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Spectroscopic investigation of stars with large proper motions

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Abstract. A sample from the list of stars with large proper motions (Carney et al., 1994) has been studied to investigate in details the chemical composition of the extremely old population of the Galaxy. CCD–spectra with a S/N of more than 100 and spectral resolution R $\approx$ 25000 within the wavelength range 5000–7200 Å or 5500–8700 Å have been obtained for all the objects of the sample with the echelle–spectrometer Lynx of the 6 m telescope. The atmosphere parameters and abundances of more than 20 chemical elements including lithium have been determined for 10 program stars by the model atmosphere method using the spectral criteria only. Radial velocities with an accuracy better than 0.2 km/s have been determined from a large set of lines. The metallicity of the star sample is within $-0.1 > [Fe/H] > -2.5$ dex. The oxygen abundance derived from lines of IR–triplet OIλ7773 for all 10 stars is enhanced with respect to iron ([OI/Fe] = 0.47 dex). For 6 metal–poor stars ([Fe/H] < -1.4 dex) the abundance of scandium, chromium, magnesium corresponds to that of iron: the mean value for them is [X/Fe] = 0.1 dex. Overabundances of a number of elements produced by α–process have been revealed for these metal–poor objects: [Mg/Fe] = 0.76 dex, [Si/Fe] = 0.56 dex, [Ca/Fe] = 0.74 dex. At the same time the sodium abundance is normal with respect to that of iron [Na/Fe] = 0.04 dex. The abundance ratio of odd/even elements produced by α–process is [Na/Mg] ≈ -0.72, which causes the neutron excess $[\eta] = -1.0$. Considerable overabundances of lanthanides have been found: for lanthanum, cerium, neodymium and europium the mean value is [X/Fe] = 0.88 dex. The barium abundance, most of which is synthesized in the processes of slow neutronization, is significantly lower in the investigated halo stars: [Ba/Fe] = -0.48 dex. For the extreme halo stars with [Fe/H] ≈ -2 the Ba and Eu abundance ratio is log(Ba/Eu) = 0.57, which indicates the r–process to be the main mechanism of production of heavy metals at the early epoch of nucleosynthesis. For the stars with the metallicity close to solar, [Fe/H] ≈ -0.2, this ratio is log(Ba/Eu) = 1.64, which corroborates the contribution of s–process for barium production and including of type I supernovae into iron production at the stage of formation of the disk population.

The evolution status of the stars studied has been determined from the obtained set of parameters. The kinematically homogeneous sample studied is inhomogeneous in metallicity and radial velocities and includes both the type II population stars and the stars which belong to the young and old (thick) disk. It should be noted that the investigated metal–poor stars by their spectroscopically determined luminosity refer rather to subgiants and halo giants than to the stage of unevolved stars. Such decrease in the fraction of unevolved subdwarfs among the old halo stars will cause revision of the mass function of the type II population stars and reestimation of the halo age.

Key words: stars: abundances – stars: atmospheres – stars: subdwarfs

1. Introduction

Spectra of stars belonging to different populations (halo, thick and thin disks) are the main sources of data on the character of evolution of chemical composition of the Galaxy. Chemical element abundances which we observe are a combined product of nuclear reactions which occurred in the interiors of stars of different masses with initial chemical composition dependent upon the population type. Due to some factors (mass function for different galactic generations, functions of production of different chemical elements, matter quantity enriched as a result evolution of the star of the given mass and ejected later into the interstellar medium), it is rather difficult to interprete chemical element abundance ratios and to compare observations with theoretical models of chemical composition evolution. It is evident that the best way to study the initial (protostellar) chemical composition of the Galaxy is to determine chemical composition of the oldest unevolved halo stars. Such objects are selected by their low luminosity (subdwarfs), kinematic characteristics (large proper motions, a considerable part of these stars moving perpendicular to the galactic plane), and by the low abundance of heavy elements (iron abundance relative to the solar $[Fe/H] < -1.5$ dex). It is obvious that for reconstruction of the pattern of chemical composition evolution of the Galaxy, apart from the data on metallicity (identified usually with iron abundance) we need data on abundance of chemical elements synthesized in the course of basically different nuclear reactions, occuring in the interiors of stars of different mass and evolution stage: burning of α–particles (α–process), slow (s-) and rapid (r-) processes of neutronization of heavy nuclei.

The data on lithium abundance are of particular significance. Reliable data on lithium abundance in the atmospheres of stars belonging to different populations of the Galaxy and observed at different stages of evolution are known to be necessary for both testing of different cosmological models and modeling of stellar evolution processes and construction of models of stars and stellar atmospheres. In spite of the fact that in the last few years numerous observations have been devoted to the questions of lithium production and evolution, and such basic phenomena as "plateau" of Spite (Spite and Spite, 1982) for extremely old stars and "gap" of Boesgaard (Boesgaard and Tripicco, 1986a,b) for stars in open clusters have been detected, there remains many problems. Such basic questions as initial lithium abundance, mechanisms of its production in the halo and disk, origin of lithium dispersion on the "plateau", origin of lithium–rich stars, mechanisms of lithium destruction in the course of stellar evolution have not been solved yet. In this connection the most valuable are highly accurate estimates of lithium abundance for stars with reliably fixed belonging to one or another galactic population and stage of stellar evolution. It is important to note that papers on lithium abundance determination are often based on observations in narrow, about 50–70 Å, spectral intervals. Therefore, apart from lithium there are presented data on abundance of one–two chemical elements only, Ca and Fe, as a rule. In order to determine abundances of a large set of elements, high accuracy spectral observations in a wide spectral range are needed. Besides, observations of rather representative samples of stars are necessary for reliable revealing of fine details in the chemical abundance curve. This will allow diminishing the influence of dispersion of parameters of individual stars. Thus, at present the most actual is the task of detailed study of physical parameters, lithium abundance and a large set of other chemical elements for stars which, by their luminosity, kinematic characteristics and metallicity, may be referred to the extremely old stellar population in the Galaxy.

2. Observations

Our program of spectroscopic investigation of chemical element abundances in the atmospheres of halo stars is composed on the basis of Laird et al. (1988) survey and a later version of this survey (Carney et al., 1994). The papers mentioned are based on Lowell catalogue of proper motions and include the data on spatial velocities, absolute luminosity, temperature, interstellar reddening, metallicity, determined both from photometric observations of the authors in the UBV system and on the basis of echelle spectra analysis with the extremely low S/N ratio obtained by the same authors for a large sample of stars.

For observations with a high spectral resolution and high S/N ratio we selected from the lists of Laird et al. (1988) and Carney et al. (1994) objects brighter than $V = 11^m$ with metallicity relative to solar $[Fe/H] < -1.0$ dex, preference being given to halo stars with $[Fe/H] < -1.5$ dex. Up to present spectral data have been processed for the stars presented in Table 1.

All the observations have been carried out by V.Klochkova and V.Panchuk with the 6 m telescope echelle spectrometer LYNX (Panchuk et al., 1993) equipped with a CCD of 530×580 pixels. For each star 2–4 spectra have been obtained with the spectral resolution $R \approx 25000$ and S/N ratio more than 100 within the wavelength range $5000 - 7200$ or $5200 - 8800$ ÅÅ. Echelle spectra have been processed using the program of Galazutdinov (1992). Fig. 1 presents a fragment of one of 32 echelle orders (which contains resonance lithium doublet) in spectra of the metal–poor star HD 64090 and the star $G122 - 57$ with chemical composition close to solar.

For some stars of our program there are published equivalent widths of the selected lines measured from the spectral material, the quality of which (S/N ratio and spectral resolution) is not inferior to ours. This gives a possibility of comparing the sets of equivalent widths, which is important for the subsequent generalization of the data in chemical composition. A comparison of our measurements with those published earlier is presented in Fig. 2. The few data in the figure are due to the fact that, as different from our echelle spectra that embrace a spectral range of several thousand angströms, the cited authors, who operate coude spectrograph with medium format CCD, are able to cover intervals only as long as $30 - 60$ ÅÅ around the doublet LiI during one ex-

Table 1: *The main characteristics of the program stars, taken from Carney et al. (1994).*

Star	V	B-V	T_{eff}, K	M_v	[m/H]	V_r km/s	$\sigma(V_r)$	Notes
G90-25	8.28	0.61	5381	0.61	-1.75	-235.0	0.6	HD 64090
BD 23°3912	8.90				-1.29			**
G29-20	9.17	0.75	4988		-1.71	-190.4	0.6	HD 219715 *
G122-57	8.36	0.86	4744		-1.71:	47.2	0.4	HD 103912 *
G126-62	9.47	0.44	5885	0.67	-1.95	-291.4	1.0	BD 17°4708
G170-47	8.95	0.64	5126	0.57	-2.89:	-284.6	1.1	BD 23° 3130
G182-7	8.10	0.76	5051	0.64	-0.71	4.4	0.5	HD 157948
G188-22	10.05	0.49	5934	0.69	-1.45	-95.1	0.7	BD 26°4251
G246-38	9.91	0.65	5219	0.58	-2.10	-162.4	0.8	BD 66°0268
G265-1	8.37	0.65	5348	0.63	-1.16	-79.9	0.9	HD 245

* - T_e and [m/H] from Laird (1988),

**- [m/H] from Shuster and Nissen (1989).

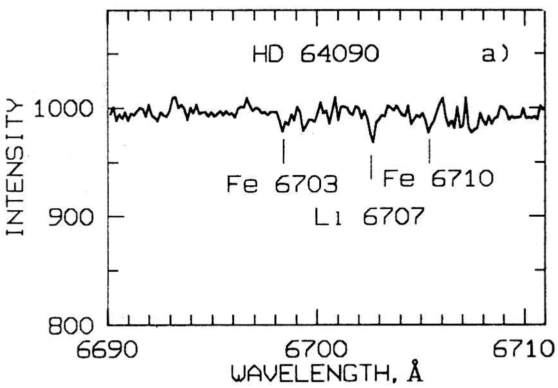

Figure 1: *a) Spectrum region near the lithium doublet λ6707 for HD 64090 star.*

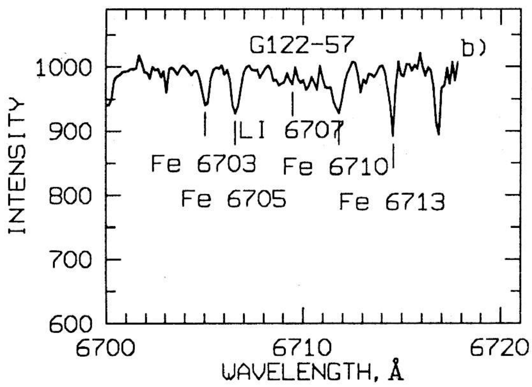

Figure 1: *b) Spectrum region near the lithium doublet λ6707 for* G122 − 57 *star.*

posure, since most programs of high-resolution spectroscopy of subdwarfs are aimed at studying the behaviour of exactly this element.

To isolate in the spectra the lines of the telluric spectrum every night we obtained an analogous spectrum of a hot fastly rotating star. The spectrum quality of the program stars was such that we could measure the equivalent widths W with an accuracy of 2 − 4 mÅ, which is in agreement with the estimates made by the formula of Cayrel (1985).

3. Determination of atmosphere parameters and metallicity

To determine the main parameters of model atmospheres of stars: effective temperature T_{eff}, surface gravity log g, and to calculate chemical composition we used model grids of Kurucz (1979) and Bell et al. (1976). But at first let us dwell on the selection of strategy for investigation of stellar atmospheres.

Particular attention has always been paid to the procedure stellar effective temperature determination when calculating chemical composition. To determine T_{eff} of faint stars photometric criteria are used most frequently. However this approach causes much doubt, since the application of average calibration relationship between photometric indices and effective temperature does not take into account individual characteristic properties of the atmospheres of particular stars and may introduce inaccuracies caused by the uncertainties in allowance made for the interstellar reddening (Klochkova and Panchuk, 1987). This is very important when studying stars whose evolution stage and population type have not been yet determined. For stars whose evolutionary status and chemical composition are obviously unknown the

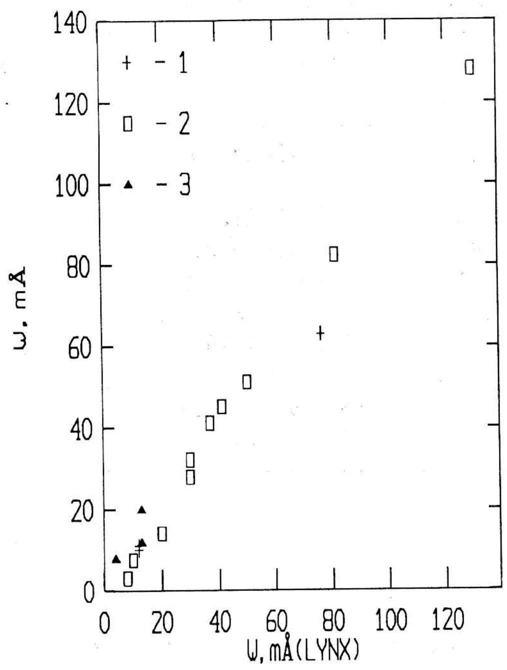

Figure 2: *Comparison of the measured equivalent widths W with those published: by Rebolo et al. (1988) - 1, Pilachowski et al. (1993) - 2, Thorburn (1994) - 3.*

choice of a particular line of intrinsic colours is ambiguous, therefore the correction of the observed photometrical indices for the interstellar reddening may cause considerable errors in effective temperature. This, in turn, may result in gross errors in the inferences concerning the chemical composition and evolutionary status, since the expected values of evolutionary chemical composition variations are not large and only slightly exceed probable errors.

For simplicity we may assume that flux in the bands which determine the photometric index of the effective temperature is generated in the photosphere, and then absorption in lines is cut from this flux. The degree of this absorption depends on both effective temperature (through the function of temperature distribution with depth and through the populations of levels), and number of atoms of a given element (i.e. on metallicity). Metallicity index is defined mainly by characteristics of the external layers of atmospheres, where absorption in lines is formed. Galazutdinov et al. (1991) showed that individual differences in the structure of the external layers of atmospheres are displayed in the excess dispersion of equivalent widths and metallicity indices among stars of equal effective temperature. This dispersion is not associated with real metallicity variations. This effect causes the low correlation of spectroscopic and photometric determinations of metallicity. This is reported by Spite (1995) in other words: "A structure difference will make that similar deep layers (similar colours) do not necessarily imply similar external layers, at the accuracy aimed for" (in this phrase only colour indices are meant as criteria of effective temperature).

Within the particular model approximations there is no place for the conception "dispersion of characteristics of external layers of atmospheres with similar T_{eff} and log g" as yet. Therefore, the hopes of a successful model description of both line intensities and colour indices are still associated with the increase of the list of atomic lines, whose absorption is allowed for in model atmosphere calculation. Suppose that we are dealing only with the specific lists of measured absorption lines, in this case we have uncertainties of the model description of the given list of lines only. It is shown that relative errors of chemical composition definition can be reduced by selection of specific line groups (Klochkova et al., 1991; Klochkova, 1991). Thus, part of the uncertainties of the model description of the given list of lines can be avoided. If, however, we use the photometric techniques for defining atmospheric parameters, then, apart from the above mentioned inaccuracies in the model description of the list of the measured lines, we deal with both the inaccuracies of the model description of **all** the lines that form a particular colour index and the uncertainties of the oscillator strength system (semiempirical mainly) in the greater part of the list of all the lines, taken into account in calculating the colour indices, and the incompleteness of the list. In this case, additional errors of methodological nature introduced in the chemical composition determinations are inevitable. It is evident that the spectroscopic criteria for determination of fundamental parameters reduce relative errors of chemical composition definition, therefore they are more preferable for the models atmosphere method. We believe that labour–consuming way of spectroscopic determination of atmospheric parameters that we chose as basic in the early 80s has been justified.

The direct method of measuring T_{eff} turned out to be in a similar situation. The temperature estimated by the infrared fluxes method (Blackwell et al., 1980) approximates at maximum the definition "effective temperature". However, in the calculation of chemical composition by the model atmosphere method the results are more realistic when the "indirect" T_{eff} values are used, which are based on the spectroscopic criteria. The statement is clearly proved by the situation with the parameters of the Procyon atmosphere. Steffen (1985) in his paper on the parameters and chemical composition of this nearby star with the reliably known values of mass, visual angular diameter, luminosity and effective temperature consideres in details the fitness of T_{eff} determined by different procedures. He draws a conclusion that to obtain a plausible chemical composition $\epsilon(X)$ and minimize scatter in individual values of $\epsilon(X)$ obtained from separate lines of a particular chemical element, it is necessary to abandon the fundamental value of $T_{eff} = 6500$ K, and to use $T_{eff} = 6750$ K at which ionization balance for iron is obeyed and iron abundance drift in lines with different excitation potentials is absent.

The best "spectral thermometer" for G–dwarfs is the H_α line profile, which, being highly temperature sensitive in the case of G–stars, does not depend on surface gravity and metallicity of a star (Fuhrman et al., 1993). Unfortunately, the echelle spectra which we used at the first stage of the work were registered on a small–format 530 × 580 CCD, that is why the neighbouring spectral orders were not overlapped and we could not obtain confidently hydrogen line profiles and use this most reliable temperature criterion. Now, after the redesign of the echelle–spectrometer scheme and its equipment with a CCD of a larger format this shortcoming has been eliminated (Panchuk and Klochkova, 1995).

However, owing to the wide spectral range of the original observational material, we still could make use for determination of the model parameters T_{eff} and log g only spectral criteria free from the influence of interstellar reddening and other above mentioned methodological effects.

In this paper the effective temperature is determined from the condition that neutral iron is independent of excitation potential of the lines, surface gravity is selected from the condition of ionization balance for iron atoms, the microturbulent velocity value – from the condition that iron abundance is independent of line intensities. In practice the process of the model parameters determinations is iterational. Fig. 3a,b presents the enumerated procedures of determination of the model atmosphere parameters for one of the program stars – HD 64090.

