Nejednoznačnost Sajberg-Vitenovog preslikavanja i renormalizabilnost nekomutativne kiralne elektrodinamike

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Divčibare

Nekomutativni prostor

- $[\hat{x}^\mu, \hat{x}^\nu] \neq 0$
- $[\hat{x}^\mu, \hat{x}^\nu] = \mathrm{i}\theta^{\mu\nu}$
  - $\theta^{\mu\nu}$ realna, konstantna i antisimetrična matrica.
  - $|\theta| = \ell^2$, $\theta = \Lambda_{NC}^{-2}$

Mojal-Weyl-ov ili $\star$-proizvod

- $(\hat{\mathcal{A}}_x, \cdot) \leftrightarrow (\mathcal{A}_x, \star)$
- $W : \mathcal{A}_x \to \hat{\mathcal{A}}_x$
- $W(f) \cdot W(g) = \hat{f} \cdot \hat{g} = W(f \star g)$
- $(f \star g)(x) = \exp\left(\frac{\mathrm{i}}{2}\theta^{\mu\nu}\frac{\partial}{\partial y^\mu}\frac{\partial}{\partial z^\nu}\right) f(y)g(z)\Big|_{y,z \to x}$
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Polja na NC prostoru

- Lorencova simetrija je eksplicitno narušena.
- Gradijentne teorije se definišu pomoću Sajberg-Vitenovog preslikavanja.
- Gejdž transformacija: $\hat{\delta}_{\hat{\lambda}}\hat{\psi}(x) = \mathrm{i}\hat{\lambda}(x) \star \hat{\psi}(x)$
- Kovarijantni izvod: $D_\mu\hat{\psi}(x) = \partial_\mu\hat{\psi}(x) - \mathrm{i}\hat{A}_\mu \star \hat{\psi}(x)$
- Jačina polja: $\hat{F}_{\mu\nu}\hat{\psi}(x) = \mathrm{i}[D_\mu \stackrel{\star}{,} D_\nu]\hat{\psi}(x)$
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SW preslikavanje

- $\begin{pmatrix} \hat\lambda \\ \hat A \\ \hat\psi \end{pmatrix} \to \begin{pmatrix} \lambda \\ A \\ \psi \end{pmatrix}$
- $\hat A_\mu(A;\theta) \to e^{i\hat\lambda(\lambda,A;\theta)} \star (\hat A(A;\theta) + i\partial_\mu) \star e^{-i\hat\lambda(\lambda,A;\theta)} \equiv \hat A_\mu(A';\theta)$
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SW preslikavanje

- $\hat{\lambda} = \lambda + \lambda^{(1)}(\lambda, A; \theta) + \lambda^{(2)}(\lambda, A; \theta) + \dots$
- $\hat{A}_\mu = A_\mu + A_\mu^{(1)}(A; \theta) + A_\mu^{(2)}(A; \theta) + \dots$
- $\hat{\psi} = \psi + \psi^{(1)}(\psi, A; \theta) + \psi^{(2)}(\psi, A; \theta) + \dots$

SW jednačina za $\lambda^{(1)}$:

$$\delta_{\lambda_1}\lambda^{(1)}(\lambda_2) - \delta_{\lambda_2}\lambda^{(1)}(\lambda_1) - \mathrm{i}[\lambda^{(1)}(\lambda_1), \lambda_2]$$
$$+\mathrm{i}[\lambda^{(1)}(\lambda_2), \lambda_1] + \mathrm{i}\lambda^{(1)}([\lambda_1, \lambda_2]) = -\frac{1}{2}\theta^{\mu\nu}\{\partial_\mu\lambda_1, \partial_\nu\lambda_2\}$$

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SW preslikavanje

- $\lambda^{(1)}(\lambda, A; \theta) = -\frac{1}{4}\theta^{\mu\nu}\{A_\mu, \partial_\nu \lambda\}$
- $A^{(1)}_\rho(A; \theta) = -\frac{1}{4}\theta^{\mu\nu}\{A_\mu, F_{\nu\rho} + \partial_\nu A_\rho\}$
- $\psi^{(1)}(\psi, A; \theta) = -\frac{1}{4}\theta^{\mu\nu} A_\mu \left(D_\nu + \partial_\nu\right)\psi$

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- $\lambda^{(1)}(\lambda, A; \theta) = -\frac{1}{4}\theta^{\mu\nu}\{A_\mu, \partial_\nu \lambda\}$
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Nejednoznačnosti SW preslikavanja:

- $\lambda'^{(1)} = \mathrm{i}c_{1,\lambda}\theta^{\mu\nu}[A_\mu, \partial_\nu\lambda]$
- $A_\rho'^{(1)} = \mathrm{i}c_{1,\lambda}\theta^{\mu\nu}[D_\rho A_\mu, A_\nu] - 2\mathrm{i}c_{1,A}\theta^{\mu\nu}D_\rho F_{\mu\nu}$
- $\psi'^{(1)} = -c_{1,\lambda}\theta^{\mu\nu}A_\mu A_\nu\psi + \frac{1}{2}c_{1,\psi}\theta^{\mu\nu}F_{\mu\nu}\psi$
  - $A_\rho^{(n)} \to A_\rho^{(n)} + \mathbb{A}_\rho^{(n)}$, $\psi^{(n)} \to \psi^{(n)} + \Psi^{(n)}$

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Dejstvo na NC prostoru

- $\mathcal{L}_{YM} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu}$
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Uopštena nekomutativna gejdž teorija

- $S_a = S_{YM}^{NC} + \frac{a-1}{4} \mathrm{Tr} \int \mathrm{d}^4 x (\theta^{\mu\nu} F_{\mu\nu} \star F_{\rho\sigma} \star F^{\rho\sigma})$
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- $\mathcal{L}_0 = \mathrm{i}\bar{\varphi}\bar{\sigma}^\mu(D_\mu\varphi) - \frac{1}{4}F_{\mu\nu}F^{\mu\nu}$
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- $\Gamma[A_\mu, \psi] = S_{\mathrm{cl}}[A_\mu, \psi] - \frac{1}{2\mathrm{i}} \,\mathrm{STr} \log \mathcal{B}[A_\mu, \psi]$
- $S^{(2)} = \int \mathrm{d}^4 x \begin{pmatrix} \mathcal{A}_\kappa & \bar{\Psi} \end{pmatrix} \mathcal{B} \begin{pmatrix} \mathcal{A}_\lambda \\ \Psi \end{pmatrix}$
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- $\mathcal{B}_{\mathsf{kin}} = \frac{1}{2}\begin{pmatrix} g^{\kappa\lambda}\Box & 0 \\ 0 & \mathrm{i}\not{\partial} \end{pmatrix}$
  - $\mathcal{I} = \begin{pmatrix} g^{\kappa\lambda} & 0 \\ 0 & 1 \end{pmatrix}$
  - $\mathcal{B}_{\mathsf{kin}}\mathcal{C} = \mathcal{I}$
  - $\mathcal{C} = 2\begin{pmatrix} 1 & 0 \\ 0 & -\mathrm{i}\not{\partial} \end{pmatrix}$
- $\mathrm{STr}\left(\log\mathcal{B}\right) = \mathrm{STr}\left(\log\Box^{-1}\mathcal{B}\mathcal{C}\right) - \mathrm{STr}\left(\log\mathcal{C}\Box^{-1}\right)$

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Metod pozadinskog polja

- $\mathcal{BC} = \Box\mathcal{I} + N_1 + T_1 + T_2$
- Kvantna korekcija:

$$\begin{aligned}\Gamma^{(1)} &= \frac{i}{2}\mathrm{STr}\log\left(\mathcal{I} + \Box^{-1}N_1 + \Box^{-1}T_1 + \Box^{-1}T_2\right)\\ &= \frac{i}{2}\sum\frac{(-1)^{n+1}}{n}\mathrm{STr}\left(\Box^{-1}N_1 + \Box^{-1}T_1 + \Box^{-1}T_2\right)^n\end{aligned}$$

- $N_1 = \begin{pmatrix} 0 & -i\bar{\psi}\gamma_5\gamma^\lambda\not{\partial} \\ -\gamma_5\gamma^\kappa\psi & i\gamma_5\not{A}\not{\partial}\end{pmatrix}$

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&= \frac{i}{2}\sum\frac{(-1)^{n+1}}{n}\mathrm{STr}\left(\Box^{-1}N_1 + \Box^{-1}T_1 + \Box^{-1}T_2\right)^n
\end{aligned}$$

- $N_1 = \begin{pmatrix} 0 & -i\bar{\psi}\gamma_5\gamma^\lambda\not{\partial} \\ -\gamma_5\gamma^\kappa\psi & i\gamma_5\not{A}\not{\partial} \end{pmatrix}$

Metod pozadinskog polja

- $\mathcal{BC} = \Box\mathcal{I} + N_1 + T_1 + T_2$
- Kvantna korekcija:

$$\begin{aligned}\Gamma^{(1)} &= \frac{\mathrm{i}}{2}\mathrm{STr}\log\left(\mathcal{I} + \Box^{-1}N_1 + \Box^{-1}T_1 + \Box^{-1}T_2\right)\\ &= \frac{\mathrm{i}}{2}\sum\frac{(-1)^{n+1}}{n}\mathrm{STr}\left(\Box^{-1}N_1 + \Box^{-1}T_1 + \Box^{-1}T_2\right)^n\end{aligned}$$

