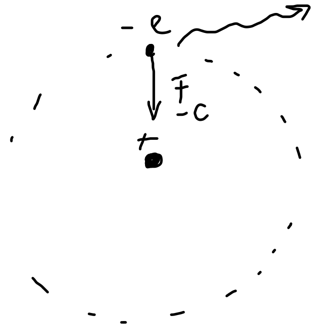
Modello di Rutherford



$r_{atomo} \approx \mathring{A} \quad (10^{-10} m)$

$r_{nucleo} \approx 10^{-15} m$

$$\oint_c \underline{E} \cdot d\underline{l} = -\frac{\partial}{\partial t} \int_S \underline{B} \cdot d\underline{S}$$

$$\oint_c \underline{B} \cdot d\underline{l} = \mu_0 I_{conc} + \varepsilon_0 \mu_0 \frac{\partial}{\partial t} \int_S \underline{E} \cdot d\underline{S}$$

$j = nqv$ $\quad$ Se $a \neq 0 \Rightarrow \vec{v} = \vec{v}(t)$

dens. corrente $\quad$ $I^{conc} = j \cdot S = I^{conc}(t)$

Mi aspetto $B = B(t)$ $\Rightarrow \exists \, \underline{E}^{\neq 0}$ indotto ed è "spesso" funzione di t

Moto circolare dell'elettrone

$$K_e \frac{e^2}{\cancel{r^2}} = m_e \cdot a_c = m_e \cdot \frac{v^2}{\cancel{r}} \; ; \quad v^2 = \frac{K_e e^2}{m_e r}$$

$$E_{el} = \frac{1}{2} m_e v^2 + U_{es} = \frac{1}{2} \cancel{m_e} \frac{K_e e^2}{\cancel{m_e} r} - \frac{K_e e^2}{r} = -\frac{K_e e^2}{2r} \qquad t \sim 10^{-8}\,s$$

$$v = \underbrace{\omega r} \; ; \quad \omega = \underbrace{2\pi\nu} \; ; \quad \nu = \frac{1}{2\pi}\omega$$

$$\nu = \frac{1}{2\pi}\frac{v}{r} = \frac{1}{2\pi}\left(\frac{K_e e^2}{m_e r}\right)^{\frac{1}{2}} \cdot \frac{1}{r} \propto \frac{1}{r^{3/2}}$$

Postulati di Bohr

1) Le orbite possibili (stabili) sono quelle per cui

$$L = m v r = n \hbar \qquad n = 1, 2, 3 \ldots$$

$$\hbar \stackrel{\text{def}}{=} \frac{h}{2\pi}$$ h → cost. di Planck

2) Le transizioni possibili sono tra orbite stabili.

$$h\nu = E_{\text{radiazione}} = E_n - E_m$$

energie degli stati n ed m

$$v^2 = \frac{e^2}{4\pi\varepsilon_0 m_e r} \qquad v = \frac{n\hbar}{mr}$$

a_0 raggio di Bohr $\simeq 0.53\,\mathring{A}$

$$\frac{n^2\hbar^2}{m^{\cancel{2}} r^{\cancel{2}}} = \frac{e^2}{4\pi\varepsilon_0 \cancel{m_e} \cancel{r}} \; ; \quad r = \underbrace{\left(\frac{4\pi\varepsilon_0 \hbar^2}{e^2 m_e}\right)}_{a_0} \cdot n^2 \qquad n = 1, 2, 3 \ldots$$

$$r_n = n^2 \cdot a_0$$

$$r = a_0,\ 4a_0,\ 9a_0 \ \ldots$$

$Ry \simeq 13.6\,eV$

$$E_{el} = \frac{-e^2}{8\pi\varepsilon_0 r_n} = -\underbrace{\frac{e^2}{8\pi\varepsilon_0 a_0}}_{Ry} \cdot \frac{1}{n^2}$$

$$E_n = -Ry/n^2 \qquad n = 1, 2 \ldots$$

$$h\nu = E_n - E_m = -Ry/n^2 + Ry/m^2$$

$$\nu_{m,n} = \frac{Ry}{h}\left(\frac{1}{m^2} - \frac{1}{n^2}\right) \qquad m, n = 1, 2, 3 \ldots$$

$$\lambda\nu = c \, ; \quad \lambda_{m,n} = \frac{c}{\nu_{m,n}}$$

$m = 2$ $n = 3$ $\lambda \simeq 657$ nm (rosso)

