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Elemental abundance analyses with DAO spectrograms

XXVII. The superficially normal stars theta And (A2 IV), epsilon Del (B6 III), epsilon Aqr (A1.5 V), and iota And (B9 V) [⋆]

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Abstract. The superficially normal stars θ And (A2 V), ϵ Del (B6 III), ϵ Aqr (A1 V), and ι And (B9 V), which show some rotation, are analyzed in a manner consistent with previous studies of this series using 2.4 Å mm^{-1} spectrograms obtained with CCD detectors and S/N $\geq$ 200. Their variable radial velocities strongly suggest they are spectroscopic binaries. As no evidence is seen for lines of their companions they are analyzed as single stars. Their derived abundances are generally near solar. But those for θ And suggest that it is possibly a fast rotating Am star.

Key words. stars: abundances – stars: individual: θ And – stars: individual: ϵ Del – stars: individual: ϵ Aqr – stars: individual: ι And

1. Introduction

Although most stars studied in this series of papers are quite sharp-lined, some showed definite rotation (e.g, Merak (Adelman 1996); λ UMa and 29 Cyg (Adelman 1999)). With high signal-to-noise spectrograms (S/N $\geq$ 200) obtained with Reticon and CCD detectors, one can study such stars and still obtain quite decent derived abundances especially when v sin i $\leq$ 60 km s^{-1}. This permits some investigation of whether the sharpest-lined normal stars have abundances which are typical for their spectral type.

With stars that exhibit rotationally broadened lines, one has to be selective **in the choice of** lines. Further some atomic species which cannot be studied by fine analyses might be by synthesizing the spectrum. Our intent here is to see what can be done via the technique of fine analysis for two stars whose v sin i values are near the upper limit for this technique and contribute additional data concerning two stars apparently rotating at about half of this value. We recognize from the **outset** that we can use only those lines with at **most** minimal blending. This exercise is also a way of obtaining initial values for future synthetic spectral analyses.

The stars θ And (24 And, HD 1280, HR 63), spectral type A2 IV (Abt & Morrell 1995), ϵ Aqr (2 Aqr, HD 198001, HR 7950), spectral type A1.5 V (Abt & Morrell 1995), and ι And (17 And, HD 222173, HR 8965), spectral type B9 V (Abt et al. 2002) are among the least variable stars in photometry from the Hipparcos satellite (Adelman 2001). ϵ Del (2 Del, HD 195810, HR 7852) is spectral type B6 III (Abt et al. 2002). ϵ Aqr has been used **as** a secondary spectrophotometric standard (see, e.g., Taylor 1984). Hill (1995) derived abundances from both θ And and ϵ Aqr which have rotational velocities near 100 km s^{-1} using spectral synthesis techniques. Both ϵ Del and

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[⋆] Table 4 is only 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

ι And have smaller v sin i values and hence are much more amenable to study. Glushneva et al. (1992) proposed ι And as a secondary spectrophotometric standard and Napiwotzki et al. (1993) derived $T_{\rm eff}$ = 11850 K, log g = 3.47.

2. The Spectra

For all four stars we obtained Dominion Astrophysical Observatory (DAO) 2.4 Å $\rm mm^{-1}$ SITe-2 or SITe-4 CCD spectrograms with a typical signal-to-noise ratio of 200 and a wavelength coverage of 63 or 144 Å, respectively. The observations were started with the SITe-2 CCD with the intent of obtaining exposures with central wavelengths between λ3830 and λ4740 with 55 Å offsets. Later when the longer SITe-4 CCD became available, the program was changed to exposures with central wavelengths between λ3898 and λ4864 with 138 Å offsets. For all four stars, we obtained at least the originally planned coverage. Further 20 Å $\rm mm^{-1}$ DAO spectrograms containing the Hγ region were acquired for θ And and ϵ Aqr. We extracted the Hβ profiles for ϵ Del and ι And from SITe4 spectra centered at λ4864. To flat field the exposures we used exposures of an incandescent lamp in the Coudé mirror train, which was viewed through a filter to eliminate first order light. A central stop removed light from the beam in the same manner as the secondary mirror of the telescope. We rectified the exposures with the interactive computer graphics program REDUCE (Hill, Fisher & Poeckert 1982) and applied a 3.5% correction for scattered light in the dispersion direction (Gulliver, Hill & Adelman 1996) for many of the SITe-2 spectrograms. The scattered light for the remaining SITe-2 and for all SITe-4 spectrograms was removed during the extraction procedure using the program CCDSPEC (Gulliver & Hill 2003).

We fit rotational profiles through the metal lines of all four stars. Rotational velocity estimates from clearly single, medium-strength lines near λ4481 are 93 km $\rm s^{-1}$ for θ And, 54 km $\rm s^{-1}$ for ϵ Del, 110 km $\rm s^{-1}$ for ϵ Aqr, and 60 km $\rm s^{-1}$ for ι And. Often the He I lines showed Gaussian or Lorentzian profiles. The lines of ι And with equivalent widths $\geq$ 30 mÅ usually showed Gaussian profiles and were so fit. In measuring the spectrum with VLINE (Hill, Fisher & Poeckert 1982) the **fixed parameter feature was applied, particularly to the line widths, as needed to better fit close blends**. In any star with moderate rotation one has to be selective in choosing lines to be analyzed due to a substantial amount of line blending. Measuring θ And was more difficult than ϵ Aqr despite its slightly greater rotational velocity.

In comparison Hill (1995) finds v sin i = 95 km $\rm s^{-1}$ and 108 km $\rm s^{-1}$ for θ And and ϵ Aqr, respectively. Abt & Morrell (1995) quote v sin i = 90 km $\rm s^{-1}$ for both θ And and ϵ Aqr. Abt et al. (2002) find 70 and 50 km $\rm s^{-1}$, respectively, for ι And and ϵ Del.

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 Huldt et al. (1982) for Ti II, Iglesias & Velasco (1964) for Mn II, Nave et al. (1994) for Fe I, and Johansson (1978) for Fe II.

