# Physics 717: Gravitation
# Term Paper Topics

Term papers should be about 10 pages, single-spaced, typed. If you want a template, use the template provided on the web page. In addition to excellent content, I expect the term paper to be well written and well organized. **Please read Kip Thorne's notes on writing a scientific paper.** The papers should not be a list of equations. I expect discussion illustrated appropriately by equations and figures. If you want a particular figure, talk to me; I may have an example I can give you. If you have problems or concerns, come talk to me early. The written papers are due on *10 December 2007*. Each person will be expected to make a presentation about their term paper; the dates will be decided later. **Please read Geroch's advice on giving talks before you prepare your talk.**

1. **Black Holes:**
   (a) Examine the structure of charged, spherical black hole solutions and discuss their properties [1]
   (b) Discuss the differences between event horizons, apparent horizons and (not-so) isolated horizons by illustrative examples [2]
   (c) Examine the motion of small particle in the spacetime of a rotating black hole; discuss frame dragging; precession effects [3]
2. **Singularities:**
   (a) Examine the strength of singularities inside black holes, cosmological solutions, and in sample spacetimes with naked singularities [4, 5]
   (b) Investigate the current status of the cosmic censorship hypothesis and illustrate some aspects by studying a particular example [6]
   (c) Investigate self-similar scalar field spacetimes and use them to study sample singularities [7]
3. **Cosmology**
   (a) Investigate current data relating to the acceleration of the Universe; in what mathemetical sense is this like the existence of a cosmological constant? Give sample solutions. [8]
   (b) Investigate cosmological inflation theory, how it works and why it is needed. [9]
4. **Other possible topics**
   (a) Discuss the radiation reaction force on slow motion, weak field sources (the Burke-Thorne potential) [10]
   (b) Examine models for stars in general relativity. Construct a spherically symmetric solution representing a stable star. Construct a model for gravitational collapse of a star [11]

## References

[1] E. Poisson and W. Israel, Phys. Rev. D **41**, 1796 (1990).

[2] Abhay Ashtekar, Badri Krishnan, "Isolated and Dynamical Horizons and Their Applications", Living Rev. Relativity textbf10, 7 (2004) [http://www.livingreviews.org/lrr-2004-10]

[3] S. Chandrasekhar, *Oxford, UK: Clarendon (1992)*

[4] Beverly K. Berger, "Numerical Approaches to Spacetime Singularities", Living Rev. Relativity 5, (2002) [http://www.livingreviews.org/lrr-2002-1]

[5] A. Ori, Phys. Rev. Lett **67**, 789 (1991).

[6] Carsten Gundlach, "Critical Phenomena in Gravitational Collapse", Living Rev. Relativity 2, (1999) [http://www.livingreviews.org/lrr-1999-4]

[7] Patrick R Brady, Phys. Rev. D**51**, 4168 (1995)

[8] R. Bean, S. M. Carroll and M. Trodden, arXiv:astro-ph/0510059.

[9] M. Trodden and S. M. Carroll, "TASI lectures: Introduction to cosmology," arXiv:astro-ph/0401547.

[10] Misner, Thorne and Wheeler, *Gravitation* (1973)

[11] S. Shapiro and S. A. Teukolsky, *Black Holes, White Dwarfs and Neutron Stars: The Physics of Compact Objects*, Wiley (1983).