①

$$\Psi(t) = \lim_{\Delta t \to 0} \{ K(t, t-\Delta t) K(t-\Delta t, t-2\Delta t) \cdots K(t-(n-1)\Delta t, 0) \Psi(0) \}$$

$$K(t, t-\Delta t) = 1 -$$

$$\Psi(t) = K(t, t-\Delta t) \Psi(t-\Delta t)$$

$$= \int K(t, t_1) \Psi(t_1) dt_1$$

$$K(t, t_1) = \delta(t - t_1 - \Delta t) \left(1 - \frac{i \bar{H}'\left(\frac{t+t_1}{2}\right)}{\hbar} \Delta t\right)$$

$$\Psi(t') = K(t', t''') K(t''', t'') \Psi(t'')$$

$$\int K(t', t''') K(t''', t'') dt'''$$

$$= \int \left(1 - \frac{i \bar{H}'\left(\frac{t'+t'''}{2}\right)}{\hbar} \Delta t\right) \delta(t' - t''' - \Delta t) \left(1 - \frac{i \bar{H}'\left(\frac{t'''+t''}{2}\right)}{\hbar} \Delta t\right) \delta(t''' - t'' - \Delta t) \, dt'''$$

$$= \left(1 - \frac{i \bar{H}'\left(\frac{t'+t''+\Delta t}{2}\right)}{\hbar} \Delta t\right) \delta(t' - t'' - 2\Delta t)$$

$$\times \left(1 - \frac{i \bar{H}'\left(\frac{t'+t''-\Delta t}{2}\right)}{\hbar} \Delta t\right)$$

②

$$\cancel{\Xi(t')} = \Big(1 - \frac{i\bar{H}'(T)}{\hbar}\Delta t\Big)\delta(\tau - \Delta t)$$

$$K^{(1)}(t', t'') =$$

$$\int K(t', t''')K(t''', t'')\,dt''' \equiv K^{(2)}(t', t'')$$

$$= \Big(1 - \frac{i\bar{H}'(T + \frac{\Delta t}{2})\Delta t}{\hbar}\Big)$$

$$\times \Big(1 - \frac{i\bar{H}'(T - \frac{\Delta t}{2})\Delta t}{\hbar}\Big)\delta(\tau - 2\Delta t)$$

$$K^{(3)}(t', t'') =$$

$$K(t', t'') = \Big(1 - \frac{i\int\!\!\int\!\!\int\!\!\int \cancel{(x' \ldots x'')}\, d\cdot\; H'(X, r)\Delta t\,(dX)^3(dr)^3}{\hbar}\Big)$$

$$\cancel{\times\Delta t} \times \delta(r^4 - \Delta t)$$

$$K(t', t'') = \Big\{1 - \frac{i}{\hbar}\int\cdots\int H'(X_\mu, r_i)^{(c)}\Delta t\,(dX)^3(dr)^3\Big\}$$

$$\times\, \delta(r^4 - c\Delta t)$$

$$= \Big\{\int\!\!\int\!\!\int\!\!\int \exp(i\,c\Delta t \cdot p_4/\hbar)\,(dX)^3(dr)^3 - \frac{i}{\hbar}\int\cdots\int H'(X_\mu, r_i)\,c\Delta t\,(dX)^3(dr)^3 \exp(i\,c\Delta t\,p_4/\hbar)\Big\}$$

$$\frac{1}{V}$$

(3)

$$K^{(1)}(t',t'')=\left\{\frac{1}{V}\exp(ic\Delta t\cdot p_4/\hbar)-\frac{i}{\hbar}H'(x_\mu,\gamma_\mu)\,c\Delta t\exp(ic\Delta t\cdot p_4/\hbar)\right\}$$

$$=\exp\left(-\frac{i}{\hbar}H'(x_\mu,\gamma_\mu)\Delta t\right)\cdot\exp(ic\Delta t\cdot p_4/\hbar)$$

$$K^{(2)}(t',t'')=\left(1-\cancel{iH'(x_\mu}\right.$$

$$=\int K(t',t'')K(t'',t')dt''$$

$$=\int\left(1-\frac{i\int(x'_\mu|H'|x''_\mu)(dx'_\mu)^3(dx''_\mu)^3 c\Delta t}{\hbar}\right)\delta(x'_4-x''_4-c\Delta t)$$

$$\times\left(1-\frac{i\int(x''_\mu|H'|x^{IV}_\mu)(dx''_\mu)^3(dx^{IV}_\mu)^3 c\Delta t}{\hbar}\right)$$

$$dx'''_4\,dx^{IV}_4\,\delta(x''_4-x^{IV}_4)\,\delta(x^{IV}_4-x''_4-c\Delta t)$$

$$c\Delta t\,\delta(x'_4-x''_4-c\Delta t)\,\delta(x''_4-x^{IV}_4)\qquad c\Delta t\,\delta(x^{IV}_4-x''_4-c\Delta t)$$

$$=1-\iint(x'_\mu|H'|x''_\mu)(x^{IV}_\mu|H'|x''_\mu)(dx'_\mu)^3(dx''_\mu)^3\times(dx'''_\mu)^4(dx^{IV}_\mu)^4$$

$$\iint\delta(x'_4-x'''_4-c\Delta t)\,\delta(x'''_4-x^{IV}_4)\,\delta(x^{IV}-x''_4-c\Delta t)(dx'''_4)(dx^{IV}_4)$$

all terms in $K^{(2)}(t'-t'')$

(4) Thus the ~~second order term consist of~~ ~~the~~ contain the common factor

$$\delta((x_4'')^4-(x_4')^4-2\Delta c\Delta t),$$

as it should be.

