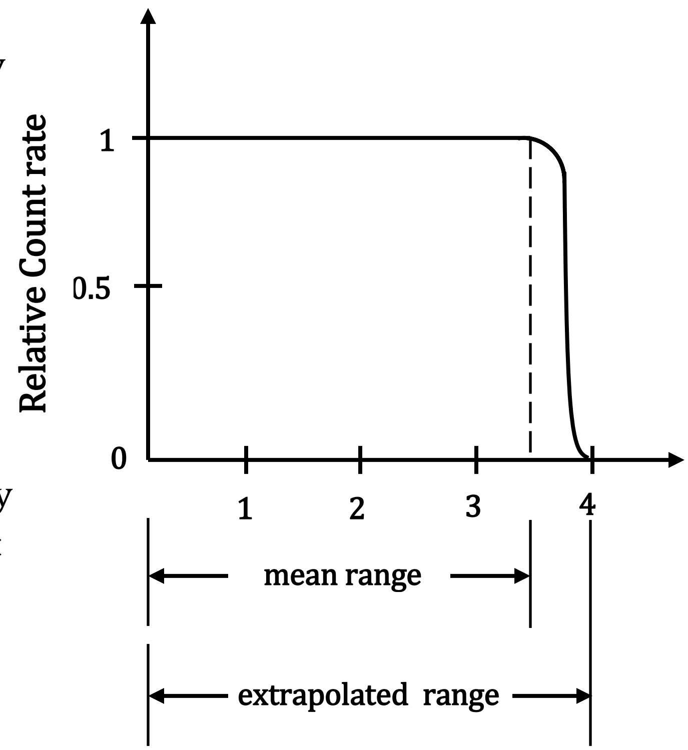
Range – Energy Curves :

Alpha particles absorption curve is flat because **α - radiation** is essentially monoenergetic particles. Near the very end of the curve , the absorption rate **decreases** due to straggling phenomena or the combined effects of the statistical distribution of the average energy loss per ion and the scattering by the absorber nuclei.



The mean range is the most accurately determined range . The range in air at **0°C** and **760 mm Hg** pressure is (**within 10% error**) given by **:**

$\mathbf{R(cm) = 0.56\ E\ (MeV)}$ for $\mathbf{E_\alpha < 4\ MeV}$

$\mathbf{R(cm) = 1.24\ E\ (MeV) - 2.62}$ for $\mathbf{E_\alpha < 4 < 8\ MeV}$

$\mathbf{\bar{R}(cm) = 0.318\ E^{3/2}}$ ⇒ in general for **all** $\mathbf{E_\alpha}$

The range of **α - particles** in any other medium is given by **:**

$$\mathbf{R_{med.}(mg/cm^2) = 0.56\ A^{1/3} \times R_\alpha(air)}$$

Where

$\mathbf{R_\alpha}$ = **the range of α - particles in air (in cm).**

A = atomic mass number of the medium.

