THE CHEMICAL ABUNDANCES OF ATMOSPHERES OF K GIANT STARS

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ABSTRACT. The abundances of 18 of cool giant stars in vicinity of Sun have been determinated. This determination was made by using the method of model atmospheres. It should be noted that almost all elements show discrepancies in abundances determined for absorption lines of atoms and their ions.

Key words: Cool giant stars, abundances, evolution of stars

One of the goal of modern astrophysics is the testing of theories of nucleosynthesis and stellar evolution, chemical evolution of the Galaxy based upon data of abundances of chemical elements in diverse object of the Galaxy. In particular, it is necessary to know about the abundances of chemical elements and their isotopes in the atmospheres of stars different masses and which have passed through this or that stage of evolution.

Stars of the Galactic disk (Population I) were considered to have been formed after 10^9 years'lifetime of our Galaxy. At present, however, stars of Galaxy disk are discovered of the age equal to that of Globular clusters (Komarov et al. 1996).

So, there are at least four types of stars responsible for abundances of nuclides in the Galaxy (in all the Universe). Their contribution is suggested to change with the Galaxy age, and with that merely partial matter mixing can be expected due to SNI, SNII, N and AGB contribution, and therefore stars of the given metallicity can have various abundances of other elements, in particular, elements of α-process. This problem is discussed in the most perfect and detailed by B.Edvardson et al. (1993).

The information about atmospheres of giant stars are a key to the solution of many problems on the evolution of stars and stellar systems, formation of nuclidies with mass more the mass H, enrichment of star atmospheres of heavy and light elements and isotopes. However, here we come across a paradox - the presence of a tremendous number of atomic and molecular lines of absorption permits to determine abundance of many nuclidies and, unfortunately, at the same time these mainly hinder both the investigations of parameters of atmospheres of cool giant stars and the construction of mathematical model of atmospheres of stars.

In the Astronomical Observatory of Odessa State University the new data of temperature, gravity, microturbulent velocity, radius, mass and total luminosity of ≈2000 G-,K-,M giant stars are obtained (Korotina et al. 1989, Korotina et al. 1992, Komarov et al. 1996).

An attempt has been made by use of creating a catalogue of equivalent widths W_λ of lines of absorption in spectra of cool giant stars on the basis of our observation and of literature sources. It is used of spectral Data with high resolution. The catalogue examination has shown only a few number of stars whose spectra was obtained by different authors. In addition, for common stars have a little quantity of common absorption lines even for Fe peak elements. Therefore, at the first stage the data for investigation was reduced by unified procedure by using model atmospheres and common input physics: wavelength, strength of oscillator, energies of lower and higher levels. The determination of abundances in atmospheres of oxygen cool giant stars was calculate to use of model atmospheres (Bell 1978) and codes (Tsymbal 1995). The other our data about abundances of chemical elements can be founded Komarov et al. 1985a, Komarov et al. 1985b, Mishenina et al, Gopka et al. 1990a, Gopka & Komarov 1990b, Komarov & Basak 1992, Komarov et al. 1994 and so on. The nuclides of s-process can be synthesized only in the entrails of giant and supergiant stars with $M>1.5M_{\odot}$. It is shown, that atmospheres of giant stars of field of the Galaxy disk in spectral range G-K with solar metallicity have almost solar abundances of elements of s-process. The prevalence of metallic–poor giant–stars is characteristics of G8-K1 spectral types, as to giant–stars of K2-K5 spectral types it being vice versa (Korotina et al. 1989) and it have support of our new investigation. It is early to draw ultimate conclusion - excess Na in atmospheres of cool giant stars (Komarov et al. 1985b)- now can notice a constant Na excess tending to enhance from G8 to K4! It is noted that have correlation between abundances Na and luminosities of stars (and namely with gravities) - the larger stellar luminosity conform to greater Na-excess. This correlation may be is due to dependence of luminosity of stars upon its mass or its age. It should be noted that many elements show discrepancies in abundances determined from absorption lines of atoms and there ions. These discrepancies are various for different elements.