The temperature reality criterion is the absence of a relationship between the abundance obtained from individual lines and the low level excitation potential for chemical elements represented in the spectra by numerous lines (CaI, CrI, NiI, for instance). Similarly, individual abundances are not dependent on the equivalent widths used for the calculations of lines. This is indicative of reality of the microturbulent velocity determination. As a whole, the inherent agreement of the parameters indicates that the used homogeneous atmosphere models are suitable for calculation of weak lines in the LTE approximation.

It should be noted that the corrections for the superfine structure and the isotopic shifts which broaden CoI, MnI, NiI and BaII lines are not taken into consideration, since for weak lines of these metals in the spectra of metal–poor stars of low luminosity these corrections are not significant. The obtained model parameters for the investigated stars are given in Table 2, for comparison the earlier published data are presented in Table 3.

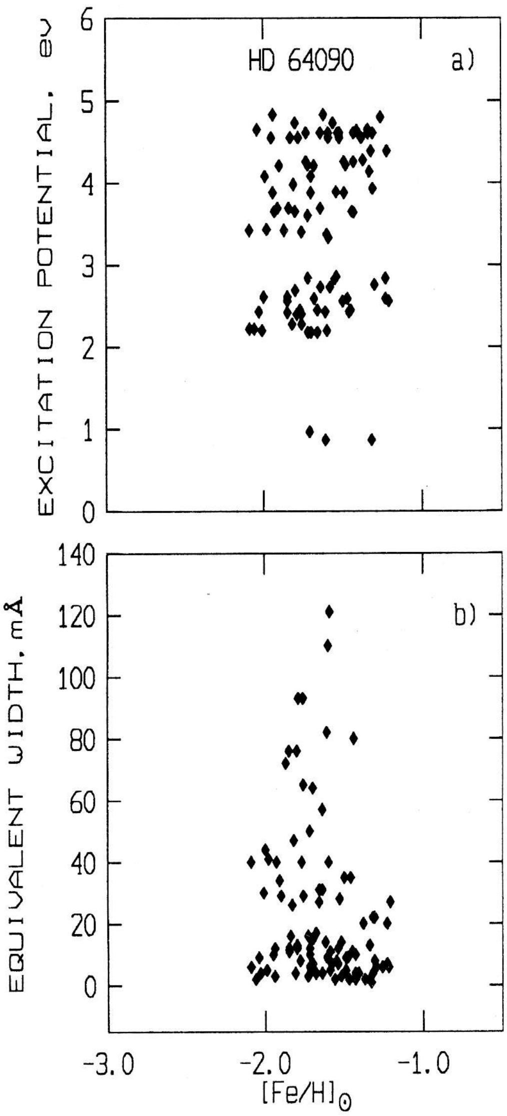

Figure 3: *a) Neutral iron abundance determined from individual lines as a function of equivalent line width to illustrate the method of microturbulent velocity.*
b) Neutral iron abundance determined from individual lines as a function of potential excitation of appropriate level to illustrate the method of effective temperature determination.

As follows from these two tables for most of the studied stars the values of effective temperature we have obtained agree with those published, the differences are within the errors and do not exceed 100 K.

Table 2: *Model atmosphere parameters and radial velocities*

Star	T_{eff}, K	log g	V_t km/s	[Fe/H]	V_r km/s	$\sigma(V_r)$ km/s
G90-25	5370	3.0	2.5	-1.67	-236.6	0.4
BD 23°3912	5650	3.0	1.3	-1.46	-115.7	0.2
					-115.0	0.4
G29-20	5030	2.0	1.2	-0.91	-191.0	0.1
G122-57	5040	3.0	1.0	-0.33	+58.2	0.1
G126-62	5810	3.0	2.0	-1.88	-288.7	0.2
G170-47	5250	2.0	2.0	-2.46	-282.5	0.1
G182-7	5500	4.2	2.0	-0.14	-0.3	0.2
G188-22	5860	3.5	1.7	-1.43	-93.9	0.2
G246-38	5240	3.5	3.5	-2.18	-162.2	0.2
G265-1	5500	3.5	1.5	-0.66	-81.0	0.1

Table 3: *Model atmosphere parameters for a number of program stars published earlier*

Star	T_{eff}, K	log g	Reference
G90-25	5361	3.54	Hernshaw 1976
	5250	4.5	Peterson 1978
	5400		Peterson 1981
	5380		Hobbs, Dunkan 1987
	5370	4.0	Rebolo et al. 1988
	5500	4.5	Gilgroy et al. 1988
	5400	4.0	Abia, Rebolo 1989
BD 23°3912	5600	4.0	Spite et al. 1984
	5720		Rebolo et al. 1988
	5600		Pilachowski et al. 1993
G122-57	4800		Pilachowski et al. 1993
G126-62	5960	3.4	Magain 1989
	5890	4.0	Abia, Rebolo 1989
G170-47	5250		Pilachowski et al. 1993
G217-08	6030		Pilachowski et al. 1993
G246-38	5240	4.0	Rebolo et al. 1988

The stars G122 − 57 and G182 − 7 are an exception. For these stars the "spectroscopic" values of T_{eff} are by 300–400 K higher than the "photometric". The metallicity calculated for these two stars with the new values of T_{eff}, allows classifying these objects among the disk population stars. The radial velocities of these stars, which correspond to the disk population (see Table 2), as well as the details of the abundance curve of the chemical elements typical of the Galaxy population type I (see Section 5) are an argument in favour of the greater validity of the "spectroscopic" T_{eff} values.

When comparing the "photometric" T_{eff} from Table 1 and "spectroscopic" T_{eff} from Table 2 one can see the "photometric" T_{eff} to be systematically lower with respect to the "spectroscopic" T_{eff} at $T_{eff} < 5100$K (taken from Carney et al., 1994). Note, that the photometric method of T_{eff} determination in combination with the technique of metallicity estimation used by Carney et al. (1987) for cold Hyades dwarfs, beginning with $T_{eff} < 5100$ K, a systematic decrease in metallicity by 0.5 dex with T_{eff} lowering by 500 K is observed (see Fig. 4 in the paper of Carney et al., 1987). It is known that direct spectro-

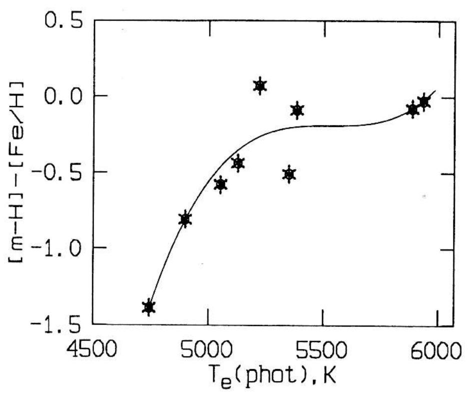

Figure 4: *Relationship between the differences in metallicity estimates,* $\Delta = [\mathrm{m/H}] - [\mathrm{Fe/H}]$ *from the data of the low S/N ([m/H] from Table 1) survey and spectroscopic metallicity values with a high S/N ([Fe/H] from Table 2) and the effective temperature* T_{eff} *(phot) determined by photometry (Table 1).*

scopic methods do not give such a trend of metallicity inside one open cluster. For stars with $[\mathrm{Fe/H}] > -1.3$ a systematic metallicity decrease according to Carney et al. (1987) is observed relative to the classic estimates from the high-dispersion spectra with the mean and high S/N values (see Fig. 3 in the paper of Carney et al., 1987). Fig. 4 presents the difference between metallicity values from the data of a spectral survey with a low and high S/N as a function of effective temperature determined photometrically. For $T_{eff} < 5200$ K a systematic metallicity decrease according to Carney et al. (1987) is observed also relative to our estimates from the spectra with the high S/N ratio. Note, that in contrast to the result for Hyades (Fig. 4 from the paper of Carney et al., 1987) the effect of the metallicity decrease is seen in objects with the wide range of values [Fe/H].

These three facts, in our opinion, suggest that the method of Carney et al. (1987) contains additional systematic errors which increase metallicity dispersion in both the disk and the halo. It should be borne in mind that log g determined spectroscopically from the condition of ionization balance for the iron atom in the approximation of LTE, may be burdened with systematic errors. However, the use of the most complete models of atomic levels for iron shows that non–LTE corrections for the neutral iron atoms are not so essential (Axer et al., 1994) as it follows from the early estimates of these corrections (Bikmaev et al., 1990) based on approximate models of iron atoms with a relatively small number of levels. Tomkin et al. (1992) emphasize that in the metal–poor subdwarf HD 103095 with a large parallax ($\pi = 0\farcs107$) log g calculated on the basis of this parallax agrees well with the spectroscopic value of log g. In the case of metal–deficient subgiants, when using the low excitation potential lines, systematic errors may reach $\Delta \log g \leq 0.3$ dex (Axer et al., 1994) due to the fact that deviations from LTE are not allowed for. However, in our lists the lines with high excitation potentials prevail, therefore, such a systematic error does not change our conclusion that there is a good proportion of the evolved stars among the small mass stars with high spatial velocities.

4. Determination of chemical composition

The used oscillator strengths gf of the spectral lines are presented in Table 6. For a large bulk of the lines they have been taken from the wide homogeneous sample of Thevenin (1989; 1990), however, for neutral iron lines we preferred the accurate experimental values of gf from the publications of the Oxford group (for references see the paper of Blackwell et al., 1986).

The chemical element abundances $\log\epsilon(\mathrm{X})$ calculated from W of individual lines are given in Table 6. We thought it necessary to present the measured equivalent widths W of lines, which will allow in future redefining chemical composition with new model atmospheres and atomic constants.

The typical accuracy of determination of the model parameters for a subdwarf ($\log g = 3.8$) with a temperature of about 5800 K is on the average $\Delta T_{eff} \leq 200$ K, $\Delta \log g \leq 0.3$ dex, $\xi_t \leq 0.5$ km/s. The uncertainties in the calculation of abundances of different chemical element caused by these errors are given in Table 4. It should be borne in mind, that most of the lines used for the calculation of chemical composition of subdwarfs have equivalent widths up to 100 mÅ, which imposes stringent requirements on the accuracy of the observing material, since at a given spectral resolution the accuracy of W of weak lines depends mainly on S/N ratio in the spectrum.

Table 2 presents our radial velocities, obtained by averaging individual measurements of positions of about a hundred absorption lines for every star, as well as the errors of the mean values. Attention should be paid to a higher accuracy of our V_r as compared to the data of Carney et al. (1994). Comparing V_r data from Tables 2 and 3 we reveal radial velocity variability in G122 – 57 with good agreement of our data with the data from the list of Carney et al. (1994) for the rest of the studied stars.

5. Discussion of results

The final abundances, $\lg\epsilon(\mathrm{X}) \pm \sigma$, of chemical elements averaged over the set of the measured lines are listed in Table 5. The second column of this table gives appropriate values for the solar atmosphere

Table 4: *Typical errors of the abundance estimation* $\Delta \lg\epsilon(X)$ *of chemical element X with typical errors of the model parameters*

	$\Delta T_{eff} = 200$ K	log g = 0.3	$\xi_t = 0.5$km/s
LiI	0.18	0.01	0.01
OI	0.19	0.14	0.01
OI*	0.21	0.13	0.05
NaI	0.16	0.06	0.04
MgI	0.05	0.00	0.03
AlI	0.06	0.01	0.03
SiI	0.06	0.01	0.03
SiII	0.17	0.14	0.06
CaI	0.12	0.03	0.12
ScII	0.05	0.12	0.05
TiI	0.16	0.03	0.01
TiII	0.02	0.12	0.01
VI	0.20	0.01	0.01
VII	0.02	0.12	0.01
CrI	0.03	0.16	0.02
MnI	0.14	0.00	0.08
FeI	0.15	0.01	0.05
FeII	0.02	0.13	0.10
NiI	0.14	0.00	0.01
CuI	0.23	0.03	0.03
ZnI	0.04	0.09	0.02
YI	0.22	0.02	0.00
ZrI	0.23	0.01	0.02
BaII	0.10	0.10	0.23
LaII	0.09	0.11	0.14
CeII	0.10	0.13	0.00
NdII	0.07	0.11	0.00
EuII	0.05	0.12	0.00

(Grevesse, 1993) which were used for calculation of the quantities

$$[X/Fe]_\odot = \{\lg\epsilon(X) - \lg\epsilon(Fe)\} - \{\lg\epsilon(X) - \lg\epsilon(Fe)\}_\odot$$

(see Table 6), needed for the analysis of the chemical abundance curve with different metallicity values. In the case of lithium its abundance in meteorites is taken as solar. In Tables 5 and 6 the value ϵ(OI) means oxygen abundance according to intensity of all the measured oxygen lines, except IR-triplet, but ϵ(OI*) means oxygen abundance according intensity of the IR-triplet lines, λ7773 Å. Below we consider in detail the behaviour of individual chemical elements.

Lithium. To calculate the lithium abundance we used the equivalent widths of the resonance lithium doublet λ6707 Å. The intensity of this doublet is known to be very sensitive to the model temperature, which places stringent requirements to the reliability of determination of this parameter. It should be borne in mind that for stars with $T_{eff} < 5500$ K the equivalent width of lithium is sensitive to surface gravity log g too, which causes the necessity of individual determination of this parameter for the stars being studied. Besides, in the case of stars with lithium overabundance it is necessary to know the parameter of microturbulent velocity ξ_t in the atmosphere. However, as a rule, the authors of the papers on determination of ϵ(Li) for halo stars have taken a priori certain typical of this type stars values of log g and ξ_t parameters, i.e. "fixed" the evolutionary status of objects in advance. (In most publications are adopted log g = 4 and $\xi_t = 2$ km/s). If a real sample contains stars differing at least by the degree of deviation from the zero age main sequence (ZAMS) of halo stars (we would remind that for halo stars with different metallicities even the ZAMS position is different), such a simplification inevitably introduces errors into the results of lithium abundance determination or leads to incorrect interpretation of results. Depict the latter by a concrete example.

Rebolo et al. (1988) and Pilachowski et al. (1993) obtained a considerable lithium overabundance for the metal–poor star BD 23°3912. We have included this object in the observational program with the aim to examine these data at other moments of observations, since the existence of lithium overabundance for unevolved halo subdwarfs is an unexplained phenomenon. Our definitions confirm the lithium overabundance in BD 23°3912. An important circumstance in this case is an enhanced luminosity of the object: according to log g, reliably determined by us from a large set of neutral and ionized iron lines, BD 23°3912 is a subgiant rather than a subdwarf, while for subgiants with $T_{eff} \approx 5600$ K lithium overabundance is predicted in the diffusion models (Profitt and Michaud, 1990). Note that in the paper of Pilachowski et al. (1993) the star BD 23°3912 is also in the list of subgiants. Chemical composition and radial velocity of BD 23°3912 was defined from two spectra obtained in summer 1994 with a time difference of 73 days. The equivalent widths corresponding to two dates of observations agree well, that is why they have been averaged for the calculation of chemical composition. The radial velocities for the two spectra of BD 23°3912 are also in agreement (see Table 2), this does not provides grounds to suppose the spectral duplicity of the star, which could cause methodological errors in the definition of T_{eff}, log g parameters and chemical composition. Thus, the observed lithium overabundance in the atmosphere of BD 32°3912 can be a result of evolutionary changes in chemical composition of the atmosphere for this star at the stage of subgiant.

The non–LTE calculations of the equivalent width of the resonance lithium doublet, made in the last few years (Carlson et al., 1994; Pavlenko, 1995) have shown that for the subdwarfs within the temperature interval of about 5000 – 6500 K and for the metallicities from solar to [Fe/H] = −3 dex the non–LTE corrections are negligibly small ($\Delta\epsilon$(Li) $\leq$ 0.01 dex), which allows obtaining reliable lithium abundances for such objects, remaining in the frames of LTE–approximation.

It should be noted, that this conclusion is valid in the frames of a one–dimensional model atmospheres. Kurucz (1995) reminds that the one–dimensional model atmosphere of a cold dwarf is a time– and space–averaged three–dimensional structure, whose temperature inhomogeneties are caused by convection. Kurucz reported that the transition from the one–dimensional to the three–dimensional model atmospheres will result in a nearly one order increase in the lithium abundance in halo stars since the one–dimensional model atmosphere does not make allowance for the lithium superionization. This result may have serious consequencies for the standard model of the primordial nucleosynthesis. Not going to the premature polemics, note only that this conclusion is made for stars with $T_{eff} > 5500$ K, where lithium is almost completely ionized. Hence, for colder stars the effect of lithium superionization (if it does exist) must be less pronounced, i.e. the lithium abundance calculated in LTE–approximation must increase. However, observations show that the lithium abundance decreases with T_{eff} drop, and this is traditionally explained by the effects of dilution and/or mix of the atmosphere with underphotospheric levels, where lithium has burned away. The degree of lithium superionization is defined by the transparency of cold and hot convective elements for the UV–radiations, and therefore, in the three–dimensional model the non–LTE corrections applied to lithium abundance should also be dependent on metallicity. But observations show that the lithium abundance in the atmospheres of halo subdwarfs with $T_{eff} > 5500$ K is practically stable within two orders of metallicity variations (Spite plateau).

Two objects from our list (G126 – 62 and G188 – 22) by metallicity and effective temperature are members of the Spite plateau. Their lithium abundance corresponds to the mean value for the plateau.

Determination of lithium abundance for halo subdwarfs HD 64090, G170 – 47 and G246 – 38 with $T_{eff} < 5500$ K is of great importance for testing different models of lithium exhaustion in convection development. The difficulty in such determinations is the necessity of accurate measurement of weaker lithium lines and of valid T_{eff} determination.

