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Non-LTE analyses of strontium abundances in stars: A stars

Belyakova E., Mashonkina L., Sakhibullin N.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

The formation of SrII lines in the atmospheres of stars of various types in the absence of local thermodynamic equilibrium (LTE) is analyzed. Departures from LTE are insignificant for normal-metallicity stars with T eff ≤ 7000 K. In A stars, SrII exhibits "overionization," which decreases substantially the estimated equivalent widths of SrII lines and increases the inferred Sr abundances compared to LTE estimates. The corrections to the LTE abundances increase with temperature, reaching 0.8 and 1.4 dex for resonance lines for mainsequence stars with T eff ≈ 10000 K and supergiants with T eff ≈ 9000 K, respectively. The corrections for the λ4161 Å subordinate line do not exceed 0.3 for main-sequence stars and 0.9 dex for supergiants. The lines of the λλ10036, 10327, and 10914 Å infrared triplet are sensitive to non-LTE effects throughout the entire range of stellar parameters, with the non-LTE corrections ranging from -0.7 to +0.7 dex. The departures from LTE in SrII lines increase with metallicity. Non-LTE strontium abundances are determined for 17 F0-A0 halo and disk stars. The sample consists of four "normal" A stars, five Am stars, and eight horizontal-branch (HB) stars. The [Sr/Fe] abundance ratios for the normal A stars are confined in the narrow interval from 0.3 to 0.45 dex, in contrast to the LTE [Sr/Fe] ratios, which range from -0.4 to +0.4 dex. The horizontal-branch stars also exhibit an overabundance of strontium relative to iron. The mean value of [Sr/Fe] for Galactic-field HB stars, [Sr/Fe] ≈ 0.4 dex, coincides with the strontium overabundance in normal A stars, whereas an LTE analysis yields a substantial scatter in the [Sr/Fe] values, which range from -0.8 to +0.3 dex. HB stars in the globular cluster M4 have [Sr/Fe] ≈ 1.0 dex, which is close to the strontium overabundance in Am stars. Taking into account departures from LTE made it possible to remove the effective-temperature dependence of [Sr/Fe] for HB and normal A stars. Allowance for non-LTE effects in Am stars increases the strontium abundances of these stars even more, resulting in an average [Sr/Fe] ratio of ≈ 1.2 dex and a stronger correlation between [Sr/Fe] and the effective temperature. The dependence of elemental abundances on the atomic number Z taking into account non-LTE effects in SrII and BaII lines is analyzed. Overabundances of elements with Z > 26 are characteristic of A stars.