General Relativity HW6 Problems

1. Argue that naively adding a finite speed of propagation to Newtonian gravity will result in stable orbits becoming unstable. A simple scenario to consider is two equal mass objects in a circular orbit around a common point under their mutual gravitational interaction.

2. Suppose that we lived in a world with only two forces: gravity and the electromagnetic force. Also suppose that every bit of matter in this world was “extremal”, i.e. the electromagnetic charge of any particle is always equal to its mass (with a universal constant to get the dimensions correct). In this context, does it make sense to single out gravity as providing the “curvature of spacetime”, or could we instead use electromagnetism, or perhaps both?

3. When we constructed the atlas for a circle in class, we started with two labels $\theta, \phi$ that ran from $[0,2\pi)$. It was the closed end of these intervals that prevented us from using just one of them as a single chart covering the space. Why would the following not have helped:
   a) Use one label with $(0,2\pi)$.
   b) Use one label with $(0,2\pi + \varepsilon)$.

4. Given that a circle requires at least two charts to form an atlas, it might be surprising that the surface of an infinite cylinder can be covered with an atlas consisting of only one chart. Construct such an atlas for the cylinder. Remember, this is now a 2D space.

5. To be continued...