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Elemental abundance studies using the EBASIM spectrograph of the 2.1-m CASLEO Observatory telescope. I. The normal stars 5 Aqr and 30 Peg

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Abstract. Using data from the new EBASIM spectrograph at the 2.1-m telescope of the Complejo Astronómico El Leoncito (CASLEO), two rather sharp-lined B stars 5 Aqr (=HD 198667, B9 III) and 30 Peg (=HD 211924, B5 IV) are being studied. The measurements are compared with those from the coudé spectrograph of the 1.22-m telescope of the Dominion Astrophysical Observatory (DAO). The equivalent width scales of the EBASIM and the DAO data are similar. As we found that the line profiles of 30 Peg are variable, we are trying to determine whether this star is a slowly pulsating B star. 5 Aqr has abundances close to those of the Sun.

Keywords. Techniques: spectroscopic, stars: abundances, stars: atmospheres, stars: early-type, stars: individual (5 Aqr, 30 Peg)

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1. Introduction

We report observations made using the new EBASIM (Echelle de Banco Simmons) spectrograph at the 2.1-m telescope of the Complejo Astronómico El Leoncito (CASLEO) of two relatively sharp-lined stars. New spectrograms were also obtained with the long camera of the coudé spectrograph of the 1.22-m telescope of the Dominion Astrophysical Observatory (DAO) for this study. In the regions of overlap we compared the equivalent widths, and use both sets of spectrograms for elemental abundance studies.

We selected 5 Aqr (HD 198667, HR 7985, HIP 103005) for study as it is relatively bright sharp-lined star with spectral type B9 III. Optical region studies include Adelman (1986). Cowley (1972) noted that silicon lines are weakly enhanced in 5 Aqr. Hipparcos photometry of 30 Peg (HD 211924, HR 8513, HIP110298) indicates that it is a photometric constant although some previous photometry suggests it is variable. With somewhat variable line profiles and a spectral type of B5 IV, it is probably too cool to be a β Cep star. It has a companion 5.3 mag fainter 6.2 arcsec away. So we doubt that the companion influences the line profiles. Thus it might be a slowly pulsating B star.

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Table 1. EBASIM observing log

Star	Date	Wavelength range (nm)	Grating ($\mathrm{l\,mm^{-1}}$)	Fiber	Number of spectra
5 Aqr	Oct. 2001	382-550	226	blue	3
	May 2002	382-550	226	blue	1
	Oct. 2002	382-550	226	blue	2
		550-770	226	red	2
	Jun. 2003	382-550	226	blue	3
30 Peg	Oct. 2001	382-550	226	blue	3
	May 2002	382-550	226	blue	1
	Oct. 2002	382-550	226	blue	3
		550-750	226	red	2
	Jun. 2003	382-550	226	blue	3

2. Observational material

Details of the new EBASIM spectrograph at CASLEO can be found in Pintado & Adelman (2003). Table 1 lists the EBASIM spectra we obtained. The signal-to-noise ratios (S/N) of the coadded spectra are typically 200 in the centers of orders. The 2002 and 2003 spectra are of higher quality than those obtained previously, because of technical improvements in the instrument. For 5 Aqr, Adelman (1986) analyzed its elemental abundances using five 4.3 $\mathrm{Å\,mm^{-1}}$ IIaO spectrograms obtained with the 2.5-m telescope at Mt. Wilson Observatory and one 8.9 $\mathrm{Å\,mm^{-1}}$ IIaO spectrogram obtained with the coudé feed telescope of Kitt Peak National Observatory. Three new spectrograms for 5 Aqr and 21 for 30 Peg, $S/N \geqslant 200$, were obtained by Adelman with the DAO coudé spectrograph using Reticon and CCD detectors. The resolution is 0.072 $\mathrm{Å\,mm^{-1}}$.

At most there are 20% differences among the equivalent width measurements of the same lines from different CASLEO spectra. The spectra were reduced by MG using IRAF standard procedures for echelle spectra adapted for EBASIM and were normalized order by order with the SPLOT task of the same package. The equivalent widths were measured by fitting Gaussian profiles through the stellar metal lines using the same task. The stellar lines were identified with the general references A Multiplet Table of Astrophysical Interest (Moore 1945) and Wavelengths and Transition Probabilities for Atoms and Atomic Ions, Part I (Reader & Corliss 1980) as well as the more specialized references for P II: Svendenius *et al.* (1983), S II: Pettersson (1983), Ti II: Huldt *et al.* (1982), Mn II: Iglesias & Velasco (1964), and Fe II: Johansson (1978). There are problems when comparing our EBASIM equivalent widths with those from the DAO spectrograms. For 5 Aqr the DAO spectra cover only a relatively limited spectral range (449-455 nm). While for 30 Peg the equivalent widths from DAO spectrograms are systematically larger than those from the EBASIM spectrograms. Using unblended lines in the region 385 to 750 nm we find for 30 Peg: $W_\lambda(\mathrm{EBASIM}) = 0.8453\, W_\lambda(\mathrm{DAO}) - 0.6776$.

As Pintado & Adelman (2003) found much closer agreement between EBASIM and DAO equivalent widths, we need to understand the reason for this discrepancy that could be due to spectrum variability or the lines not quite having Gaussian profiles. Once we understand this difference, we will proceed with an abundance analysis.

3. Atmospheric parameters

For 5 Aqr we have adopted the parameters T_{eff} and $\log g$ published by Adelman *et al.* (2002). They are: $T_{\mathrm{eff}} = 11125$ K, $\log g = 3.55$. For 30 Peg the parameters were first estimated using Strömgren $uvby\beta$ photometry and the computer program of Napiwotzki

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et al. (1993). We obtained: $T_{\rm eff} = 14509$ K, $\log g = 3.38$. After, we have used the correction suggested by Adelman *et al.* (2002) for stars with 10050 K $\leqslant T_{\rm eff} \leqslant$ 17000 K, we found $T_{\rm eff} = 14430$ K, $\log g = 3.38$. With the values of effective temperature and $\log g$ chosen for 5 Aqr we have computed a model atmosphere using ATLAS9 (Kurucz 1993) with [M/H] = 0.0 (solar abundances) which seems to be adequate for a normal star.

4. Abundance analyses of 5 Aqr

For calculating the microturbulent velocity we use standard methods. We have calculated abundances from 184 Fe II lines for a range of possible microturbulent velocities (ξ). For deriving the final values the abundances should be independent of the equivalent widths and they should minimize the rms scatter of the abundances. A value of $\xi = 0.3\,\mathrm{km\,s^{-1}}$ was finally adopted. Using the average equivalent widths of our all EBASIM and DAO spectra, we are now calculating the metal abundances.

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