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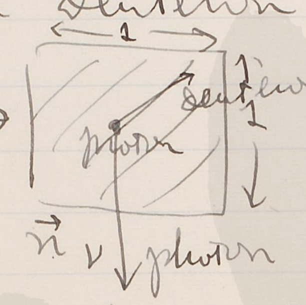
DATE
NO. 1

Cross Sections of Capture of the Neutrons by the Proton and the Photoelectric Effect of the Deuteron

1) Neutron $\vec{v}$ →



$$\sigma_c = \frac{2\pi}{\hbar}\frac{\rho_2}{v}|V_{12}|^2$$

$$\rho_2 = \frac{8\pi\nu^2}{hc^3} = \frac{4\nu^2}{\hbar c^3}$$

$$\frac{\hbar}{Mv} = k \qquad \frac{Mv}{\hbar} = k \qquad \frac{1}{v} = \frac{M}{\hbar k}$$

$$V_{12} = -\frac{e}{c}\{\vec{A}(\vec{r}_2)\vec{p}_2\}_{12}$$

	momentum	energy
state 1.	$M\vec{v}$	$\frac{1}{2}Mv^2$
state 2.	$2M\vec{V}(+\frac{h\nu}{c}\vec{n})$	$MV^2 - W(+h\nu)$.

$$M\vec{v} = 2M\vec{V} + \frac{h\nu}{c}\vec{n}$$

$$\frac{1}{2}Mv^2 = MV^2 - W + h\nu. \qquad \alpha = \left(\frac{MW}{\hbar^2}\right)^{1/2} \quad \frac{ME}{2\hbar^2} + \frac{MW}{\hbar^2} = \frac{2\pi Mv}{\hbar}$$

$$\cancel{M^2v^2 + 4M^2V^2 + 4M^2\vec{v}\vec{V} = E}$$

$c \gg v$ as $\vec{V} \cong \vec{v}/2$

$$\{\vec{A}(\vec{r}_2)\vec{p}_2\}_{12} \cong \{\vec{A}(0)\cdot(\tfrac{1}{2}\vec{P} - \vec{p})\}_{12}$$

$$= -\{\vec{A}(0)\cdot\frac{M}{2}\cdot 2\pi\nu i\cdot\vec{r}\}_{12}$$

$$|V_{12}|^2 = |A(0)|^2\cdot\frac{e^2\pi^2\nu^2}{c^2}\cdot|\vec{r}_{12}|^2$$

$$\vec{E} = -\frac{1}{c}\dot{\vec{A}} = \frac{2\pi\nu i}{c}\vec{A}_{\vec{n}}e^{\cdots}$$

$$\vec{H} = \frac{2\pi\nu i}{c}[\vec{n}\vec{A}_n]e^{\cdots}$$

$$\frac{1}{8\pi}\int\{\vec{E}^2 + \vec{H}^2\}dv = \frac{\pi\nu^2}{c^2}\sum_{\vec{n}}\vec{A}_{\vec{n}}^2 = h\nu$$

$$|\vec{A}_n| = 2c\sqrt{\frac{\hbar}{\nu}}\,\vec{e}$$

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$$C = \left(\frac{\alpha}{2\pi(1+a\alpha)}\right)^{\frac{1}{2}} \frac{V_0 - W}{V_0} e^{-\alpha}$$

$$C^2 \simeq \frac{\alpha}{2\pi}\left(\cancel{\frac{V_0-W}{V_0}}\right)^2_n$$

$$|V_{12}|^2 = \frac{4\pi^2 e^2 \nu \hbar \nu}{3} |z_{12}|^2$$

$$z_{12} = C \iint e^{-i\frac{kz}{2}} \cdot z \cdot \frac{e^{-\alpha r}}{r} \cdot r^2 dr \sin\theta d\theta$$

2π

$$\int_{-1}^{1} e^{-\frac{ikr}{2}x} \cdot x\, dx = \frac{e^{-\frac{ikr}{2}} + e^{\frac{ikr}{2}}}{\left(-\frac{kr}{2}i\right)}$$

$$- \int_{-1}^{1} \frac{e^{-\frac{ikr}{2}x}}{\left(-\frac{kr}{2}i\right)} dx = - \frac{e^{\frac{ikr}{2}} + e^{-\frac{ikr}{2}}}{\frac{kr}{2}i} - \frac{e^{-\frac{ikr}{2}} - e^{+\frac{ikr}{2}}}{\left(-\frac{kr}{2}i\right)^2}$$

