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M1-E2 MIXING RATIOS OF GAMMA-GROUND TRANSITIONS IN ^{168}Er

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ABSTRACT

The L subshell ratios of four γ -g transitions in ^{168}Er have been measured with the high resolution, iron, β -spectrometer at the Institut Laue-Langevin. The reduced M1-E2 mixing ratios are not consistent with the values predicted by Warner on the basis of IBA-1. It may be possible to explain the results in IBA-2 in terms of the $\Delta K=1$ mixing of the gamma-band and the pure antisymmetric states such as the $1+$ isovector mode.

INTRODUCTION

M1 transitions in even-even nuclei are forbidden in the simplest form of collective models because the leading term of the collective M1 operator is proportional to the total angular momentum, which is a good quantum number. Such transitions are observed however in the decay of the gamma band in deformed nuclei. To date their origins are not fully understood.

Schreckenbach and Gelletly⁽¹⁾ studied the M1 components in the intraband transitions within the gamma band of ^{168}Er by measuring the L subshell conversion line intensity ratios for these transitions. A comparison with the less precise measurements on neighbouring nuclei revealed that the experimental E2/M1 mixing ratios for the $\Delta I = -1$ transitions within the γ -band are remarkably constant in the even-even, rare-earth nuclei. On the assumption that IBA-1 gives the E2 decay rates for levels in the γ -band Warner et al⁽²⁾ showed that $B(M1) \approx 8 \times 10^{-4}$ s.p.u. for all these M1 transitions. The constancy and small size of these M1 components in a range of nuclei argue that these transitions are collective.

On the basis of these measurements of mixing ratios in intraband transitions Warner⁽³⁾ derived values of

$$\Delta(E2/M1) = \frac{B(E2/M1)}{0.835 E_\gamma \text{ (MeV)}}$$

for the γ -g transitions in a series of rare-earth nuclei on the assumption that the M1 matrix element is effectively proportional to the E2 matrix element. Overall he found passable agreement with experiment although the errors on the experimental values, which are mainly derived from angular correlations, are large. γ - γ correlations are a powerful tool for measuring spins, parities and mixing ratios but they are subject to systematic errors and ambiguities where the spectra are complex.

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transition. In all it was possible to extract L subshell ratios for four of the γ -g transitions studied. Overlapping lines, identified from our previous, extensive study⁽⁴⁾ of this reaction, interfered in the other three cases.

RESULTS

The results are summarised and compared with previous results and Warner's predictions in Table 1. In the only case where Δ had been measured previously with high precision the agreement is excellent.

The measured values are less than half of Warner's predicted values, which suggests that we require a more sophisticated description of the M1 matrix element in IBA-1.

A better explanation may be found in IBA-2, where neutron and proton degrees of freedom are included explicitly. Here M1 transitions result from admixtures of states which are not fully

TABLE 1

Preliminary results of measurements of M1-E2 mixing in gamma-ground transitions in ¹⁵⁶Er.

I_i	I_f	IBA ²	$\Delta(E2/M1)$	
			Previous expts. ³	Present Work
2 ⁺ - 2 ⁺		-26.5±1.0	$ \Delta > 140$	—
3 ⁺ - 2 ⁺		-25.0±1.0	+24.7 ^{+3.7} _{-4.7}	7.5 ^{+1.8} _{-1.8}
3 ⁺ - 4 ⁺		-18.1±0.7	-9.3±0.6	9.6 ^{+10.8} _{-2.4}
4 ⁺ - 4 ⁺		-13.8±0.5	-164 ⁺⁹⁸ ₋₈₀	—
5 ⁺ - 4 ⁺		-14.2±0.5	—	5.1 ^{+3.3} _{-1.1}
5 ⁺ - 6 ⁺		-11.9±0.5	—	—
6 ⁺ - 6 ⁺		- 9.6±0.4	—	5.0 ^{+2.8} _{-1.8}

symmetric with respect to the neutron and proton degrees of freedom.

These

admixture depend on the positions of the pure antisymmetric states. A principal component of any admixture in

the rare-earth nuclei is expected to be the 1⁺ isovector mode which was recently identified (5) in ¹⁵⁶Gd. If this state is fairly constant in energy in the rare-earth region it would explain the observed constancy of the M1 components in the γ -band, intraband transitions. At the same time the observed M1 components provide a clue to the portion of the 1⁺ isovector mode.

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MEASUREMENTS

Appropriate sections of the conversion electron spectrum from the $^{167}\text{Er} (n, e^-) ^{168}\text{Er}$ reaction were scanned with the BILL spectrometer. The target (3×10 cm) consisted of $\approx 100 \mu\text{g cm}^{-2}$ enriched ^{167}Er evaporated on to an Al backing. A ten wire proportional

Fig. 1. A section of the $^{167}\text{Er} (n, e^-) ^{168}\text{Er}$ spectrum.

counter was used to detect the electrons. Each set of lines was scanned at least three times. An example of a section of the spectrum is shown in fig. 1.

Fig. 2. A fit to the L lines of the 815.99 keV, $3^+ \rightarrow 2^+_g$ transition

Fig. 2 shows a fit to the L Lines of the 815.99 keV, $3^+ \rightarrow 2^+_g$

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