Physics 786, Spring 2017
Problem Set 5, Due Thursday, March 16, 2017.

Final Paper Assignment - Due last day of class

For your final paper, you should identify and describe either a theoretical aspect of or extension of general relativity, or an experiment or application which either makes use of general relativity or provides a test of general relativity. You should explain in detail those aspects of general relativity which are relevant. Example topics include gravity in extra dimensions, torsion, curvature perturbations during inflation, the cosmic microwave background, Gravity Probe B, LIGO, Planck, BICEP.... As a guideline, aim for five double-spaced pages.

1. *Curvature of the Two-Sphere*

Consider the two-sphere with metric
$$ds^2 = a^2 \left(d\theta^2 + \sin^2 \theta \, d\varphi^2 \right).$$

a) In Problem Set 2 you calculated the Christoffel symbols of the *unit* two-sphere. How are those Christoffel symbols related to those of the two-sphere with radius a?

b) Calculate all the components of the Ricci tensor $R_{\mu\nu}$ and the Gaussian curvature, $K = -R/2$, of the two-sphere.

c) In 2D, $R_{\lambda\mu\nu\rho} = \frac{1}{2}R(g_{\lambda\nu}g_{\mu\rho} - g_{\lambda\rho}g_{\mu\nu})$. Check that this relation is true for the two-sphere.

2. *Rindler Space*

Consider the 2D spacetime whose metric is given by
$$ds^2 = d\rho^2 - \rho^2 \, d\eta^2.$$

a) Calculate the components of the curvature tensor $R_{\mu\nu\lambda\sigma}$.

b) What can you infer about this spacetime from your results of part (a)?