INTERPRETATIONS OF STELLAR SPECTRA: NLTE EFFECTS

YAKIV V. PAVLENKO
The Principal Astronomical Observatory of the National Academy of Sciences, Golosiiv, Kyiv 252650 Ukraine

1. Procedure

To solve the system of statistical balance equations and radiative transfer equations (NLTE problem) we followed the modification of linearization method proposed by Auer and Heasley(1976) and used 20-level model of the lithium atom. The 70 radiative and all possible collisional transitions were included into the rate matrix (Pavlenko 1994).

2. Results

2.1 T Tau stars.

During a few years we studied NLTE formation of the lithium lines in the atmospheres of Pre-Main Sequence stars. Spectra of these stars have prominent Li Lines. Often these lines are saturated.

The main result was presented in the paper of Magazzù et al. (1992). We have found different impact of NLTE on profiles of weak and strong lines. In the case of weak resonance lines the overionization of lithium dominates, and as a result, the NLTE profiles are weaker than LTE ones. In the case of saturated lines we have found NLTE cores are stronger in comparison with LTE, because in the region of their formation the source function of 670.8 nm lines S_l exceeds the Plank function B_ν (Magazzù et al. 1992). *So, the abundance correction due to NLTE effects changes its sign when the Li I resonance lines become saturated.* As a result, NLTE abundances of lithium obtained from the modelling of stronger Li I lines in the spectra of K-M dwarfs are *systematically shifted* toward lower values (Martín et al. 1994). This result was confirmed by Carlsson et al.(1994).

In the papers of Magazzù et al.(1992) and Martín et al.(1994) we have found the NLTE abundances of lithium in the atmospheres of the majority of the unevolved stars $logN(Li)_{nlte} = 3.1 - 3.3$.

I. Appenzeller (ed.), Highlights of Astronomy, Vol. 10, 453–454.

2.2 Lithium plateau

Rebolo et al. (1988) suggested the existence of a slope in the "lithium plateau" ($logN(Li) \simeq 2.1$) of halo dwarfs (Spite & Spite 1982). Recent results of Thorburn (1994) give this slope $S_p = \Delta logN(Li)/\Delta T_{eff} = 0.017(100K)^{-1}$. Two attempts were made to explain this slope by NLTE effects. Carlsson et al. (1994) have obtained $S_p \sim 0.01(100K)^{-1}$. At the same time we have got $S_p \sim 0.004 - 0.006(100K)^{-1}$ (see Table 1). *For the moment we cannot explain this slope by impact of NLTE only.*

TABLE 1. NLTE lithium abundance corrections as a function of metallicity

Model atmosph.	μ	$logN(Li)_{lte}$	$W_\lambda(670.8)$	$logN(Li)_{nlte}$	$\Delta_{nlte-lte}$
5270/4.44	0	2.1	9.94	2.138	0.038
	-1	2.1	9.52	2.163	0.063
	-2	2.1	8.88	2.189	0.089
	-3	2.1	7.76	2.17	0.070
6270/4.44	0	2.1	2.04	2.11	0.01
	-3	2.1	1.976	2.13	0.03

Acknowledgments

I am grateful to F. Spite for comments which helped to clarify and improve my talk, and Drs. R. Rebolo, E.L. Martin, R.J. García López all contributed generously to problems, thoughts, ideas which prompted my investigations.

References

Auer, L.H., Heasley, I.N. (1976) An alternative formulation of non-LTE transfer problem. *Astrophys. J.*, **v. 205**, pp. 165-171.

Carlsson, M., Rutten, R.J., Bruls, R.H.M.J., Shchukina, N.G. (1994) The non-LTE formation of Li I lines in cool stars, *Prepr. of Inst.of Theoret. Astrophys., Oslo*, **no.17**, pp. 01–24.

Magazzù, A., Rebolo, R., Pavlenko, Ya.V., (1992) Lithium abundances in classical and weak T Tauri stars *Astrophys.J.*, **v.392**,pp. 159-171.

Martín, E.L., Rebolo, R., Magazzù, A., Pavlenko, Ya.V.(1994) Pre-main sequence lithium burning. I. Weak T Tauri stars *Asrton. & Astrophys.*, **v.282**,pp. 503-517.

Pavlenko, Ya. V. Statistical equilibrium of the lithium in different metallicity dwarfs atmospheres with $T_{eff} = 5770K, log\ g = 4.44$. (1994)*Astrophys. Lett., in press*

Rebolo, R. Molaro, P., Beckman, J.E. (1988) Lithium abundances in metal-deficient dwarfs *Astron. & Astrophys.*,**v. 192**, pp. 192-205.

Spite F., Spite, M. (1982) Abundance of lithium in unevolved halo stars and Old disk stars: Interpretations and consequences. *Astron. & Astrophys.*, **v.115**, pp. 357-366.

Thorburn, J.A. (1994) The Primordial Lithium Abundance from Extreme Subdwarfs: New Observations. *Astrophys. J.*, **v.421**,pp. 318-335.