Lithium in Brown Dwarf Atmospheres: EOS, NLTE, Spectra

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1. Lithium lines in brown dwarf spectra

Low luminosity M-dwarfs at the bottom of the Main Sequence are the best brown dwarf candidates. Rebolo et al. (1992) and Magazzù et al. (1993) put forward the idea of a lithium test for searching for these substellar objects. Recently Basri et al. (1995) and Rebolo et al. (1995) reported the discovery of the first brown dwarfs. Spectroscopic studies of M-dwarfs are still hampered by many problems to be solved.

In the case of $T_{\text{eff}} < 3500 K$ atmospheres we get extremely strong saturated spectra. Only strong Li I resonance lines may be detected.

The region of formation of strong molecular and atomic lines shifts toward the outer boundary of stellar atmosphere which may contain chromospheric-like features (CLF). To study the impact of those features on the Li I lines formed in the spectra of latest M-dwarfs, we constructed a set of few model atmospheres with temperature inversion in the outer part of a 2500/5.0 model atmosphere from Allard's (1991) grid. We followed the scheme proposed in Pavlenko et al. (1995). Several CLF models with temperature minimum at 1750 K ($T_t = T_{\text{eff}}/T_{\text{min}} = 0.7$; for the Sun $T_t = 0.76$) and $G_r = dT/d\log m = 200, 400, 800, 1200$ (for the Sun $G_r = 800$) were built over the photosphere of a 2500/5.0 star. These CLF do not change the flux of radiative energy in the infrared, but the fluxes in the visible spectral region may be severely affected. For our grid of model atmospheres with CLF we computed the NLTE effects for a 20-level lithium atom.

The results of the solution of the NLTE problem for the Li I atom in classical 2500/5.0 model atmospheres have been discussed in Pavlenko et al. (1995). We found that the NLTE of Li may impact on the equation of state of the outermost layers of the coolest atmospheres. Lithium cannot be considered here as contaminating metal. Li and Na become important (NLTE) contributors of electrons in the atmospheres of stars with $T_{\text{eff}} < 2500K$.

The ratios $S_i/B_i$ for lithium lines formed in 2500/5.0 with CLF ($G_r = 800$) computed for $\log N(Li) = 1.0$ and 3.0 are shown in the Fig.1a. The profiles of the saturated Li resonance doublet computed for several Li I abundances are shown in fig.1b. Even the strongest Li I NLTE resonance lines do not show emission cores.
2. Conclusions

The dependence of profiles of strong Li lines on the structure of the outer part of the coolest atmospheres is rather weak. The results obtained in this work correspond to the simplest model of CLF. Our knowledge about the structure of the outermost layers is far from completeness. At the time being we may only suggest the existence of CLF and make first order estimations.

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References

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