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 (“spacetime geometry”) and the associated mathematics (“differential geometry”). After motivating the equations of motion, known as the “Einstein’s equations” or “the field equations”, we will concentrate on applications including the classic tests of GR like the “bending of light,” gravitational lensing, black holes, cosmology, and (the now detected!) gravitational waves.

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Course Info:
The Phys 325 web site is [here](#).

Course Structure:
The course will be in approximately traditional format. We can take advantage of our smallish numbers to have plenty of spontaneous discussion, choose to have presentation if we wish, and determine which topics to focus on.

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:
We will have approximately nine problem sets (due on Thursdays) and some flavor of final which in recent years has been a take-home.

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…