Lines of Mg I, Mg II, Al I, Si II, Ca I, Ca II, Ti II, Cr I, Cr II, Mn II, Fe I, Fe II, Ni I, Ni II, Sr II, Y II, Zr II, and Ba II were sufficiently unblended for abundances to be derived in the observed spectrum of θ And. In the spectrum of ϵ Del we found lines of He I, C II, N II, O I, Mg II, Al II, Si II, Si III, S II, Ca II, Ti II, Cr II, Fe II, Ni II, and Sr II. While for ϵ Aqr, we used lines of C I, Mg II, Al I, Si II, Ca I, Ca II, Ti II, V II, Cr I, Cr II, Fe I, Fe II, Ni II, Sr II, Zr II, and Ba II. The ι And spectra provided lines of He I, C II, O I, Mg II, Al II, Si II, S II, Ca II, Ti II, Cr II, Fe II, and Ni II for analysis.

The radial velocities (Table 1) were found from comparisons of the stellar and laboratory wavelengths after corrections were applied for the Earth's orbital velocity. All four stars apparently have variable radial velocities. Although often these values depend on measuring only a few lines, in general when listed in JD order the differences between values obtained on adjacent nights are small. A few values may be discrepant. As there was no evidence for the lines of the secondaries, we analyze these stars as if they are single.

Abt & Biggs (1972) show values for the radial velocity of θ And between -4.7 and +6.2 km $\rm s^{-1}$. Duflot et al. (1995) give 0.9 km $\rm s^{-1}$ based on 36 values. Those from 6 SITe-4 DAO spectrograms average 2 ± 5 km $\rm s^{-1}$ and those from 5 SITe-2 DAO spectrograms -5 ± 8 km $\rm s^{-1}$. **The uncertainty in the individual spectrum measurements averages x.x km $\rm s^{-1}$.** Those based on SITe-4 spectrograms contain about 2.4 times the number of lines as those based on SITe-2 spectrograms. Although this star has a spectrum that is difficult to measure, these values suggest possible variability.

The mean radial velocity from 20 spectrograms of ϵ Del was -24.2 ± 4.2 km $\rm s^{-1}$ which is suggestive of variability. We did not include a radial velocity based on only one line. **The uncertainty in the individual spectrum measurements averages x.x km $\rm s^{-1}$.** Abt & Biggs (1972) list values between -17.2 and -29.3 km $\rm s^{-1}$ while Duflot et al. (1995) give -19.3 km $\rm s^{-1}$

From 8 SITe-4 spectrograms, we derived a mean radial velocity of -16.6 ± 4.2 km $\rm s^{-1}$ for ϵ Aqr. The uncertainty in the individual spectrum measurements averages 1.9 km $\rm s^{-1}$. Abt & Biggs (1972) list values between -15 and -20 km $\rm s^{-1}$ while Duflot et al. (1995) give -16 km $\rm s^{-1}$ based on 21 values and Grenier et al. (1999) -15.5 km $\rm s^{-1}$ while Hill (1995) finds -8.6 km $\rm s^{-1}$. One of our values agrees with Hill's while the others with those of other studies. This suggests ϵ Aqr is a radial velocity variable.

From 17 spectrograms, we found a mean radial velocity of 3.6 ± 6.9 km $\rm s^{-1}$ for ι And with the uncertainities in the individual values of order 1 km $\rm s^{-1}$. Abt & Biggs (1972) give values betwen 0 and -30 km $\rm s^{-1}$ while Duflot et al. (1995) give -0.5 km $\rm s^{-1}$.

Two possible ways to detect the presence of a companion would be to look for strong lines in the red and examine high quality optical spectrophotometry. Either would permit estimates of the effects of the companions on our analyses, which we anticipate will be small.

3. Stellar Parameters

Table 2 lists our effective temperature and surface gravity estimates with the last values for each star being those adopted. We began with the computer program of Napiwotzki et al. (1993) and the homogeneous *uvbyβ* data of Hauck & Mermilliod (1980, 1998). The uncertainties are about ±150 K and ±0.2 dex (Lemke 1989). To refine these values we calculated synthetic spectra of the Hγ regions from ATLAS9 LTE plane parallel model atmospheres (Kurucz 1993) with Program SYNTHE (Kurucz & Avrett 1981) as well as the predicted fluxes with ATLAS9 for comparison with the observations which are from Adelman, Pyper & White (1980) for θ And and Schild et al. (1971) as recalibrated by Breger (1976) to the Hayes & Latham (1975) calibration of Vega for ϵ Aqr. As the resulting model for the latter star did not yield equal mean abundances from Fe I and Fe II lines, we accepted a good, but a slightly less perfect fit to the spectrophotometry and Hγ profile resulting in derived mean abundances from Fe I and Fe II lines which were close to agreement.

For ϵ Del, which has no published spectrophotometry, we corrected the effective temperature as did Adelman et al. (2002). To check the value of the surface gravity we compared the observed Hβ profile with that calculated using an ATLAS9 model with the corrected photometric values and found that they were in good agreement.

For ι And we used spectrophometry from Wolff, Kuhi & Hayes (1968) as recalibrated by Breger (1976) to the Hayes & Latham (1975) calibration of Vega. The adopted effective temperature is about 250 K less than the photometric value.

Hill (1995) finds by comparison $T_{\rm eff}$ = 8960 K and log g 3.95 for θ And and $T_{\rm eff}$ = 9470 K and log g 3.64 for ϵ Aqr. For θ And these values differ from ours by 40 K and 0.05 dex, but for ϵ Aqr these differences are 420 K and -0.11 dex. **Thus,** the derived abundances values between these studies should be somewhat discrepant for this reason alone for the latter star.

4. The Abundance Analyses

The metal abundances were determined using program WIDTH9 (Kurucz 1993) with metal line damping constants from Kurucz & Bell (1995) or semi-classical approximations in their absence. Abundances from Fe I and II lines were derived for a range of possible microturbulences whose adopted values (Table 3) result in the derived abundances being independent of the equivalent widths (ξ_1) or having a minimal scatter about the mean (ξ_2) (Blackwell, Shallis & Simmons 1982). As the microturbulence for θ And was found using models with $\xi = 2$ km s^{-1}, resulted

Table 1. Radial Velocity Measurements.

