GAMMA-GAMMA ANGULAR CORRELATION IN Sn^{125}

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ABSTRACT. Spin assignment to the 2.23, 1.98, 1.88, 1.41 and 1.07 MeV levels of Sb^{125} has been made from directional angular correlation measurements.

INTRODUCTION

The levels of Sb^{125} excited through the decay of Sn^{125} have been previously studied by several authors (Nuclear Data Sheets, 1964, Devare *et al.*, 1964). The spin-parities of these levels were ascertained mainly from the knowledge of the beta-decay log ft-values. In the present work the spins of some of the levels have been determined from $\gamma-\gamma$ angular correlation experiments.

The experimental sources were prepared in small thin-walled perspex containers from chemically processed Sn^{125} obtained from the Oak Ridge National Laboratory. The 9.4 min activity of Sn^{125} was allowed to decay sufficiently before the chemical separation was carried out in order to get rid of some Sb^{125} activity formed therefrom. The activity of Sb^{125} accumulating from the decay of the 9.7*d* Sn^{125}, was not large enough to disturb our measurements within the short time in which the experiments were performed.

EXPERIMENTS AND RESULTS

$\gamma-\gamma$ angular correlation between five cascades, shown in Table I has been measured. The spins of the 2.23 1.98, 1.88, 1.41 and 1.07 MeV levels were determined. As it was not possible to study the short lived isomer of Sn^{125}, the spins of the levels at 0.325, 0.640, 0.910, 1.470, 1.720, 1.940 MeV could not be determined. The summation technique of Hoogenboom (1958) was used to separate the peaks more effectively from the general Compton background and from other adjoining peaks. Fig. 1 shows some of the representative spectra measured with the help of this method. The spectrum of Fig. 1(a) was recorded with the sum channel set at 1.8–2.1 MeV region. As both of 0.81 and 0.91 MeV γ-rays are in coincidence with the 1.07 MeV γ-ray, they, with their respective intensities, contribute to the area under the 1.07 MeV peak. The prominent peak in Fig. 1(b) is due to the coincidence between the sum-pulses at 1.41 MeV (= 1.07+0.34) and 0.34MeV γ-ray. The second peak in the same spectrum arises due to the straightforward coincidence between the 0.47 MeV γ-ray and the γ-ray of 1.41 MeV energy selected along with the sum-pulses. In order to increase the area under the 1.16 MeV peak shown in Fig. 1(d), a broad selection was made in the sum channel (2—2·3MeV) which admitted some of the sum-pulses of the 0.81—1.07 and 0.91—1.07 MeV cascades resulting in an increase in the area under the 1.07 MeV peak.

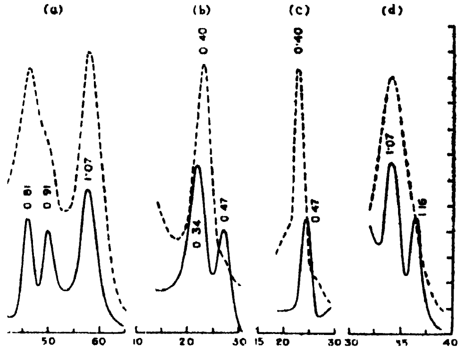

Fig. 1. Solid Curves: Hoogenboom-spectra of the γ rays of Sb^{125}. Dotted Curves: Spectra recorded in the straightforward manner. Spectra in the region of interest have been Shown.

The correlation experiment performed with these spectra in the channels need little correction due to other perturbing radiations. However, for the weak intensity cascades, statistical accuracy in the result could not be increased sufficiently. Measurements were also conducted using the conventional slow-fast coincidence method for all the cascades except the 1.16—1.07 MeV one and essentially same results were obtained. The A_2 and A_4 coefficients were calculated according to the formulation of Rose (1953). Geometry correction was made from the curves by Stanford and Rivers (1959).

TABLE I

Experimental results

Cascade MeV	Sum channel setting	A_2 Exp.	A_4 Exp.	Possible Assignment
0.81—1.07	1 80—2.00	0 131±0.032	−0.046±0.05	$13/_2(3)7/2(1)7/_2$
0.91—1.07	1 90—2.10	0 176±0.031	−0.111±0.05	$11/_2(2)7/2(1)7/_2$
0.34—1.07	1.35—1.45	0.031±0.036	0.037±0.05	$11/_2(2)7/_2(1)7/_2$
0.47—1.41	1.80—2.00	−0.078± .078	−0.026±0.12	$13/_2(1)11/_2(2)7/_2$
1.16—1.07	2 00—2.30	0.084±0.083	0.019±0.10	$11/_2(2)7/_2(1)7/_2$ $11/_2(2)9/_2(1)7/_2$ $9/_2(2)9/_2(1)7/_2$

DISCUSSION

The ground state of Sn^{125} and Sb^{125} have been assigned on the basis of single particle shell model (Goldhabor and Hill, 1952). The beta spectrum of 9.7*d* Sn^{125} was also measured with a Sieghbahn-Slätis spectrometer. The end-energies and log ft-values were found to be in accord with these previous results (Devare *et al.*, 1964). The spin assignments to the levels of Sb^{125} from the present measurements shown under $J[\gamma\gamma(\theta)]$ in Fig 2. are compatible with both log ft and angular correlation data.

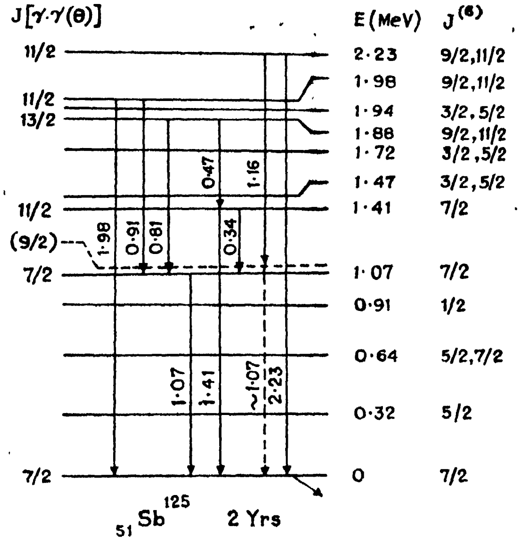

Fig. 2. Proposed level-scheme of Sb^{125}.

Explanation of the level spectrum of Sb^{125} was suggested by Silverberg (1961) on the basis of the coupling between the $g_{7/2}$ and $d_{5/2}$ odd protons with the harmonic vibration of the 2^+ one phonon excitation of the even-even core. However the centre of gravity rule does not seem to hold good there. In order to make the C. G. Rule fit into this scheme we require two sets of states arising due to these couplings. For the $g_{7/2}$, 2^+ coupling the C. G. lies at 1.15 MeV considering the 0.640, 1.075, 1.41 and 1.47 MeV levels of Fig. 2, in which a $9/2^+$ level has been left out. In Table 1 the 1.16-1.075 MeV cascade shows the possibility of a $9/2^+$ intermediate level at or near 1.075 MeV, not resolved from the $7/2^+$ 1.075 MeV line in the spectrum. This would, however, suggest a mode of decay for the 2.23 MeV level and a $9/2^+$ level very nearly at 1.075 MeV. When this level is taken into consideration the above values of C. G. comes out to be at 1.11 MeV, fairly in agreement with the energy of the 2^+ state of Sn^{124} at 1.13 MeV. Some of the other levels belong to the $d_{5/2}-2^+$ coupling. At the present stage the set for this scheme cannot be completed. Moreover, the levels at 1.88, and 1.98 MeV have high spin values whose origin cannot be connected to any of the above mode of couplings.

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