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Experimental study of halo in isobar-analog states

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One of the most striking discoveries in nuclear physics made at the end of the last century was the discovery of the neutron halo in the ground states of some light nuclei located near the neutron stability boundary. The discovery of the halo led to a revision of many existing ideas in nuclear physics. The purpose of this research is to search and study halo in isobar - analog states of light nuclei. The study of states with a halo in isobar analogs allows one to investigate the manifestation of isotopic invariance at new objects and to relate the properties of the neutron and proton halo. The question of the existence of halo in isobar - analog states has so far not been practically raised in the experimental plan.
The proposed approach is based on measuring the radii of states in which the halo exists or can exist. Its first application made it possible to determine the proton halo in an unbound state of ^{13}N. Isobaric invariance leads to the fact that the states of two neighboring nuclei obtained by replacing a neutron with a proton are analogous, i.e. have in the first approximation the same structure. In the case of isobar analogs having a halo, the situation is more complicated, since such a change leads to a change in the thresholds that determine the very fact of the appearance of the halo. The data on the radii can give new information for solving the long-standing problem of a single description of the halo in both parts of the spectrum - discrete and continuous. It is proposed to solve problem: Experimentally determine the radii of a number of states in which there can be a halo in nuclei from ^{6}Li to ^{14}O, forming isobar - analog doublets and triplets.
We have discovered new possible candidates for a halo in the isobar-analog multiplets A = 12 and A = 14. Signs of a halo were found for the 2^{-} and 1^{-} states in the A = 12 multiplet members: 1.19 and 1.80 MeV in ^{12}B, 16.57 MeV and 17.23 MeV in ^{12}C and 1.67 and 2.62 MeV in ^{12}N. In the multiplet A = 14, the 1^{-} 8.06 MeV state in ^{14}N turned out to be a candidate for the halo. It should be noted that this is a rather nontrivial result. First, most of the states lie in the continuous spectrum. Secondly, the results were obtained within the framework of two independent methods: ANC (method of asymptotic normalization coefficients) and MDM method (Modified diffraction model). A great achievement was the development of the ANC method for studying resonance states, which made it possible to identify new cases of a proton halo in isobaric analog states. The research results correspond to the world level.

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