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Coulomb-nuclear interference and isospin characterization of the first 2+ and 3- transitions by inelastic scattering of alpha particles on 90,92Zr

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The Zirconium isotopic chain, where rather abrupt changes in nuclear properties are experimentally observed, in special along the N=50 to 60 region, has attracted renewed interest in recent years. In particular, a group of authors of the University of Tokyo (1) after performing large-scale Monte Carlo shell-model calculations claims that a "Quantum Phase Transition"is observed in the systematics of the excitation energies of low-lying states in Zr isotopes. Shape coexistence has consistently been invoked as a cause of some of the experimentally observed aspects and the work of Heyde and Wood (2) may be taken as an example. However, from an experimental point of view, several unexpected results continue to intrigue researchers, resulting in an effort to find causes for differences in the outcomes of inelastic scattering by different probes, either in the data themselves or in their analyses. Some years ago, a great investment was made in the attempt of reconciling results of a (6Li,6Li') work by the Yale group (3) with other data, particularly with findings of a former (α,α') experiment on 90-96Zr, performed in Heidelberg by Rychel et al. (4). With this purpose, a very careful reproduction of the Heidelberg alpha results was undertaken by Lund et al. (5), at the Yale facility, with the same incident energy of 35.4 MeV. No disagreement with the german data or their analysis was found. In fact, a clear explanation of the observed differences of the results between different probes is still lacking. In this scenario, the present contribution aims at putting forward some interesting aspects of experimental studies which examine differences between 90Zr and its neighbors. The unpublished data for 90,92Zr(α,α') (6), taken with the São Paulo Pelletron-Enge-Spectrograph system, are being analyzed in more detail, in view of recent interpretations. Coulomb-nuclear interference effects are much enhanced at the lower incident energy (21 MeV) of this experiment, favoring thus the isospin characterization of the transitions to the first 2+ and 3- states. The experimental angular distributions demonstrate a clear difference in the excitation of the first quadrupole states of 90Zr and 92Zr . In fact, in 92Zr the excitation is preferentially driven by neutrons, to an extent that had not been formerly observed in other nuclei. On the other hand, the semi-magic 90Zr reveals the usual collective contribution of protons and neutrons. It is to be noted that no such difference is detected for the octupole excitations, for which data, taken simultaneously with those for first 2+ levels, are well reproduced by homogeneous collective contributions.

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