Classical E&M Homework 01

March 7, 2005
Due date: March 14, 2005

1. (10 points) Currently, positive and negative unit charges are equal in magnitude with astonishing precision. Let Q_p be the charge of the proton, Q_e be the charge of the electron and their difference δ in the following way.

$$\delta = \frac{Q_p - Q_e}{e},$$

   where e is the unit charge $e = 1.602 \times 10^{-19} C$. Estimate δ which will make electromagnetic repulsion between two galaxies (for example, our galaxy and Andromeda galaxy, which is about 200 light years apart) equal to gravitational pull between them. Assume that the universe is made of hydrogen, which is almost true.

2. (5 points) Using δ obtained from the previous question, what would be the net charge of the sun?

3. (10 points) Calculate the electric field felt at earth from such *charged* sun for the following two cases.

   (a) The inverse square law is exact.

   (b) Photon as a small mass and the potential has the Yukawa form

   $$\phi = \frac{q}{4\pi\epsilon_0} \frac{e^{-\mu r}}{r}, \quad \mu = 10^{-8} \text{m}^{-1}$$

   (c) Get the ratio of the two electric field values.

4. (5 points) Repeat the previous question at Pluto.