About trend in zinc stellar abundances with metallisity

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ABSTRACT. We have carried out investigation of zinc abundance behavior in wide range of stellar metallicities from 0 to -5. It has been determined zinc abundance using our Zn atom model and NonLTE calculation method. It has been shown that difference between LTE and NonLTE Zn abundances may reached up to $1.27 dex$.We have obtained the dependence of $[Zn/H]$ from $[Fe/H]$. The first value is greater as metallicity lower.

Key words: abundances - stars: fundamental parameters - stars.

1. Introduction

The well known metallicity index [Fe/H] is close connected with stellar age. The study of relationships of stellar chemical elements abundances with $[Fe/H]$ is the actual astrophysical task. Sneden et al. (1991) and Mishenina et al. (2002) conducted the determinations of zinc abundance for the wide range of stars (mainly for AGB type stars). Particularly, they investigated the correlation between $[Zn/H]$ and $[Fe/H]$ values. But this correlation were not been found in range of metallicities from 0 to -3. The Zn abundance determinations by previous authors was been carried out in LTE assumption for the stellar atmospheres.

This assumption may lead to great errors in the abundance estimations. Our study has been carried out without LTE assumption. For this purpose we have used MULTI code (Carlsson, 1998) and stellar atmosphere models of Kurucz (1993).

2. Zn atom model and test calculations.

Our Zn atom model consists of 12 Zn I levels and one Zn II level. We have used 18 radiative transitions in detail.

The test calculations has been carried out using our Zn atom model and solar atmosphere model of Kurucz (1993). The zinc abundance equals to $\log(\epsilon_{\odot}) = 4.60$ has been taken from Anders and Grevesse (1989). We have used constant micro-turbulence velocity value equals to 1 km/s. The fig.1 shows observed (dot) and calculated profiles of $\lambda 4722$ ZnI lines. As it follows from this figure the good agreement has been reached between observed and calculated profiles.

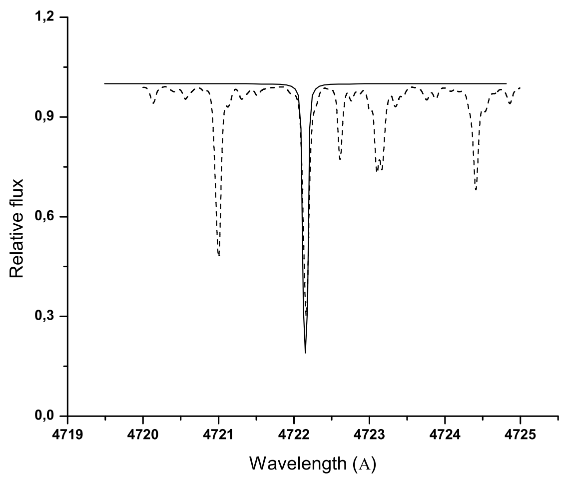

Figure 1: Calculated and observed (dot) profiles of $\lambda 4722 ZnI$ line.

We also calculated equivalent widths of $\lambda\lambda 4722, 4810 ZnI$ lines for the solar disc center and for the whole disc. These values with observed ones (Moore et al. 1966) are given in table 1. Good agreement between calculated and observed values has been achieved again. This is means, that our atom model as well as Kurucz's atmosphere models are useful for the stellar zinc abundance determinations.

Table 1: The calculated and observed equivalent widths of $\lambda\lambda 4722, 4810 ZnI$ lines for the solar disc center and for the whole disc.

$\lambda(\mathring{A})$	W(center)	W (disc)	W(center)Moore et al.
4722.151	75.390	75.143	63
4810.527	86.102	85.504	84

3. Dependence of stellar $[Zn/H]$ values from metallicity

As it has been mentioned above, Sneden at al. (1991) and Mishenina et al. (2002) carried out study of [Zn/H] dependence from $[Fe/H]$ for the wide range of stellar metallicities. They not obtained this dependence. We have restudied this problem using NonLTE Zn abundance determination and stellar list from these works. The $\lambda\lambda 4722, 4810 ZnI$ lines equivalent widths, stellar effective temperatures, gravities and metallicities have been adopted according previously mentioned articles.