star	central λ(Å)	Heliocentric Julian Date	RV (km s^{-1})
θ And	4740	2450752.822	-18*
	3970	2451028.001	-3*
	3915	2451471.812	-5*
	3860	2451472.705	-2*
	4685	2451478.965	3*
	4036	2451740.990	-4
	4450	2451741.983	7
	4864	2451742.942	9
	4174	2451746.910	6
	4312	2451747.957	2
	4588	2452210.783	-4
ϵ Aqr	4864	2451742.882	-17
	4036	2451740.958	-18
	4450	2451741.864	-17
	4174	2451746.858	-15
	4726	2451749.892	-19
	3898	2451778.928	-20
	4588	2452090.050	-7
	4312	2452103.875	-20
ϵ Del	4520	2450302.887	-21*
	4465	2450305.014	-24*
	4410	2450306.014	-26*
	4080	2450307.011	-25*
	4135	2450308.012	-25*
	3915	2450309.119	-27*
	3860	2450309.836	-21*
	5070	2450592.986	-24*
	5015	2450649.989	-24*
	4740	2450652.987	-35*
	3970	2450653.998	-23*
	4025	2450654.991	-22*
	4190	2450656.002	-20*
	4300	2450657.001	-22*
	4355	2450658.003	-32*
	4575	2450658.996	-23*
	4630	2450661.009	-18*
	4245	2450696.023	-30*
	6600	2451744.832	-22
	4864	2451774.000	-21
ι And	3970	2450653.998	-7:*
	4575	2450658.996	-4*
	4630	2450661.009	-2*
	4080	2450753.741	3*
	4245	2451404.916	-9*
	4355	2451407.834	4*
	4300	2451408.024	-1*
	4025	2451413.813	7*
	4410	2451442.840	-1*
	5015	2451470.778	15*
	4740	2451477.709	13*
	4685	2451478.965	8*
	4465	2451480.898	7*
	4520	2451483.677	7*
	4174	2451739.984	4
	4864	2451742.923	5
	3898	2452167.971	13

Note: Values from SITe-2 CCDs are indicated by an * while those from SITe-4 CCDs are not.

Table 2. Effective Temperature and Surface Gravity Determinations

Star	$T_{\rm eff}$(K)	Log g	Method
θ And	8968	3.87	Napiwotzki et al.(1993) with *uvby*β photometry
	9000	4.00	Spectrophotometry and Hγ profile fitting, solar model
ϵ Del	13755	3.65	Napiwotzki et al.(1993) with *uvby*β photometry
	13679	3.65	same with correction from Adelman et al. (2002)
	13679	3.65	same with Hβ fitting
ϵ Aqr	9229	3.56	Napiwotzki et al.(1993) with *uvby*β photometry
	9200	3.50	Spectrophotometry and Hγ profile fitting, solar model
	9050	3.75	Spectrophotometry and Hγ profile fitting, solar model, iron equilibrium
ι And	11845	3.35	Napiwotzki et al.(1993) with *uvby*β photometry
	11600	3.35	Spectrophotometry and Hβ profile fitting, solar model

Table 3. Microturbulence Determinations from Fe I and Fe II Lines

Star	Species	Number of Lines	ξ_1 (km s^{-1})	log N/N$_T$	ξ_2 (km s^{-1})	log N/N$_T$	gf values
θ And	Fe I	34	3.9	-4.27±0.28	3.9	-4.27±0.28	MF+KX
	Fe II	23	3.2	-4.22±0.24	3.2	-4.22±0.24	MF+KX
		adopted	3.6				
ϵ Del	Fe II	32	0.0	-4.56±0.21	0.0	-4.56±0.21	MF+KX
		adopted	0.0				
ϵ Aqr	Fe I	33	3.1	-4.66±0.25	3.1	-4.66±0.25	MF+KX
	Fe II	24	2.4	-4.60±0.26	2.5	-4.62±0.24	MF+KX
		adopted	2.8				
ι And	Fe II	44	1.3	-4.71±0.19	1.2	-4.69±0.19	MF+KX
	Fe II	34	1.4	-4.75±0.20	1.4	-4.75±0.20	MF
		adopted	1.3				

gf value references: MF = Fuhr et al. (1988), KX = Kurucz & Bell (1995)
Note: For ξ_1 and ξ_2 the abundances are found so that there is no trend of values for lines of different equivalent widths and have minimum scatter about the mean, respectively.

in a value of 3.6 km s^{-1}, we changed to the use of a model calculated with the same effective temperature and surface gravity but with a 4 km s^{-1} microturbulence. This resulted in derived Fe abundances with values of 0.01 to 0.03 dex smaller.

We assumed that the helium abundances were solar for both θ And and ϵ Aqr for which we do not see any He I lines. Thus to convert their log N/N$_T$ values to log N/H values -0.04 dex were added. For ϵ Del and ι And, their helium abundances (Table 4) were found by comparing the line profiles with theoretical predictions calculated using programs SYNSPEC (Hubeny et al. 1994) which were convolved with the rotational velocity and the instrumental profile. The average values show that ϵ Del and ι And have solar He/H ratios.

Table 5, the analyses of the metal line spectra, contains for each line the multiplet number (Moore 1945), the laboratory wavelength, the logarithm of the gf-value

Table 4. He/H Determinations

λ(Å)	He/H ϵDel	He/H ι And
3819	...	0.10
3867	0.08	0.08
4009	0.08	0.09
4026	0.09	0.11
4121	0.09	0.08
4143	0.10	...
4169	0.08	...
4388	0.09	0.09
4437	0.08	...
4472	0.10	0.12
4713	0.10	0.11
4921	0.10	0.10
5015	0.10	0.10
5047	0.11	...
average	0.09±0.01	0.10±0.01

and its source, the equivalent width in mÅ as observed, and the deduced abundance. Source references are given at the end of this table. Letters are used in place of multiplet numbers to indicate sources other than Moore (1945): D = Dworetsky (1971) and J = Johansson (1978).

This study's abundances are compared with those of the Sun (Grevesse, Noels, & Sauval 1996) in Table 6. For θ And, that the derived abundances for the light elements tend to be close to solar and those for Fe and heavier species are greater than solar suggests that this star might be a fast rotating Am star. The results from Mn II and Zn I lines should be considered tenative. For the other 12 atomic species (with the mean value used for Mg I and II, Ca I and II, Cr I and II, Fe I and II, and Ni I and II lines), the mean value for the abundances with respect to solar is 0.26 ± 0.40 dex.

The mean of 7 metallic elements based on 2 or more lines of ϵ Del relative to solar is -0.04±0.19 which is solar. Of these elements only Ni is underabundant. Of the elements whose abundances are based on single lines, C, O, Ca, and Ti are solar, N and Al are underabundant, and Sr is overabundant. These all require confirmation as well as the Ni value. On the whole, the abundance pattern is best considered as solar.

