

Ph634: Advanced Quantum Mechanics / Quantum Field Theory
Problem Set 1: Scalar Fields

(1) Compute the stress-energy tensor $T^{\mu\nu}$ for a real scalar field, assuming the Klein-Gordon Lagrangian. Verify that T^{00} is the Hamiltonian density. Is the stress tensor symmetric? Does it have to be in general (for any Lagrangian)?

(2) Compute the conserved current J_μ for a complex scalar field under the transformation

$$\phi \rightarrow e^{ia}\phi \quad ,$$

assuming the free particle Lagrangian. Give a physical interpretation of the conserved charge associated with this symmetry.

(3) Work out equations (2.30) and (2.33) in Peskin explicitly, making sure you understand all the steps.

(4) Work out equations (2.34)-(2.36) in Peskin explicitly.

(5) Work out equations (2.54)-(2.60) in Peskin explicitly.