We have also included two extremely metal poor stars HR4045 and CS 22949-037. The Zn observed equivalent widths and stellar parameters for these stars have been taken from Takeda et al. (2002) and Depagne et al. (2002), respectively.

We have plotted Zn abundance differences versus stellar effective temperatures. The NonLTE effects in these abundances grow linearly with temperature rising. We have also investigated dependence of the NonLTE Zn abundance discrepancies from stellar gravity. These discrepancies have complicated character and we not discuss these ones now.

Fig.2 shows dependence of $[Zn/H]$ from $[Fe/H]$. According for our calculations the $[Zn/H]$ values grow linearly with metallicity decreasing. The slope of approximation line has value -0.084. This result contradicts for that one obtained by Sneden et al. (1991) and Mishenina et al. (2002). We remind, that according them the $[Zn/H]$ values are not changed in wide range of stellar metallicities. For the checking our conclusion we added two stars not from list of Snaden et al. (1991)and Mishenina et al. (2002). There are HR4045 (Takeda et al. (2002)) and CS 22949-037 (Depagne et al. (2002) with extremely low metallicities -4.7 and - 3.9 respectively. As it is shown from fig.3 the investigated dependence has now exponential character. This dependence may be described by function $[Zn/H] = 0.064 + 0.0031 \exp(\frac{-[Fe/H]}{0.66})$.

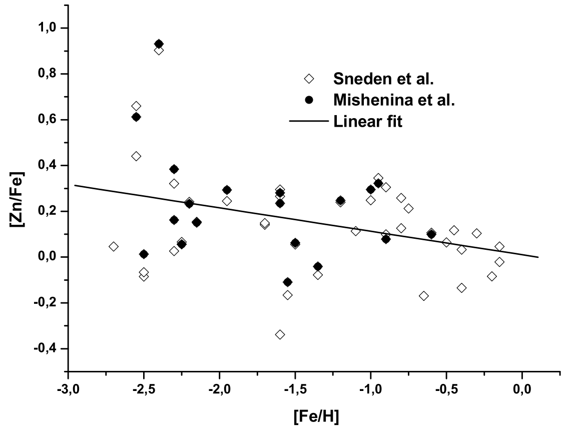

Figure 2: The dependence of $[Zn/H]$ from $[Fe/H]$ for the Sneden's et al. and Mishenina et al. stellar lists.

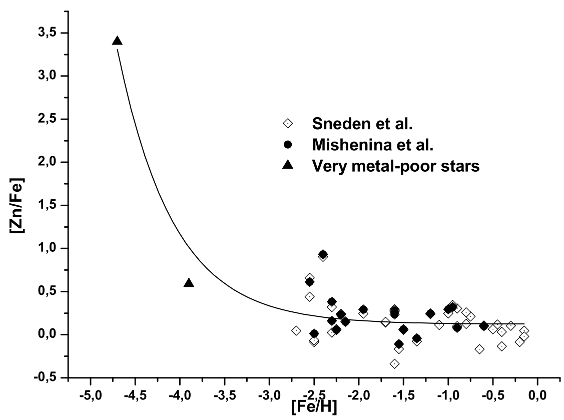

Figure 3: The dependence of $[Zn/H]$ from $[Fe/H]$ with two added metal-poor stars.

4. Conclusions

We have carried out investigation of zinc abundance behavior for wide range of stellar metallicities.

It has been determined zinc abundance using our Zn atom model and NonLTE calculation method (MULTI code (Carlsson 1998)). The list of investigated stars has been chosen from Sneden et al. (1991) and Mishenina et al. (2002). We have also included two extremely metal pure stars to used stellar list. It has been shown that difference between LTE and NonLTE Zn abundances may reached up to 1.27 dex (HR4045). NonLTE deviations grow by rising of stellar effective temperatures.

We have obtained the dependence of [Zn/H] from [Fe/H]. The first value is greater as metallicity lower. This result contradicts to that one was obtained by Sneden et al. (1991) and Mishenina et al. (2002).

If our conclusion is true, this is means that zinc abundance values was higher in earlier stages of stellar evolution than this ones in younger stars.

Because the [Zn/H] trend from metallicity is unlinear, we must include to further investigations wide set of stars with extremely low metallicities near -4, -5.

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