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SMOOTHNESS OF MASS SURFACE OF ODD ACTINIDE NUCLEI AND PAIRING ENERGIES

Thursday, 14 July 2022 18:15 (20 minutes)

As it was shown in [1,2], the mass surface M of odd deformed atomic nuclei with 150 < A < 190 in the vicinity of a given number of protons can be described with good accuracy by the sum of two terms:
μ–a Tailor series expansion up to the second order by degrees of deviation of the number of nucleons from the given values:
PN (PZ) – neutron (proton) pairing energy, depending on the state of odd nucleon.
For example, for odd neutron number (N^') nuclei:
M(N^',Z)=μ(N^',Z)+P_N (N^',Z),
hereafter the apostrophe denotes an odd number (N neutrons, Z protons).
A smooth part of the mass surface μ(N^',Z) can be defined from masses M(N^'+s^',Z+t) of a few adjacent even-even nuclei using the second-order decomposition:
μ(N^',Z)=M(N^'+s^',Z+t)- s^' d_1n-td_1p-⍰1/2 s⍰^'2 d_2n-⍰1/2 t⍰^2 d_2p-std_(1n,1p).
There is some uncertainty in the values of μ(N^',Z),d_1n,d_1p,d_2n,d_2p,d_(1n,1p) due to the different sets of reference even-even nuclei.
The first set (s-approximation) includes masses of even-even nuclei with the same Z and neutron numbers N^'±1,N^'±3 . In this case t=0 and
d_1n=[M(N^'+1,Z)-M(N^'-1,Z)]⁄2;
d_2n=[M(N^'+3,Z)+M(N^'-3,Z)-M(N^'+1,Z)-M(N^'-1,Z)]⁄2.
Then μ(N^',Z)= M(N^'+1,Z)-d_1n-d_2n⁄2.
The second set (st-approximation) uses reference even-even nuclei with charges Z±2,Z±4 and neutron numbers N^'±1,N^'±3 so that the mass number of these nuclei differs from the mass number of odd nucleus under consideration by 1 or 3, i. e. (N^'±1,Z∓2), (N^'±1,Z±2), (N^'±1,Z∓4), (N^'±3,Z∓2). This approximation leads to another formulae for d_1n and d_2n.
The calculations of these parameters for U and Th odd actinide nuclei have been conducted. The results show that values of d_1n and d_2n slightly differ for different sets of reference even-even nuclei, however the values of neutron pairing energies for both approximations are withing the empirical error limits.

1. D.G. Madland and J.R. Nix, Nucl. Phys. A 476, 1 (1988).
2. A.K. Vlasnikov, A.I. Zippa and V.M. Mikhajlov, Bull. Russ. Acad. Sci.: Phys. 80, 905 (2016); 81, 1185 (2017); 84, 919 (2020); 84, 1191 (2020); 84, 1309 (2020).
3. https://www-nds.iaea.org/amdc/

The speaker is a student or young scientist

No

Section

1. Nuclear structure: theory and experiment

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