\[
\frac{d\sigma}{d\cos\theta} = 2\pi Z^2 \lambda^2 \left( \frac{\hbar c}{E_K} \right)^2 \frac{1}{(1-\cos\theta)^2}
\]

\[
b = \frac{K q_1 q_2}{m v^2} \sqrt{\frac{1 + \cos\theta}{1 - \cos\theta}} = \frac{2 K Z e^2}{m v^2} \sqrt{\frac{1 + \cos\theta}{1 - \cos\theta}}
\]

Cross section for a scattering at angles greater than \( \Theta_{\text{min}} \)

\[
\sigma = \int_{0}^{b_{\text{max}}} db \frac{d\sigma}{db} = 2\pi \int_{0}^{b_{\text{max}}} b \cdot db = \pi b_{\text{max}}^2
\]

\[
b_{\text{max}} = \frac{K Z e^2}{E_K} \sqrt{\frac{1 + \cos\Theta_{\text{min}}}{1 - \cos\Theta_{\text{min}}}}
\]

\[
\sigma = \pi Z^2 \left( \frac{K e^2}{E_K} \right)^2 \frac{1 + \cos\Theta_{\text{min}}}{1 - \cos\Theta_{\text{min}}}
\]
In class problem

A beam of $d^{-}$ particles ($E_K = 5$ MeV) are incident on a silver nucleus ($Z = 47$).

What must the flux be to see scattering into angles greater than $\frac{\pi}{2}$ at 1 event/second?
Solution

\[ \sigma = \pi \left( \frac{K e^2}{E_k} \right)^2 = \pi \left( \frac{47}{5 \times 10^6 \text{ eV}} \right)^2 \left( \frac{1.44 \text{ eV} \cdot 10^{-9} \text{ m}}{5 \times 10^6 \text{ eV}} \right) = 5.8 \text{ b} \]

\[ l_b = 10^{-28} \text{ m}^2 \]

\[ \Gamma = \frac{R_S}{\Phi} \leftarrow \text{Scattering Rate} \]

\[ \Phi = \frac{R_S}{\sigma} = \frac{R_S}{\pi \left( \frac{E_k}{K e^2} \right)^2} = 1.7 \times 10^{27} \text{ m}^{-2} \text{ s}^{-1} \]

\[ = 1.7 \times 10^6 \text{ Å}^{-2} \text{ s}^{-1} \]
Scattering by thin foils

- foil thickness = \( L \)
- foil is made up of atoms with
  - atomic mass \( A \)
  - density \( \rho \)

number density \( n = \frac{N_A \rho}{A (10^{-3} \text{ kg})} \)

\( N_A \) or grams, since

\( N_A \) is related to grams

\( (N_A = \text{number of atoms in 12 g of } C_{12}) \)

effective flux \( \Phi = \frac{R_i \ln n}{v} = \frac{R_i \ln N_A \rho}{A (10^{-3} \text{ kg})} \)

\( \frac{J}{\Phi} = \frac{R_s A (10^{-3} \text{ kg})}{R_i \ln N_A \rho} \)

No longer need to know flux, just

incident rate of \( \alpha \)-particles,
For 5 MeV α-particles incident on silver

τ = 5.8 b for scattering events larger than \( \frac{\tau}{2} \)

for a silver foil of lam thickness

what incident rate do we need to see

1 event/s?

\[
R_i = \frac{R_s A \left(10^{-3} \text{ Kg}\right)}{\sigma L N_A \rho}
\]

\(\rho = 1.05 \times 10^4 \text{ Kg/m}^3\)

\(A = 108\)

\[
R_i = \frac{(1 \text{ s}^{-1})(108)(10^{-3} \text{ Kg})}{(5.8 \times 10^{-28} \text{ m}^2)(10^{-6} \text{ m})(6.02 \times 10^{23})(1.05 \times 10^4 \text{ Kg/m}^3)}
\]

\(R_i = 30,000 \text{ α-particles/second}\)