The Course Outline: General Relativity, Winter 1389 (Winter 2011)

General Relativity (GR) is one of the major revolutions in physics in 20th century. It governs the dynamics of universe on the largest scales. Furthermore, unifying GR with quantum mechanics, another 20th century physics cornerstone, on the smallest possible scales proved extremely challenging. Therefore a proper understanding of GR is necessary not only in astrophysics and cosmology, but also in high energy physics.

This course is devoted to classical general relativity. There are numerous textbooks on this subject, many of them written by leading researchers of this field. In this course we will mainly follow the excellent textbook by Steven Weinberg:

"Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity."

This is an excellent textbook. It emphasizes Equivalence Principle as the logical starting point to incorporate the effects of gravitation so the physical understandings of GR are put ahead of its mathematical formulation. Weinberg introduces the necessary mathematical tools only when they are needed. Perhaps, this is is in contrast to many other textbooks where the mathematical tools are presented from the start.

During the course, we will closely follow Weinberg till the end of Chapter 13. The exception is chapter 9, Post-Newtonian Celestial Mechanics, which may not be covered in this course. Furthermore, we will have additional reviews on Black Hole physics which was not covered by Weinberg. In addition, we will have more up to date review of cosmology than the materials presented in this textbook. If time permits, we may also review some selected topics such as gravity in models of extra dimensions.

As additional references, the following books are recommended:

1- **"Spacetime and Geometry"** by Sean M. Carroll. This is a nice book where the mathematical tools useful for GR are presented in some details. It also has good discussions of black holes which can be useful for this course.

2- **"Gravitation"** by C. W. Misner, K. S. Thorne and J. A. Wheeler. It is an extensive book on GR, describing many of its physical and mathematical aspects. It is not recommended as a standard textbook, but it is a very useful reference for selected topics.

3- **"Gravity: An Introduction to Einstein's General Relativity"** by J. B. Hartle. This is a very nice book with clear physical presentations. Also numerous observational tests and some applications of GR are reviewed. It is perhaps at the level of an advanced undergraduate or a Master course on GR, but nevertheless it is very useful.

During the semester several problems sets will be presented. All students are strongly advised to work out the exercises carefully. Working these exercises are essential for a proper and practical understanding of GR. As a collection of problems with solutions on GR, the following reference is useful:

" Problem Book in Relativity and Gravitation" by A. R. Lightman, W. H. Press, R. H. Price and S. A. Teukolsky.

The course first session starts on Sunday, Bahman 24th, 3 pm.

Contact information

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