

Physics 295. Independent Study on Advanced Quantum Field  
Theory. Professor Dine

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Spring, 2010. Homework Set 1. Due Wed, April 14.

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1. Verify the transversality of the vacuum polarization tensor,  $\Pi^{\mu\nu}$ . This is basically done in PS, but it is a good exercise to grind this one out.
2. Draw the one loop diagrams for three processes: Bhabha scattering,  $e^+e^-$  annihilation, and Compton scattering. Verify that the only ultraviolet divergent diagrams in each case are the electron and photon self-energy and the vertex. Discuss the implications for renormalizability (i.e. that all of the divergences can be absorbed in a redefinition of the *same* coupling which controls these processes).
3. Now repeat the exercise for  $e^+e^-$  annihilation at two loops. Argue that, again, the only divergent diagrams are those associated with the self-energies and the vertex correction.