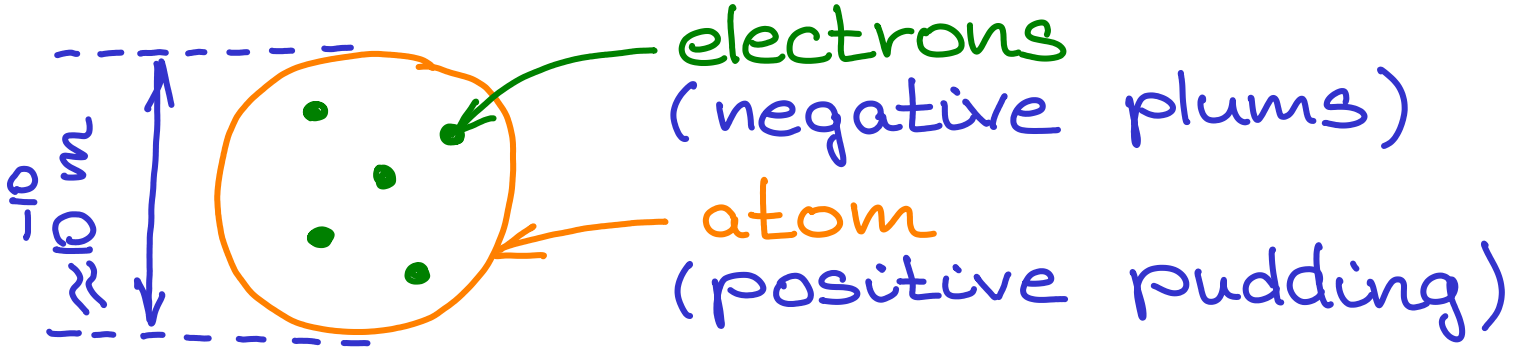
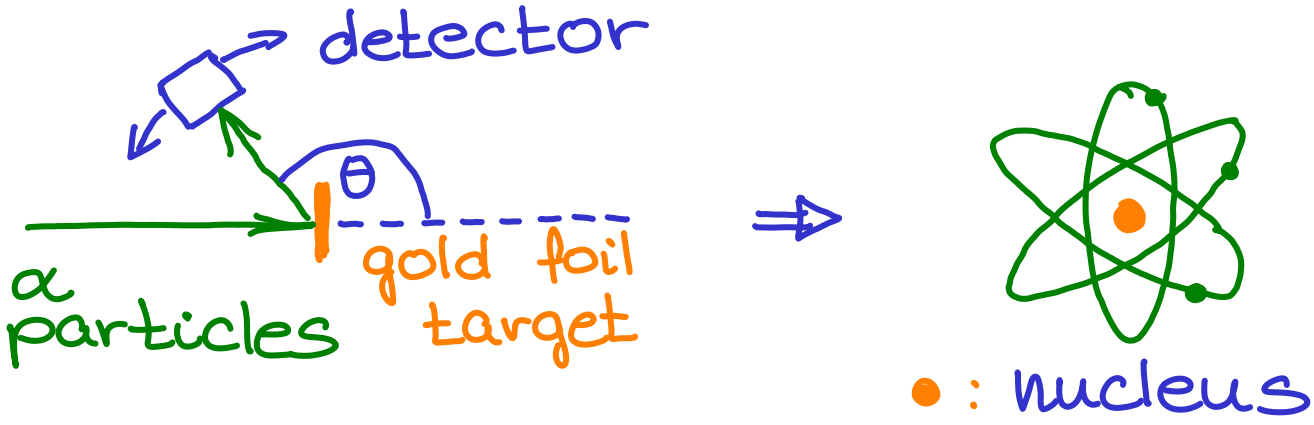
The structure of atoms

J.J. Thomson: plum-pudding model



Lord Ernest Rutherford (Nobel in Chemistry, 1908): very small and massive core: nucleus.