Oxygen. The data on the oxygen abundance in the atmospheres of halo stars is a test for the evolution scenario of the earliest stellar populations in the Galaxy (Matteucci and Francois, 1992). However, such data are yet scanty due to the fact that oxygen lines in the spectra of subdwarfs in the traditional spectral range are very weak. Application of CCDs in astronomical observations made it possible to determine oxygen abundance from the lines of the IR–triplet of about λ7773 Å which are the strongest details in the spectra of metal–poor subdwarfs, their equivalent widths reach dozens mÅ even in the case of the extremely low metallicity (see Table 6). Due to the fact that the metastable level takes part in the formation of the triplet lines, the oxygen IR–triplet intensity is very sensitive to the luminosity of the star (often triplet intensity is used as a spectroscopic criterion of absolute magnitude). That is why the determination of oxygen abundance from the IR–triplet intensity implies a reliable estimate of log g using other criteria.

The oxygen abundance we have determined from the lines of the IR–triplet λ7773 Å, which were measured in the spectra of 7 stars, is enhanced with respect to iron ([OI/Fe] = 0.47 dex), while from weak highly–excited lines of about λ6156 Å this overabundance is higher [OI/Fe] = 0.86 dex. Disagreement in oxygen abundance, obtained using the IR–triplet on the one hand and other absorption details (both permitted and forbidden) on the other hand, has already been noted for halo stars (see, for example, the references in the paper of King, 1993). The traditional explanation due to incompleteness of the LTE–approximation for oxygen atom does not remove the disagreement, since the non–LTE calculations for the IR–triplet made with complete enough models of atomic levels and reliable atomic constants (Kiselman, 1991; Tomkin et al., 1992) show that the non–LTE corrections to equivalent widths of the oxygen IR–triplet lines are small.

King (1993) suggests that the unreliable temperature calibrations of the photometric indices are mainly responsible for the anomalous behaviour of the IR-triplet. However, as follows from our results, the significant difference in oxygen abundance revealed using the IR–triplet and weak lines in the red spectrum range is observed also in the case of spectroscopic determination of effective temperature. One may suppose that the most likely cause of the discrepancy is the model description (which is far from reality) of the atmospheric layers of subdwarfs where the IR oxygen triplet is formed. Kiselman (1991) points out that even for the Sun the homogeneous models give a pattern inadequate to observations. In the frames of our investigation it is important, however, to emphasize that the effect discussed, which is possibly of methodological origin, does not change the general conclusion about oxigen overabundance in the atmospheres of the stars studied.

Elements of α–process. For 6 metal deficient stars ([Fe/H] < −1.4 dex) overabundances are revealed for a number of chemical elements produced by

α–process: [Mg/Fe] = 0.76 dex, [Si/Fe] = 0.56 dex, [Ca/Fe] = 0.74 dex, and [Ti/Fe] = 0.78 dex. High dispersion should be noted of [Mg/Fe], [Ca/Fe] and [Ti/Fe], which exceeds the methodological errors. This can be explained by inefficient mixing of protogalactic matter from which metal–poor halo stars are formed. However, the behaviour of other chemical elements (iron group, Si, Na) in the atmospheres of the stars studied is inconsistent with this conclusion. Apparently, one should look for additional methodological causes of different dispersion in [X/Fe] values for different elements of α–process.

The sodium abundance relative to iron is normal with a slight dispersion: the mean value is [Na/Fe] = 0.04 dex. The [Na/Mg] ≈ -0.72 ratio is not dependent on metallicity, which confirms the behaviour of odd/even element abundances for metal–poor stars, predicted by theoretical models of nucleosynthesis in the Galaxy. Synthesis of light even nuclear charge metals ($11 \leq Z \leq 22$) occurs through α–particle capture independent of the initial metallicity of the star, while that of odd nuclear charge is dependent on the neutron excess in the region of synthesis. This difference in behaviour of odd/even elements makes it possible to evaluate the degree of neutron excess. Using the calculation results of Arnett (1971) of explosive carbon burning and the obtained odd/even element abundance ratio, we find the value of neutron excess $[\eta] = -1.0$.

The obtained pattern of light metals behaviour is typical of subdwarfs and is in agreement with the data of other authors (see, for example, the papers of Francois, 1986; Magain, 1989). The same pattern is observed for halo giants (Wheeler et al., 1989).

Iron group. For the same 6 metal–poor stars (with [Fe/H] < -1.4 dex) scandium, cromium, and manganese abundances correspond to iron abundance: for these stars the mean value [X/Fe] = 0.14 dex. This result, expected a priori due to the common mechanism of nuclear synthesis of the iron group, is an additional confirmation of validity of the obtained model parameters and reliability of the observational data.

Heavy metals. The elements heavier than iron are synthesized in the processes of neutronization. These processes are accepted to be divided into rapid (r–process, when the characteristic time of production of the dominating isotope is comparable with the time of β–decay) and slow (s–process, when the addition of neutrons is several orders slower). It is known (see, for example, the surveys of Wheeler et al., 1989; or Spite, 1992) that the elements of s– and r–processes are synthesized mainly in the course of evolution of different mass stars, therefore their abundance is crucial for modeling chemical evolution of the Galaxy. In connection with such approximation of the neutronization theory usually the behaviour of these chemical elements is analyzed separately.

Experimental determination of heavy metals abundance is particularly impeded due to the small number of lines suitable for analysis. For example, Ba (s–process) and Eu (r–process) abundances are defined from 2–3 lines. In the case of halo subdwarfs the situation is additionally complicated by the fact that because of the low metallicity, the lines of these metals are very weak and their measurement is unreliable. So, the accuracy of a part of our data on heavy metals abundance (from Y to Eu) in Tables 4 and 5 is not high, the main contribution to the determination error being introduced by inaccurate measurement of weak lines with W = 2 – 10 mÅ.

At the same time, as follows from Table 6, Ba abundance is determined with a high accuracy, since the abundance values calculated from three separate lines agree well for each of the studied stars. In this connection we consider that the barium overdeficiency [Ba/Fe] = -0.48 dex is determined rather reliably. The obtained value of Ba overdeficiency agrees well with the modern models of chemical evolution of the Galaxy, in which the barium overdeficiency for halo stars with [Fe/H] < -1.5 is interpreted as a result of the fact that for the extreme halo population heavy metals can be synthesized only in conditions of high neutron density at type II supernova bursts (r–process).

The considerable overabundances of lanthanides (for lanthanum, cerium, neodium and europium the mean value [X/Fe] = 0.88) also confirm this mechanism. It is likely that part of the overabundance for lanthanides may result from systematic overestimation of W for very weak lines. The overabundance of lanthanides is apparently a common feature of halo subdwarfs (see, for example, Fig.6 in Gilroy et al., 1988).

For the two stars, G126 – 62 and G246 – 38, with a metallicity of [Fe/H] ≈ -2, the difference of barium and europium abundances is log(Ba/Eu) = 0.57. At the same time for two stars, whose metallicity is [Fe/H] ≈ -1.5 (BD 23°3912, G188 – 22), abundance of barium relative to that of europium is enhanced: log(Ba/Eu) = 0.91. For the most metal-rich stars, G122 – 57 and G182 – 7 with [Fe/H] ≈ -0.2, barium and europium abundances relate as log(Ba/Eu) = 1.64.

The obtained increase in barium relative to europium abundances in transition from stars of the extreme halo population to intermediate and then to objects of the old disk is in good agreement with the general scheme of rising the role of s–process relative to r–process, with nearing to the phase of galactic disk (Truran, 1984). A considerable fraction of iron nuclei, necessary, in particular, for barium to be produced is assumed to form during the disk formation through bursts of SNIb type supernovae, while the nuclei of iron observed in the spectra of the oldest stars are synthesized in the course of nucleosynthesis in bursts of massive stars (SNII type supernovae). The obtained relation log(Ba/Eu) = 0.57 for the extreme halo population agrees well with the theoretical value of this parameter in models, where synthesis of heavy nuclei in the early Galaxy occurs only due to r–process (see Fig. 5 in Spite, 1992).

It is interesting to correlate europium and magnesium abundances for stars of different metallicity. Both the elements are synthesized in the course of evolution of massive stars only, however, as follows from Table 6 in combination with the data of Gratton and Sneden (1994), the [Eu/Mg] relation varies with metallicity: in the wide metallicity interval from $[Fe/H] = 0.0$ to $[Fe/H] = -2.0$ the value $[Eu/Mg] \approx -0.2$, and at $[Fe/H] \leq -2$ a tendency to decreasing of [Eu/Mg] by more than an order is observed with a dispersion exceeding essentially apparent errors of determination. This means that at origin of matter, from which the oldest type II population stars were subsequently formed, the efficiency of α–process exceeded that of r–process, i.e. the initial mass function of exploding stars of type III population (protogalactic stars?) differed greately from the Salpeter's one (increase in the fraction of massive and supermassive stars). The revealed dispersion of this relation may be indicative of incomplete mixing of protogalactic matter prior to formation of type II population stars.

6. Conclusions

This paper presents new results on chemical composition for halo population stars obtained from high–accuracy CCD–echelle spectra with high spectral resolution. The validity of the obtained results is confirmed by their comparison with the data of other authors, who also used a good observational material and modern methods of analysis. For example, our metallicity and lithium abundance are in good agreement with the results of Hobbs and Duncan (1987) for HD 64090, Rebolo et al. (1988) for G246 – 38 and Pilachowski et al. (1993) for BD 23°3912.

At the same time for the stars G122 – 57 and G182 – 7 disagreement between our data and the initial data on metallicity from the catalogue of Laird et al. (1988) has been revealed. Systematic differences have been detected in the calculation of metallicity made from spectra with the low and high S/N ratio. This means that spectral surveys, carried out with the low S/N ratio (S/N = 5), should be treated carefully when used for the construction of the distribution function of unevolved stars by metallicity (see, for example, Bikmaev et al., 1990).

The statement that the catalogue of Laird et al. (1988) contains mainly unevolved stars is also open to question. For example, we have shown that the star G182 – 7 considered by Carney et al. (1994) as a halo subdwarf is, judging by the metallicity values and the relation between chemical elements and radial velocities, a disk star. The main cause of the contradiction is the difference in effective temperature values. We are apt to think that our estimates of metallicity, close to solar, is likely probable for G182 – 7 since by the radial velocity value, $V_r = -0.39$ km/s, this star belongs to the disk population. Besides, the absence of abundance of elements produced by α–process (Na, Si, Ca) confirms also the status of G182 – 7 as a normal unevolved disk star.

Note, that a large part of the stars we have studied, as follows from the low log g, are, apparently, evolved objects. It can be stated that stars with large proper motions, i.e. kinematically old small mass objects, are often subgiants and halo giants, whose classical prototypes are the well studied bright halo stars HD 122563 and HD 140283. Based on spectroscopic observations Hartman and Gehren (1988) have inferred that the portion of subgiants among metal–poor subdwarfs is large, which points out to essential deficiency of small mass subdwarfs among metal-poor stars. In the same paper they have noted the portion of stars that have markedly evolved from the main sequence tend to increase (when evolving to the extremely metal–poor stars). The small share of subdwarfs among the extreme halo population is the representation of differences in the initial mass function for the population of the disk and halo.

The obtained atmospheric parameters has served as the basis for conclusion about evolution status of the sample stars. According to metallicity and radial velocity values the sample being studied is inhomogeneous and includes both the type II population stars and the stars belonging to the young and the old (thick) disks.

In the next papers on detailed analysis of chemical composition of old stars we hope to specify, using a larger sample of stars, the conclusions presented in this paper concerned with the behaviour of oxygen, lithium and heavy metals. A study of CNO–elements relation in the atmosphere of halo stars from molecular spectra is a separate problem.

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Table 5: *Chemical composition of the program stars (at log (H) = 12.0)*

	Sun	G90-25		BD 23°3912		G29-20		G122-57		G126-62	
LiI	3.31	1.41		2.69		1.03		0.76		2.27	
OI	8.87	8.54	0.13	8.93	0.10	8.36	0.10	8.57	0.18	8.39	0.22
OI*		7.30	0.12			8.51	0.16	9.06	0.05		
NaI	6.33	5.06	0.07	4.63	0.11	5.28	0.06	5.96	0.10	4.65	0.11
MgI	7.58	6.69	0.21	6.80	0.07	6.97	0.12	7.83	0.17	6.28	0.12
AlI	6.47	4.52				5.67	0.22			6.41	
SiI	7.55	6.38	0.07	6.46	0.06	6.94	0.08	7.37	0.04	6.39	0.09
SiII				6.71		6.57				6.08	
SI	7.21							7.60	0.15		
CaI	6.36	5.03	0.06	5.39	0.04	5.93	0.05	6.36	0.04	6.90	0.04
ScII	3.17	1.15	0.12	1.59	0.06	2.02	0.04	2.92	0.08	1.21	0.12
TiI	5.02	3.64	0.08	3.97	0.05	4.30	0.05	4.80	0.04	3.76	0.07
TiII				3.68	0.09	4.33		5.01		3.30	0.15
VI	4.00	3.23	0.09	3.17	0.09	3.02	0.05	3.74	0.05	3.33	0.16
VII		3.24	0.03			2.50	0.09	3.90	0.06	2.91	0.22
CrI	5.67	4.20	0.10	4.16	0.09	4.91	0.10	5.32	0.05	3.51	0.09
CrII				4.48	0.10					4.33	0.08
MnI	5.39	3.59	0.17	4.25	0.16	4.25	0.12	4.80	0.10	4.08	0.19
FeI	7.50	5.83	0.03	6.06	0.02	6.57	0.02	7.15	0.01	5.60	0.02
FeII		5.83	0.14	6.02	0.05	6.58	0.05	7.19	0.05	5.66	0.05
NiI	6.25	4.79	0.09			5.22	0.03	6.10	0.07	4.18	0.07
CuI	4.21			2.62	0.25	2.91				2.14	0.33
ZnI	4.60	3.49				3.92					
YI	2.24	1.71	0.19			1.18	0.12	1.70	0.11		
YII		1.30	0.32	0.91	0.10	1.70	0.01	2.28	0.22	0.76	0.18
ZrII	2.60			1.44	0.26					0.99	0.48
MoI	1.92					1.59		1.74			
BaII	2.13	-0.56	0.12	0.39	0.08	1.42	0.17	2.35	0.23	-0.18	0.17
LaII	1.22	0.36	0.11	0.35	0.18	0.21	0.20	1.16	0.08	0.45	0.04
CeII	1.55	0.01		0.80	0.14	0.31	0.04	1.25			
NdII	1.50	0.25	0.26	0.88	0.13	1.02	0.27	1.65	0.09	0.35	0.15
EuII	0.51			-0.50		-0.23		0.38	0.18	-0.71	

	G170-47		G182-7		G188-22		G246-38		G265-1	
LiI	1.45		1.22		2.38		0.69		1.23	
OI	7.18		9.42	0.28	8.12				9.14	0.22
OI*			8.28	0.12	8.28	0.14	7.79	0.08	8.84	0.12
NaI	3.71	0.07	6.28	0.16	5.06	0.13	4.07	0.20	5.64	0.13
MgI	5.34	0.09	7.83	0.13	6.81	0.11	7.05	0.14	7.46	0.06
AlI	6.46		6.10	0.37	5.74	0.14	5.40	0.19	6.20	0.09
SiI	5.61	0.08	7.40	0.03	6.72	0.05	6.05	0.09	7.18	0.04
SiII	5.57		7.18		6.66		5.78		7.29	
CaI	4.27	0.05	6.49	0.08	5.48	0.05	4.48	0.05	5.92	0.04
ScII	0.79	0.33	2.89	0.11	1.86	0.10	1.13	0.30	2.42	0.08
TiI	2.94	0.11	5.11	0.04	5.11	0.07	3.84	0.09	4.65	0.05
TiII	2.45	0.04	4.84	0.01	4.69				4.23	
VI	2.76	0.10	4.04	0.04	3.60	0.14	2.81	0.15	3.20	0.07
VII	2.60	0.35	4.03	0.25	4.64	0.14	3.10	0.24	3.39	0.14
CrI	3.12	0.12	5.62	0.07	5.66	0.10			4.95	0.07
CrII	3.80	0.16								
MnI	3.10	0.19	5.33	0.13	4.06	0.32	3.35		4.48	0.03
FeI	5.01	0.02	7.37	0.02	6.08	0.02	5.34	0.03	6.85	0.02
FeII	5.07	0.04	7.34	0.09	6.06	0.04	5.30	0.08	6.83	0.06
NiI	3.65	0.06	6.13	0.05	5.39	0.08	4.86	0.14	5.56	0.04
CuI	1.72						1.92		3.20	
ZnI			4.12						4.24	
YI			2.47	0.11					1.76	0.04
YII	0.04	0.31	2.34						2.01	
ZrI			2.48	0.14					2.37	0.00
BaII	-1.11	0.21	1.87	0.15	0.50	0.17	-0.18	0.09	0.93	0.11
LaII	-0.64	0.12	1.49	0.03	0.74	0.16			0.85	0.21
CeII	-0.18	0.07	2.13				0.14	0.08	0.46	0.16
NdII	0.00	0.07	1.58	0.15	1.30	0.15	0.78		0.82	0.12
EuII			0.56	0.52	-0.44		-0.79		0.02	

Table 6: *Relative chemical element abundance in the atmospheres of the stars studied*

