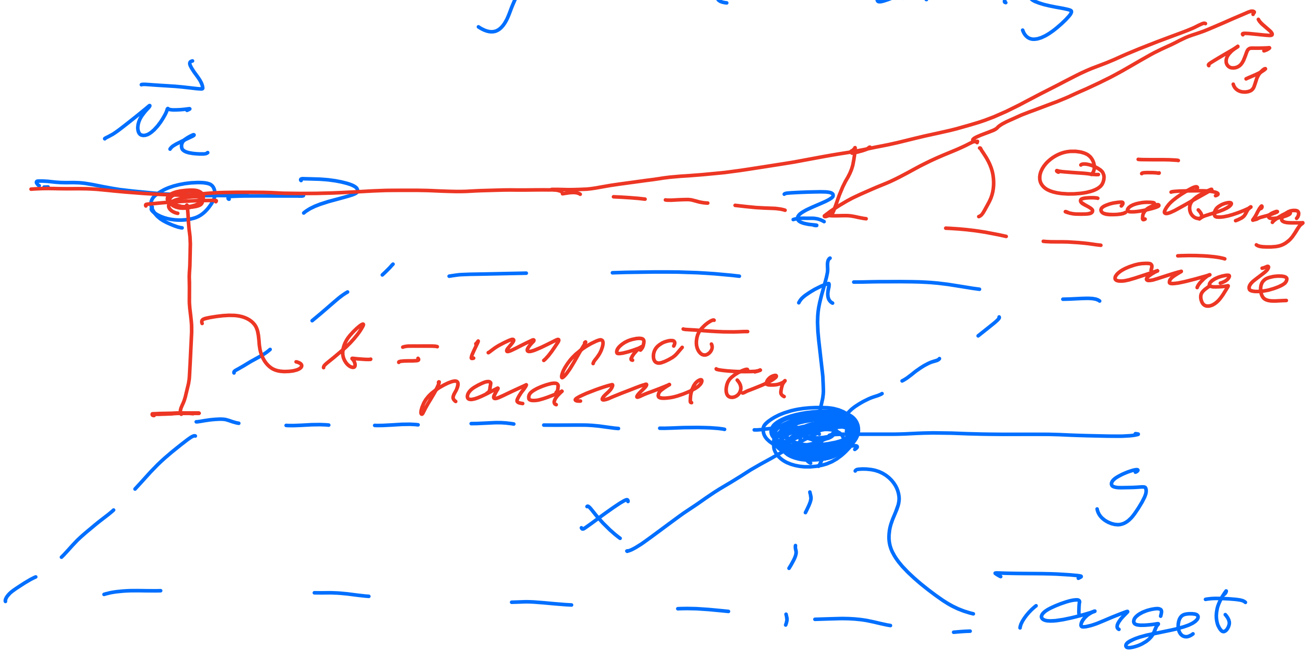
PHY 321, APRIL 11, 2022

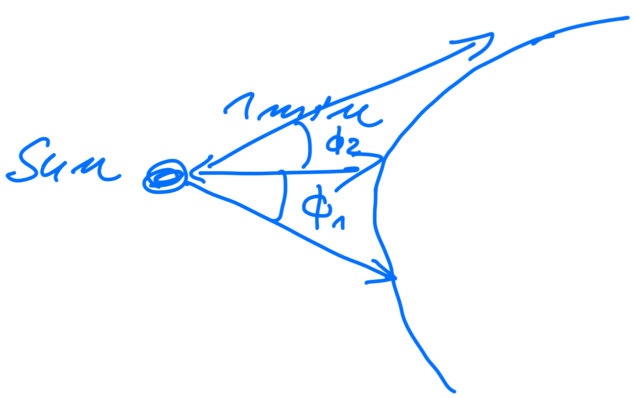
Two-body scattering

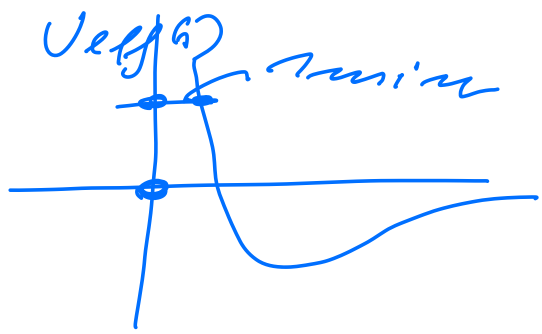


$$V(r) = -\alpha/r$$

$$\left\{ \begin{array}{l} \alpha = G m_1 m_2 \\ \alpha = \frac{1}{4\pi\varepsilon_0} q_1 q_2 \end{array} \right.$$