- $N_1 = \begin{pmatrix} 0 & -\mathrm{i}\bar{\psi}\gamma_5\gamma^\lambda\partial\!\!\!/ \\ -\gamma_5\gamma^\kappa\psi & \mathrm{i}\gamma_5 A\!\!\!/\partial\!\!\!/ \end{pmatrix}$

Metod pozadinskog polja

$$T_1 = \begin{pmatrix} V^{\kappa\lambda} & -\frac{1}{4}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\delta^{\kappa}_{\alpha}(\partial_\beta\bar{\psi})\gamma^\rho\partial_\gamma\overleftarrow{\partial\!\!\!/} \\ -\frac{\mathrm{i}}{4}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\delta^{\lambda}_{\alpha}\gamma^\rho(\partial_\beta\psi)\partial_\gamma & -\frac{1}{8}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}F_{\alpha\beta}\gamma^\rho\partial_\gamma\overleftarrow{\partial\!\!\!/} \end{pmatrix}$$

- $V^{\kappa\lambda} = -\partial_\sigma V^{\sigma\kappa,\tau\lambda}\partial_\tau$
- $V^{\sigma\kappa,\tau\lambda} = \frac{1}{2}(g^{\sigma\tau}g^{\kappa\lambda} - g^{\sigma\lambda}g^{\tau\kappa})\theta^{\alpha\beta}F_{\alpha\beta} - g^{\kappa\lambda}(\theta^{\xi\sigma}F_\xi{}^\tau + \theta^{\xi\tau}F_\xi{}^\sigma) - g^{\sigma\tau}(\theta^{\xi\kappa}F_\xi{}^\lambda + \theta^{\xi\lambda}F_\xi{}^\kappa) + g^{\kappa\tau}(\theta^{\xi\lambda}F_\xi{}^\sigma + \theta^{\xi\sigma}F_\xi{}^\lambda) + g^{\sigma\lambda}(\theta^{\xi\kappa}F_\xi{}^\tau + \theta^{\xi\tau}F_\xi{}^\kappa) - \theta^{\kappa\lambda}F^{\sigma\tau} + \theta^{\kappa\tau}F^{\sigma\lambda} + \theta^{\sigma\lambda}F^{\kappa\tau} + \theta^{\sigma\kappa}F^{\tau\lambda} + \theta^{\tau\lambda}F^{\sigma\kappa} - \theta^{\sigma\tau}F^{\kappa\lambda}$

$$T_2 = -\frac{1}{8}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\begin{pmatrix} \delta^{\kappa}_{\alpha}\delta^{\lambda}_{\beta}(\partial_\gamma\bar{\psi}\gamma_5\gamma^\rho\psi + \bar{\psi}\gamma_5\gamma^\rho\psi\partial_\gamma) & \mathrm{i}\delta^{\kappa}_{\alpha}(2\partial_\beta A_\gamma + F_{\beta\gamma})\bar{\psi}\gamma_5\gamma^\rho\overleftarrow{\partial\!\!\!/} \\ -\delta^{\lambda}_{\alpha}\gamma_5\gamma^\rho\psi(2A_\beta\partial_\gamma + F_{\beta\gamma}) & \mathrm{i}F_{\alpha\beta}A_\gamma\gamma_5\gamma^\rho\overleftarrow{\partial\!\!\!/} \end{pmatrix}$$

Metod pozadinskog polja

$$T_1 = \begin{pmatrix} V^{\kappa\lambda} & -\frac{1}{4}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\delta^{\kappa}_{\alpha}(\partial_\beta\bar{\psi})\gamma^\rho\partial_\gamma\bar{\not\partial} \\ -\frac{i}{4}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\delta^{\lambda}_{\alpha}\gamma^\rho(\partial_\beta\psi)\partial_\gamma & -\frac{1}{8}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}F_{\alpha\beta}\gamma^\rho\partial_\gamma\bar{\not\partial} \end{pmatrix}$$

- $V^{\kappa\lambda} = -\partial_\sigma V^{\sigma\kappa,\tau\lambda}\partial_\tau$
- $V^{\sigma\kappa,\tau\lambda} = \frac{1}{2}(g^{\sigma\tau}g^{\kappa\lambda} - g^{\sigma\lambda}g^{\tau\kappa})\theta^{\alpha\beta}F_{\alpha\beta} - g^{\kappa\lambda}(\theta^{\xi\sigma}F_\xi{}^\tau + \theta^{\xi\tau}F_\xi{}^\sigma) - g^{\sigma\tau}(\theta^{\xi\kappa}F_\xi{}^\lambda + \theta^{\xi\lambda}F_\xi{}^\kappa) + g^{\kappa\tau}(\theta^{\xi\lambda}F_\xi{}^\sigma + \theta^{\xi\sigma}F_\xi{}^\lambda) + g^{\sigma\lambda}(\theta^{\xi\kappa}F_\xi{}^\tau + \theta^{\xi\tau}F_\xi{}^\kappa) - \theta^{\kappa\lambda}F^{\sigma\tau} + \theta^{\kappa\tau}F^{\sigma\lambda} + \theta^{\sigma\lambda}F^{\kappa\tau} + \theta^{\sigma\kappa}F^{\tau\lambda} + \theta^{\tau\lambda}F^{\sigma\kappa} - \theta^{\sigma\tau}F^{\kappa\lambda}$

$$T_2 = -\frac{1}{8}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\begin{pmatrix} \delta^{\kappa}_{\alpha}\delta^{\lambda}_{\beta}(\partial_\gamma\bar{\psi}\gamma_5\gamma^\rho\psi + \bar{\psi}\gamma_5\gamma^\rho\psi\partial_\gamma) & i\delta^{\kappa}_{\alpha}(2\partial_\beta A_\gamma + F_{\beta\gamma})\bar{\psi}\gamma_5\gamma^\rho\bar{\not\partial} \\ -\delta^{\lambda}_{\alpha}\gamma_5\gamma^\rho\psi(2A_\beta\partial_\gamma + F_{\beta\gamma}) & iF_{\alpha\beta}A_\gamma\gamma_5\gamma^\rho\bar{\not\partial} \end{pmatrix}$$

Metod pozadinskog polja

$$T_1 = \begin{pmatrix} V^{\kappa\lambda} & -\frac{1}{4}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\delta^{\kappa}_{\alpha}(\partial_\beta\bar{\psi})\gamma^\rho\partial_\gamma\bar{\partial} \\ -\frac{i}{4}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\delta^{\lambda}_{\alpha}\gamma^\rho(\partial_\beta\psi)\partial_\gamma & -\frac{1}{8}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}F_{\alpha\beta}\gamma^\rho\partial_\gamma\bar{\partial} \end{pmatrix}$$

- $V^{\kappa\lambda} = -\partial_\sigma V^{\sigma\kappa,\tau\lambda}\partial_\tau$
- $V^{\sigma\kappa,\tau\lambda} = \frac{1}{2}(g^{\sigma\tau}g^{\kappa\lambda} - g^{\sigma\lambda}g^{\tau\kappa})\theta^{\alpha\beta}F_{\alpha\beta} - g^{\kappa\lambda}(\theta^{\xi\sigma}F_\xi{}^\tau + \theta^{\xi\tau}F_\xi{}^\sigma) - g^{\sigma\tau}(\theta^{\xi\kappa}F_\xi{}^\lambda + \theta^{\xi\lambda}F_\xi{}^\kappa) + g^{\kappa\tau}(\theta^{\xi\lambda}F_\xi{}^\sigma + \theta^{\xi\sigma}F_\xi{}^\lambda) + g^{\sigma\lambda}(\theta^{\xi\kappa}F_\xi{}^\tau + \theta^{\xi\tau}F_\xi{}^\kappa) - \theta^{\kappa\lambda}F^{\sigma\tau} + \theta^{\kappa\tau}F^{\sigma\lambda} + \theta^{\sigma\lambda}F^{\kappa\tau} + \theta^{\sigma\kappa}F^{\tau\lambda} + \theta^{\tau\lambda}F^{\sigma\kappa} - \theta^{\sigma\tau}F^{\kappa\lambda}$

$$T_2 = -\frac{1}{8}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\begin{pmatrix} \delta^\kappa_\alpha\delta^\lambda_\beta(\partial_\gamma\bar{\psi}\gamma_5\gamma^\rho\psi + \bar{\psi}\gamma_5\gamma^\rho\psi\partial_\gamma) & i\delta^\kappa_\alpha(2\partial_\beta A_\gamma + F_{\beta\gamma})\bar{\psi}\gamma_5\gamma^\rho\bar{\partial} \\ -\delta^\lambda_\alpha\gamma_5\gamma^\rho\psi(2A_\beta\partial_\gamma + F_{\beta\gamma}) & iF_{\alpha\beta}A_\gamma\gamma_5\gamma^\rho\bar{\partial} \end{pmatrix}$$

