Contribution ID : **49** Type : **oral contribution**

The kink effect of the nuclear charge radius in mean-field relativistic models

Tuesday, 28 May 2024 12:50 (20)

The significant alteration in the trend of the nuclear charge radius within certain isotopic families, when plotted against the mass number A, is called the kink effect (KE). The most typical example of the KE is found in the charge radii of Pb isotopes. This kink is reasonably well reproduced by the nuclear relativistic mean-field [1-4] and relativistic Hartree-Fock approximations [5], while non-relativistic Skyrme-Hartree-Fock (SHF) functionals with standard parametrisations [6] or Gogny forces [7] fail to reproduce it. Thus, new non-relativistic density functionals have been proposed to improve the description of the nuclear charge radii [8-16], trying to understand the mechanism responsible for the KE. However, the entire theoretical understanding has yet to be reached.

This communication aims to give a detailed and complete explanation of the KE in the most common relativistic models in the mean-field approximation. To do this, we analyse the contribution of the valence neutrons to the proton central potential. We show that relativistic effects due to the small component of the Dirac spinors are essential in the kink formation and also to achieve a good description of the charge radii in the lead isotopic family. We explain, in particular, why relativistic models tend to be more kinky than non-relativistic ones [16].

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Session Classification : Session 6