For ϵ Aqr the results for 13 atomic species (with the mean value used for Ca I and II, Cr I and II, and Fe I and II lines) is -0.08 ± 0.35 dex. Most notably both Al and Sr appear to be quite underabundant. Both results are somewhat dependent on the adopted microturbulence. Still it appears that ϵ Aqr has abundances for the most part which are close to solar.

The mean abundance of 10 elements for ι And relative to solar is -0.19 ± 0.14 **revealing** a tendency to be slightly metal poor. Ca is the most underabundant relative to solar. **That the He abundance is solar** excludes the possibility of its belonging to many of the peculiar classes near A0. **Clarification of its status is hampered by its relatively high** rotation that makes it difficult to obtain the abundances of other species which would be expected to be found in sharp-lined stars of similar effective temperature and surface gravity.

Table 7. Comparison of the Derived Abundances (log N/H)

Quantity	Hill (1995)	This Study
θ And		
log Mg/H	-4.15	-3.84:
log Si/H	-4.63	-4.44
log Ca/H	-5.62	-5.32
log Ti/H	-7.04	-7.01
log Cr/H	-6.28	-6.10
log Mn/H	-5.76	-5.88
log Fe/H	-4.35	-4.26
log Sr/H	-7.46	-8.60
log Y/H	-7.46	-
log Zr/H	-9.15	-8.38
log Ba/H	-8.94	-
$T_{\rm eff}$ (K)	8960	9000
log g	3.95	4.00
ϵ Aqr		
log C/H	-3.37	-3.51
log Mg/H	-4.11	-3.85:
log Si/H	-4.55	-4.41
log Ca/H	-5.39	-5.95
log Ti/H	-6.79	-6.86
log V/H	-7.78	-7.96
log Cr/H	-6.22	-6.33
log Fe/H	-4.42	-4.60
log Ni/H	-5.45	-5.49
log Zr/H	-9.23	-9.15
log Ba/H	-9.71	-10.03
$T_{\rm eff}$ (K)	9470	9050
log g	3.64	3.75

5. Comments

Table 7 compares the values found for θ And and ϵ Aqr by Hill (1995) with this study. **We include in the table values for Mg II λ 4481 that are probably too large, are marked uncertain and not used further in this comparison**. In addition we markedly disagree with the Sr abundances of θ And. The mean discrepancy (Hill - this study) for θ And (9 species, Mg and Sr not included) is -0.09±0.19 and for ϵ Aqr (10 species) is 0.13 ± 0.20 dex. For the latter star, corrections for the differences in the adopted effective temperature would ease many, but not all of the discrepancies of which that of Ca is the most serious. Correcting for the temperature discrepancy will make our values more metal-rich while the surface gravity discrepancy will tend to reduce the values for the singly-ionized species. We in fact used spectra which covered parts of three of Hill's four regions, but did not necessarily use the same spectral features. **That Hill was able to deduce the abundances of additional species suggests that spectral synthesis studies have an advantage over the fine analysis approach.** The discrepancy in the effective temperature determinations may reflect the possibility that the companion to ϵ Aqr makes a small contribution to the visible light of the system.

That our values tend to be close to Hill's despite the difference in techniques indicates that our goal of reasonably good initial abundance estimates has been achieved for both θ And and ϵ Aqr. That the former star is more metal-rich than the latter helps to explain why the latter had a line spectrum easier to measure despite its slightly greater rotational velocity. [**Saul: I don't understand why a weaker-lined star should be easier to measure.**] Spectrum synthesis techniques are dependent on the underlying template of lines and their atomic data. If this data is of sufficient quality, then this technique can produce high quality results even for stars which show some rotation. Any template must be tested upon high signal-to-noise, high dispersion spectra of sharp-lined stars which cover the range of abundances expected in the faster rotating stars.

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Table 5. Abundances in θ And, ϵ Del, ϵ Aqr, and ι And

				θ And		ϵ Del		ϵ And		ι And	
Mult.	$\lambda(\AA)$	log gf	Ref.	W_λ(m$\AA$)	log N/N_T	W_λ(m$\AA$)	log N/N_T	W_λ(m$\AA$)	log N/N_T	W_λ(m$\AA$)	log N/N_T
C I				log C/N_T = ...			...		-3.55		...
6	4771.72	-1.87	WF	...	...	...	...	29	-3.55	...	...
C II				log C/N_T = ...			-3.54±0.10		...		-3.63±0.25
4	3918.97	-0.53	WF	...	...	40	-3.47	...	...	19	-3.69
	3920.68	-0.23	WF	...	...	46	-3.61	...	...	22	-3.91
6	4267.13	+0.97	WF	...	...	...	...	...	...	53	-3.30
N II				log N/N_T = ...			-4.71		...		...
12	3994.99	+0.21	WF	...	...	40	-3.47	...	...	...	...
O I				log O/N_T = ...			-3.37		...		-3.19
3	3947.00	-1.77	WF	...	...	10	-3.37	23	-3.19		
Mg I				log Mg/N_T = -4.69			...		...		...
11	4702.99	-0.38	FW	95	-4.69	...	...	...	...	...	...
Mg II				log Mg/N_T = ...			-4.43±0.11		-3.89:		-4.57±0.13
4	4481.32	+0.97	FW	531	-3.88:	...	...	467	-3.89:	...	...
5	3848.24	-1.59	WS	...	...	20	-4.47	...	...	24	-4.66
	3850.39	-1.88	WS	...	...	14	-4.39	...	...	15	-4.64
9	4427.99	-1.21	WS	...	...	17	-4.47	...	...	20	-4.58
	4433.98	-0.90	WS	...	...	22	-4.61	...	...	26	-4.73
10	4384.64	-0.79	WS	...	...	37	-4.41	...	...	54	-4.33
	4390.57	-0.53	WS	...	...	61	-4.25	...	...	62	-4.46
Al I				log Al/N_T = -6.02±0.34			...		-6.37±0.21		...
1	3944.01	-0.64	FW	140	-5.78	...	...	85	-6.22	...	...
	3961.52	-0.34	FW	125	-6.26	...	...	84	-6.52	...	...
Al II				log Al/N_T = ...			-5.92		...		-5.76
2	4663.10	-0.28	FW	...	...	25	-5.92	...	...	31	-5.76
Si II				log Si/N_T = -4.48±0.24			-4.45±0.10		-4.46±0.15		-4.64±0.13
1	3853.66	-1.44	LA	93	-4.65	84	-4.33	...	...	77	-4.75
	3856.01	-0.49	LA	...	...	126	-4.52	...	...	127	-4.76
	3862.59	-0.74	LA	...	...	105	-4.61	...	...	112	-4.76
3	4128.07	+0.38	LA	160	-4.20	113	-4.56	134	-4.35	126	-4.57
	4130.89	+0.53	LA	130	-4.59	125	-4.49	127	-4.56	136	-4.62
3.01	4075.45	-1.40	SG	...	...	28	-4.41	...	...	...	...
	4076.78	-1.67	SG	...	...	18	-4.40	...	...	...	...
5	5041.02	+0.29	SG	...	...	95	-4.53	...	...	105	-4.42
	5055.98	+0.51	LA	...	...	106	-4.59	...	...	...	...
	5056.31	-0.36	SG	...	...	62	-4.47	...	...	...	...
7.07	3954.30	-1.04	KP	...	...	9	-4.40	...	...	...	...
7.15	4673.28	-0.71	KP	...	...	15	-4.25	...	...	...	...
7.34	6671.84	+0.52	LA	...	...	19	-4.31	...	...	...	...
	6717.04	+0.63	LA	...	...	18	-4.48	...	...	...	...
Si III				log Si/N_T = ...			-4.28±0.23		...		...
2	4552.62	+0.29	WS	...	...	24	-4.12	...	...	...	...
	4567.84	+0.07	WS	...	...	13	-4.44	...	...	...	...
S II				log S/N_T = ...			-4.77±0.19		...		-4.66±0.06
7	5009.57	-0.09	WM	...	...	18	-4.93	...	...	...	...
	5032.43	+0.18	WS	...	...	34	-4.52	...	...	21	-4.61
9	4656.77	-0.81	WS	...	...	13	-4.51	...	...	...	...
	4716.27	-0.32	WM	...	...	20	-4.67	...	...	...	...
	4815.55	+0.18	WM	...	...	27	-4.82	...	...	...	...
15	4917.21	-0.40	WM	...	...	13	-4.69	...	...	...	...
	5014.07	+0.03	WM	...	...	18	-4.84	...	...	...	...
40	4524.94	+0.08	WM	...	...	22	-4.49	...	...	...	...