4ψ verteks

- $\Gamma_{4\psi} \sim \frac{1}{(4\pi)^2\epsilon}\varepsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma_5\gamma^\sigma\psi)(\bar{\psi}\gamma^\rho\psi)$
- $\mathcal{D}_1 = \mathrm{STr}\left((\Box^{-1}N_1)^3(\Box^{-1}T_1)\right)$
- $\mathcal{D}_2 = \mathrm{STr}\left((\Box^{-1}N_1)^2(\Box^{-1}T_2)\right)$
    - $A_\mu = 0$
- $\mathcal{D}_1\big|^{4\psi}_{\mathrm{div}} = 0$
- $\mathcal{D}_2\big|^{4\psi}_{\mathrm{div}} = -\frac{3}{8}\frac{1}{(4\pi)^2\epsilon}\varepsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma^\rho\gamma_5\psi)(\bar{\psi}\gamma^\rho\gamma_5\psi) = 0$

4ψ verteks

- $\Gamma_{4\psi} \sim \frac{1}{(4\pi)^2\epsilon}\varepsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma_5\gamma^\sigma\psi)(\bar{\psi}\gamma^\rho\psi)$
- $\mathcal{D}_1 = \mathrm{STr}\left((\Box^{-1}N_1)^3(\Box^{-1}T_1)\right)$
- $\mathcal{D}_2 = \mathrm{STr}\left((\Box^{-1}N_1)^2(\Box^{-1}T_2)\right)$
  - $A_\mu = 0 \Rightarrow V^{\kappa\lambda} = 0$

4ψ verteks

- $\Gamma_{4\psi} \sim \frac{1}{(4\pi)^2\epsilon}\varepsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma_5\gamma^\sigma\psi)(\bar{\psi}\gamma^\rho\psi)$
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  - $A_\mu = 0 \Rightarrow V^{\kappa\lambda} = 0$
- $\mathcal{D}_1|^{4\psi}_{\mathrm{div}} = 0$
- $\mathcal{D}_2|^{4\psi}_{\mathrm{div}} = -\frac{3}{8}\frac{1}{(4\pi)^2\epsilon}\epsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma^\rho\gamma_5\psi)(\bar{\psi}\gamma^\sigma\gamma_5\psi) = 0$

4ψ verteks

- $\Gamma_{4\psi} \sim \frac{1}{(4\pi)^2\epsilon}\varepsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma_5\gamma^\sigma\psi)(\bar{\psi}\gamma^\rho\psi)$
- $\mathcal{D}_1 = \mathrm{STr}\left((\Box^{-1}N_1)^3(\Box^{-1}T_1)\right)$
- $\mathcal{D}_2 = \mathrm{STr}\left((\Box^{-1}N_1)^2(\Box^{-1}T_2)\right)$
  - $A_\mu = 0 \Rightarrow V^{\kappa\lambda} = 0$
- $\mathcal{D}_1\big|_{\mathrm{div}}^{4\psi} = 0$
- $\mathcal{D}_2\big|_{\mathrm{div}}^{4\psi} = -\frac{3}{8}\frac{1}{(4\pi)^2\epsilon}\epsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma^\rho\gamma_5\psi)(\bar{\psi}\gamma^\sigma\gamma_5\psi) = 0$

4ψ verteks

- $\Gamma_{4\psi} \sim \frac{1}{(4\pi)^2\epsilon}\varepsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma_5\gamma^\sigma\psi)(\bar{\psi}\gamma^\rho\psi)$
- $\mathcal{D}_1 = \mathrm{STr}\left((\Box^{-1}N_1)^3(\Box^{-1}T_1)\right)$
- $\mathcal{D}_2 = \mathrm{STr}\left((\Box^{-1}N_1)^2(\Box^{-1}T_2)\right)$
    - $A_\mu = 0 \Rightarrow V^{\kappa\lambda} = 0$
- $\mathcal{D}_1|_{\mathrm{div}}^{4\psi} = 0$
- $\mathcal{D}_2|_{\mathrm{div}}^{4\psi} = -\frac{3}{8}\frac{1}{(4\pi)^2\epsilon}\epsilon_{\mu\nu\rho\sigma}\theta^{\mu\nu}(\bar{\psi}\gamma^\rho\gamma_5\psi)(\bar{\psi}\gamma^\sigma\gamma_5\psi) = 0$

Divergentni deo efektivnog dejstva

$$\Gamma^{(1)}\big|_{\mathrm{div}} = \mathit{\Gamma}_2 + \mathit{\Gamma}_3 + \mathit{\Gamma}_4 = \Gamma_2 + \Gamma_3$$

$$\begin{aligned}\mathit{\Gamma}_2 &= -\frac{\mathrm{i}}{2}\,\mathrm{STr}(\Box^{-1}N_1\Box^{-1}T_1)\big|_{\mathrm{div}} \\ &= \frac{1}{(4\pi)^2\epsilon}\,\theta^{\mu\nu}\left(\frac{\mathrm{i}}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}(\partial_\rho\bar{\psi})\gamma_\sigma(\Box\psi) + \frac{1}{12}\varepsilon_{\mu}{}^{\rho\sigma\tau}F_{\rho\sigma}(\Box F_{\nu\tau})\right)\end{aligned}$$

Divergentni deo efektivnog dejstva: 3-point

$$\Gamma_3 = \frac{\mathrm{i}}{2}\left(\mathrm{STr}(\Box^{-1}N_1\Box^{-1}N_1\Box^{-1}T_1)\Big|_{\mathrm{div}} - \mathrm{STr}(\Box^{-1}N_1\Box^{-1}T_2)\Big|_{\mathrm{div}}\right)$$

$$\begin{aligned}\Gamma_3 = \frac{1}{(4\pi)^2\epsilon}\theta^{\mu\nu}\Bigg(&\frac{1}{6}F_{\mu\nu}F^{\rho\sigma}F_{\rho\sigma} - \frac{2}{3}F_{\mu\rho}F^{\nu\sigma}F_{\rho\sigma} + \frac{5\mathrm{i}}{6}F_{\mu\rho}\bar\psi\gamma^\rho(\partial_\nu\psi)\\ &- \frac{\mathrm{i}}{6}F_{\mu\rho}\bar\psi\gamma_\nu(\partial^\rho\psi) - \frac{2\mathrm{i}}{3}F_{\mu\nu}\bar\psi\gamma^\rho(\partial_\rho\psi) + \frac{4}{3}\varepsilon_\mu{}^{\rho\sigma\tau}F_{\rho\sigma}\bar\psi\gamma_5\gamma_\tau(\partial_\nu\psi)\\ &+ \frac{3}{2}\varepsilon_{\mu\nu}{}^{\rho\sigma}F_{\rho\tau}\bar\psi\gamma_5\gamma_\sigma(\partial^\tau\psi) + \frac{1}{8}\varepsilon_{\mu\nu}{}^{\rho\sigma}F_{\rho\sigma}\bar\psi\gamma_5\gamma^\tau(\partial_\tau\psi)\\ &+ \frac{1}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}A_\rho\bar\psi\gamma_5\gamma_\sigma(\Box\psi) - \frac{1}{6}\varepsilon_{\mu\nu}{}^{\rho\sigma}A^\tau(\partial_\rho\bar\psi)\gamma_5\gamma_\sigma(\partial_\tau\psi)\\ &+ \frac{1}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}(\partial_\tau A^\tau)\bar\psi\gamma_5\gamma_\rho(\partial_\sigma\psi)\Bigg)\end{aligned}$$

Divergentni deo efektivnog dejstva: 3-point

$$\Gamma_3 = \tfrac{i}{2}\left(\mathrm{STr}(\Box^{-1}N_1\Box^{-1}N_1\Box^{-1}T_1)\big|_{\mathrm{div}} - \mathrm{STr}(\Box^{-1}N_1\Box^{-1}T_2)\big|_{\mathrm{div}}\right)$$

$$\begin{aligned}\Gamma_3 = \frac{1}{(4\pi)^2\epsilon}\theta^{\mu\nu}\Bigg(&\frac{1}{6}F_{\mu\nu}F^{\rho\sigma}F_{\rho\sigma} - \frac{2}{3}F_{\mu\rho}F^{\nu\sigma}F_{\rho\sigma} + \frac{5i}{6}F_{\mu\rho}\bar{\psi}\gamma^{\rho}(\partial_\nu\psi)\\ &- \frac{i}{6}F_{\mu\rho}\bar{\psi}\gamma_\nu(\partial^\rho\psi) - \frac{2i}{3}F_{\mu\nu}\bar{\psi}\gamma^{\rho}(\partial_\rho\psi) + \frac{4}{3}\varepsilon_{\mu}{}^{\rho\sigma\tau}F_{\rho\sigma}\bar{\psi}\gamma_5\gamma_\tau(\partial_\nu\psi)\\ &+ \frac{3}{2}\varepsilon_{\mu\nu}{}^{\rho\sigma}F_{\rho\tau}\bar{\psi}\gamma_5\gamma_\sigma(\partial^\tau\psi) + \frac{1}{8}\varepsilon_{\mu\nu}{}^{\rho\sigma}F_{\rho\sigma}\bar{\psi}\gamma_5\gamma^\tau(\partial_\tau\psi)\\ &+ \frac{1}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}A_\rho\bar{\psi}\gamma_5\gamma_\sigma(\Box\psi) - \frac{1}{6}\varepsilon_{\mu\nu}{}^{\rho\sigma}A^\tau(\partial_\rho\bar{\psi})\gamma_5\gamma_\sigma(\partial_\tau\psi)\\ &+ \frac{1}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}(\partial_\tau A^\tau)\bar{\psi}\gamma_5\gamma_\rho(\partial_\sigma\psi)\Bigg)\end{aligned}$$

