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Evolution of shell structure in neutron rich Cu and Ni nuclei

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The evolution of shell structure with neutron and proton excess is a compelling interest in nuclear physics over the decade. The existence of the single-proton (single-neutron) shifts is well known experimentally in a series of isotopes (isotones) [1]. Although shell gaps, defined within a given theoretical framework as differences of effective single particle energies (ESPE), are not observables, they are useful quantities to assess the underlying structure of nuclei [2]. The nucleon-nucleon (NN) interaction is originally due to meson exchange processes as predicted by Yukawa, and its tensor-force part is one of the most distinct manifestations of this meson exchange origin [3]. The introduction of tensor force improved the systematic agreement between model predictions and experimental data in the shell evolution of exotic nuclei, and also the spin-orbit splitting [4]. A region of experimental interest nowadays is around the magic numbers Z=28 and N =50, where measurements of the decay properties in Co, Ni, Cu and Zn reveal the magic character of the nucleus 78Ni. The experimental results in Cu isotopes suggest that the crossing between the 2p3/2 and 1f5/2 proton levels take place in the nucleus 75Cu, which implies that the ground-state of 79Cu has spin-parity 5/2- [2]. It has been examined using different mean-field interactions such as Skyrme, Gogny and SEI-interactions that the tensor interaction may not always be necessary to reproduce the crossing between the 2p3/2 and 1f5/2 single-particle proton levels in neutron-rich Cu and Ni isotopes.

References

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Experimental nuclear physics

Theoretical nuclear physics

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