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Elemental abundance analyses with Complejo Astronómico El Leoncito REOSC echelle spectrograms*

II. μ Leporis, 7 Sextantis, HR 4817, and 28 Herculis

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Abstract. Elemental abundances are derived for four sharp-lined stars, the Mercury-Manganese stars μ Lep, HR 4817, and 28 Her, and 7 Sex, a Population I star with Population II space motions, using REOSC echelle spectrograms obtained at CASLEO to extend previous studies. Comparisons with published equivalent widths indicate that the CASLEO scale is marginally larger than those of DAO Reticon and KPNO CCD spectra. The CASLEO spectrograms have improved the quality of the abundance determinations. New abundances are found for a few elements.

Key words: stars: abundances — stars: chemically peculiar — star: μ Leporis — stars: HR 4817 — stars: 28 Herculis — stars: 7 Sextantis

1. Introduction

This paper presents studies of four sharp-lined B and A stars using spectrograms obtained at the 2.15 m telescope of the Complejo Astronomico El Leoncito (CASLEO) and a REOSC echelle spectrograph, which is on loan from the Institute d'astrophysique de Liége, Belgium, and a TEK 1024 CCD. The cross disperser was a grating with 1200 lines mm^{-1}. The resolution is 0.10 Å pixel^{-1}. The spectral reductions were made using IRAF 2.10[1]. From bias and flat fields we obtained a combined flat field which was used to divide the stellar spectra to remove the pixel-to-pixel variations. The extraction was performed with APALL and the wavelength calibration with IDENTIFY and DISPCOR using the comparison spectra. Additional details are given in Paper I (Pintado & Adelman 1996).

In that paper comparisons of equivalent widths obtained with the REOSC and other spectrographs indicated that the REOSC equivalent widths were in some cases too large and in other cases too small. To help resolve this issue we selected four stars for which there are well determined equivalent widths in regions with moderate line blending. As we found that $\lambda\lambda\,4640-5100$ contained lines of some important atomic species for middle B to early A stars, we also choose stars for which we could extend published studies.

The Mercury-Manganese (HgMn) stars μ Leporis (= HD 33904 = HR 1702) and 28 Herculis (= HD 149121 = HR 6158) were most recently analyzed by Adelman (1987) and (1988), respectively. Their apparent rotational velocities are 18 and 8 km s^{-1}, respectively. An effective temperature of 12500 K and surface gravity, $\log g = 3.5$, of μ Lep was derived by comparing spectrophotometry and the Hγ profile with the predictions of ATLAS6 (Kurucz 1979) model atmospheres. For 28 Her, the values $T_{\mathrm{eff}} = 10750$ K, $\log g = 3.65$ were found using $uvby\beta$ photometry and the Hγ profile.

The A0 V star 7 Sex (= HD 85504 = HR 3906) ($v \sin i$ = 25 km s^{-1}) has nearly solar abundances, but the space motions of a Population II object. The

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[*] Tables 3-6 will be available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/Abstract.html

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recent analysis by Adelman & Philip (1996) used the homogeneous *uvbyβ* colors of Hauck & Mermilliod (1980) with the calibration of Napiwotzki et al. (1993) to find $T_{\rm eff}$ = 10135 K, $\log g$ = 3.69. They compared a Kitt Peak National Observatory (KPNO) CCD spectrogram centered at Hγ with the predictions of ATLAS9 solar composition models (Kurucz 1993) by employing SYNTHE (Kurucz & Avrett 1981) to calculate a 200 Å wide spectral region centered at 4340 Å to confirm the surface gravity.

The HgMn star HR 4817 (= HD 110073) ($v \sin i$ = 23 km s^{-1}) was most recently studied by Adelman & Philip (1994). Using photometry as for 7 Sex, these investigators found $T_{\rm eff}$ = 12900 K, $\log g$ = 3.72. In many respects it is similar to the peculiar HgMn star 53 Tau, but it is one of the most He normal members of its class.

For 7 Sex and HR 4817, we could not improve determination of effective temperature and surface gravity. But for μ Lep and 28 Her 20.4 Å mm^{-1} DAO Reticon spectrograms containing the Hγ profile were obtained. When we compared spectrophotometry and the Hγ profile with the predictions of ATLAS9 model atmospheres we found for μ Lep $T_{\rm eff}$ = 12400 K, $\log g$ = 3.80 for both solar and +[0.2] enhanced models, which are slightly different from those of Adelman (1987). For 28 Her, we used *uvbyβ* photometry and the calibration of Napiwotzki et al. (1993) to find $T_{\rm eff}$ = 10906 K, $\log g$ = 3.86. As the predicted Hγ profile of a 10900 K, $\log g$ = 3.85 solar composition ATLAS9 model agreed with the observations, we adopted this model which means 28 Her is slightly hotter and has a slightly greater surface gravity than found by Adelman (1988). Allowing for the differences in helium abundances between the models and the stars (see below), $\log g$ = 3.91 for μ Lep and 3.96 for 28 Her.

2. Reduction of spectrograms

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 1 (Reader & Corliss 1980) as well as the more specialized references P II (Svendenius et al. 1983), P III (Magnusson & Zetterberg 1987), Mn II (Iglesias & Velasco 1964), Fe II (Johansson 1978), and Ga II (Isberg & Litzen 1985). We measured CASLEO spectrograms which cover 4522 – 5589 Å for μ Leo, 4450 – 5057 Å for 7 Sex, 4422 – 5607 Å for HR 4817, and 4521 – 5617 Å for 28 Her. Although these spectra extended further into the blue, we did not utilize these regions as they were too heavily line blanketed at our dispersion for equivalent width comparisons.

For 7 Sex, the previous spectroscopic material consisted of 4.7 Å mm^{-1} KPNO CCD spectrograms covering approximately 3907 – 3962 Å, 4118 – 4168 Å, and 4207 – 4542 Å and a DAO 2.4 Å mm^{-1} Reticon spectrogram of 4541 – 4601 Å. In the region of overlap 4450 – 4601 Å, comparison of the equivalent widths of 18 unblended lines yields

$$W_\lambda(\text{CASLEO}) = 0.9873\, W_\lambda(\text{DAO or KPNO}) + 3.927$$

which indicates good agreement except for a minor offset in the zero point.

For μ Lep, the previous analysis used coadded 2.4 Å mm^{-1} DAO IIaO spectrograms (9 U plates and 11 V plates). Comparison of 17 equivalent widths in the 4534 – 4636 Å region yields

$$W_\lambda(\text{CASLEO}) = 1.106\, W_\lambda(\text{DAO}) - 3.293$$

and for 28 Her whose previous analysis also used a similar coaddition (14 U and 20 V plates), comparison of 20 equivalent widths in the $\lambda\lambda$4522 – 4639 region, yields

$$W_\lambda(\text{CASLEO}) = 1.173\, W_\lambda(\text{DAO}) - 2.713,$$

a result which is in not as good agreement.

