ϰ-Уравнение Движения

Полное уравнение:

$$E(x) = E_K(x) + E_T(x) + E_V(x) + E_S(x) = 0$$

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1. Кинетический Вклад $E_K(x)$

$$\begin{aligned} E_K(x) = & -\frac{1}{2}\,\partial_\mu \left(G^{\mu\nu} D_\nu \varphi\right) + \frac{1}{2} G^{\mu\nu} T_a^\dagger \Gamma_a^\mu D_\nu \varphi \\ & + \frac{1}{2} G^{\mu\nu} \varphi^\dagger T_a^\dagger \left(\kappa_1 \cdot \mathrm{Im}\left[\frac{\partial \varphi^\dagger}{\partial T} T_a \partial^\mu \varphi + \varphi^\dagger T_a \partial^\mu \left(\frac{\partial \varphi}{\partial T}\right)\right] + \kappa_2 \cdot \partial^\mu T(\varphi) \cdot \frac{d\mathcal{F}_a(T)}{dT}\right) \cdot \frac{\partial \varphi^\dagger}{\partial T}\, D_\nu \varphi \\ & + \frac{1}{2} G^{\mu\nu} (D_\mu \varphi)^\dagger \left(\kappa_1 \cdot \mathrm{Im}\left[\frac{\partial \varphi^\dagger}{\partial T} T_b \partial^\nu \varphi + \varphi^\dagger T_b \partial^\nu \left(\frac{\partial \varphi}{\partial T}\right)\right] + \kappa_2 \cdot \partial^\nu T(\varphi) \cdot \frac{d\mathcal{F}_b(T)}{dT}\right) \cdot \frac{\partial \varphi^\dagger}{\partial T}\, T_b \varphi \\ & + \frac{1}{2} \frac{\partial G^{\mu\nu}}{\partial T} \cdot \frac{\partial \varphi^\dagger}{\partial T} \cdot \langle D_\mu \varphi, D_\nu \varphi \rangle \end{aligned}$$

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2. Когерентный Кинетический Член $E_T(x)$

$$\begin{aligned} E_T(x) = & -\frac{1}{2}\,\partial_T \left(G_T D_T \varphi\right) + \frac{1}{2} G_T T_a^\dagger \Omega_a D_T \varphi \\ & + \frac{1}{2} G_T \varphi^\dagger T_a^\dagger \frac{\partial \Omega_a}{\partial T} \cdot \frac{\partial T}{\partial \varphi^\dagger} D_T \varphi \\ & + \frac{1}{2} G_T (D_T \varphi)^\dagger \frac{\partial \Omega_b}{\partial T} \cdot \frac{\partial T}{\partial \varphi^\dagger} T_b \varphi \\ & + \frac{1}{2} \frac{dG_T}{dT} \cdot \frac{\partial T}{\partial \varphi^\dagger} \cdot \langle D_T \varphi, D_T \varphi \rangle \end{aligned}$$

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3. Потенциальный Член $E_V(x)$

$$E_V(x) = E_{V_0}(x) + E_{V_T}(x) + E_{V_Z}(x)$$

Где:

$$E_{V_0}(x) = 2\lambda_1 \left(\varphi^\dagger \varphi - v^2\right) \cdot \varphi$$

$$E_{V_T}(x) = 2\lambda_2 \left(T(\varphi) - T_0\right) \cdot \left[\alpha \varphi + \beta \cdot \frac{\partial}{\partial \varphi^\dagger} \mathrm{Im}\left(\log \det \rho(\varphi)\right) + \gamma E_S(x)\right]$$

$$E_{V_Z}(x) = \lambda_3 \sum_a 2 \cdot \left(\frac{\partial_T Z_a(T)}{Z_a(T)}\right) \cdot \left[-\frac{\partial_T Z_a(T)}{Z_a^2(T)} \cdot \frac{\delta Z_a(T)}{\delta \varphi^\dagger} + \frac{1}{Z_a(T)} \cdot \frac{d}{dT} \left(\frac{\delta Z_a(T)}{\delta \varphi^\dagger}\right)\right]$$

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4. Энтропийный Член $E_S(x)$

$$E_S(x) = \frac{Z(T)^2}{2b} \sum \mathrm{Re}\left[\varphi^\dagger T_b \varphi\right] \cdot \mathrm{Re}\left[T_b \varphi\right] \cdot S_Z - \frac{Z(T)^2}{2a} \sum \mathrm{Re}\left[\varphi^\dagger T_a \varphi\right] \cdot \mathrm{Re}\left[T_a \varphi\right] \cdot (1 + \log \rho_T(x))$$

где:

$$S_Z := \int d^4x' \ (1 + \log \rho_T(x')) \cdot \left(\sum_a \left(\mathrm{Re}[\varphi^\dagger(x') T_a \varphi(x')]\right)^2 + \delta_0^2 \right)$$

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5. Производные

5.1. Производная $\partial_T G^{\mu\nu}(x)$

$$\frac{\partial G^{\mu\nu}}{\partial T} = -G^{\mu\alpha} G^{\nu\beta} \frac{\partial G_{\alpha\beta}}{\partial T}$$

$$\frac{\partial G_{\alpha\beta}}{\partial T} = \epsilon \cdot \frac{\left(\partial_\alpha \left(\frac{\partial T}{\partial \varphi}\right) \partial_\beta T + \partial_\alpha T \partial_\beta \left(\frac{\partial T}{\partial \varphi}\right)\right) (\Lambda^2 + \partial_\rho T \partial^\rho T) - (\partial_\alpha T \partial_\beta T) \cdot 2 \partial^\rho T \partial_\rho \left(\frac{\partial T}{\partial \varphi}\right)}{(\Lambda^2 + \partial_\rho T \partial^\rho T)^2}$$

5.2. Производная $\partial_T \Gamma_a^\mu$

$$\frac{\partial \Gamma_a^\mu}{\partial T} = \kappa_1 \cdot \mathrm{Im}\left[\frac{\partial \varphi^\dagger}{\partial T} T_a \partial^\mu \varphi + \varphi^\dagger T_a \partial^\mu \left(\frac{\partial \varphi}{\partial T}\right)\right] + \kappa_2 \cdot \partial^\mu T(\varphi) \cdot \frac{d\mathcal{F}_a(T)}{dT}$$

5.3. Производная $\frac{\partial T}{\partial \varphi^\dagger}$

$$\frac{\partial T}{\partial \varphi^\dagger(x)} = \alpha \cdot \varphi(x) + \beta \cdot \frac{\partial \varphi^\dagger(x)}{\partial \, \mathrm{Im} \log \det \rho(\varphi)} + \gamma \cdot E_S(x)$$