ELECTRIC MONOPOLE COMPONENT IN THE 340 keV TRANSITION IN ^{233}U

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1. INTRODUCTION

The electric monopole deexcitation mode of excited states in odd-A nuclei is not yet studied in sufficient detail. The single-particle "Weisskopf" estimate[1,2] gives a rather high value for the monopole matrix element in proton transitions (ρ=0.6), however, the monopole component is experimentally found in one proton transition only [3]. It is not quite clear what causes such a great forbidness of the E0 decay mode as compared to the single-particle estimate. Grechukhin [1,4] showed that the collective quadrupole excitations in odd N nuclei could induce E0 transitions with the monopole matrix element of the order of $(3/4\pi)Z\beta^2$ (β is the nuclear deformation). Bezghanov et al [5] treated non-adiabatically the motion of the unpaired nucleon in the field of the even-even core to which the collective degrees of freedom are allowed. They have shown that the energy of the collective vibrational excitations in ^{233}U is about 300 keV. The β-vibrational component in the wave function of the 340 keV state should lead to the nonzero E0 contribution to the $5/2^+ \rightarrow 5/2^+$ transition to the ground state.

In the present work we have measured the K conversion coefficient and conversion ratios for the 340 keV transition and thence deduced the amount of the E0 admixture in this transition.

2. EXPERIMENTAL RESULTS

The conversion spectrum was taken with the $\pi\sqrt{2}$ double-focusing electron spectrometer at the Vinča Institute. Each line was measured seven times, the time of measurement on each current being four minutes. Weighted mean values together with standard deviations are listed in Table I. Relative intensities were normalized to the K line of the 312 keV transition. From

Table 1.

Relative conversion intensities for the 340 keV
transition

Shell	I_e(rel.)	
	present work	ref. 7
K	8.89 (5)	8.52
L_I	1.61 (1)	1.85
L_{II}	0.24 (1)	0.24
L_{III}	0.022(6)	-

the measured α_K (312 keV) = 0.69 (7) [6] and gamma intensities
from ref. 7, the K conversion coefficient was found to be
α_K (340 keV) = 0.55 (6).

3. ANALYSIS OF THE RESULTS

If it is assumed that the equispin $5/2^+ \rightarrow 5/2^+$
340 keV transition is of the M1+E2+E0 type, and if the pene-
tration effects in the conversion of the hindered [8] M1 compo-
nent are taken into account, the conversion coefficient for the
i-th shell reads:

$$\alpha_i = \left\{ \alpha_i(M1) \left[1 + B_1^i \lambda + B_2^i \lambda^2 \right] + \alpha_i(E2)\delta^2 + \frac{A_i(E0)}{A_K(E0)} q_K^2 \right\} (1 + \delta^2)^{-1} \quad (1)$$