Table 5. - *continued*

				θ And		ϵ Del		ϵ Aqr		ι And	
Mult.	$\lambda(\AA)$	log gf	Ref.	W_λ(m$\AA$)	log N/N$_T$	W_λ(m$\AA$)	log N/N$_T$	W_λ(m$\AA$)	log N/N$_T$	W_λ(m$\AA$)	log N/N
S II	*(continued)*										
44	4153.10	+0.62	WS	...	...	28	-4.59	...	...	16	-4.70
	4162.70	+0.78	WS	...	...	22	-4.96	...	...	...	...
49	4294.40	+0.56	WM	...	...	16	-4.87	...	...	...	...
55	3923.44	+0.44	WS	...	...	12	-5.12	...	...	...	...
59	3998.76	+0.05	WS	...	...	10	-4.79	...	...	...	...
	4032.77	+0.24	WM	...	...	10	-4.96	...	...	...	...
Ca I				log Ca/N$_T$ = -5.36±0.01			...		-6.18		...
2	4226.73	0.24	FW	188	-5.35	...	...	104	-6.18	...	...
5	4302.53	0.28	FW	97	-5.37	...	...	...	...	...	...
Ca II				log Ca/N$_T$ = -6.02			-5.77		-5.79		-6.18
1	3933.66	0.13	WM	1573	-6.02	133	-5.77	1851	-5.79	174	-6.18
Ti II				log Ti/N$_T$ = -7.07±0.25			-7.01		-6.90±0.19		-7.39±0.1
19	4395.03	-0.66	MF	182	-6.66	...	...	...	...	21	-7.45
	4443.80	-0.70	MF	145	-7.13	...	...	143	-6.86	18	-7.50
	4450.49	-1.45	MF	70	-7.22	...	...	85	-6.99	...	...
20	4287.89	-2.02	MF	...	...	...	...	39	-7.01	...	...
30	4545.14	-2.78	KX	24	-6.49	...	...	18	-6.65	...	...
31	4468.49	-0.60	MF	...	...	...	...	135	-7.06	...	...
	4501.27	-0.75	MF	130	-7.26	...	...	120	-7.18	15	-7.50
34	3900.55	-0.45	MF	125	-7.55	14	-7.01	...	...	28	-7.42
40	4417.72	-1.43	MF	...	...	...	...	94	-6.83	...	...
	4464.46	-2.08	MF	52	-6.74	...	...	30	-7.06	...	...
41	4290.22	-1.12	MF	126	-6.89	...	...	119	-6.76	...	...
	4300.05	-0.77	MF	129	-7.19	...	...	142	-6.72	19	-7.34
	4301.93	-1.16	MF	95	-7.19	...	...	95	-7.08	...	...
	4307.86	-1.29	MF	...	...	...	...	...	...	11	-7.11
	4312.86	-1.16	MF	95	-7.17	...	...	...	...	...	...
	4330.71	-2.04	MF	...	...	...	...	42	-6.89	...	...
49	4708.65	-2.21	MF	33	-6.83	...	...	19	-7.12	...	...
50	4563.76	-0.96	MF	114	-7.17	...	...	122	-6.87	12	-7.39
51	4399.77	-1.27	MF	94	-7.05	...	...	...	...	...	...
60	4568.31	-2.65	MF	...	...	...	...	25	-6.56	...	...
82	4529.46	-2.03	MF	...	...	...	...	53	-6.51	...	...
	4571.97	-0.53	MF	140	-7.07	...	...	133	-6.90	17	-7.43
87	4028.33	-1.00	MF	140	-7.07	...	...	75	-7.01	...	...
92	4779.99	-1.37	MF	...	...	...	...	44	-6.99	...	...
	4805.09	-1.10	MF	66	-6.99	...	...	49	-7.18	...	...
94	4330.24	-1.51	MF	33	-6.99	...	...	...	...	...	...
105	4163.64	-0.40	MF	59	-7.40	...	...	105	-6.75	...	...
114	4911.20	-0.34	MF	64	-7.09	...	...	...	...	...	...
115	4411.08	-1.06	MF	...	...	...	...	34	-6.78	...	...
V II				log V/N$_T$ = ...			...		-8.00±0.25		...
10	3951.97	-0.78	BG	...	...	...	...	30	-8.18	...	...
32	4035.63	-0.77	BG	...	...	...	...	40	-7.83	...	...
Cr I				log Cr/N$_T$ = -6.50			...		-6.78		...
1	4254.35	-0.11	MF	65	-6.50	...	...	36	-6.78	...	...
Cr II				log Cr/N$_T$ = -6.14±0.27			-6.23±0.18		-6.37±0.19		-6.46±0.2
19	4051.93	-2.19	KX	...	...	...	...	37	-6.33	...	...
30	4812.34	-1.80	MF	37	-6.26	...	...	28	-6.43	...	...
	4824.13	-1.22	MF	126	-5.81	15	-6.12	80	-6.25	39	-6.17
	4848.23	-1.14	MF	56	-6.67	...	...	52	-6.71	17	-6.81
	4876.41	-1.46	KX	59	-6.32	...	...	51	-6.41	...	...

