Physics 721, Fall 2006 Josh Erlich

Problem Set 5: Electrodynamics

Due Tuesday, November 7.

1. Peskin & Schroeder, Problem 2.1 part b.

You are asked to calculate the symmetric form of the electromagnetic energy-momentum tensor and from it the Hamiltonian and spatial momentum of the electromagnetic field.

Note that the canonical momentum conjugate to A^0 vanishes, $\Pi_{A^0} = 0$. This is similar to what happened for the Dirac spinor field: In that case $\Pi_{\overline{\psi}}$ vanished, but we argued that ψ and Π_ψ at some initial time provide a complete set of boundary information to solve the Dirac equation so we didn't need to impose equal time commutation relations on anything else. If you are interested, you can try to think through a similar argument for the vector field. However, you do not need to impose any commutation relations on the fields to solve the assigned problem– it is a purely classical problem.

Also note that the term you will add to make the energy-momentum tensor derived from Nöether's theorem symmetric is a total derivative, so it does not contribute to the Hamiltonian or the spatial momentum. Hence, you *are* calculating the conserved quantities as a result of spacetime translation invariance.