Quadrupole moment of the $8^+$ yrast state in $^{84}$Kr

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- Level Mixing Spectroscopy
- Results
- Systematics and interpretation

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Measurement of nuclear moments

- Nuclear moments are very sensitive to the structure of nuclear states.
- Their measurement is 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.
- Effective $g$ factors and effective charges accounting for the influence of orbits not included in the model space may be examined.
Level-mixing spectroscopy

B=0
pure quadrupole interaction

high magnetic field
pure magnetic interaction

Anisotropy
$\frac{N(0^\circ)}{N(90^\circ)}$

B low
intermediate
B high
competition

$\beta = 40^\circ$

$\omega_Q \propto Q s V_{ZZ}$

$\omega_Q \propto \mu B$

By courtesy of D. L. Balabanski and G. Neyens
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B high
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β = 40°

ω_Q ∝ μB

ω_Q ∝ Q_s V_{ZZ}

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\[ \omega_Q \propto Q_s V_{ZZ} \]
\[ \omega_Q \propto \mu B \]

B low intermediate competition B high

By courtesy of D. L. Balabanski and G. Neyens
**Quadrupole moments measurements:**

*the Level-mixing spectrometer*

**at the CRC**

Louvain-la-Neuve, Belgium

By courtesy of D. L. Balabanski and G. Neyens
LEMS experiment for $^{84}$Kr

$^{8+}$ yrast isomer:
Energy: $E_x = 3236.2$ keV
Lifetime: $\tau = 2.65(6) \mu$s
Magnetic moment: $\mu = -1.968(16) \mu_N$
Main configuration: $\nu(0g_{9/2}^\text{-2})$

Experiment:
Reaction: $^{82}$Se($\alpha$,2$n$) at $E_\alpha = 24$ MeV
Target: $^{82}$Se (96 $\mu$g/cm$^2$) + Cd (432 $\mu$g/cm$^2$) (Host) + Au (154 $\mu$g/cm$^2$)
LEMS experiment for $^{84}$Kr

Quadrupole moment of the $8^+$ yrast isomer: $Q = 36(4)$ $\text{efm}^2$
Shell-model calculations

Configuration space:

\[
\begin{array}{ccc}
\pi & & \nu \\
0g_{9/2} & & 0g_{9/2} \\
1p_{1/2} & & 1p_{1/2} \\
1p_{3/2} & & \text{Core } 66_{28} \text{Ni}_{38}
\end{array}
\]

Two-body matrix elements:

\(\pi\pi\): empirical from fit to \(N=50\) nuclei, \(^{78}\text{Ni}\) core; X. Ji, B.H. Wildenthal, PRC 37 (1988) 1256

\(\pi\nu, \nu\nu\ (0g_{9/2},1p_{1/2})\): emp. from fit to \(N=48,49,50\) nuclei, \(^{88}\text{Sr}\) core; R. Gross, A. Frenkel, NPA 267 (1976) 85

\(\pi\nu\ (\pi 0f_{5/2},\nu 0g_{9/2})\): experimental from transfer reactions; P.C. Li et al., NPA 469 (1987) 393

\(\nu\nu\ (0g_{9/2},1d_{5/2})\): exp. from energies of the multiplet in \(^{88}\text{Sr}\); P.C. Li, W.W. Daehnick, NPA 462 (1987) 26

remaining:
MSDI;
K. Muto et al., PLB 135 (1984) 349

Code: RITSSCHIL
Quadrupole moments of $9/2^+$ and $8^+$ states in Kr, Sr and Zr isotopes

SM1: $e_\pi = 1.35 \, e$, $e_\nu = 0.35 \, e$
SM2: $e_\pi = 1.72 \, e$, $e_\nu = 1.44 \, e$
SM1N: $e_\pi = 1.35 \, e$, $e_\nu = 1.00 \, e$

(M.K. Kabadiyski et al., ZPA 343 (1992) 165)
Summary

○ Quadrupole moment of the \(8^+_1\) state in \(^{84}\text{Kr}\) measured for the first time by using the LEMS technique: \(Q = 36(4) \text{ efm}^2\).

○ Experimental quadrupole moment compared with predictions of the shell model. The quadrupole moment is very sensitive to model space and to effective charges.

○ Tendencies of quadrupole moments with changing neutron numbers in \(\text{Kr, Sr and Zr}\) isotopes with \(N = 47 – 49\) are qualitatively reproduced by calculations using common sets of effective charges.

○ The overall agreement between experimental and calculated quadrupole moments of neutron-dominated states in those nuclides is improved with a modified effective charge for neutrons.