素粒子の基礎理論討論会
第8回　　5月4日　10時半～　①

1. 田中一, 細谷[illegible]氏：束縛状態について

$$(H_0+H_1)V = V(H_0+\langle H_1 V\rangle)$$

$$H_0 = -\frac{d^2}{dx^2} \qquad H_1 = -\alpha\delta(x)$$

$$(k'^2-k^2)(k'|V|k) - \frac{\alpha}{2\pi}\int dk''(k''|V|k)$$
$$+\frac{\alpha}{2\pi}\int (k'|V|k'')\langle(k'''|V|k)\rangle dk'''dk'' = 0$$

$$(k'|V|k) = \delta(k'-k) + \frac{\alpha}{2\pi}\frac{P}{k'^2-k^2}$$

$$(k'|V|k) = f(k')\delta(k)$$

$$f(k') = \frac{\alpha^2/4}{k'^2+\alpha^2/4}$$

$$\psi(x) \sim e^{-\alpha/2|x|} \qquad E = -\alpha^2/4$$

2. 木庭二郎氏：Dirac 粒子の速度
3. 木庭氏：Schrödinger 場の量子化

$$[j_i(x), j_k(x')] \neq 0 \quad \text{Schrödinger}$$
$$= 0 \quad \text{K. G.}$$

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4. 片山・徳岡・山崎：超関数的記述と第三量子化

Feynman amplitude

$$g_n(z_1 \cdots z_n) = \langle \Psi_0\, N(\phi_H(z_1) \cdots \phi_H(z_n))\, \Psi \rangle$$

(Heisenberg operator, state)

$$\{g_n(z_1 \cdots z_n)\} = \begin{pmatrix} g_0 \\ g_1(z_1) \\ \vdots \\ \vdots \end{pmatrix}$$

$$C(z)\{g_n(z_1 \cdots z_n)\} = \{(n+1)^{1/2} g_{n+1}(z_1 \cdots z_n, z)\}$$

$$C^+(z)\{g_n(z_1 \cdots z_n)\} = \{n^{1/2} S_n \delta(z-z_n) g_{n-1}(z_1 \cdots z_{n-1})\}$$

↓ Friedrichs

$$C^+(z')C(z'')\{g_n(\cdots)\} = \{n S_n \delta(z'-z_n) g_n(z_1 \cdots z_{n-1} z'')\}$$

$$C(z'')C^+(z')\{\ '' \ \} = \{\ '' \ + \delta(z'-z'') g_n(\ )\}$$

$$[C(z''), C^+(z')] = \delta(z'-z'')$$

Third quantization: Ω-space

$\psi(x)$, $\bar{\psi}(y)$ $\phi(z)$

$$\Omega_H = \sum \frac{1}{\sqrt{n!\,m!\,k!}} \int d^4x_n \cdots d^4z_k\, g_{nmk}(x_n \cdots z_k) \times \Omega_{nmk}$$

$$\langle \Omega_{nmk}(z_k \cdots x_n)\, \Omega_{nmk}(z'_k \cdots x'_n) \rangle = \delta(z_k - z'_k) \cdots \delta(x_n - x'_n)$$

$$\langle \Omega_{nmk} \quad \Omega_{n'm'k'} \rangle = 0$$

for $n \neq n'$ etc

$$C(z) \to \{\langle \Omega_{nmk}\, C(z)\, \Omega_{nmk+1} \rangle\}$$

$$C^+(z) \to \{\langle \Omega_{nmk+1}\, C^+(z)\, \Omega_{nmk} \rangle\}$$

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$$\Omega_{nmk} = \frac{1}{\sqrt{n!\,m!\,k!}} C^\dagger(z_k)\cdots a^\dagger(x_n)\Omega_0$$

$$N_c = \int d^4z\, c^\dagger(z) c(z)$$

$$N_c \Omega_{nmk} = k\,\Omega_{nmk}$$

$$\Omega_H = (\Psi_0, N(\exp\int a^\dagger\psi_H - \bar\psi_H b^\dagger + \phi_H c^\dagger)\Phi)\Omega_0$$

$$\Omega = (\Phi_0, N(\exp\int a^\dagger\varphi - \cdots)\Phi)\Omega_0$$

$$(\Box - \mu^2)\phi = 0$$

$$(\Box - \mu^2) c\Omega = 0$$

Coester

$$\Omega_H = \exp \iint dx dy\, a^\dagger(x) S_F(x-y) b^\dagger(y)$$
$$-\frac{1}{2}\iint dz dz'\, c^\dagger(z) \Delta_F(z-z') c^\dagger(z')$$

$$(\Psi_0, T(\exp\int dx(a^\dagger\psi_H \cdots)\Phi))\Omega_0$$

$$\Omega = \quad '' \quad (\quad T \quad \Phi)\Omega_0$$

$$\langle\Psi_0, T(\cdots)\Psi\rangle = \frac{\langle\Phi_0 T(U \quad)\Phi\rangle}{\langle\Phi_0, T(U)\Phi_0\rangle}$$

$$\Omega_H = e^{\iint dx dy \cdots} e^{i\int(L_I - L_0)} e^{-\iint} \Omega$$

$$L_I = g\, b\gamma_5 a c$$

$$e^+ a e^- = a - \int S_F b^\dagger = \psi$$

$$\Omega_H = e^{i\int(L_I(\psi, \bar\psi, \phi) - L_0)}\Omega$$

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$$\left[(\Box-\mu^2)C(z)+\frac{\delta \bar{L}_I(\psi\bar{\psi}\phi)}{\delta\phi(z)}\right]\Omega_H=0$$

