DEPARTMENT OF PHYSICS
OSAKA IMPERIAL UNIVERSITY.

DATE May 4, 1935
NO. 9

新談話会原稿.

Nuclear Collision における Resonance の問題.

近頃の Fermi Proton Effect の発見は、slow neutron に対する capture or disintegration の cross section は非常に大きなものであることを ~~暗示させる~~ 示す。その原因として種々のことが考へられるが、最も手近なのは resonance の問題である。之は neutron に限らず、proton, α-particle に対しても考へうる。而して proton の場合においては resonance の存在することが ~~最近~~ 実験的に証明(?)された。

§ Charged Particle の Anomalous Scattering.

high energy の α-particle に対しては scattering は Rutherford の formula から deviate する。
之は nucleus の近傍で field が Coulomb field から deviate していることに原因する。

DEPARTMENT OF PHYSICS
OSAKA IMPERIAL UNIVERSITY.

DATE..........
NO..........

Resonance ~~Scattering~~ Capture.

Neutron.

○ ~~Ptw~~ F. Perrin et W. M. Elsasser, Théorie de la capture sélective des neutrons lents par certains noyaux. (C. R, 200, 450, 1935)

○ G. Beck and L. H. Horsley, Phys. Rev. 47, 510, 1935.

Charged Particles.

○ G. Breit and F. L. Yost, Phys. Rev. 46, 1110, 1934
47, 508, 1935

~~○ G. Beck and L. H. Horsley, Nature,~~

○ Wenzel, ZS. 90, ~~五~~ 754, 1934.

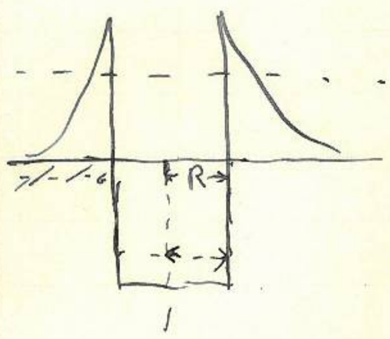
Ordinary Capture

Neutron. Bethe, Peierls.
Massey, Mohr.

DEPARTMENT OF PHYSICS
OSAKA IMPERIAL UNIVERSITY.

DATE
NO.

Capture of charged Particles by Nuclei
(Breit and Yost, Phys. Rev.,)



DEPARTMENT OF PHYSICS
OSAKA IMPERIAL UNIVERSITY.

DATE..........
NO..........

Resonance Scattering の Cross Section

$$|C_0|^2 = \frac{(k_1 R \sin k_2 R \cos k_1 R - k_2 R \sin k_1 R \cos k_2 R)^2}{(k_1 R \sin k_2 R)^2 + (k_2 R \cos k_2 R)^2}$$

k_1の小さな値で、$\cos k_2 R = 0$, となる点とすると、

$$|C_0|^2 \fallingdotseq \frac{k_1^2 R^2 \cancel{\sin k_2}}{\cancel{\sin k_2}\, k_1^2 R^2}$$

$$\simeq 1$$

一般には、 $$|C_0|^2 = \frac{(k_1 R)^2 (\sin k_2 R - k_2 R \cos k_2 R)^2}{(k_2 R \cos k_2 R)^2}$$

$$Q_0 = \frac{4\pi}{k_1^2} \quad ; \qquad Q_0 = 4\pi R^2 \frac{(\sin k_2 R - k_2 R \cos k_2 R)^2}{(k_2 R \cos k_2 R)^2}$$

$\cancel{k_1^2}\ \cancel{1\,\text{volt}}$ $\quad \frac{3.3 \times 1.6}{8} \quad \frac{48 \times 48}{528}$

$$k_1^2 = 2ME/\hbar^2 = 2 \times 1.66 \times 10^{-24} \times \overset{\text{volt}}{V} \times 10^{-12} \times 1.6 \times 10^{54}$$
$$= 5 \times 10^{+18} \times V \text{ volt.}$$

$$Q_0 = \frac{4\pi}{5} \cdot 10^{-18}\, V \cdot \text{cm}^2.$$

(resonance がなければ
$Q_0 = 4\pi \cdot 10^{-25}\ \text{cm}^2$)

