

1. 因果性について

i) Non-local 因果性の問題...

Non-local local の区別は...
因果性...
specific

ii) Relativity と因果性...
Lorentz-invariant formulation.

①

A.

$$\phi(x) = C(x) + \int G(x-y) C^\dagger(y)$$

$$\begin{aligned} [\phi(x), \phi(x')] &= \int G(x'-y') [C(x), C^\dagger(y')] \\ &\quad + \int G(x-y) [C^\dagger(y), C(x')] \\ &= G(x'-x) - G(x-x') \end{aligned}$$

$$\Psi_\alpha(x) = a_\alpha(x) + \int \Gamma_{\alpha\beta}(x-y) b_\beta^\dagger(y)$$

$$\Psi_\alpha^\dagger(x) = b_\alpha(x) + \int \Gamma_{\alpha\beta}(x-y) a_\beta^\dagger(y)$$

$$\begin{aligned} \{\Psi_\alpha(x), \Psi_\beta^\dagger(x')\} &= \int \Gamma_{\alpha\beta\gamma\delta}(x'-y') \{a_\alpha(x), a_\beta^\dagger(y')\} \\ &\quad + \int \Gamma_{\alpha\beta}(x-y) \{b_\beta^\dagger(y), b_\alpha(x')\} \\ &= \Gamma_{\beta\alpha}(x'-x) + \Gamma_{\alpha\beta}(x-x') \end{aligned}$$

$$\mathcal{H}(x) \phi(x) = \mathcal{H}(x) C(x) + C^\dagger(x)$$

$$\mathcal{D}_{\alpha\beta}(x) \Psi_\beta(x) = \mathcal{D}_{\alpha\beta}(x) a_\beta(x) + b_\alpha^\dagger(x)$$

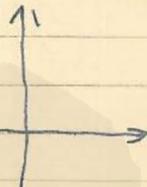
(i) $G(x)$: even fn $\hat{a} \hat{a}^\dagger$ $\phi(x)$ is τ -commutative

$$\phi^\dagger(x) = C^\dagger(x) + \int G(x-y) C(y)$$

$$[\phi(x), \phi^\dagger(x')] = \delta(x-x')$$

$$+ \iint G(x-y) G(x'-y') [C^\dagger(y), C(y)]$$

$$= \delta(x-x') - \int G(x-y) G(x'-y)$$



(2)

$$B. \quad \phi(x) = \frac{c(x) + c^{\dagger}(x)}{2} + i \int K(x-y) \frac{c(x) - c^{\dagger}(x)}{2}$$

$$[\phi(x), \phi(x')] = \frac{1}{4} \left\{ [c(x), c^{\dagger}(x')] + [c^{\dagger}(x), c(x')] \right\}$$

$$+ i \left\{ K(x'-y) \frac{1}{4} [\delta(x-y') + \delta(x-y')] \right\}$$

$$+ i \left\{ K(x-y) \frac{1}{4} [\delta(x'-y) + \delta(x'-y')] \right\}$$

+ 0

$$= \frac{1}{2} i \{ K(x'-x) - K(x-x') \}$$

→

C.

$$\int F(x-y) \phi(y) dy = 0$$

$$F(x) = \int f(k) e^{ikx} dk$$

$$\iint e^{ikx} e^{-iky} f(k) \phi(y) dy dk$$

$$\phi(y) = \int c(k') e^{ik'y} dk'$$

$$\iint e^{ikx} c(k') f(k) e^{i(k+k')y} dy dk$$

$$= \int e^{ikx} c(k) f(k) dk$$

$$f(k) c(k) = 0$$

$$f(k) = f(R_n k_n)$$

$$f(k_n^2) = 0 \quad n=1, 2, \dots$$

(3)

$$f(x)\Omega = \int f(x-y)\varphi(y)dy \cdot \Omega = 0$$

$$\chi(x) = \int K(x-y)\varphi(y)dy$$

$$[f(x), \chi(x)] = \left[\int f(x-y)\varphi(y)dy, \chi(x) \right] = 0$$

$$F(x-y)K(x'-y')$$