Abstract

In the last decade shape-phase transitions in atomic nuclei were an important center of attention in nuclear structure physics. Drastic changes of nuclear shapes between collective excited nuclei are interpreted as phase transitions. This work is separated into four distinct parts that all deal with the common topic of shape-phase transitions.

The transition strengths between nuclear states are important observables for the determination of nuclear deformation. Therefore, a fast-timing experiment was performed to measure lifetimes in low-lying excited states in the long time identified phase transitional nucleus ^{98}Zr. For the 2_1^+ state an upper limit of the lifetime, the lowest measured yet, of $t_{1/2} < 11$ ps was determined. The experimental error of the lifetime of the 4_1^+ state was lowered and for the 6_1^+ state an upper limit for the lifetime was measured for the first time. Additionaly, lifetimes of longliving isomers were certified. Shell-model and IBM calculations were performed to give a prediction of the actual lifetime of the 2_1^+ state.

The 0^+ level density in ^{170}Yb was determined with a (p,t) transfer experiment. Since the nucleus ^{170}Yb is a good candidate of a realization of the Alhassid-Whelan Arc of Regularity, a region of regular IBM spectra (typical IBM spectra have a chaotic characteristic, except for the dynamical symmetries), the consequences of the regular character on the 0^+ level density was investigated. Nuclei in phase transitional regions show an increasing 0^+ level density compared with well deformed nuclei. A similar behavior was expected for ^{170}Yb. However, the 0^+ level density in ^{170}Yb matches other recently measured level densities in the rare earth region well.

Besides the experiments, IBM calculations were performed, that yield a deeper understanding of shape-phase transitions in nuclei. At the O(6) symmetry of the IBM, evidence of a required signature for first-order shape-phase transition was demonstrated for the first time. IBM fits of nuclei in the Hf-Hg mass region were able to place these isotopes in the transitional region. Further IBM calculations of (p,t) and (t,p) transfer reactions show, that large reaction-cross sections to excited 0^+ states do not prove a shape-phase transition. This finding is in contrast to the established interpretation.