Week 6 (due Nov. 9)

1. Problem 3.2 in Peskin-Schroeder (10 pts).
2. Problem 3.4(a,b) in Peskin-Schroeder (20 pts).
3. Quantize the complex Klein-Gordon field $\phi(x)$by imposing anti-commutation relations:

$$\begin{aligned}
\{\phi(\vec{x}), \phi(\vec{y})\} &= \quad 0, & (1)\\
\{\phi(\vec{x}), \phi^\dagger(\vec{y})\} &= \quad 0, & (2)\\
\{\phi(\vec{x}), \partial_0\phi(\vec{y})\} &= \quad 0, & (3)\\
\{\phi(\vec{x}), \partial_0\phi^\dagger(\vec{y})\} &= \; i\delta^3(\vec{x}-\vec{y}). & (4)
\end{aligned}$$

(a) Write down anti-commutation relations for oscillators a_p, b_p, where a_p and b_p are defined in the usual way by Fourier-expanding $\phi(x)$:

$$\phi(x) = \int \frac{d^3p}{(2\pi)^3} \frac{1}{\sqrt{2E_p}} \left(a_p e^{-ipx} + b_p^\dagger e^{ipx}\right).$$

(b) What is wrong with these anti-commutation relations for a_p, b_p? (Hint: one does not need to compute the Hamiltonian to see that something is wrong; the problem appears at a more basic level).