Departure from LTE in Stellar Atmospheres. Li I Lines in Spectra of K-M-C Giants

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1. Procedure

The NLTE computations were carried out for a 20-level lithium atom. Opacities due to absorption of atomic and molecular lines were taken into account (see Pavlenko et al. 1995 for details). Model atmospheres of red giants were computed by SAM71 program (Pavlenko & Yakovina 1994).

2. Results

K-giants.

Results of computations for the lithium-rich K-giant HD112127 (4420/2.3/ +0.31 = T_{eff}/log g/[\mu]) are shown in the Fig.1a as an example of the impact of NLTE on the lithium lines. Brown et al. (1989) have got log N_{Lte}(Li) = 2.7 dex. NLTE effects shift lithium abundance toward lower values: log N_{Nlte}(Li) = 2.3 dex (Fig.1a). Note that the NLTE abundance corrections for the subordinate Li lines are always positive (see also Pavlenko 1992).

M-C giants

The nature of NLTE effects in the lithium lines formed in the atmospheres of C-M stars are similar. The most important difference is caused by different opacity sources in the frequencies of bb and bf transitions of lithium. In the case of M-stars the Li resonance doublet lines are formed at the background of TiO saturated bands, but in the case of C-stars the C containing molecules absorption dominates in the UV and visible regions. A few results for M-giants are given below.

Dependence of NLTE on metallicity. NLTE effects for Li I lines are more pronounced in metal deficient atmospheres (Fig.1b). Overionization processes of lithium are more effective in this case.

Dependence on log g. The dependence of NLTE effects in the atmospheres of M-giants on the log g parameter is rather weak. Still for unsaturated Li lines we note that the NLTE curves of growth (COG's) show less pronounced dependence on log g in comparison with LTE. The same effect was found for stars with higher log g (Pavlenko & Magazzu 1995).

Dependence on T_{eff}. More interesting results we found in the comparison of COG's computed for giants of different T_{eff}. The differences of LTE and NLTE COG's increase with decreasing T_{eff} from 3750 to 3200 K (Fig.1b). This is not an evident effect because the ratios S_l/B_v do not differ as much for weak lines as they do for strong ones.
Figure 1.  
a) LTE (solid lines) & NLTE COG's (dashed lines) of Li I resonance and subordinate lines formed in the atmosphere of K-giant HD 112127.  
b) LTE(solid lines) and NLTE(dashed lines) COG's of resonance Li I lines computed for M-giant atmospheres: (triangles - 3200/1.5/0, circles - 3725/1.5/-2, boxes - 3725/1.5/0.0)

Acknowledgments.  I thank SOC and LOC of CS9 for financial support for my participation in CS9 and Drs. A.Magazzu and R.Garcia Lopez for their help in preparing this poster.

References

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