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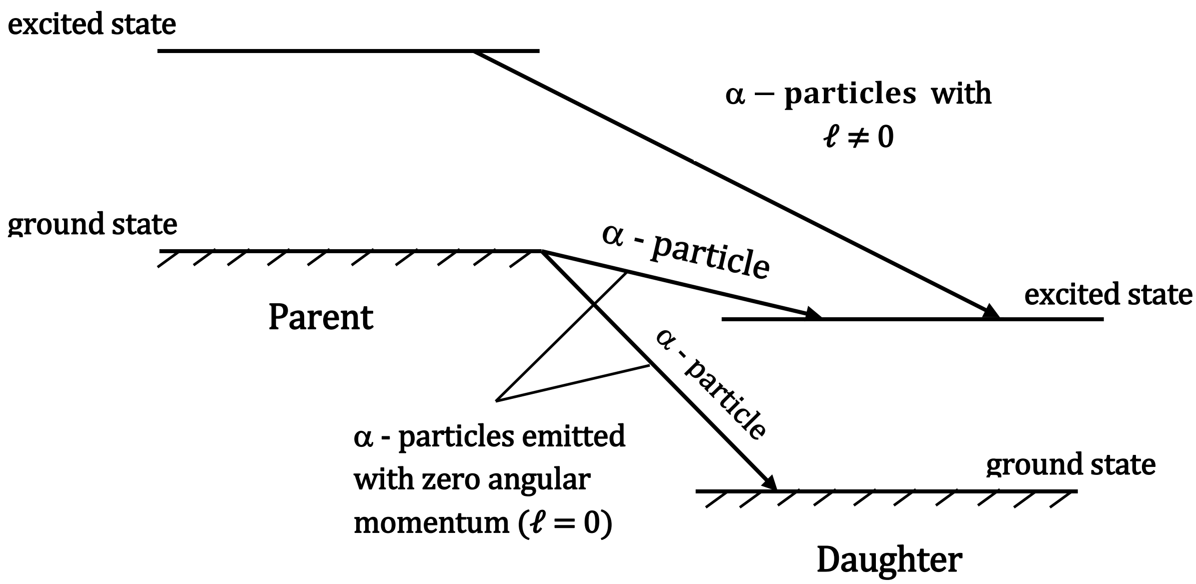
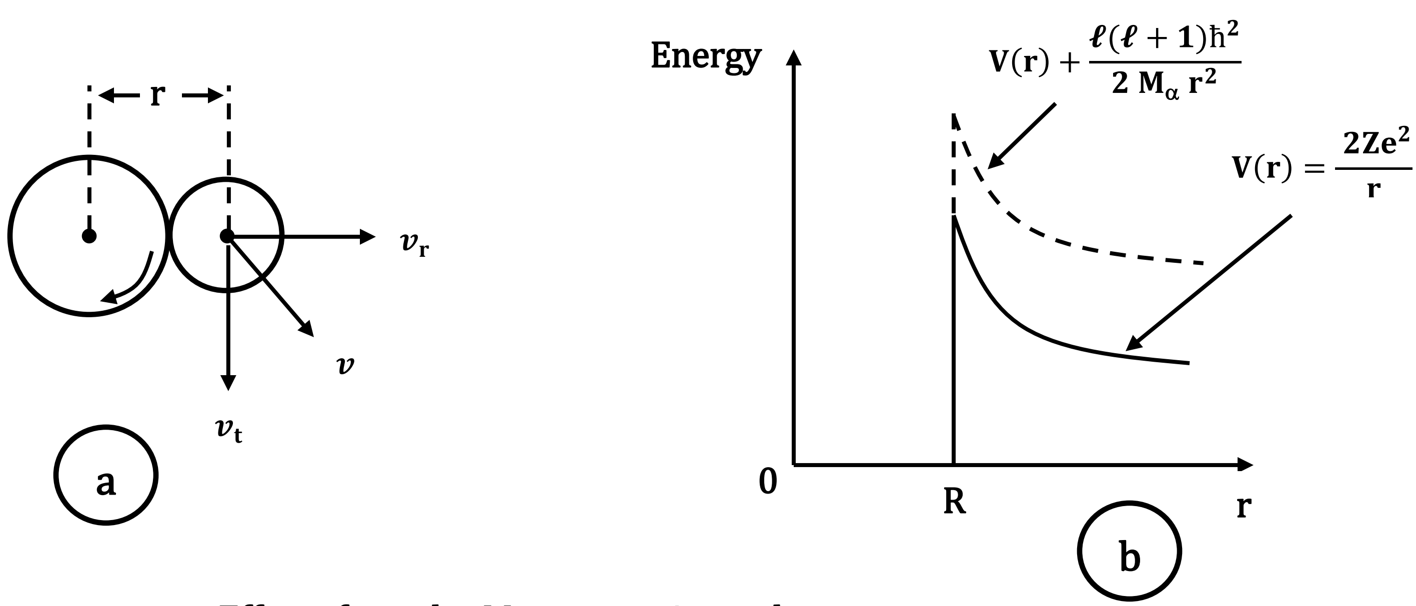
Hindrance Factor

The theory of **α - decay** is applied only to ground state decay of **even – even** nuclei , where **no** angular momentum ($\ell = 0$) is carried by **α - particles.**



When the decay of an excited state of the daughter an angular momentum change will happened , this will affect the decay constant (λ_α).



Effect of angular Momentum in α - decay
(a) Classical interpretation.
(b) Modification of the effective thickness.

When α **- particle** leaves the nucleus (**even from the classical point of view**) the daughter nucleus will obtain an angular momentum (**recoil**).

$$\mathbf{L} = \mathbf{M}_\alpha \boldsymbol{v}_\mathbf{t}\, \mathbf{r} \quad , \quad \boldsymbol{v}_\mathbf{t} = \frac{\mathbf{L}}{\mathbf{M}_\alpha\, \mathbf{r}}$$ $\boldsymbol{v}_\mathbf{t}$ is the tangential component of $\boldsymbol{\upsilon}$

The kinetic energy in the tangential direction $\mathbf{E}_\mathbf{t} = \frac{1}{2}\mathbf{M}_\alpha\, \boldsymbol{v}_\mathbf{t}^2 = \frac{1}{2}\mathbf{M}_\alpha \frac{\mathbf{L}^2}{\mathbf{M}_\alpha^2\, \mathbf{r}^2}$, and since $\mathbf{L}^2 = \boldsymbol{\ell}(\boldsymbol{\ell} + \mathbf{1})\hbar^2$, then $\mathbf{E}_\mathbf{t} = \frac{\boldsymbol{\ell}(\boldsymbol{\ell} + \mathbf{1})\hbar^2}{\mathbf{M}_\alpha^2\, \mathbf{r}^2}$ which known as the **centrifugal potential**, that <u>**must**</u> be included in the spherical coordinates , therefore ; the total potential = $\mathbf{V}(\mathbf{r}) + \frac{\boldsymbol{\ell}(\boldsymbol{\ell} + \mathbf{1})\hbar^2}{2\mathbf{M}_\alpha\, \mathbf{r}^2}$ includes the **hindrance factor** $\boldsymbol{\ell}(\boldsymbol{\ell} + \mathbf{1})\hbar^2/\mathbf{M}_\alpha^2\, \mathbf{r}^2$.