場の量子論 p260check9.12

谷脇 貞善

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1 本文

$$\mathcal{L}(A_\mu,\Phi,\psi)=-\frac{1}{4}F_{\mu\nu}F^{\mu\nu}+(D_\mu\Phi)^*D^\mu\Phi-m_\psi^2\Phi^*\Phi-\frac{\lambda}{4}(\Phi^*\Phi)^2+\bar{\psi}(i\gamma^\mu D_\mu-m_\psi)\psi \tag{1}$$

$$D_\mu\Phi\equiv(\partial_\mu+iq_\Phi A_\mu)\Phi,\qquad D_\mu\psi\equiv(\partial_\mu+iq_\psi A_\mu)\psi \tag{2}$$

$$j_\Phi^\mu=iq_\Phi\{\Phi^*D^\mu\Phi-(D^\mu\Phi)^*\Phi\},\qquad j_\psi^\mu=q_\psi\bar{\psi}\gamma^\mu\psi \tag{3}$$

$$0=D_\mu(\frac{\partial\mathcal{L}}{\partial D_\mu\Phi})-\frac{\partial\mathcal{L}}{\partial\Phi} \tag{4}$$

$$=D_\mu(D^\mu\Phi)^*+m_\psi^2\Phi^*+\frac{\lambda}{2}(\Phi^*\Phi)\Phi^* \tag{5}$$

$$0=D_\mu(\frac{\partial\mathcal{L}}{\partial D_\mu\Phi^*})-\frac{\partial\mathcal{L}}{\partial\Phi^*} \tag{6}$$

$$=D_\mu(D^\mu\Phi)+m_\psi^2\Phi+\frac{\lambda}{2}(\Phi^*\Phi)\Phi \tag{7}$$

$$D_\mu j_\Phi^\mu=iq_\Phi\{(D_\mu\Phi^*)D^\mu\Phi+\Phi^*(D_\mu D^\mu\Phi)-[D_\mu(D^\mu\Phi)^*]\Phi-(D^\mu\Phi)^*(D_\mu\Phi)\} \tag{8}$$

$$=iq_\Phi\{-\Phi^*[m_\psi^2\Phi+\frac{\lambda}{2}(\Phi^*\Phi)\Phi]+[m_\psi^2\Phi^*+\frac{\lambda}{2}(\Phi^*\Phi)\Phi^*]\Phi\} \tag{9}$$

$$=0 \tag{10}$$

$$0=D_\mu(\frac{\partial\mathcal{L}}{\partial D_\mu\psi})-\frac{\partial\mathcal{L}}{\partial\psi} \tag{11}$$

$$=D_\mu(\bar{\psi}i\gamma^\mu)+m_\psi\bar{\psi} \tag{12}$$

$$0=D_\mu(\frac{\partial\mathcal{L}}{\partial D_\mu\bar{\psi}})-\frac{\partial\mathcal{L}}{\partial\bar{\psi}} \tag{13}$$

$$=-(i\gamma^\mu D_\mu-m_\psi)\psi \tag{14}$$

$$D_\mu j_\psi^\mu=q_\psi(D_\mu\bar{\psi}\gamma^\mu)\psi+q_\psi\bar{\psi}(\gamma^\mu D_\mu\psi) \tag{15}$$

$$=q_\psi(im_\psi\bar{\psi})\psi+q_\psi\bar{\psi}(-im_\psi\psi) \tag{16}$$

$$=0 \tag{17}$$

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)