Divergentni deo efektivnog dejstva: 2-point

$$\Gamma_2 = \frac{1}{(4\pi)^2\epsilon}\,\theta^{\mu\nu}\left(\frac{\mathrm{i}}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}(\partial_\rho\bar{\psi})\gamma_\sigma(\Box\psi) + \frac{1}{12}\varepsilon_{\mu}{}^{\rho\sigma\tau}F_{\rho\sigma}(\Box F_{\nu\tau})\right)$$

$$\Gamma_2 = -\frac{1}{12}\frac{1}{(4\pi)^2\epsilon}\theta^{\mu\nu}\Big(\varepsilon_{\mu\rho\sigma\tau}(D_\lambda F^{\rho\lambda})(D_\nu F^{\sigma\tau})$$

$$+\varepsilon_{\mu\nu\rho\sigma}\left(\mathrm{i}(D^\rho\bar{\varphi})\bar{\sigma}^\sigma(D^2\varphi) + \mathrm{h.c.}\right)\Big)$$

Divergentni deo efektivnog dejstva: 2-point

$$\Gamma_2 = \frac{1}{(4\pi)^2\epsilon}\,\theta^{\mu\nu}\left(\frac{\mathrm{i}}{12}\varepsilon_{\mu\nu}{}^{\rho\sigma}(\partial_\rho\bar{\psi})\gamma_\sigma(\Box\psi) + \frac{1}{12}\varepsilon_{\mu}{}^{\rho\sigma\tau}F_{\rho\sigma}(\Box F_{\nu\tau})\right)$$

$$\Gamma_2 = -\frac{1}{12}\frac{1}{(4\pi)^2\epsilon}\theta^{\mu\nu}\Big(\varepsilon_{\mu\rho\sigma\tau}(D_\lambda F^{\rho\lambda})(D_\nu F^{\sigma\tau})$$

$$+\varepsilon_{\mu\nu\rho\sigma}\left(\mathrm{i}(D^\rho\bar{\varphi})\bar{\sigma}^\sigma(D^2\varphi) + \mathrm{h.c.}\right)\Big)$$

Divergentni deo efektivnog dejstva: 3-point

$$\Gamma_3 = \frac{1}{(4\pi)^2\epsilon}\theta^{\mu\nu}\left(\frac{1}{6}F_{\mu\nu}F_{\rho\sigma}F^{\rho\sigma} - \frac{2}{3}F_{\mu\rho}F_{\nu\sigma}F^{\rho\sigma}\right)$$
$$+ \frac{1}{(4\pi)^2\epsilon}\theta^{\mu\nu}\left(\frac{5\mathrm{i}}{6}F_{\mu\rho}\,\bar{\varphi}\bar{\sigma}^{\rho}(D_\nu\varphi) - \frac{\mathrm{i}}{6}F_{\mu\rho}\,\bar{\varphi}\bar{\sigma}_{\nu}(D^{\rho}\varphi)\right.$$
$$- \frac{2\mathrm{i}}{3}F_{\mu\nu}\,\bar{\varphi}\bar{\sigma}^{\rho}(D_\rho\varphi) + \frac{4}{3}\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\,\bar{\varphi}\bar{\sigma}^{\tau}(D_\nu\varphi)$$
$$+ \frac{3}{2}\varepsilon_{\mu\nu\rho\tau}F^{\rho\sigma}\,\bar{\varphi}\bar{\sigma}^{\tau}(D_\sigma\varphi)$$
$$\left.+\frac{1}{8}\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\,\bar{\varphi}\bar{\sigma}^{\tau}(D_\tau\varphi) + \mathrm{h.c.}\right)$$

Redefinicije polja

- $\varphi \to \varphi + \Phi, \qquad A_\mu \to A_\mu + \mathbb{A}_\mu$
- $\int \mathrm{d}^4x\, \mathrm{i}\bar{\varphi}\bar{\sigma}^\mu(\partial_\mu - \mathrm{i}A_\mu)\Phi + \mathrm{h.c.}$
- $\int \mathrm{d}^4x\, (\partial_\mu F^{\mu\nu})\mathbb{A}_\nu + \int \mathrm{d}^4x\, \bar{\varphi}\bar{\sigma}^\mu \mathbb{A}_\mu \varphi$

$$\begin{aligned}
\mathbb{A}^{(1)}_\rho &= \theta^{\mu\nu}(a_1\varepsilon_{\mu\rho\sigma\tau}(\partial_\nu F^{\sigma\tau}) + a_2\varepsilon_{\mu\nu\rho\tau}(\partial_\sigma F^{\tau\sigma}) + a_3\varepsilon_{\mu\nu\tau\sigma}(\partial_\rho F^{\tau\sigma})), \\
\Phi^{(1)} &= \theta^{\mu\nu}(\mathrm{i}b_1\sigma_{\mu\nu}(D^2\varphi) + b_2 qF_\mu{}^\rho\sigma_{\nu\rho}\varphi + b_3 qF_{\mu\nu}\varphi + \mathrm{i}b_4 q\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\varphi),
\end{aligned}$$

Redefinicije polja

- $\varphi \to \varphi + \Phi, \quad A_\mu \to A_\mu + \mathbb{A}_\mu$
- $\int \mathrm{d}^4x\, \mathrm{i}\bar{\varphi}\bar{\sigma}^\mu(\partial_\mu - \mathrm{i}A_\mu)\Phi + \mathrm{h.c.}$
- $\int \mathrm{d}^4x\, (\partial_\mu F^{\mu\nu})\mathbb{A}_\nu + \int \mathrm{d}^4x\, \bar{\varphi}\bar{\sigma}^\mu \mathbb{A}_\mu \varphi$

$$
\begin{aligned}
\mathbb{A}^{(1)}_\rho &= \theta^{\mu\nu}(a_1\varepsilon_{\mu\rho\sigma\tau}(\partial_\nu F^{\sigma\tau}) + a_2\varepsilon_{\mu\nu\rho\tau}(\partial_\sigma F^{\tau\sigma}) + a_3\varepsilon_{\mu\nu\tau\sigma}(\partial_\rho F^{\tau\sigma})),\\
\Phi^{(1)} &= \theta^{\mu\nu}(\mathrm{i}b_1\sigma_{\mu\nu}(D^2\varphi) + b_2 q F_\mu{}^\rho\sigma_{\nu\rho}\varphi + b_3 q F_{\mu\nu}\varphi + \mathrm{i}b_4 q\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\varphi),
\end{aligned}
$$

Redefinicije polja

- $\varphi \to \varphi + \Phi, \qquad A_\mu \to A_\mu + \mathbb{A}_\mu$
- $\int \mathrm{d}^4x\, \mathrm{i}\bar{\varphi}\bar{\sigma}^\mu(\partial_\mu - \mathrm{i}A_\mu)\Phi + \mathrm{h.c.}$
- $\int \mathrm{d}^4x\, (\partial_\mu F^{\mu\nu})\mathbb{A}_\nu + \int \mathrm{d}^4x\, \bar{\varphi}\bar{\sigma}^\mu \mathbb{A}_\mu \varphi$

$$\begin{aligned} \mathbb{A}_\rho^{(1)} &= \theta^{\mu\nu}(a_1\varepsilon_{\mu\rho\sigma\tau}(\partial_\nu F^{\sigma\tau}) + a_2\varepsilon_{\mu\nu\rho\tau}(\partial_\sigma F^{\tau\sigma}) + a_3\varepsilon_{\mu\nu\tau\sigma}(\partial_\rho F^{\tau\sigma})), \\ \Phi^{(1)} &= \theta^{\mu\nu}(\mathrm{i}b_1\sigma_{\mu\nu}(D^2\varphi) + b_2 q F_\mu{}^\rho \sigma_{\nu\rho}\varphi + b_3 q F_{\mu\nu}\varphi + \mathrm{i}b_4 q \varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\varphi), \end{aligned}$$

