Decay Schemes of Cd^{114} and Te^{125}

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Using the scintillation-crystal summing technique, coincidences between the gamma rays of Cd^{114} and of Te^{125} were studied. In the case of Cd^{114} no indications were seen of the existence of a 1.3-Mev and a 576-kev gamma ray previously reported. In the case of Te^{125}, the 176-kev gamma ray appeared not to be in coincidence with any other gamma rays. It must, therefore, end in a metastable state or the ground state.

COINCIDENCE studies have been made on the γ rays emitted following orbital electron capture of In^{114} and the β decay of Sb^{125}, using the single scintillation crystal summing technique described in a previous letter.[1] This method consists of introducing the nuclear samples at the center of a NaI(Tl) crystal. Coincidences are then revealed by the appearances of new peaks in the γ spectrum whose positions correspond to the sums of the individual energies of the coincident γ rays.

The result for In^{114} is shown in Fig. 1. The upper curve represents the ordinary γ-ray spectrum taken with the sample six inches outside the crystal; a weak peak appears at 1.28 Mev. The lower curve, taken with the sample inside the crystal, shows a marked strengthening of the 1.28-Mev peak. This is interpreted as being due to the coincidences between the 552-kev and the 725-kev γ rays. No indication is noticed, however, of a sum peak representing the coincidence between the 1.3-Mev and the 552-kev γ rays as is required by the decay shown in Fig. 1. This decay scheme was taken from the table of isotopes compiled by Hollander, Perlman, and Seaborg.[2] The 1.3-Mev γ ray, if it exists, must be much weaker in intensity than has been reported.[3] The strong β activity of In^{114} and the 22.6-kev K x-rays of Cd^{114} produced from electron capture were mostly cut off by a 2.5-mm copper shield and therefore essentially do not interfere with the measurements.

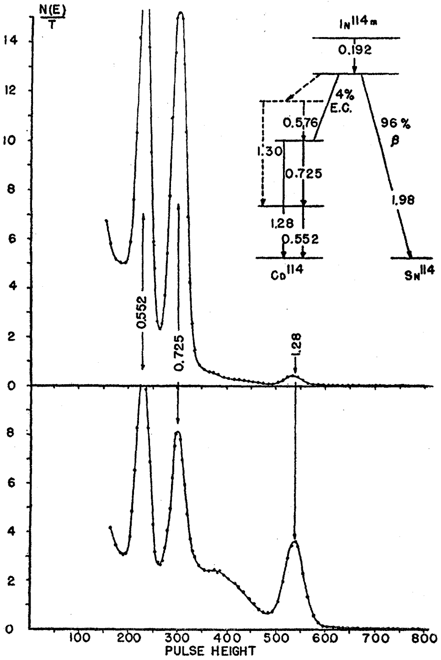

FIG. 1. γ-ray spectra of Cd^{114}. Energies in Mev indicated at the top of peaks.

The γ rays of Te^{125} following β decay from Sb^{125} have been studied by previous investigators.[4,5] Figure 2 shows the results of the present investigation and the decay scheme proposed by Siegbahn and Forsling.[4] The dotted curve represents the ordinary γ-ray spectrum with the sample outside, the solid curve with the sample inside. The shift in positions of the 425-kev and the 601-kev peaks are interpreted as an indication of their being in coincidence with the 27-kev K x-ray from the very highly internally converted 35-kev transition. The decay scheme also indicates that the 176-kev γ ray is in cascade with the 425-kev and the 35-kev transitions. In view of the relatively high efficiency of the crystal for the low-energy 176-kev γ ray and the 27-kev x-ray, this cascade should be clearly revealed,

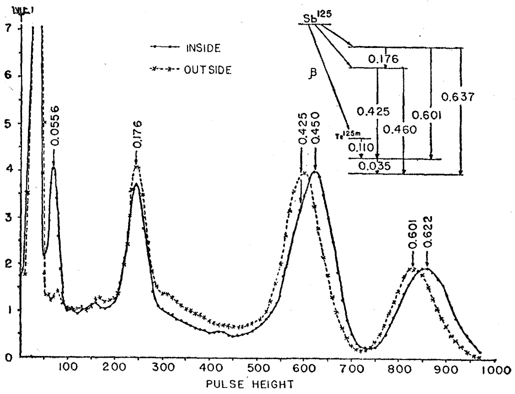

FIG. 2. γ-ray spectra of Te^{125} dotted curve with sample outside crystal, solid curve with sample inside. Energies in Mev indicated at the top of peaks.

