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Statistical equilibrium of silicon in the atmospheres of cool stars

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Abstract. The statistical equilibrium of neutral and ionized silicon in the atmospheres of cool stars is discussed. Non-local thermodynamic equilibrium effects (NLTE) are investigated. It is found that the NLTE effects for Si are important, in particular for warm metal-poor stars. For warm metal-poor stars, the NLTE abundance correction reaches ∼0.2 dex relative to standard LTE calculations.

Keywords. abundances, late-type, line formation, Galaxy.

Silicon is not only an important reference element for comparison of various types of cosmic matter with the Sun, but also one of the main electron contributors and opacity sources in the near UV in the atmospheres of cool stars. Our silicon model atom includes the most important levels of Si I and Si II and comprises 132 terms of Si I, 41 terms of Si II, plus the Si III ground state. The full analysis of the solar spectrum allows a reasonable choice of the hydrogen collision enhancement factor resulting in $S_H = 0.1$ for Si (Shi *et al.* 2008).

Our results show that the weak optical lines have the smallest NLTE abundance effects (<0.02 dex), thus they are the best abundance indicators for LTE analysis of moderately metal-poor stars. For the two strong lines at 3905 and 4102 Å, which is very important for extremely metal-poor stars, the NLTE correction is >0.15 dex for extremely metal-poor warm stars. Therefore, these two lines should no longer be analyzed with LTE (Shi *et al.* 2009). The NLTE abundance corrections for two Si II lines are negative, and they are large for high temperature stars, and even larger than 0.2 dex for warm stars (Shi *et al.* 2011). And the strong Si I infrared lines clearly show the NLTE effects, the abundance differences between the LTE and NLTE analysis for strong SI I infrared lines may increase with decreasing surface gravity (Shi *et al.* 2012).

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