

## PHYS 942 homework assignment #06

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PHYS 942  
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Names ( $\leq 3$ , write clearly): \_\_\_\_\_

Due: Friday, December 6, at noon, in any of my mailboxes (DeMerrit, Morse, office, or under the door). **Show all your steps!**

1. (30 points) Using the covariant form of the Euler-Lagrange equations:

$$\frac{d}{d\tau} \frac{\partial L}{\partial U^\gamma} = \frac{\partial L}{\partial x^\gamma}$$

- (a) show that the covariant particle Lagrangian

$$L = -\frac{mU_\alpha U^\alpha}{2} - \frac{q}{c} U_\alpha A^\alpha$$

gives the correct equation of motion of a particle with mass  $m$  and charge  $q$  in an external field given by  $A^\alpha(x)$ .

- (b) What is the corresponding covariant canonical momentum?  
(c) Write out the Hamiltonian both in covariant form and in space-time form.

A peek at Jackson 12.1.B may help.

2. (70 points) Jackson, problem 12.15. Start with the Proca equation in the static limit. First show that:

$$G(\mathbf{x}, \mathbf{x}') = \frac{e^{-\mu|\mathbf{x}-\mathbf{x}'|}}{|\mathbf{x}-\mathbf{x}'|}$$

is a Green function for the operator  $(\nabla^2 - \mu^2)$  in the infinite domain, and make use of that Green function. The photon mass in terms of  $\mu$  is  $\mu\hbar/c$ .