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[1] D. C. Lu and M. L. Wiedenbeck, Phys. Rev. 94, 501 (1954).

[2] Hollander, Perlman, and Seaborg, Revs. Modern Phys. 25, 469 (1953).

[3] Johns, Cox, Donnelly, and McMullen, Phys. Rev. 87, 1134 (1952).

[4] K. Siegbahn and W. Forsling, Arkiv. Fysik 1, 505 (1949).

[5] Kern, Mitchell, and Zaffarano, Phys. Rev. 76, 94 (1949).

when the sample is inside, by (a) a shift to the right of the position of the 176-kev peak as a result of its coincidence with the 27-kev x-rays; and (b) a marked increase in intensity for the peak at 622 kev due to the coincidence between the 176-kev and the 425-kev γ rays. Such indications, however, are definitely lacking here. If the good energy fitting of this decay scheme is to be preserved, one must assume that the energy level at 470 kev is metastable with a half-life longer than several microseconds. However, γ rays originating in this level have been reported to have low e/γ factors. An alternative solution is to place the 176-kev transition elsewhere. This would require a fourth β transition from Sb^{125}, which has not been reported.

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A β-Decay Matrix Element for a Deformed Core Model*

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The *ft* value for an allowed unfavored β transition, calculated on a deformed core$+$single-particle model, is ≤ 3 times the single-particle value and about 4 percent of the observed value. The deformations of initial and final states were based on their quadrupole moments. The calculation indicates that for this model core orthogonality generally does not account for the difference between allowed favored and unfavored *ft* values.

I. INTRODUCTION

THERE exist many nuclei whose quadrupole moments are much larger than can be expected from the shell model. For example, the quadrupole moments of two In ($Z=49$) isotopes and two Sb ($Z=51$) isotopes, which, according to that model, have single-hole and single-particle proton configurations, are approximately three times the theoretical values. It is noteworthy, however, that the signs of quadrupole moments are quite generally (as for In and Sb) those predicted by shell theory, and further, that no anomalous quadrupole moments appear for those nuclei which have both closed neutron and closed proton shells$\pm$one nucleon. In order to explain the high quadrupole moments observed in some regions, deformed core models have been introduced.[1]

Another discrepancy between shell theory and experiment appears in the *ft* values for allowed β transitions. The shell model calculations indicate that all allowed transitions should have *ft* values of about the same order of magnitude.[2] Actually, nearly all *ft* values for allowed transitions fall into two groups: Favored, $\log ft=2.9$ to 3.6, and unfavored, $\log ft=4.5$ to 6.0. Empirically, it appears that only transitions between states which, according to the supermultiplet theory, should belong to the same supermultiplet, are favored. Nearly all of these transitions appear for light nuclei (with mass number $A<40$). On the other hand, nearly all allowed transitions for heavier nuclei, as well as many for the light nuclei, have unfavored *ft* values. It is for the heavier nuclei that anomalously high quadrupole moments appear, and one might suspect that a deformed core model which accounts for these would also account for the high unfavored *ft* values. There is no indication at all, however, that substantial core deformations exist for light nuclei, so that the unfavored *ft* values which appear in that region would remain unexplained. It will be seen below that the most obvious interpretation of the deformed core model, in terms of a wave function in configuration space, fails to account for the whole difference between favored and unfavored transitions even in medium heavy nuclei. This need not be considered as a conflict between the deformed core models and experiment because the deformed core model's wave function in ordinary configuration space has not hitherto been specified closely enough to permit definite conclusions to be drawn. On the contrary, it may be hoped that the flexibility of the model is sufficient to avoid the apparent difficulty to which we are drawing attention.

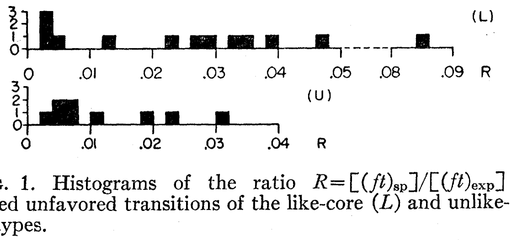

FIG. 1. Histograms of the ratio $R=[(ft)_{\mathrm{sp}}]/[(ft)_{\mathrm{exp}}]$ for allowed unfavored transitions of the like-core (L) and unlike-core (U) types.

In a deformed core$+$one particle model (for odd-A

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