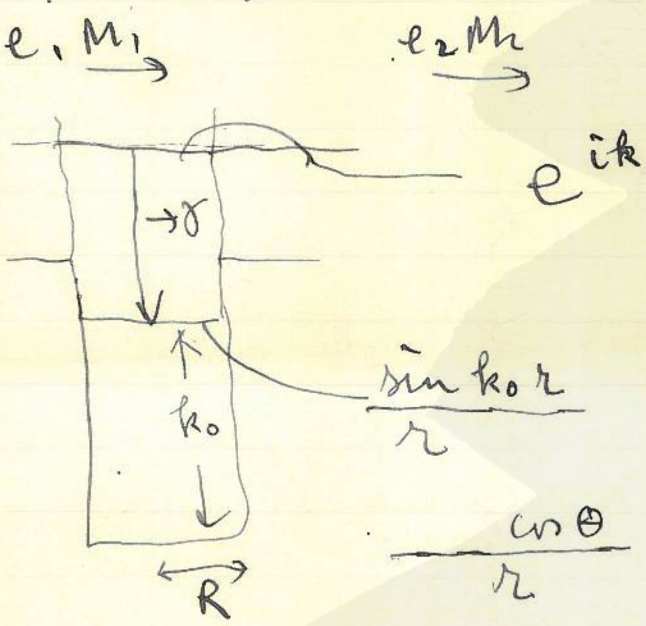
DEPARTMENT OF PHYSICS
OSAKA IMPERIAL UNIVERSITY.

DATE..............

NO..............

Resonance ~~Absorption~~ Capture ; Cross Section

$$\frac{64\pi^4}{3}\left(\frac{\nu}{c}\right)^3\frac{1}{h\nu}\left(\frac{e_1M_2-e_2M_1}{M_1+M_2}\right)^2\left(|x_{0k}|^2+|y_{0k}|^2+|z_{0k}|^2\right)$$



$$e^{ik_1 r\cos\theta} + \cancel{\frac{e^{ik_1 r}}{r}}\sqrt{\frac{\pi}{2}}\frac{1}{k_1}C_0\,\Xi^{+}(r)$$

$$\Xi^{+}(r) = \sqrt{\frac{2}{\pi}}\frac{e^{ik_1 r}}{r}(-i)$$

$$+\ \frac{-i}{k_1}C_0\frac{e^{ik_1 r}}{r}$$

$$\frac{C_0}{k_2}\frac{\sin k_2 r}{r} =$$

$$\frac{-i}{2k_1 r}\left(e^{ik_1 r}-e^{-ik_1 r}+2C_0e^{ik_1 r}\right)_R$$

$$= \frac{C_0}{k_2}\frac{\sin k_2 r}{r}\Big|_R$$

$$\frac{1}{2r}\left(e^{ik_1 r}+e^{ik_1 r}+2C_0e^{ik_1 r}\right)_R$$

$$= \frac{C_0}{\cancel{k_2}}\frac{\cos k_2 r}{r}\Big|_R$$

DEPARTMENT OF PHYSICS
OSAKA IMPERIAL UNIVERSITY.

DATE

NO.

$-i$

k_2R

k_2R

$$\left(\sin k_1R - iC_0 e^{ik_1R}\right) \cancel{\frac{}{k_1R}} = \frac{C_0 \sin k_2R}{\cancel{k_2R}}\ k_1R$$

$$-k_1R)\ \frac{\sin k_1R}{k_2R}\ \cos k_1R + C_0 e^{ik_1R} = C_0 \cos k_2R$$

$$\left(k_2R \sin k_1R \cos k_2R - k_1R \sin k_2R \cos k_1R\right)$$
$$= \left(ik_2R \cos k_2R + k_1R \sin k_2R\right) C_0 e^{ikR}$$

$$|C_0|^2 = \frac{\left(k_2R \sin k_1R \cos k_2R - k_1R \sin k_2R \cos k_1R\right)^2}{(k_2R \cos k_2R)^2 + (k_1R \sin k_2R)^2}$$

$$\left(-ik_2R \sin k_2R + k_2R \cos k_1R\right)$$
$$= C_0\left(-i\sin k_2R\cdot k_1R + k_2R \cos k_2R\right)$$

$$k_2R\ e^{-ik_2R} = C_0\left(k_1R\cdot -i\sin k_2R + k_2R\cos k_2R\right)$$

$$|C_0|^2 = \cancel{\frac{(k_1^2R \sin k_2R)^2 + (k_2R\cos k_2R)^2}{k_2^2R^2}}$$
$$= \frac{k_2^2R^2}{(k_1R\sin k_2R)^2 + (k_2R\cos k_2R)^2}$$

$\cancel{\cos k_2R}$

$$\frac{C_0}{k_2}\int \frac{\sin k_2 r}{r}\cdot \cancel{\frac{\sin k_0 r}{r}}\, r^3 dr$$

$$\frac{1}{R_2^{3}}\cancel{\frac{(\sin k_0 r - k_0 r\cos k_0 r)}{r^2}}$$

$$\frac{C_0}{k_2}\int_0^R \frac{\sin k_2 r}{\cancel{r}}\, \frac{1}{k_0\sqrt{R}}\, \frac{(\sin k_0 r - k_0 r\cos k_0 r)}{\cancel{r^2}}\, \cancel{r^3}\, dr$$

$$= \frac{C_0}{k_2\, k_0^2\sqrt{R}}\int_0^{k_0 R} \sin \underbrace{k_2 r}_{\lambda x}\, (\sin x - x\cos x)\, dx$$

$$\cong \frac{\sqrt{R}}{k_2\, k_0}\, C_0$$

$$Q \cong \frac{64\pi^4}{3}\,\frac{1}{\lambda^3}\,\frac{1}{h\nu}\left(\frac{2e}{m}\right)^2 \frac{|C_0|^2 R}{k_2^2\, k_0^2}$$

