General Relativity or "GR" (PHYS 325) Spring 2014 v1.0

Welcome to GR! This course will be an introduction to Einstein's general relativity. We will spend the first bit of the course on curved space and the associated mathematics ("spacetime geometry"). After the equations of motion, known as the Einstein equations of the field equations, we will concentrate on applications related to the propagation of light in a curved space - things like the classic test of "bending of light," gravitational lensing, and the study of light-like curves (ultra-cool geometry), black holes, cosmology, and gravitational waves.

The main goal of the course will be to work in this new world of curvy spacetime.

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Course Info:

The Phys 325 web site is here.

Course Structure:

The course will be in approximately traditional format. But I hope we can take advantage of our smallish numbers and have plenty of spontaneous discussion.

Textbooks:

There are many good GR texts. We will primarily use Schutz's *A first course in general relativity*, now out in the 2nd edition. On approximately the same level as our book there are Jim Hartle, *Gravity: An introduction to Einstein's General Relativity* and Ohanian and Ruffini, *Gravitation and Spacetime*. The Mother Book is *Gravitation* by Misner, Thorne, and Wheeler. This weighty book is fondly known as "MTW". There are two short (breath takingly brief) introductions by Dirac and 't Hooft (Nobel prize winners). A recent introductory book by Ludvigsen is simply titled *General Relativity*. It takes a much more modern perspective but, alas, it is hard to read. A much easier introduction to SR and some GR ideas is contained in the lovely book *Flat and Curved Spacetimes* by Ellis and Williams. Finally, I should add that Schutz has also written a fine introductory book on differential geometry.

Work:

When it seems like a good moment I will hand out or post a problem set. We will also have some flavor of test(s). You can let me know what is best.

Topics:

- **Special Relativity**: (Schutz Chapters 1-3) the physics of SR, indicies, 4-vectors, some tensors, electrodynamics in 4-vector form
- **Curved Space**: (Schutz Chapters 5-7) tensor algebra, metric, covariant differentiation, Bianchi identities, curvature and physics, curvature and geometry
- **Einstein Equations**: (Schutz Chapter 8) The Theory, linear approximation
- **Black Holes**: (Schutz Chapter 11) Schwarschild solution
- **Cosmology**: (Schutz Chapter 12)
- **Gravitational Waves**: (Schutz Chapter 9)
- **Further Applications?**: Whatever we have time for and find interesting...