Abstract

The mass region around $A \sim 100$ is known for the rich variety of nuclear phenomena. In particular, the onset of deformation shows very different character in neighboring isotopic chains. Stable nuclei and nuclei in the proximity of shell closures have been experimentally studied in detail since the beginning of nuclear structure research. However, even in these well-known nuclei, the mechanisms behind the emergence of collectivity are still an open question. For mid-shell nuclei, the deformation is known as a driving mechanism to collective behavior. The widely accepted view is that low-energy excitations in near-spherical nuclei are of collective nature and can be described as quantized surface vibrations. Regarding the excitation energies, predictions in an anharmonic vibrator model show good agreement for some Ru, Pd and Cd nuclei. However, a comparison of available data on transition strengths and decay branchings is not as convincing. Recently, systematic deviations in the Cd isotopes stirred a debate about the validity of the vibrational picture for excited states in these nuclei.

In order to extent the study of the existence or absence of vibrational patterns, experiments on weakly collective nuclei in the $A \sim 100$ mass region were performed and analyzed within the scope of this thesis.

In the $N = 54$ isotone ^{100}Pd, the lack of data on lifetimes complicated structural conclusions. An experiment performed at the University of Cologne provided results on lifetimes of the groundstate-band up to the 12^+ state and of a 5^- state.

Furthermore, an experiment on its even-even isotonic neighbor ^{98}Ru supplied data on spins and multipole mixing ratios enabling a more detailed study of the low-spin excitations in this nucleus.

Lifetime measurements performed on the Ru isotopes ^{96}Ru, ^{98}Ru,

and ^{104}Ru at Yale University, USA, improved the precision and solved discrepancies between earlier measurements.

The hyperfine interaction that acts on ions that are highly-ionized after a reaction and recoil into vacuum is a known feature. However, a description based on first principles is missing. The correction for the resulting deorientation effect is crucial in the context of Recoil Distance Doppler Shift Method (RDDS) lifetime measurements. In addition, the effect is sensitive to the g factor of the excited state. The series of lifetime experiments on the Ru isotopes ^{96}Ru, ^{98}Ru, and ^{104}Ru was analyzed with the intent to study the deorientation effect in very detail. A procedure to account for the deorientation effect within the RDDS analysis was developed. In addition, the time-dependence of the attenuation of the angular correlations was investigated and a technique was formulated that allowed the extraction of absolute values of g factors. The new results on g factors agree well with the literature values. In addition, the experiments provided input data for theoretical calculations on the hyperfine interaction that are highly needed to reach progress in the description from first principles. The approach of the simultaneous measurement of lifetimes and g factors promises success but needs further investigations regarding its feasibility limits and its application to radioactive ion beam experiments.

The comparison of the lifetimes in ^{100}Pd to a shell model calculation showed very good agreement. The shell model predictions for ^{98}Ru did not agree well with the experimental data. A more pronounced collective behavior than predicted seems to be present in this nucleus. The vibrational picture shows discrepancies regarding the predictions for absolute or relative transition strengths. As observed in the Cd isotopes, systematic deviations occur questioning the existence of low-energy vibrational excitations. These results emphasize the need of further experimental and theoretical studies in order to gain an understanding of the nature of the excitations in weakly-collective nuclei.