	[X/Fe]				
	G90-25	BD 23°3912	G29-20	G122-57	G129-62
OI	1.34	1.52	0.42	0.03	1.39
OI*	0.10	-	0.57	0.52	-
NaI	0.40	-0.24	-0.12	-0.04	0.19
MgI	0.78	0.68	0.32	0.58	0.57
AlI	-0.28	-	0.13	-	1.81
SiI	0.50	0.37	0.32	0.15	0.71
SiII	-	0.62	-0.05	-	0.40
SI	-	-	-	0.72	-
CaI	0.34	0.49	0.50	0.33	2.41
ScII	-0.35	-0.12	-0.22	0.08	-0.09
TiI	0.29	0.29	0.21	0.11	0.61
TiII	-		0.24	0.32	0.15
VI	0.90	0.63	-0.05	0.97	1.20
VII	0.91	-	-0.57	0.23	0.78
CrI	-0.20	-0.05	0.17	-0.02	-0.29
CrII	-	0.27	-	-	-
MnI	-0.13	0.32	-0.21	-0.26	0.56
FeI	0.00	-0.02	0.00	0.02	0.03
FeII	0.00	0.02	0.01	-0.02	-0.03
NiI	0.21	-	-0.10	0.18	-0.20
CuI	-	-0.13	-0.37	-	-0.20
ZnI	0.56	-	0.25	-	-
YI	0.60	-	-0.13	-0.21	-
YII	0.73	0.13	0.39	0.37	0.39
ZrII	-	-	-	-	0.26
MoI	-	-	0.60	0.15	-
BaII	-1.02	-0.28	0.22	0.55	-0.44
LaII	0.81	0.59	-0.08	0.27	1.10
CeII	0.13	0.71	-0.31	0.03	
NdII	0.42	0.84	0.45	0.48	0.72
EuII		0.46	0.19	0.20	0.65

	[X/Fe]				
	G170-47	G182-7	G188-22	G246-38	G265-1
OI	0.77	0.70	0.68		0.93
OI*	-	-0.44	0.84	1.10	0.63
NaI	-0.16	0.10	0.16	-0.08	-0.03
MgI	0.22	0.40	0.66	1.65	0.54
AlI	2.45	-0.22	0.70	1.11	0.39
SiI	0.52	0.00	0.60	0.68	0.29
SiII	0.48	-0.22	0.54	0.41	0.40
CaI	0.37	0.28	0.55	0.30	0.22
ScII	0.08	-0.13	0.12	0.14	-0.09
TiI	0.38	0.24	1.52	1.00	0.29
TiII	-0.11	-0.03	1.10	-	-0.13
VI	1.22	0.19	1.03	0.99	-0.14
VII	1.06	0.18	2.07	1.28	0.05
CrI	-0.09	0.10	1.42	-	-0.06
CrII	0.59	-	-	-	-
MnI	0.17	0.09	0.10	0.14	-0.25
FeI	0.03	-0.02	-0.01	-0.02	-0.01
FeII	-0.03	0.01	0.01	0.02	0.01
NiI	-0.14	0.03	0.57	0.79	-0.03
CuI	-0.03	-	-	-0.11	-0.35
ZnI	-	-0.33	-	-	0.30
YI	-	0.38	-	-	0.18
YII	0.26	0.25	-	-	0.43
ZrI	-	0.03	-	-	0.43
BaII	-0.78	-0.11	-0.20	-0.13	-0.54
LaII	-0.60	0.42	0.95	-	0.29
CeII	0.73	0.73	-	0.77	-0.43
NdII	0.96	0.23	1.23	1.46	-0.02
EuII	-	0.20	0.48	0.88	0.17

Table 7: *Atomic data, measured equivalent widths W of lines in the spectra of the stars studied and appropriate chemical element content (A) (hydrogen content A(H)=0)*

	gf	Pot	HD 64090 W	HD 64090 A	BD 23°3912 W	BD 23°3912 A	G29-20 W	G29-20 A	G122-57 W	G122-57 A
LiI										
6707.78	0.02	0.00	12	-10.76	83	-9.31	15	-10.97	8	-11.24
OI										
6155.99	-0.66	10.74	2	-3.25	5	-2.89				
6156.78	-0.44	10.74			4	-3.22	2	-3.43	2	-3.26
6158.19	-0.45	10.74	2	-3.47	5	-3.10	1	-3.76	2	-3.25
6300.32	-9.76	0.00	17	-3.66	4	-4.17	19	-3.72	7	-3.79
7771.96	0.29	9.15	15	-4.43			44	-3.33	52	-2.91
7774.17	0.14	9.15	11	-4.46			29	-3.65	40	-3.05
7775.39	-0.14	9.15	3	-4.84					37	-2.87
NaI										
5682.63	-0.60	2.10			8	-7.60	50	-6.84	108	-5.84
5688.20	-0.15	2.10			23	-7.51	78	-6.80	119	-6.18
5889.95	-0.05	0.00								
5895.92	-0.29	0.00	232	-7.07						
6154.22	-1.66	2.10	5	-6.94	2	-7.18	15	-6.56	27	-6.23
6160.75	-1.35	2.10	6	-7.17	4	-7.18	22	-6.66	62	-5.91
MgI										
5167.32	-0.75	2.71								
5172.68	-0.32	2.71								
5183.60	-0.08	2.72								
5528.40	-0.47	4.35			130	-5.20				
5711.09	-1.75	4.35	27	-5.99	50	-5.32	97	-4.78	114	-4.49
6318.70	-1.96	5.11					14	-5.43	64	-4.38
6319.24	-2.30	5.11	7	-5.32	9	-5.07	8	-5.37		
8305.62	-1.41	5.93							84	-3.81
8310.25	-1.14	5.93							125	-3.54
8473.68	-2.02	5.93	5	-4.99			9	-4.78	22	-4.31
8710.21	-1.76	5.93	20	-4.60			17	-4.73	50	-4.02
8712.69	-1.18	5.93	14	-5.36					104	-3.79
8717.83	-0.88	5.93	8	-5.92			40	-5.07	42	-5.04
AlI										
6696.03	-1.65	3.15					23	-6.12		
7084.62	-1.34	4.02			30	-5.16				
7362.28	-.96	4.02							81	-4.90
8772.87	-.36	4.02								
8773.91	-.06	4.02	5	-7.53			36	-6.55	73	-5.96
SiI										
5622.23	-3.09	4.93	5	-4.85					13	-4.35
5645.66	-2.15	4.93	13	-5.35					38	-4.64
5665.60	-2.11	4.92	10	-5.52					44	-4.57
5666.69	-1.67	5.62	5	-5.57					25	-4.69
5684.52	-1.66	4.95	9	-5.99					60	-4.67
5690.47	-1.91	4.93	13	-5.35						
5701.10	-2.07	4.93								
5622.23	-3.09	4.93	5	-4.85					13	-4.35
5645.66	-2.15	4.93	13	-5.35					38	-4.64
5665.60	-2.11	4.92	10	-5.52					44	-4.57
5666.69	-1.67	5.62	5	-5.57					25	-4.69
5684.52	-1.66	4.95	9	-5.99					60	-4.67
5690.47	-1.91	4.93	13	-5.35						
5701.10	-2.07	4.93								
5622.23	-3.09	4.93	5	-4.85					13	-4.35
5645.66	-2.15	4.93	13	-5.35					38	-4.64
5665.60	-2.11	4.92	10	-5.52					44	-4.57
5666.69	-1.67	5.62	5	-5.57					25	-4.69

	gf	Pot	HD 64090 W	HD 64090 A	BD 23°3912 W	BD 23°3912 A	G29-20 W	G29-20 A	G122-57 W	G122-57 A
5684.52	-1.66	4.95	9	-5.99					60	-4.67
5690.47	-1.91	4.93	13	-5.35						
5701.10	-2.07	4.93								
5622.23	-3.09	4.93	5	-4.85					13	-4.35
5645.66	-2.15	4.93	13	-5.35					38	-4.64
5665.60	-2.11	4.92	10	-5.52					44	-4.57
5666.69	-1.67	5.62	5	-5.57					25	-4.69
5684.52	-1.66	4.95	9	-5.99					60	-4.67
5690.47	-1.91	4.93	13	-5.35						
5701.10	-2.07	4.93								
5708.44	-1.49	4.95	20	-5.77						
5753.64	-1.45	5.62	1	-6.50					21	-5.01
5772.26	-1.78	5.08	14	-5.53					61	-4.41
5793.13	-2.05	4.93	7	-5.74					38	-4.74
5797.86	-2.03	4.95	6	-5.80					48	-4.53
5873.77	-2.98	4.93	2	-5.37					12	-4.50
5948.54	-1.22	5.08	7	-6.42					85	-4.56
6087.79	-1.80	5.87	2	-5.59					19	-4.45
6091.92	-1.33	5.87							25	-4.76
6125.02	-1.63	5.61	21	-4.93						
6142.49	-1.56	5.62	10	-5.36					17	-5.02
6145.08	-1.48	5.62	4	-5.86					36	-4.62
6155.14	-0.84	5.62	14	-5.92					68	-4.65
6237.34	-1.22	5.61	9	-5.76					74	-4.18
6243.82	-1.34	5.62	19	-5.28					48	-4.52
6244.13	-2.33	5.62	4	-5.02						
6244.47	-1.38	5.62	8	-5.65					50	-4.44
6254.84	-2.43	5.62	2	-5.22						
6414.99	-1.11	5.87	10	-5.56					40	-4.64
6741.63	-1.62	5.98							7	-5.03
6976.50	-1.07	5.95	9	-5.57					35	-4.71
7003.57	-0.86	5.96	12	-5.64					41	-4.78
7034.91	-0.85	5.87							56	-4.61
7405.78	-0.71	5.61	23	-5.84					69	-4.82
7415.96	-0.67	5.62	15	-6.09						
7849.97	-0.77	6.19	11	-5.56						
7918.39	-0.58	5.95	11	-6.00					58	-4.79
7932.35	-0.50	5.96								
8556.79	-0.21	5.87							112	-4.50
8742.46	-0.56	5.87	8	-6.30					75	-4.69
8752.02	-0.37	5.87							89	-4.66
SiII										
6347.09	0.31	8.12	4	-6.29			16	-5.43	22	-4.86
SI										
8693.96	-0.41	7.87							23	-4.25
8694.64	0.06	7.87							28	-4.56
CaI										
5265.56	-0.10	2.52			62	-6.86				
5349.47	-0.51	2.71			43	-6.67				
5581.97	-0.63	2.52	33	-7.25	50	-6.60	104	-5.81	126	-5.45
5588.76	-0.05	2.53	74	-7.24	73	-6.68	115	-6.17	147	-5.75
5590.12	-.74	2.52	26	-7.27	32	-6.87	76	-6.32	104	-5.72
5594.47	-.31	2.52	82	-6.89	76	-6.34	155	-5.22	179	-5.19
5598.49	-.35	2.52	76	-6.93	82	-6.19	155	-5.22	188	-5.09
5601.28	-.63	2.53	44	-7.07	37	-6.86	69	-6.60	109	-5.73
5857.45	.07	2.93			62	-6.64	113	-5.91		
5867.57	-1.79	2.93	2	-7.01	3	-6.64	35	-5.69	40	-5.59
6102.72	-.80	1.88	70	-7.25	61	-6.86	133	-5.90	166	-5.46
6122.22	-.20	1.89	131	-7.00	96	-6.69	129	-6.57		
6161.30	-1.45	2.52	23	-6.65	20	-6.47	44	-6.32	83	-5.49

	gf	Pot	HD 64090 W	HD 64090 A	BD 23°3912 W	BD 23°3912 A	G29-20 W	G29-20 A	G122-57 W	G122-57 A
6162.17	-.10	1.90	145	-6.89	110	-6.52	170	-6.02	198	-5.86
6163.75	-1.46	2.52					83	-5.49	105	-5.04
6166.44	-1.26	2.52	22	-6.87	20	-6.66	54	-6.31	74	-5.88
6169.06	-.75	2.52	40	-7.04	45	-6.60	99	-5.87	150	-5.06
6169.56	-.57	2.53	56	-6.98	50	-6.66	88	-6.28	145	-5.29
6417.69	-.75	4.44								
6439.07	-.05	2.53	82	-7.17	93	-6.29	138	-5.87	171	-5.57
6449.81	-.62	2.52	18	-7.62	50	-6.64	68	-6.68		
6455.60	-1.50	2.52								
6471.66	-.88	2.53	49	-6.78			82	-6.13	105	-5.64
6493.78	-.39	2.52	56	-7.18	65	-6.55	103	-6.22	124	-5.80
6499.65	-1.00	2.52	18	-7.24	34	-6.59	62	-6.43	98	-5.67
6508.84	-2.65	2.53					15	-5.83		
6572.79	-3.97	.00							73	-6.12
6717.69	-.39	2.71	12	-7.86			79	-6.49		
6798.47	-2.72	2.71					5	-6.10	11	-5.72
7148.15	-.08	2.71	96	-6.80	84	-6.30	129	-5.88	145	-5.69
7202.20	-.34	2.71	38	-7.32					130	-5.64
ScII										
5239.82	-0.80	1.46			24	-10.26				
5526.82	0.18	1.77			38	-10.63				
5552.22	-2.08	1.46								
5640.97	-1.02	1.50	4	-11.01	13	-10.36			64	-8.89
5657.87	-0.55	1.51	13	-10.93	30	-10.34			83	-8.89
5667.16	-1.21	1.50	5	-10.72	11	-10.25			43	-9.16
5669.03	-1.10	1.50	5	-10.83	9	-10.46			50	-9.12
5684.19	-1.08	1.51	17	-10.27	5	-10.75			70	-8.68
5854.31	-2.23	1.36	10	-10.57					5	-9.56
6245.63	-1.15	1.51			11	-10.34			50	-9.08
6279.75	-1.28	1.50	1	-11.39						
6300.68	-1.88	1.51							25	-8.92
6320.87	-1.89	1.50							17	-9.15
6604.59	-1.23	1.36	12	-10.50	13	-10.34			43	-9.34
TiI										
5064.65	-0.99	0.05			50	-8.03				
5120.42	0.35	2.58			3	-8.42				
5173.74	-1.12	0.00			36	-8.25				
5192.97	-1.01	0.02			53	-7.98				
5210.39	-0.88	0.05			43	-8.30				
5219.70	-2.29	0.02			7	-7.98				
5223.62	-0.56	2.09								
5338.33	-2.05	0.83								
5426.25	-3.01	0.02			3	-7.66				
5460.51	-2.75	0.05			3	-7.89				
5490.15	-0.93	1.46			5	-8.05				
5514.54	-0.50	1.44			13	-8.04				
5644.14	0.00	2.27	8	-8.24	7	-8.02	44	-7.46	72	-6.78
5648.57	-0.36	2.50			5	-7.59	16	-7.50	26	-7.19
5662.15	-0.11	2.32					16	-7.96	53	-7.05
5673.43	-0.29	3.11								
5689.47	-0.47	2.30					11	-7.81	58	-6.60
5716.45	-0.78	2.30					7	-7.72	27	-6.98
5720.45	-0.93	2.29	4	-7.60					7	-7.55
5739.48	-0.71	2.25					12	-7.55		
5739.98	-0.76	2.24	2	-8.14					23	-7.17
5766.33	0.31	3.29							23	-7.06
5774.03	0.27	3.31					10	-7.48	29	-6.85
5812.83	-0.11	3.32							11	-7.01
5823.69	-1.08	2.27	2	-7.79						
5839.76	-2.36	1.46								

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
5866.45	-0.84	1.07	12	-8.51	10	-8.23	63	-7.65	80	-7.14
5880.27	-2.01	1.05					24	-7.29	37	-6.95
5899.30	-1.15	1.05					67	-7.28		
5918.55	-1.69	1.07					4	-8.49	50	-7.00
5922.12	-1.47	1.05	5	-8.31			14	-8.13	61	-7.00
5937.81	-1.92	1.07	3	-8.07			6	-8.07	25	-7.30
5940.65	-3.03	0.05							16	-7.61
5944.68	-3.79	0.00					20	-6.85	13	-7.02
5953.17	-0.33	1.89	2	-8.95	8	-8.02	62	-7.22	61	-7.17
5965.83	-0.41	1.88	4	-8.57			23	-7.97	53	-7.28
5988.56	-1.12	1.89					18	-7.93	12	-7.57
5999.04	-1.68	2.17					6	-7.87		
5999.69	-0.78	2.24							18	-7.30
6031.71	-3.75	0.05					4	-7.62	10	-7.14
6064.62	-1.88	1.05					6	-8.14	19	-7.52
6091.17	-0.42	2.27			4	-7.87	5	-8.29	37	-7.16
6092.81	-1.38	1.89					2	-8.18	17	-7.13
6098.66	-0.10	3.06			3	-7.53			13	-7.24
6121.06	-1.33	1.88							13	-7.33
6126.22	-1.43	1.07	8	-8.13			27	-7.80		
6146.23	-1.52	1.87					7	-7.48	6	-7.53
6258.11	-0.36	1.44	12	-8.61	10	-8.34	49	-7.99	85	-7.11
6261.10	-0.48	1.43			10	-8.24	43	-8.01	69	-7.40
6303.76	-1.57	1.44					29	-7.18	10	-7.73
6312.24	-1.55	1.46	3	-8.03					42	-6.87
6325.16	-3.45	0.02							9	-7.54
6336.11	-1.74	1.44	2	-8.04			1	-8.64	17	-7.29
6366.35	-1.74	1.46					12	-7.48		
6419.09	-1.39	2.17					1	-8.16	2	-7.83
6497.68	-1.98	1.44							9	-7.38
6508.15	-2.03	1.43	2	-7.78			9	-7.38	5	-7.62
6554.23	-1.22	1.44	6	-7.84						
6599.11	-2.06	0.90					18	-7.62	52	-6.83
6666.54	-2.09	1.46					22	-6.83	23	-6.77
6716.67	-1.09	2.49					2	-7.81		
6743.12	-1.76	0.90							35	-7.48
7138.90	-1.72	1.44							28	-7.06
7188.57	-1.76	1.43	5	-7.67					22	-7.19
7251.71	-0.86	1.43								
7357.73	-1.10	1.44							55	-7.15
TiII										
5072.29	-1.12	3.12			29	-7.74				
5129.16	-1.27	1.89			55	-8.28				
5154.06	-1.77	1.57			50	-8.23				
5185.90	-1.43	1.89			40	-8.45				
5211.53	-1.85	2.59			4	-8.59				
5336.81	-1.65	1.58			46	-8.43				
5418.80	-2.17	1.58			27	-8.32				
6606.95	-2.85	2.06					15	-7.67		
VI										
5604.95	-1.19	1.04	5	-8.59			2	-9.32	12	-8.45
5657.45	-1.06	1.06	2	-9.11			9	-8.74	32	-7.99
5668.36	-1.05	1.08	4	-8.79			11	-8.63	8	-8.74
5670.85	-0.65	1.08					13	-8.95	55	-7.89
5703.58	-0.32	1.05	5	-9.46	4	-9.20	37	-8.70	64	-8.04
5727.06	-0.26	1.08	14	-9.01	9	-8.85	26	-8.96	71	-7.91
5727.66	-1.00	1.05	5	-8.78			17	-8.50	35	-8.00
5737.07	-0.87	1.06	9	-8.63			8	-8.99	26	-8.32
5817.08	0.09	1.89	2	-9.37	5	-8.66	6	-9.14		
5830.68	0.62	3.11	2	-8.60			13	-7.92		