In Table 1a, 1b and 1c the abundances of atmospheres of next cool stars are given:

1) HD 2796	5340/2.5/-0.84/2.5
2) HD 4306	5390/3.0/-1.17/1.8
3) HD 6497	4610/2.0/-0.68/2.4
4) HD 35620	4250/1.6/-0.20/2.2
5) HD 37160	4700/2.4/-0.82/1.8
6) HD 43039	4720/2.6/-0.31/1.8
7) HD 49009	4480/2.1/-0.57/2.2
8) HD 68879	4450/2.2/-0.65/2.1
9) HD 95272	4780/2.4/0/2.3
10) HD 95689	4690/2.7/-0.25/1.9
11) NGC 2281 N18	4730/2.3/-0.63/2.2
12) NGC 752 N213	4760/2.6/-0.62/2.4
13) HD 107328	4350/2.1/-0.54/2.4
14) HD 129312	5060/2.6/-0.06/2.5
15) HD 135722	4760/2.6/-0.63/1.7
16) HD 148856	4970/2.8/-0.23/1.9
17) HD 188056	4690/1.9/0/2.2
18) HD 197989	4780/2.5/0/1.6

where are given $T_{\rm eff}$ /log g/[Fe/H], ξ_t -effective temperature, gravity, metallicity - abundance of elements of group Fe to respect of solar one and microturbulent velocity accordingly.

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Table 1a. The abundances in atmospheres of K-giant

El	1	2	3	4	5	6
LII	-	-	-	-	-	-
NaI	-	-	6.41		5.83	6.35
MgI	6.14	5.99	-	6.69	7.11	6.89
AlI	-	-	7.53	-	-	-
SiI	6.46	6.42	6.80	6.76	7.18	7.16
SiII	-	-	-	7.69	-	8.86
SI	-	-	-	-	7.49	-
CaI	4.33	4.07	6.38	6.29	5.87	5.89
ScI	-	-	3.05	3.34	2.34	2.73
ScII	1.16	1.17	-	2.54	2.45	2.86
TiI	3.37	3.06	4.65	4.98	4.48	4.70
TiII	3.45	3.13	4.64	5.24	4.57	4.54
VI	1.65	1.85	3.86	3.98	3.35	4.08
VII	2.56	1.99	-	-	5.51	-
CrI	3.13	2.96	5.45	6.04	4.95	5.19
CrII	4.19	3.95	5.07	5.82	4.86	5.28
MnI	2.98	2.45	5.30	5.87	4.80	5.47
FeI	5.29	5.00	-	8.76	6.80	-
FeII	5.80	5.14	6.93	7.50	6.81	6.99
CoI	2.96	3.18	7.10	8.07	4.31	7.59
NiI	4.94	4.66	4.51	5.15	5.41	4.52
CuI	-	-	5.73	6.14	4.33	5.82
ZnI	-	-	3.66	-	-	-
SrI	-	-	4.10	4.90	-	-
SrII	0.50	-0.30	1.43	1.36	-	-
YI	-	-	-	-	2.71	-
YII	0.56	0.84	1.41	-	1.14	-
ZrI	-	-	-	2.66	1.57	2.09
ZrII	-	-	-	-	-	-
MoI	-	-	-	-	1.55	-
BaII	-	-	1.40	-	1.28	1.57
LaII	0.30	-0.52	-	-	1.32	1.72
CeII	-	-	-	-	0.50	-
PrII	-	-	-	-	1.18	-
NdII	0.69	0.08	-	-	0.75	-
EuII	-	-	-	0.66	1.23	-

