

Complex two-phonon structures in ^{93}Nb

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While collective rotations in axially symmetric deformed nuclei have been comprehensively described [1], the phenomenological description of vibrations in nuclei remains less clear. The phonon model encounters discrepancies when considering the observed anharmonic effects that break the degeneracy of the phonon multiplets in nearly spherical nuclei. Frequently, transition rates predicted by the phonon model are significantly violated. Anharmonic corrections to the harmonic approximation are diverse and approached in terms of residual interactions, including the Pauli principle in the realistic fermionic nuclear system [2,3,4], the inclusion of two- and three-body interactions, like admixtures of different multiphonon modes due to non-linearities of larger-amplitude vibrations [5], or the consideration of higher multipole order (λ) in the parametrized surface of the liquid drop model. Consequently, the identification and understanding of multi-phonon structures remain challenging tasks in low-energy nuclear structure physics. Whereas studies of multi-phonon structures in nearly spherical even-even nuclides are extensive and rapidly evolving [6], the lack of information on multi-phonon structures in odd-mass nuclides should be addressed in order to have a global picture of the character of vibrational nuclides. For this reason, the low-spin structure of $^{93}\text{Nb}_{52}$ has been studied using the $(n,n'\gamma)$ reaction at neutron energies ranging from 1.5 to 2.6 MeV, the $(n,n'\gamma\gamma)$ reaction at 3 MeV, and the $^{94}\text{Zr}(p,2n\gamma)^{93}\text{Nb}$ reaction at bombarding energies from 11.5 to 19 MeV. Excitation functions, lifetimes, and branching ratios were measured, and multipolarities and spin assignments were determined. The coincidence data collected in these experiments have been crucial in examining the complex two-phonon structures built on the $9/2^+$ ground state and $2p_{1/2}$ single-particle state. Assignments have been made by considering energy systematics, spins and parities, and branching ratios to the one-phonon states.

* This material is based upon work supported by the U.S. National Science Foundation under Grant No. PHY-0354656.

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