

場の量子論 p262check9.13

谷脇 貞善

2024 年 8 月 16 日

1 本文

$$\Psi'(x) = U(x)\Psi(x) \quad (1)$$

$$A'_\mu(x) = U(x)A_\mu(x)U^{-1}(x) + \frac{i}{g}[\partial_\mu U(x)]U^{-1}(x) \quad (2)$$

$$D'_\mu(x)\Psi'(x) = \{\partial_\mu + igA'_\mu(x)\}\Psi'(x) \quad (3)$$

$$= \{\partial_\mu + igU(x)A_\mu(x)U^{-1}(x) - [\partial_\mu U(x)]U^{-1}(x)\}U(x)\Psi(x) \quad (4)$$

$$= [\partial_\mu U(x)]\Psi(x) + U(x)[\partial_\mu \Psi(x)] + igU(x)A_\mu(x)\Psi(x) - [\partial_\mu U(x)]\Psi(x) \quad (5)$$

$$= U(x)[\partial_\mu + igA_\mu(x)]\Psi(x) \quad (6)$$

$$= U(x)D_\mu(x)U^{-1}(x)U(x)\Psi(x) \quad (7)$$

$$D'_\mu(x) = U(x)D_\mu(x)U^{-1}(x) \quad (8)$$

$$F'_{\mu\nu}(x) = \frac{1}{ig}[D'_\mu(x), D'_\nu(x)] \quad (9)$$

$$= \frac{1}{ig}[U(x)D_\mu(x)U^{-1}(x), U(x)D_\nu(x)U^{-1}(x)] \quad (10)$$

$$= U(x)\frac{1}{ig}[D_\mu(x), D_\nu(x)]U^{-1}(x) \quad (11)$$

$$= U(x)F_{\mu\nu}(x)U^{-1}(x) \quad (12)$$

$$\mathcal{L}'(x) = -\frac{1}{4}\text{tr}[F'^{\mu\nu}(x)F'_{\mu\nu}(x)] \quad (13)$$

$$= -\frac{1}{4}\text{tr}[U(x)F^{\mu\nu}(x)U^{-1}(x)U(x)F_{\mu\nu}(x)U^{-1}(x)] \quad (14)$$

$$= -\frac{1}{4}\text{tr}[F^{\mu\nu}(x)F_{\mu\nu}(x)] \quad (15)$$

$$= \mathcal{L}(x) \quad (16)$$

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)