Cross Sections of Capture of Neutrons

$$V_{12} = \frac{e\hbar}{2Mc}\iint \tilde{\Psi}_1 (\mu_n\vec{\sigma}_n + \mu_p\vec{\sigma}_p)\frac{\partial}{\partial \vec{r}}\Psi_2\, dv_1 dv_2$$

$$|V_{12}|^2 = \frac{\hbar\nu}{2\pi c}\sqrt{\frac{\hbar}{\nu}}\cdot\frac{e\hbar}{M}\cdot\left|\iint \tilde{\Psi}_1(\mu_n\vec{\sigma}_n+\mu_p\vec{\sigma}_p)\Psi_2\, dv_1 dv_2\right|^2$$

$$= \frac{4\pi^2\nu\hbar^3 e^2}{8 M^2 c^2}\left|\iiint \tilde{\Psi}_1(\mu_n\vec{\sigma}_n+\mu_p\vec{\sigma}_p)\frac{\vec{\partial}}{\partial \vec{r}}\Psi_2\, dv_1 dv_2\right|^2$$

$(\vec{r}_1\vec{r}_2\vec{\sigma}_1\vec{\sigma}_2)$ $(\vec{r}_1, \vec{r}_2, \vec{\sigma}_1, \vec{\sigma}_2)$

$$\frac{1}{\sqrt{2}}\{\alpha(1)\beta(2)-\alpha(2)\beta(1)\}(\mu_n\vec{\sigma}_n+\mu_p\vec{\sigma}_p)$$

$$\frac{1}{\sqrt{2}}\{\alpha(1)\beta(2)+\alpha(2)\beta(1)\}$$

$\mu_n\sigma$

この場合、$\vec{\sigma}$ が他の方向を向いて居ても $|V_{12}|^2$ [illegible] z 方向にとると、 $(\mu_n-\mu_p)(\alpha(1)\beta(2)-\alpha(2)\beta(1))$

$$= \frac{1}{2}\{\alpha(1)\beta(2)-\alpha(2)\beta(1)\}\{\mu_n\alpha(1)\beta(2)-\mu_n\alpha(2)\beta(1)$$

$$-\mu_p\alpha(1)\beta(2)+\mu_p\alpha(2)\beta(1)\}$$

故に $\sigma_n=1,-1$; $\sigma_p=1,-1$ について sum up すると

$$= \frac{1}{2}(\mu_n-\mu_p)\{\alpha^2(1)\beta^2(2)+\alpha^2(2)\beta^2(1)$$

$$~~2(\mu_n+\mu_p)~~\ \alpha(1)\alpha(2)\beta(1)\beta(2)\}$$

$$= \mu_n-\mu_p.$$

$$|V_{12}|^2 = \frac{1}{2}(\mu_p-\mu_n)^2\cdot\frac{4\pi^2\nu\hbar^3 e^2}{M^2c^2}\left|\iint \tilde{\Psi}_1(\vec{r}_1\vec{r}_2)\Psi_2(\vec{r}_1\vec{r}_2)\, dv_1 dv_2\right|^2$$