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Unique correlation of quadrupole deformation of nuclei with their half-lives

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The problem of halo nuclei [1] in a detailed analysis of sizes and deformations in isotopic series reveals not abrupt behavior in the topology of nuclei, but a sequential continuous change in the structural nuclear parameters as they move away from the axis of the “Line of stability”. This suggests the inevitable correlation of structural isotopic parameters with electromagnetic and purely nuclear [2].
In the this work, this phenomenon is traced by the example of isotopic series of Barium and Xenon, in which, as in the previous study [2], it was possible to find a correlation between the parameter β2 and half-life T1/2 for oblate nuclei with signβ2<0 and anti-correlation for elongated nuclei signβ2>0. Using the found analytical expressions for the function β2(T1/2) in these isotopic series, it is possible to semi-empirically approach the boundary of the bound states of nucleon systems both from the side of neutron-deficient nuclei and from the side of neutron-rich ones, which is an independent fundamental problem. These relations make it possible to calculate quadrupole deformation parameters β2 from the usually measured half-lives T1/2 with high accuracy (from 5 to 10%), and through them the average radii of exotic nuclei <R>. Of particular interest is the possibility of extending this pattern to the region of superheavy nuclei. This method is a new way of assessing the Z-region, in which, probably, the maximum of the “Island of stability”is located.
In addition, when considering isotopic changes in the radii of nuclei in the present work, it can be seen that if the law of growth of radii, based on the growth of their masses <R>=r0Aˆ(1/3) (or for isotopic series <R>=r0Nˆ(1/3) is well observed in the direction of neutron excess, then this law is broken in the direction of neutron deficiency due to Coulomb repulsion of protons. And, as the mass number A decreases, it does not lead to a decrease in their radii, but, on the contrary, to their growth. This effect apparently allows for the first time to ascertain the experimental detection of void nuclei.

1. Yu.E. Penionzhkevich, R. Kalpakchieva, Light nuclei at the neutron stability boundary. –Dubna: JINR, 2016. –383 p.
2. Yu.A. Zaripova, V.V. Dyachkov, Yu.M. Sereda, A.V. Yushkov, Dependence of deformation of exotic nuclei from the half-life // The LXIX International Conference “Nucleus-2019” on Nuclear Spectroscopy and Nuclear Structure “Fundamental Problems of Nuclear Physics, Nuclei at Borders of Nucleon Stability, High Technologies”, Dubna. –2019. –P.42.

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