quantization of Dirac-Fock, ... Wigner ...

$$\left\{\Delta - \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \lambda^2\right\} U = \Psi^\dagger \underbrace{\cdot}_{(\tau_x - i\tau_y)} \Psi$$

at $a = N\Delta \cdot \Delta N$ $\begin{pmatrix}0&1\\1&0\end{pmatrix}\begin{pmatrix}0&0\\0&1\end{pmatrix} = \begin{pmatrix}0&1\\0&0\end{pmatrix}$

$$\{\quad '' \quad\} U^\dagger = \Psi^\dagger(\tau_x + i\tau_y)\Psi.$$

$$\Psi = \frac{1}{2}(1+\tau_3)\sum_n a_n u_n$$
$$+ \frac{1}{2}(1-\tau_3)\sum_m b_m v_m$$

$U = \qquad U_{mn}$

$$-\frac{L}{c} = \frac{\partial U^\dagger}{\partial x}\frac{\partial U}{\partial x} + \frac{\partial U^\dagger}{\partial y}\frac{\partial U}{\partial y} + \frac{\partial U^\dagger}{\partial z}\frac{\partial U}{\partial z} - \frac{1}{c^2}\frac{\partial U^\dagger}{\partial t}\frac{\partial U}{\partial t}$$
$$+ \chi^2 U^\dagger U + \cdots$$

$$U = \iiint F(k)\, e^{-ick_0 t + ikr} + G(k)\, e^{ick_0 t - ikr}\, dk_x dk_y dk_z$$

$$U^\dagger = \iiint F^\dagger(k)\, e^{ick_0 t - ikr} + G^\dagger(k)\, e^{-ick_0 t + ikr}\, dk_x dk_y dk_z$$

$$\frac{\partial U^\dagger}{\partial t}(x) U(x') - U(x)\frac{\partial U^\dagger}{\partial t}(x') = 2\pi i\, \delta(x, x')$$

$$\frac{k_0 i}{c}\{F(k)\cdot F^\dagger(k') - F^\dagger(k')F(k)\}$$
$$= C \cdot 2\pi i\, \delta(k, k')$$

etc

$$\iiint \{F(k)F^\dagger(k')\ldots\} \ldots$$

$$\exp\{ict(k_0 - k_0') - i(r(k - k'))\}\, dk\, dk'$$

$$= \iiint \frac{e^{ict k_0 - ikR}}{k_0 k_0}\, dk$$

$$= C$$

$$\int \ldots k^2 dk \iint e^{-iRk\cos\theta} \sin\theta\, d\theta\, d\varphi$$

$x \quad -dx$

$$2\pi \int_{-1}^{1} e^{-iRkx}\, dx$$

$$2\pi \frac{e^{-iRk} - e^{iRk}}{iRk}$$

$k \to -k$

$$= \frac{i C'}{R} \int_0^\infty \frac{e^{i(ck_0T + kR)} - e^{i(ck_0T - kR)}}{k_0}\, k\, dk$$

$$= \frac{i C'}{R} \int_{-\infty}^{\infty} \frac{e^{i(ck_0T + kR)}\, k\, dk}{k_0}$$

之は Bessel Fn [illegible] ([illegible])

$$\Delta = \cancel{\frac{\delta(r-ct)}{r} - \frac{\delta(r+ct)}{r}} \; \frac{J_1(s)}{s}$$

$$\cancel{\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial \Delta}{\partial r}\right) - \lambda^2\Delta - \frac{1}{c^2}\frac{\partial^2\Delta}{\partial t^2}}$$

$$\left\{\Delta' - \frac{1}{c^2}\frac{\partial^2}{\partial t'^2} - \lambda^2\right\} f(\cdot\cdot) = 0$$

$$\left\{\Delta'' - \frac{1}{c}\frac{\partial^2}{\partial t''^2} - \lambda^2\right\} f(\cdot\cdot) = 0.$$

$$x' - x'' = x, \qquad x' + x'' = 2X, \quad \text{etc}$$

$$\frac{\partial}{\partial x'} = \frac{\partial}{\partial x} + \cdots \qquad \frac{1}{s}$$

$$\frac{\partial}{\partial x''} = \frac{\partial}{\partial x} + \cdots \qquad s = \sqrt{x^2 + \cdots} \qquad \frac{\partial s}{\partial x} = \frac{xs}{\sqrt{\cdots}}$$

