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A note on the spin of the 1970 keV level in Ba^{134}*

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The directional correlation of the 802-1168 keV gamma ray cascade in the decay of Cs^{134} to Ba^{134} has been measured by sum-peak coincidence spectrometer to check the recently proposed (Rama Mohan *et al* 1967) spin assignment 3 to the 1970 keV level of Ba^{134}. The present investigations favour a spin 4 to this level. The 802 keV gamma transition has been found to be pure E2.

1. Introduction

In a recent study of the directional correlation of some cascades in Ba^{134} (Rama Mohan *et al* 1967), a spin 3 has been proposed for the 1970 keV level of Ba^{134} (figure 1a) on the basis of results for the 802-1168 keV cascade. These authors observed a negative asymmetry, whereas previous investigators (Everett & Glaubman 1955, Segaert *et al* 1963) had observed a positive asymmetry for this cascade. A spin assignment 3 to the 1970 keV level is in contradiction with the hereto-fore accepted spin 4 for this level. Hence it was considered worthwhile to reinvestigate the directional correlation of the 802-1168 keV cascade so as to verify the spin assignment to the 1970 keV level of Ba^{134}.

The measurement of the directional correlation of the 802-1168 keV cascade is complicated by the presence of a strong 563-605 keV cascade de-exciting the 1168 keV level in competition with the weak 1168 keV cross-over transition. Therefore, it is desirable to use large source-to-crystal distance for the detector selecting the 1168 keV transition so as to reduce the detection of the cascade sum (563+605 keV) compared to the cross-over gamma ray.

An increase in the source-to-crystal distance, however, also reduces the detection efficiency for 1168 keV gamma ray, making it very time consuming to measure the directional correlation of 802-1168 keV cascade with conventioal slow-fast coincidence spectrometer. The sum-peak coincidence spectrometer (Kantele & Fink 1962) has more than twice the coincidence detection efficiency compared to a conventional slow-fast coincidence

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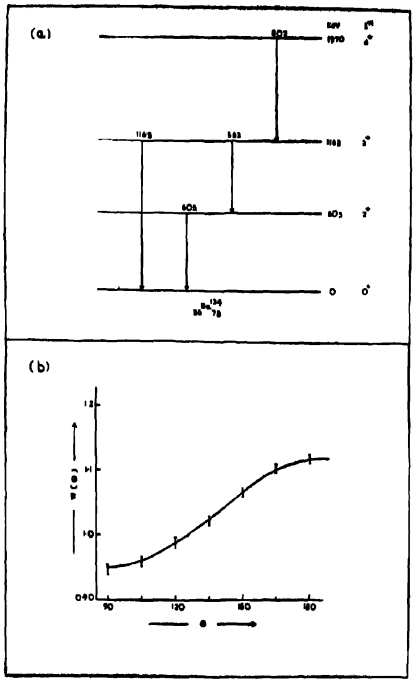

Figure 1. (a) Partial Level Scheme of Ba^{134} populated in the decay of Cs^{134}.
(b) Plot of angular correlation function W (θ) Vs θ for the 802-1168 KeV cascade of Ba^{134}.

spectrometer and has proved useful in the measurement of angular correlation of weak gamma ray cascades (Sud *et al* 1968). Therefore a sum peak peak coincidence spectrometer has been utilized in the present study.

2. Measurements and Results

The experimental arrangement was the same as described elsewhere (Sud *et al* 1968) except the detectors which were a matched pair of Harshaw integral line assemblies with 3″ dia and 3″ thick Na I (Tl) crystals. These detectors have a resolution of 7.6% for 662 keV gamma rays. A

moderately strong liquid source of radioisotope Cs^{134} was prepared in a cylinderical perspex holder with a vertical cavity of 1.5 mm dia × 4 mm depth. This source was mounted vertically at the inter-section of the axes of the two detectors at a distance of 14 cm from each crystal. The face of either crystal was covered with 7 mm of lead. This geometry reduced the detection of cascade sum (563-605 keV) compared to the 1168 keV crossover gamma ray to less than 2%. Compton graded lead cylinders and lead cones were used to eliminate crystal-to-crystal scattering. The source could be centred to within less than 0.5% variation in the singles rate of movable detector. The integral biases of the two single channel analysers were set at 700 keV to completely bias out the 605 keV gamma ray. The sum-peak coincidence spectrum was recorded on a 256-channel pulse height analyser at seven angles from 90° to 180° at intervals of 15° each. This spectrum after substraction of random coincidences shows a peak at 1970 keV corresponding to the sum of 802 and 1168 keV cascade. The area under this peak directly gave the coincidences between the 8020 and 1168 keV gamma rays. After a least squares fit of the data (Rose 1953) the correlation coefficients were corrected for finite angular resolution of the detectors (Yates 1965). The corrected correlation coefficients (an average of two independent measurements) are given in table 1 along with the results of previous investigators. The present results are in good agreement with the results of Everett and Glaubman (1955) and Segaert *et al* (1963) but do not agree with the results of Rama Mohan *et al* (1967).

