PHYS 4392
Fall 2014
TE Coan
Due: 21 Nov '14 6:00 PM

Homework 11

1. What is the magnetic field **B** on the axis of a uniformly magnetized cylinder and *outside* the cylinder? The cylinder could be a cylindrical bar magnet stuck to your refrigerator or, alternatively, to the skull of your roommate. Let the cylinder have a length L, a radius a and a uniform magnetization **M** pointing along the cylinder's axis.

2. Suppose that a star of radius 10^6 km and a uniform magnetic field of 10^{-2} T undergoes gravitational collapse to a neutron star of radius 5 km. Assume that the magnetic field remains uniform (I have no idea how reasonable this assumption is) and that the magnetic flux going through the star remains constant owing to the high electrical conductivity of the stellar interior. Find the magnitude B of the magnetic field in the neutron star.

3. Why can't Earth's magnetic field be due to the presence at its center (an iron core) of an enormous *permanent* magnet? No calculation is required, just some well-chosen words.

4. Here is a problem that may be familiar from PHYS 4211. Suppose you have a transmission line built from a pair of long, thin strips of width w. The strips are parallel and one is above the other and separated by a small distance h ($h \ll w$) so that on edge they look like a parallel plate capacitor. The current I travels down one strip and then returns along the other. In each case, it spreads out uniformly over the surface of the strip.

a.) Find the capacitance per unit length $\mathcal{C}$ of this configuration.

b.) Find the inductance per unit length $\mathcal{L}$ of this configuration.

c.) What is the product $\mathcal{LC}$, numerically? From advanced lab you may recall that a pulse will propagate down the line at a speed $v = 1/\sqrt{\mathcal{LC}}$. Different style transmission lines will have a different $\mathcal{C}$ and $\mathcal{L}$ but the expression for v is unaltered.

d.) Real transmission lines almost always have a coating around the conductors. Suppose the goop coating each of the conductors has permittivity ϵ and permeability μ. Find the product $\mathcal{LC}$ and the propagation speed v. Example 4.6 may help you get off in the right direction.