Quantum Field Theory Equation Sheet

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Here are some useful equations

Table 1: Equation Sheet

Name/Description	Equation	Remarks
Noether conserved current	$j^\mu = \partial_{\partial_\mu \phi}\mathcal{L}\delta\phi - F^\mu$	here $\mathcal{L}(x+\delta x) = \mathcal{L} + \delta x \partial_\mu F^\mu$, $\partial_\mu j^\mu = 0$
The conserved charge arising from a conserved current	$Q = \int d^3x j^0$	
The Energy-Momentum Tensor	$T^\mu_\nu = \partial_{\partial_\mu \phi}\mathcal{L}\partial_\nu\phi - \delta^\mu_\nu \mathcal{L}$	This is the Noether current under translation. This tensor can always be chosen to be symmetric. It is a Noether current, so conserved as $\partial_\mu T^{\mu\nu} = 0$
Ladder Operators	$[a_p, a_q^\dagger] = (2\pi)^3\delta(p-q)$	
Field Operator	$\phi = \int \frac{d^3p}{(2\pi)^3}\frac{1}{\sqrt{2\omega_p}}(a_p e^{ip\cdot x} + a_p^\dagger e^{-ip\cdot x})$	
Momentum Operator	$\pi = \int \frac{d^3p}{(2\pi)^3}(-i)\sqrt{\frac{\omega_p}{2}}(a_p e^{ip\cdot x} - a_p^\dagger e^{-ip\cdot x})$	