NON-LTE EFFECTS IN AL I LINES: CHOICE OF ATOMIC DATA

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ABSTRACT. The analyses of deviations from the LTE in the atmospheres of *F*-*K* stars show that their magnitude largely depend on the ground levels photoionization cross-section of the studied elements. In particular, the *AlI* atoms with significant threshold sections are intensely ionized by the UV flux and transit to the "overionization" state with underpopulation of the ground level. Therefore, for the *AlI* atoms we should observe large deviations from the LTE (Baumuller D. and Gehren T., 1996; Menzhevitski V.S., Shimansky V.V., Shimanskaya N.N., 2012). As the photoionization of *AlI* atoms occurs exclusively from the ground state 3p, the value of this cross-sections becomes main parameter for non-LTE calculating.

We performed special test calculations for 2 different sets of atomic data: with data from *TOPbase* database (Seaton M.J., Zeippen C.J., Tully J.A. et al., 1992), and with set of sections from (Hofsaess D., 1979) to estimate the effect of adopted values of photoionization cross-sections on the value of non-LTE deviations. A comparison of the result of calculations (Menzhevitski V.S., Shimansky V.V., Shimanskaya N.N., 2012) shows that the use both sets of atomic data do not change the conclusion on the nature of the non-LTE deviations: the values of ΔX_{NLTE} remain positive and increase with increasing atmospheric temperature and with decreasing of metallicity. However, the use of a set of sections from (Hofsaess D., 1979) leads to decrease of non-LTE corrections in comparison with atomic data from *TOPbase*.

It was shown (Menzhevitski V.S., Shimansky V.V., Shimanskaya N.N., 2012) the difference in the choice of used photoionization cross-sections is most pronounced for the stars with temperatures in the range of $T_{eff} = 5500 \div 7000$ K. Therefore, in order to select the correct set of ionization cross-sections from the low levels of the Al I atom, it seems desirable to determine simultaneously the aluminum abundance in the atmospheres of such stars from the resonance and subordinate lines. The best option is the study of stars with metallicity close to $[Fe/H] = -1.0$.

On May 22, 2013 we obtained the spectrum on the range $\lambda\lambda$ 3900-7000 Å for HD 201889 star with temperature $T_{eff} = 5740 \pm 10$ and the force of gravity $\log g = 4.11 \pm 0.05$. The observations were performed by echelle-spectrograph NES (resolution $R = 60000$, signal-to-noise ratio $S/N = 150$) of BTA SAO RAS telescope. The star metallicity ($[Fe/H] = -0.92 \pm 0.09$) and value of microturbulence velocity ($\xi_{turb} = 1.2$ km/s) were redeterminated using the standard analysis of the equivalent *FeII* line widths, implemented based on the *WIDTH* code, similar to the our work (Menzhevitski V.S., Shimanskaya N.N., Shimansky V.V. et al., 2013).

The comparison the theoretical and observed profiles for resonance doublet $\lambda\lambda$ 3944.01, 3961.52 Å and for subordinate doublet $\lambda\lambda$ 6693.03, 6698.68 Å was made for both sets of photoionization cross-sections. We show that the agreement of the theoretical and observed profiles both for resonance and subordinate doublets was achieved only with atomic data from (Hofsaess D., 1979) and with the common aluminum abundance for a both group of lines: $[Al/Fe] = 0.33$. This result demonstrates the need for to use atomic data with low values of photoionization cross-sections for a determination of non-LTE aluminium abundances. This is especially important in the study of halo stars (e.g. for the stars with low metallicity), where the aluminium abundance is determined by the resonance lines with the largest deviations from LTE.

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Key words: stars: abundances: aluminium; line: profiles; atomic data: photoionization cross-sections.

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