Table 5. - *continued*

				θ And		ϵ Del		ϵ Aqr		ι And	
Mult.	$\lambda(\AA)$	log gf	Ref.	W_λ(m$\AA$)	log N/N$_T$	W_λ(m$\AA$)	log N/N$_T$	W_λ(m$\AA$)	log N/N$_T$	W_λ(m$\AA$)	log N/N$_T$
Cr II	*(continued)*										
31	4252.62	-2.02	KX	44	-5.93	...	...	...	...	...	...
	4261.92	-1.53	KX	59	-6.23	...	...	50	-6.34	...	...
	4284.21	-1.86	KX	...	...	...	...	39	-6.18	...	...
39	4565.74	-2.11	MF	40	-5.79	...	...	...	...	...	...
44	4555.02	-1.38	MF	77	-6.05	12	-6.03	...	...	25	-6.25
	4558.66	-0.66	MF	123	-6.26	23	-6.34	103	-6.36	49	-6.41
	4588.22	-0.63	MF	98	-6.58	17	-6.58	81	-6.70	43	-6.57
	4592.05	-1.22	MF	72	-6.27	...	...	53	-6.49	16	-6.65
	4616.63	-1.29	MF	72	-6.20	...	...	48	-6.49	...	...
	4618.80	-1.11	MF	114	-5.93	15	-6.16	76	-6.29	28	-6.44
	4634.07	-1.24	MF	81	-6.16	12	-5.65	76	-6.16	...	...
162	4145.77	-1.16	KX	...	...	...	...	33	-6.07	...	...
190	4912.46	-0.95	KX	25	-5.70	...	...	...	...	...	...
Mn II				log Mn/N$_T$ = -5.92			...		...		...
5	4755.73	-1.24	KX	39	-5.92	...	...	...	...	...	...
Fe I				log Fe/N$_T$ = -4.21±0.28			...	-4.60±0.26			...
2	4427.31	-3.04	KX	51	-3.78	...	...	...	...	...	...
4	3856.37	-1.29	MF	...	...	...	...	128	-4.14	...	...
	3859.91	-0.71	MF	161	-4.68	...	...	...	...	...	...
	3899.71	-1.53	MF	...	...	...	...	115	-4.12	...	...
	3920.25	-1.75	MF	...	...	...	...	80	-4.47	...	...
	3922.91	-1.65	MF	86	-4.74	...	...	51	-5.00	...	...
	3927.92	-1.59	MF	...	...	...	...	43	-5.15	...	...
20	3849.97	-0.87	MF	...	...	...	...	104	-4.41	...	...
22	3850.82	-1.73	MF	51	-4.44	...	...	...	...	...	...
41	4383.54	0.20	MF	223	-3.81	...	...	132	-4.74	...	...
	4404.75	-0.14	MF	...	...	...	...	85	-5.14	...	...
	4415.12	-0.61	MF	138	-4.21	...	...	99	-4.44	...	...
42	4202.02	-0.71	MF	...	...	...	...	81	-4.65	...	...
	4325.75	-0.01	MF	161	-4.46	...	...	141	-4.26	...	...
43	4005.25	-0.61	MF	...	...	...	...	101	-4.39	...	...
	4045.82	0.28	MF	...	...	...	...	122	-4.96	...	...
	4063.59	0.07	MF	191	-4.02	...	...	120	-4.73	...	...
	4071.74	-0.02	MF	188	-3.97	...	...	115	-4.71	...	...
	4132.06	-0.65	MF	140	-4.09	...	...	...	...	...	...
	4143.87	-0.45	MF	141	-4.33	...	...	...	...	...	...
68	4408.41	-1.71	MF	27	-4.10	...	...	...	...	...	...
	4447.72	-1.34	MF	20	-4.61	...	...	27	-4.36	...	...
	4459.12	-1.28	MF	66	-4.02	...	...	...	...	...	...
	4494.57	-1.41	MF	61	-3.93	...	...	31	-4.23	...	...
71	4282.41	-0.81	MF	83	-4.29	...	...	37	-4.73	...	...
152	4187.04	-0.55	MF	107	-4.10	...	...	...	...	...	...
	4210.35	-0.87	MF	...	...	...	...	26	-4.68	...	...
	4222.22	-0.97	MF	48	-4.35	...	...	31	-4.49	...	...
	4235.94	-0.34	MF	...	...	...	...	69	-4.59	...	...
	4260.47	-0.02	MF	136	-4.31	...	...	73	-4.89	...	...
	4299.24	-0.46	KX	128	-3.96	...	...	...	...	...	...
175	3859.21	-0.68	MF	...	...	...	...	56	-4.41	...	...
	3873.76	-0.79	MF	26	-4.86	...	...	...	...	...	...
278	3956.68	-0.58	KX	...	...	...	...	42	-4.53	...	...
	3997.39	-0.39	MF	108	-4.05	...	...	...	...	...	...
318	4878.21	-1.01	MF	78	-4.33	...	...	19	-4.46	...	...
352	4245.25	-1.17	MF	23	-4.30	...	...	...	...	...	...
354	4181.75	-0.18	MF	108	-4.21	...	...	72	-4.46	...	...

