Physics 472 – Spring 2010

Homework #11, due Friday, April 16

(Point values are in parentheses.)

1. [4] Griffiths 3.39. We did several parts of this problem in class. Do them again anyway.

2. [6] Griffiths problem 4.56. For those of you who are careful enough to notice a sign error, you will find that Griffiths made a mistake in the sign of the exponent. His operator actually rotates spinors in the left-hand sense about the axis of rotation.

   When you get to part (e), do it for the special case $\hat{n} = \hat{j}$, i.e. a spin rotation about the y-axis. Apply the spin rotation operator you obtain to the state $\left|\uparrow\right\rangle$ and check that you get the answer we obtained in class long ago for a spinor pointing along an arbitrary direction in the x-z plane. If you are feeling inspired, derive the general formula given in the problem.

3. [8] Griffiths problem 9.20

4. [2] Consider a sample of 1 cm^3 of water used in a nuclear magnetic resonance (NMR) experiment at room temperature (T = 300 K). The sample is placed in a uniform magnetic field of 1.5 Tesla pointing upward. Calculate the ratio of upward to downward pointing proton spins in the sample, in thermal equilibrium. (Use the Boltzmann factor we discussed in class.) You can get the proton magnetic moment from Equation 6.85. Calculate the gyromagnetic ratio for the proton, in units of MHz/T. (Watch out for the factor of 2π.) How many protons contribute to the NMR signal, approximately? (In other words, what is the difference in the number of upward and downward pointing proton spins?)