For HR 4817, the previous spectroscopic material is 4.7 Å mm^{-1} KPNO CCD spectrograms covering approximately 3915 – 3953 Å, 4120 – 4169 Å, 4218 – 4269 Å, and 4435 – 4593 Å. In the region of overlap 4422 – 4593 Å, comparison of the equivalent widths of 18 lines yields

$$W_\lambda(\text{CASLEO}) = 1.0098\, W_\lambda(\text{KPNO}) + 1.073$$

in better agreement than for 7 Sex.

Thus the CASLEO equivalent width scale is marginally larger than that based on KPNO CCD and DAO Reticon spectrograms. The discrepancies with the photographic DAO equivalent widths may well reflect problems with the calibration and continuum placement. But please note that only isolated lines which were typically 15 mÅ and larger were used for the comparison.

Table 1. He/H Values

λ(Å)	μ Lep	7 Sex	HR 4817	28 Her
4009	0.02	...	...	...
4026	0.03	...	...	0.01
4120	0.03	...	...	...
4144	0.02	...	0.06	...
4388	0.04	0.10	...	0.01
4438	0.03	...	...	0.01
4472	0.02	0.12	0.04	0.02
4713	0.02	0.11	0.04	0.01
4921	0.02	0.08	...	...
average	0.03	0.10	0.05	0.01

Table 2. Determination of the microturbulences

Star	Species	gf values	n	ξ_1 km/s	log Fe/$N_{\rm T}$	ξ_2 km/s	log Fe/$N_{\rm T}$
7 Sex	Fe I	MF+KX	51	1.7	-4.19 ± 0.25	1.6	-4.19 ± 0.25
		MF	46	1.7	-4.22 ± 0.23	1.7	-4.22 ± 0.23
	Fe II	MF+KX	67	1.5	-4.35 ± 0.26	1.4	-4.33 ± 0.26
		MF	37	1.8	-4.48 ± 0.19	1.8	-4.48 ± 0.19
	adopted			1.7			
μ Lep	Fe II	MF+KX	107	0.2	-4.60 ± 0.24	0.4	-4.61 ± 0.23
		MF	44	0.3	-4.67 ± 0.25	0.4	-4.68 ± 0.28
	adopted			0.3			
HR 4817	Fe II	MF+KX	65	0.0	-4.85 ± 0.27	0.0	-4.85 ± 0.27
		MF	25	0.0	-4.94 ± 0.23	0.0	-4.94 ± 0.23
	adopted			0.0			
28 Her	Fe I	MF+KX	90	0.0	-4.37 ± 0.31	0.0	-4.37 ± 0.31
			83	0.0	-4.38 ± 0.32	0.0	-4.38 ± 0.32
	Fe II	MF+KX	223	0.2	-4.35 ± 0.22	0.0	-4.35 ± 0.22
		MF	56	0.5	-4.40 ± 0.20	0.5	-4.40 ± 0.20
	adopted			0.2			

Reference: MF = Fuhr et al. (1988).
KX = Kurucz (1993).

3. The elemental abundance analyses

We used programs SYNSPEC (Hubeny et al. 1994) and WIDTH9 (Kurucz, private communication, respectively, to determine the helium and metal abundances. The adopted metal-line damping constants were the default semi-classical approximations, except for iron-peak element lines, whose values were based on the data of Kurucz (1993). We applied a 3% scattered light correction to account for light scattered along the direction of the dispersion, which is an appropriate value for clean optical systems (Gulliver et al. 1996).

Table 1 contains both the derived He/H ratios from lines on the CASLEO spectrograms (λ4713 and λ4921) and the older modern spectroscopic material. The slight changes in the effective temperature and surface gravity help increase the He/H ratio of μ Lep. The values derived from the CASLEO equivalent widths for this star are slightly less than those from the DAO equivalent widths. The CASLEO values make 7 Sex appear to be slightly more solar-like. The λ4713 values confirm the relatively high He/H ratio for the HgMn star HR 4817 and the relatively low He/H ratio for 28 Her.

Table 2 summarizes the determination of the microturbulence using Fe I and Fe II lines. The derived abundances are independent of the equivalent width (ξ_1) and result in a minimum scatter about the mean (ξ_2). For μ Lep and 28 Her, we find microturbulences of 0.3 and 0.2 km s^{-1}, respectively, rather than zero as previously found for these and most HgMn stars. The use of additional lines makes the values from both species agree better for 7 Sex. For HR 4817, the Fe II lines still indicate no microturbulence. Now there are substantially more lines and a determination can be done just with MF gf values.

Tables 3-6 (which are available only in electronic form) contain the metal line results from our spectra. For each new line, they contain the multiplet number, the wavelength in Å, the equivalent width in mÅ, the gf value and its source, and the derived abundance ($\log N/N_{\rm T}$) where $N_{\rm T}$ is the total number of atoms per unit volume.

The CASLEO spectrograms for μ Lep increase the number of lines analyzed relative to Adelman (1987). Of special interest is the detection of Hg I (1) 5460.74 whose derived abundance is in excellent agreement with those from Hg I (1) 4358.34 and Hg II 3983.96. The slight changes in effective temperature and surface gravity produce minor changes in the abundances by of order 0.1 dex. The agreement between values derived from species of the same element is marginally worse suggesting some further small adjustments in the effective temperature and surface gravity may be required.

For 7 Sex, the CASLEO spectrograms yield new abundances for C I and Y II lines and improved values especially for Mg I, S II, and Mn II lines. Most abundances are slightly closer to solar (Anders & Grevesse 1989 as updated in Adelman 1996) than the previous study by Adelman & Philip (1996). The CASLEO values confirm

Table 7. Comparison of Superficially Normal Star and Solar Abundances (log N/H)

