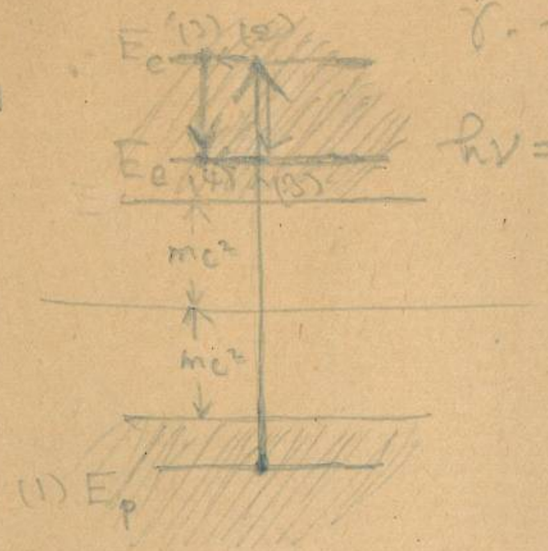
Materialization [illegible] γ-ray




$h\nu = E_p + E_e$

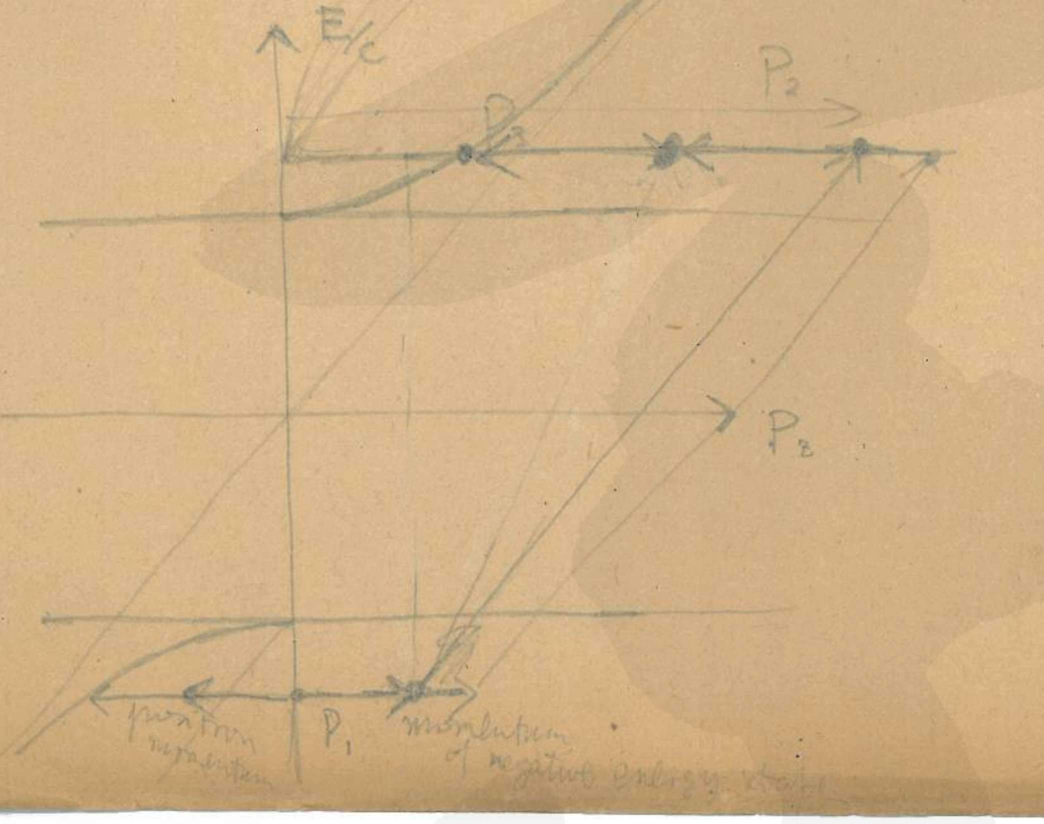
