P.S.

$$N \xrightarrow[NM]{} P + M_k^- \xrightarrow[NME]{} N.$$

$$\begin{cases} H^{NM}_{M_k^- \text{emission}} = \dfrac{1}{\sqrt{L^3}} \cdot u^{(a)*} K(k)\, u^{(b)} \\ H^{NME}_{M_k^- \text{absorption}} = \dfrac{1}{L^3 \sqrt{L^3}} \displaystyle\int_V u^{(b)*} \cdot \frac{f_2 e}{\kappa} \sqrt{\frac{2\pi}{\varepsilon_k}} \cdot (\vec{A}, \vec{\sigma}) \cdot u^{(a)} \cdot d\vec{r} \end{cases}$$

$$\therefore\ W_{\text{IV}}(H) = -\frac{\sqrt{2\pi} \cdot f_2 e}{\kappa L^6} \sum_{k,} \sum \int_V \frac{u^{(a)*} K(k)\, u^{(b)} \cdot u^{(b)*} (\vec{A}, \vec{\sigma})\, u^{(a)}}{\sqrt{\varepsilon_k} \cdot (E_k + \varepsilon_k - Mc^2)} \cdot d\vec{r}$$

$$= -\frac{\sqrt{2\pi} \cdot f_2 e}{\kappa L^6} \sum_k \int_V \frac{u^{(a)*} K(k) (H(k) - \varepsilon_k + Mc^2)(\vec{A}\vec{\sigma})\, u^{(a)}}{\sqrt{\varepsilon_k} \cdot [E_k^2 - (Mc^2 - \varepsilon_k)^2]} d\vec{r}$$

$Mc^2 \gg \hbar c k,\ \hbar c \kappa.$ トスルト

$$\cong -\frac{\sqrt{2\pi} \cdot f_2 e}{2\kappa L^6} \sum_k \int_V \frac{u^{(a)*} K(k) (1 + \rho_3)(\vec{A}\vec{\sigma})\, u^{(a)}}{\sqrt{\varepsilon_k} \cdot \varepsilon_k} d\vec{r}$$

$u^{(a)} = \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}$, $\quad u^{(a)*} = (1\ 0\ 0\ 0)$ トスルト

$$u^{(a)*} K(k)(1 + \rho_3)(\vec{A}\vec{\sigma})\, u^{(a)} = 2\beta(k) \left((\vec{A}, \vec{k}) - i [\vec{A} \times \vec{k}]_z \right)$$

$$= -\frac{2 f_2 \hbar c}{\kappa} \cdot \sqrt{\frac{2\pi}{\varepsilon_k}} \cdot \left[(\vec{A}, \vec{k}) - i [\vec{A} \times \vec{k}]_z \right]$$

之ヲ入レ、$L \to \infty$ トスルト、

$$\frac{1}{L^3} \int_V d\vec{r} \longrightarrow \int d\vec{r}; \qquad \frac{1}{\sqrt{L^3}} \sum_k \longrightarrow \frac{1}{(2\pi)^3} \int d\vec{k}.$$

トナッテ

$$W_{\text{IV}}(H) = \frac{f_2^2 \hbar c e}{4\pi^2 \kappa^2} \iint \frac{(\vec{A}, \vec{k}) - i [\vec{A} \times \vec{k}]_z}{\varepsilon_k^2} d\vec{r}\, d\vec{k}$$

$$= \frac{f^2 e}{4\pi^2 \cdot \hbar c \kappa^2} \iint \frac{(\vec{A}, \vec{k}) - i [\vec{A} \times \vec{k}]_z}{k^2 + \kappa^2} d\vec{r}\, d\vec{k}.$$

$\therefore$ $\vec{k}$-space ノ polar angle ニツイテノ積分ニヨッテ消失スル。故ニ

$$\underline{\underline{W_{\text{IV}}(H) = 0.}}$$

$$N \xrightarrow[NME]{} \cancel{N\!M} \; P + M_k^- \xrightarrow[NM]{} N.$$

$$\begin{cases} H^{NME}_{M_k^- \text{emission}} = \dfrac{1}{L^3\cdot\sqrt{L^3}} \displaystyle\int_V u^{(a)*} \frac{f_2 e}{\kappa} \sqrt{\frac{2\pi}{\varepsilon_k}} (\vec{A}\vec{\sigma})\, u^{(b)}\, d\vec{r} \\ H^{NM}_{M_k^- \text{absorption}} = \dfrac{1}{\sqrt{L^3}}\, u^{(b)*} K^*(k)\, u^{(a)} \end{cases}$$

$$\therefore\; W_{\mathrm{V}}(H) = -\frac{\sqrt{2\pi}\cdot f_2 e}{\kappa L^6} \sum_k \sum \int_V \frac{u^{(a)*}(\vec{A}\vec{\sigma})\, u^{(b)}\cdot u^{(b)*} K^*(k)\, u^{(a)}}{\sqrt{\varepsilon_k}\cdot[E_k + \varepsilon_k - Mc^2]}\, d\vec{r}$$

$$= -\frac{\sqrt{2\pi}\cdot f_2 e}{\kappa L^6} \sum_k \int_V \frac{u^{(a)*}(\vec{A},\vec{\sigma})[H(k) - \varepsilon_k + Mc^2] K^*(k)\, u^{(a)}}{\sqrt{\varepsilon_k}\cdot[E_k^2 - (Mc^2 - \varepsilon_k)^2]}\, d\vec{r}$$

$$\cong -\frac{\sqrt{2\pi}\, f_2 e}{2\kappa L^6} \sum_k \int_V \frac{u^{(a)*}(\vec{A},\vec{\sigma})(1+\rho_3) K^*(k)\, u^{(a)}}{\varepsilon_k\cdot\sqrt{\varepsilon_k}}\, d\vec{r}$$

$u^{(a)*} = (1\ 0\ 0\ 0)$, $u^{(a)} = \begin{pmatrix}1\\0\\0\\0\end{pmatrix}$ ヲ用ヒルト

$$u^{(a)*}(\vec{A},\vec{\sigma})(1+\rho_3) K^*(k)\, u^{(a)} = 2\beta(k)\{(\vec{A},\vec{k}) + i[\vec{A}\times\vec{k}]_z\}$$
$$= -\frac{2 f_2 \hbar c}{\kappa} \sqrt{\frac{2\pi}{\varepsilon_k}} \cdot \{(\vec{A},\vec{k}) + i[\vec{A}\times\vec{k}]_z\}$$

$L \to \infty$ トスルト

$$W_{\mathrm{V}}(H) = \frac{f_2^2 e}{4\pi^2 \hbar c \kappa^2} \iint \frac{(\vec{A},\vec{k}) + i[\vec{A}\times\vec{k}]_z}{k^2 + \kappa^2}\, d\vec{r}\, d\vec{k}.$$

之モ $W_{\mathrm{IV}}(H)$ ト同様ニシテ vanish スル。故ニ

$$\underline{W_{\mathrm{V}}(H) = 0.}$$