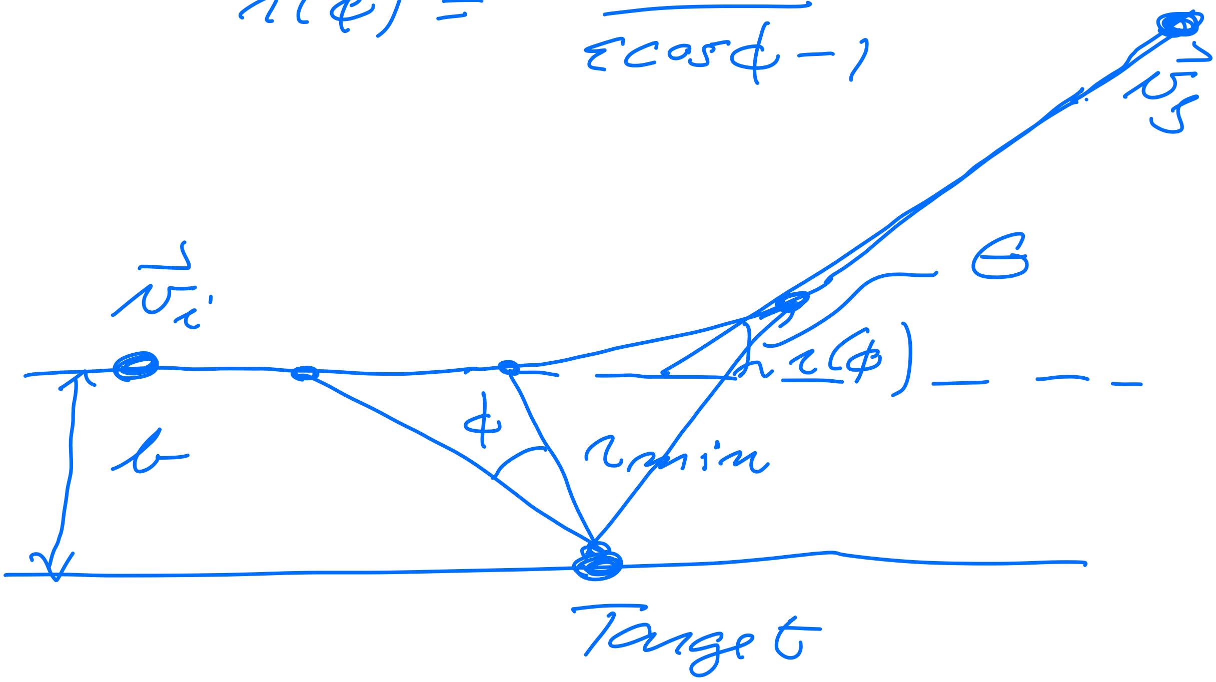
$$r(\phi) = \frac{c}{1 + \varepsilon \cos\phi}$$





$$V(r) = \alpha/r$$

$$r(\phi) = \frac{c}{\varepsilon \cos\phi - 1}$$



when $r = -\infty$ (far away)

$$E = \frac{1}{2}\mu v_i^2 + 0$$

only kinetic

$$r = +\infty$$

$$E = \frac{1}{2} v_f^2 \cdot \mu$$ kinetic energy

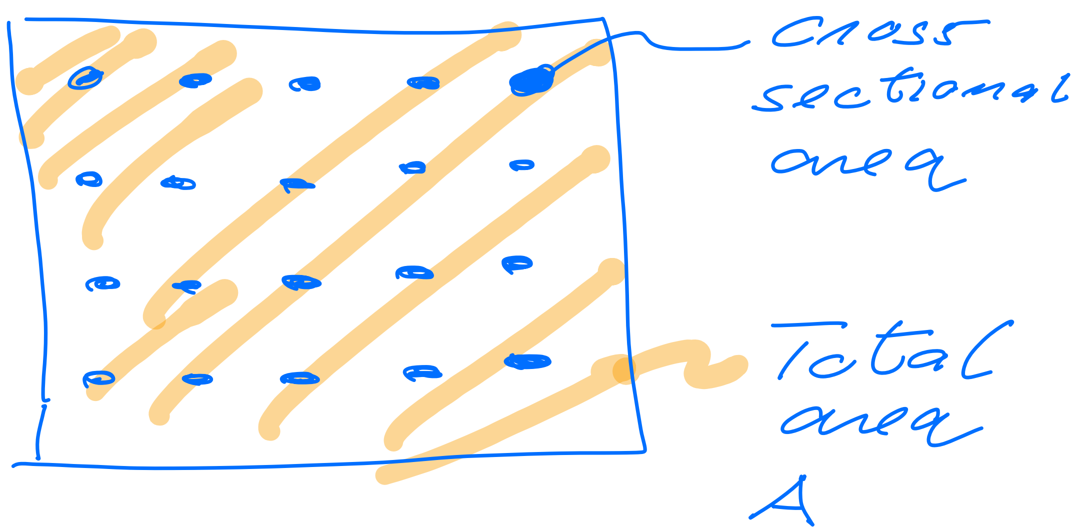
$r(\phi)$ (theoretical result)

we want to relate this to Θ (expt), the cross section σ (expt)

cross - section [illegible]
and the impact parameter - b -

- ## More definitions

- cross section
- Target assembly



ρ_t = number of targets per area

targets = number of targets
$= \rho_t \cdot A$

- likelihood of making

a hit:

- cross sectional area

$$\sigma = \pi R^2$$

 — target with radius R.