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial \Delta}{\partial r}\right) - \lambda^2\Delta - \frac{1}{c^2}\frac{\partial^2\Delta}{\partial t^2}$$

$$\frac{\partial}{\partial x} = \frac{x}{s}\frac{\partial}{\partial s} \qquad \frac{\partial}{\partial t} = \frac{-t}{s}\frac{\partial}{\partial s}$$

$$\frac{\partial^2}{\partial x^2} = \left(\frac{x}{s}\right)^2\frac{\partial^2}{\partial s^2} + \left(\frac{1}{s} - \frac{x^2}{s^3}\right)\frac{\partial}{\partial s}$$

$$\left\{\Delta - \frac{\partial^2}{\partial t^2}\right\} = \frac{\partial^2}{\partial s^2} + \left(\frac{4}{s} - \frac{1}{s}\right)\frac{\partial}{\partial s}$$

$$\left\{\frac{d^2}{ds^2} + \frac{3}{s}\frac{d}{ds} - \lambda^2\right\} U = 0,$$

$$U = \frac{V(s)}{s} \qquad \frac{dU}{ds} = \frac{1}{s}\frac{dV}{ds} - \frac{1}{s^2}V$$

$$\frac{d^2U}{ds^2} = \frac{1}{s}\frac{d^2V}{ds^2} - \frac{2}{s^2}\frac{dV}{ds} + \frac{2V}{s^3}$$

$$-\lambda^2\frac{d^2V}{ds^2} + \frac{1}{-\lambda^2 s}\frac{dV}{ds} - \frac{\lambda^2 V}{-\lambda^2} - \frac{1}{-\lambda^2 s^2}V = 0$$

$x = i\lambda s$

$$\frac{d^2V}{dx^2} + \frac{1}{x}\frac{dV}{dx} + \left(1 - \frac{1}{x^2}\right)V = 0$$

$$V = J_1(i\lambda s)$$

$$H = \Psi^\dagger (\ ) \Psi + \Psi^\dagger \frac{1}{2} g (\tau_1 + i\tau_2) U^\dagger \Psi$$

$$+ \Psi^\dagger \frac{1}{2} g (\tau_1 - i\tau_2) U \Psi$$

$$+ \frac{1}{4\pi} \{ U^\dagger (\Delta - \cdots) U \}$$

$$(\Delta - \cdots) U = -4\pi \cdot \frac{1}{2} g \, \Psi^\dagger (\tau_1 + i\tau_2) \Psi$$

W.W. $(= \Psi^\dagger \frac{1}{2} g (\tau_1 - i\tau_2) \Psi \ \frac{1}{2} g \, \Psi^\dagger (\tau_1 + i\tau_2) \Psi)$

$-e$ emission
$+e$ absorption
U

$+e$ emission
$-e$ absorption
$U^\dagger$

$$\mathbf{E} = -\,\mathrm{grad}\,V - \frac{1}{c}\frac{\partial \mathbf{A}}{\partial t}$$

$$\mathbf{H} = \mathrm{curl}\,\mathbf{A}$$

$$\mathrm{curl}\,\mathbf{H} - \frac{1}{c}\frac{\partial \mathbf{E}}{\partial t} = \frac{4\pi \mathbf{I}}{c}$$

$$-\Delta \mathbf{A} + \mathrm{grad}\,\mathrm{div}\,\mathbf{A} + \mathrm{grad}\,\frac{1}{c}\frac{\partial V}{\partial t}$$

$$+ \frac{1}{c^2}\frac{\partial^2 \mathbf{A}}{\partial t^2} = \frac{4\pi \mathbf{I}}{c}$$

$$\mathrm{div}\,\mathbf{E} = 4\pi\rho$$

$$-\,\mathrm{div}\,\mathrm{grad}\,V - \frac{1}{c}\frac{\partial}{\partial t}\{\mathrm{div}\,\mathbf{A}\} = 4\pi\rho$$

$$\Delta V - \frac{1}{c^2}\frac{\partial^2 V}{\partial t^2}$$

$$\therefore \frac{1}{c}\frac{\partial}{\partial t}\left\{\frac{1}{c}\frac{\partial V}{\partial t} + \mathrm{div}\,\mathbf{A}\right\} = -4\pi\rho$$

$$-\,\mathrm{grad}\left\{\frac{1}{c}\frac{\partial V}{\partial t} + \mathrm{div}\,\mathbf{A}\right\} = -\frac{4\pi \mathbf{I}}{c}$$

$$L = \sum\left(\frac{\partial V}{\partial x}\right)^2 - \sum\left(\frac{\partial \mathbf{A}}{\partial x}\right)^2$$

$$\frac{\partial L}{\partial \frac{\partial V}{\partial t}} = -\frac{1}{c^2}\frac{\partial V}{\partial t}, \quad \frac{\partial L}{\partial \frac{\partial A_x}{\partial t}} = \frac{1}{c^2}\frac{\partial A_x}{\partial t}$$