Species	κ Cep	ν Cap	7 Sex	α Dra	Merak	o Peg	21 Lyn	Sun
He I	−1.08	−1.19	−1.00	−1.04	−1.52	−1.26	−1.10	−1.04
C I	−3.78	...	−2.97	−3.91	−3.68	...	−3.71	−3.43
C II	−3.62	−3.39	−2.81	−3.51	−3.76	−4.40	...	−3.43
O I	...	−3.33	−2.94	−3.49	...	−3.36	...	−3.09
Mg I	−4.41	−4.71	−3.99	−4.61	−4.46	−4.49	−4.86	−4.42
Mg II	−4.55	−4.61	−4.27	−4.86	−4.59	−4.54	−4.79	−4.42
Al I	−5.97	−6.03	−5.82	−6.07	−5.43	−5.58	−6.06	−5.53
Al II	−5.66	...	...	−5.76	−5.28	...	...	−5.53
Si I	...	...	...	...	...	−4.69	...	−4.45
Si II	−4.56	−4.69	−4.40	−4.89	−4.49	−4.43	−4.53	−4.45
S II	−4.65:	−4.85	−3.99	−4.60	...	−4.00	...	−4.79
Ca I	−5.71	−5.98	−5.05	−6.28	−5.75	−5.61	−6.00	−5.64
Ca II	−5.41	−5.55	−5.24	−5.61	−5.28	−5.43	−5.66	−5.64
Sc II	−9.20	−9.34	−8.64	−9.41	−9.20	−9.30	−9.39	−8.90
Ti II	−6.91	−7.05	−6.78	−7.10	−6.85	−6.86	−7.15	−7.01
V II	−8.03	−7.64	−7.88	−8.04	−7.46	−7.31	−7.79	−8.00
Cr I	−6.13	−6.20	−5.79	−6.26	−6.08	−6.16	−6.50	−6.26
Cr II	−6.21	−6.13	−5.96	−6.34	−6.10	−6.17	−6.41	−6.26
Mn I	...	...	...	−6.84	−6.53	−6.42	−6.89	−6.45
Mn II	−6.28	−6.69	−5.65	−6.54	−6.12	−6.22	−6.45	−6.45
Fe I	−4.54	−4.58	−4.16	−4.81	−4.28	−4.32	−4.70	−4.52
Fe II	−4.58	−4.47	−4.37	−4.71	−4.34	−4.35	−4.63	−4.52
Co I	...	...	...	...	...	−6.54	−6.67	−7.08
Ni I	−5.82	−5.67	...	...	−5.10	−5.31	−5.71	−5.75
Ni II	−5.87	−5.67	−5.64	−5.91	−5.00	−5.00	−5.48	−5.75
Zn I	...	...	...	...	−6.00	...	...	−7.40
Sr II	−8.79	−8.77	−9.12	−9.52	−8.35	−8.01	−8.30	−9.10
Y II	...	...	−9.40	...	−8.97	−9.13	−9.65	−9.76
Zr II	−8.99	−9.36	−8.93	...	−8.44	−8.43	−8.94	−9.44
Ba II	...	−9.29	−9.69	−10.07	−8.62	−8.49	−9.29	−9.87
T_{eff}	10325	10250	10135	10025	9600	9600	9500	
$\log g$	3.70	3.90	3.69	3.75	3.83	3.60	3.75	
ξ (km/s)	0.3	0.0	1.8	0.0	2.5	1.8	1.6	

the S and Mn overabundances. The discrepancies between the iron values derived from Fe I and Fe II lines can be reduced by making the star slightly cooler. The star appears to be slightly metal rich compared to the Sun and to the other superficially normal stars with effective temperatures near 10000 K in Table 7 (Adelman 1996 and references therein). This is consistent with the idea that 7 Sex might be the product of a binary having coalest.

New abundances have been derived from O I, Mg I, and P II lines found on the CASLEO spectrograms of HR 4817. The star is both O and Mg normal while being slightly P rich. Further the abundances from Mn I and II lines have been brought in better agreement.

The CASLEO spectrograms for 28 Her increase the number of lines analyzed relative to Adelman (1988). We now have an abunance of O I which suggests a slight deficiency. For the most part the changes in stellar parameters make the star slightly more metal rich.

4. Final comments

Table 8 compares the abundances of the HgMn stars with those from Adelman (1994) and shows that they fall within the general systematics. To see what correlations of abundance exist, we examined those which are available for all the stars in the table (He I, C II, Si II, Mg II, Si II, S II, Ca II, Ti II, Cr II, Mn II, Fe II, and Y II) with one another and with surface gravity and effective temperature. The correlation is regarded as significant if there is less than one chance in 20 that this value will occur by chance. For 14 items, the absolute value of r must be greater than 0.532 (Bevington & Robinson 1992). Those correlations with absolute r values greater than this are given in Table 9. However, relative to Adelman's (1992, 1994) similar analyses with smaller number of HgMn stars, only the strongest correlations are found in common. Thus there is no question that the He, Mg, Cr abundances

Table 8. Comparison of HgMn star abundances (log N/H)