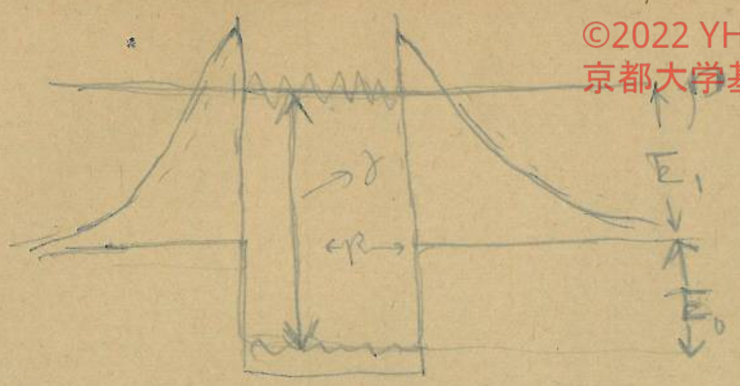
$\lambda = 10^{-10}$

$$= 2\times 10^3 \cdot 10^{30} \cdot \frac{10^{27}}{\underset{2\times 10^{-19}}{6}}\,\frac{1}{\nu}\,\frac{1}{4}\,\frac{|C_0|^2\, 10^{-13}}{\underset{k_0^2}{5\times 10^{24}} \times \underset{k_2^2}{10^{25}}}$$

$$\cong \;\cdot\cdot \times \frac{1}{\nu} \times 10^{-23} \times |C_0|^2$$

10^{-2}.

60
-62



$\cancel{\frac{mv^2}{2} = h\nu - E_0}$

$\cancel{mvc = h\nu}$

~~解~~ $E_1 + E_0 = h\nu$

~~$p = \frac{h\nu}{c}$~~

$\int \psi_{E,Z}^{*} \psi_A \, dv = \cancel{d\theta} \, d\varphi$

$\cancel{\frac{mv^2}{2} - \frac{mv}{c} c + E_0 = 0}$.

~~E_0 : fixed.~~

~~velocity が定まる.~~

v を与へれば, ~~E_0 が定まる.~~

$\iiint$ 厄 e^{ikr}

$r\cos\theta \, e^{ikr\cos\theta} \, r^2 \sin\theta \, d\theta \, d\varphi$

$\frac{64\pi^4}{3}\left(\frac{\nu}{c}\right)^{?} \frac{1}{h\nu}\left(|X_{0K}|^2 + |\quad|^2 + |\quad|^2\right)$

26.3
3 6
1578
789

9.46.8
53.2

1.5) 53.2 (34
45
82.

$\left|\frac{1}{2}+C_l\right|^2 = \frac{1}{4} - \frac{p_l}{4}$

$C_l = |C_l| e^{i\gamma_l}$

$|C_l|\cos\gamma_l + |C_l|^2 + \frac{p_l}{4} = 0.$

$|C_l| = -\frac{1}{2}\left(\cos\gamma_l \pm \sqrt{\cos^2\gamma_l - p_l}\right)$

$p_l = 0$

$|C_l| = -\cos\gamma_l$ or 0.

$\frac{\pi}{2} \le \gamma_l \le \frac{3\pi}{2}$,

$\gamma_l = \frac{\pi}{2} + \delta_l$

$|C_l| = \cancel{-\cos\gamma_l}\ \sin\delta_l$

$0 \le \delta_l \le \pi$

$1 - \frac{(k_2-k_1)^2}{(k_2+k_1)^2} = \frac{4k_1k_2}{(k_2+k_1)^2}$

$\frac{4\pi}{k_1k_2}$

$C_l = \sin\delta_l \cdot e^{i\delta_l}$

$\frac{i\gamma + i\alpha}{}$　$\frac{\gamma-\alpha}{\gamma+\alpha}$　$\frac{k_1}{k_2}$

$k_2^2R^2$

$A \mp B + Ci$　$e^{-i\omega t}$

$\left|\frac{i(A-B)+C}{i(A+B)-C}\right|^2$

$\frac{(k_1-k_2)^2R^2}{\eta_0^2R^2}$　$\frac{ik_1R - ik_2R + \eta_0R}{ik_1R + ik_2R - \eta_0R}$　$\frac{C^2+(A-B)^2}{C^2+(A+B)^2}$