triple transition

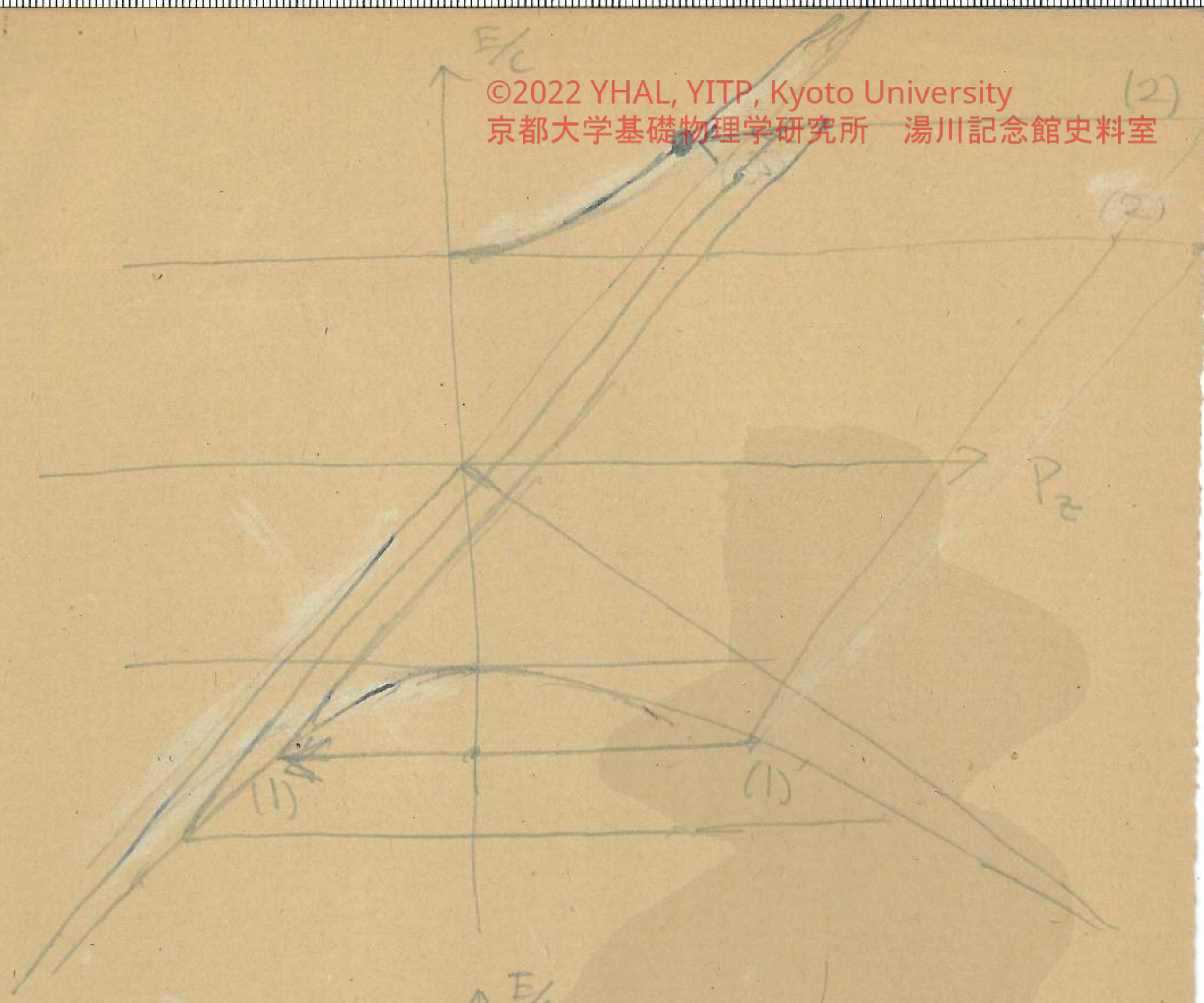
(1) $-E_p$ → (2) $E_e'$ → (3) $E_e'$ → (4) $E_e$

