SPURIOUS FINITE-SIZE INSTABILITIES IN NUCLEAR ENERGY DENSITY FUNCTIONALS : SPIN CHANNEL

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It has been recently shown that some Skyrme functionals can lead to non-converging results in the calculation of some properties of atomic nuclei. A previous study has pointed out a pos- sible link between these convergence problems and the appearance of finite-size instabilities in symmetric nuclear matter (SNM) around saturation density. We show that the finite-size insta- bilities not only affect the ground state properties of atomic nuclei, but they can also influence the calculations of vibrational excited states in finite nuclei. We perform systematic fully-self consistent Random Phase Approximation (RPA) calculations in spherical doubly-magic nuclei. We employ several Skyrme functionals and vary the isoscalar and isovector coupling constants of the time-odd term $\mathbf{s} \cdot \Delta\mathbf{s}$. We determine critical values of these coupling constants beyond which the RPA calculations do not converge because the RPA stability matrix becomes non- positive. By comparing the RPA calculations of atomic nuclei with those performed for SNM we establish a correspondence between the critical densities in the infinite system and the criti- cal coupling constants for which the RPA calculations do not converge. We find a quantitative stability criterion to detect finite-size instabilities related to the spin $\mathbf{s} \cdot \Delta\mathbf{s}$ term of a functional. This criterion could be easily implemented into the standard fitting protocols to fix the coupling constants of the Skyrme functional.