	gf	Pot	HD 64090 W	A	BD 23°3912 W	A	G29-20 W	A	G122-57 W	A
6039.73	-0.72	1.06	4	-9.16			11	-9.01	50	-7.98
6058.11	-1.38	1.04								
6081.44	-0.74	1.05			7	-8.53	9	-9.10	37	-8.24
6090.21	-0.22	1.08			6	-9.10	30	-8.93	64	-8.15
6111.65	-0.93	1.04					3	-9.43	20	-8.46
6119.53	-0.51	1.06	3	-9.50			18	-8.97	36	-8.48
6135.37	-0.88	1.05								
6150.15	-1.71	0.30	16	-8.37			4	-9.39	32	-8.25
6199.18	-1.63	0.29	5	-9.01			6	-9.30	28	-8.44
6213.86	-2.01	0.30							7	-8.78
6216.36	-1.09	0.28			4	-9.24			56	-8.41
6224.50	-1.85	0.29	3	-9.02	2	-8.78	5	-9.17	33	-8.11
6251.82	-1.45	0.29	3	-9.42	4	-8.87	8	-9.35	52	-8.13
6266.32	-2.12	0.28	4	-8.64					13	-8.40
6274.67	-1.77	0.27			6	-8.38	10	-8.95	29	-8.31
6452.31	-0.98	1.19					9	-8.71		
6504.18	-0.74	1.18			4	-8.68	8	-9.02	21	-8.49
6531.42	-0.94	1.22					9	-8.73	27	-8.09
VII										
5819.93	-1.80	2.52	1	-9.48			13	-8.38	9	-8.18
5928.88	-1.74	2.52					10	-8.57	11	-8.14
6028.27	-1.98	2.49	5	-8.63					10	-7.98
6029.00	-1.94	2.56	4	-8.70						
CrI										
5206.04	0.06	0.94			105	-7.58				
5247.57	-1.63	0.96			14	-8.12				
5296.69	-1.39	0.98								
5300.75	-2.13	0.98			6	-8.01				
5329.14	-0.06	2.91			7	-8.08				
5345.81	-0.97	1.00			44	-7.99				
5348.32	-1.29	1.00			24	-8.11				
5409.79	-0.71	1.03			51	-8.08				
5664.59	-0.90	3.83							8	-6.61
5702.32	-0.67	3.45					10	-7.16	28	-6.55
5712.77	-1.23	3.01					15	-6.88	17	-6.79
5719.83	-1.66	3.01					12	-6.57	6	-6.88
5729.20	-1.15	3.84							2	-6.98
5781.75	-0.85	3.32								
5783.07	-0.57	3.32							40	-6.53
5783.86	-0.30	3.32	3	-8.05			12	-7.59	43	-6.73
5787.92	-0.08	3.32	5	-8.05			27	-7.34		
5788.39	-1.65	3.01					10	-6.67		
5825.81	-4.38	.97					3	-6.83		
6330.09	-2.99	.94	5	-7.72			16	-7.49	45	-6.75
6362.87	-3.08	.94					20	-7.28	32	-6.93
6501.20	-3.66	.98							9	-7.02
6529.18	-1.31	3.89							5	-6.38
6680.15	-0.52	4.16					5	-6.89	13	-6.41
6789.15	-1.17	3.84							8	-6.36
6978.40	0.01	3.46	12	-7.62					60	-6.56
6979.80	-0.46	3.46	5	-7.56			17	-7.12	29	-6.78
6980.94	-1.12	3.46					13	-6.61	12	-6.63
7400.18	-0.08	2.90					31	-7.80	78	-6.74
CrII										
5237.34	-1.39	4.07			19	-7.62				
5249.43	-2.64	3.76								
5279.87	-2.17	4.07								
5305.85	-2.20	3.83								
5308.44	-2.07	4.07								
5310.70	-2.35	4.07								

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
5313.59	-1.78	4.07			6	-7.83				
5334.88	-1.89	4.07			5	-7.80				
5508.63	-2.20	4.16								
5510.73	-2.48	3.83								
MnI										
5377.63	-0.39	3.84								
5394.67	-3.50	0.00								
5407.43	-1.74	2.14			11	-7.61				
5413.68	-0.87	3.86								
5432.54	-3.80	0.00								
5537.76	-2.21	2.19								
6013.50	-0.25	3.07					38	-7.93	61	-7.35
6016.64	-0.24	3.07	19	-8.22	11	-8.20	57	-7.53	75	-7.00
6021.80	0.03	3.08	10	-8.80	12	-8.43	58	-7.78	76	-7.24
FeI										
5044.21	-2.10	2.85			20	-5.90				
5049.82	-1.41	2.28			56	-6.31				
5067.15	-0.92	4.22			14	-5.91				
5068.77	-1.07	2.94			45	-6.23				
5074.75	-0.05	4.22			57	-5.67				
5083.34	-2.96	0.96			54	-6.17				
5090.78	-0.50	4.26			15	-6.26				
5109.65	-0.77	4.30			22	-5.72				
5110.43	-3.76	0.00			9	-5.84				
5123.73	-3.07	1.01			54	-6.01				
5127.36	-3.31	0.91			39	-6.20				
5131.48	-2.55	2.22			22	-6.03				
5133.69	0.19	4.18			67	-5.70				
5137.39	-0.20	4.18			42	-5.93				
5141.74	-2.12	2.42			33	-5.98				
5150.84	-2.97	0.99			50	-6.23				
5151.91	-3.32	1.01			41	-6.05				
5159.07	-0.87	4.28			14	-5.90				
5162.29	0.09	4.18			54	-5.92				
5165.41	-0.57	4.22			18	-6.13				
5166.28	-4.20	0.00			50	-6.02				
5171.61	-1.79	1.48			96	-5.73				
5191.66	-0.55	3.04			85	-5.64				
5192.35	-0.50	3.00			82	-5.81				
5194.94	-2.09	1.56			80	-5.76				
5195.48	-0.15	4.22			34	-6.12				
5196.06	-0.78	4.26			11	-6.15				
5198.71	-2.14	2.22			36	-6.10				
5215.18	-0.80	3.27								
5216.28	-2.15	1.61			60	-6.18				
5217.39	-1.00	3.21			33	-6.31				
5225.53	-4.79	0.11								
5228.38	-1.16	4.22			8	-5.96				
5232.96	-0.02	2.94			108	-5.75				
5242.50	-1.05	3.63								
5243.77	-1.11	4.24			15	-5.67				
5247.05	-4.95	0.09								
5250.21	-4.94	0.12			29	-5.62				
5250.65	-2.01	2.20			44	-6.09				
5253.46	-1.60	3.28			16	-6.10				
5263.31	-0.80	3.27								
5266.56	-0.30	3.00			71	-6.30				
5269.55	-1.32	0.86			172	-5.74				
5281.79	-0.60	3.04								
5283.62	-0.27	3.24			66	-6.23				

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
5302.30	-0.57	3.28			64	-5.93				
5307.36	-2.99	1.61			21	-6.25				
5324.19	-0.10	3.21			99	-5.59				
5329.99	-1.33	4.08			8	-5.93				
5332.90	-2.84	1.56			43	-5.94				
5339.93	-0.57	3.27			71	-5.76				
5364.88	0.20	4.45			56	-5.73				
5365.40	-1.28	3.57			20	-6.01				
5367.47	0.26	4.42			53	-5.90				
5369.96	0.39	4.37			72	-5.58				
5371.50	-1.64	0.96			124	-5.91				
5383.37	0.48	4.31			65	-5.91				
5389.48	-0.40	4.42			26	-5.88				
5391.46	-0.94	4.15			14	-5.97				
5393.17	-0.60	3.24			53	-6.23				
5397.13	-1.99	0.91			94	-6.21				
5398.28	-0.65	4.45			8	-6.26				
5404.78	-1.84	0.99								
5409.13	-1.19	4.37			8	-5.79				
5410.91	0.43	4.47			42	-6.27				
5415.20	0.51	4.39			51	-6.23				
5424.08	0.55	4.32			63	-6.03				
5429.70	-1.88	0.96			111	-5.91				
5432.95	-0.79	4.45			13	-5.87				
5434.53	-2.12	1.01			87	-6.15				
5445.04	0.05	4.39			50	-5.79				
5446.92	-2.42	0.99			21	-5.80				
5455.62	-2.10	1.01								
5473.91	-0.80	4.15			14	-6.11				
5487.15	-1.50	4.42								
5497.52	-2.85	1.01			65	-6.00				
5501.47	-2.93	0.96								
5506.78	-2.80	0.99			69	-5.97				
5543.19	-1.73	3.69			5	-6.15				
5546.50	-1.19	4.37			6	-5.93				
5554.90	-0.37	4.55			21	-5.92				
5565.71	-0.29	4.61			16	-6.10			80	-4.84
5567.40	-2.81	2.61			12	-5.74			64	-4.91
5568.87	-2.91	3.64							15	-4.87
5569.62	-0.40	3.42	72	-6.53	55	-6.21				
5572.85	-0.22	3.40	93	-6.44	69	-6.06	141	-4.97	195	-4.60
5576.10	-0.73	3.43	41	-6.62	42	-6.17	84	-5.68	110	-5.00
5577.02	-1.53	5.03					7	-5.16	12	-4.85
5579.35	-2.37	4.22							18	-4.66
5583.99	-2.61	4.37							8	-4.69
5584.77	-2.45	3.57					22	-5.25	43	-4.68
5586.76	-0.12	3.37	110	-6.33	93	-5.58	140	-5.13	166	-4.93
5587.57	-1.74	4.14					14	-5.58	38	-4.87
5608.98	-2.45	4.21					7	-5.14	10	-4.91
5611.36	-3.03	3.64					4	-5.46		
5614.28	-1.38	5.09					4	-5.52		
5615.65	0.00	3.33	121	-6.30	90	-5.81	172	-4.85	233	-4.66
5618.65	-1.41	4.21	4	-6.27	5	-5.96	20	-5.64	46	-4.94
5619.59	-1.58	4.39	4	-5.92	5	-5.61	9	-5.70		
5620.49	-1.86	4.15			5	-5.56	14	-5.45	32	-4.88
5624.03	-1.27	4.39					27	-5.39		
5624.55	-0.65	3.42	40	-6.73	50	-6.08	88	-5.68		
5633.97	-0.32	4.99			13	-5.81			45	-5.21
5635.82	-1.67	4.26			3	-5.89	18	-5.39	38	-4.82
5636.69	-2.59	3.64							31	-4.74

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
5638.27	-0.85	4.22	12	-6.32	19	-5.83	43	-5.63	76	-4.78
5641.44	-1.18	4.26	9	-6.09	12	-5.72	27	-5.62	64	-4.71
5650.02	-0.80	5.10			6	-5.61	10	-5.65	37	-4.80
5650.70	-0.83	5.09					12	-5.53	34	-4.85
5651.47	-1.85	4.47					10	-5.28	25	-4.71
5652.32	-1.86	4.26			4	-5.56	13	-5.37	28	-4.86
5653.89	-1.50	4.39	4	-5.82			30	-5.09	39	-4.82
5661.35	-1.95	4.28	2	-5.97					16	-5.09
5677.69	-2.73	4.10					1	-5.86		
5679.02	-0.85	4.65			8	-5.86	32	-5.40	49	-4.95
5680.24	-2.42	4.19					5	-5.36		
5686.53	-0.64	4.55	8	-6.37	22	-5.63	55	-5.20	67	-4.79
5701.55	-2.22	2.56	35	-6.17	26	-5.94			108	-4.43
5705.46	-1.57	4.30					25	-5.24		
5705.99	-0.58	4.61	14	-6.11	17	-5.78	63	-5.00		
5717.83	-1.12	4.28			6	-6.09	54	-5.04	67	-4.67
5720.89	-1.95	4.55					7	-5.27	11	-5.00
5723.67	-2.51	4.47							12	-4.47
5731.76	-1.19	4.26	10	-6.03			35	-5.43	50	-5.02
5732.27	-1.50	4.99							7	-5.20
5732.88	-2.99	4.10					1	-5.60	4	-4.93
5738.24	-2.35	4.22					4	-5.50	16	-4.76
5741.85	-1.77	4.24			4	-5.67			31	-4.90
5752.04	-0.99	4.55					32	-5.38	42	-5.07
5753.14	-0.66	4.26	16	-6.33	15	-6.12	57	-5.46		
5760.34	-2.55	3.64	2	-6.05			8	-5.62		
5762.42	-2.42	3.64					14	-5.46		
5762.99	-0.23	4.21	29	-6.50						
5775.09	-1.23	4.22	9	-6.08	10	-5.80	32	-5.50	55	-4.90
5778.46	-3.60	2.59	2	-6.12			18	-5.34	26	-5.04
5793.92	-1.75	4.22			5	-5.61	20	-5.29	26	-5.06
5804.03	-2.31	3.88								
5806.73	-1.00	4.61	5	-6.17	6	-5.89	20	-5.61	55	-4.72
5807.79	-3.40	3.29					4	-5.48	11	-4.94
5809.22	-1.83	3.88	5	-6.11			28	-5.38	48	-4.85
5811.94	-2.44	4.14	1	-5.93			7	-5.24	14	-4.83
5814.80	-1.96	4.28					11	-5.34		
5816.38	-0.69	4.55	11	-6.18	15	-5.81	51	-5.24	67	-4.77
5826.64	-2.89	4.28								
5827.87	-3.23	3.28					6	-5.48		
5837.70	-2.37	4.29							21	-4.50
5849.68	-2.99	3.69					6	-5.26	10	-4.94
5852.22	-1.36	4.55	3	-6.11			24	-5.21	35	-4.88
5853.15	-5.15	1.48					8	-5.48	18	-4.97
5855.09	-1.66	4.61	2	-5.92			13	-5.19	22	-4.84
5856.08	-1.69	4.29					10	-5.64	47	-4.56
5858.79	-2.29	4.22					10	-5.13	12	-4.97
5859.61	-0.60	4.55	20	-5.98	16	-5.86	53	-5.29	57	-5.11
5861.11	-2.45	4.28							8	-4.95
5862.36	-0.38	4.55	10	-6.54	22	-5.90			87	-4.68
5873.21	-2.12	4.26							19	-4.85
5876.29	-2.64	4.30							7	-4.81
5879.49	-2.03	4.61							12	-4.81
5881.28	-1.86	4.61					3	-5.69	24	-4.59
5883.81	-1.37	3.89	12	-6.15			72	-4.82	61	-5.00
5909.97	-2.79	3.21							45	-4.72
5916.25	-2.99	2.45	11	-6.12			40	-5.59	55	-5.17
5920.56	-2.69	3.24								
5927.80	-1.16	4.65							38	-4.89
5929.68	-1.34	4.55					27	-5.15	50	-4.54

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
5930.19	-0.23	4.65	9	-6.63	28	-5.78	60	-5.38	78	-4.92
5934.65	-1.26	3.93	22	-5.93			65	-5.06	61	-5.07
5947.50	-2.05	4.61					3	-5.51	11	-4.84
5952.72	-1.51	3.98	4	-6.42	11	-5.71	52	-5.04		
5956.69	-4.60	.86	9	-6.34	9	-5.89	50	-5.67	69	-5.07
5958.34	-4.33	2.18					11	-5.35	18	-5.01
5963.26	-4.78	2.22					6	-5.14		
5983.68	-0.71	4.55			15	-5.79			72	-4.62
5984.80	-0.31	4.73			15	-6.01				
5987.06	-0.59	4.80			8	-5.99	40	-5.32	61	-4.75
5997.78	-1.05	4.61	4	-6.23			30	-5.30	55	-4.65
6003.01	-1.12	3.88	15	-6.31			52	-5.56	76	-4.91
6007.96	-0.76	4.65	13	-5.93	4	-6.28	48	-5.13	61	-4.74
6008.56	-0.98	3.88	12	-6.96	12	-6.30	76	-5.13	82	-4.86
6015.24	-4.67	2.22							10	-4.93
6019.36	-3.34	3.57							7	-4.91
6020.17	-0.21	4.61	28	-6.13	25	-5.93	91	-4.69		
6024.07	-0.02	4.55	26	-6.42	28	-6.10	72	-5.42	96	-4.72
6027.06	-1.15	4.08	5	-6.59	10	-6.03	49	-5.38	53	-5.21
6034.03	-2.41	4.31					6	-5.15	7	-5.03
6055.99	-0.46	4.73							53	-5.18
6065.49	-1.53	2.61	44	-6.68	50	-6.05	80	-6.02	118	-4.91
6078.49	-0.38	4.80	3	-6.83	13	-5.95	47	-5.38	57	-5.05
6078.99	-1.12	4.65					28	-5.23	36	-5.00
6082.71	-3.57	2.22			5	-5.81	34	-5.42	64	-4.66
6093.67	-1.45	4.61					7	-5.72	28	-4.90
6094.36	-1.69	4.65					5	-5.59	16	-4.95
6096.66	-1.98	3.98			4	-5.73	25	-5.20	35	-4.90
6102.18	-0.26	4.83	14	-6.20	17	-5.89	56	-5.24		
6103.19	-0.65	4.83	3	-6.53	11	-5.73	43	-5.15		
6105.13	-2.02	4.55					6	-5.29	7	-5.16
6107.09	-3.05	4.26								
6114.39	-3.39	3.93							3	-4.86
6120.25	-5.97	.91					3	-5.80		
6136.62	-1.40	2.45			53	-6.28				
6137.70	-1.40	2.59			51	-6.18			127	-4.96
6151.62	-3.30	2.18	6	-6.40	6	-6.05			68	-4.88
6157.73	-1.28	4.08	7	-6.31	7	-6.08	31	-5.65	56	-5.02
6159.38	-1.97	4.61					2	-5.77	9	-5.02
6165.37	-1.63	4.14					29	-5.27	37	-5.02
6173.34	-2.88	2.22	6	-6.77	12	-6.08	60	-5.57	89	-4.72
6180.21	-2.80	2.73	7	-6.23	7	-5.91	41	-5.46	70	-4.70
6187.40	-4.21	2.83					2	-5.52	5	-5.04
6188.04	-1.84	3.94					23	-5.44	45	-4.86
6191.56	-1.48	2.43	13	-7.59	67	-5.88	140	-5.00	139	-4.88
6200.32	-2.44	2.61	11	-6.52	9	-6.28				
6213.44	-2.61	2.22							101	-4.70
6215.14	-1.44	4.19								
6219.29	-2.43	2.20	40	-6.29	30	-6.03	81	-5.61	102	-4.86
6220.78	-2.48	3.88					81	-3.55		
6226.73	-2.21	3.88					11	-5.54	27	-4.97
6229.22	-3.02	2.84	7	-5.89	4	-5.84	26	-5.44	55	-4.71
6230.73	-1.28	2.56	76	-6.56	67	-5.96	129	-5.28		
6232.64	-1.33	3.65	13	-6.42	15	-6.07	52	-5.63	84	-4.74
6240.65	-3.41	2.22	2	-6.73	6	-5.89			48	-5.19
6246.33	-0.70	3.60	50	-6.36	36	-6.19	81	-5.65	119	-4.75
6252.56	-1.69	2.40	65	-6.46	53	-6.04	95	-5.80	116	-5.09
6254.26	-2.38	2.28	29	-6.45	37	-5.84	83	-5.52	114	-4.54
6256.36	-2.34	2.45	27	-6.34	28	-5.91	70	-5.64	100	-4.71
6265.14	-2.55	2.18	31	-6.35	41	-5.69	78	-5.59	85	-5.22