$$= \frac{e^{\frac{ikr}{2}} + e^{-\frac{ikr}{2}}}{\frac{kr}{2}i} - \frac{e^{\frac{ikr}{2}} - e^{-\frac{ikr}{2}}}{\left(\frac{kr}{2}\right)^2}$$

$$\cancel{z_{12} = 2\pi C \cdot \int e}$$

$$= \frac{1}{\left(\frac{kr}{2}\right)^2}\left\{\left(1 - \frac{kr}{2}i\right) e^{\frac{ikr}{2}} - \left(1 + \frac{kr}{2}i\right) e^{-\frac{ikr}{2}}\right\}$$

$$z_{12} = 2\pi C \cdot \int \frac{1}{\left(\frac{k}{2}\right)^2} \left\{ \int \left(1 - \frac{kr}{2}i\right) e^{\frac{ikr}{2} - \alpha r} dr - \int \left(1 + \frac{kr}{2}i\right) e^{-\frac{ikr}{2} - \alpha r} dr \right\}$$

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$$\int_0^\infty \left(1 \mp \frac{kr}{2} i\right) e^{-\left(\alpha + \frac{ik}{2}\right) r} dr$$

$$= \frac{1}{\alpha + \frac{ik}{2}} \mp \frac{ki}{2} \frac{1}{\left(\alpha + \frac{ik}{2}\right)^2}$$

$$= \frac{\quad}{\left\{\alpha^2 + \left(\frac{k}{2}\right)^2\right\}^2} \mp i \frac{\alpha^2 k}{\quad}$$

$$\left\{\alpha^2 + \left(\tfrac{k}{2}\right)^2\right\}\left(\alpha - \frac{ik}{2}\right) \mp \frac{ki}{2}\left(\alpha^2 - \left(\tfrac{k}{2}\right)^2\right) \mp \frac{k}{2}\alpha k$$

$$- \frac{\alpha^2 k}{2} - \frac{\alpha^2 k}{2}$$

$$= -i \left(\frac{k}{2}\right)^3$$

$$Z_{12} = 2\pi C k i \frac{1}{\left\{\alpha^2 + \left(\frac{k}{2}\right)^2\right\}^2}$$

$$|V_{12}|^2 = \frac{4\pi^2 e^2 \hbar \nu}{3} 4\pi^2 C^2 k^2 \frac{1}{\left\{\alpha^2 + \left(\frac{k}{2}\right)^2\right\}^4}$$

$$\sigma_c = \cancel{(4\pi)^4 \cdot 2 \cdot 4\pi} \frac{8\pi e^2 (2\pi)^4 \nu^3 k}{3 \hbar^2 c^3} \frac{C^2 \frac{\alpha}{2\pi}}{\left\{\quad\right\}^4}$$

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$$\sigma_c = \frac{8\pi}{3}\frac{(2\pi\nu)^3}{c^3}\cdot\frac{\cancel{M}e^2}{\hbar^2}\frac{\alpha k}{(\alpha^2+(k/2)^2)^4}$$

$$k = \frac{\sqrt{2ME}}{\hbar}.$$

$$\alpha = \frac{(MW)^{1/2}}{\hbar}$$

$$\alpha^2+\left(\frac{k}{2}\right)^2 = \frac{2\pi M\nu}{\hbar}$$

$$\sigma_c = \frac{8\pi}{3}\cdot\frac{\hbar e^2}{M^3c^3}\frac{\alpha k}{\alpha^2+\left(\frac{k^2}{2}\right)}$$

$$\frac{ME}{2\hbar^2}+\frac{MW}{\hbar^2}$$

$$= \frac{16\pi}{3}\frac{\hbar e^2}{M^2c^3}\cdot\frac{\sqrt{\cancel{X4}E_2W}}{\frac{E}{2}+W}$$

$$= \frac{16\pi}{3}\frac{e^2}{Mc^2}\cdot\frac{\hbar}{Mc}\cdot\frac{\sqrt{E_{/2}W}}{\frac{E}{2}+W}$$

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$$\times\frac{3}{4}.$$

$$\sigma_c = 4\pi\frac{e^2}{Mc^2}\cdot\frac{\hbar}{Mc}\frac{\sqrt{\frac{E}{2}W}}{\frac{E}{2}+W}$$

$$\frac{\hbar}{Mc} = \cancel{2.09}\ 4\pi\times1.52_5\times10^{-16}\times 2.09\times10^{-14}$$

$$= 2\cancel{4}\times10^{-29}.\ \frac{2\sqrt{\frac{E}{2}W}}{\frac{E}{2}+W}$$