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Elemental abundances for HgMn stars observed with EBASIM echelle spectrograph at CASLEO

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Abstract. Elemental abundance analysis are derived for the Mercury-Manganese stars HR 4817 (B8 II/III) and μ Lep (B9 IV) using CCD recorded exposures obtained at the EBASIM echelle spectrograph at the 2.1-m CASLEO (Complejo Astronómico El Leoncito) telescope in Argentina. The spectra coverage is 390-900 nm. The results are compared with previous analyses made with spectra taken using the REOSC echelle spectrograph at CASLEO, the coudé feed telescope at Kitt Peak National Observatory, and/or with the Dominion Astrophysical Observatory coudé spectrograph. As these new spectra go farther into the red and have better resolution than those obtained with the REOSC, we could make better abundance determinations.

Keywords. Stars: abundances, individual:(HR 4817, μ Lep), stars: chemically peculiar stars

1. Introduction

We report observations made using the new EBASIM echelle spectrograph at the 2.1-m telescope of the CASLEO observatory of the Mercury-Manganese (HgMn) stars HR 4817 and μ Lep. A detailed description of the spectrograph is found in Pintado & Adelman (2003). The spectra coverage is 390-900 nm. We used two gratings as cross dispersors, one with 226 l mm^{-1} and a 650 nm blaze angle, the other with 115 l mm^{-1} and a 1100 nm blaze angle. The CCD detectors were from Tektroniks with 1024 x 1024 pixels (pixel size = 24μm x 24μm) and one designated as Roper with 1340 x 1300 pixels (pixel size = 20μm x 20μm). Table 1 shows the observing log.

HR 4817 (= HD 110073) ($v \sin i = 23$ km s^{-1}) was studied by Adelman & Philip (1994) and Adelman & Pintado (1997). These investigators found $T_{\rm eff} = 12900$ K, $\log g = 3.72$. μ Leporis (= HD 33904 = HR 1702) ($v \sin i = 18$ km s^{-1}) was analyzed by Adelman (1987) and Adelman & Pintado (1997). These authors derived $T_{\rm eff} = 12500$ K and $\log g = 3.5$.

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Table 1. Observing Log

Star	Date	Wavelength range (nm)	Grating	Detector	Number of spectra
HR 4817	Jun. 2000	380-750	226	Tek	4
	Feb. 2001	380-750	226	Tek	5
	Apr. 2003	520-720	226	Roper	2
	Feb. 2001	640-890	150	Tek	2
μ Lep	Oct. 2003	360-650	226	Roper	2
	Oct. 2003	640-890	150	Roper	2

2. Data analyses

The EBASIM spectral reductions were made with IRAF 2.12. Using bias, darks and flat fields we obtain a combined flat field which was used to divide the specta to remove pixel-to-pixel variatons. The spectra with the same wavelength range were combined using SCOMBINE. The extraction was performed with APALL and the wavelength calibration with ECIDENTIFY and DISPCOR, using the exposures of a Th-Ar comparison lamp. The spectra were rectified with REDUCE and measured with VLINE (Hill & Fisher 1986).

ATLAS9 model atmospheres and WIDTH9 (Kurucz 1993) were used in the analyses. The results for the HgMn stars are compared with previous analyses made with spectra taken using the REOSC echelle spectrograph at CASLEO, the coudé feed telescope at Kitt Peak National Observatory, and/or with the Dominion Astrophysical Observatory's (DAO) coudé spectrograph in Table 2. As these new spectra go farther into the red and have better resolution than those obtained with the REOSC, we could make better determinations of abundances. The signal-to-noise ratio (S/N) is typically 400-500 in the center of the orders, but only 50-200 at the ends of the orders.

Table 2. Comparison of abundances

	EBASIM	REOSC[1]	KITT PEAK[2]	EBASIM	REOSC[1]	DAO[3]
Species	HR 4817	HR 4817	HR 4817	μ Lep	μ Lep	μ Lep
C II	-3.82	-3.84	-4.03	-3.70	-3.68	-3.80
O I	-3.00	-3.03	...	...	...	...
Mg I	-4.45	-4.51	...	-5.00	-5.17	-4.07
Mg II	-4.80	-4.76	-4.89	-4.80	-4.76	-4.77
Si II	-4.70	-4.76	-4.80	-4.25	-4.29	-4.33
Si III	-4.90	-4.86	-4.96	-4.30	-4.22	-4.46
S II	-5.00	-5.06	-5.13	-4.72	-4.68	-4.81
Ca II	-5.43	-5.36	-5.43	-5.30	-5.27	-5.24
Ti II	-5.48	-5.50	-5.62	-6.30	-6.41	-6.15
Cr II	-5.45	-5.40	-5.37	-5.90	-5.89	-6.03
Mn I	-4.00	-3.97	-4.00	-4.62	-4.58	-4.40
Mn II	-4.10	-4.04	-4.27	-4.50	-4.45	-4.50
Fe II	-4.90	-4.87	-5.00	-4.60	-4.62	-4.75
Hg I	...	...	...	-5.70	-5.73	-5.72
Hg II	...	...	...	-5.65	-5.65	-5.73

1. Adelman, S.J & Pintado, O.I., 1997, *A&AS*, 125, 219,
2. Adelman, S.J. & Philip, A G. D., 1994, *PASP*, 106, 1239,
3. Adelman, S.J., 1987, *MNRAS*, 228, 573.

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3. Final comments

Compared with our previous spectra obtained with the REOSC spectrograph, properly exposed spectra obtained using the EBASIM spectrograph had greater resolution and higher signal-to-noise ratios. This greater resolution allowed us to deconvolve blends which resulted in more consistent elemental abundances. A new CCD, designed Roper, has a slightly better quantum efficiency than the previous CCD in the red and considerably better in the blue. Even so this new detector permitted us to improve our detection of chemical elements with lines in whose wavelengths were greater than 700 nm.

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References

Adelman, S.J. 1987, *MNRAS* 228, 573
Adelman, S.J. & Philip, A. G. D. 1994, *PASP* 106, 1239
Adelman, S.J & Pintado, O.I. 1997, *A&AS* 125, 219
Hill, G. & Fisher, W.A. 1986, *Publ. Dom. Astrophys. Obs. Victoria*, 16, 27
Kurucz, R.L. 1993, *ATLAS9 Stellar Atmosphere Programs and 2 km/s grid, Kurucz CD-Rom*, No 13, SAO, Cambridge, MA
Pintado, O.I. & Adelman, S.J. 2003, *A&A* 406, 897