Now in ~~the~~ local field theory, we have to ~~$\Delta t \to$~~ go over to the limit $\Delta t \to 0$ in order obtain the solution of Schrödinger equation.

However, in nonlocal field theory,

$$\Psi(t')=\int K^{(1)}(t',t'')\,\Psi(t'')\,dt''$$

may be the substitute for Schrödinger equation, if we take

$$c\Delta t=\lambda,$$

where λ is the universal length,* provided that the relativistic considerations ~~are~~ are unnecessary. In this case

$$K^{(1)}(t',t'')=\left\{\frac{1}{V}\exp(i\lambda p_4/\hbar)-\frac{\lambda}{\hbar}H'(x_\mu,r_i)\times\lambda\exp(i\lambda p_4/\hbar)\right\}$$

(5) In order to generalize the formalism, so as to be relativistically covariant, as the first step,

$$\overline{\Psi}(t') = \iiint \Psi(x'_\mu)(dx'_\mu)^3$$

$$\cancel{\int \overline{\Psi}(t')\,dt' = \iint K^{(1)}(t',t'')\,\overline{\Psi}(t'')\,dt'\,dt''}$$

$$\cancel{= \iint K^{(1)}(t',t''')\,\delta(t''',t'')\,\overline{\Psi}(t'')\,dt'\,dt'''}\quad dt''$$

$$\Psi(x'_\mu) = \int\cdots\int K^{(1)}(x'_\mu, x'''_\mu)\,\Psi(x''_\mu)(dx''_\mu)^4(dx'''_\mu)^4,\quad H'_\mu l^\mu D_s(x'''_\mu, x''_\mu)$$

where D_s is an operator displacing by an arbitrary amount in the space direction and no displacement in the time direction, ~~and~~ As the second step:

$$\cancel{K^{(1)}(x'_\mu, x'''_\mu)} = \left\{\frac{1}{V}\exp(i\lambda p_4/\hbar) - \frac{i}{\hbar}H'(x'_\mu, i)\right.$$

$$K^{(1)}D \qquad D(x''_\mu, x'''_\mu) \qquad \left.(\lambda\exp(i\lambda p_4/\hbar)\right\}D$$

must be replaced by

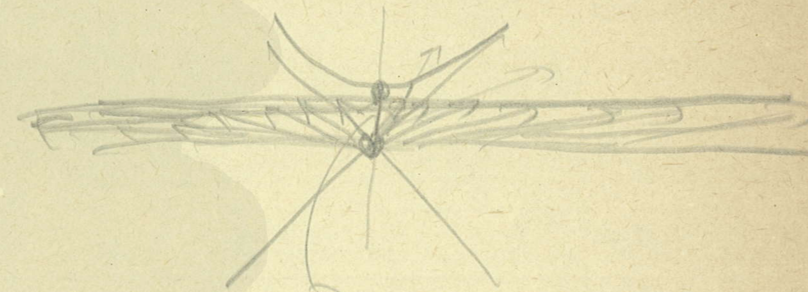
$$D_t \cancel{D} - \frac{i}{\hbar}H'_\mu l^\mu D_s \qquad \text{space direction}$$

so that $[x^\mu, H_\mu]D_s\ \cancel{[x^\mu, D_s]}$

$$\left(D_t - \frac{i}{\hbar}H''_\mu l^\mu D_s - E\right)\Psi = 0$$

(6) where E is the unit operator and

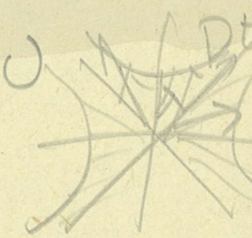
$$\cancel{D_t D_s = C\int\int \exp(i l^\mu p_\mu/\hbar)\cdot (dl^\mu)^4 \, \delta(l_\mu l^\mu + \lambda^2)}$$



D_t

$$\cancel{[p_\mu, x^\mu]}$$

$$\cancel{\{p_\mu - [x_\mu, H']\}\Psi = 0}$$



$$\{D_t - \frac{i}{\hbar}[x_\mu, H'] D_s - E\}\Psi = 0$$

$(x'|D_t|x'')$

$$\Psi(t+\Delta t) = \Psi(t) - \frac{i\bar{H}'(t)}{\hbar}\Psi(t), \quad \Delta t$$

$$\exp(i c\Delta t\cdot p_4/\hbar)\Psi(t)$$

$$= 1 - \frac{i\bar{H}'(t)\Delta t}{\hbar}\Psi(t)$$

$$\exp(i\lambda p_4/\hbar)\Psi = \left(1 - \frac{i[x_4 \bar{H}']}{\hbar}\right)\Psi$$

$$\exp(i l^\mu p_\mu/\hbar)\Psi = (1 - i[x_\mu, \bar{H}']/\hbar)\Psi$$

(7)

~~exp~~ $\Psi = \exp(-i l^\mu p_\mu/\hbar)\left(1 - \frac{i[x_\mu \overline{H}^\mu]}{\hbar}\right)\Psi$

H_μ - spacelike displacement

$\cancel{\exp - \frac{i[x_\mu \overline{H}^\mu]}{\hbar}}$