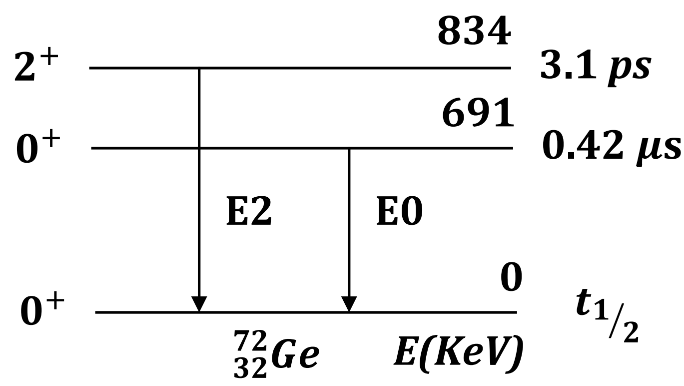
(مثال محلول في كتاب الفيزياء النووية صفحة **240 – 241**)



The fig. above shows a decay scheme for germanium $^{72}_{32}Ge$ isotope. The excited state ($\mathbf{0^+}$) decay to the ground state ($\mathbf{0^+}$) transferring of type (**E0**) , and with a half – life of ($\mathbf{0.42\mu s}$) , and in this case the transition will be internal conversion (**E0**) , while the near level from it in the $\mathbf{2^+}$ (half – life of **3.1 ps**) , and it can be decayed to the ground level by emission of $\boldsymbol{\gamma - rays}$, with a transition of (**E2**) and with a very short time. Also , it can be decayed with internal conversion of coefficient ($\boldsymbol{\alpha}(\mathbf{E2}) = \mathbf{49 \times 10^{-4}}$).

for (**E0**) transition $\lambda_\gamma = \mathbf{0}$

$$\lambda_{tot.} = \lambda_e = \alpha(\mathbf{E0}) = \mathbf{0.693}/t_0 \; ----- \; (\mathbf{7.33})$$

and for (**E2**) transition (from eq. (7.28))

$$\lambda_{tot.} = \lambda_\gamma(\mathbf{1} + \alpha) = \gamma(\mathbf{E2})[\mathbf{1} + \alpha(\mathbf{E2})] = \frac{\mathbf{0.693}}{t_2} \; ----- \; (\mathbf{7.33})$$

From these two equations [**7.32** , **7.33**] we can get the relation by which internal conversion coefficient type is (**E0**) can be calculated.

$$\frac{\alpha(\mathbf{E0})}{\lambda_{tot.}} = \frac{\mathbf{0.693}/t_0}{\mathbf{0.693}/t_2} = \frac{t_2}{t_0}$$

$$\therefore\ \alpha(E0) = \frac{t_2}{t_0} \times \lambda(E2)[1 + \alpha(E2)] \quad ----- \quad (7.34)$$

Where **λ(E2)** can be calculated from the relation

$$\lambda(E2) = 7.28 \times 10^7\ A^{4/3}\ E^5$$

And by substituting in eq. (**7.34**) with the given values , we can calculate the value of **α(E0).**

(مثال محلول في كتاب الفيزياء النووية صفحة **242**)

Example : calculate the internal conversion coefficient for the transition (**E0**) of $^{72}_{32}Ge$ nucleus , if you know that the internal coefficient for $2^+ \rightarrow 0^+$ transition is (4.9×10^{-4}) , **A = 72** , $t_2 = 3.1 \times 10^{-12}$ **sec** , $t_0 = 0.42 \times 10^{-6}$ **sec** , **E = 0.834 MeV.**

Solution : The internal conversion coefficient for **E0** transition from $0^+ \rightarrow 0^+$ can be calculated from eq. (**7.34**)

$$\alpha(E0) = \frac{t_2}{t_0} \times \lambda(E2)[1 + \alpha(E2)]$$

$$\lambda(E2) = 7.28 \times 10^7\ A^{4/3}\ E^5$$

$$= 7.28 \times 10^7 \times (72)^{4/3} \times (0.834)^5$$

$$= 7.28 \times 10^7 \times (3 \times 10^2) \times (0.4)$$

$$\lambda(E2) = 8.8 \times 10^9\ sec^{-1}$$

$$\therefore\ \alpha(E0) = \frac{3.1 \times 10^{-12}}{0.42 \times 10^{-6}} \times 8.8 \times 10^9 [1 + 4.9 \times 10^{-4}]$$

$$= 64.95 \times 10^3 + 31.8$$

$= (64.95 + 0.031) \times 10^3$

$\alpha(E0) = 6.5 \times 10^4$

as it is expected $\alpha(E0) \gg \alpha(E2)$

(مثال محلول في كتاب الفيزياء النووية صفحة **243 – 244**)

Example : calculate the internal conversion coefficient $\alpha_K(E2)$ for **K – shell** and (**E2**) transition , for the two decays of energy **1.72 MeV** and **1.22 MeV** of the two nuclei ${}^{22}_{10}Ne$, ${}^{182}_{74}W$ alternatively and then prove that the ratio of the two coefficients is equal approximately to the ratio between their atomic numbers.

Solution : As the transition is an electric so we can use eq.(**7.45**) , where **n = 1** for **K – shell** , as the transition type is (**E2**) , **L = 2**

$$\alpha_K(E2) = \frac{Z^3}{n^3} \times \frac{L}{L+1} \times \left(\frac{1}{137}\right)^4 \times \left(\frac{2m_ec^2}{E_i - E_f}\right)^{2+5/2}$$

For ${}^{22}_{10}Ne$ nucleus , $\alpha(E2)$ is equal

$$\alpha_K(E2) = \frac{(10)^3}{1^3} \times \frac{2}{2+1} \times \left(\frac{1}{137}\right)^4 \times \left(\frac{1.022}{1.27}\right)^{9/2}$$

$$= 10^3 \times \frac{2}{3} \times (0.28 \times 10^{-8}) \times (0.376)$$

$$= 0.07 \times 10^{-5}$$

$\alpha_K(E2) = 7 \times 10^{-7}$

For ${}^{182}_{74}W$ nucleus

$$\alpha_K(\mathbf{E2}) = \frac{(74)^3}{1^3} \times \frac{2}{2+1} \times \left(\frac{1}{137}\right)^4 \times \left(\frac{1.022}{1.22}\right)^{9/2}$$

$$= 4.05 \times 10^5 \times \frac{2}{3} \times (0.28 \times 10^{-8})\,(0.45)$$

$$\alpha_K(\mathbf{E2}) = 0.34 \times 10^{-3} = 3.4 \times 10^{-4}$$

Now we prove that the ratio between the two conversion coefficients is equal to the ratio between the atomic numbers of the two nucleus

$$\frac{\alpha_K({}^{22}_{10}Ne)}{\alpha_K({}^{182}_{74}W)} = \left(\frac{Z_1}{Z_2}\right)^3$$

$$\frac{7 \times 10^{-7}}{3.4 \times 10^{-4}} = \left(\frac{10}{74}\right)^3$$

$$2 \times 10^{-3} \cong 2.4 \times 10^{-3}$$