

Physics 4410 - Quantum Mechanics II – Fall 2004  
Problem Set 13

Due December 8, 2004 at 11:00 AM in Duane G2B21

Please take the pedagogy survey at:

<http://cosmos.colorado.edu/phet/survey/CLASSfa04/CLASSfa04-physics-ugrads.html> (link is on course web site).

NOTICE: Final exam will be Monday, December 13, 1:30-4:00pm, in room **G1B30**.

Reading assignment: Shankar Section 18.5, Chapter 20.

1. Shankar 19.3.3. Compare the angular dependence of this cross-section to the Yukawa cross-section.
2. Show that for the classical electromagnetic field in charge-free space, the variables

$$Q_{\lambda\mathbf{k}} \equiv \frac{1}{\sqrt{4\pi c^2}} (A_{\lambda\mathbf{k}}^* + A_{\lambda\mathbf{k}})$$
$$P_{\lambda\mathbf{k}} \equiv \frac{i\omega}{\sqrt{4\pi c^2}} (A_{\lambda\mathbf{k}}^* - A_{\lambda\mathbf{k}})$$

are canonically conjugate. You may use the Lagrangian approach or show that they satisfy Hamilton's equations given the proper time dependence.