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
6267.84	-2.80	4.29					3	-5.11	5	-4.82
6270.22	-2.71	2.86	7	-6.19	8	-5.82	42	-5.39	53	-5.04
6271.28	-2.85	3.33					15	-5.37	29	-4.90
6280.62	-4.39	.86					64	-5.64		
6297.79	-2.74	2.22			30	-5.70			107	-4.45
6301.50	-0.59	3.65	40	-6.56	55	-5.82	80	-5.73	114	-4.79
6302.49	-1.16	3.69	16	-6.46			78	-5.17	72	-5.18
6311.58	-3.21	2.83					23	-5.34		
6315.81	-1.76	4.08					9	-5.88	33	-5.07
6318.02	-2.00	2.45	40	-6.45			84	-5.68	128	-4.46
6322.69	-2.43	2.59	17	-6.34	17	-5.98	56	-5.69	92	-4.68
6330.86	-1.32	4.73	2	-6.15	5	-5.55	7	-5.72	24	-5.00
6335.34	-2.20	2.20	30	-6.70	42	-6.00	74	-6.00	101	-5.13
6336.84	-0.68	3.69	34	-6.53	38	-6.08	77	-5.68		
6339.97	-4.17	3.40							4	-4.55
6344.15	-2.92	2.43	4	-6.69	12	-5.84	47	-5.57		
6353.84	-6.48	.91					3	-5.30	10	-4.64
6355.04	-2.38	2.84	10	-6.37	20	-5.68	56	-5.44	75	-4.87
6358.69	-4.47	.86	22	-6.06	10	-5.99	67	-5.51	82	-4.93
6364.36	-1.35	4.80								
6380.75	-1.44	4.19			7	-5.82			45	-5.00
6392.54	-4.04	2.28					7	-5.77	28	-4.94
6393.60	-1.57	2.43	82	-6.34	62	-5.93	102	-5.75	137	-4.79
6408.02	-1.00	3.69	31	-6.27	22	-6.16	66	-5.61	84	-5.06
6411.66	-0.49	3.65	80	-6.11	45	-6.15	110	-5.17	107	-5.07
6419.95	-0.27	4.73	12	-6.39	19	-5.93	55	-5.39	74	-4.83
6421.36	-2.03	2.28	47	-6.51	43	-6.07	100	-5.53	109	-5.03
6430.85	-2.01	2.18	64	-6.42	47	-6.10	108	-5.51	118	-4.97
6494.98	-1.27	2.40	93	-6.52	80	-5.82	165	-4.91		
6498.94	-4.69	.96	5	-6.45			42	-5.66	74	-4.82
6518.37	-2.67	2.83	8	-6.21	12	-5.69	48	-5.35	66	-4.84
6533.93	-1.38	4.56					21	-5.28		
6575.02	-2.80	2.59	20	-5.90						
6581.21	-4.82	1.48							45	-4.72
6591.31	-2.07	4.59							8	-5.02
6592.92	-1.60	2.73	57	-6.32			93	-5.59	122	-4.71
6593.88	-2.42	2.43	35	-6.15	18	-6.13	66	-5.70	84	-5.12
6597.56	-1.07	4.80	6	-5.95	6	-5.66	25	-5.22	44	-4.70
6608.02	-4.02	2.28					13	-5.50	31	-4.91
6609.11	-2.69	2.56	27	-5.89	11	-6.00	57	-5.47	90	-4.57
6627.54	-1.59	4.55					14	-5.32		
6646.93	-4.01	2.61							21	-4.79
6648.08	-5.92	1.01							14	-4.94
6653.91	-2.53	4.15							20	-4.55
6665.47	-5.69	1.56								
6667.42	-4.42	2.45							24	-4.47
6677.99	-1.22	2.69	76	-6.50	51	-6.29	96	-5.96	130	-5.05
6703.57	-3.13	2.76	28	-5.22			28	-5.40		
6705.10	-1.28	4.61			5	-5.73	29	-5.12	30	-5.03
6710.32	-4.90	1.48	24	-4.92			24	-5.21	44	-4.67
6713.04	-1.63	4.61					20	-5.01		
6713.77	-1.52	4.80					11	-5.24		
6715.38	-1.63	4.61					16	-5.14		
6737.98	-1.78	4.56							34	-4.50
6739.52	-4.98	1.56							23	-4.97
6745.10	-2.17	4.58							18	-4.51
6750.15	-2.62	2.42	12	-6.52	14	-6.08	47	-5.91	75	-5.18
6752.70	-1.30	4.64			4	-5.78	10	-5.68	30	-5.00
6753.46	-2.30	4.56								
6786.85	-2.01	4.19					14	-5.30		

	gf	Pot	HD 64090		BD 23°3912		G29-20		G122-57	
			W	A	W	A	W	A	W	A
6806.85	-3.24	2.73					24	-5.43		
6810.26	-1.12	4.61	3	-6.32			28	-5.31		
6837.02	-1.81	4.59								
6841.34	-0.79	4.61			7	-6.07	28	-5.64		
6842.68	-1.28	4.64	4	-6.00	5	-5.70	11	-5.66		
6843.65	-0.98	4.55					37	-5.31	55	-4.85
6851.65	-5.33	1.61					6	-5.35		
6855.16	-0.63	4.56			16	-5.85				
6855.72	-1.83	4.61					20	-4.82		
6857.24	-2.20	4.08					7	-5.58		
6858.14	-1.09	4.61	8	-5.90	9	-5.64	23	-5.47	43	-4.95
FeII										
5100.65	-4.35	2.81								
5197.57	-2.31	3.23			51	-6.02				
5234.62	-2.31	3.22			45	-6.17				
5264.80	-3.26	3.23								
5284.09	-3.31	2.89								
5325.55	-3.38	3.22			18	-5.77				
5414.09	-3.78	3.22			6	-5.93				
5425.27	-3.49	3.20			12	-5.91				
5534.86	-3.19	3.24			25	-5.75				
5991.38	-3.76	3.15			8	-5.91			25	-4.88
6084.10	-3.99	3.20	7	-5.70	2	-6.27	14	-5.39	28	-4.51
6113.33	-4.26	3.22	4	-5.66			8	-5.39	7	-5.06
6149.24	-2.88	3.89	4	-6.35	13	-5.81	17	-5.64	30	-4.82
6238.38	-2.87	3.89	2	-6.67	10	-5.96	31	-5.22	36	-4.66
6247.56	-2.55	3.89	10	-6.26	20	-5.90	36	-5.40	42	-4.82
6383.75	-2.26	5.55					4	-5.35		
6416.90	-2.86	3.89	12	-5.87	15	-5.76	29	-5.28	22	-5.09
6432.65	-3.85	2.89	11	-5.97	10	-5.99	30	-5.36	32	-4.87
6446.40	-2.11	6.22							3	-4.65
6516.05	-3.55	2.89	10	-6.32	13	-6.16	29	-5.69	42	-4.92
7479.70	-3.77	3.89							10	-4.68
7515.88	-3.57	3.90					6	-5.52	12	-4.77
NiI										
5081.11	0.25	3.85			31	-7.31				
5082.34	-0.65	3.66			13	7.12				
5084.10	0.06	3.68			22	-7.51				
5088.54	-1.18	3.85			20	-6.16				
5099.93	-0.15	3.68			12	-7.65				
5102.97	-2.89	1.68			4	-7.44				
5115.40	-0.18	3.83			24	-7.07				
5137.08	-1.66	1.68			28	-7.66				
5435.86	-2.58	1.99								
5452.85	-1.68	3.80			5	-6.44				
5453.23	-1.52	4.09			8	-6.09				
5476.92	-0.65	1.83			92	-6.98				
5578.73	-2.84	1.68	3	-8.00			46	-6.77		
5587.86	-2.49	1.94					44	-6.86		
5589.36	-1.22	3.90	2	-7.43			5	-7.17		
5593.74	-0.93	3.90					15	-6.92	34	-6.27
5625.32	-0.78	4.09					7	-7.25		
5641.88	-1.12	4.11	4	-7.00	8	-6.48	7	-6.88	22	-6.17
5682.20	-0.60	4.11	8	-7.21			32	-6.55	69	-5.49
5748.36	-3.36	1.68	3	-7.49	5	-6.91	14	-7.04	48	-6.03
5754.68	-2.17	1.94	7	-8.02			76	-6.49		
5760.84	-0.90	4.11	7	-6.97						
5796.09	-3.74	1.95	4	-6.69			14	-6.35		
5805.22	-0.20	4.17	8	-7.55	4	-7.67	16	-7.32		
5847.00	-3.52	1.68			4	-6.86	14	-6.89	51	-5.81

			HD 64090		BD 23°3912		G29-20		G122-57	
	gf	Pot	W	A	W	A	W	A	W	A
5996.74	-1.15	4.24	4	-6.85			10	-6.55	12	-6.35
6007.31	-3.44	1.68	6	-7.12			18	-6.84	40	-6.15
6086.28	-0.70	4.27	6	-7.09	3	-7.21	16	-6.72	51	-5.69
6108.12	-2.61	1.68	10	-7.71	6	-7.59	53	-6.90	82	-5.98
6111.07	-0.97	4.09	4	-7.19			10	-6.90	21	-6.38
6175.37	-0.63	4.09	2	-7.83	5	-7.22	28	-6.65	45	-6.12
6176.81	-0.42	4.09	5	-7.64	10	-7.10	35	-6.69	64	-5.87
6177.25	-3.60	1.83	7	-6.73			14	-6.65	40	-5.82
6186.72	-1.06	4.11					10	-6.79	22	-6.24
6191.19	-2.51	1.68	13	-7.70			72	-6.60	134	-4.88
6204.61	-1.25	4.09	9	-6.54			6	-6.86		
6223.99	-1.08	4.11	5	-6.96	2	-7.18	11	-6.72	41	-5.74
6230.09	-1.28	4.11	3	-6.99			10	-6.57	23	-5.99
6322.17	-1.33	4.15							29	-5.73
6327.60	-3.23	1.68	5	-7.43	6	-6.98	23	-6.93	88	-5.22
6360.81	-1.20	4.17	7	-6.63			7	-6.76	10	-6.48
6482.81	-2.97	1.94	2	-7.82			18	-7.04	73	-5.59
6532.88	-3.47	1.94					9	-6.89		
6580.23	-1.40	4.42	5	-6.33						
6586.31	-2.95	1.95	38	-6.41	9	-6.80	75	-5.81	51	-6.12
6598.60	-1.02	4.24			4	-6.81	16	-6.45	29	-5.97
6767.78	-1.89	1.83	36	-7.65	18	-7.63	76	-7.01		
6772.32	-1.07	3.66	18	-6.86	11	-6.86	21	-6.90	49	-6.10
6842.03	-1.52	3.66	21	-6.33	5	-6.79			62	-5.35
7110.91	-3.15	1.94			6	-6.83	35	-6.48	51	-5.98
CuI										
5782.13	-1.81	1.6			5	-9.61	39	-9.09	106	-6.80
ZnI										
6362.35	-0.07	5.77	5	-8.47			11	-8.08		
YI										
5630.10	0.47	1.35							3	-10.45
6023.42	-0.99	0.00	1	-10.71			4	-10.47	8	-10.10
6222.61	-1.09	0.00	3	-10.15			1	-11.00		
6435.04	-0.83	0.06					2	-10.90	10	-10.11
6687.50	-0.43	0.00	4	-10.70			6	-10.89	11	-10.54
YII										
5087.42	-0.39	1.07			2	-11.30				
5119.12	-1.36	0.98								
5200.42	-0.79	0.98			10	-11.38				
5289.82	-1.95	1.02			3	-10.74				
5728.91	-1.21	1.83	2	-10.94			10	-10.29	9	-9.94
6795.43	-1.59	1.73	5	-10.31			6	-10.30	13	-9.50
ZrI										
5735.71	-0.39	0.00	7	-9.90	7	-10.01				
5885.63	-0.89	0.07			10	-9.27	6	-10.37		
5955.63	-1.46	0.00	3	-9.79			8	-9.75		
6025.44	-1.32	0.15			6	-9.02				
6134.58	-1.19	0.00								
6140.46	-0.84	0.51			4	-9.32				
6143.18	-1.14	0.07	4	-9.92	2	-9.79	6	-10.14		
6445.72	-0.50	0.99	4	-9.57						
6762.36	-1.09	0.00	8	-9.77	6	-9.44				
ZrII										
5350.09	-0.93	1.76								
5350.36	-1.12	1.81			3	-10.30				
MoI										
5751.42	-0.63	1.41					3	-10.41		
6030.68	-0.23	1.52							7	-10.26
BaII										
5853.68	-.92	0.60	13	-12.28	35	-11.46			116	-9.20

	gf	Pot	HD 64090 W	HD 64090 A	BD 23°3912 W	BD 23°3912 A	G29-20 W	G29-20 A	G122-57 W	G122-57 A
6141.72	0.27	0.70	49	-12.64	70	-11.70			146	-9.95
6496.90	-.07	0.60	34	-12.67	63	-11.68			142	-9.79
LaII										
5377.06	0.70	2.29								
5808.31	-2.08	0.00	4	-11.48	4	-11.29	4	-11.62	7	-10.93
6262.25	-1.45	0.40	3	-11.83	2	-11.85	7	-11.55	12	-10.68
6320.41	-1.42	0.17			4	-11.81			17	-10.96
6390.48	-1.49	0.32					2	-12.19	20	-10.62
6526.95	-1.58	0.23	7	-11.52					34	-10.25
CeII										
5274.22	0.26	1.04	1	-11.93						
5610.24	0.00	1.04								
6043.38	-0.17	1.20							7	-10.75
NdII										
5092.80	-0.60	0.37			13	-11.25				
5293.16	-0.09	0.81								
5311.47	-0.43	0.98			5	-11.28				
5371.92	0.28	1.40								
5416.38	-1.01	0.85			8	-10.61				
5603.77	0.00	0.37	11	-12.17						
5740.87	-0.43	1.15	2	-11.67	3	-11.36			12	-10.52
5842.38	-0.34	1.27	16	-10.69			6	-11.25	12	-10.49
6031.30	-0.42	1.27	4	-11.26	7	-10.87			16	-10.25
6034.22	-0.40	1.53					9	-10.71	12	-10.15
EuII										
6437.64	0.05	1.31			3	-12.50	8	-12.23	16	-11.45
6645.11	-0.25	1.37							4	-11.80