$n = 4$ $\lambda \simeq 486$ nm (verde)

$n = 5$ $\lambda \approx 434$ nm (blu)

$E = h\nu$

$\lambda\nu = c$

$p = E/c = \frac{h\nu}{c} = \frac{h}{\lambda} \Longrightarrow \lambda = \frac{h}{p}$

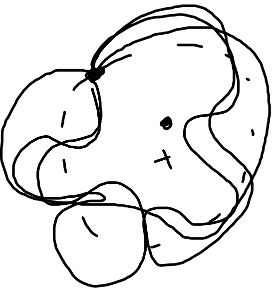
$\nu = E/h$

$m = 70\ kg \qquad v \approx 5\ km/h \approx 1.4\ m/s$

$\lambda \approx \frac{h}{mv} \approx 6.6 \cdot 10^{-36}\ m \qquad L = mvr = n\hbar$

Elettrone su orbita $n=1$ $\qquad r_n = a_0 \qquad p = mv = \frac{L}{r} = \frac{\hbar}{a_0} = \frac{h}{2\pi a_0}$

$\lambda = \frac{\cancel{h}}{\cancel{h}} 2\pi a_0 = \underbrace{2\pi a_0}_{\text{lungh. dell'orbita } n=1}$



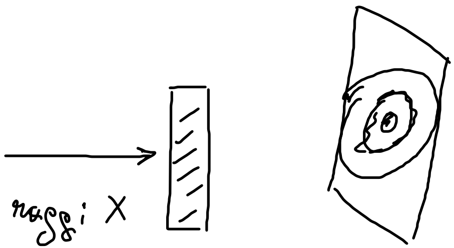
$$2\pi r_n = n\lambda \qquad n = 1, 2, 3 \ldots$$

onde si "chiude" sull'orbita

$$2\pi r_n = n\frac{h}{p} \; ; \quad r_n = \frac{n}{2\pi}\frac{h}{p}$$

$$L = rmv = rp = \frac{n}{2\pi}\frac{h}{\cancel{p}}\cdot\cancel{p} = n\hbar$$

(1° postulato di Bohr)



$$2d\sin\theta = n\lambda$$

λ fissata (es $\lambda = 1$ Å)

$$p = \frac{h}{\lambda} \; ; \quad \lambda = \frac{h}{p}$$

$$E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$

$$v = p/m$$

$$E = \frac{p^2}{2m} = \frac{h^2}{2 m_e \lambda^2} \approx 150\ eV$$

$$\lambda = 1\ \text{Å}$$

Eq. Schrödinger $\qquad \psi(\underline{x}, t)$

$$\left[-\frac{\hbar^2}{2m} \nabla^2 + \underbrace{V(\underline{x}, t)}_{\text{potenziali}} \right] \psi(\underline{x}, t) = i\hbar \frac{\partial \psi}{\partial t}$$

Pr. indeterm per un'onda $\qquad |\psi(\underline{x}, t)|^2 \Delta V$

$$\Delta x \, \Delta k \geq \frac{1}{2}$$

$$k = \frac{2\pi}{\lambda} \qquad A \cos(kx - \omega t) \qquad \lambda = \frac{2\pi}{k}$$

$\lambda = \frac{h}{p}$; $\quad k = \frac{2\pi}{\lambda} = \frac{2\pi p}{h}$

$$\Delta x \Delta k = \Delta x \frac{2\pi}{h} \Delta p \geq \frac{1}{2}$$

$$\boxed{\Delta x \Delta p \geq \frac{\hbar}{2}}$$

Pr. incert.

$m = 70\ kg \quad v = 1.4\ m/s \quad \Delta x = 10^{-3}\ m \Longrightarrow \Delta p \sim \frac{\hbar}{\Delta x} \sim 10^{-31}\ kg\,m/s$

atomul Bohr

$\Delta x \sim a_0 \qquad \Delta p \sim \hbar / a_0$

$p = \hbar / a_0 \qquad \frac{\Delta p}{p} \sim 100\%$