Quadrupole Moment of the 8^+ Yrast State in ^{84}Kr[E]

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Nuclear moments are very sensitive to the structure of nuclear states and their measurement is therefore a stringent test of nuclear models. States with a structure dominated by a few nucleons outside a closed shell are good candidates for tests of predictions of the shell model. In particular, effective g factors and effective charges accounting for the influence of orbits not included in the model space may be examined.

The quadrupole moment of the 8^+ yrast isomer ($\tau = 2.65(6)$ μs) in ^{84}Kr was measured at the CYCLONE facility in Louvain-la-Neuve using level-mixing spectroscopy (LEMS) [1, 2]. In a LEMS experiment recoiling nuclei are implanted into a suitable host with a non-cubic lattice, where they experience a combined electric quadrupole and magnetic dipole interaction. A split-coil superconducting magnet provides an external magnetic field of up to $B = 4.4$ T which is oriented parallel to the beam axis and thus coincides with the normal vector of the plane in which the spins are oriented after a fusion-evaporation reaction. At low strength of the magnetic field, the electric quadrupole interaction between the electric field gradient, V_{zz}, and the quadrupole moment of the isomer of interest, Q, dominate, and destroy the initial spin orientation. At a high magnetic field this interaction is negligible in comparison to the magnetic dipole interaction, and the spins perform a Larmor precession around the magnetic field $\vec{B}$. As the magnetic field is along the normal vector of the spin-orientation plane, a high field leads to an anisotropy of the intensities of isomeric transitions at 0° and 90° relative to the beam as induced by the spin alignment produced in a fusion-evaporation reaction. The anisotropy is measured as a function of the magnetic field, giving rise to the LEMS curve, which yields the ratio of the electric quadrupole frequency, $\nu_Q = eQV_{zz}/h$, to the magnetic interaction frequency, $\nu_\mu = \mu B/hJ$. From the LEMS curve measured in the present experiment we have deduced a quadrupole moment of $Q = 36(4)$efm^2 for the 8^+ yrast state in ^{84}Kr. Experimental quadrupole moments of ^{84}Kr and neighboring nuclei [5] are compared with predictions of the shell model in Fig. 1. Shell-model calculations were performed with a model space including the active proton orbits $\pi(0f_{5/2}, 1p_{3/2}, 1p_{1/2}, 0g_{9/2})$ and neutron orbits $\nu(1p_{1/2}, 0g_{9/2}, 1d_{5/2})$ relative to a hypothetic ^{66}Ni core using a combination of various empirical interactions and surface delta interactions. For details see, e.g., Refs. [3, 4]. Various sets of effective charges used in the literature have been applied: $e_\pi = 1.35e$, $e_\nu = 0.35e$ (SM1); $e_\pi = 1.72e$, $e_\nu = 1.44e$ (SM2). While the quadrupole moment in ^{84}Kr deduced in the present work is well reproduced with set SM1, the general behaviour of the quadrupole moments shows that e_π is too large in SM2 and e_ν is too small in SM1. Therefore, we applied a modified set of $e_\pi = 1.35e$, $e_\nu = 1.0e$ (SM1N) which improves the overall agreement between calculated and experimental quadrupole moments of the neutron-dominated states (see Fig. 1).

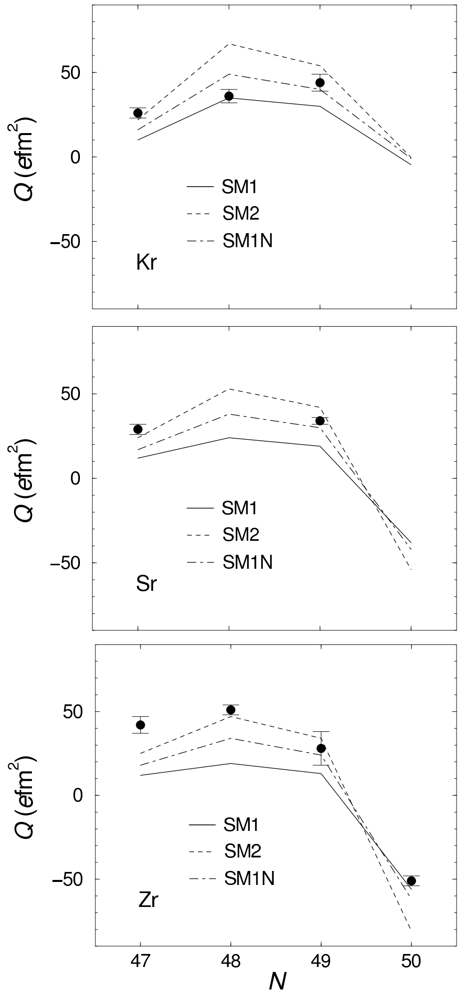

Fig. 1 *Comparison of experimental and calculated quadrupole moments for $9/2^+$ and 8^+ states in the Kr, Sr and Zr isotopes with N = 47 – 50. The calculations were performed with different sets of effective charges (see text).*

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