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Observational restrictions on sodium and aluminium abundance variations in evolution of the galaxy

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Abstract

In this paper we construct and analyze the uniform non-LTE distributions of the aluminium ([Al/Fe]-[Fe/H]) and sodium ([Na/Fe]-[Fe/H]) abundances in the sample of 160 stars of the disk and halo of our Galaxy with metallicities within -4.07 ≤ [Fe/H] ≤ 0.28. The values of metallicity [Fe/H] and microturbulence velocity ξ turb indices are determined from the equivalent widths of the Fe II and Fe I lines. We estimated the sodium and aluminium abundances using a 21-level model of the Na I atom and a 39-level model of the Al I atom. The resulting LTE distributions of [Na/Fe]-[Fe/H] and [Al/Fe]-[Fe/H] do not correspond to the theoretical predictions of their evolution, suggesting that a non-LTE approach has to be applied to determine the abundances of these elements. The account of non-LTE corrections reduces by 0.05-0.15 dex the abundances of sodium, determined from the subordinate lines in the stars of the disk with [Fe/H] ≥ -2.0, and by 0.05-0.70 dex (with a strong dependence on metallicity) the abundances of [Na/Fe], determined by the resonance lines in the stars of the halo with [Fe/H] ≤ -2.0. The non-LTE corrections of the aluminium abundances are strictly positive and increase from 0.0-0.1 dex for the stars of the thin disk (-0.7 ≤ [Fe/H] ≤ 0.28) to 0.03-0.3 dex for the stars of the thick disk (-1.5 ≤ [Fe/H] ≤ -0.7) and 0.06-1.2 dex for the stars of the halo ([Fe/H] ≤ -2.0). The resulting non-LTE abundances of [Na/Fe] reveal a scatter of individual values up to Δ[Na/Fe] = 0.4 dex for the stars of close metallicities. The observed non-LTE distribution of [Na/Fe]-[Fe/H] within 0.15 dex coincides with the theoretical distributions of Samland and Kobayashi et al. The non-LTE aluminium abundances are characterized by a weak scatter of values (up to Δ[Al/Fe] = 0.2 dex) for the stars of all metallicities. The constructed non-LTE distribution of [Al/Fe]-[Fe/H] is in a satisfactory agreement to 0.2 dex with the theoretical data of Kobayashi et al., but strongly differs (up to 0.4 dex) from the predictions of Samland.

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Keywords

abundances-Galaxy, evolution, stars