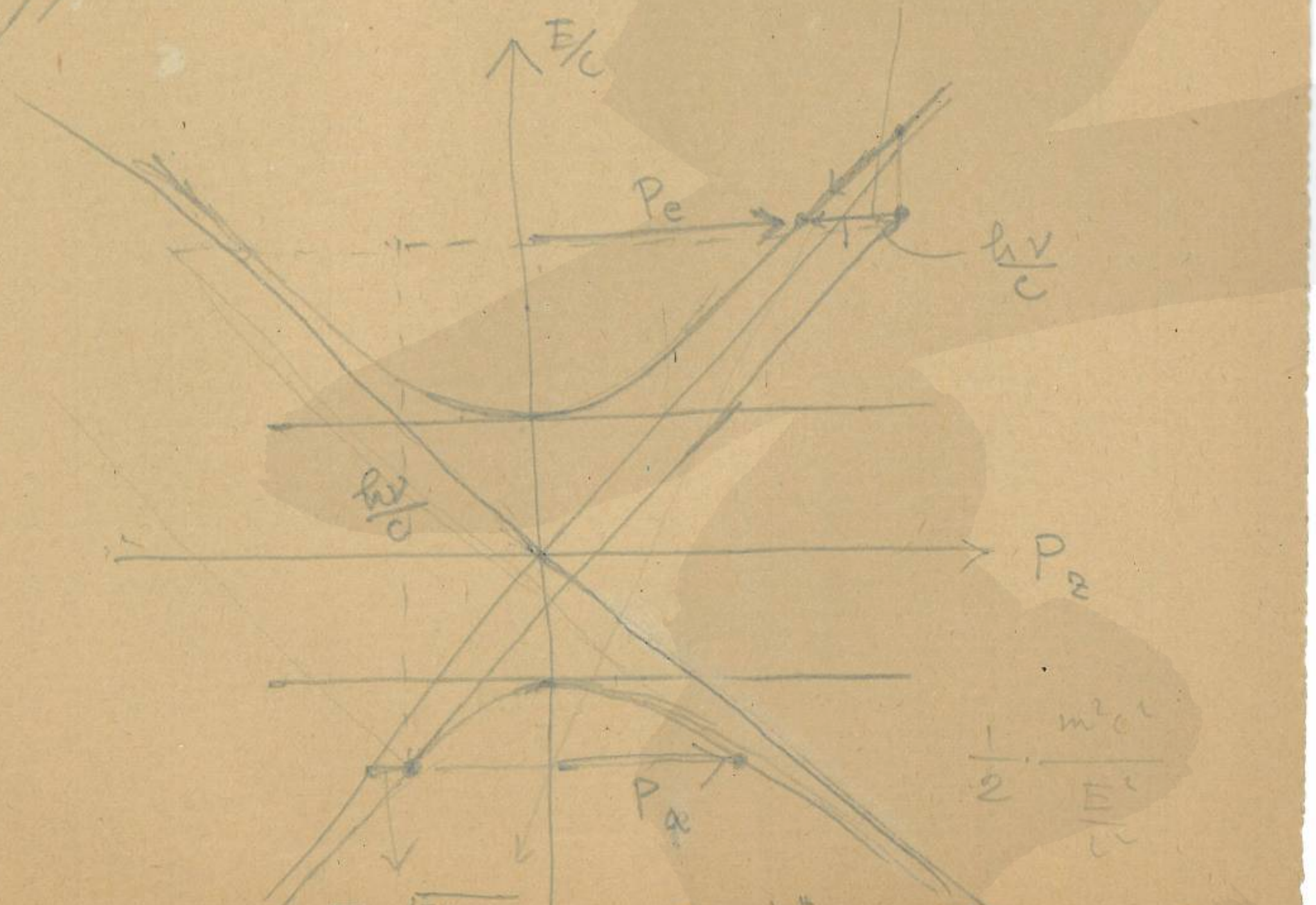
(2) $E_e'$ → (3') $E_e$ → (4) $E_e$

$$\sum_{2,3'} \{\tilde\psi \tfrac{e}{4c} \ldots\}\{\tilde\psi_3 \tfrac{2e^2}{r}\psi_2\}\{\tilde\psi_2 \tfrac{e}{c}A_z \psi_1\}$$

