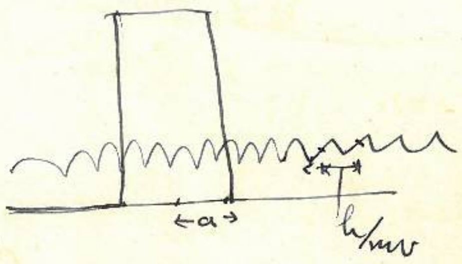
Mott, Handbuch 24 I, Kap 6. 833.

Neutronの衝突

Bohr ならば

Rigid sphere with ~~a <~~ radius $a \ll \hbar/mv$ とすると.

cross section は $4\pi a^2$



∴ ~~nucleus~~ proton, electron に対し

同じ cross section を得る.

これは実験と合はぬ. electron の mass が

小さいから. Neutron が undurchdringlich であるためには

Wechselwirkungsenergie 10^{12} volt 位でなければならぬ.

W.W.E. 10^6 volt 位とすると. Electron と Neutron の

cross section は Born の appr. ~~では~~ では

$$4\pi\left(\frac{2M}{\hbar^2}V\frac{a^3}{3}\right)^2 = (10^{-17}\,\mathrm{cm})^2$$

$$M = \frac{M_e M_n}{M_e + M_n}$$

$V = 10^6$ volt. $a = 2.10^{-13}$ とすると.

すると. 10^{11} cm の Wegstrecke で 一つの Ionenpaar が生ずることになる.

Kern との stoß では.

$$4\pi\left(\frac{2MV}{\hbar^2}\frac{r_0^2}{3}\right)^2 \simeq \pi r_0^2$$

$$M = M_K M_N / M_K + M_N \sim M_n$$

$r_0 \sim 10^{-12}$ cm. $\rightarrow V \sim \frac{3}{4}\frac{\hbar^2}{M r_0^2} \sim 3.10^5$ volt.

$$\left\{\Delta + \frac{2M}{\hbar^2}(E - V)\right\}\psi = 0.$$

$$\psi = e^{ikz} + \psi'$$

$$\int \frac{e^{-ikr}}{r}\cdot\frac{2M}{\hbar^2}V\cdot e^{ikz}\cdot r^2 dr \, \cancel{d\theta} \sin\theta \, d\theta \, d\varphi \qquad \frac{e^{ikr}-e^{-ikr}}{ik}$$

$$= 2\pi\frac{2MV}{\hbar^2}\int_{r=0}^{a} \cancel{e^{-ikr(1-\cos\theta)}\, r\, dr \sin\theta\, d\theta} \; e^{-ikr}\left(\frac{e^{ikr}-e^{-ikr}}{ik}\right) r\, dr.$$

$$= 2\pi\cdot\frac{2MV}{\hbar^2}$$

$W\psi = H\psi$ $\qquad H_0 = \frac{\hbar^2}{2M}\Delta.$

$i\hbar \frac{\partial \psi}{\partial t} = (H_0 + V)\psi$

$\psi = \sum_n c_n \exp \frac{i}{\hbar}(k_n r - W_n t)$

$i\hbar \dot{c}_n = \{(\frac{k_n^2}{2M} - W_n)\delta_{nm} + V_{nm}\} c_m e^{\frac{i}{\hbar}(W_n - W_m)t}$

$i\hbar c_n(t) = \cancel{(\frac{k_n^2}{2M} - W_{0n}}\quad V_{n0} \frac{e^{\frac{i}{\hbar}(W_n - W_0)t} - 1}{\frac{i}{\hbar}(W_n - W_0)} c_n(0)$

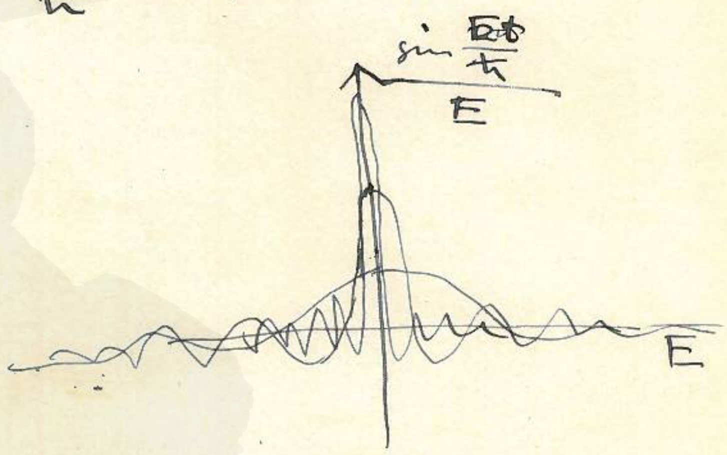
$\cancel{i\hbar \int c_n(t)\, dW_n = V_{n0} \int \frac{e^{\frac{i}{\hbar}(W_n - W_0)t} - 1}{\frac{i}{\hbar}(W_n - W_0)} dW_n}$

