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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].

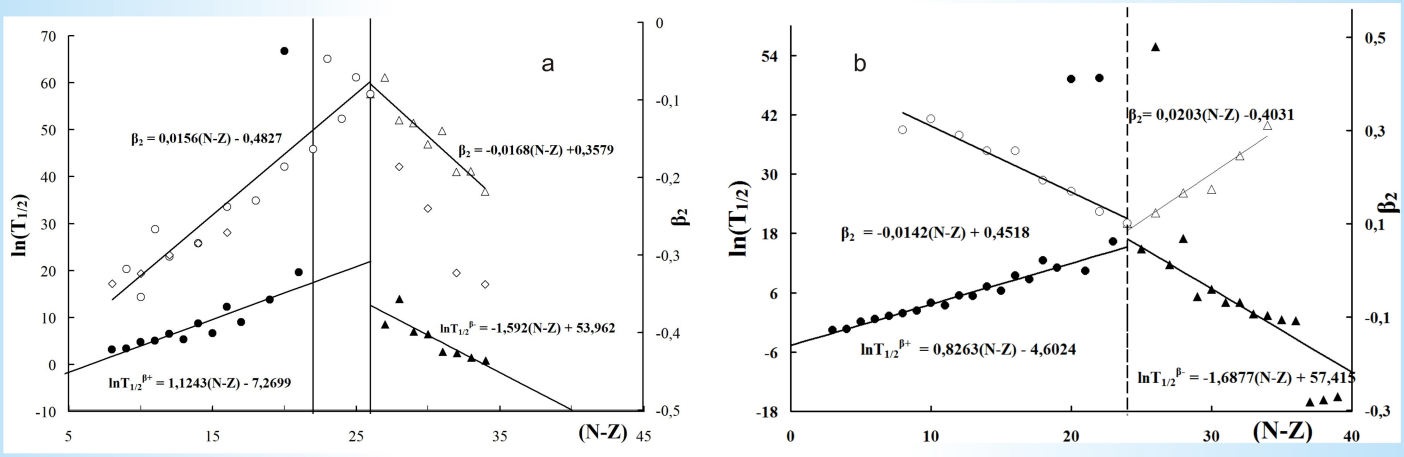


Fig. 1. The phenomenon of correlation between β2 and T1 / 2 for Ba nuclei (a) and anticorrelation between β2 and T1 / 2 for Ce nuclei (b).

In this work managed to find a correlationand and anti-correlation between the parameter β2 and half-life T1/2.

For example, for Ce

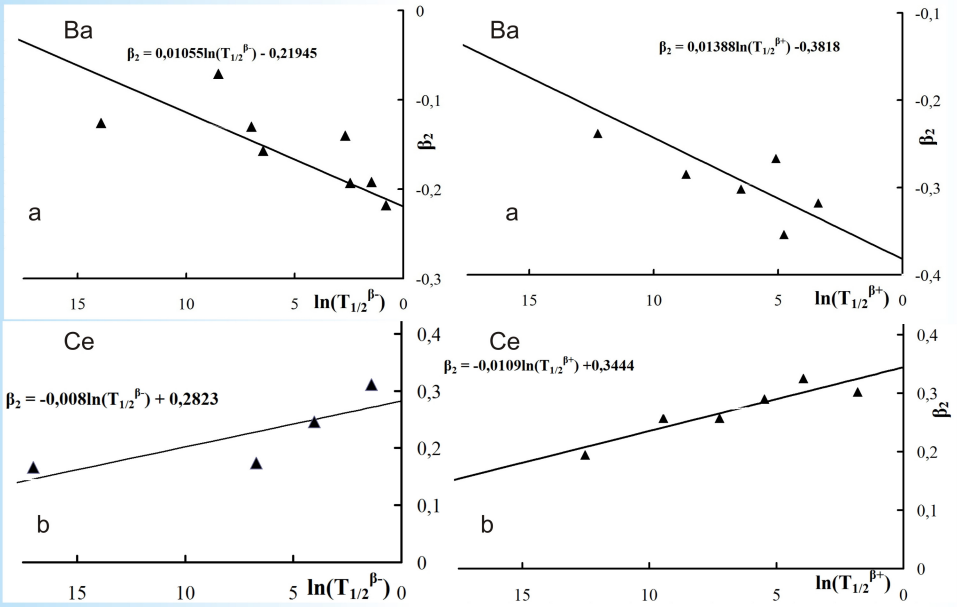
$$\beta_2\left(T_{\frac{1}{2}}^{\beta^+}\right) = -0{,}0109 \cdot \ln T_{\frac{1}{2}}{}^{\beta^+} + 0{,}3444,$$

$$\beta_2\left(T_{\frac{1}{2}}^{\beta^-}\right) = -0{,}008 \cdot \ln T_{\frac{1}{2}}{}^{\beta^-} + 0{,}2823$$

For Ba

$$\beta_2\left(T_{\frac{1}{2}}^{\beta^+}\right) = 0{,}01388 \cdot \ln T_{\frac{1}{2}}{}^{\beta^+} - 0{,}3818,$$

$$\beta_2\left(T_{\frac{1}{2}}^{\beta^-}\right) = 0{,}01055 \cdot \ln T_{\frac{1}{2}}{}^{\beta^-} - 0{,}21945$$



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.

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.