Species	HR 7361	κ Cnc	HR 8349	HR 4817	HR 7664	π^1 Boo	μ Lep	53 Tau	ν Her	ϕ Her	HR 4072A	28 Her	HR 7775	ν Cnc	Sun
He I	-2.00	-2.26	-1.72	-1.30	-2.10	-1.72	-1.57	-1.80	-1.82	-1.62	-1.46	-2.00	-1.60	-1.57	(-1.01)
C I	...	...	...	...	...	...	...	...	...	...	-3.37	...	...	...	-3.34
C II	-3.89	-3.97	-3.54	-3.84	-3.88	-3.81	-3.68	-3.95	-4.07	-3.58	-3.23	-3.94	-4.10	-3.88	-3.34
O I	-3.23	...	...	-3.03	...	-3.43	...	...	...	...	...	-3.37	-3.58	...	-3.07
O II	-2.82	...	-2.59	...	...	-2.76	...	...	...	...	...	...	...	...	-3.07
Mg I	...	-5.17	-5.27	-4.51	...	-5.20	-5.17	...	-5.56	-5.28	-4.65	-5.51	-4.74	-4.66	-4.42
Mg II	-5.14	-5.17	-4.94	-4.76	-5.75	-4.79	-4.76	-4.94	-5.08	-4.80	-4.57	-5.26	-4.67	-4.71	-4.42
Al I	...	...	-6.29	...	...	...	...	...	...	...	-6.42	...	-6.69	-6.38	-5.53
Al II	...	...	...	...	...	...	...	...	...	...	-6.85	...	...	...	-5.53
Si I	...	...	...	...	...	...	...	...	...	...	...	...	...	-4.78	-4.45
Si II	-4.19	-4.48	-4.16	-4.76	-4.48	-4.31	-4.29	-4.65	-4.82	-4.64	-4.53	-4.78	-4.50	-4.50	-4.45
Si III	-4.56	-4.47	-4.26	-4.86	-4.80	-4.47	-4.22	-4.59	-4.85	...	...	...	...	...	-4.45
P II	-4.52	-4.73	-4.65	-6.25	-4.99	-5.66	-5.41	...	-5.82	...	-5.54	-5.60	-5.59	...	-6.55
P III	-4.45	-4.77	-4.88	...	...	...	...	...	...	...	...	...	...	...	-6.55
S II	-5.66	-5.56	-5.08	-5.06	-5.48	-5.24	-4.68	-5.34	-5.29	-4.91	-4.64	-4.35	-4.72	-5.05	-4.79
Ca I	...	...	...	...	...	...	...	-5.34	...	-5.20	-5.24	-6.11	-5.24	-6.21	-5.64
Ca II	-4.93	-5.67	-4.95	-5.36	-5.55	-5.17	-5.27	-5.02	-5.83	-5.36	-4.80	-5.51	-5.25	-6.06	-5.64
Sc II	-7.94	-8.37	-7.67	-7.69	-9.14	-7.64	-8.43	-9.54	-9.06	-7.47	-8.40	...	-9.55	-8.19	-8.90
Ti II	-6.83	-6.82	-6.86	-5.50	-6.20	-6.75	-6.41	-5.76	-6.26	-6.37	-6.16	-6.82	-6.08	-6.38	-7.01
V II	...	-7.60	...	...	...	...	<-7.44	...	...	...	-8.68	...	-8.18	-8.20	-8.00
Cr I	...	...	...	...	...	...	...	-5.80	...	-5.18	-5.69	-5.90	-5.75	-5.73	-6.33
Cr II	-6.15	-6.42	-6.11	-5.40	-6.70	-5.69	-5.89	-5.89	-6.12	-5.50	-5.62	-6.16	-5.72	-5.88	-6.33
Mn I	-3.97	-4.39	-4.28	-3.97	...	-4.07	-4.58	-4.45	-4.70	-4.92	-5.51	-5.62	-5.83	-6.21	-6.61
Mn II	-4.10	-4.45	-4.16	-4.04	-5.42	-4.18	-4.45	-4.68	-4.88	-5.08	-5.38	-5.48	-5.84	-5.84	-6.61
Fe I	-4.23	-4.49	-4.65	...	-3.96	-4.84	-4.77	-5.28	-4.76	-4.35	-4.00	-4.37	-4.12	-4.44	-4.52
Fe II	-4.41	-4.57	-4.46	-4.87	-3.97	-4.88	-4.62	-5.24	-4.85	-4.59	-4.08	-4.35	-4.22	-4.60	-4.52
Fe III	-4.26	-4.44	-4.22	...	-4.04	-4.64	-4.67	-4.65	-4.68	-4.64	-3.97	-4.32	-4.08	...	-4.52
Ni I	...	...	...	...	...	...	...	...	...	...	...	...	...	-5.58	-5.75
Ni II	-6.21	-6.18	-6.11	...	-6.15	-6.77	-6.32	-6.49	-6.77	-6.26	-6.62	...	-6.60	-5.62	-5.75
Ga II	-4.81	-4.75	...	-5.79	-6.14	-4.86	-4.44:	-6.41	-5.64	-6.00	...	...	-5.34	...	-9.12
Sr II	-8.46:	-8.54	-7.88	...	-8.75	-6.84	-7.32	-8.17	-8.10	-8.34	-6.49	-6.62	-6.48	-8.01	-9.10
Y II	-7.59	-8.33	-7.17	-7.71	-8.21	-6.36	-7.14	-8.20	-7.76	-6.72	-6.56	-6.67	-6.94	-7.76	-9.76
Zr II	...	...	-7.33	...	...	...	<-8.34	-7.49	-8.95	-7.32	-8.04	-8.53	-8.73	-7.60	-9.40
Xe II	-5.22	-5.60	...	...	...	...	...	...	...	...	...	...	...	...	(-9.77)
Ba II	...	...	...	...	...	...	...	<-9.55	-8.85	<-8.06	-9.14	<-9.81	-9.70	<-6.97	-9.87
La II	...	...	...	...	...	...	...	...	...	...	-9.29	...	...	...	-10.78
Pr II	...	...	...	...	...	...	...	...	...	...	...	...	-7.72	...	-11.29
Nd II	...	...	...	...	...	...	...	...	...	...	...	...	-7.82	...	-10.50
Gd II	...	...	-7.95	...	...	...	...	...	...	...	...	...	-9.15	-9.29	-10.88
Ho II	...	...	...	...	...	...	...	...	...	...	...	...	-8.90	...	-11.7
Tm II	...	...	...	...	...	...	...	...	...	...	...	...	-9.47	...	-12.00
Pt I	...	...	...	...	...	...	...	...	...	...	...	...	-5.53:	...	-10.2
Pt II	...	...	-7.80:	...	...	...	...	...	...	...	-7.32:	-7.68:	-7.23:	...	-10.2
Au II	...	...	...	...	...	...	...	...	...	...	-7.34:	...	-7.18:	...	-10.99
Hg I	...	...	...	...	...	...	-5.73	...	-6.02	-6.33	-5.67	...	-5.90	...	(-10.91)
Hg II	-6.00	-5.98	-5.67	...	-7.40	-5.27	-5.65	...	-5.76	-6.38	-5.83	-7.80	-6.06	-7.80	(-10.91)
T_{eff}	13300	13125	12975	12900	12875	12700	12400	12000	11900	11325	10900	10900	10650	10650	
log g	3.75	3.59	3.90	3.72	3.51	4.02	3.91	4.21	3.74	3.79	4.07	3.96	4.13	4.13	

correlate with one another and that the Mn abundance is a function of temperature. The *S* and *Y* abundances correlate with one another. But we should cautiously regard the other correlations.

Table 9. Definite Correlations

Compared Values	r
He I Mg II	0.816
He I Ti II	0.567
He I Cr II	0.875
C II Ca II	0.535
Mg II Cr II	0.876
Si II Ti II	−0.539
S II Y II	0.686
S II $T_{\rm eff}$	−0.690
Ca II $\log g$	0.650
Cr II Y II	0.548
Mn II $T_{\rm eff}$	0.853
Y II $\log g$	0.533

These studies showed that the CASLEO spectra have increased the quality of previous analyses. Further the CASLEO equivalent width scale is similar to those for KPNO and DAO spectrograms. Our studies also indicate that for the HgMn stars there are probably a sufficient number of Fe II to determine the microturbulence using the region 4500 − 5000 Å. Thus elemental abundance analyses of such stars based solely on CASLEO spectrograms in the yellow are anticipated to produce good results.

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Table 3. The analysis of the metal lines of 7 Sex