$\hbar^2 |c_n(t)|^2 = |V_{n0}|^2 \cdot \hbar^2 \frac{2(1 - \cos \frac{W_n - W_0}{\hbar} t)}{(W_n - W_0)^2}.$

$d|c_n(t)|^2 = dt \cdot |V_{n0}|^2 \frac{2}{\hbar} \frac{\sin \frac{W_n - W_0}{\hbar} t}{W_n - W_0}$

$= dt\, |V_{n0}|^2 \cdot \frac{2\pi}{\hbar} \delta(W_n - W_0)$

$\int_{-\infty}^{\infty} \frac{\sin \frac{W_n - W_0}{\hbar} t}{W_n - W_0} d(W_n - W_0) = \pi.$



$W_n = \frac{k_n^2}{2m}$

$\cancel{dk}\int \delta(W_n - W_0)\, dW_n$

$0 \leq t < \tau.$

$\cancel{\sum_n |c_n(\tau)|^2 = \sum_n |V_{n0}|^2 \frac{1 - \cos \frac{W_n - W_0}{\hbar}}{(W_n - W_0)^2}}$

$= \int \frac{k_n\, dk_n}{m}$

$\delta(W_n - W_0) = \frac{m}{k_n} \delta(k_n - k_0)$

$\left(\frac{k_n}{\hbar}\right)^2 4\pi\, d\frac{k_n}{\hbar}.$

$4\pi \frac{k_n^2}{\hbar^3} \cdot dk_n$

$|V_{n0}|^2 \frac{2\pi}{\hbar} \cdot \frac{4\pi m k_n}{\hbar^3} \cdot dk_n\, \delta(k_n - k_0)$

$\frac{4\pi a^3}{3}$

$$\iiint |V_{\cancel{kk_0}}|^2 \frac{2\pi}{\hbar} \delta(W_k - W_0)\, dk\, d\theta\, d\varphi \quad \cancel{d\omega_n \; d\theta}$$

$$\cdots \int \frac{m}{\hbar k'} dk' \qquad \delta(k' - k_0)$$

$$\cancel{= 4\pi \quad V}$$

$$(k\,\theta\varphi | V | k_0\, \theta_0 \varphi_0) = \frac{1}{h^3} \int e^{i(k_n - k_0) r}\, V r^2 dr\, \sin\theta\, d\theta\, d\varphi.$$

$$= \frac{1}{h^3} \iiint e^{i k' r \cos\theta} \sin\theta\, d\theta\, d\varphi \cdot V r^2 dr$$

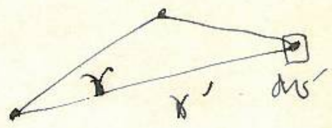
$$= \frac{2\pi}{h^3} \int_0^a \left(e^{ik'r} - e^{-ik'r}\right) \frac{1}{ik'r} V r^2 dr$$

$$e^{ik'r} \cdot \frac{r^2}{2}$$

$$= \frac{2\pi V}{h^3 \cdot ik'} \int_0^a \left(e^{ik'r} - e^{-ik'r}\right) r\, dr$$

$$A\cancel{V} = \frac{[\alpha\, r]}{r^3}$$

$$(\Delta + k^2)\psi_1 = \frac{\alpha_x y - \alpha_y x}{r^3} e^{ikz}$$

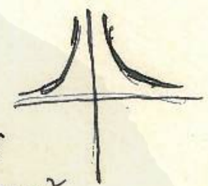


$$\psi_1 = \iiint \frac{e^{ik(|r' - r| + z')} (\alpha_x y' - \alpha_y x')}{|r' - r| \cdot r'^3} dv'$$

$$\alpha_x y' - \alpha_y x' =$$

$$\sin\theta' \sin\varphi' \quad \sin\theta' \cos\varphi'$$

$$= \frac{e^{ik(|r'-r| + z')} \left(\alpha_x \frac{y'}{r'} - \alpha_y \frac{x'}{r'}\right)}{|r' - r|} \sin\theta'\, d\theta'\, d\varphi$$



$$\frac{m}{2\pi\hbar^2} \frac{V_{mean}}{k} \cancel{\iiint dx'\, dy'\, dz'} =$$

$$\frac{Ze^2}{r} \qquad \frac{e^2}{\hbar c}.$$

$$\beta > Z e^2 \alpha$$

$$\hbar v_0 \sim e_1 e_2$$

$$\cancel{m v^2} \; \frac{e_1 e_2}{r} \quad v$$

$$\hbar v_0 = \frac{e_1 e_2}{\alpha \frac{\hbar}{mc}}$$