Table 5. - *continued*

				θ And		ϵ Del		ϵ Aqr		ι And	
Mult.	$\lambda(\AA)$	log gf	Ref.	W$_\lambda$(m$\AA$)	log N/N$_T$	W$_\lambda$(m$\AA$)	log N/N$_T$	W$_\lambda$(m$\AA$)	log N/N$_T$	W$_\lambda$(m$\AA$)	log N/N
Fe I	*(continued)*										
488	3867.22	-0.42	MF	...	...	...	...	25	-4.79	...	...
522	4199.10	0.25	MF	...	...	...	...	94	-4.44	...	...
554	4736.77	-0.74	MF	49	-4.11	...	...	21	-4.49	...	...
562	3948.10	-0.26	KX	...	...	...	...	25	-4.83	...	...
693	4196.20	-0.74	MF	42	-4.06	...	...	...	...	...	...
	4238.81	-0.28	MF	83	-4.05	...	...	...	...	...	...
	4227.43	0.23	KX	...	...	...	...	69	-4.60	...	...
695	4158.79	-0.67	MF	80	-3.68	...	...	...	...	...	...
726	4136.99	-0.54	MF	56	-4.07	...	...	...	...	...	...
800	4219.36	0.12	MF	66	-4.52	...	...	40	-4.73	...	...
801	4118.55	0.28	MF	71	-4.62	...	...	40	-4.89	...	...
820	4673.16	-0.98	MF	29	-3.89	...	...	...	...	...	...
826	4525.14	-0.34	KX	46	-4.30	...	...	...	...	...	...
Fe II					log Fe/N$_T$ = -4.30±0.24		-4.56±0.21		-4.69±0.24		-4.72±0.2
3	3914.50	-4.05	MF	98	-4.00	...	...	...	...	...	...
21	4075.95	-3.38	MF	...	...	...	...	44	-4.76	...	...
25	4670.18	-4.10	MF	51	-3.95	...	...	41	-4.08	...	...
27	4173.46	-2.18	MF	...	...	33	-5.00	...	...	57	-5.06
	4233.16	-2.00	MF	...	...	...	...	...	...	79	-4.68
	4273.32	-3.34	MF	...	...	...	...	76	-4.28	...	...
	4303.17	-2.49	MF	...	...	30	-4.72	78	-5.10	52	-4.81
	4351.77	-2.10	MF	168	-4.46	34	-5.00	114	-4.97	57	-5.10
	4385.38	-2.57	MF	...	...	30	-4.20	...	...	60	-4.51
	4416.83	-2.60	MF	...	...	25	-4.73	96	-4.71	48	-4.76
28	4122.66	-3.38	MF	...	...	14	-4.43	41	-4.78	16	-4.90
	4178.86	-2.48	MF	178	-3.98	38	-4.56	...	...	61	-4.68
	4258.16	-3.40	MF	88	-4.14	...	...	41	-4.69	16	-4.81
	4296.56	-3.01	MF	...	...	16	-4.66	21	-5.03		
	4369.40	-3.67	MF	77	-3.95	...	...	...	...	...	...
29	3824.91	-3.41	MF	...	...	...	...	...	...	14	-4.91
32	4314.31	-3.48	KX	...	...	...	...	...	...	23	-4.52
37	4472.92	-3.43	MF	53	-4.42	...	...	...	...	...	...
	4489.18	-2.97	MF	...	...	17	-4.62	...	...	43	-4.48
	4491.40	-2.70	MF	93	-4.70	22	-4.70	83	-4.74	44	-4.72
	4515.34	-2.48	MF	123	-4.69	33	-4.59	98	-4.76	50	-4.80
	4520.22	-2.60	MF	...	...	32	-4.51	73	-5.02	45	-4.82
	4555.89	-2.29	MF	147	-4.49	36	-4.71	134	-4.38	53	-4.94
	4582.84	-3.10	MF	81	-4.44	11	-4.73	55	-4.72	21	-4.87
	4629.34	-2.37	MF	149	-4.40	35	-4.65	101	-4.86	54	-4.83
	4666.75	-3.33	MF	105	-3.97	...	...	68	-4.33	15	-4.86
38	4508.28	-2.21	MF	142	-4.61	42	-4.59	114	-4.79	67	-4.66
	4522.63	-2.03	MF	...	...	44	-4.73	...	...	65	-4.87
	4541.52	-3.05	MF	95	-4.34	18	-4.48	72	-4.53	23	-4.86
	4576.33	-3.04	MF	79	-4.52	18	-4.48	74	-4.53	29	-4.74
	4583.83	-2.02	MF	170	-4.48	49	-4.58	118	-4.94	79	-4.55
	4620.51	-3.28	MF	71	-4.38	36	...	...	-4.82	17	-4.84
42	4923.93	-1.32	MF	232	-4.37	...	...	169	-4.80	94	-4.83
43	4601.34	-4.40	KX	12	-4.20	...	...	...	...	...	...
	4656.98	-3.63	MF	...	...	...	...	...	...	14	-4.57
	4731.44	-3.36	MF	...	...	13	-4.34	56	-4.41	24	-4.52
126	4032.94	-2.70	KX	...	...	...	...	...	...	19	-4.53
127	4024.55	-2.48	MF	...	...	...	...	26	-4.78	...	...
153	3814.12	-2.41	MF	...	...	...	...	...	...	34	-4.30
172	4048.83	-2.14	KX	...	...	10	-4.51	...	...	10	-4.93