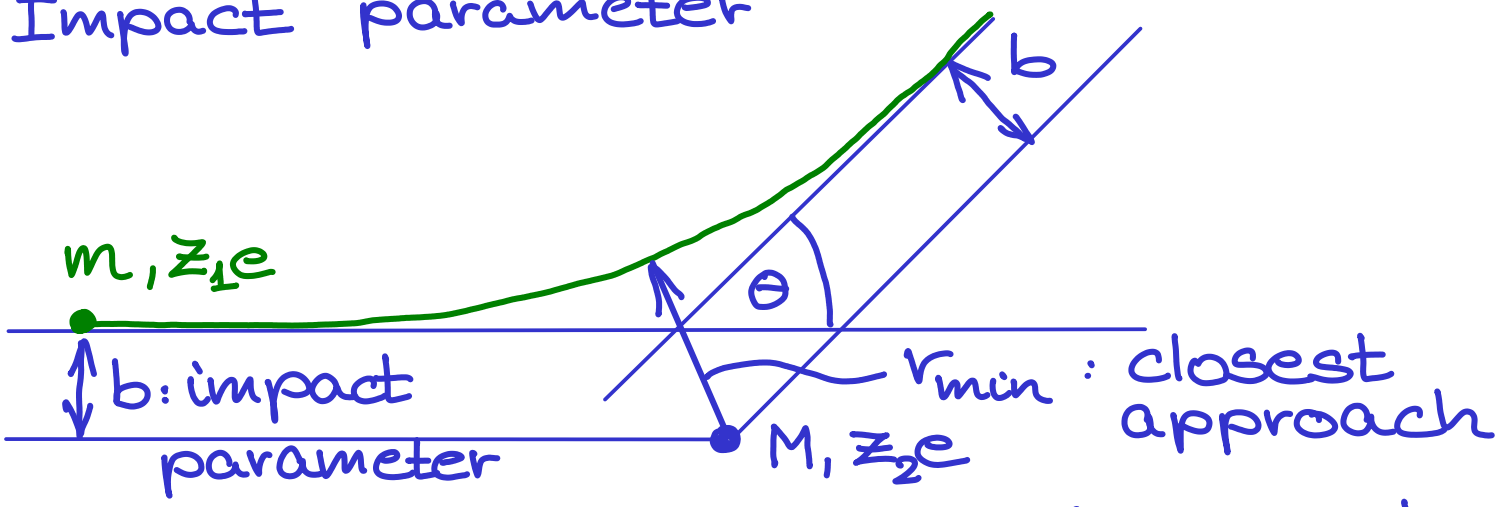
atom $\approx 10^{-10}$ m = 1 Å (Angström)

nucleus $\approx 10^{-15}$ = 1 fm = 1 fermi

fm: femtometer

Rutherford scattering 1.

Impact parameter



→ force : Coulomb : $F_e = k\frac{(z_1e)(z_2e)}{r^2}$

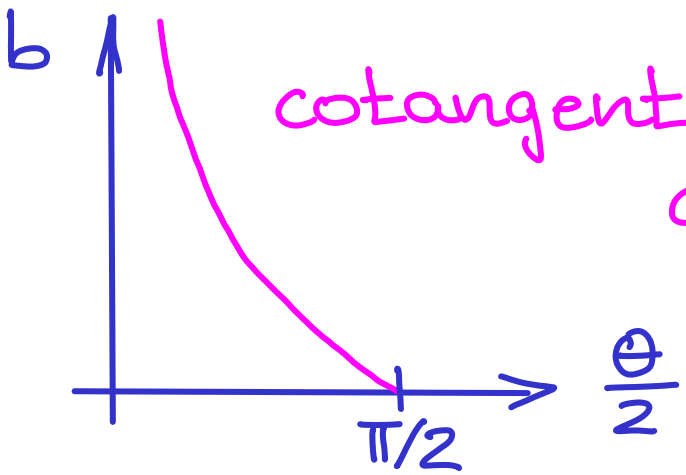
→ the bombarding and the target particles are point-like

→ $M \gg m \Rightarrow KE_f = KE_i$ for the bombarding α particle

→ very thin target : only one scattering occurs

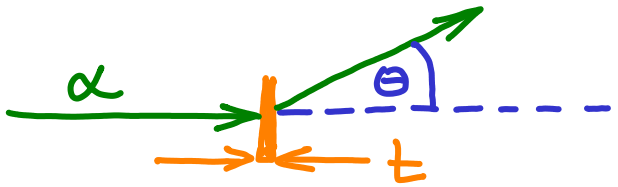
$$b = \frac{1}{2} k (z_1e)(z_2e) \cdot \frac{1}{KE} \cdot \cot\left(\frac{\theta}{2}\right)$$

$$\left[k = \frac{1}{4\pi\varepsilon_0}\right]$$



$$\cot(\alpha) = \frac{1}{\tan(\alpha)}$$

Rutherford scattering 2.



$$n = \frac{\#\text{ of atoms}}{\text{volume}}$$

t = thickness

$$nt = \frac{\#\text{ of atoms}}{\text{area}}$$

Integral form:

$$f = \frac{\pi}{4} nt \left(kZ_1eZ_2e\right)^2 \cdot \frac{1}{KE^2} \cdot \cot^2\left(\frac{\theta}{2}\right)$$

Differential form:

$$\frac{N(\theta)}{N_i} = \frac{1}{16} \cdot nt \cdot \left(kZ_1eZ_2e\right)^2 \cdot \frac{1}{KE^2} \cdot \frac{1}{r^2} \cdot \frac{1}{\sin^4\left(\frac{\theta}{2}\right)}$$

$[f] = 1$ f: fraction

$\left[\frac{N(\theta)}{N_i}\right] = \frac{1}{m^2}$ $N(\theta)$: number of scattered particles per unit area