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The 2691 keV Level of Te^{124}

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THE 2691 keV LEVEL OF Te^{124}

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Abstract: Spin and parity of the 2691 keV level of Te^{124} are determined as 3^-.

1. Introduction

Though many papers have been published on the 60 d-decay $Sb^{124} \rightarrow Te^{124}$ (see e.g. refs. [2-9]), the spin and parity assignments of the 2691 keV level † of the daughter nucleide have remained doubtful up to now. Most authors found that spin 3 and odd parity did not contradict the experimental data, but there was some difficulty to justify this assignment theoretically: First, a log *ft* value of 6.9 is rather large for an allowed transition ($3^- \rightarrow 3^-$); second, the well-established 3^- level at 2295 keV makes another 3^- level in the 2500 keV region unlikely; third the "first-third"-type angular correlation measurement of the 1370-(722)-603 keV γ-γ cascade by Lindqvist and Marklund [8]) did not yield the expected 4^+ level at 1326 keV when assuming the 2691 keV level to be 3^-. It appeared interesting, therefore, to perform a high precision measurement of the 2090 keV — 603 keV — γ-γ angular correlation to determine unambiguously spin and parity of the 2691 keV level of Te^{124} from the well-established assignments 2^+ and 0^+ of the intermediate and ground states, respectively.

2. Apparatus

The measurements were performed with a very stable automatic coincidence arrangement of the fast-slow type which is described elsewhere [10]). The detectors used were two Harshaw NaI(Tl) crystals, 10.2 cm diameter $\times$ 15.2 cm long, coupled to RCA-7046 photomultiplier tubes. To obtain small statistical variances the total number of coincidences measured was as high as 2.7×10^5.

3. Results

The experimental data were corrected for statistical fluctuations in the single-channels, decay time of the nucleide and random coincidences. Finite size of the

† All energies have been taken from the Nuclear Data Sheets [1]).

source, finite angular resolution of the detectors and Compton scattering in the source material were taken into account by using the formalism of Michaelis [11]) which consists in a generalization of the well-known calculations of Feingold and Frankel [12]). The experimental setup, however, was such that all corrections remained very small.

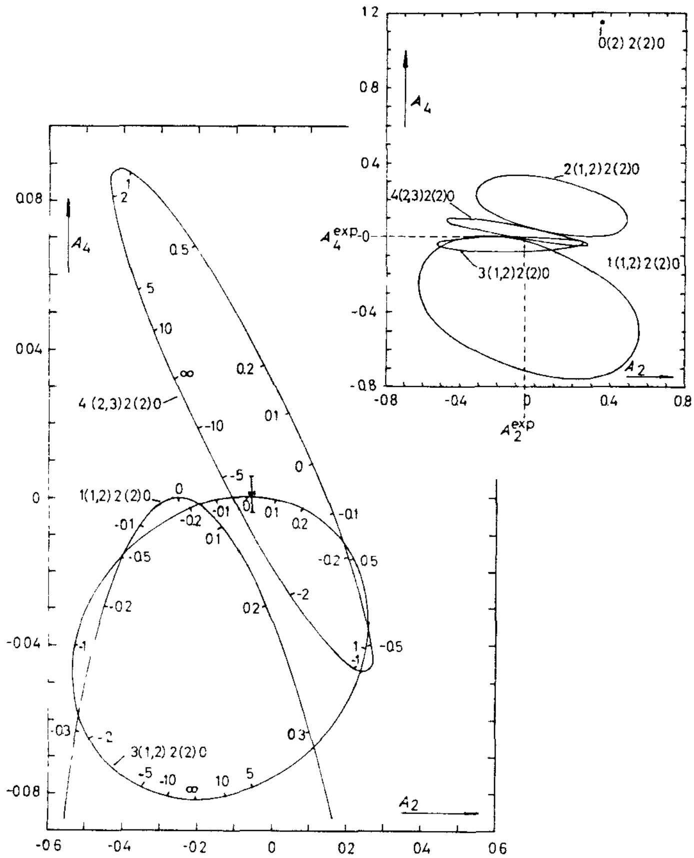

Fig. 1. Parametric plot of the angular correlation coefficients A_2 and A_4 as a function of the mixing ratio δ_1. The measured coefficients A_2^{exp} and A_4^{exp} and expected errors are indicated by $+$.

The result of the angular correlation measurement is

$$W(\cos\vartheta) \equiv 1+A_2P_2(\cos\vartheta)+A_4P_4(\cos\vartheta)$$

$$=(1.000\pm0.002)-(0.058\pm0.005)P_2(\cos\vartheta)+(0.001\pm0.005)P_4(\cos\vartheta),$$

where P_k are Legendre polynomials of the order k. The errors quoted contain statistical as well as systematical deviations and are much smaller than the errors in all previous publications. Fig. 1 gives the theoretical curves of the angular correlation coefficients A_2 and A_4 as a function of the mixing ratio δ_1 of the first (unknown) transition. These curves have been calculated using the F coefficient tables of Ferentz and Rosenzweig [13]). It may be seen that the measured coefficients are consistent only with spin 3 of the initial level. As can be seen further the experimental δ_1 is 0.023 ± 0.006, hence the intensity ratio of quadrupole to dipole radiation $\delta_1^2 = (5.5 \pm 2.7) \times 10^{-4}$ is extremely small; it therefore seems very probable that there is a parity change, i.e. the transition is an E1-M2 mixture, and 3^- is the correct assignment of the 2691 keV level.

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