$$\mathcal{L}=-\frac{i}{2}\phi(\Box-\mu^2)\phi+i\,\bar{\psi}(\gamma\frac{\partial}{\partial x}+\varkappa)\psi$$
$$-g\,\bar{\psi}\gamma_5\psi\phi$$

$$[\bar{\mathcal{L}},C^{+}(z)]\Omega_H=C^{+}(z)\Omega_H$$
$$[\mathcal{L}\quad a^{+}\ ]\Omega_H=a^{+}(\ )\Omega_H$$
$$[\quad b^{+}\ ]\Omega_H=b^{+}(\ )\Omega_H$$

$$\boxed{\bar{\mathcal{L}}\,\Omega_H=l\,\Omega_H}$$
$$\bar{\mathcal{L}}\ a^{+}\Omega_H=(l+1)\Omega_H$$

$\mathcal{L}$: non-hermitic $=-iL$

$$\frac{1}{2}(\bar{\mathcal{L}}+\bar{\mathcal{L}}^{*})\to\mathcal{L}$$
negative energy

5、素粒子の理論：固有時形式と四次元量子化

particle: $[c(t),c^{*}(t')]=\delta(t-t')$

$$\mathcal{L}=c^{*}(t\,\tau)\,i\frac{\partial}{\partial\tau}c(t\,\tau)-c^{*}(t\,\tau)\left(i\frac{\partial}{\partial t}-\omega\right)c(t\,\tau)$$
$$L=\int\mathcal{L}\,d\tau$$
$$\delta L=0$$
$$\left[i\frac{\partial}{\partial\tau}+\left(i\frac{\partial}{\partial t}-\omega\right)\right]c(t\,\tau)=0$$
$$\pi(t\,\tau)=i\,c^{*}(t\,\tau)$$
$$[c(t\,\tau),c^{*}(t'\,\tau)]=\delta(t-t')$$
$$[c(t),c^{*}(t')]=e^{-i\omega(t-t')}$$

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$$c(t) = \lim_{T\to\infty} \frac{1}{\sqrt{T}} \int_{-T/2}^{T/2} c(t\,\tau)\,d\tau$$

$$U(t\,\tau) = e^{-i\omega\tau}\,\delta(t-\tau)$$

$$= \frac{1}{2\pi}\int e^{-i(kt+\lambda\tau)}\,\delta(\lambda+k-\omega)\,dk\,d\lambda$$

$$U(t\,0) = \delta(t)$$

$$[c(t\tau), c^*(t'\tau')] = \int dt'' \underbrace{U^*(t'\tau'|t''\tau)}_{U(t''\tau|t'\tau')} \underbrace{[c(t,\tau), c^*(t''\tau)]}_{\delta(t-t'')}$$

$$= \exp(-i\omega(t-\tau')) \cdot \delta(t-t'-\overline{\tau-\tau'})$$

$$\int d\tau\,d\tau' [\qquad] = e^{-i\omega(t-t')}$$

$$[c(t), c^*(t')] = \text{''}$$

Coester:

$$[C(t\tau) - C(t)]\,\Psi = 0$$

$$H \sim \int \mathcal{H}\,d\tau \qquad \mathcal{H} = +c^*(t\tau)\left(i\frac{\partial}{\partial\tau} - \omega\right)c(t\tau)$$

$$[\mathcal{H}, c(t\tau) - c(t)]\,\Psi = 0$$

$$\left(i\frac{\partial}{\partial\tau} - \omega\right) c(t\tau)\,\Psi = 0$$

二階の場合

$$\left.\begin{aligned} &\mathcal{L} = c^*(t\tau)\, i\frac{\partial}{\partial\tau}(t\tau) + c^*(t\tau)\left(\frac{\partial^2}{\partial t^2} + \omega^2\right)c(t\tau) \\ &\left[i\frac{\partial}{\partial\tau} - \left(\frac{\partial^2}{\partial t^2} + \omega^2\right)\right] c(t\tau) = 0 \end{aligned}\right\}$$

$$[c(t\tau), c^*(t'\tau')] = U(t\tau|t'\tau')$$

$$U(t\tau) = \sqrt{\frac{i}{4\pi\tau}}\, e^{-i\left(\omega^2\tau + \frac{t^2}{4\tau}\right)}$$

$$c(t) = \int c(t-u, \tau)\,\delta_+(u)\,d\tau\,du$$

or $= \frac{1}{2\omega}\left(i\frac{\partial}{\partial t} + \omega\right)\int c(t, \tau)\,d\tau$

$$[c(t), c^*(t')] = \int d\tau\, d\tau' \tfrac{1}{2}(1 + \varepsilon(t-t')\varepsilon(\tau-\tau'))$$
$$\times L(t\tau | t'\tau')$$

6. 岡山氏：素粒子の統一理論

Pais: $\Lambda^\pm$ Λ^0
$\Sigma^\pm$ Σ^0
Y^-

Okayama: mass level と charge とは別，

$p + \pi^- \to \Lambda^0 + \theta^0$ strong
$\Lambda^0 \to \pi^- + p$ weak (Pais)

$p + \pi^- \to \Sigma^0 + \theta^0$
$\Sigma^0 \to \Lambda^0 + \gamma$

$\Lambda^0 \to \pi_w^- + p$
star or capture

b: baric charge　π_w: S or V
l: leptic charge

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