EXPERIMENT 5.2

Beta End Point Energy of ^{204}Tl

Experimental Procedure

1. Remove the source and replace it with the ^{204}Tl source. Accumulate a spectrum for ^{204}Tl for a period of time that is long enough to get reasonable statistics in the spectrum. The ^{204}Tl spectrum will resemble fig. 5.2 which is a pure β emitter. The number of counts/ch at the height h_1 in the spectrum should be approximately 500.

2. From the spectrum select ten points that are evenly spaced between h_1 and h_2 in your ^{204}Tl spectrum (see fig. 5.2). Record in Table 5.2, the channel numbers and the number of counts in these channels. From the calibration curve determine the energy of each point that was taken.

Discussion

The shape of the β distribution for ^{204}Tl will be fitted to a Kurie plot and the end point energy can accurately be determined from this plot.

For an allowed β transition, the pulse height distribution for a given β can be written:

$$\frac{1}{W}\left(\frac{N(E)}{G(Z,W)}\right)^{1/2} = K\,(E_0 - E) \qquad (5)$$

where

N(E) = the number of counts at energy E
W = E + 1; E is the energy of the point in MeV divided by 0.511
G(Z,W) = The modified Fermi function (see ref. 5).

Table 5.2 Data Table for the Kurie Plot of ^{204}Tl

Channel Number	Energy (MeV)	N(E)	W	P	G(Z,W)	$\frac{1}{W}\left(\frac{N(E)}{G(Z,W)}\right)^{1/2}$

For this experiment G(Z,W) can be obtained from Table 5.3. In these dimensionless units, $P = (W^2 - 1)^{1/2}$. This is the momentum of the electron. For example, assume that the energy of one of the points N(E) is 0.50 MeV. Therefore W = .5/.511 + 1 or 1.978. This would give the momentum a value $p = [(1.978)^2-1]^{1/2} = 1.71$. The corresponding value of G(Z,W) from Table 5.3 would be 20.8.

Table 5.3 Modified Fermi Function G(Z,W) for the β Decay of ^{204}Tl (See Reference 5)

P	G(Z,W)	P	G(Z,W)
0.0	28.26	0.9	24.53
0.1	28.19	1.0	23.98
0.2	27.99	1.2	22.95
0.3	27.67	1.4	22.01
0.4	27.25	1.6	21.17
0.5	26.76	1.8	20.41
0.6	26.23	2.0	19.72
0.7	25.66	2.2	19.10
0.8	25.09	2.4	18.54

Exercise On linear graph paper, make a plot of P vs G(Z,W). Calculate the dimensionless momentum P for each Energy in Table 5.2. Record these (P) values in the table. From the curve of P vs G(Z,W) read off G(Z,W) for each of the momentum values and record them in Table 5.2. Calculate $1/W\,[N(E)/G(Z,W)]^{1/2}$ for each point and record in the table. Make a plot of $1/W\,[N(E)/G(Z,W)]^{1/2}$ versus the energy of the point in MeV. Figure 5.6 shows this typical Kurie plot for ^{204}Tl. Look up the accepted value in ref. 1 or ask the instructor.

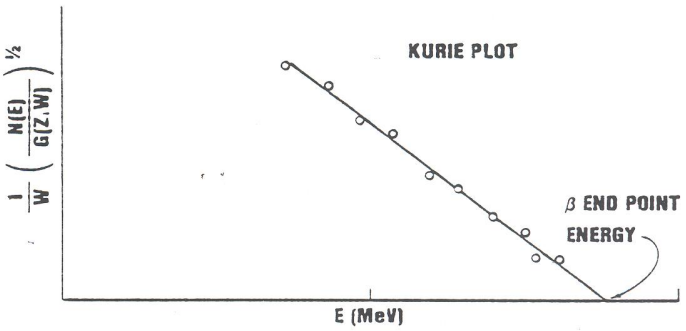

Figure 5.6. Typical Kurie Plot for the Allowed Beta Transitions from ^{204}Tl.