$$\text{initial state=infinite past } \tau \leadsto +\infty i \Rightarrow x = {}^{\tau i}\mathfrak{e} \leadsto {}^{-\infty}\mathfrak{e} = +0$$

$$\text{final state=infinite future } \tau \leadsto -\infty i \Rightarrow x = {}^{\tau i}\mathfrak{e} \leadsto {}^{+\infty}\mathfrak{e} = +\infty$$

Fadeev-Popov gauge fixing

$$1 \leqslant i < j < k \leqslant m\text{:} \quad \infty > u_i > u_j > u_k > 0 \text{ radial coord}$$

$$\int_{\Lambda^{u_i u_j u_k}_{u_{\ell \neq ijk}}}^{\infty > u_1 \underset{\cdot\cdot}{\geqslant} u_{i-1} > u_i > u_{i+1} \underset{\cdot\cdot}{\geqslant} u_{j-1} > u_j > u_{j+1} \underset{\cdot\cdot}{\geqslant} u_{k-1} > u_k > u_{k+1} \underset{\cdot\cdot}{\geqslant} u_m > 0}$$

$$= \left(u_i - u_j\right)\left(u_i - u_k\right)\left(u_j - u_k\right) \int_{\begin{cases} du_1 \cdot\cdot du_{i-1} \\ du_{i+1} \cdot\cdot du_{j-1} \\ du_{j+1} \cdot\cdot du_{k-1} \\ du_{k+1} \cdot\cdot du_m \end{cases}}^{\begin{cases} \infty > u_1 \underset{\cdot\cdot}{\geqslant} u_{i-1} > u_i \\ u_i > u_{i+1} \underset{\cdot\cdot}{\geqslant} u_{j-1} > u_j \\ u_j > u_{j+1} \underset{\cdot\cdot}{\geqslant} u_{k-1} > u_k \\ u_k > u_{k+1} \underset{\cdot\cdot}{\geqslant} u_m > 0 \end{cases}}$$

$$\int_{du_1 \cdot\cdot du_{i-1}}^{\infty > u_1 \underset{\cdot\cdot}{\geqslant} u_{i-1} > u_i} \int_{du_{j+1} \cdot\cdot du_{k-1}}^{u_j > u_{j+1} \underset{\cdot\cdot}{\geqslant} u_{k-1} > u_k} \int_{du_{k+1} \cdot\cdot du_m}^{u_k > u_{k+1} \underset{\cdot\cdot}{\geqslant} u_m > 0}$$

$${}^{u_{\ell \neq ijk}}_{u_i u_j u_k}\overbrace{\underset{1}{V} \cdot\cdot \underset{m}{V}} = \frac{{}^{u_1}\underset{1}{V}}{u_1} \cdots \frac{{}^{u_m}\underset{m}{V}}{u_m}$$

$${}^{u_{\ell \neq ijk} \rtimes g}_{u_i \rtimes g u_j \rtimes g u_k \rtimes g}\overbrace{\underset{1}{V} \cdot\cdot \underset{m}{V}} = \prod_{\ell} \overbrace{a - cu_\ell \rtimes g}^{-2} \; {}^{u_{\ell \neq ijk}}_{u_i u_j u_k}\overbrace{\underset{1}{V} \cdot\cdot \underset{m}{V}}$$

$$\Lambda^{u_i \rtimes g u_j \rtimes g u_k \rtimes g}_{u_{\ell \neq ijk} \rtimes g} = \prod_{\ell} \overbrace{a - c u_{\ell} \rtimes g}^{2} \, d \, \Lambda^{u_i u_j u_k}_{u_{\ell \neq ijk}}$$

$$\Lambda^{u_i \rtimes g u_j \rtimes g u_k \rtimes g}_{u_{\ell \neq ijk} \rtimes g} \quad {}^{u_{\ell \neq ijk} \rtimes g}_{u_i \rtimes g u_j \rtimes g u_k \rtimes g} \overbrace{V_1 \cdots V_m} = \Lambda^{u_i u_j u_k}_{u_{\ell \neq ijk}} \quad {}^{u_{\ell \neq ijk}}_{u_i u_j u_k} \overbrace{V_1 \cdots V_m}$$

$$\underbrace{L - 1} \Phi_1 = 0 = \underbrace{L - 1} \Phi_m$$

$$\begin{cases} \Phi_1 \overset{\infty}{\leftsquigarrow}{}^{u_1} |\Omega| u_1{}^{u_1}\underset{1}{V} \\ \dfrac{{}^{u_m}\underset{m}{V}}{u_m}\Omega \underset{u_m \rightsquigarrow 0}{\rightsquigarrow} \Phi_m \end{cases} \Longrightarrow \Lambda^{u_1 1 u_m}_{u_1 1 u_m} \overline{\underset{1}{V}\cdot\cdot\underset{m}{V}} \underset{u_m\rightsquigarrow 0}{\overset{\infty\leftsquigarrow u_1}{\rightsquigarrow}} \Phi_1|\underset{2}{V}\Delta\underset{3}{V}\Delta V\cdot\cdot\Delta\underset{m-1}{V}\Phi_m$$

