

場の量子論 p300check10.15

谷脇 貞善

2024 年 9 月 16 日

1 本文

$O(\theta^2)$ は無視。

$$S = \int d^4x \{ (\partial_\mu \Phi)^* \partial^\mu \Phi - V(\Phi^* \Phi) \} \quad (1)$$

$$\Phi(x) \rightarrow \Phi'(x) = \Phi(x) + \delta_Q \Phi(x) = \Phi(x) - iq\theta(x)\Phi(x) \quad (2)$$

$$\Phi^*(x) \rightarrow [\Phi']^*(x) = \Phi^*(x) + \delta_Q \Phi^*(x) = \Phi^*(x) + iq\theta(x)\Phi^*(x) \quad (3)$$

$$S' = \int d^4x \{ (\partial_\mu \Phi')^* \partial^\mu \Phi' - V([\Phi']^* \Phi') \} \quad (4)$$

$$= \int d^4x \{ [\partial_\mu \Phi^* + iq\{\partial_\mu \theta\}\Phi^* + iq\theta\{\partial_\mu \Phi^*\}][\partial^\mu \Phi - iq\{\partial^\mu \theta\}\Phi - iq\theta\{\partial^\mu \Phi\}] - V(\Phi^* \Phi) \} \quad (5)$$

$$= \int d^4x \{ (\partial_\mu \Phi^*)(\partial^\mu \Phi) + iq(\partial_\mu \theta)\Phi^*(\partial^\mu \Phi) - iq(\partial_\mu \theta)\Phi(\partial^\mu \Phi^*) - V(\Phi^* \Phi) \} \quad (6)$$

$$= S + \int d^4x \{ (\partial_\mu \theta) j^\mu \} \quad (7)$$

$$= S + \delta_Q S \quad (8)$$

$$j^\mu = iq\{\Phi^*(\partial^\mu \Phi) - (\partial^\mu \Phi^*)\Phi\} \quad (9)$$

$$\delta_Q S = 0$$

$$\delta_Q S = \int d^4x \{ \partial_\mu (\theta j^\mu) - \theta (\partial_\mu j^\mu) \} = 0 \quad (10)$$

$$\partial_\mu j^\mu = 0 \quad (11)$$

参考文献

- [1] 坂本眞人著「場の量子論-不変性と自由場を中心にして」(裳華房,2014,ISBN9784785325114)