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Shell model understanding of nuclear isomerism

Content

Nuclear isomers, which are longer-lived excited states of atomic nuclei, arise due to structural peculiarities that hinder their decay processes. The advent of advanced measurement techniques that are revealing exotic isomeric properties has led to an ample amount of data on the isomeric states which is crucial given their fundamental as well as interdisciplinary applications in industry and science. One of such applications, called isomer depletion, can have implications for energy storage. The $21/2^+$ isomeric state in ^{93}Mo is famous for the potential nuclear excitation by electronic capture (NEEC). These NEEC probabilities suffer limitations due to the lack of knowledge of the involved nuclear electro-magnetic transition rates due to which a reliance on theory estimates becomes crucial. With this in mind, we study the $N = 51$ isotones from ^{93}Mo to ^{99}Cd and the corresponding structural evolution by using an empirically-derived shell model interaction [1]. The neutron-proton interaction between $g_{9/2}$ proton and $d_{5/2}$ neutron plays an important role governing the location of $21/2^+$ isomeric state with respect to the possible $E2$ decay branch $17/2^+$ state. A quantitative analysis is performed to depict the role of involved shell model matrix elements connecting $g_{9/2}$ proton and $d_{5/2}$ neutron. These results are further compared with the available interaction in large-scale shell model calculations. This type of analysis will also help the search for finding new candidates for the isomeric depletion in various mass regions of nuclear chart.

Because nuclear isomers are known to exist throughout the nuclear landscape, it is interesting to depict their global features and, if any, systematics. The $M4$, $13/2^+$ isomers in odd-mass $^{197-207}$Pb isotopes support nearly constant $B(M4)$ values, though the corresponding gamma-energies range from 200 keV to 1000 keV. We can understand this characteristic behavior using generalized seniority arguments [2]. These results are further supported by full-space large-scale shell-model calculations for the neutron space consisting of $0h_{9/2}$, $1f_{7/2}$, $1f_{5/2}$, $2p_{3/2}$, $2p_{1/2}$ and $0i_{13/2}$ orbitals. The shell model overall explains the experimental data but it becomes quite difficult to decipher the physics involved in such huge-dimensional Hamiltonian matrices. The generalized seniority helps to follow the simplifications by these $13/2^+$ isomers in these odd-mass lead isotopes. The calculated results are also verified analytically. Interestingly, such $M4$ isomers also exist in neighboring odd-mass Pt, Hg and Po isotopes and are therefore being explored to see if and to what extent the generalized seniority arguments hold in the $B(M4)$ values on going away from the semi-magic nuclei. Such results are not region-dependent, and so these arguments are also tested in Zr region. Key implications of these findings will be discussed.

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References

1. B. Maheshwari, P. Van Isacker, and P. Walker, to be published.
2. B. Maheshwari, Z. Podolyak and P. Van Isacker, to be published.

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