Role of pair-vibrational correlations in forming the odd-even mass difference

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Abstract. In the random phase approximation (RPA)-amended Nilsson-Strutinsky method of calculating nuclear binding energies [1, 2], the conventional shell correction terms derived from the independent-nucleon model and the Bardeen-Cooper-Schrieffer pairing theory are supplemented by a term which accounts for the pair-vibrational correlation energy. This term is derived by means of the RPA from a pairing Hamiltonian which includes a neutron-proton pairing interaction. The method was used previously in studies of the pattern of binding energies of nuclei with approximately equal numbers $N$ and $Z$ of neutrons and protons and even mass number $A = N + Z$. Here it is applied to odd-$A$ nuclei. Three sets of such nuclei are considered: (i) The sequence of nuclei with $Z = N - 1$ and $25 \leq A \leq 99$. (ii) The odd-$A$ isotopes of In, Sn, and Sb with $46 \leq N \leq 92$. (iii) The odd-$A$ isotopes of Sr, Y, Zr, Nb, and Mo with $60 \leq N \leq 64$. The RPA correction is found to contribute significantly to the calculated odd-even mass differences, particularly in the light nuclei. In the upper $sd$ shell this correction accounts for almost the entire odd-even mass difference for odd $Z$ and about half of it for odd $N$. The size and sign of the RPA contribution varies, which is explained qualitatively in terms of a closed expression for a smooth RPA counter term.

This work is reported in ref. [3], to which we refer our readers.

References
[1] Bentley I, Neergård K and Frauendorf S 2014 Phys. Rev. C 89 034302
[2] Neergård K 2017 Nucl. Theor. 36 195
[3] Neergård K and Bentley I 2019 Phys. Rev. C 99 054315