Table 1b. The abundances in atmospheres of K-giant

El	7	8	9	10	11	12
LiI	-	-	1.04	-	-	-
NaI	6.17	6.40	6.53	6.36	6.34	6.22
MgI	7.43	6.28	7.50	7.19	6.31	7.25
AlI	-	-	6.47	-	-	-
SiI	7.60	7.27	7.57	7.65	7.08	7.27
SiII	7.80	8.03	7.75	8.42	8.54	8.58
SI	8.08	8.47	-	-	-	-
CaI	6.19	5.76	6.39	6.22	5.98	5.92
ScI	2.68	2.43	3.18	2.86	2.94	2.32
ScII	3.13	2.74	2.99	3.16	2.56	2.33
TiI	4.82	4.57	5.07	4.85	4.71	4.33
TiII	4.98	3.81	4.89	5.00	4.06	4.38
VI	3.77	3.67	4.10	3.81	3.85	3.56
VII	5.93	-	5.85	6.39	-	-
CrI	5.33	4.95	5.55	5.45	5.08	4.90
CrII	5.61	5.33	5.49	5.78	4.83	5.36
MnI	5.52	5.48	5.82	5.63	5.48	5.30
FeI	7.34	6.91	-	-	-	-
FeII	7.62	7.26	7.46	7.39	6.91	7.01
CoI	4.81	4.49	7.38	7.66	7.44	7.43
NiI	6.03	5.52	4.89	4.80	4.52	4.25
CuI	5.11	3.22	6.06	6.02	5.81	5.77
ZnI	5.12	-	-	4.90	-	-
SrI	-	-	5.10	5.18	-	-
SrII	-	-	3.76	3.88	-	-
YI	2.78	-	3.17	3.08	-	-
YII	1.97	-	2.10	2.17	-	-
ZrI	-	2.03	2.32	2.16	1.84	1.84
ZrII	-	-	2.24	2.14	-	-
MoI	1.91	-	-	-	-	-
BaII	2.15	1.63	1.92	2.20	1.05	0.97
LaII	0.58	1.94	0.85	1.08	1.47	2.03
CeII	1.53	-	1.60	1.73	-	-
PrII	1.87	-	1.82	2.17	-	-
NdII	1.48	-	1.59	2.18	-	-
EuII	-	-	0.32	-	-	-

Table 1c. The abundances in atmospheres of K-giants

El	13	14	15	16	17	18
LiI	1.04	-	-	-	0.79	-
NaI	6.62	5.85	5.95	6.46	7.32	6.37
MgI	7.37	7.10	6.95	-	7.46	7.43
AlI	6.48	-	-	-	7.36	6.33
SiI	7.62	7.47	7.24	7.53	7.94	7.67
SiII	8.06	8.12	7.57	-	8.94	-
SI	7.26	-	7.66	-	-	-
CaI	6.53	5.87	5.98	6.02	6.86	6.22
ScI	3.13	2.44	2.33	2.61	4.28	2.85
ScII	3.24	2.67	2.73	3.03	3.06	3.07
TiI	5.12	4.60	4.44	4.68	5.69	5.02
TiII	5.17	4.79	4.88	4.95	4.66	-
VI	4.06	3.60	3.41	3.69	4.89	3.89
VII	6.06	5.89	5.93	-	5.76	4.14
CrI	5.68	4.97	4.95	5.39	5.94	5.51
CrII	5.83	5.44	5.42	5.74	5.83	5.76
MnI	5.80	5.11	5.10	5.68	6.69	5.74
MnII	7.61	-	6.98	7.43	-	-
FeI	7.70	7.03	7.24	7.76	7.69	7.47
FeII	4.98	7.30	4.42	4.68	7.27	7.58
CoI	6.14	4.69	5.68	6.05	5.50	4.90
NiI	5.08	5.71	4.49	-	6.35	6.14
CuI	5.39	4.52	4.62	-	-	-
ZnI	4.24	-	-	-	6.39	-
SrI	-	-	-	-	4.27	3.28
YI	3.53	2.23	2.71	3.35	3.76	3.00
YII	2.21	1.66	1.57	2.15	2.42	2.36
ZrI	2.43	1.38	1.61	3.01	3.74	2.08
MoI	-	1.53	-	2.74	2.84	2.14
BaI	2.61	-	1.62	2.03	-	2.78
BaII	2.29	2.63	1.73	-	1.57	2.25
LaII	1.36	0.08	0.15	2.41	2.45	2.37
CeII	1.23	0.99	1.31	1.64	1.53	1.77
PrII	1.99	1.40	1.44	1.29	2.29	-
NdII	1.96	0.89	1.21	2.15	2.00	1.56
EuII	-	-	-	-	-	1.37