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GAMMA - GAMMA ANGULAR CORRELATIONS IN THE DECAY OF Sb^{124} (93 sec) AND Sb^{128} (10,8 min).

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The decay schemes of Sb^{124} (93 sec) to Te^{124} as studied by Vanhorenbeeck [1] and of Sb^{128} (10,8 min) to Te^{128} as studied by del Marmol and Colard [2] are shown in Slides 1 and 2. They involve two γ-ray triple cascades: 505 - 645 - 603 keV in Te^{124} and 320 - 754 - 754 keV in Te^{128}. It is likely [1,2] that the levels at 1.248 keV in Te^{124} and 1.508 keV in Te^{128} have spin 4. We have measured the angular correlations for these 2 triple cascades in order to confirm this point and to obtain indications on the spin of the upper levels of the cascades, at 1.753 keV in Te^{124} and 1.828 keV in Te^{128}.

The angular correlation apparatus involves two 2" x 2" NaI (Tl) crystals with conical lead shields in order to present counter-to-counter scattering. The source-to-detector distance is 4". The electronics includes a fast-slow coincidence circuit with a resolving time: 2τ = 20 n/sec.

DISCLAIMER

The spectrum in the movable detector, in coincidence with a part of the spectrum in the stationary detector selected by a single channel pulse height analyser, is registered with a TMC 400 channels analyser, for 3 angles between the 2 detectors, 90°, 135° and 180°.

The isomeric state Sb^{124} (93 sec) is prepared by thermal neutron capture in Sb^{123}. Hundred mg of natural antimony contained in a lucite capsule are irradiated for 30 sec. in a flux of 2×10^{12} n/cm2 sec. using the fast pneumatic rabbit installed at the BR1 reactor at Mol [3]. The angular correlation measurements begin 1,5 min after the end of the irradiation; one sample is used for each angle between the 2 detectors and the measurement lasts 1,5 min per sample. Four series of 18 measurements (6 per angle) have been performed. The number of random coincidences and the influence of the long half-life isotopes produced along with Sb^{124} (93 sec.), mainly Sb^{122} (2,8 d) and Sb^{124} (60 d), have been determined experimentally and substracted from the results; their relative importance is low (3 to 4%).

For Sb^{128} (10,8 min), an equilibrium source Sn^{128} - Sb^{128} (effective half-life $\approx$ 67 min) was used since there are no γ-ray cascades in the decay of Sn^{128} to Sb^{128} which could interfere with the ones studied here [2]. The nucleus Sn^{128} was separated from the fission products of U^{235} using the method described previously [2]. Each source was studied for about 3 hours and a total of 7 useful experiments were performed. The influences of random coincidences and longer half-life isotopes is very small in this case ($<1\%$).

The part of the spectrum in the stationary detector selected by the single channel pulse height analyser comprises the double γ-ray lines of the triple cascades which cannot be resolved with the NaI (Tl) crystal, i.e. the

603 + 645 keV and 754 + 754 keV lines in Te^{124} and Te^{128} respectively. The sum of the coincidence spectra in the movable detector obtained at the 3 angles between the 2 counters for all the angular correlation experiments are shown in Slide 3 for Te^{124} and Slide 4 for Te^{128}; they display, as expected, the 505 keV and double 603 - 645 keV lines for Te^{124} and the 320 keV and double 754 keV lines for Te^{128}.

The results of the angular correlation experiments are given in Slide 5. The results for the 645 - 603 keV and 754 - 754 keV cascades in Te^{124} and Te^{128} respectively, given in the second line of Slide 5, confirm the spin sequence 4 - 2 - 0 suggested previously for these cascades [1,2], the theoretical angular correlation of which is given in the fourth column of Slide 5. In this case, it can be shown that the angular correlations for the 505 - 603 keV (the 645 keV γ-ray being unobserved) and 320 - (lower 754 keV γ-ray) (the upper 754 keV γ-ray being unobserved) cascades are identicals with the ones for the 505 - 645 keV and 320 - (upper 754 keV γ-ray) cascades in Te^{124} and Te^{128} respectively. Moreover, the results given in the third line of Slide 5 are in agreement with a spin sequence 6 - 4 - 2 for the 505 - 645 keV and 320 - (upper 754 keV γ-ray) cascades in Te^{124} and Te^{128} respectively, the angular correlation of which is given in the fourth column of Slide 5.

The results do not unambiguously determine the spin of the 1753 and 1.828 keV levels in Te^{124} and Te^{128} as 6. Other values are allowed (4 or 5 for instance) and the results given in the third line of Slide 5 could then be used to determine the dipole- quadrupole mixing parameter in the 505 and 320 keV transitions in Te^{124} and Te^{128} respectively. However, the closeness of the experimental angular correlations for the two triple cascades in Te^{124} and Te^{128} and their agreement with the theoretical angular correlations for a spin sequence 6 - 4 - 2 for the 1753, 1248 and 603 keV levels in Te^{124}

and for the 1.828, 1.508 and 754 keV levels in Te^{128} are strong arguments in favour of the latter spin assignments.

Analogous triple cascades exist in the decay of Sb^{126} to Te^{126} and of Sb^{130} to Te^{130} (ref.[4]); they are shown in the upper part of Slide 6. In the case of Te^{126}, recent experiments [5)] suggest spin 6 for the upper level, at 1.775 keV. If we adopt the spin sequence 6 - 4 - 2 - 0 for the four triple cascades in $Te^{124,\ 126,\ 128,\ 130}$ as indicated in Slide 6, these four "compressed rotational bands" can be interpreted in the frame work of nuclear models. The 2 protons of the tellurium isotopes (Z = 52) with mass $\geqslant$ 124, outside the 50 closed shells, are probably in a g 7/2 orbit, as suggested by the spins of the ground state and first excited level of the odd-mass isotopes of antimony (Z = 51) (ref. 6). The levels with spin 6,4,2,0 in $Te^{124\ \mathrm{to}\ 130}$ could then be identified with those of the $(g\ 7/2)^2$ proton configuration. It is possible to calculate the position of the levels of the $(g\ 7/2)^3$ configuration, i.e. of the odd-mass isotopes of iodine (Z = 53) from those of the $(g\ 7/2)^2$ configuration, taken from the even tellurium isotopes with the same number of neutrons as the iodines. The results for the $7/2^+$, $5/2^+$ and $3/2^+$ levels (Slide 6, b) are compared in Slide 6 with the experimental data (Slide 6 c). One sees that there is a qualitative agreement. In particular, the ground state spin is correctly predicted as well as the motion of the various levels when passing from I^{125} to I^{131}. The absolute value of the levels energies is not in quantitative agreement with experiments; this is probably due to the influence of the neutrons outside closed shells in these isotopes, neglected here.

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