$$+\sum_{2,3'}\{\tilde\psi \tfrac{e}{4c}A_z\psi_{3'}\}\{\tilde\psi_{3'}\tfrac{2e^2}{r}\psi_2\}\{\tilde\psi_2\tfrac{e}{c}A_z\psi_1\}$$






$$\frac{E}{c} - \sqrt{\frac{E^2}{c^2} - m^2c^2} \cong \frac{1}{2}\frac{E}{c} \cdot \frac{m^2c^4}{E^2} = \frac{1}{2}\frac{mc^2}{E} \cdot mc \quad \text{for } \frac{E}{c} \gg mc$$

$$\frac{1}{r} = \iiint c_k e^{ikr} dk_x dk_y dk_z$$

$$c_k = \iiint e^{ikr} dx dy dz$$

$$= 2\pi \iint e^{ikr\cos\theta} r^2 dr \sin\theta d\theta$$

$$= 4\pi \int_0^\infty \frac{e^{ikr} - e^{-ikr}}{2i\, kr} r^2 dr$$

$$\int_{-\infty}^{\infty} e^{ik_x x} dx = \left. \frac{e^{ik_x x} - e^{-ik_x x}}{i k_x} \right|_{x\to\infty}$$

$$= \left. \frac{2 \sin k_x x}{k_x} \right|_{x\to\infty}$$

$$\lim_{x\to\infty} \int_{-0k_x}^{+0k_x} \frac{2\sin k_x x}{k_x} dk_x = 2\int_{-\infty}^{\infty} \frac{\sin y}{y} dy$$

$$= 2\pi$$

$$\int_0^\infty dk \int \cos kx \, dx =$$

$$c_k = \left(\frac{1}{2\pi}\right)^{\frac{3}{2}} \iiint \frac{1}{r} e^{-ikr} dx\, dy\, dz$$

$$= \left(\frac{1}{2\pi}\right)^{3/2} 2\pi \int_0^\infty \frac{e^{+ikr} - e^{-ikr}}{ki} dr$$

$$= \left(\frac{1}{2\pi}\right)^{\frac{1}{2}} \cdot \frac{2}{k}\int_0^\infty \sin y\, dy$$

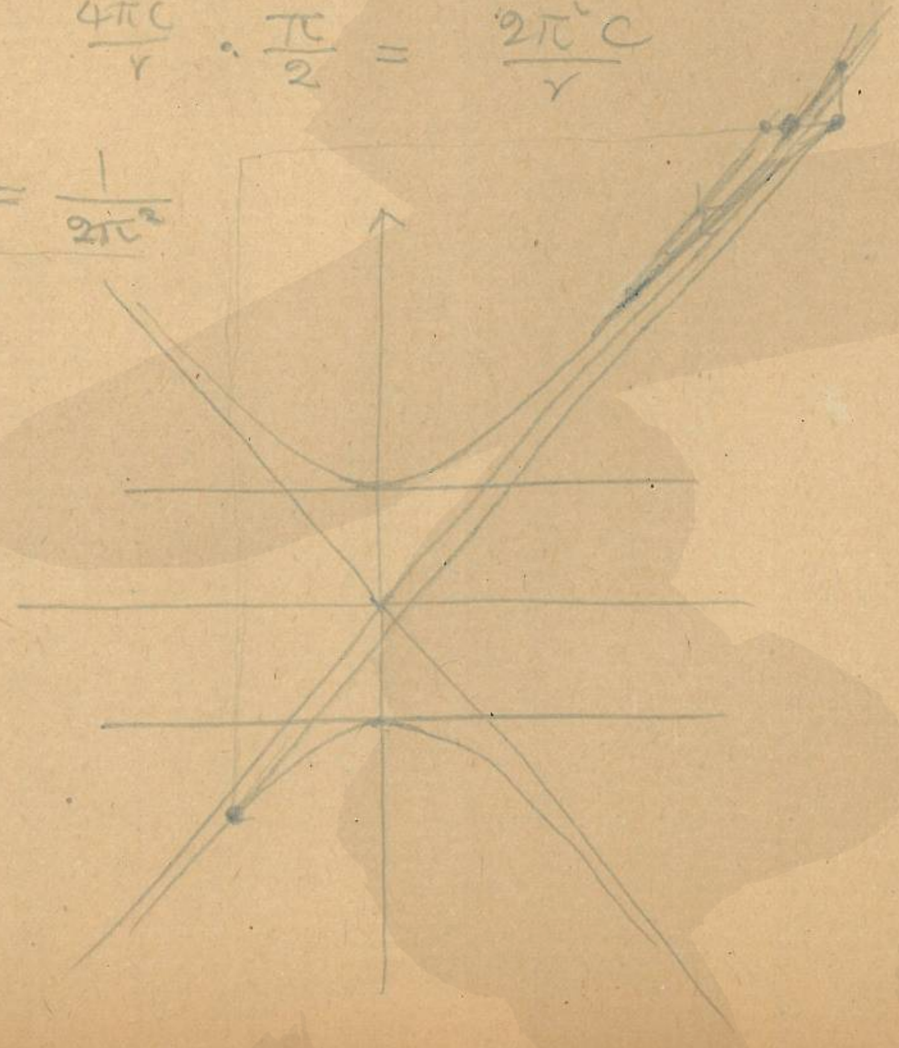
$$\frac{1}{r} = C \iiint \frac{e^{ikr}}{k^2}\, dk_x\, dk_y\, dk_z$$