Redefinicije polja

- $\varphi \to \varphi + \Phi, \qquad A_\mu \to A_\mu + \mathbb{A}_\mu$
- $\int \mathrm{d}^4x \, \mathrm{i}\bar{\varphi}\bar{\sigma}^\mu(\partial_\mu - \mathrm{i}A_\mu)\Phi + \mathrm{h.c.}$
- $\int \mathrm{d}^4x \, (\partial_\mu F^{\mu\nu})\mathbb{A}_\nu + \int \mathrm{d}^4x \, \bar{\varphi}\bar{\sigma}^\mu \mathbb{A}_\mu \varphi$

$$\begin{aligned}
\mathbb{A}_\rho^{(1)} &= \theta^{\mu\nu}(a_1\varepsilon_{\mu\rho\sigma\tau}(\partial_\nu F^{\sigma\tau}) + a_2\varepsilon_{\mu\nu\rho\tau}(\partial_\sigma F^{\tau\sigma}) + a_3\varepsilon_{\mu\nu\tau\sigma}(\partial_\rho F^{\tau\sigma})), \\
\Phi^{(1)} &= \theta^{\mu\nu}(\mathrm{i}b_1\sigma_{\mu\nu}(D^2\varphi) + b_2 q F_\mu{}^\rho \sigma_{\nu\rho}\varphi + b_3 q F_{\mu\nu}\varphi + \mathrm{i}b_4 q \varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\varphi),
\end{aligned}$$

Doprinos SW nejednoznačnosti

- $S'_{\mathrm{NC}} = S_{\mathrm{NC}} + \Delta S^{(1)}_{\mathrm{SW}}$
- $$\begin{aligned}
\Delta\mathcal{L}^{(1)}_{\mathrm{SW}} &= \mathrm{i}\,\frac{b_1}{2}\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\bar{\varphi}\bar{\sigma}^{\sigma}D^{\rho}D^{2}\varphi \\
&\quad + q\theta^{\mu\nu}\Big[-\mathrm{i}\left(b_1+\frac{b_2}{2}\right)F_{\mu\rho}\bar{\varphi}\bar{\sigma}_{\nu}D^{\rho}\varphi + \mathrm{i}\frac{b_2}{2}F_{\mu\rho}\bar{\varphi}\bar{\sigma}^{\rho}D_{\nu}\varphi \\
&\quad + \mathrm{i}b_3F_{\mu\nu}\bar{\varphi}\bar{\sigma}^{\rho}D_{\rho}\varphi + \left(a_1+a_2-\frac{b_2}{4}\right)\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\bar{\varphi}\bar{\sigma}^{\tau}D_{\nu}\varphi \\
&\quad + \left(a_3-\frac{a_2}{2}+b_4\right)\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\bar{\varphi}\bar{\sigma}^{\tau}D_{\tau}\varphi\Big] + h.c.
\end{aligned}$$
- $\kappa_2 = -b_2, \quad \kappa_3 = \frac{b_1}{2}, \quad \kappa_4 = -b_1 - \frac{b_2}{2}, \quad \kappa_5 = \frac{b_2}{4} + b_3, \quad \kappa_6 = a_1 + a_2 - \frac{b_2}{4}, \quad \kappa_7 = a_3 - \frac{a_2}{2} + b_4$
- $\kappa_2 - 4\kappa_3 - 2\kappa_4 = 0$

Doprinos SW nejednoznačnosti

- $S'_{\rm NC} = S_{\rm NC} + \Delta S^{(1)}_{\rm SW}$
- $$\begin{aligned} \Delta\mathcal{L}^{(1)}_{\rm SW} &= \mathrm{i}\,\frac{b_1}{2}\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\bar\varphi\bar\sigma^\sigma D^\rho D^2\varphi \\ &+ q\theta^{\mu\nu}\Big[-\mathrm{i}\left(b_1+\frac{b_2}{2}\right)F_{\mu\rho}\bar\varphi\bar\sigma_\nu D^\rho\varphi + \mathrm{i}\,\frac{b_2}{2}F_{\mu\rho}\bar\varphi\bar\sigma^\rho D_\nu\varphi \\ &+ \mathrm{i} b_3 F_{\mu\nu}\bar\varphi\bar\sigma^\rho D_\rho\varphi + \left(a_1+a_2-\frac{b_2}{4}\right)\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\nu\varphi \\ &+ \left(a_3-\frac{a_2}{2}+b_4\right)\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\tau\varphi\Big] + h.c. \end{aligned}$$
- $\kappa_2 = -b_2, \quad \kappa_3 = \frac{b_1}{2}, \quad \kappa_4 = -b_1 - \frac{b_2}{2}, \quad \kappa_5 = \frac{b_2}{4} + b_3, \quad \kappa_6 = a_1 + a_2 - \frac{b_2}{4}, \quad \kappa_7 = a_3 - \frac{a_2}{2} + b_4$
- $\kappa_2 - 4\kappa_3 - 2\kappa_4 = 0$

Doprinos SW nejednoznačnosti

- $S'_{\rm NC} = S_{\rm NC} + \Delta S^{(1)}_{\rm SW}$
-

$$
\begin{aligned}
\Delta\mathcal{L}^{(1)}_{\rm SW} \quad = \quad & \mathrm{i}\,\frac{b_1}{2}\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\bar\varphi\bar\sigma^\sigma D^\rho D^2\varphi \\
& + q\theta^{\mu\nu}\Big[-\mathrm{i}\left(b_1+\frac{b_2}{2}\right)F_{\mu\rho}\bar\varphi\bar\sigma_\nu D^\rho\varphi + \mathrm{i}\,\frac{b_2}{2}F_{\mu\rho}\bar\varphi\bar\sigma^\rho D_\nu\varphi \\
& + \mathrm{i}b_3 F_{\mu\nu}\bar\varphi\bar\sigma^\rho D_\rho\varphi + \left(a_1+a_2-\frac{b_2}{4}\right)\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\nu\varphi \\
& + \left(a_3-\frac{a_2}{2}+b_4\right)\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\tau\varphi\Big] + h.c.
\end{aligned}
$$

- $\kappa_2 = -b_2, \quad \kappa_3 = \frac{b_1}{2}, \quad \kappa_4 = -b_1 - \frac{b_2}{2}, \quad \kappa_5 = \frac{b_2}{4} + b_3, \quad \kappa_6 = a_1 + a_2 - \frac{b_2}{4}, \quad \kappa_7 = a_3 - \frac{a_2}{2} + b_4$
- $\kappa_2 - 4\kappa_3 - 2\kappa_4 = 0$

Doprinos SW nejednoznačnosti

- $S'_{\rm NC} = S_{\rm NC} + \Delta S^{(1)}_{\rm SW}$
-

$$\begin{aligned}
\Delta\mathcal{L}^{(1)}_{\rm SW} &= \mathrm{i}\,\frac{b_1}{2}\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\bar{\varphi}\bar{\sigma}^{\sigma}D^{\rho}D^{2}\varphi \\
&+ q\theta^{\mu\nu}\Big[-\mathrm{i}\left(b_1+\frac{b_2}{2}\right)F_{\mu\rho}\bar{\varphi}\bar{\sigma}_{\nu}D^{\rho}\varphi + \mathrm{i}\,\frac{b_2}{2}F_{\mu\rho}\bar{\varphi}\bar{\sigma}^{\rho}D_{\nu}\varphi \\
&+\mathrm{i}b_3F_{\mu\nu}\bar{\varphi}\bar{\sigma}^{\rho}D_{\rho}\varphi + \left(a_1+a_2-\frac{b_2}{4}\right)\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\bar{\varphi}\bar{\sigma}^{\tau}D_{\nu}\varphi \\
&+\left(a_3-\frac{a_2}{2}+b_4\right)\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\bar{\varphi}\bar{\sigma}^{\tau}D_{\tau}\varphi\Big] + h.c.
\end{aligned}$$

- $\kappa_2 = -b_2, \quad \kappa_3 = \frac{b_1}{2}, \quad \kappa_4 = -b_1 - \frac{b_2}{2}, \quad \kappa_5 = \frac{b_2}{4} + b_3, \quad \kappa_6 = a_1 + a_2 - \frac{b_2}{4}, \quad \kappa_7 = a_3 - \frac{a_2}{2} + b_4$
- $\kappa_2 - 4\kappa_3 - 2\kappa_4 = 0$

Kvantizacija novog modela

- $$\begin{aligned}\Gamma^{(1)} &= \frac{\mathrm{i}}{2}\,\mathrm{STr}\log\left(\mathcal{I} + \Box^{-1}N_1 + \Box^{-1}T_0 + \Box^{-1}T_1 + \Box^{-1}T_2\right)\\ &= \frac{\mathrm{i}}{2}\sum\frac{(-1)^{n+1}}{n}\mathrm{STr}\left(\Box^{-1}N_1 + \Box^{-1}T_0 + \Box^{-1}T_1 + \Box^{-1}T_2\right)^n .\end{aligned}$$
- $T_0 = 2\kappa_3\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} 0 & 0 \\ 0 & \gamma^\sigma \not\partial\partial^\rho\Box \end{pmatrix}$

Kvantizacija novog modela

- $$\begin{aligned}\Gamma^{(1)} &= \frac{i}{2}\,\mathrm{STr}\log\left(\mathcal{I} + \Box^{-1}N_1 + \Box^{-1}T_0 + \Box^{-1}T_1 + \Box^{-1}T_2\right)\\ &= \frac{i}{2}\sum\frac{(-1)^{n+1}}{n}\mathrm{STr}\left(\Box^{-1}N_1 + \Box^{-1}T_0 + \Box^{-1}T_1 + \Box^{-1}T_2\right)^n.\end{aligned}$$