$\mp\frac{(k_1+k_2)^2R^2}{\eta_0^2R^2}\ \eta_0R - \frac{2k_1R}{(\eta_0R)^2}$

$= 1 - \frac{2k_1R}{\eta_0R}$

$$\frac{4\pi}{k_1}\sum_l (2l+1)$$

$$C_l = -\left(\frac{\Xi_l' - \Xi_l \frac{d\ln\chi_l}{dr}}{\Xi_l^{(+)\prime} - \Xi_l^{(+)}\frac{d\ln\chi_l}{dr}}\right)_{r=R}$$

$l=0,$ $$\Xi_0 \cancel{\propto} \cancel{\sqrt{\frac{k_1}{r}}} \cdot \frac{1}{2}\left(\Xi_l^{(+)} + \Xi_l^{(-)}\right)$$

$$\Xi_l^{(\pm)} = \sqrt{\frac{2}{\pi}}\,\frac{e^{\pm i(k_1 r - \frac{l+1}{2}\pi)}}{r}$$

$$\Xi_0 = \sqrt{\frac{2}{\pi}}\,\frac{\sin(k_1 r)}{r}$$

$$\chi_0 = \frac{\sin k_2 r}{r} \quad -\sin \quad \sin$$

$$\frac{d\ln\chi_0}{dr} = \left(\frac{k_2\cos k_2 r}{r} - \frac{\sin k_2 r}{r^2}\right)\frac{r}{\sin k_2 r}$$

$$= k_2\frac{\cos k_2 r}{\sin k_2 r} - \frac{1}{r}$$

$$C_0 = -\left(\frac{\sqrt{\frac{2}{\pi}}\,\frac{k_1\cos k_1 r}{r} - \frac{\sin k_1 r}{r}\left(k_2\frac{\cos k_2 r}{\sin k_2 r} - \frac{1}{r}\right)}{\cancel{\frac{-i\,e^{i(k_1 r - \frac{\pi}{2})}}{r}}}\right)$$

$$\Xi_0' = \sqrt{\frac{2}{\pi}}\left\{\frac{k_1 \cos k_1 r}{r} - \frac{\sin k_1 r}{r^2}\right\}$$

$$\Xi_0^{(+)\prime} = \sqrt{\frac{2}{\pi}}\left\{\frac{k_1 e^{i(k_1 r)}}{r} + \frac{i e^{i(k_1 r)}}{r^2}\right\}$$

$$|C_0|^2 = \frac{\left\{k_1 \cos k_1 r - \sin k_1 r/r - \sin k_1 r\left(k_2 \frac{\cos k_2 r}{\sin k_2 r} - \frac{1}{r}\right)\right\}^2}{\left\{\cancel{k_1} + \frac{i}{r} - i k_2 \frac{\cos k_2 r}{\sin k_2 r} - \frac{i}{r}\right\}\left\{k_1 - \frac{i}{r} + i k_2 \frac{\cos k_2 r}{\sin k_2 r} + \frac{i}{r}\right\}} \quad r = R$$

$$= \frac{\left(k_1 R \sin k_2 R \cos k_1 R - \cancel{k_1 \sin k_1 R \sin k_2 R} - k_2 R \sin k_1 R \cos k_2 R\right)^2}{(k_1 R \sin k_2 R)^2 + (k_2 R \cos k_2 R)^2}$$

$$|C_0|^2 = \frac{\left(\sin k_2 R \cos k_1 R - \frac{k_2}{k_1} \sin k_1 R \cos k_2 R\right)^2}{1 - \left(\left(\frac{k_2}{k_1}\right)^2 - 1\right)\cos^2 k_2 R}$$

$k_1 R \to 0$.

$$= \frac{\left(\sin k_2 R - k_2 R \cos k_2 R\right)^2}{k_1^2 - \cancel{\left(\frac{k_2}{k_1}\right)^2} k_2^2 \cos^2 k_2 R} k_1^2$$

$$Q_0 = 4\pi \frac{\left(\sin k_2 R - k_2 R \cos k_2 R\right)^2}{k_1^2 - k_2^2 \cos^2 k_2 R} \quad \boxed{\cos k_2 R = 0}$$

$$\int_0^R \left(\frac{\sin k_0 r - k_0 r \cos k_0 r}{r^2} \right)^2 r^2 \, dr$$

$$= k_0 \int_0^{k_0 R} \frac{(\sin x - x \cos x)^2}{x^2} \, dx$$

$$= k_0 \left[\int_0^{k_0 R} \frac{\sin^2 x}{x^2} \, dx - \int_0^{k_0 R} \frac{\sin 2x}{x} \, dx + \int_0^{k_0 R} \cos^2 x \, dx \right]$$

$$\approx k_0^2 R .$$