$$= C\, 2\pi \int_0^\infty \frac{e^{ikr} - e^{-ikr}}{kri}\, dk$$

$$= \frac{4\pi C}{r} \int_0^\infty \frac{\sin y}{y}\, dy$$

$$= \frac{4\pi C}{r} \cdot \frac{\pi}{2} = \frac{2\pi^2 C}{r}$$

$$C = \frac{1}{2\pi^2}$$



$$H = H^{(0)} + H^{(1)}_{mn}$$

$$S = S^{(0)} + S^{(1)} + S^{(2)} + \cdots$$

$$W S^{(0)} = H^{(0)} S^{(0)}$$

$$W S^{(1)} = H^{(0)} S^{(1)} + H^{(1)} S^{(0)}$$

$$H_{nm} = H^{(0)}_{n} \delta_{nm} + H^{(1)}_{nm}$$

$$S = S^{(0)} + S^{(1)} + S^{(2)} + \cdots$$

$$\cancel{H S^{(0)} + S^{(1)}}$$

$$(H^{(0)} + H^{(1)})(S^{(0)} + S^{(1)} + S^{(2)} + \cdots)$$

$$= (W^{(0)} + W^{(1)} + \cdots)(S^{(0)} + S^{(1)} + S^{(2)} + \cdots)$$

$$H^{(0)} S^{(0)} = W^{(0)} S^{(0)}$$

$$H^{(0)} S^{(1)} + H^{(1)} S^{(0)} = W^{(0)} S^{(1)} + W^{(1)} S^{(0)}$$

$$H^{(0)} S^{(2)} + H^{(1)} S^{(1)} = W^{(0)} S^{(2)} + W^{(1)} S^{(1)} + W^{(2)} S^{(0)}$$

$$\{H^{(0)} - W^{(0)}\} S^{(1)} + \{H^{(1)} - W^{(1)}\} S^{(0)} = 0$$

$$\{H^{(0)} - W^{(0)}\}^{2} S^{(2)}$$

$$H = H_0 + V$$

$$i\hbar \frac{\partial c_m}{\partial t} = V_{mn} c_n \cdot e^{-\frac{i}{\hbar}(W_n - W_m)t}$$

$$c_m = V_{m0} \frac{e^{-\frac{i}{\hbar}(W_0 - W_m)t} - 1}{W_0 - W_m} + \delta_{m0}$$

$$|c_m|^2 = |V_{m0}|^2 \frac{4 \sin^2 \frac{i}{2\hbar}(W_0 - W_m)t}{(W_0 - W_m)^2}$$