- $T_0 = 2\kappa_3\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} 0 & 0 \\ 0 & \gamma^\sigma \not{\partial}\partial^\rho\Box \end{pmatrix}$

Kvantizacija novog modela

- $T_1 = \sum_{i=2}^{7} T_1^{\kappa_i}$
- $T_1^{\kappa_2} = \frac{1}{8}\kappa_2 q\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\begin{pmatrix} 0 & 2\delta^{\kappa}_{\alpha}(\partial_\beta\bar{\psi})\gamma^\rho\partial_\gamma\partial\!\!\!/ \\ 2\mathrm{i}\delta^{\lambda}_{\alpha}\gamma^\rho(\partial_\beta\psi)\partial_\gamma & F_{\alpha\beta}\gamma^\rho\partial_\gamma\partial\!\!\!/ \end{pmatrix}$
- $T_1^{\kappa_3} =$
  $2\kappa_3 q\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} 0 & \mathrm{i}(\bar{\psi}M^{\rho\kappa}_{\alpha\beta}\partial^\alpha\partial^\beta\psi-(\partial^\rho\bar{\psi})\partial^\kappa)\gamma^5\gamma^\sigma\partial\!\!\!/ \\ \gamma^5\gamma^\sigma(M^{\rho\lambda}_{\alpha\beta}(\partial^\alpha\partial^\beta\psi)-\overleftarrow{\partial^\rho}(\partial^\lambda\psi)) & \mathrm{i}(N^{\rho\alpha\beta}\partial_\alpha\partial_\beta-\overleftarrow{\partial^\rho}A^\tau\partial_\tau)\gamma^5\gamma^\sigma\partial\!\!\!/ \end{pmatrix}$
- $T_1^{\kappa_4} = 2\kappa_4 q\theta^{\mu\nu}\begin{pmatrix} 0 & (\overleftarrow{\partial}_\mu g_{\rho\kappa}-\overleftarrow{\partial}_\rho g_{\mu\kappa})\bar{\psi}\gamma_\nu\partial^\rho\partial\!\!\!/ \\ \mathrm{i}\gamma_\nu(\partial^\rho\psi)(g_{\rho\lambda}\partial_\mu-g_{\mu\lambda}\partial_\rho) & F_{\mu\rho}\gamma_\nu\partial^\rho\partial\!\!\!/ \end{pmatrix}$
- $T_1^{\kappa_5} = 2\kappa_5 q\theta^{\mu\nu}\begin{pmatrix} 0 & 2\overleftarrow{\partial}_\mu g_{\nu\kappa}\bar{\psi}\Box \\ 2\mathrm{i}\gamma^\rho(\partial_\rho\psi)g_{\nu\lambda}\partial_\mu & F_{\mu\nu}\Box \end{pmatrix}$
- $T_1^{\kappa_6} = 2\kappa_6 q\theta^{\mu\nu}\varepsilon_{\mu\rho\sigma\tau}\begin{pmatrix} 0 & 2\mathrm{i}\overleftarrow{\partial^\rho}\delta^\sigma_\kappa\bar{\psi}\gamma^\tau\gamma_5\partial_\nu\partial\!\!\!/ \\ -2\delta^\sigma_\lambda\gamma^\tau\gamma_5(\partial_\nu\psi)\partial^\rho & \mathrm{i}F^{\rho\sigma}\gamma^\tau\gamma_5\partial_\nu\partial\!\!\!/ \end{pmatrix}$
- $T_1^{\kappa_7} = 2\kappa_7 q\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} 0 & -2\mathrm{i}\overleftarrow{\partial^\rho}\delta^\sigma_\kappa\bar{\psi}\gamma^5\Box \\ -2\delta^\sigma_\lambda\gamma^\tau\gamma_5(\partial_\tau\psi)\partial^\rho & -\mathrm{i}F^{\rho\sigma}\gamma_5\Box \end{pmatrix}$

Kvantizacija novog modela

- $T_1 = \sum_{i=2}^{7} T_1^{\kappa_i}$
- $T_1^{\kappa_2} = \frac{1}{8}\kappa_2 q\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\begin{pmatrix} 0 & 2\delta^{\kappa}_{\alpha}(\partial_\beta\bar{\psi})\gamma^\rho\partial_\gamma \not{\partial} \\ 2\mathrm{i}\delta^{\lambda}_{\alpha}\gamma^\rho(\partial_\beta\psi)\partial_\gamma & F_{\alpha\beta}\gamma^\rho\partial_\gamma\not{\partial} \end{pmatrix}$
- $T_1^{\kappa_3} =$
  $2\kappa_3 q\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} 0 & \mathrm{i}(\bar{\psi}M^{\rho\kappa}_{\alpha\beta}\partial^\alpha\partial^\beta\psi - (\partial^\rho\bar{\psi})\partial^\kappa)\gamma^5\gamma^\sigma\not{\partial} \\ \gamma^5\gamma^\sigma(M^{\rho\lambda}_{\alpha\beta}(\partial^\alpha\partial^\beta\psi) - \overleftarrow{\partial^\rho}\,(\partial^\lambda\psi)) & \mathrm{i}(N^{\rho\alpha\beta}\partial_\alpha\partial_\beta - \overleftarrow{\partial^\rho}\,A^\tau\partial_\tau)\gamma^5\gamma^\sigma\not{\partial} \end{pmatrix}$
- $T_1^{\kappa_4} = 2\kappa_4 q\theta^{\mu\nu}\begin{pmatrix} 0 & (\overleftarrow{\partial}_\mu\, g_{\rho\kappa} - \overleftarrow{\partial}_\rho\, g_{\mu\kappa})\bar{\psi}\gamma_\nu\partial^\rho\not{\partial} \\ \mathrm{i}\gamma_\nu(\partial^\rho\psi)(g_{\rho\lambda}\partial_\mu - g_{\mu\lambda}\partial_\rho) & F_{\mu\rho}\gamma_\nu\partial^\rho\not{\partial} \end{pmatrix}$
- $T_1^{\kappa_5} = 2\kappa_5 q\theta^{\mu\nu}\begin{pmatrix} 0 & 2\,\overleftarrow{\partial}_\mu\, g_{\nu\kappa}\bar{\psi}\Box \\ 2\mathrm{i}\gamma^\rho(\partial_\rho\psi)g_{\nu\lambda}\partial_\mu & F_{\mu\nu}\Box \end{pmatrix}$
- $T_1^{\kappa_6} = 2\kappa_6 q\theta^{\mu\nu}\varepsilon_{\mu\rho\sigma\tau}\begin{pmatrix} 0 & 2\mathrm{i}\,\overleftarrow{\partial^\rho}\,\delta^\sigma_\kappa\bar{\psi}\gamma^\tau\gamma_5\partial_\nu\not{\partial} \\ -2\delta^\sigma_\lambda\gamma^\tau\gamma_5(\partial_\nu\psi)\partial^\rho & \mathrm{i}F^{\rho\sigma}\gamma^\tau\gamma_5\partial_\nu\not{\partial} \end{pmatrix}$
- $T_1^{\kappa_7} = 2\kappa_7 q\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} 0 & -2\mathrm{i}\,\overleftarrow{\partial^\rho}\,\delta^\sigma_\kappa\bar{\psi}\gamma^5\Box \\ -2\delta^\sigma_\lambda\gamma^\tau\gamma_5(\partial_\tau\psi)\partial^\rho & -\mathrm{i}F^{\rho\sigma}\gamma_5\Box \end{pmatrix}$