$$\infty > u_1 > u_2 = 1 > u_3 > \cdot\cdot > u_{m-1} > u_m > 0$$

$$3 \leqslant i \leqslant m-1: \quad 1 > x_i = u_i / u_{i-1} > 0$$

$$\Lambda^{u_1 1 u_m}_{u_1 1 u_m} \overline{\underset{1}{V}\cdot\cdot\underset{m}{V}} = \underbrace{u_1 - 1}\,\underbrace{u_1 - u_m}\,\underbrace{1 - u_m} \int\limits_{du_3\cdot\cdot du_{m-1}}^{1 > u_3 > \cdot\cdot > u_{m-1} > 0} \Omega| \frac{{}^{u_1}\underset{1}{V}}{u_1}\frac{\underset{2}{V}}{1}\frac{{}^{u_3}\underset{3}{V}}{u_3}\cdot\cdot\frac{{}^{u_{m-1}}\underset{m-1}{V}}{u_{m-1}}\frac{{}^{u_m}\underset{m}{V}}{u_m}\Omega$$

$$= \underbrace{1 - 1/u_1}_{\rightsquigarrow 1}\;\underbrace{1 - u_m/u_1}_{\rightsquigarrow 1}\;\underbrace{1 - u_m}_{\rightsquigarrow 1}\;\underbrace{\Omega|u_1{}^{u_1}\underset{1}{V}}_{\rightsquigarrow \Phi_1} \int\limits_{du_3/u_3\cdot\cdot du_{m-1}/u_{m-1}}^{1 > u_3 > \cdot\cdot > u_{m-1} > 0} \underset{2}{V}\,{}^{u_3}\underset{3}{V}\cdot\cdot{}^{u_{m-1}}\underset{m-1}{V}\,\underbrace{{}^{u_m}\underset{m}{V}\Omega/u_m}_{\rightsquigarrow \Phi_m}$$

$$\rightsquigarrow \int\limits_{du_3/u_3\cdot\cdot du_{m-1}/u_{m-1}}^{1 > u_3 > \cdot\cdot > u_{m-1} > 0} \Phi_1|\underset{2}{V}\,{}^{u_3}\underset{3}{V}\cdot\cdot{}^{u_{m-1}}\underset{m-1}{V}\,\Phi_m = \int\limits_{dx_3/x_3}^{0|1}\cdot\cdot\int\limits_{dx_{m-1}/x_{m-1}}^{0|1} \Phi_1|\underset{2}{V}\,{}^{x_3}\underset{3}{V}\,{}^{x_3x_4}\underset{4}{V}\cdot\cdot{}^{x_3\cdot\cdot x_{m-1}}\underset{m-1}{V}\,\Phi_m$$

$$= \int\limits_{dx_3/x_3}^{0|1}\cdot\cdot\int\limits_{dx_{m-1}/x_{m-1}}^{0|1} \Phi_1|\underset{2}{V}\,x_3^L\,\underset{3}{V}\,x_3^{-L}\,\overline{x_3x_4}^{L}\,\underset{4}{V}\,\overline{x_3x_4}^{-L}\cdot\cdot\overline{x_3\cdot\cdot x_{m-1}}^{L}\,\underset{m-1}{V}\,\overline{x_3\cdot\cdot x_{m-1}}^{-L}\,\Phi_m$$

$$= \int\limits_{dx_3/x_3}^{0|1}\cdot\cdot\int\limits_{dx_{m-1}/x_{m-1}}^{0|1} \Phi_1|\underset{2}{V}\,x_3^L\,\underset{3}{V}\,x_4^L\,\underset{4}{V}\cdot\cdot x_{m-1}^L\,\underset{m-1}{V}\,\overline{x_3\cdot\cdot x_{m-1}}^{-1}\,\Phi_m$$

$$= \int\limits_{dx_3/x_3}^{0|1}\cdot\cdot\int\limits_{dx_{m-1}/x_{m-1}}^{0|1} \Phi_1|\underset{2}{V}\,x_3^{L-1}\,\underset{3}{V}\,x_4^{L-1}\,\underset{4}{V}\cdot\cdot x_{m-1}^{L-1}\,\underset{m-1}{V}\,\Phi_m = \Phi_1|\underset{2}{V}\Delta\underset{3}{V}\Delta V\cdot\cdot\Delta\underset{m-1}{V}\,\Phi_m$$