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Shift of the proton drip-line due to Λ-hyperons

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Studies of nuclei with proton or neutron excess remain highly relevant in modern nuclear physics. New information about the nature of baryon-baryon interactions can be extracted from properties of hypernuclei near the stability limits. ΛN-interaction is attractive, therefore, addition of a Λ-hyperon to non-strange nuclei can lead to an increase in the binding energy and formation of a bound hypernucleus with an unbound nucleon core.

We consider light proton-rich hypernuclei. The position of the proton drip-line is determined by the sign of the separation energy of one or two protons. For light nucleus, these values are well known today. In particular, for isotopes with $5 \leq Z \leq 12$, the nuclei with the largest neutron deficiency are ^{8}B, ^{9}C, ^{12}N, ^{13}O, ^{17}F, ^{17}Ne, ^{20}Na and ^{20}Mg. Nuclei with an even Z: ^{12}O, ^{16}Ne, ^{19}Mg decay by emission of two protons. For nuclei with odd Z: ^{7}B, ^{11}N, ^{16}F, ^{19}Na the line of existence of nuclei is determined by the separation energy of one proton. ^{8}C is unstable with respect to the emission of four protons. Since the addition of a Λ-hyperon gives an extra binding, the goal was to answer the question: are hypernuclei ^{8}B, ^{9}C, ^{12}N, ^{13}O, ^{17}F, ^{17}Ne, ^{20}Na and ^{20}Mg stable with respect to protons emission?

To this aim, we employ the Skyrme-Hartree-Fock approach in order to describe the structure of the isotopes under consideration. The condition for the existence of bound isotopes is the positive value of the separation energy of one or two protons. Proton separation energy in hypernuclei depends on proton separation energy in nuclei S_p and Λ separation energies B:

$S_p\,(^{A+1}Z) = S_p\,(^{A}Z) + B\,(^{A+1}Z) - B\,(^{A}(Z-1))$.

For two protons separation energy formula looks similar:

$S_{2p}\,(^{A+1}Z) = S_{2p}\,(^{A}Z) + B\,(^{A+1}Z) - B\,(^{A-1}(Z-2))$.

For estimates in the presence of experimental data, we use the values of the protons separation energies and Λ separation energies of hypernuclei from the experiment. The rest of the quantities we calculate in the Skyrme-Hartree-Fock approximation.

Calculations with various combinations of NN- and ΛN-interactions have shown that the addition of a Λ-hyperon to the nucleus ^{8}C leads to the formation of a bound hypernuclei ^{9}C. Based on the results obtained, it can be suggested that hypernuclei ^{17}F it is also bound, and the hypernuclei ^{8}B, ^{12}N, ^{13}O, ^{17}Ne and ^{20}Mg are not. The boundness of ^{20}Na remains questionable.

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