Total area of all target

$$= \sigma \cdot \rho_t \cdot A$$

probability of hit

$$= \frac{\text{area occupied by targets}}{\text{total area}}$$

$$= \frac{\rho_t \cdot A\,\sigma}{A} = \rho_t \cdot \sigma$$

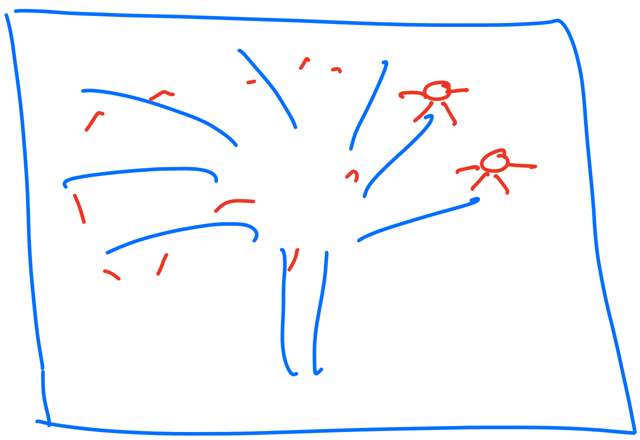
want this as function of θ, b

- Number of scattered:

$= N_{scatter} = N_{incoming} \times \rho_t \cdot \sigma$

σ = effective area of the targets interacting with a beam of particles

Example (Taylor)



oak tree

$A = 150 ft^2$

50 pigeons each with $\sigma = 1 ft^2$

Fire 60 bullets randomly

$N_{hits} = N_{incoming} \times \rho_{pigeons}\ \sigma$

$\rho_{pigeons} = \frac{50}{150} = \frac{1}{3}\ ft^{-2}$

$N_{hits} = 60 \times \left(\frac{1}{3}\ ft^{-2}\right)\left(\frac{1}{2}\ ft^{2}\right)$

$\simeq 10$ pigeons

In nuclear physics

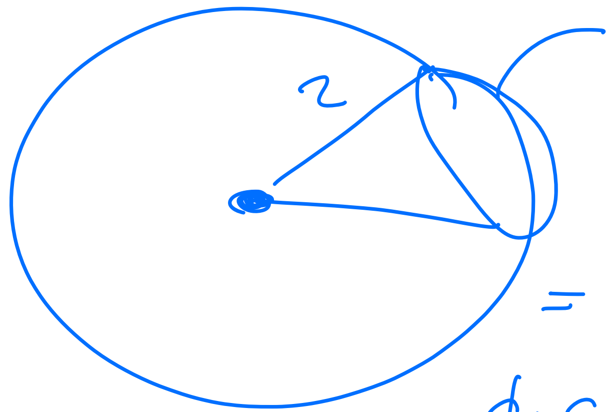
$R \sim 10^{-14}\ m$

$\sigma \sim 10^{-28}\ m^{2} = 1$ barn

Expt : θ, cross section σ

$$\sigma = \int \frac{d\sigma}{d\Omega}\, d\Omega$$

Sphere and solid angle

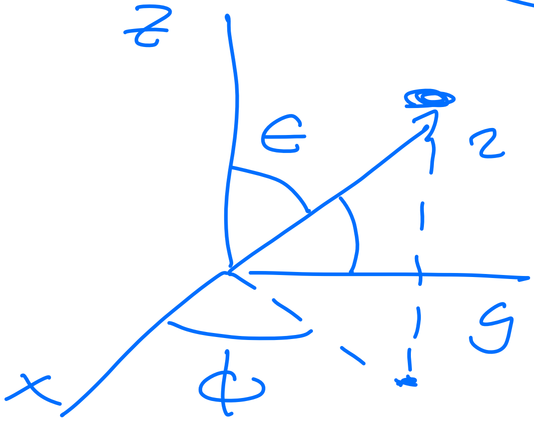


area A

$$d\Omega = A/r^2 = d\phi \sin\theta \, d\theta$$

$$\phi \in [0, 2\pi]$$

$$\theta \in [0, \pi]$$



$$\frac{d\sigma}{d\Omega} = \frac{b \, db}{\sin\theta \, d\theta}$$