Homework # 8; due Thursday, November 4

Reading: Chapter 7 of Griffiths (plus you may need to review earlier material)

28. Find rotational invariants corresponding to the following processes:
    a. Natural optical activity: rotation of the direction of the polarization of linearly polarized light propagating in an isotropic medium.
    b. Faraday rotation: rotation of the direction of the polarization of linearly polarized light propagating in an isotropic medium in the presence of a static magnetic field collinear with the light-propagation direction.
    c. Same as in (b) but with magnetic field replaced with an electric field.

Examine the properties of each of these invariants with respect to spatial inversion (P) and time reversal (T). Are any of these processes allowed if both parity and time-reversal invariance are good symmetries (i.e., neglecting the weak interactions)?

29. Explain why the nucleus containing one proton and one neutron (the *deuteron*) is stable, but there is no *dineutron*---the bound state of two neutrons. Hint: Assume that the strong-interaction forces are the same for a proton and a neutron (isospin invariance), and make use of the fact that there is only one bound state for the proton-neutron system (the deuteron), and it is spin-one, mostly coming from the addition of the proton's and neutron's spins. (There is, in fact, a small admixture of the orbital angular momentum L=1, but we can neglect it here.)

30. Consider photon scattering on a tau lepton.

    a. Draw the Feynman diagrams for the process.
    b. Follow the QED rules summarized in Section 7.5 of Griffiths and write out the full expression for the total amplitude of the process.
    c. Explain why this process is legitimately described by QED (and not, for example, by QCD).
    d. Examine your expression for the amplitude. What are the dimensions (units) of the amplitude? (You may need to read around in Griffiths to see how the spinors are normalized, etc.)
    e. Find (by browsing Ch. 7) the appropriate expression for the differential cross-section of the scattering in terms of the amplitude. Verify that substituting the amplitude with the units you obtained in (c), you get the expected units for the cross-section.