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1.63 High Resolution Polarized Deuteron Scattering on ^{104}Ru Investigation of Neutron-Proton Differences in the Triaxial Nucleus x)

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The nucleus ^{104}Ru has recently gained much attention since many features of its low-lying excitation spectrum exhibit strong evidence for the existence of a stable triaxial shape. This is supported especially by the static and dynamic E2-moments measured recently in multiple Coulomb excitation experiments[1] for states up to the 10^+-level. The observed signature has stimulated a number of new theoretical investigations. In an attempt to incorporate triaxial shapes in the IBA-model, e.g., the $SU^*(3)$-symmetry has been introduced[2], which in its geometrical interpretation assumes the neutron and proton distributions to have opposite intrinsic quadrupole deformations. As a consequence proton and neutron transition matrix elements are expected to deviate appreciably from each other.

Stimulated by this model we have measured at E_d=23 MeV the hadronic excitation of ^{104}Ru by polarized deuterons, which due to their isoscalar character are sensitive to the moments (M_m) of the mass distribution and its transition densities. Together with the corresponding proton moments (M_p) known from Coulomb excitation these yield the neutron moments (M_n) of the transitions. The experiment has been performed at the Munich MP-tandem accelerator using the Q3D-magnetic spectrograph. In order to separate the 4_1^+-2_2^+- doublet with an energetic difference of only 4.6 keV (fig. 1) special emphasis has been put on highest possible energy resolution.

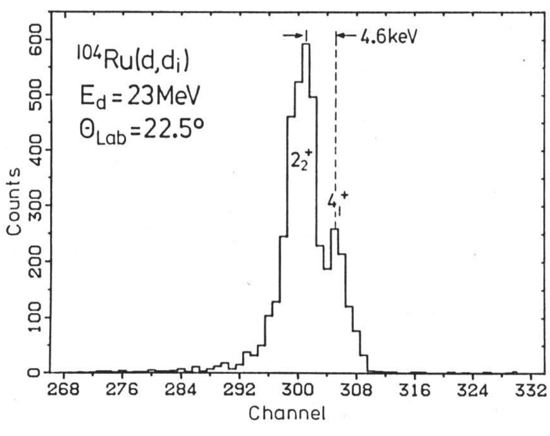

Fig. 1: deuteron spectrum at 22.5° for the 4_1^+-2_2^+-doublett

The scattering data for cross section and analyzing power are shown in fig.2 for the members of the groundstate- and γ-bands. Both in σ(θ) and in $iT_{11}(\theta)$ the 2_1^+- and 2_2^+-excitations differ strongly in their angular distributions implying different excitation mechanisms and in consequence of it different structures of these states. Similar statements hold for the 4^+- states.

The solid curves in fig. 2 represent the CC-analysis of the data using a global ansatz for the deuteron-nucleus interaction. The details of the calculations are described elsewhere[3]. For the 4^+- and 6^+-levels the dashed lines show the pure multistep quadrupole excitation of these states as it is seen in Coulomb excitation[1]. The data exhibit that a substantial part of the excitation of these levels proceeds also directly from the groundstate with multipolarities λ=4 and 6, respectively, The observation of appreciable hexadecapole strengths is remarkable in view of theoretical efforts[4] to incorporate triaxial shapes in the IBA by inclusion of g-bosons.

The quadrupole mass moments resulting from the analysis yield neutron moments, which in part deviate substantially from the corresponding proton moments. The ratio $\hat{M}_n/\hat{M}_p$ of neutron to proton moments normalized to the number of neutrons and protons in the nucleus, respectively ($\hat{M}_n = M_n/N$ and $\hat{M}_p = M_p/Z$), should be unity in the case

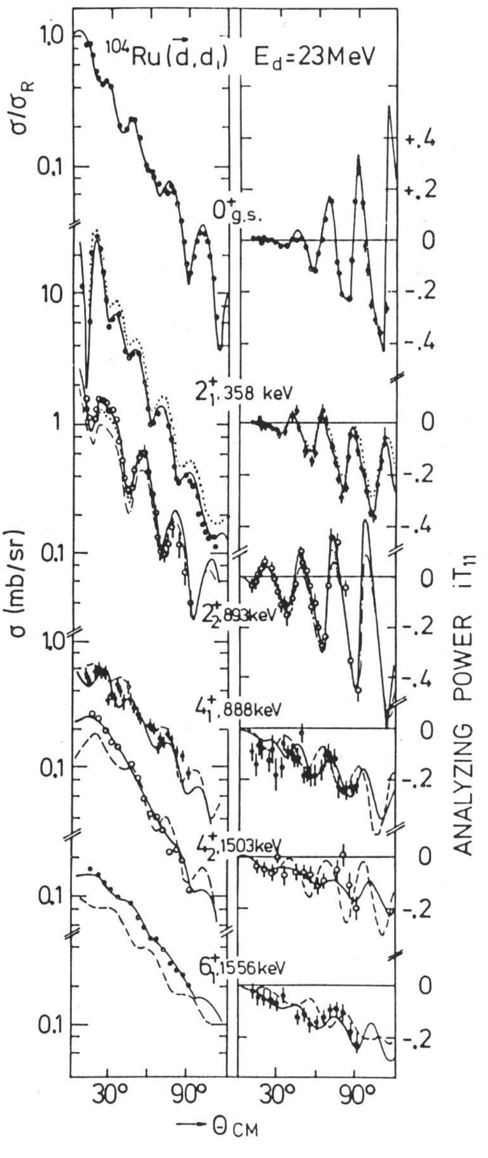

Fig. 2: $\sigma(\theta)$ and $iT_{11}(\theta)$ for the excitation of the ground-state- and γ-bands. The curves are discussed in the text.

of pure isoscalar transitions. Whereas most of the quadrupole transitions indeed yield a ratio compatible with unity within their experimental uncertainties, we find for the ground state transition of the 2_1^+ and 2_2^+-states the values $\hat{M}_n/\hat{M}_p$ = 0.87(5) and 1.4(2), respectively. This implies that in the 2_1^+-excitation dominantly protons are involved, whereas in the 2_2^+-excitation a preference for neutrons is observed. This is just opposite to what is expected from the picture employed in the IBA-SU*(3)-calculation[2)].

A CC-calculation assuming pure isoscalar character for all quadrupole transitions involved in the low-lying excitation of ^{104}Ru is shown for the 2^+-excitations by the dotted lines. The calculation overestimates the observed 2_1^+-excitation by approximately 20% and underestimates the 2_2^+-data by about the same amount reflecting just the deviations from isoscalarity for the groundstate transitions of these states.

A calculation utilizing the triaxial rotor model[5)], which has been quoted[1,6)] to successfully describe the Coulomb excitation results, underestimates the 2_2^+- cross section even by a factor of two (dash-dotted lines in fig. 2). There is no way within this model to describe the 2_1^+- and 2_2^+-data simultaneously, if the quadrupole operator is treated properly in all orders[3,6)] of β and γ.

1) J. Stachel et al., Nucl. Phys. A419 (1984) 589 and A383 (1982) 429
2) A.E.L. Dieperink, R. Bijker, Phys. Lett. 116B (1982) 650
3) H. Clement et al., Phys.Rev.Lett. 48 (1982) 1082, Phys.Lett. 116B (1982) 109 and to be published
4) K. Heyde et al., Nucl.Phys. A398 (1983) 235
5) A.S. Davydov, G.F. Filippov, Nucl.Phys. 8 (1958) 237
6) in ref.1 only the first order result as given in ref.5 had been used for the comparison to the experiment.

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