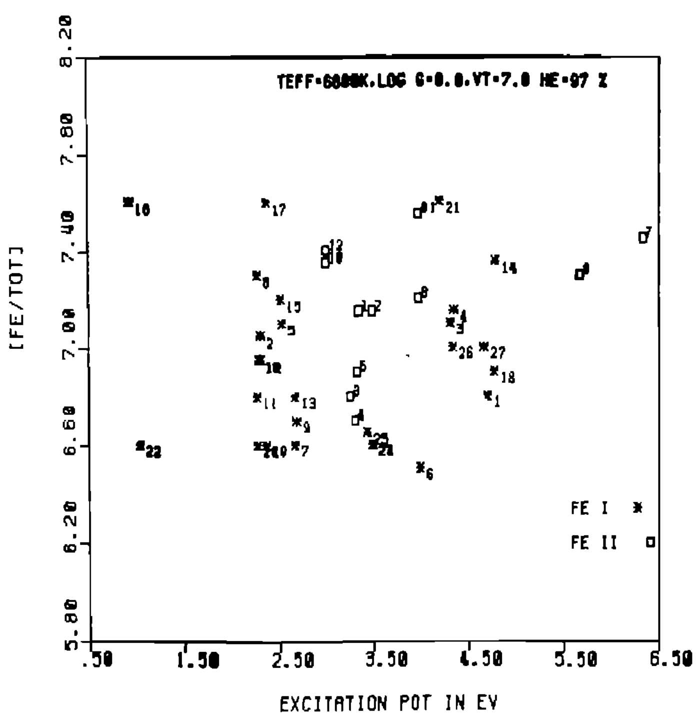

Figure 1. Derived [Fe/Tot] abundances as a function of excitation potentials of the lines.

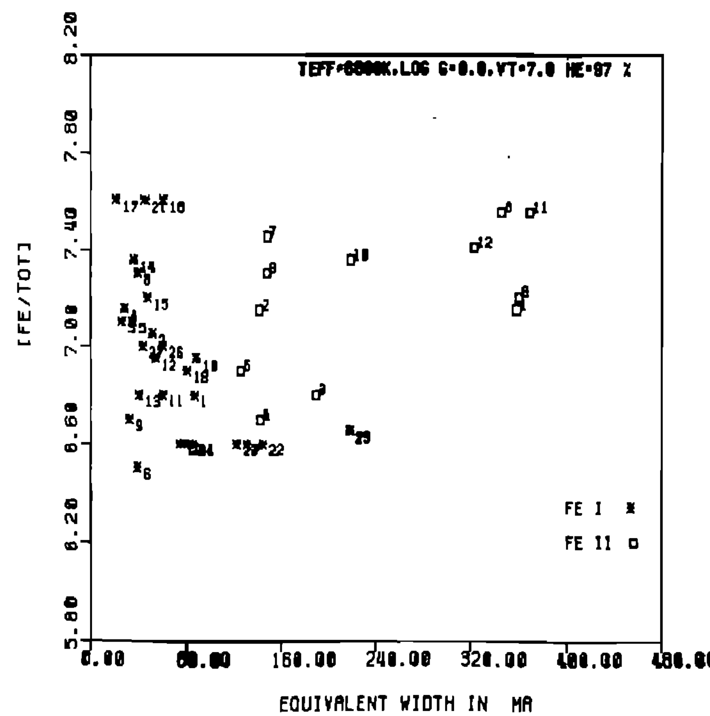

Figure 2. Derived [Fe/Tot] abundances as a function of equivalent widths of the lines.

Similar analysis was carried out for comparison star δ CMa which was analysed in the investigation of Burrell (1976) and also of Searle (1961). The abundance analysis for δ CMa was done using the lines that were common in the two investigations and a model atmosphere of $T_{eff} \simeq 6250$ K, log g=1.0 of Kurucz (1979) with V_t of 7.0 kms^{-1}. δ CMa has been recently analysed by Castely and Desikachary (1984).

3. RESULTS

The derived atmospheric parameters and the abundances of different elements for UW Cen and δ CMa are presented in the Table 2. The table also contains the abundances for R CrB derived by Schönberner (1975). For δ CMa there is a good agreement between abundances derived by Castely and Desikachary and by us. For UW Cen we arrive at almost solar abundances for most of the elements

Table 2.

	UW Cen		R CrB	δ CMa		
Element	No. lines	Present work	Schonberner	No. lines	Present work	Castley & Desikachary
He I	5	11.51	11.51			
Si I	2	7.11±.58		2	7.30±.2	
Si II	2	7.60		2	7.75±.15	7.70±.16
Ca I	5	5.44±.4		5	6.01±.25	6.24±.11
V I	2	4.1				
Cr II	4	5.42		4	5.69±.17	6.00±.23
Fe I	26	6.95±.51	7.1	10	7.55±.33	7.40±0.20
Fe II	12	7.26±.18		2	7.50±.15	7.40±.18
Ni I				3	6.03±.17	5.82±.19
Y II	2	3.65		3	2.28±.20	1.70±.57

It should also be noted that for UW Cen T_{eff} estimated in the present investigation is about 6800 K indicating an earlier spectral type against the spectral type K assigned to it by Gaposhkin (1936).

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