SCPY639 Quantum Field Theory
Problem Set # 1
Date: September 21, 2022. Due date: September 28, 2022.

1. Do canonical quantization of the complex scalar field with the Lagrangian

$$\mathcal{L} = \partial_\mu \phi^*(x) \partial^\mu \phi(x) - m^2 \phi^*(x) \phi(x)$$

with free field solution

$$\phi(x) = \int \frac{d^3k}{(2\pi)^3 2\omega_k} (a(k) e^{-ik\cdot x} + b^*(k) e^{ik\cdot x})_{\omega=\omega_k}$$

and then calculate its quantized Hamiltonian operator.

2. Write the LSZ reduction formula of the spinor field S-matrix for 2-to-2 particle-antiparticle scattering

$$S_{\alpha\beta}^{+-,+-} = \langle (p_s', s_1', +), (p_2', s_2', -), \beta | (p_1, s_1, +), (p_2, s_2, -), \alpha \rangle$$

3. Calculate the trace of eight gamma matrices

$$Tr[\gamma^{\mu_1} \gamma^{\mu_2} \gamma^{\mu_3} \gamma^{\mu_4} \gamma^{\mu_5} \gamma^{\mu_6} \gamma^{\mu_7} \gamma^{\mu_8}]$$