Table 5. - *continued*

				θ And		ϵ Del		ϵ Aqr		ι And	
Mult.	$\lambda(\AA)$	log gf	Ref.	$W_\lambda(m\AA)$	log N/N_T	$W_\lambda(m\AA)$	log N/N_T	$W_\lambda(m\AA)$	log N/N_T	$W_\lambda(m\AA)$	log N/N
Fe II	*(continued)*										
173	3906.01	-1.83	MF	...	...	...	...	...	...	42	-4.29
	3935.96	-1.86	MF	...	...	21	-4.38	...	...	23	-4.73
186	4635.33	-1.65	MF	50	-4.33	24	-4.31	30	-4.66	...	...
190	3938.97	-1.85	MF	...	...	16	-4.41	...	...	29	-4.43
212	4057.45	-1.54	KX	...	...	...	...	...	...	10	-4.71
218	4913.30	+0.01	KX	26	-3.84	...	...	...	...	...	...
D	4596.02	-1.84	KX	...	...	...	...	...	...	19	-4.54
J	4357.57	-2.11	KX	...	...	8	-4.47	...	...	17	-4.42
	4451.54	-1.82	KX	26	-4.44	...	...	...	...	18	-4.60
	4826.68	-0.44	KX	...	...	11	-4.12	...	...	...	...
	4984.49	+0.01	KX	...	...	...	...	...	...	13	-4.60
	4993.35	-3.65	MF	...	...	12	-4.13	...	...	14	-4.56
	5001.92	+0.89	KX	...	...	27	-4.84	...	...	33	-4.85
	5004.19	+0.49	KX	...	...	17	-4.80	...	...	25	-4.70
	5018.45	-1.22	MF	...	...	78	-4.42	...	...	114	-4.51
	5097.27	+0.31	KX	...	...	21	-4.41	...	...	...	...
Ni I				log Ni/N_T = -5.24±0.25			...		...		...
32	3858.30	-0.97	MF	87	-5.56	...	...	...	...	...	...
98	4648.66	-0.16	MF	38	-5.11	...	...	...	...	...	...
	4765.10	-0.34	MF	33	-4.98	...	...	...	...	...	...
113	4829.03	-0.33	MF	17	-5.31	...	...	...	...	...	...
Ni II				log Ni/N_T = -5.30±0.12			-6.21±0.28		-5.53±0.08		-6.00±0.1
9	4362.10	-2.72	KX	34	-5.21	...	...	22	-5.47	...	...
11	3849.55	-1.88	KX	...	...	18	-6.01	...	...	34	-5.88
	4067.03	-1.29	KX	...	...	23	-6.41	...	...	...	...
12	4015.50	-2.42	KX	43	-5.38	...	...	31	-5.59	10	-6.12
Zn I				log Zn/N_T = -6.80			...		...		...
2	4810.53	-0.14	KX	33	-6.80	...	...	...	...	...	...
Sr II				log Sr/N_T = -8.64			-9.78±0.18		- 8.54		...
1	4077.71	0.15	WM	180	-8.64	...	...	94	-9.91	...	...
	4215.52	-0.17	WM	...	...	6	-8.54	91	-9.65	...	...
Y II				log Y/N_T = -8.87±0.23			...		...		...
5	4358.73	-1.32	HL	38.	-8.71	...	...	...	...	...	...
22	4883.68	0.07	HL	76	-9.03	...	...	...	...	...	...
Zr II				log Zr/N_T = -8.42±0.26			...		-9.19		...
16	3958.24	-0.31	KX	73	-8.60	...	...	...	...	...	...
	3998.95	-0.67	GB	43	-8.58	...	...	...	...	...	...
30	3991.16	-0.25	KX	45	-8.85	...	...	...	...	...	...
40	4317.32	-1.38	BG	30	-7.99	...	...	...	...	...	...
41	4149.22	-0.03	BG	...	...	...	...	35	-9.19	...	...
79	4370.95	-0.71	GB	33	-8.31	...	...	...	...	...	...
	4457.42	-0.80	KX	32	-8.26	...	...	...	...	...	...
88	4379.74	-0.36	KX	40	-8.33	...	...	...	...	...	...
Ba II				log Ba/N_T = -9.10±0.28			...		-9.91		...
1	4554.03	0.14	KF	122	-9.25	...	...	...	...	...	...
	4934.08	-0.16	KF	124	-8.95	...	...	34	-9.91	...	...

Table 5. - *continued*

Note: gf value references follow:
BG = Biemont et al. (1989) for V II, Biemont et al. (1981) for Zr II
BK = Biemont et al. (1982)
FW = Fuhr & Wiese (1990)
GB = Grevesse et al. (1981)
HL = Hannaford et al. (1982)
KP = Kurucz Peytremann (1975)
KX = Kurucz & Bell (1995)
LA = Lanz & Artru (1985)
LD = Lawler & Dakin (1989)
MF = Fuhr, Martin & Wiese (1988) and Martin, Fuhr & Wiese (1988)
SG = Scholz-Gulde (1969
WF = Wiese, Fuhr & Deters (1996)
WM = Wiese & Martin (1980)
WS = Wiese, Smith & Glennon (1966) and Wiese, Smith & Miles (1969)

Table 6. Comparison of Derived and Solar Abundances as log N/H

Species	ϵ Del	ι And	ϵ Aqr	θ And	Sun
C I	...	...	-3.51	...	-3.45
C II	-3.50±0.10	-3.59±0.25	...	...	-3.45
N II	-4.67	...	...	...	-4.03
O I	-3.33	...	...	...	-3.13
Mg I	...	...	...	-4.65	-4.42
Mg II	-4.39±0.11	-4.53±0.13	-3.85:	-3.84:	-4.42
Al I	...	...	-6.33±0.21	-5.98±0.34	-5.53
Al II	-5.88	-5.72	...	...	-5.53
Si II	-4.41±0.10	-4.60±0.13	-4.42±0.15	-4.44±0.24	-4.45
Si III	-4.24±0.23	...	...	...	-4.45
S II	-4.73±0.19	...	...	...	-4.67
Ca I	...	...	-6.14	-5.32±0.01	-5.64
Ca II	-5.73	-6.14	-5.75	-5.98	-5.64
Ti II	-6.97	-7.35±0.12	-6.86±0.19	-7.03±0.25	-6.98
V II	...	...	-7.96±0.25	...	-8.00
Cr I	...	...	-6.74	-6.46	-6.33
Cr II	-6.19±0.18	-6.42±0.21	-6.33±0.19	-6.10±0.27	-6.33
Mn II	...	...	...	-5.88	-6.61
Fe I	...	...	-4.56±0.26	-4.17±0.28	-4.50
Fe II	-4.52±0.21	-4.68±0.20	-4.65±0.24	-4.26±0.24	-4.50
Ni I	...	...	...	-5.20	-5.75
Ni II	-6.17±0.28	-5.96±0.17	-5.49±0.08	-5.26±0.12	-5.75
Zn I	...	...	...	-6.76	-7.40
Sr II	-8.50	...	-9.74±0.18	-8.60	-9.03
Y II	...	...	...	-8.83	-9.76
Zr II	...	...	-9.15	-8.38±0.26	-9.40
Ba II	...	...	-9.87	-9.06±0.28	-9.87
$T_{\rm eff}$ (K)	13679	11600	9050	9000	5600