Phys 340: HOMEWORK ASSIGNMENT No (3)

Friday, Feb. 26th

This assignment is to be handed in during or before the class on Monday, March 10th. Please note that late assignments will not receive a mark. Since the questions involve sketching various things, it will probably be necessary to hand in a hard copy, rather than emailing the assignment to me.

(1) **Static EM Fields**: This question has two parts, one dealing with your intuition for field configurations, the other with your conceptual understanding of them.

(a) Sketch the static field configurations for the following situations:

(i) Show the electric field lines near a pair of electric charges, having charges q and $-q$ (an electric dipole). Assume the only fields around are those generated by these 2 charges.

(ii) Show the equipotential lines (contours of constant electric potential energy) for the same pair of charges as in (i).

(iii) Show the magnetic field lines near a single loop of wire carrying a current- assume there are no other magnetic fields around apart from that generated by the loop.

(iv) Now, see if you can plot the electric field lines around an electric dipole, such as that in (i), when there is also a uniform electric field being generated from elsewhere (this situation could be set up, for example, by putting the dipole between the plates of a capacitor- see course slides). You should also try to sketch the equipotential lines for this situation (you might even find it easier to start by doing this).

(b) Explain, using sketches if you wish, how you would go about investigating the magnetic interaction between 2 current carrying wires. The simplest situation to consider is 2 parallel wires- one could look first at 2 parallel straight wires carrying currents I_1 and I_2 in the same direction, and then in opposite directions. One could thus vary both the magnitudes of these currents and their directions- explain how you would then investigate experimentally the way the interaction depends on these.

How do you think that the force between the wires would depend on these variations? You can actually figure this out if you look at the notes, and examine how the direction and magnitude of the field generated by a current depends on the direction and magnitude of the current. You might also care to guess how the strength of the interaction would vary with the distance between the wires.

Finally, in what sense can we say that the forces between the wires are genuine forces, in the way defined originally by Newton?

(2) **Wave Interference and Diffraction**: Here we focus on just one aspect of the physics of waves- again involving intuitive and conceptual aspects.

(a) Sketch first what you think the intensity of light will look like on a screen which is illuminated through a slit. Consider 2 cases- first where the width of the slot is large (much larger than the wavelength of the light), and second where the slit size is small (comparable to the wavelength of the light).

(b) Now consider the case where the screen is illuminated through 2 different parallel slits. Show first what the intensity of the light will look like when both slits are open- we assume here that the slits are both very narrow, with width not much greater than the wavelength of light. Then, second, show what the intensity on the screen will look like of only on of these slits is open.

(c) Now, the conceptual part. Explain why it is that the results of the second experiment (with 2 slits) are so hard to understand if light is considered to be simply a set of particles propagating through space according to Newtons's laws. You can try to think of ways to explain the results

with Newton's laws, introducing any peculiar forces you like- but remember that these must really be forces, in the sense defined by Newton (ie., no "magic" forces!).

Philip Stamp