

Gamma de-excitation of ^{90m}Zr isomer

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The nuclear metastable energy levels or isomers arise as a result of a dramatic change in the structure between two nuclear states. This can be due to large differences in the angular momenta of these initial and final states and/or other degrees of freedom such as spin projection, single particle configuration or shape, as well as small energy differences between levels [1]. On the basis of hindrance mechanisms to their respective decays, the isomers can be classified into spin and seniority isomers in spherical regions. The traditional areas where such states are observed, and indeed where more are expected, are in medium-heavy to heavy nuclei close to closed shells, where the valence particles can occupy orbits with high spin. This occurs near the closed neutron and proton shells with $N=50$ and $Z=40$ ($A\sim 90$), $N=82$ and $Z=50$ ($A\sim 130$), $N=82$, $Z=64$ ($A\sim 150$), and $N=126$, $Z=82$ ($A\sim 210$). These conditions lead to the formation of multi-particle states with high-spin at relatively low energies. The $Z=40$ subshell closure is clearly demonstrated by the well-known level structure of the ^{90}Zr nucleus, for which the lowest-energy particle-hole $\{\pi 1p_{1/2}; \pi 1g_{9/2}^{-1}\}$ excitation produces the 0.8 sec 5^- isomeric state [2].

A powerful microscopic approach for describing the low-energy nuclear spectroscopy is the quasiparticle-phonon model (QPM) [3]. The model Hamiltonian is diagonalized in a space spanned by states composed of one, two, and three phonons which are generated in quasiparticle random phase approximation (QRPA). The QPM enables one to perform the calculations in very large configurational spaces. Up-to-date model is based on the Skyrme energy density functional (EDF) [4].

The analysis of the decay of the 0.8 sec 5^- isomeric state is performed by using the EDF f. in the p-h channel and the density-dependent pairing interaction [5]. The influence of the phonon-phonon coupling is studied. The calculated branching ratios generally align closely with the experimental ones.

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References

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