Scattering in Relativistic Quantum Field Theories by Prof. Dingyu Shao

Jinyuan Wu

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The vacuum state of a field theory with interaction is given by

$$|\Omega\rangle = \lim_{T\to\infty(1-\mathrm{i}\epsilon)} (\mathrm{e}^{-\mathrm{i}E_0(t-(-T))}\langle\Omega|0\rangle)^{-1} U(t_0,-T)\,|0\rangle\,. \tag{1}$$

Suppose $x^0 > y^0 > t_0$, we have

$$\langle\Omega|\mathcal{T}[\phi(x)\phi(y)]|\Omega\rangle$$

So in the end we have

$$\langle\Omega|\mathcal{T}[\phi(x)\phi(y)]|\Omega\rangle = \lim_{T\to\infty(1-\mathrm{i}\epsilon)} \frac{\langle 0|\mathcal{T}\,\phi_{\mathrm{I}}(x)\phi_{\mathrm{I}}(y)\exp\left(-\mathrm{i}\int_{-T}^{T}\mathrm{d}t\,H_{\mathrm{I}}(t)\right)|0\rangle}{\langle 0|\mathcal{T}\exp\left(-\mathrm{i}\int_{-T}^{T}\mathrm{d}t\,H_{\mathrm{I}}(t)\right)|0\rangle}. \tag{2}$$

A scattering experiment involves processes like the following:

$$p_1 + p_2 \longrightarrow \sum_i q_i. \tag{3}$$

$$\mathrm{d}P = \tag{4}$$