Continued

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
LiI												
6707.78	40	-9.73	20	-10.55	7	-10.78	42	-9.64	4	-11.33	8	-10.77
OI												
6155.99	5	-3.02									10	-2.44
6156.78	2	-3.68			7	-2.68	1	-3.88			8	-2.80
6158.19	2	-3.67			6	-2.75						
6300.32	5	-4.08	4	-4.82	8	-3.11					33	-2.73
7771.96					40	-3.54	40	-4.00	19	-4.24	65	-3.15
7774.17					28	-3.67	52	-3.62	12	-4.34	51	-3.28
7775.39					12	-3.95	42	-3.53	12	-4.06	49	-3.04
NaI												
5682.63	10	-7.44	2	-8.42	143	-5.68			3	-8.26	55	-6.58
5688.20	12	-7.79			139	-6.17	28	-7.31	5	-8.48	87	-6.57
5889.95	175	-7.16	120	-8.31			222	-6.78	208	-7.76	430	-6.16
5895.92	167	-7.02	117	-8.15			171	-6.97	189	-7.76	323	-6.29
6154.22	1	-7.43			49	-5.66					18	-6.23
6160.75	3	-7.25			97	-5.38	9	-6.71	4	-7.39	40	-6.08
MgI												
5167.32	244	-5.31										
5172.68	231	-5.82	184	-6.39								
5183.60	234	-6.03	180	-6.66								
5528.40	102	-5.78	54	-6.77								
5711.09	16	-6.00	5	-6.83	115	-4.65	47	-5.31			83	-4.95
6318.70					68	-4.31			31	-4.96	46	-4.57
6319.24	4	-5.39			70	-3.95	4	-5.36	10	-5.19	35	-4.41
8305.62					70	-4.11	12	-5.04			33	-4.60
8310.25					46	-4.68	10	-5.40			56	-4.50
8473.68					36	-3.96					11	-4.58
8710.21					87	-3.62					30	-4.33
8712.69					97	-4.10	12	-5.29	47	-4.70	62	-4.40
AlI												
6696.03	20	-5.87					11	-6.14	5	-6.79	34	-5.69
7084.62	22	-5.31	18	-5.54			4	-6.11	3	-6.41		
7362.28					36	-5.53						
8772.87											66	-5.73
8773.91					53	-6.27	27	-6.53			70	-5.97
SiI												
5622.23					8	-4.36					8	-4.47
5645.66	6	-5.51	1	-6.58	38	-4.49	16	-4.98			21	-4.93
5665.60	4	-5.75	1	-6.63	29	-4.71					26	-4.86
5666.69	4	-5.52	2	-6.03	23	-4.61	5	-5.37			19	-4.79
5684.52			4	-6.42	63	-4.60			7	-6.17	58	-4.70
5690.47	11	-5.47					13	-5.33	9	-5.83	44	-4.70
5701.10	8	-5.46	3	-6.17	59	-4.26						
5708.44	3	-6.47	4	-6.60	90	-4.41	17	-5.59	6	-6.41	67	-4.73
5753.64	5	-5.64									28	-4.80
5772.26	4	-5.92									29	-4.97
5793.13					50	-4.41			7	-5.81	36	-4.71
5797.86					85	-3.94	11	-5.27			49	-4.48
5873.77					7	-4.54					5	-4.81
5948.54	54	-5.09			83	-4.71			2	-6.86	55	-5.08
6087.79					24	-4.22	5	-5.02			14	-4.58
6091.92					24	-4.69					17	-4.95
6125.02							4	-5.53			22	-4.76
6142.49	10	-5.22			28	-4.62	13	-5.04			16	-5.00
6145.08			1	-6.53	30	-4.66					17	-5.05
6155.14	9	-5.00	3	-6.68	84	-4.55	15	-5.69	15	-5.94	62	-4.82

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
6237.34	3	-6.12	5	-6.08	44	-4.69	20	-5.17	7	-5.92	59	-4.50
6243.82					42	-4.60	11	-5.35			30	-4.87
6244.13					39	-4.61					28	-4.87
6244.47	5	-5.72	1	-6.63	46	-3.55	14	-5.19				
6254.84							2	-5.04			3	-4.92
6414.99	7	-5.60	5	-5.92	52	-4.44			5	-5.92	31	-4.84
6741.63					8	-4.84					20	-4.47
6976.50	10	-5.41			32	-4.73	11	-5.32			26	-4.91
7003.57	12	-5.52			13	-5.40			14	-5.60	32	-4.99
7034.91												
7405.78					89	-4.70	46	-5.20			59	-5.04
7415.96							39	-5.35			66	-5.00
7849.97					50	-4.55					75	-4.20
7918.39					70	-4.73	18	-5.60			84	-4.51
7932.35							20	-5.62				
8556.79					118	-4.75	86	-5.00			95	-4.88
8742.46					66	-4.94						
8752.02					105	-4.73					132	-4.34
SiII												
6347.09	14	-5.92	4	-6.43	28	-4.82	27	-5.34	4	-6.22	42	-4.64
CaI												
5265.56	52	-7.11	17	-8.14								
5349.47	28	-6.96	24	-7.34								
5581.97	29	-7.01	8	-7.99	112	-5.96	66	-6.26			72	-6.39
5588.76	74	-6.80	44	-7.60	200	-5.67			74	-7.36	124	-6.09
5590.12	26	-6.97	18	-7.48	94	-6.10	58	-6.30	14	-7.65	75	-6.22
5594.47	58	-6.81	31	-7.59	213	-5.32	77	-6.38	39	-7.55		
5598.49	58	-6.78	26	-7.66	233	-5.16	77	-6.35	26	-7.74		
5601.28	29	-7.01	21	-7.50	144	-5.59	36	-6.81	12	-7.83	72	-6.39
5857.45	52	-6.91	18	-7.86			61	-6.67	46	-7.40	138	-5.68
5867.57			1	-7.34	30	-5.59	6	-6.22			21	-5.78
6102.72	50	-7.11	24	-7.96			65	-6.75	47	-7.65	119	-6.11
6122.22	76	-7.26	44	-8.15					81	-7.84	143	-6.37
6161.30	11	-6.72			155	-4.70	11	-6.67	19	-6.63	50	-5.98
6162.17	99	-6.91					122	-6.42	122	-7.44	166	-6.20
6163.75	19	-6.44			153	-4.71	14	-6.55	11	-6.88		
6166.44	14	-6.79			78	-5.84	32	-6.28	12	-7.22	54	-6.10
6169.06	26	-6.97	8	-7.88	145	-5.51	34	-6.74			88	-6.01
6169.56	32	-7.02	13	-7.82	201	-5.19			32	-7.41	94	-6.09
6417.69					12	-5.63					9	-5.78
6439.07	81	-6.71	52	-7.47	236	-5.53	78	-6.65	63	-7.51		
6449.81	46	-6.73	12	-7.83			66	-6.31	25	-7.51	104	-5.91
6455.60												
6471.66	21	-6.97	14	-7.49	98	-5.97	22	-6.89			75	-6.13
6493.78	48	-6.93	30	-7.56	212	-5.34	50	-6.82	38	-7.51	95	-6.29
6499.65			6	-7.78	105	-5.76	36	-6.47	21	-7.22	59	-6.29
6508.84											7	-5.91
6572.79												
6717.69	43	-6.84	10	-7.96	138	-5.81					98	-6.07
6798.47					20	-5.14						
7148.15			31	-7.66	190	-5.69			18	-7.88	124	-6.04
7202.20					176	-5.53	76	-6.26	36	-7.41	92	-6.25
ScII												
5239.82	15	-10.57	6	-11.54								
5526.82			7	-12.11								
5552.22			3	-10.59								
5640.97	6	-10.77	4	-11.47	71	-8.57	12	-10.17			40	-9.30
5657.87	9	-11.04			91	-8.74	22	-10.32			74	-9.16
5667.16	5	-10.66			51	-8.67	3	-10.62			38	-9.15
5669.03	2	-11.18			18	-9.41			5	-11.13	25	-9.53

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
5684.19	15	-10.27			20	-9.37	21	-9.81			42	-9.20
5854.31					2	-9.46			4	-10.27		
6245.63					30	-9.10	10	-10.15			24	-9.52
6279.75					20	-9.20			3	-11.21	44	-9.00
6300.68					7	-9.11	4	-9.85				
6320.87			8	-10.32								
6604.59	3	-11.06			19	-9.44	14	-10.07			21	-9.69
TiI												
5064.65	17	-8.67	25	-9.09								
5120.42	3	-8.33										
5173.74	27	-8.34	9	-9.55								
5192.97	16	-8.72	14	-9.42								
5210.39	31	-8.46	18	-9.39								
5219.70	7	-7.84	1	-9.35								
5223.62	2	-8.08										
5338.33			1	-8.71								
5426.25			1	-8.64								
5460.51			1	-8.87								
5490.15	8	-7.72	4	-8.54								
5514.54	4	-8.49	6	-8.80								
5644.14					91	-6.44			6	-8.45	26	-7.46
5648.57							9	-7.17			16	-7.13
5662.15	5	-7.93										
5673.43					5	-7.10					2	-7.55
5689.47					17	-7.17	18	-6.90	3	-8.26		
5716.45					25	-6.66	14	-6.72			14	-6.99
5720.45					18	-6.69	3	-7.30				
5739.48					10	-7.24					14	-7.07
5739.98	1	-8.07			14	-7.04	7	-7.14				
5766.33												
5774.03					27	-6.65					10	-7.17
5812.83					7	-6.92	7	-6.75				
5823.69					5	-7.18						
5839.76											3	-7.00
5866.45	5	-8.44	2	-9.38	71	-7.17						
5880.27					16	-6.96	5	-7.21				
5899.30									12	-8.31	36	-7.38
5918.55					38	-6.80			7	-8.01	20	-7.18
5922.12					48	-6.89	17	-7.16			24	-7.32
5937.81					32	-6.67						
5940.65					36	-6.56	20	-6.51			5	-7.58
5944.68							4	-6.57				
5953.17					62	-6.93					33	-7.39
5965.83					32	-7.34					18	-7.67
5988.56					8	-7.32						
5999.69					24	-6.76			3	-8.02	7	-7.39
6031.71					4	-6.93					2	-7.28
6064.62					36	-6.67						
6091.17	1	-8.40			20	-7.19	16	-7.06			8	-7.66
6092.81					8	-7.07						
6098.66					12	-6.95	19	-6.23	4	-7.67		
6121.06												
6146.23					15	-6.64						
6258.11	21	-7.86			85	-7.09						
6261.10	4	-8.56			60	-7.33					38	-7.64
6303.76					32	-6.65	16	-6.72				
6312.24					43	-6.47	17	-6.69	5	-7.88		
6325.16					13	-6.74						
6336.11					32	-6.48						
6366.35											10	-7.09

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
6419.09					7	-6.84						
6497.68					14	-6.68					2	-7.61
6508.15					14	-6.65						
6599.11	1	-8.13			24	-6.91	6	-7.26			14	-7.21
6666.54					2	-7.46						
6716.67					4	-7.09	9	-6.49				
7188.57					20	-6.78						
7251.71					94	-6.57					24	-7.59
TiII												
5072.29	18	-8.11										
5129.16	30	-8.90	22	-9.56								
5154.06	26	-8.82	21	-9.44								
5185.90	20	-8.98	14	-9.64								
5211.53	11	-8.16	1	-9.67								
5336.81	25	-8.95	25	-9.46								
5418.80	8	-9.01	2	-10.15								
6606.95					8	-7.16	16	-7.31			7	-7.52
VI												
5604.95					6	-8.24	2	-8.44				
5657.45							6	-8.06				
5668.36					12	-8.03					3	-8.70
5670.85					30	-7.95					9	-8.60
5703.58	6	-8.89	6	-9.42	38	-8.17						
5727.06	9	-8.14	13	-9.09	50	-8.02					26	-8.44
5727.66					19	-7.88					2	-8.97
5737.07					17	-8.06	9	-8.07				
5817.08					33	-7.80					3	-9.01
6039.73					18	-8.20						
6081.44	3	-8.81	2	-9.52	31	-7.90	2	-8.91	11	-8.79	3	-9.07
6090.21	4	-9.17			58	-7.98			6	-9.55	11	-8.96
6111.65	4	-8.50	5	-8.93	29	-7.76	2	-8.73	2	-9.37	4	-8.76
6119.53	2	-9.21	5	-9.32	36	-8.04			5	-9.36		
6150.15	3	-8.59	5	-8.96	31	-7.73					7	-8.50
6199.18					34	-7.77	7	-8.21	8	-8.89		
6216.36					3	-8.3						
6224.50	8	-8.02	1	-9.56								
6251.82			2	-9.66	35	-7.94						
6266.32					8	-8.03						
6274.67			3	-9.18	31	-7.71						
6504.18					39	-7.65					3	-8.95
6531.42			5	-8.75								
VII												
5819.93	4	-8.87	7	-9.05	4	-8.13	5	-8.51			4	-8.44
5928.88					18	-7.48					9	-8.12
6028.27					2	-8.30	7	-8.22	3	-9.13	2	-8.61
6029.00	1	-9.32	1	-9.75					8	-8.66		
CrI												
5206.04	71	-8.57	60	-9.29								
5247.57	6	-8.41	3	-9.28								
5296.69	15	-8.20	9	-9.00								
5329.14			5	-8.52								
5345.81	24	-8.35	20	-9.00								
5348.32	4	-8.90	14	-8.86								
5409.79	30	-8.46	26	-9.08								
5664.59					8	-6.33						
5702.32					38	-6.12					9	-6.92
5712.77					12	-6.63					5	-7.08
5719.83					22	-5.89	6	-6.33				
5781.75												
5783.07					24	-6.62	20	-6.53			10	-7.10

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
5783.86			1	-8.58	35	-6.68					20	-7.01
5787.92					49	-6.67					16	-7.35
5788.39							5	-6.43			1	-7.37
6330.09					31	-6.55	7	-6.97			6	-7.40
6362.87					18	-6.76					17	-6.81
6501.20					12	-6.34						
6529.18					6	-6.03						
6680.15					4	-6.74					2	-7.08
6789.15					7	-6.15	6	-6.06				
6978.40					88	-6.12						
6979.80					38	-6.38					15	-6.91
6980.94					13	-6.30					6	-6.69
7400.18					129	-6.11					40	-7.30
CrII												
5237.34	12	-7.96	5	-8.67							19	-7.62
5249.43	6	-7.34	5	-7.75								
5279.87	3	-7.82	1	-8.61							10	-7.19
5305.85	4	-7.90										
5308.44	9	-7.42	4	-8.10							6	-7.54
5310.70	7	-7.26	4	-7.81								
5313.59	6	-7.89									6	-7.83
5334.88	10	-7.55									5	-7.80
5508.63	2	-7.90									4	-7.52
5510.73	4	-7.63	2	-8.26								
MnI												
5377.63	1	-8.29	1	-8.62								
5394.67	5	-8.26	2	-9.37								
5407.43	4	-7.99	1	-9.09								
5413.68	4	-7.18	1	-8.12								
5432.54	12	-7.55										
5537.76			2	-8.27								
6013.50			1	-9.60	96	-6.72	21	-7.71			43	-7.49
6016.64			2	-9.30	117	-6.41	9	-8.16	9	-8.65	42	-7.52
6021.80	14	-8.27	3	-9.39	105	-6.87					52	-7.61
FeI												
5044.21	3	-6.73										
5049.82	55	-6.39	44	-7.09								
5067.15	3	-6.57										
5068.77	49	-6.18	30	-6.98								
5074.75	30	-6.30	20	-6.87								
5083.34	28	-6.66	44	-6.99								
5090.78	16	-6.17	10	-6.74								
5109.65	15	-6.09										
5110.43	52	-6.39	51	-7.12								
5123.73	29	-6.47	41	-6.88								
5127.36	22	-6.49	27	-7.02								
5131.48	11	-6.30	11	-6.83								
5133.69	34	-6.50	29	-6.93								
5137.39	21	-6.41	25	-6.63								
5141.74	16	-6.35	14	-6.92								
5150.84	26	-6.66	34	-7.13								
5151.91	9	-6.84	26	-6.93								
5159.07			3	-6.90								
5162.29	42	-6.25	28	-6.86								
5165.41	16	-6.14	3	-7.26								
5166.28	15	-6.72	33	-7.02								
5171.61	79	-6.37	82	-6.84								
5191.66	58	-6.46	35	-7.30								
5192.35	59	-6.52	51	-7.09								
5194.94	49	-6.55	57	-6.96								

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
5195.48	17	-6.53	12	-7.04								
5196.06			3	-7.02								
5198.71	12	-6.67	9	-7.34								
5215.18	30	-6.49										
5216.28	44	-6.52										
5217.39	10	-6.93	5	-7.68								
5225.53	4	-6.65	14	-6.79								
5228.38	5	-6.11										
5232.96	94	-6.35	70	-7.27								
5242.50	14	-6.30										
5243.77	1	-6.85										
5247.05			5	-7.14								
5250.21	1	-7.10	9	-6.84								
5250.65	22	-6.52	27	-6.92								
5253.46			3	-7.24								
5263.31	20	-6.73	18	-7.20								
5266.56	68	-6.56	50	-7.31								
5269.55	123	-6.54	120	-7.07								
5281.79	35	-6.82	34	-7.27								
5283.62	48	-6.71	42	-7.22								
5302.30	29	-6.73	21	-7.33								
5307.36	16	-6.30	11	-7.06								
5324.19	68	-6.54	51	-7.26								
5329.99			3	-6.66								
5332.90	11	-6.69	22	-6.91								
5339.93	39	-6.55	20	-7.38								
5364.88	28	-6.39	14	-7.07								
5365.40	10	-6.30	7	-6.86								
5367.47	39	-6.25	26	-6.82								
5369.96	42	-6.37	19	-7.18								
5371.50	98	-6.66	113	-6.83								
5383.37	49	-6.39	28	-7.11								
5389.48	5	-6.69	5	-7.00								
5391.46			6	-6.65								
5393.17	38	-6.57	24	-7.27								
5397.13	96	-6.40	107	-6.68								
5398.28	8	-6.19										
5404.78			97	-7.00								
5409.13	2	-6.35										
5410.91	96	-6.49	20	-7.09								
5415.20	49	-6.35	21	-7.23								
5424.08	47	-6.49	32	-7.08								
5429.70	92	-6.56	104	-6.82								
5432.95	2	-6.68	3	-6.81								
5434.53	99	-6.11	80	-7.10								
5445.04	26	-6.34	11	-7.11								
5446.92	68	-6.45	105	-6.22								
5455.62			97	-6.71								
5473.91	4	-6.57	5	-6.88								
5487.15			1	-6.63								
5497.52	46	-6.41	47	-7.01								
5501.47	41	-6.47										
5506.78	43	-6.53										
5543.19	2	-6.48										
5546.50	2	-6.36	1	-6.98								
5554.90	15	-6.07	1	-7.62								
5565.71					99	-4.79						
5567.40					63	-4.79						
5568.87					6	-4.96					3	-5.33
5569.62	36	-6.64	20	-7.39	173	-4.92	63	-6.02	90	-6.46	111	-5.32