Kvantizacija novog modela

- $T_2 = \sum_{i=2}^{5} T_2^{\kappa_i}$
- $T_2^{\kappa 2} =$
$$\frac{1}{8}\kappa_2 q^2 \theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}\begin{pmatrix} 2\delta^\lambda_\beta\delta^\kappa_\gamma\bar\psi\gamma^\rho\gamma_5\psi\partial_\alpha & -\mathrm{i}(\delta^\kappa_\gamma F_{\alpha\beta} + 2\overleftarrow{\partial}_\alpha\ \delta^\kappa_\beta A_\gamma)\bar\psi\gamma^\rho\gamma^5\not\partial \\ \gamma^\rho\gamma^5\psi(F_{\alpha\beta}\delta^\lambda_\gamma + 2A_\gamma\delta^\lambda_\beta\partial_\alpha) & -\mathrm{i}F_{\alpha\beta}A_\gamma\gamma^\rho\gamma_5\not\partial \end{pmatrix}$$
- $T_2^{\kappa 3} =$
$$-2\kappa_3 q^2\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\begin{pmatrix} \mathrm{i}(2\delta^\rho_\lambda\bar\psi\gamma^\sigma(\partial_\kappa\psi) + g_{\lambda\kappa}\bar\psi\gamma^\sigma(\partial^\rho\psi)) & 2A^\alpha\bar\psi\partial^\beta P^\rho_{\alpha\beta\gamma}\gamma^\sigma\not\partial \\ 2\mathrm{i}\gamma^\sigma A^\alpha(\partial^\beta\psi)P^\rho_{\alpha\beta\lambda} & \gamma^\sigma(2A^\tau A^\rho\partial_\tau + A^\tau A_\tau\partial^\rho)\not\partial \end{pmatrix}$$
- $T_2^{\kappa 4} = 2\kappa_4 q^2\theta^{\mu\nu}\begin{pmatrix} -g^{\rho\kappa}\bar\psi\gamma_5\gamma_\nu\psi\delta^\lambda_{[\rho}\partial_{\mu]} & \mathrm{i}(F_{\mu\kappa} + \overleftarrow{\partial}_{[\mu}\ g_{\rho]\kappa}A^\rho)\bar\psi\gamma_5\gamma_\nu\not\partial \\ -\gamma_5\gamma_\nu\psi(F_{\mu\lambda} + A^\rho g_{\lambda[\rho}\partial_{\mu]}) & \mathrm{i}F_{\mu\rho}A^\rho\gamma_5\gamma_\nu\not\partial \end{pmatrix}$
- $T_2^{\kappa 5} =$
$$2\kappa_5 q^2\theta^{\mu\nu}\begin{pmatrix} 2\delta^\lambda_\mu\bar\psi\gamma_5\gamma^\kappa\psi\partial_\nu & \mathrm{i}(F_{\mu\nu}\bar\psi\gamma_5\gamma^\kappa + 2\overleftarrow{\partial}_\mu\ \delta^\kappa_\nu A^\rho\bar\psi\gamma_5\gamma_\rho)\not\partial \\ -F_{\mu\nu}\gamma_5\gamma^\lambda\psi + 2A^\rho\gamma^5\gamma_\rho\psi\delta^\lambda_\nu\partial_\mu & \mathrm{i}F_{\mu\nu}\gamma_5\not A\not\partial \end{pmatrix}$$

Kvantizacija novog modela

- $T_2 = \sum_{i=2}^{5} T_2^{\kappa_i}$
- $T_2^{\kappa 2} =$
$$\frac{1}{8}\kappa_2 q^2 \theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho} \begin{pmatrix} 2\delta^\lambda_\beta \delta^\kappa_\gamma \bar\psi\gamma^\rho\gamma_5\psi\partial_\alpha & -\mathrm{i}(\delta^\kappa_\gamma F_{\alpha\beta} + 2\overleftarrow{\partial}_\alpha \delta^\kappa_\beta A_\gamma)\bar\psi\gamma^\rho\gamma^5\not\partial \\ \gamma^\rho\gamma^5\psi(F_{\alpha\beta}\delta^\lambda_\gamma + 2A_\gamma\delta^\lambda_\beta\partial_\alpha) & -\mathrm{i}F_{\alpha\beta}A_\gamma\gamma^\rho\gamma_5\not\partial \end{pmatrix}$$
- $T_2^{\kappa 3} =$
$$-2\kappa_3 q^2\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma} \begin{pmatrix} \mathrm{i}(2\delta^\rho_\lambda\bar\psi\gamma^\sigma(\partial_\kappa\psi) + g_{\lambda\kappa}\bar\psi\gamma^\sigma(\partial^\rho\psi)) & 2A^\alpha\bar\psi\partial^\beta P^\rho_{\alpha\beta\gamma}\gamma^\sigma\not\partial \\ 2\mathrm{i}\gamma^\sigma A^\alpha(\partial^\beta\psi)P^\rho_{\alpha\beta\lambda} & \gamma^\sigma(2A^\tau A^\rho\partial_\tau + A^\tau A_\tau\partial^\rho)\not\partial \end{pmatrix}$$
- $$T_2^{\kappa 4} = 2\kappa_4 q^2\theta^{\mu\nu} \begin{pmatrix} -g^{\rho\kappa}\bar\psi\gamma_5\gamma_\nu\psi\delta^\lambda_{[\rho}\partial_{\mu]} & \mathrm{i}(F_{\mu\kappa} + \overleftarrow{\partial}_{[\mu}\, g_{\rho]\kappa}A^\rho)\bar\psi\gamma_5\gamma_\nu\not\partial \\ -\gamma_5\gamma_\nu\psi(F_{\mu\lambda} + A^\rho g_{\lambda[\rho}\partial_{\mu]}) & \mathrm{i}F_{\mu\rho}A^\rho\gamma_5\gamma_\nu\not\partial \end{pmatrix}$$
- $T_2^{\kappa 5} =$
$$2\kappa_5 q^2\theta^{\mu\nu} \begin{pmatrix} 2\delta^\lambda_\mu\bar\psi\gamma_5\gamma^\kappa\psi\partial_\nu & \mathrm{i}(F_{\mu\nu}\bar\psi\gamma_5\gamma^\kappa + 2\overleftarrow{\partial}_\mu\,\delta^\kappa_\nu A^\rho\bar\psi\gamma_5\gamma_\rho)\not\partial \\ -F_{\mu\nu}\gamma_5\gamma^\lambda\psi + 2A^\rho\gamma^5\gamma_\rho\psi\delta^\lambda_\nu\partial_\mu & \mathrm{i}F_{\mu\nu}\gamma_5\not A\not\partial \end{pmatrix}$$

Divergencije u novom modelu

$$\begin{aligned}
\mathcal{L}'_{\rm NC}+\mathcal{L}'_{\rm ct} &= -\frac{1}{4}F_{\mu\nu}F^{\mu\nu}\left(1-\frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}\right)+\frac{1}{2}\left(\mathrm{i}\bar\varphi\bar\sigma^\mu D_\mu\varphi+h.c.\right)\left(1-2\frac{q^2}{(4\pi)^2\epsilon}\right)\\
&+\frac{1}{2}q\mu^{\frac{\epsilon}{2}}\theta^{\mu\nu}\left(F_{\mu\rho}F_{\nu\sigma}F^{\rho\sigma}-\frac{1}{4}F_{\mu\nu}F_{\rho\sigma}F^{\rho\sigma}\right)\left(1-\frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}(1+\kappa_2-8\kappa_3-4\kappa_4)\right)\\
&+\frac{1}{16}q\mu^{\frac{\epsilon}{2}}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}F_{\alpha\beta}\left(\mathrm{i}\bar\varphi\bar\sigma^\rho D_\gamma\varphi+h.c.\right)\left(1+\kappa_2+\frac{q^2}{(4\pi)^2\epsilon}\frac{-5+3\kappa_2-20\kappa_3-20\kappa_4-8\kappa_5+8\kappa_7}{3}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\mathrm{i}\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\bar\varphi\bar\sigma^\sigma D^\rho D^2\varphi+h.c.\right)\left(\kappa_3-\frac{q^2}{(4\pi)^2\epsilon}\frac{-\kappa_2+16\kappa_3+14\kappa_4-4\kappa_5+16\kappa_7}{12}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\mathrm{i}\theta^{\mu\nu}F_{\mu\rho}\bar\varphi\bar\sigma_\nu D^\rho\varphi+h.c.\right)\left(\kappa_4+\frac{q^2}{(4\pi)^2\epsilon}\frac{-1+9\kappa_2+68\kappa_3+26\kappa_4-4\kappa_5-8\kappa_7}{6}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\mathrm{i}\theta^{\mu\nu}F_{\mu\nu}\bar\varphi\bar\sigma^\rho D_\rho\varphi+h.c.\right)\left(\kappa_5+\frac{q^2}{(4\pi)^2\epsilon}\frac{-1-\kappa_2-20\kappa_3-6\kappa_4-4\kappa_5+8\kappa_7}{4}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\theta^{\mu\nu}\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\nu\varphi+h.c.\right)\left(\kappa_6-\frac{q^2}{(4\pi)^2\epsilon}\frac{6+5\kappa_2-132\kappa_3+24\kappa_4+24\kappa_5+72\kappa_6-24\kappa_7}{36}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\tau\varphi+h.c.\right)\left(\kappa_7+\frac{q^2}{(4\pi)^2\epsilon}\frac{7+\kappa_2-16\kappa_3+2\kappa_4+4\kappa_5-16\kappa_7}{8}\right).
\end{aligned}$$

