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Lifetimes and moments measurements to investigate the structure of mid–heavy nuclei

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Abstract

Mid–heavy nuclei present unique opportunities to study the collective and single–particle aspects of nuclear structure. This mass regime is a dynamic area where protons and neutrons generally occupy different orbitals, giving rise to complex structures with a wide variety of shapes, shape evolution and shape coexistence.

Measurements of nuclear lifetimes and electromagnetic moments (μ, Q) can both provide invaluable information on the nuclear structure of these isotopes. Wave functions, transition rates and shapes can be traced down, identified and determined in measurements of low-lying energy levels by using gamma–ray spectroscopy involving state–of–the–art instrumentation and contemporary experimental methods in close synergy with theory.

Recent experimental activities of our group in Athens in collaboration with several international partners, employing the Bucharest ROSPHERE array, have focused on mid–heavy nuclei to understand structural phenomena. For example, the neutron–rich $^{144-146}$Ba isotopes have been studied recently in terms of their experimental $B(E3)$ values [1, 2]. Although featuring large uncertainties, the results were found to be significantly larger than any theoretical calculation. Similar questions exist for the slightly lighter isotope ^{140}Ba, which is particularly interesting since it is located at the onset of octupole correlations. The lifetimes of the lower–lying states are completely unknown, with the sole exception of the first 2^+ state [3].

In addition, recent experimental studies in lower-mass molybdenum isotopes, but also heavier hafnium isotopes, provide stringent tests to theoretical models revealing new information on isomeric states and laying important questions that need to be answered in the immediate future. A few more research directions will be discussed in the same context, exhibiting the wide lack of nuclear data in this mass regime, as the community moves from the value of stability towards more and more exotic species in the Segré chart.

References

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