mult.	λ|(Å)	log gf	Ref	W_λ (mÅ)	log N/N_T
C I (3 lines)			(log C/N_T = -3.02 ± 0.30)		
6	4771.72	-1.70	WS	62	-2.61
12	5052.12	-1.49	WS	32	-3.15
13	4932.00	-1.78	WS	14	-3.30
C II (3 lines)			(log C/N_T = -2.86 ± 0.12)		
O I (1 line)			(log O/N_T = -2.99)		
(Mg I (2 lines)			log Mg/N_T = -4.04 ± 0.06)		
11	4702.98	-0.58	WS	41	-4.09
Mg II (4 lines)		(log Mg/N_T = -4.32 ± 0.17)			
Al I (2 lines)			(log Al/N_T = -5.87 ± 0.30)		
Si II (2 lines)			(log Si/N_T = -4.45 ± 0.05)		
S II (3 lines)			(log S/N_T = -4.04 ± 0.23)		
9	4815.52	-0.05	WS	17	-3.89
15	4917.21	-0.40	WS	4	-4.36
Ca I (3 lines)			(log Ca/N_T = -5.10 ± 0.35)		
Ca II (1 line)			(log Ca/N_T = -5.29)		
Sc II (4 lines)			(log Sc/N_T = -8.69 ± 0.20)		
Ti II (40 lines)			(log Ti/N_T = -6.83 ± 0.26)		
47	4708.65	-2.22	MF	17	-6.61
92	4779.98	-1.37	MF	23	-6.84
	4805.09	-1.10	MF	42	-6.70
114	4874.01	-0.79	MF	18	-6.93
	4911.18	-0.34	MF	24	-7.21
V II (2 lines)			(log V/N_T = -7.93 ± 0.20)		
Cr I (2 lines)			(log Cr/N_T = -5.84 ± 0.04)		
Cr II (22 lines)			(log Cr/N_T = -6.01 ± 0.31)		
24	4824.12	-1.22	MF	66	-5.87
44	4616.64	-1.29	MF	39	-6.24
	4618.82	-1.11	MF	57	-6.05
	4634.10	-1.24	MF	60	-5.87
30	4836.22	-2.25	MF	16	-5.93
	4848.24	-1.14	MF	34	-6.60
	4876.41	-1.46	MF	58	-5.81
Mn II (5 lines)			(log Mn/N_T = -5.70 ± 0.29)		
5	4738.30	-2.24	KX	13	-5.32
	4755.73	-1.24	KX	30	-5.81
-	4764.73	-1.35	KX	38	-5.53
Fe I (51 lines)			(log Fe/N_T = -4.21 ± 0.24)		
318	4878.21	-1.01	MF	10	-3.96
	4891.49	-0.14	MF	43	-3.95
	4920.50	0.06	MF	35	-4.32
554	4707.28	-1.08	MF	7	-3.85
	4736.77	-0.74	MF	15	-3.83
687	4966.09	-0.89	MF	9	-3.89
Fe II (67 lines)			(log Fe/N_T = -4.42 ± 0.23)		
25	4670.17	-3.97	KX	23	-4.19
36	4993.35	-3.65	MF	36	-4.09
37	4629.34	-2.37	MF	76	-4.55
	4666.75	-3.33	MF	30	-4.53
38	4620.51	-3.28	MF	27	-4.66
42	4923.93	-1.32	MF	113	-4.64
43	4731.44	-3.36	MF	43	-4.19
	5018.45	-1.22	MF	146	-4.03
186	4625.91	-2.22	KX	31	-3.89
	4635.33	-1.65	MF	25	-4.62
218	4913.29	0.01	KX	11	-4.53
-	4638.05	-1.47	KX	14	-4.25
	4640.84	-1.81	KX	8	-4.21
	4908.15	-0.30	KX	4	-4.67
	4948.10	-0.32	KX	19	-3.81
	4951.58	0.18	KX	13	-4.58
	4977.03	0.18	KX	27	-4.06
	5004.20	0.50	KX	20	-4.62
	5021.59	-0.30	KX	18	-3.88
	5030.63	0.40	KX	33	-4.10
	5035.71	0.61	KX	41	-4.13
	5047.64	-0.07	KX	23	-3.92
Ni II (2 lines)			(log Ni/N_T = -5.69 ± 0.03)		
Sr II(1 line)			(log Sr/N_T = -9.17)		
Y II (1 line)			(log Ni/N_T = -9.45)		
22	4883.68	0.07	HL	7	-9.45
Zr II (1 line)			(log Zr/N_T = -8.98)		
Ba II (1 line)			(log Ba/N_T = -9.74)		

Table 4. The analysis of the metal lines of HR 4817

mult.	λ(Å)	log gf	Ref	W_λ (mÅ)	log N/N_T
C II (3 lines)			(log C/N_T = -3.87 ± 0.21)		
O I (3 lines)			(log O/N_T = -3.06 ± 0.13)		
12	5328.98	-1.24	WF	13	-3.06
	5329.59	-1.06	WF	13	-3.23
	5330.66	-0.88	WF	29	-2.91
Mg I (2 lines)			(log Mg/N_T = -4.54 ± 0.21)		
2	5172.68	-0.28	WS	11	-4.39
	5183.60	-0.16	WS	8	-4.68
Mg II (1 line)			(log Mg/N_T = -4.79)		
Si II (1 lines)			(log Si/N_T = -4.79)		
Si III(1 lines)			(log Si/N_T = -4.89)		
P II (3 lines)			(log P/N_T = -6.28 ± 0.30)		
10	5425.88	0.19	WS	3	-6.69
	5253.47	0.33	WS	13	-5.96
15	4602.08	0.74	WS	6	-6.20
S II (8 lines)			(log S/N_T = -5.09 ± 0.30)		
6	5432.82	0.21	WS	12	-5.11
	5454.38	0.44	WS	11	-5.37
Ca II (1 line)			(log Ca/N_T = -5.39)		
Sc II (1 line)			(log Sc/N_T = -7.72)		
Ti II (24 lines)			(log Ti/N_T = -5.53 ± 0.32)		
17	4762.78	-2.71	MF	19	-4.87
69	5336.78	-1.70	MF	37	-5.10
	5381.01	-2.08	MF	7	-5.84
70	5188.69	-1.21	MF	20	-6.09
	5226.53	-1.30	MF	57	-4.93
86	5185.90	-1.35	MF	26	-5.63
113	5072.28	-0.75	KX	13	-6.10
Cr II (23 lines)			(log Cr/N_T = -5.43 ± 0.32)		
23	5346.54	-2.95	KX	10	-4.92
	5407.60	-2.09	KX	7	-5.92
43	5232.50	-2.09	KX	11	-5.54
	5237.35	-1.16	MF	40	-5.52
	5274.96	-1.29	KX	27	-5.78
	5308.44	-1.81	MF	19	-5.53
	5334.88	-1.56	KX	14	-5.93
44	4616.64	-1.29	MF	29	-5.76
	4618.82	-1.11	MF	51	-5.28
	4634.10	-1.24	MF	39	-5.50
50	5502.07	-1.99	MF	12	-5.56
	5503.21	-2.31	KX	8	-5.44
Mn I (3 lines)		(log Mn/N_T = -3.99 ± 0.03)			
Mn II (42 lines)			(log Mn/N_T = -4.07 ± 0.33)		
-	4717.26	-1.86	KX	29	-4.08
	4727.84	-2.02	KX	56	-3.57
	4730.40	-2.15	KX	48	-3.72
	4742.95	-2.98	KX	23	-3.68
	4749.11	-2.00	KX	14	-4.61
	4764.73	-1.35	KX	79	-3.50
	5102.52	-1.93	KX	47	-3.68
	5107.09	-1.48	KX	37	-3.80
	5123.33	-1.88	KX	32	-4.20
	5294.32	-0.04	KX	41	-3.95
	5295.38	0.66	KX	67	-3.86
	5297.00	0.83	KX	69	-3.98
	5299.30	0.40	KX	55	-3.94
	5307.51	-2.07	KX	10	-4.30
	5331.99	-0.15	KX	18	-3.63
	5421.92	-2.18	KX	19	-4.23
	5501.07	-1.75	KX	17	-4.57
	5559.05	-1.32	KX	44	-4.24
	5570.51	-1.44	KX	53	-3.81
	5578.15	-1.40	KX	62	-3.54
Fe II (65 lines)			(log Fe/N_T = -4.90 ± 0.25)		
25	4670.17	-3.97	KX	6	-4.43
37	4629.34	-2.37	MF	28	-5.02
41	5284.10	-3.19	MF	12	-4.71
42	5018.45	-1.22	MF	60	-5.07
43	4656.87	-3.63	MF	9	-4.42
	4731.44	-3.36	MF	10	-4.63
49	5234.62	-2.05	MF	31	-5.03
	5276.00	-1.94	MF	34	-5.08
55	5534.83	-2.93	MF	23	-4.38
166	5544.76	0.12	KX	9	-4.66
186	4625.91	-2.22	KX	2	-5.09
	4635.33	-1.65	MF	14	-4.76
205	5093.58	0.11	KX	11	-4.67
-	4596.02	-1.84	KX	11	-4.58
	5022.79	-0.02	KX	16	-4.34
	5030.63	0.40	KX	31	-4.25
	5035.71	0.61	KX	17	-4.93
	5047.64	-0.07	KX	15	-4.32
	5070.90	0.24	KX	11	-4.82
	5097.27	0.31	KX	13	-4.76
	5106.11	-0.19	KX	10	-4.46
	5150.49	-0.12	KX	6	-4.75
	5216.85	0.81	KX	12	-5.24
	5227.48	0.80	KX	18	-5.00
	5254.93	-3.23	KX	7	-4.80
	5260.26	1.07	KX	21	-5.15
	5291.67	0.58	KX	9	-5.19
	5339.58	0.54	KX	27	-4.38
	5362.87	-2.74	KX	21	-4.67
	5387.06	0.52	KX	8	-5.14
	5395.86	0.36	KX	7	-5.03
	5402.06	0.50	KX	16	-4.72
	5429.99	0.46	KX	7	-5.12
	5482.31	0.43	KX	8	-5.02
	5487.62	0.36	KX	12	-4.74
	5506.20	0.95	MF	15	-5.20
Ga II (2 lines)			(log Ga/N_T = -5.80 ± 0.07)		
Y II (1 line)			(log Y/N_T = -7.74)		

