Sunday, March 2nd, 2008

Phys 340: ASSIGNMENT No. (3): CLASSICAL FIELDS
Due Date: WEDNESDAY, MARCH 12th, 2008

. To be handed on Wednesday, March 12th. Late assignments will not receive a mark

(1) WAVE INTERFERENCE

1(a): Suppose we emit light waves onto a screen, but in such a way that they must first pass through 2 different parallel slits. Show, using drawings:

- first, what the intensity of the wave 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 the waves traveling through them.
- second, what the intensity on the screen will look like if only one of these slits is open.

1(b) Now explain what you would see on the screen if light were corpuscular, ie., if it were simply a set of particles propagating through space according to Newtons's laws. Explain then why the results of this experiment are apparently impossible to understand in this case.

(2) EM Fields

2(a) Static Electric and Magnetic Fields: We wish to compare and contrast these two fields. To do this:

- 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.
- Then 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.

2(b) EM waves: Describe an EM wave, showing in a picture how the magnetic and electric components vary in space and time. What are the wavelengths and frequencies of red light, blue light, typical X-rays, microwaves, and typical gamma rays? And what is the wavelength of the radio waves transmitted by the radio station "Rock 101" (at 101 MHz frequency)?

2(c) Reality of EM field: To say what kind of physical existence the EM field has, we need to say how we *define* it, and what evidence we have for its existence. Answer this question, distinguishing carefully between the EM field itself, and what are usually called 'electric' and 'magnetic' fields. What is the relationship between electric and magnetic fields, on the one hand, and the EM field, on the other? Then, giving an example of a physical experiment that can detect electric and magnetic fields, explain how we know that these fields are out there? How does our knowledge of their existence compare with, eg., our knowledge of the existence of the sun? Or our knowledge of the gravitational field of the sun?

(3) GRAVITATIONAL FIELDS and CURVED SPACETIME

3(a): Suppose you lived in an entirely 2-dimensional world- not only are you not aware of any higher dimensions, but there is no way even in principle for you to ever know about them directly. Explain 2 ways you might nevertheless test to see whether the geometry of your 2-d world is "flat" (ie., Euclidean), or not?

3(b) In Einstein's theory of gravitation, Spacetime, formerly a 'receptacle' for everything else, now becomes an object in itself - a field - but this field is not (at least in Einstein's theory) embedded in any other 'space'. However we know about it, in the same way we know about the EM field,

because we can sense distortions of it. Explain how both gravitational fields and gravity waves are distortions of spacetime, and explain also how one can do an experiment to see each of these distortions (note that gravity waves have not yet been observed).