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Non-LTE effects in Mg I lines for various types of stars

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Abstract

We have performed a detailed statistical-equilibrium analysis based on a 49-level model of the magnesium atom for the atmospheres of stars of various spectral types: Teff = 4500-12000 K, logg = 0.0 - 4.5, and [M/H] = 0 to -3. In the atmospheres of stars with Teff > 5500 K, deviations from LTE for Mg I are due to photoionization by ultraviolet radiation from the 3p level; i.e., neutral magnesium is in a state of "superionization." When Teff < 5500 K, the populations of the Mg I levels differ from their LTE values due to radiative processes in bound - bound transitions. We analyzed Mg I lines in the solar spectrum in order to empirically refine certain atomic parameters (the van der Waals broadening constant C6 and cross sections for photoionization and collisional interactions with hydrogen atoms) and the magnesium abundance in the solar atmosphere. We studied non-LTE effects for five Mg I lines for a wide range of stellar parameters. In the case of dwarfs and subdwarfs, the magnitude of non-LTE corrections to magnesium abundances does not exceed 0.1 dex for the λλ 4571, 4703, 5528, and 5711 Å lines but can be as large as ±0.2 dex for the λλ 3829-3838, 5172, and 5183 Å lines. The non-LTE corrections for giants and supergiants do not exceed 0.15 dex for the λλ 4571 and 5711 Å lines but can reach ±0.20 dex and even more for the λλ 4703, 5528, 3829-3838, 5172, and 5183 Å lines.