3. Discussion

The spin and parity of ground state of even-even nucleus Ba^{134} is 0^+. The experimental K-conversion coefficient for the 1168 keV gamma ray (Brown & Ewan 1965) assigns a character 2^+ to the 1168 keV level of Ba^{134}. The 86 keV beta group from the 4^+ ground state of Cs^{134} feeding the 1970 keV level of Ba^{134} is an allowed transition (Nuclear data sheets). This suggests a character 3^+, 4^+ or 5^+ to the 1970 keV level. The lifetime consideration for this level, however, rules out the 5^+ assignment, leaving only two possibilities 3^+ or 4^+. A spin assignment 3 requires $A_4 \leqslant 0$ for all values of mixing ratio (δ) for the 802 keV transition. The definite positive value of A_4, from the present measurements favours a 4^+ assignment for the 1970 keV level. Therefore the spin sequence for the 802-1168 keV cascade is 4 (2,3) 2(2) 0. Figure 2 shows a graphical analysis of the present results in terms of the above spin sequence for determining the mixing ratio (δ) for the 802 keV transition. This analysis gives $\delta \leqslant -0.01$ i.e. 802 keV transition is pure E2. This conclusion is in agreement with

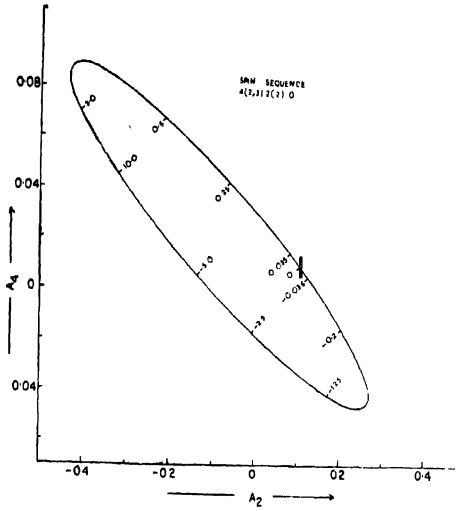

Figure 2. Parametric plot of A_2 Vs A_4 for the spin sequence 4-2-0 for determining the mixing ratio in the 802 keV transition. The shaded area corresponds to the experimental vales of A_4 and A_2.

the results based on internal conversion coefficient for the 802 keV gamma ray (Brown & Ewan 1965) which shows this transition to be pure E2.

TABLE 1. A SUMMARY OF THE RESULTS OF DIRECTIONAL CORRELATION MEASUREMEFTS ON THE 802-1168 KEV CASCADE IN Ba^{134}.

Reference	A_2	A_4
Everett & Glaubman, 1955	0.095	0.006
Segaert *et al* 1963	0.15±0.01	-0.019±0.001
Rama Mohan *et al* 1967	-0.1235±0.0015	0.0009±0.001
Present measurements	0.1081±0.0025	0.0091±0.0040

References

Brown, R.A. & Ewan, G.T. 1965 *Nucl. Phys.* **68**, 325-36.

Everett, A.E. & Glaubman, M.J. 1955 *Phys. Rev.* 100, 955A.

Kantele, J. & Fink, R.W. 1962 *Nucl. Instr. and Math.* **15**, 69-73.

Rama Mohan, R. V., Reddy, K.V., Raju, B.B.V., & Jnanananda, S. 1967 *Indian. J. Phys.* **41**, 30-8.

Rose, M.E. 1953 *Phys. Rev.* **91**, 610-15.

Segaert, O. J., Demuynck, J. L., Dorikens-Vanpraet, L. V., Dorikens, M. 1963 *Nucl. Phys.* **43**, 76-91.

Sud, S. P., Mangal, P. C., Suri, K. K., & Trehan, P. N. 1968 *Indian. J. Phys.* **42** 167-176.

Way, K. 1961 *Nucl ear Data Sheets*, Nat. Acad. Sci., Nat. Research Council Washington D. C., NRB-61-2-97.

Yates, M. J. L. 1965 *Alpha, Beta and Gama Ray Spectrocony* Ed. by K. Siegbahn North Holland Publishing Co. Amsterdam North Holland p. 1691-1703.