

four potential: $\underline{A}^\sim = \begin{pmatrix} \phi \\ \underline{A} \end{pmatrix}$

$$\underline{B} = \underline{0} \times \underline{A}$$

$$\underline{E} = -\underline{0} \phi$$

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

$$F'_{\rho\sigma} = \epsilon_{\rho\sigma\mu\nu} F^{\mu\nu}$$

$$\partial^\rho F'_{\rho\sigma} = 0$$

$$T(AB\dots N) = AB\dots N - :AB\dots N:$$

$$T(\phi^4) = \phi^4 - :\phi^4:$$

$$\phi = \int \frac{d^3 k}{(2\pi)^3} \frac{1}{2E_k} (a_k^\dagger + a_k)$$

$$\phi^4 = \int \int \int \int \frac{d^3 k_1}{(2\pi)^3} \dots \frac{d^3 k_4}{(2\pi)^3} (a_{k_1}^\dagger + a_{k_1}) (a_{k_2}^\dagger + a_{k_2}) \dots$$

oops, I made sign error!

$$\mathcal{L} = \frac{1}{2}(\partial_n \phi)^2 - M^2 \phi^2 - \frac{1}{4} \phi^4$$