Table 5. The analysis of the metal lines of μ Lep

mult.	λ(Å)	log gf	Ref	W_λ(mÅ)	log N/N_T
C II (3 lines)					(log C/N_T = -3.66 ± 0.21)
Mg I (3 lines)					(log Mg/N_T = -5.19 ± 0.14)
2	5183.60	-0.16	WS	5	-5.20
Mg II (5 lines)					(log Mg/N_T = -4.78 ± 0.04)
Si II (5 lines)					(log Si/N_T = -4.31 ± 0.15)
Si III (2 lines)					(log Si/N_T = -4.24 ± 0.25)
P II (9 lines)					(log P/N_T = -5.33 ± 0.18)
6	5425.88	+0.19	WS	29	-5.10
10	5253.47	+0.33	WS	27	-5.26
S II (13 lines)					(log S/N_T = -4.70 ± 0.25)
6	5428.67	-0.17	WS	5	-5.16
	5432.82	+0.21	WS	24	-4.35
	5454.38	+0.44	WS	17	-4.88
9	4815.52	-0.05	WS	16	-4.64
Ca II (1 line)					(log Ca/N_T = -5.27)
Sc II (3 lines)					(log Sc/N_T = -8.45 ± 0.10)
Ti II (34 lines)					(log Ti/N_T = -6.43 ± 0.20)
70	5226.53	-1.30	MF	29	-5.95
86	5185.90	-1.35	MF	12	-6.30
92	4779.98	-1.37	MF	7	-6.47
V II (1 line)					(log V/N_T = <-7.46)
Cr II (31 lines)					(log Cr/N_T = -5.91 ± 0.27)
30	4812.34	-1.80	MF	17	-5.87
	4824.12	-1.22	MF	52	-5.37
	4836.22	-2.25	MF	6	-5.92
	4848.24	-1.14	MF	45	-5.69
	4876.41	-1.46	MF	39	-5.52
43	5308.44	-1.81	MF	14	-5.82
	5232.50	-2.09	KX	7	-5.96
	5237.35	-1.16	MF	41	-5.66
	5429.99	0.46	KX	7	-5.12
	5334.88	-1.56	KX	22	-5.80
190	4901.62	-0.83	KX	16	-5.61
Mn I (7 lines)					(log Mn/N_T = -4.60 ± 0.32)
Mn II (90 lines)					(log Mn/N_T = -4.47 ± 0.30)
-	4689.56	-2.54	KX	14	-4.23
	4717.26	-1.86	KX	11	-4.82
	4727.84	-2.02	KX	42	-4.21
	4730.40	-2.15	KX	23	-4.64
	4738.30	-2.24	KX	45	-3.87
	4742.95	-2.98	KX	16	-4.06
	4749.11	-2.00	KX	17	-4.59
	4755.73	-1.24	KX	59	-4.43
	4764.73	-1.35	KX	41	-4.89
	4791.78	-1.72	KX	29	-4.51
	4806.82	-1.56	KX	40	-4.67
	4811.62	-2.34	KX	13	-4.77
	4830.06	-1.85	KX	20	-4.64
	4839.74	-1.86	KX	17	-4.76
	4842.32	-2.00	KX	17	-4.60
	4920.44	-2.09	KX	20	-4.75
	4921.23	-1.58	KX	29	-4.43
	5251.82	-1.83	KX	5	-4.99
	5299.30	+0.40	KX	53	-4.11
	5307.51	-2.07	KX	8	-4.53
	5501.70	-1.75	KX	10	-4.96
	5559.05	-1.32	KX	58	-3.92
	5578.15	-1.40	KX	53	-4.00
Fe I (10 lines)					(log Fe/N_T = -4.79 ± 0.18)
Fe II(107 lines)					(log Fe/N_T = -4.64 ± 0.24)
36	4993.35	-3.65	MF	16	-4.23
41	5284.10	-3.19	MF	19	-4.51
42	4923.93	-1.32	MF	84	-4.31
43	4731.44	-3.36	MF	26	-4.16
49	5276.00	-1.94	MF	30	-5.27
	5425.25	-3.36	MF	5	-4.95
218	4913.29	+0.01	KX	13	-4.51
-	4820.83	-0.69	KX	6	-4.22
	4951.58	+0.18	KX	11	-4.77
	4977.03	+0.04	KX	11	-4.64
	4984.48	+0.01	KX	11	-4.60
	4990.51	+0.18	KX	19	-4.41
	5001.96	+0.90	KX	35	-4.63
	5004.20	+0.50	KX	22	-4.67
	5006.80	-0.43	KX	8	-4.32
	5007.74	-0.20	KX	7	-4.61
	5009.02	-0.42	KX	3	-4.76
	5022.79	-0.02	KX	11	-4.58
	5030.63	+0.40	KX	22	-4.53
	5032.71	+0.11	KX	13	-4.55
	5061.72	+0.22	KX	16	-4.59
	5067.89	-0.20	KX	11	-4.58
	5082.23	-0.10	KX	7	-4.71
	5089.21	-0.04	KX	11	-4.52
	5070.90	+0.24	KX	14	-4.67
	5093.58	+0.11	KX	16	-4.42
	5097.27	+0.31	KX	22	-4.39
	5216.85	+0.81	KX	19	-4.95
	5227.48	+0.80	KX	35	-4.39
	5234.62	-2.05	MF	51	-4.51
	5247.95	+0.63	MF	22	-4.62
	5251.23	+0.51	KX	17	-4.69
	5306.18	+0.22	KX	25	-4.10
	5325.55	-2.60	KX	16	-5.06
	5362.87	-2.74	KX	43	-4.08
	5375.85	-0.29	KX	10	-4.24
	5387.06	+0.52	KX	23	-4.49
	5395.86	+0.36	KX	11	-4.78
	5402.06	+0.50	KX	29	-4.22
	5427.83	-1.66	KX	12	-4.50
	5429.99	+0.46	KX	12	-4.82
	5482.31	+0.43	KX	12	-4.79
	5487.62	+0.36	KX	21	-4.34
	5506.20	+0.95	MF	17	-5.12
Fe III (1 line)					(log Fe/N_T = -4.69)
Ni II (1 line)					(log Ni/N_T = -6.34)
Ga II (2 lines)					(log Ga/N_T = -4.46 ± 0.46)
Sr II (3 lines)					(log Sr/N_T = -7.34 ± 0.17)
Y II (17 lines)					(log Y/N_T = -7.14 ± 0.24)
20	5205.73	-0.34	HL	24	-7.01
22	4823.30	-1.10	HL	10	-6.83
	4883.68	+0.07	HL	48	-6.44
	4854.86	-0.38	HL	12	-7.48
	4900.12	-0.09	HL	29	-7.09
Zr II (1 line)					(log Zr/N_T ≤-8.36)
Hg I (2 line)					(log Hg/N_T = -5.75 ± 0.03)
1	5460.74	+0.45	MW	16	-5.73
Hg II (1 line)					(log Hg/N_T = -5.67)

