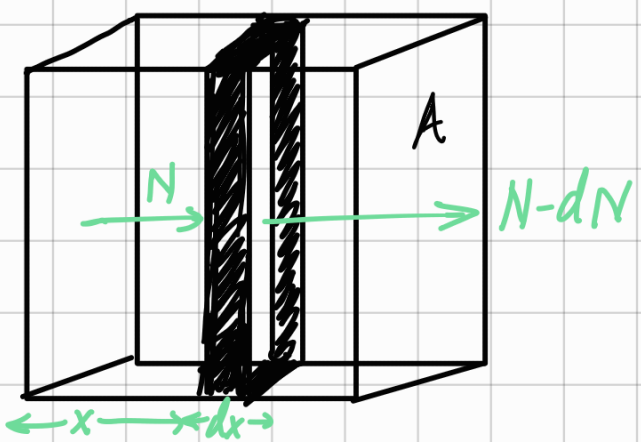
Nuclear Cross Section

The probability of the occurence of a nuclear reaction is measured by nuclear cross section.

Each nucleus has some area perpendicular to the incident beam such that if bombarded particle incident on this area the reaction will occur and if bombarded particle fall outside this area no reaction takes place, this effective area is called nuclear cross section σ.

& $\sigma = \pi R^2$

The nuclear cross section is of order $10^{-28} m^2$ & common unit used for nuclear cross section is barn.



dN = no. of particles which interact with nucleus.

n = no. of atoms per unit volume.

no. of target nucleus in vol Adx

$= n A dx$

σ = nuclear cross section.

Total nuclear C.S of all target nucleus

$= \sigma n A dx$

$$\frac{\text{No. of interacting particles}}{\text{Total incident particles}} = \frac{\text{Total cross section}}{\text{Total area of slab}}$$

$$\therefore \frac{dN}{N} = \frac{\sigma n A dx}{A} = \sigma n dx$$

$$\boxed{\sigma = \frac{dN/N}{n\,dx}}$$

If we take whole slab of thickness x &

N_0 = no. of incident particles

N = particles left after reaction

$$\therefore \int_{N_0}^{N} \frac{dN}{N} = -\int_{0}^{x} n\sigma dx$$

$-$ indicates decrease in no. of particles.

$$\therefore \boxed{N(x) = N_0 e^{-n\sigma x}}$$

As nuclear c.s increases, no. of particles decreases.

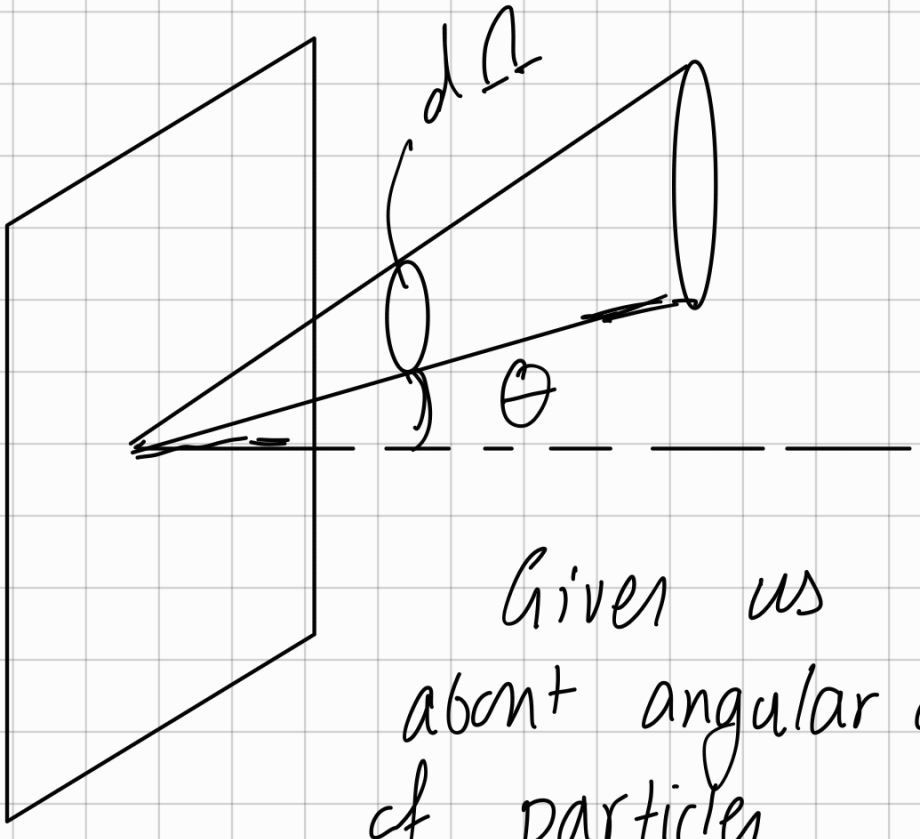
When this nuclear c.s is defined in terms of solid angle ($d\Omega$), then it is called differential cross section and is defined as $\frac{d\sigma}{d\Omega}$

Also, total c.s is the sum of several partial c.s $\quad \sigma_T = \sigma_{sc} + \sigma_r$

σ_{sc} = scattering c.s; when an incident particle is simply scattered we call it scattering c.s

σ_r = reaction c.s.

when incident particle is absorbed and a new product is formed.



Gives us info about angular dist of particles.

$\frac{d\sigma}{d\Omega}$ is defined as no. of particles scattered into unit solid angle per unit time per unit incident flux per target point.