where $\delta^2 = I_\gamma(E2)/I_\gamma(M1)$, $q_K^2 = I_K(E0)/I_\gamma(M1)$ and λ is the
penetration parameter. Other quantities are calculated by Hager
and Seltzer [9,10]. The α_K conversion coefficient and K/L_I
conversion ratio very weakly depend on δ^2 for $\delta^2 < 0.3$. This
fact enables one to find the penetration parameter λ from the
intersection of the curves $\alpha_K = \psi(\lambda, q_K^2)$ and $K/L_I = \Phi(\lambda, q_K^2)$
if δ^2 is kept zero. The resulting value is $\lambda = 10.5$ (25).
With this value for λ the measured α_K, K/L_I, K/L_{III} and
L_{II}/L_{III} are analysed in the q_K^2-δ^2 plane (Fig. 1). The obta-
ined area of solutions yields $q_K^2 = 0.40$ (9) and $\delta^2 = 0.040$ (15).
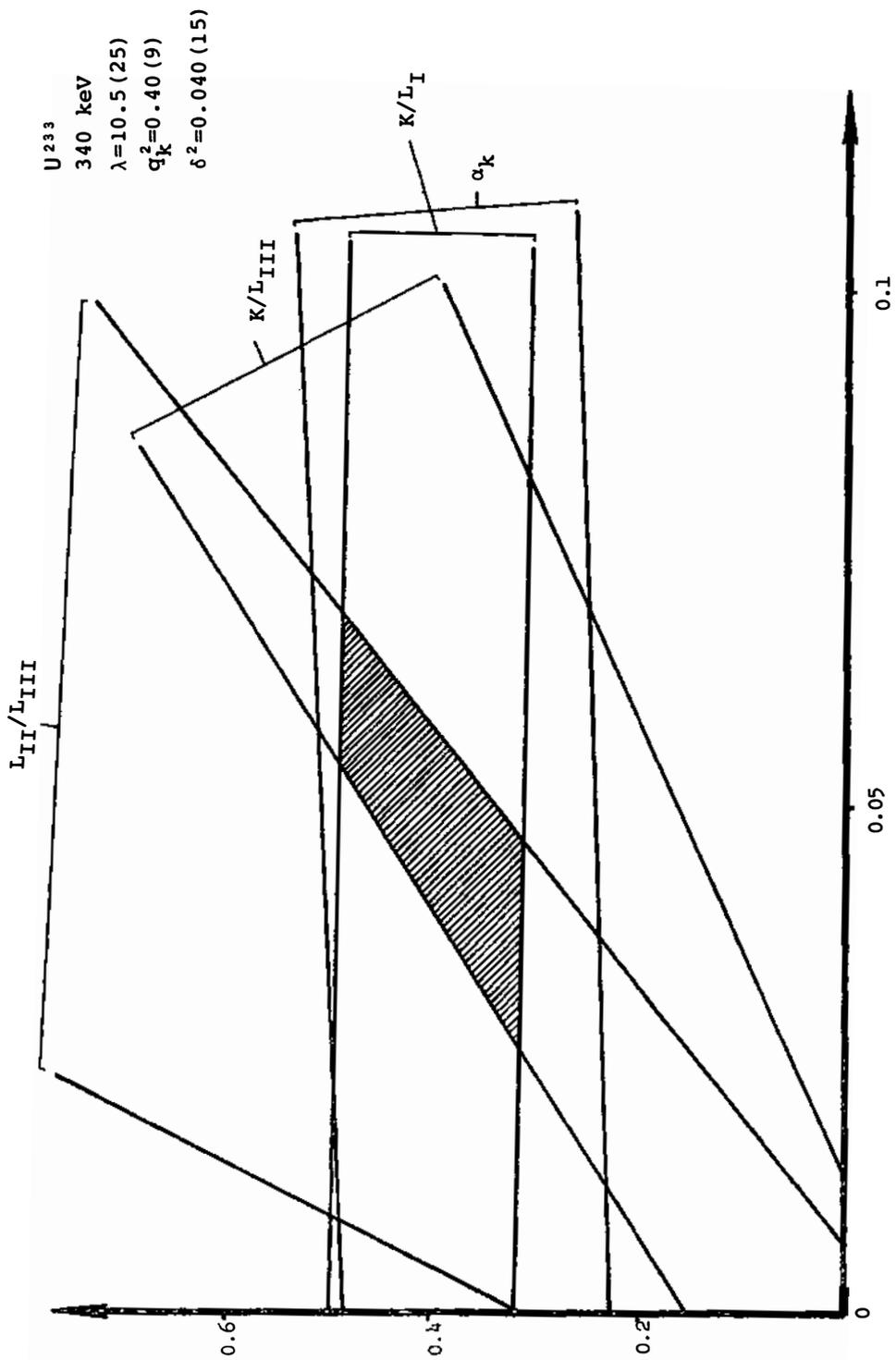The monopole matrix element is then:

Fig. 1.

$$\rho = \left[\frac{(2I_i+1)W_\gamma(M1) \cdot q_K^2 \times 10^{-20}}{8\pi\alpha k\, A_k(E0) \times 7.7631} \right]^{1/2} \tag{2}$$

where $W_\gamma(M1)$ is the absolute M1 gamma transition probability and other quantities are denoted as in ref. 10. From the quoted λ and δ^2, the measured halflife of the 340 keV state [8] and the estimated $\beta_{N+0+...} = 0.3\beta_M$ it follows that $W_\gamma(M1) \rightleftharpoons = 7.8\,(16) \times 10^9$. This value inserted in Eq.2 yields $|\rho| = = 0.123\,(19)$.

This confirms the presence of a significant E0 admixture in the 340 keV transition whose contribution to the conversion processes is hidden by the penetration effects in M1 conversion. The experimental monopole matrix element is an order of magnitude smaller than Grechukhin estimated [4] but it still points to the presence of the β-vibrational component in the 340 keV state wave function. This agrees with the results of Malmskog and Höjeberg [8] which demonstrate that the E2 transition probabilities for transitions with $|\Delta K|=1$ cannot be understood within the Nilsson model with particle-rotation interaction.

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