Table 6. The analysis of the metal lines of 28 Her

mult.	λ(Å)	log gf	Ref	W_λ(mÅ)	log N/N_T
C II (3 lines)					log C/N_T = -3.93 ± 0.10)
0 I (2 lines)					(log O/N_T = -3.38 ± 0.48)
12	5329.59	-1.06	WF	25	-3.04
	5330.66	-0.88	WF	11	-3.71
Mg I (5 lines)					(log Mg/N_T = -5.52 ± 0.21)
2	5167.32	-0.38	WS	13	-5.41
	5183.60	-0.16	WS	28	-5.21
Mg II (7 lines)					(log Mg/N_T = -5.27 ± 0.24)
Si II (5 lines)					(log Si/N_T = -4.77 ± 0.23)
P II 4 lines)					(log P/N_T = -5.61 ± 0.20)
6	5425.88	+0.19	WS	7	-5.70
7	5296.07	-0.16	WS	8	-5.33
S II (7 lines)					(log S/N_T = -4.46 ± 0.31)
6	5432.82	0.21	WS	19	-3.97
9	4815.52	-0.05	WS	6	-4.79
11	5578.89	-0.69	WS	5	-4.01
	5606.11	0.04	WS	6	-4.53
Ca I (1 line)		log Ca/N_T = -6.12)			
Ca II (1 line)					(log Ca/N_T = -5.52)
Ti II (64 lines)					(log Ti/N_T = -6.83 ± 0.32)
69	5336.78	-1.70	MF	7	-6.99
70	5154.06	-1.92	MF	15	-6.42
	5188.69	-1.21	MF	13	-7.18
	5226.53	-1.30	MF	23	-6.76
86	5185.90	-1.35	MF	14	-6.85
92	4779.98	-1.37	MF	13	-6.77
	4805.09	-1.10	MF	21	-6.77
113	5010.21	-1.34	KX	4	-6.85
	5072.28	-0.75	KX	7	-7.14
114	4874.01	-0.79	MF	9	-6.97
	4911.18	-0.34	MF	15	-7.15
H	5227.86	-2.93	KX	12	-4.95
Cr I (3 lines)					(log Cr/N_T = -5.91 ± 0.17)
7	5208.42	+0.16	MF	5	-5.98
Cr II (3 lines)					(log Cr/N_T = -6.17 ± 0.25)
23	5249.44	-2.43	KX	11	-5.81
	5407.60	-2.09	KX	6	-6.43
30	4812.34	-1.80	MF	12	-6.36
	4824.12	-1.22	MF	47	-5.82
	4836.22	-2.25	MF	10	-5.98
	4848.24	-1.14	MF	29	-6.43
	4876.41	-1.46	MF	24	-6.26
	4884.61	-2.08	KX	7	-6.30
43	5237.35	-1.16	MF	37	-6.05
	5274.96	-1.29	KX	40	-5.85
	5310.69	-2.28	KX	3	-6.44
	5334.88	-1.56	KX	11	-6.49
50	5502.07	-1.99	MF	7	-6.22
190	4901.62	-0.83	KX	12	-5.93
	4912.46	-0.95	KX	5	-6.26
Mn I (9 lines)					(log Mn/N_T = -5.63 ± 0.14)
Mn II (61 lines)					(log Mn/N_T = -5.49 ± 0.30)
-	4727.84	-2.02	KX	9	-5.58
	4730.40	-2.15	KX	11	-5.34
	4738.30	-2.24	KX	20	-4.91
	4755.73	-1.24	KX	27	-5.67
	4764.73	-1.35	KX	16	-5.91
	4791.78	-1.72	KX	10	-5.37
	4830.06	-1.85	KX	7	-5.46
	4839.74	-1.86	KX	3	-5.80
	4920.44	-2.09	KX	20	-4.97
	4921.23	-1.58	KX	8	-5.41
	5102.52	-1.93	KX	13	-5.13
	5295.38	0.66	KX	17	-5.54
	5297.00	0.83	KX	20	-5.59
	5302.44	1.10	KX	23	-5.76
	5559.05	-1.32	KX	12	-5.65
	5570.51	-1.44	KX	11	-5.57
Fe I (90 lines)					(log Fe/N_T = -4.38 ± 0.31)
Fe II (223 lines)					(log Fe/N_T = -4.36 ± 0.21)
25	4648.94	-4.39	KX	5	-4.36
	4670.17	-3.97	KX	7	-4.65
36	4993.35	-3.65	MF	20	-4.23
41	5284.10	-3.19	MF	36	-4.15
42	4923.93	-1.32	MF	100	-4.02
	5018.45	-1.22	MF	95	-4.27
43	4731.44	-3.36	MF	26	-4.33
44	4663.70	-4.28	KX	9	-4.07
48	5264.80	-3.19	KX	12	-4.77
167	5127.87	-2.54	KX	8	-4.44
168	4953.98	-2.76	KX	5	-4.44
185	5272.40	-2.03	MF	18	-4.27
205	5093.58	0.11	KX	26	-3.93
218	4913.29	0.01	KX	16	-4.26
225	5303.39	-1.61	KX	4	-4.42
-	4820.83	-0.69	KX	4	-4.36
	4826.68	-0.44	KX	14	-3.92
	4908.15	-0.30	KX	11	-4.20
	4948.10	-0.32	KX	11	-4.18
	4948.79	-0.01	KX	14	-4.33
	4951.58	0.18	KX	13	-4.57
	4958.82	-0.64	KX	6	-4.17
	4969.36	-0.78	KX	7	-3.98
	4977.03	0.04	KX	8	-4.70
	4984.48	0.01	KX	15	-4.27
	4990.51	0.18	KX	15	-4.47
	4991.46	-0.57	KX	12	-3.87
	4999.18	-0.48	KX	7	-4.28
	5001.96	0.90	KX	49	-4.07
	5004.20	0.50	KX	30	-4.24
	5006.80	-0.43	KX	8	-4.23
	5009.02	-0.42	KX	5	-4.53
	5021.59	-0.30	KX	7	-4.47
	5022.79	-0.02	KX	23	-3.96