Divergencije u novom modelu

$$
\begin{aligned}
\mathcal{L}'_{\rm NC} + \mathcal{L}'_{\rm ct} &= -\frac{1}{4}F_{\mu\nu}F^{\mu\nu}\left(1-\frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}\right) + \frac{1}{2}\left(\mathrm{i}\bar\varphi\bar\sigma^\mu D_\mu\varphi + h.c.\right)\left(1-2\frac{q^2}{(4\pi)^2\epsilon}\right)\\
&+\frac{1}{2}q\mu^{\frac{\epsilon}{2}}\theta^{\mu\nu}\left(F_{\mu\rho}F_{\nu\sigma}F^{\rho\sigma}-\frac{1}{4}F_{\mu\nu}F_{\rho\sigma}F^{\rho\sigma}\right)\left(1-\frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}(1+\kappa_2-8\kappa_3-4\kappa_4)\right)\\
&+\frac{1}{16}q\mu^{\frac{\epsilon}{2}}\theta^{\mu\nu}\Delta^{\alpha\beta\gamma}_{\mu\nu\rho}F_{\alpha\beta}\left(\mathrm{i}\bar\varphi\bar\sigma^\rho D_\gamma\varphi+h.c.\right)\left(1+\kappa_2+\frac{q^2}{(4\pi)^2\epsilon}\frac{-5+3\kappa_2-20\kappa_3-20\kappa_4-8\kappa_5+8\kappa_7}{3}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\mathrm{i}\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}\bar\varphi\bar\sigma^\sigma D^\rho D^2\varphi+h.c.\right)\left(\kappa_3-\frac{q^2}{(4\pi)^2\epsilon}\frac{-\kappa_2+16\kappa_3+14\kappa_4-4\kappa_5+16\kappa_7}{12}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\mathrm{i}\theta^{\mu\nu}F_{\mu\rho}\bar\varphi\bar\sigma_\nu D^\rho\varphi+h.c.\right)\left(\kappa_4+\frac{q^2}{(4\pi)^2\epsilon}\frac{-1+9\kappa_2+68\kappa_3+26\kappa_4-4\kappa_5-8\kappa_7}{6}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\mathrm{i}\theta^{\mu\nu}F_{\mu\nu}\bar\varphi\bar\sigma^\rho D_\rho\varphi+h.c.\right)\left(\kappa_5+\frac{q^2}{(4\pi)^2\epsilon}\frac{-1-\kappa_2-20\kappa_3-6\kappa_4-4\kappa_5+8\kappa_7}{4}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\theta^{\mu\nu}\varepsilon_{\mu\rho\sigma\tau}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\nu\varphi+h.c.\right)\left(\kappa_6-\frac{q^2}{(4\pi)^2\epsilon}\frac{6+5\kappa_2-132\kappa_3+24\kappa_4+24\kappa_5+72\kappa_6-24\kappa_7}{36}\right)\\
&+q\mu^{\frac{\epsilon}{2}}\left(\theta^{\mu\nu}\varepsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}\bar\varphi\bar\sigma^\tau D_\tau\varphi+h.c.\right)\left(\kappa_7+\frac{q^2}{(4\pi)^2\epsilon}\frac{7+\kappa_2-16\kappa_3+2\kappa_4+4\kappa_5-16\kappa_7}{8}\right).
\end{aligned}
$$

Gola polja i konstante

- $\varphi_0 = \left(1 - \frac{q^2}{(4\pi)^2\epsilon}\right)\,\varphi$
- $A_0^\mu = \left(1 - \frac{2}{3}\frac{q^2}{(4\pi)^2\epsilon}\right)\,A^\mu$
- $q_0 = \mu^{\frac{\epsilon}{2}}\left(1 + \frac{2}{3}\frac{q^2}{(4\pi)^2\epsilon}\right)\,q$
- $\theta_0^{\mu\nu} = \left(1 - \frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}(\kappa_2 - 8\kappa_3 - 4\kappa_4)\right)\,\theta^{\mu\nu}$

Gola polja i konstante

- $\varphi_0 = \left(1 - \frac{q^2}{(4\pi)^2\epsilon}\right)\varphi$
- $A_0^\mu = \left(1 - \frac{2}{3}\frac{q^2}{(4\pi)^2\epsilon}\right)A^\mu$
- $q_0 = \mu^{\frac{\epsilon}{2}}\left(1 + \frac{2}{3}\frac{q^2}{(4\pi)^2\epsilon}\right)q$
- $\theta_0^{\mu\nu} = \left(1 - \frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}(\kappa_2 - 8\kappa_3 - 4\kappa_4)\right)\theta^{\mu\nu}$

Gola polja i konstante

- $\varphi_0 = \left(1 - \frac{q^2}{(4\pi)^2\epsilon}\right)\varphi$
- $A_0^\mu = \left(1 - \frac{2}{3}\frac{q^2}{(4\pi)^2\epsilon}\right) A^\mu$
- $q_0 = \mu^{\frac{\epsilon}{2}}\left(1 + \frac{2}{3}\frac{q^2}{(4\pi)^2\epsilon}\right) q$
- $\theta_0^{\mu\nu} = \left(1 - \frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}(\kappa_2 - 8\kappa_3 - 4\kappa_4)\right)\theta^{\mu\nu}$

Gola polja i konstante

- $(\kappa_2)_0 = \kappa_2 + \frac{1}{3}\frac{q^2}{(4\pi)^2\epsilon}\left(1 + 13\kappa_2 + 4\kappa_2(\kappa_2 - 8\kappa_3 - 4\kappa_4) - 52\kappa_3 - 36\kappa_4 - 8\kappa_5 + 8\kappa_7\right),$
- $(\kappa_3)_0 = \kappa_3 + \frac{1}{12}\frac{q^2}{(4\pi)^2\epsilon}\left(-1 - \kappa_2 + 40\kappa_3 + 16\kappa_3(\kappa_2 - 8\kappa_3 - 4\kappa_4) - 4\kappa_5 + 16\kappa_7\right)$
- $(\kappa_4)_0 = \kappa_4 + \frac{1}{6}\frac{q^2}{(4\pi)^2\epsilon}\left(-1 + 9\kappa_2 + 68\kappa_3 + 38\kappa_4 + 8\kappa_4(\kappa_2 - 8\kappa_3 - 4\kappa_4) - 4\kappa_5 - 8\kappa_7\right)$
- $(\kappa_5)_0 = \kappa_5 + \frac{1}{12}\frac{q^2}{(4\pi)^2\epsilon}\left(-3 - 3\kappa_2 - 60\kappa_3 - 18\kappa_4 + 12\kappa_5 + 16\kappa_5(\kappa_2 - 8\kappa_3 - 4\kappa_4) + 24\kappa_7\right)$
- $(\kappa_6)_0 = \kappa_6 + \frac{1}{36}\frac{q^2}{(4\pi)^2\epsilon}\left(-6 - 5\kappa_2 + 132\kappa_3 - 24\kappa_4 - 24\kappa_5 + 48\kappa_6(\kappa_2 - 8\kappa_3 - 4\kappa_4) + 24\kappa_7\right)$
- $(\kappa_7)_0 = \kappa_7 + \frac{1}{24}\frac{q^2}{(4\pi)^2\epsilon}\left(21 + 3\kappa_2 - 48\kappa_3 + 6\kappa_4 + 12\kappa_5 + 32\kappa_7(\kappa_2 - 8\kappa_3 - 4\kappa_4)\right)$
- $(\kappa_2)_0 - 4(\kappa_3)_0 - 2(\kappa_4)_0 =$
  $\left(1 + \frac{4}{3}\frac{q^2}{(4\pi)^2\epsilon}\right)(\kappa_2 - 8\kappa_3 - 4\kappa_4)(\kappa_2 - 4\kappa_3 - 2\kappa_4) + \frac{1}{3}\frac{q^2}{(4\pi)^2\epsilon}(3 + 5\kappa_2 - 160\kappa_3 - 74\kappa_4)$

Gola polja i konstante

- $(\kappa_2)_0 = \kappa_2 + \frac{1}{3}\frac{q^2}{(4\pi)^2\epsilon}\big(1 + 13\kappa_2 + 4\kappa_2(\kappa_2 - 8\kappa_3 - 4\kappa_4) - 52\kappa_3 - 36\kappa_4 - 8\kappa_5 + 8\kappa_7\big),$
- $(\kappa_3)_0 = \kappa_3 + \frac{1}{12}\frac{q^2}{(4\pi)^2\epsilon}\big(-1 - \kappa_2 + 40\kappa_3 + 16\kappa_3(\kappa_2 - 8\kappa_3 - 4\kappa_4) - 4\kappa_5 + 16\kappa_7\big)$
- $(\kappa_4)_0 = \kappa_4 + \frac{1}{6}\frac{q^2}{(4\pi)^2\epsilon}\big(-1 + 9\kappa_2 + 68\kappa_3 + 38\kappa_4 + 8\kappa_4(\kappa_2 - 8\kappa_3 - 4\kappa_4) - 4\kappa_5 - 8\kappa_7\big)$
- $(\kappa_5)_0 = \kappa_5 + \frac{1}{12}\frac{q^2}{(4\pi)^2\epsilon}\big(-3 - 3\kappa_2 - 60\kappa_3 - 18\kappa_4 + 12\kappa_5 + 16\kappa_5(\kappa_2 - 8\kappa_3 - 4\kappa_4) + 24\kappa_7\big)$
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- $(\kappa_2)_0 - 4(\kappa_3)_0 - 2(\kappa_4)_0 =$
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- Krenuli smo od NC kiralne ED, uzimajući najopštiji oblik SW preslikavanja.
- Dobili smo da je SW preslikavanje nekomapatibilno sa kvantizacijom zbog ponašanja fermionskog sektora.
- θ-razvijena kiralna ED nije renormalizabilna, što znači da se takve teorije ne mogu posmatrati kao funadamentalne teorije.
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