Duality, non-renormalization, superblocks and lines of CFTs without SUSY

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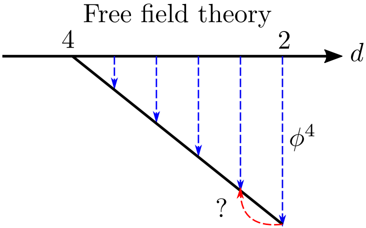
1703.05325, 1810.07199

Epsilon expansions

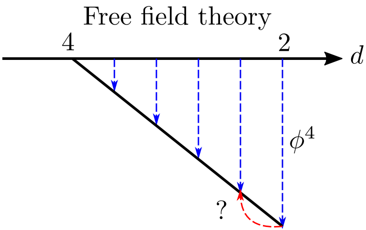


Expansion in $\varepsilon = 4 - d$:

$$S = \int \frac{1}{2}\phi\partial^2\phi + \frac{\lambda}{4!}\phi^4 d^d x$$

Expansion in $\delta = d - 2$: ???

Epsilon expansions



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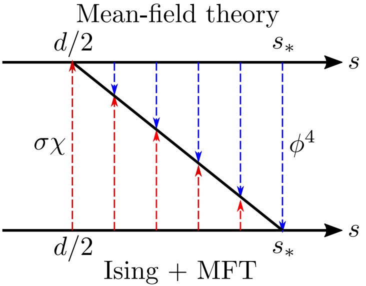

Expansion in $\varepsilon = 2s - d$:

$$S = \int \frac{1}{2}\phi\partial^s\phi + \frac{\lambda}{4!}\phi^4 d^d x$$

Expansion in $\delta = \frac{s_* - s}{2}$:

$$S = S_{Ising} + \int \frac{1}{2}\chi\partial^{-s}\chi + g\sigma\chi d^d x$$

Features of the duality

Matching operators:

$$\begin{array}{ccc} \phi & \leftrightarrow & \sigma \\ \phi^2 & \leftrightarrow & \epsilon \\ \phi^3 & \leftrightarrow & \chi \end{array} \qquad \begin{array}{c} \phi^4 \leftrightarrow \sigma\chi \\ [\phi\phi]^{\mu\nu}_{0,2} \leftrightarrow T^{\mu\nu} \\ \partial_\nu [\phi\phi]^{\mu\nu}_{0,2} \leftrightarrow [\sigma\chi]^{\mu}_{0,1} \end{array}$$

Exact dimensions:

$$\Delta_\phi = \frac{d-s}{2} = d - \Delta_{\phi^3} \;,\; \Delta_\sigma = \frac{d-s}{2} = d - \Delta_\chi$$

$$\partial^s \phi = \phi^3 \;,\; \partial^{-s}\chi = \sigma$$

Approximate dimensions:

$$\gamma^{(2)}_\epsilon = 0.27\delta \;,\; \gamma^{(2)}_{\phi^2} = \left[\psi(1) - 2\psi\left(\frac{d}{4}\right) + \psi\left(\frac{d}{2}\right)\right]\left(\frac{\varepsilon}{3}\right)^2$$

$$\gamma^{(2)}_T = 2.33\delta \;,\; \gamma^{(2)}_{[\phi\phi]_{0,2}} = -\frac{8}{d(d+2)}\left(\frac{\varepsilon}{3}\right)^2$$

$\langle \mathcal{O}_1 \mathcal{O}_2 \chi \rangle$ can be explicitly computed in terms of $\langle \mathcal{O}_1 \mathcal{O}_2 \sigma \rangle$.

$$\lambda_{12\chi}\lambda_{34\sigma} = \frac{\Gamma\left(\frac{\Delta_\chi \pm \Delta_{12} + \ell_1 + \ell_2 - 2m}{2}\right)\Gamma\left(\frac{\Delta_\sigma \pm \Delta_{34} + \ell_1 + \ell_2 - 2m}{2}\right)}{\Gamma\left(\frac{\Delta_\sigma \pm \Delta_{12} + \ell_1 + \ell_2 - 2m}{2}\right)\Gamma\left(\frac{\Delta_\chi \pm \Delta_{34} + \ell_1 + \ell_2 - 2m}{2}\right)}\lambda_{12\sigma}\lambda_{12\chi}$$

$$\lambda^2_{\sigma\chi\mathcal{O}} = \frac{\Gamma\left(\frac{d-\Delta+\ell}{2}\right)^2\Gamma\left(\frac{d-2\Delta_\sigma+\Delta+\ell}{2}\right)\Gamma\left(\frac{2\Delta_\sigma-d+\Delta+\ell}{2}\right)}{\Gamma\left(\frac{\Delta+\ell}{2}\right)^2\Gamma\left(\frac{2\Delta_\sigma-\Delta+\ell}{2}\right)\Gamma\left(\frac{2d-2\Delta_\sigma-\Delta+\ell}{2}\right)}\lambda_{\sigma\sigma\mathcal{O}}\lambda_{\chi\chi\mathcal{O}}$$

Protected operators for odd ℓ, superblocks for even ℓ!