Table 6. continued

mult.	λ(Å)	log gf	Ref	W_λ(mÅ)	log N/N_T
	5026.81	-0.22	KX	9	-4.36
	5030.63	0.40	KX	32	-4.05
	5035.71	0.61	KX	30	-4.35
	5045.11	-0.13	KX	8	-4.52
	5047.64	-0.07	KX	12	-4.33
	5060.26	-0.52	KX	6	-4.24
	5061.72	0.22	KX	23	-4.18
	5067.89	-0.20	KX	10	-4.30
	5070.90	0.24	KX	23	-4.18
	5074.05	-1.97	KX	7	-4.50
	5075.76	0.28	KX	13	-4.55
	5082.23	-0.10	KX	12	-4.28
	5089.21	-0.04	KX	18	-4.11
	5086.31	-0.48	KX	6	-4.28
	5097.27	0.31	KX	26	-4.12
	5106.11	-0.19	KX	8	-4.45
	5112.99	-0.50	KX	11	-3.95
	5117.01	-0.13	KX	6	-4.61
	5143.88	0.10	KX	23	-3.98
	5144.36	0.28	KX	11	-4.66
	5145.78	0.03	KX	9	-4.55
	5148.94	-0.40	KX	7	-4.30
	5160.85	-2.64	KX	8	-4.36
	5166.56	-0.03	KX	9	-4.46
	5169.00	-0.87	MF	88	-4.82
	5175.40	-2.27	KX	4	-4.00
	5177.02	-0.18	KX	5	-4.65
	5178.37	-0.59	KX	10	-3.87
	5180.31	0.04	KX	8	-4.64
	5186.87	-0.30	KX	7	-4.33
	5197.56	-2.10	KX	40	-4.94
	5199.12	0.10	KX	20	-4.09
	5203.64	-0.05	KX	10	-4.40
	5213.99	-0.22	KX	9	-4.26
	5215.34	-0.01	KX	9	-4.50
	5216.85	0.81	KX	20	-4.75
	5223.26	-0.41	KX	9	-4.08
	5223.80	-0.59	KX	8	-4.03
	5225.98	-0.40	KX	13	-3.92
	5234.62	-2.05	MF	68	-4.08
	5239.81	-0.46	KX	9	-4.03
	5247.95	0.63	KX	25	-4.38
	5254.93	-3.23	KX	20	-4.43
	5251.23	0.51	KX	26	-4.22
	5257.90	-0.71	KX	7	-3.90
	5260.26	1.07	KX	30	-4.67
	5264.81	-3.19	MF	38	-3.91
	5270.03	0.07	KX	14	-4.26
	5291.67	0.58	KX	27	-4.25
	5306.18	0.22	KX	21	-4.10
	5318.06	-0.14	KX	7	-4.49
	5318.75	-0.57	KX	7	-4.08
	5322.23	-0.52	KX	4	-4.36
	5339.58	0.54	KX	22	-4.41
	5375.85	-0.29	KX	11	-4.04
	5387.06	0.52	KX	23	-4.29
	5395.86	0.36	KX	12	-4.55
	5402.06	0.50	KX	23	-4.26
	5408.81	-2.39	KX	7	-4.45
	5411.36	-0.44	KX	7	-4.06
	5414.05	-3.79	MF	9	-4.34
	5425.25	-3.36	MF	18	-4.37
	5427.83	-1.66	KX	18	-4.23
	5429.99	0.46	KX	19	-4.35
	5442.35	-0.30	KX	8	-4.16
	5443.45	-0.59	KX	4	-4.22
	5444.39	-0.18	KX	10	-4.12
	5445.81	-0.11	KX	8	-4.38
	5450.10	-0.53	KX	7	-4.02
	5455.93	-0.52	KX	9	-3.94
	5465.93	0.52	KX	15	-4.57
	5466.91	-1.88	KX	20	-3.88
	5475.83	-0.18	KX	8	-4.28
	5479.41	-0.42	KX	6	-4.24
	5482.31	0.43	KX	18	-4.37
	5487.62	0.36	KX	28	-3.90
	5502.67	-0.14	KX	10	-4.22
	5503.21	-0.09	KX	13	-4.13
	5506.20	0.95	MF	26	-4.61
	5510.78	0.00	KX	11	-4.29
	5529.05	-0.25	KX	5	-4.45
	5534.83	-2.93	MF	41	-4.06
	5548.21	-0.51	KX	5	-4.14
	5549.00	-0.23	KX	4	-4.62
	5567.84	-1.89	KX	12	-4.23
	5588.22	0.09	KX	15	-4.14
Fe III (1 line)					(log Fe/N_T = -4.32)
Sr II (4 lines)					(log Sr/N_T = -6.63 ± 0.09)
Y II (32 lines)					(log Y/N_T = -6.68 ± 0.25)
12	4682.32	-1.51	HL	20	-7.11
22	4786.58	-1.29	HL	40	-6.25
20	4982.13	-1.29	HL	28	-6.70
	5119.11	-1.36	HL	34	-6.44
	5200.41	-0.57	HL	41	-6.96
27	5480.73	-0.99	HL	39	-6.20
	5497.41	-0.58	HL	38	-6.63
	5544.61	-1.09	HL	25	-6.63
28	5196.42	-0.88	HL	14	-7.23
Zr II (10 lines)					(log Zr/N_T = -8.54 ± 0.15)
Ba II (1 line)					(log Ba/N_T = -9.82)
Pt II (8 lines)					(log Pt/N_T = -7.69 ± 0.76)
Hg II (1 line)					(log Hg/N_T = -7.81)