$$2 - 2\cos \frac{i}{\hbar}(W_n - W_m)t$$

$$\cos \ldots = 1 - 2\sin^2 \frac{i}{2\hbar}(W_n - W_m)t$$

$$\int |c_m|^2 g(W)\, dW$$

$$= \underbrace{|V_{m0}|^2}_{g(W_m)} \int \frac{4 \sin^2 \frac{i}{2\hbar}(W_0 - W)t}{(W_0 - W)^2}\, dg(W)\, dW$$

$$\frac{i}{2\hbar} t$$

$$= |V_{m0}|^2 g(W_m) \frac{2it}{\hbar} \int \frac{\sin^2 x}{x^2}\, dx$$

$$i\hbar \frac{\partial \Psi}{\partial t} = (H + V)\,\Psi$$



$$\Psi = \sum_{W,k} c(W,k,t)\,\psi(W,k)\,e^{-\frac{i}{\hbar}Wt}$$

$$i\hbar\,\dot{c}(W,k,t)\,\psi(W,k)\,e^{-\frac{i}{\hbar}Wt} = V\,c(W,k,t)$$

$$V\psi(W,k) = (W'k'|V|Wk)\,\psi(W'k')$$

$$= \sum_{Wk} c(W,k) \sum_{W'k'} (W'k'|V|Wk)\,\psi(W'k')\,e^{-\frac{i}{\hbar}Wt}$$

$$i\hbar\,\dot{c}(W,k,t) = \sum_{W'k'} c(W',k',t)\,(W,k|V|W',k')\,e^{-\frac{i}{\hbar}(W'-W)t}$$

$$c_1(W,k,t) = \sum_{W'k'} (W,k|V|W_0^*,k_0^*)\,\frac{e^{-\frac{i}{\hbar}(W_0^*-W)t}-1}{W_0-W_1} \quad k = k_0$$

$$\cancel{c(W',k',0)}$$

$$+\cancel{(W,k|\quad|W',k')}\,c(W^*,k,0)$$

$$c(W,k,t) = \cancel{c(W,k,0) + c'(W,k,0)\,t}$$

$$+\ c''(W,k,0)\frac{t^2}{2!} + c'''(W,k,0)\frac{t^3}{3!} + \cdots$$

$$\cancel{i\hbar\,c'(W,k,0) = \sum}$$

$\cancel{i\hbar}$ $i\hbar\, \dot{c}_1(w,k,t)$

$$= \sum_{w',k'} (w',k'|V|w_0k_0)\frac{e^{-\frac{i}{\hbar}(w_0-w)t}-1}{w_0-w}(w,k|V|w',k')e^{-\frac{i}{\hbar}(w'-w)t}$$

$$= \sum_{w',k'} \frac{(w,k|V|w',k')(w',k'|V|w_0k_0)}{w_0-w}\left(e^{-\frac{i}{\hbar}(w_0-w)t}-e^{-\frac{i}{\hbar}(w'-w)t}\right)$$

$$c_2(w,k,t) = \sum_{w',k'} \frac{(w,k|V|w'k')(w',k'|V|w_0k_0)}{w_0-w}$$

$$\times\left\{\frac{e^{-\frac{i}{\hbar}(w_0-w)t}-1}{w_0-w}-\frac{e^{\frac{i}{\hbar}(w'-w)}-1}{w'-w}\right\}$$

$c_3(w,k,t)$

$c(W,k,t)e^{-\frac{i}{\hbar}Wt}\sum$

$\sum_{W''}(W''-W)c_{W''}(W,k,t)e^{-\frac{i}{\hbar}W''t}$

$=\sum_{W',k',W''} c_{W''}(W',k')\,(W,k|V|W',k')\,e^{-\frac{i}{\hbar}W''t}\cdots$

$c_{W''}(W,k)=\sum_{W'k'}\frac{(W,k|V|W',k')}{W''-W}c_{W''}(W',k')$

$\sum_{k'}(W,k|V|W,k')\,c_W(W,k')=0$

$\cancel{c_{W''}(W,k)}\ c^{(0)}(k)=\frac{(k|V|k_0)}{(k|V|k)}c(k_0)$

$c^{(1)}(k)=\frac{(k'|V|k_0)}{(k'|V|k')}\cancel{c(k_0)}$

$\sum(k|V|k')$