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
5572.85	49	-6.60	38	-7.19			63	-6.22	78	-6.80	161	-4.78
5576.10	24	-6.55	12	-7.32	139	-4.94	50	-5.94	21	-6.86	84	-5.51
5577.02					16	-4.48					4	-5.18
5579.35					19	-4.35						
5583.99					9	-4.33						
5584.77					53	-4.30					18	-5.00
5586.76	59	-6.56	43	-7.23					88	-6.82		
5587.57					56	-4.39						
5608.98					20	-4.26					7	-4.83
5611.36					11	-4.56					2	-5.40
5614.28											3	-5.41
5615.65	62	-6.66	58	-7.11			102	-5.67	117	-6.62	178	-4.89
5618.65					42	-4.87			2	-6.65	21	-5.31
5619.59					42	-4.52					14	-5.18
5620.49	1	-6.21			40	-4.51					16	-5.06
5624.03					42	-4.83					36	-4.93
5624.55	35	-6.41	12	-7.41	168	-4.73			32	-6.96	100	-5.29
5633.97					57	-4.97					26	-5.49
5635.82					39	-4.61					17	-5.12
5636.69					37	-4.35						
5638.27	7	-6.28	4	-6.87	95	-4.65	10	-6.06	8	-6.58	58	-5.10
5641.44					102	-4.19	4	-6.12			41	-5.06
5650.02					47	-4.53						
5650.70					30	-4.80						
5651.47											12	-4.91
5652.32	1	-6.11									10	-5.20
5653.89			1	-6.66	49	-4.50	4	-5.68			25	-4.94
5661.35					38	-4.32					15	-4.88
5677.69					4	-4.85						
5679.02	4	-6.12			73	-4.54	8	-5.76			40	-5.00
5680.24					19	-4.35					5	-5.04
5686.53					118	-4.19			6	-6.57	57	-5.00
5701.55			5	-7.19	109	-4.73					61	-5.41
5705.46	1	-6.36			50	-4.50					13	-5.32
5705.99					82	-4.67	12	-5.87			42	-5.28
5717.83			1	-7.15	106	-4.16			3	-6.68	45	-5.01
5720.89					13	-4.64					5	-5.15
5731.76	4	-6.17			102	-4.19					50	-4.88
5732.27					16	-4.56						
5738.24					5	-5.02					5	-5.08
5741.85					28	-4.73					18	-5.01
5752.04											34	-5.09
5753.14	12	-6.18	1	-7.64							64	-5.14
5760.34											6	-5.38
5762.99												
5775.09	3	-6.29	2	-6.80	66	-4.66	5	-6.01			24	-5.41
5778.46					25	-4.65					14	-5.01
5793.92	1	-6.26			29	-4.75						
5804.03					50	-4.17					12	-5.05
5806.73					56	-4.68	8	-5.65			29	-5.13
5807.79											2	-5.39
5809.22			2	-6.57	69	-4.39					24	-5.15
5811.94					15	-4.50					7	-4.91
5814.80					22	-4.64					9	-5.13
5816.38					84	-4.60	12	-5.82	6	-6.52	45	-5.18
5826.64					5	-4.42						
5827.87											9	-4.88
5849.68					7	-4.76						
5852.22					37	-4.67	2	-5.99			17	-5.15
5853.15					17	-4.45						

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
5855.09					30	-4.44						
5856.08					34	-4.65					9	-5.39
5858.79					18	-4.48					6	-5.06
5859.61			4	-6.77	76	-4.81					43	-5.31
5861.11											3	-5.15
5862.36	11	-6.23	8	-6.67	95	-4.82	24	-5.75	21	-6.24	57	-5.26
5873.21					24	-4.46					9	-5.00
5876.29					13	-4.21						
5879.49					15	-4.44					3	-5.25
5881.28					15	-4 61					6	-5.10
5883.81					68	-4.84	6	-6.10			43	-5.21
5909.97					42	-4.52						
5916.25					71	-4.68					30	-5.34
5920.56					22	-4.97					9	-5.47
5927.80					24	-5.02					32	-4.87
5929.68					58	-4.35			2	-6.37	34	-4.75
5930.19					150	-4.24			4	-6.87	74	-4.97
5934.65					94	-4.56			6	-6.62	48	-5.19
5947.50					10	-4.62					5	-5.00
5952.72					80	-4.42	4	-6.07	3	-6.62	44	-4.96
5956.69					69	-4.79	4	-6.04	17	-5.89	25	-5.52
5958.34					24	-4.38						
5963.26					9	-4.36						
5983.68					60	-4.95						
5984.80					66	-5.07					63	-5.03
5987.06					75	-4.59					45	-5.03
5997.78											29	-5.09
6003.01	8	-6.29					14	-5.96	8	-6.68	59	-5.18
6007.96	4	-6.22			76	-4.55			6	-6.35	46	-5.00
6008.56	5	-6.65	6	-6.92	129	-4.33			13	-6.59	73	-5.04
6015.24					13	-4.31					2	-5.23
6019.36					8	-4.48						
6020.17	17	-6.12	4	-7.11	134	-4.28	15	-6.14	14	-6.55	75	-5.02
6024.07	27	-6.11	8	-7.04	120	-4.73	34	-5.89	12	-6.88	74	-5.30
6027.06	6	-6.21	3	-6.86	56	-5.07	16	-5.67	3	-6.89	42	-5.27
6034.03					5	-4.88						
6065.49	50	-6.08	24	-7.05	163	-4.70	42	-6.12	36	-6.91		
6078.49	8	-6.14	4	-6.74	101	-4.40			13	-6.04		
6078.99	9	-6.17			79	-4.20					38	-4.79
6082.71			1	-6.94	31	-4.96			3	-6.48	19	-5.27
6093.67											7	-5.44
6094.36					19	-4.63						
6096.66					44	-4.51					17	-5.11
6102.18	9	-6.17	4	-6.81	117	-4.24	12	-5.98			60	-5.03
6103.19			1	-7.05			10	-5.69	5	-6.34	52	-4.80
6105.13					9	-4.77					7	-4.93
6107.09					6	-4.21						
6114.39					4	-4.39						
6120.25											4	-5.00
6136.62					212	-4.53						
6137.70					228	-4.37						
6151.62			5	-6.54	55	-4.90	6	-5.85	8	-6.36	30	-5.33
6157.73					72	-4.72	2	-6.53	10	-6.02	45	-5.09
6159.38					12	-4.62					2	-5.50
6165.37					37	-4.82					20	-5.21
6173.34	2	-6.81	36	-7.04	85	-4.86	10	-5.99	5	-6.95	41	-5.50
6180.21					70	-4.61	4	-6.01	4	-6.57	32	-5.22
6187.40					4	-4.69						
6188.04					52	-4.58					18	-5.26
6191.56	38	-6.52	36	-7.04	225	-4.46	69	-5.83	57	-6.87	118	-5.28

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
6200.32			5	-6.93	58	-5.27					53	-5.32
6215.14					32	-5.05						
6219.29	8	-6.65	11	-7.02	103	-5.07					86	-5.17
6220.78					28	-4.40					11	-4.93
6226.73					38	-4.49					8	-5.36
6229.22					39	-4.73					20	-5.16
6230.73	46	-6.46	40	-7.03	204	-4.63	57	-6.14	70	-6.78	120	-5.32
6232.64	7	-6.37			105	-4.59			12	-6.54	54	-5.31
6240.65			1	-7.10	59	-4.69					40	-4.99
6246.33	21	-6.51	8	-7.38	138	-4.90	42	-5.97	13	-6.98	98	-5.16
6252.56	36	-6.38	28	-7.03	141	-5.09	45	-6.11	42	-6.89		
6254.26	18	-6.23	15	-6.83	133	-4.61	23	-6.00	17	-6.82	93	-5.00
6256.36	17	-6.12	17	-6.61	113	-4.74	27	-5.78	14	-6.76	70	-5.28
6265.14	16	-6.22	10	-6.97	100	-5.03	26	-5.86	21	-6.66		
6270.22	1	-6.66			40	-5.01					26	-5.31
6271.28					20	-4.78					18	-4.88
6280.62			5	-6.90	96	-4.66					53	-5.23
6297.79					100	-4.80						
6301.50	40	-6.17	37	-6.59	157	-4.65	42	-6.03	30	-6.82	107	-5.07
6302.49			6	-6.96	152	-4.10			27	-6.27	60	-5.35
6311.58					52	-4.36						
6315.81					85	-4.07						
6318.02	13	-6.60	15	-7.02	132	-4.83	48	-5.70	43	-6.52	81	-5.42
6322.69	12	-6.07	8	-6.75	88	-4.89			10	-6.68		
6330.86					18	-4.95					18	-4.98
6335.34	20	-6.43	17	-7.03	126	-5.00	23	-6.27	29	-6.82	85	-5.42
6336.84	19	-6.51	8	-7.31	129	-4.88	27	-6.23	22	-6.86		
6344.15	3	-6.38	4	-6.75	93	-4.50	5	-6.08	12	-6.28	39	-5.28
6353.84					4	-4.43					1	-5.12
6355.04					81	-4.77	8	-6.00	6	-6.69	48	-5.23
6358.69	7	-6.02	9	-6.56	99	-4.55	9	-5.81			48	-5.24
6364.36					19	-4.83					13	-5.06
6380.75					43	-4.87						
6392.54					24	-4.59					6	-5.33
6393.60	33	-6.53	26	-7.17	174	-4.79	64	-5.85	67	-6.67		
6408.02	11	-6.47	5	-7.21	134	-4.51			6	-6.96		
6411.66	26	-6.55	12	-7.34	177	-4.55	54	-5.91	38	-6.79		
6419.95	12	-6.13	2	-7.23	103	-4.57	15	-5.96				
6421.36	28	-6.34	19	-7.06	130	-5.03	52	-5.77	32	-6.85	99	-5.26
6430.85	26	-6.50	29	-6.95	141	-5.02	52	-5.90	45	-6.79		
6494.98	48	-6.60	54	-6.96	241	-4.59			93	-6.70		
6498.94					51	-4.88			4	-6.65	22	-5.43
6518.37					54	-4.88					43	-5.05
6533.93					33	-4.73					14	-5.24
6575.02									14	-5.95		
6591.31					1	-4.3						
6592.92	24	-6.42					30	-6.19	38	-6.70		
6593.88			15	-6.63	96	-5.00	16	-6.03	14	-6.72	56	-5.50
6597.56					42	-4.65					34	-4.79
6608.02					11	-5.01					8	-5.23
6609.11	5	-6.27			67	-4.98	9	-5.92	22	-5.88		
6646.93					14	-4.56						
6648.08					17	-4.24						
6653.91					19	-4.31						
6665.47											2	-4.94
6667.42					9	-4.53						
6677.99	28	-6.74	30	-7.16	177	-4.94			49	-6.96		
6703.57	1	-6.35			46	-4.63					19	-5.19
6705.10					42	-4.64	5	-5.62	3	-6.04	23	-5.03
6710.32					20	-4.68			4	-5.62	17	-4.82

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
6713.04					40	-4.32					6	-5.36
6713.77					28	-4.47					5	-5.36
6715.38					20	-4.73					14	-4.95
6739.52												
6745.10					16	-4.33					4	-5.04
6750.15	6	-6.39	8	-6.76	72	-5.13	23	-5.64			46	-5.49
6752.70					37	-4.68					12	-5.33
6753.46					9	-4.50					4	-4.93
6786.85					21	-4.75			2	-5.92	15	-4.96
6806.85					24	-4.95					12	-5.35
6810.26					62	-4.52					37	-4.89
6837.02					33	-4.29						
6841.34					95	-4.35	12	-5.70			30	-5.36
6842.68					23	-4.98	4	-5.70			10	-5.44
6843.65			2	-6.73	41	-5.03					24	-5.37
6855.16					102	-4.45	16	-5.76			50	-5.18
6855.72					29	-4.33					8	-5.03
6857.24					44	-4.40					19	-4.77
6858.14					67	-4.48	4	-5.92			34	-4.97
FeII												
5100.65	2	-6.43	3	-6.53								
5197.57	32	-6.58	30	-6.96								
5234.62	45	-6.35	24	-7.12								
5264.80	4	-6.68										
5284.09	20	-6.19	9	-6.98								
5325.55	3	-6.70	5	-6.83								
5414.09	3	-6.31	10	-7.15								
5425.27	7	-6.23	2	-7.16								
5534.86	17	-6.06	9	-6.73								
5991.38			3	-6.78	32	-4.45						
6084.10	3	-6.15	2	-6.68	8	-4.93						
6113.33					20	-4.18			4	-5.67		
6149.24	5	-6.35	2	-7.05	19	-4.95			5	-6.47		
6238.38	3	-6.60	3	-6.88	30	-4.68	9	-5.86				
6247.56	16	-6.13	5	-6.97	27	-5.07						
6416.90	4	-6.48			30	-4.69	7	-5.99	2	-6.90		
6432.65	6	-6.29	2	-7.17	33	-4.62	9	-5.85	4	-6.69		
6516.05	11	-6.31	7	-6.90	41	-4.77	11	-6.06	7	-6.74		
7479.70					17	-4.15						
7515.88					8	-4.72						
NiI												
5081.11	7	-8.07	11	-8.22								
5084.10	17	-7.61	11	-8.21								
5099.93	7	-7.84	3	-8.60								
5115.40	9	-7.54	5	-8.17								
5137.08			17	-8.42								
5476.92	65	-7.80	46	-8.66								
5578.73					70	-5.88			13	-7.45	29	-6.60
5587.86			3	-8.16	71	-5.94						
5589.36							10	-6.35	8	-6.89	11	-6.47
5593.74			1	-8.09	36	-6.03					20	-6.44
5625.32					12	-6.58	14	-6.43	8	-7.12	23	-6.32
5641.88					23	-5.90	5	-6.58	11	-6.62	16	-6.17
5682.20					71	-5.59			7	-7.35		
5748.36	1	-7.51									8	-6.77
5754.68											56	-6.50
5760.84											9	-6.68
5796.09					15	-5.70	2	-6.47	5	-6.71		
5805.22	2	-7.91			17	-6.92						
5847.00					17	-6.14					13	-6.38

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
	W	A	W	A	W	A	W	A	W	A	W	A
5996.74					29	-5.62			8	-6.61	14	-6.09
6007.31											15	-6.39
6086.28					41	-5.82					26	-6.16
6108.12	3	-7.79	4	-8.21	65	-6.22			16	-7.61	39	-6.66
6111.07					38	-5.78					16	-6.35
6175.37					41	-6.07					38	-6.16
6176.81			1	-8.41	58	-6.01	14	-6.82			39	-6.35
6186.72					21	-6.03					10	-6.49
6191.19					78	-6.15						
6204.61					47	-5.31						
6223.99											13	-6.34
6230.09									6	-6.76	11	-6.22
6322.17					17	-5.83						
6327.60					56	-5.75			12	-7.13		
6360.81											10	-6.29
6482.81					111	-4.97			13	-7.08	19	-6.49
6532.88											4	-6.75
6586.31					30	-6.17	5	-6.88				
6598.60					37	-5.62						
6767.78	10	-7.84	5	-8.70	76	-6.69			12	-8.32		
6772.32					48	-5.99	10	-6.77			21	-6.57
6842.03					54	-5.45					20	-6.15
7110.91					28	-6.05						
CuI												
5782.13	1	-10.51	3	-10.2					5	-10.08	31	-8.75
ZnI												
6362.35					8	-7.88					17	-7.65
YI												
6023.42			2	-10.47	8	-9.50						
6222.61					4	-9.73						
6435.04			1	-10.88	14	-9.36	3	-9.72			2	-10.28
6687.50					4	-10.42	2	-10.37			7	-10.19
YII												
5087.42	8	-11.82	7	-12.45								
5119.12	6	-11.07	2	-12.15								
5200.42	12	-11.32	2	-12.72								
5289.82	1	-11.25	3	-11.34								
5728.91	3	-10.72	4	-11.12	6	-9.66						
6795.43											6	-9.73
ZrI												
5735.71	5	-10.03										
5885.63	14	-8.98			2	-10.16					7	-9.63
5955.63			21	-8.91	4	-9.35						
6134.58												
6140.46	11	-8.72	2	-10.10								
6143.18					9	-9.24						
6445.72			6	-9.43								
6762.36					5	-9.68					6	-9.63
BaII												
5853.68	16	-12.01	5	-13.20	80	-10.15	40	-11.16	10	-12.74	58	-10.65
6141.72	52	-12.36	28	-13.42	143	-10.38	71	-11.65	51	-12.99	113	-10.72
6496.90			54	-12.71	175	-9.86	58	-11.69	56	-12.71	84	-11.06
LaII												
5377.06			3	-12.23								
5808.31	2	-11.61			5	-10.45	1	-11.63	5	-11.73		
6262.25	4	-11.55	1	-12.80	7	-10.54	7	-11.00			11	-10.64
6320.41	9	-11.44					5	-11.42			9	-11.01
6390.48			2	-12.55	8	-10.53	8	-10.99			8	-10.85
6526.95	4	-11.61	1	-12.87								
CeII												

	G126-62		G170-47		G182-7		G188-22		G246-38		G265-1	
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5274.22			7	-12.10								
5610.24			3	-12.25					6	-11.78	2	-11.40
6043.38					14	-9.87	20	-10.15	2	-11.95	2	-11.09
NdII												
5092.80	4	-11.83										
5293.16	6	-11.72										
5311.47	1	-12.01	5	-11.90								
5371.92	6	-11.50										
5416.38	4	-10.96	1	-12.20								
5603.77					26	-10.81						
5740.87			3	-11.98	3	-10.63	4	-10.97			2	-11.14
5842.38			3	-11.94	10	-10.05					6	-10.61
6031.30					3	-10.54	6	-10.69			2	-11.04
6034.22					5	-10.06	6	-10.46	5	-11.22	2	-10.79
EuII												
6437.64	2	-12.71			2	-11.96	2	-12.44	4	-12.79	7	-11.70
6645.11					9	-10.92						