Advanced General Relativity and Black Holes PHY 690 M

Instructor: Gautam Sengupta, Office FB 473, Phone: 7139,
e-mail: sengupta@iitk.ac.in,
Website:http://home.iitk.ac.in/~sengupta

Course Objectives : To cover advanced research aspects of General Relativity in a Differential Geometric setting with applications to the study of the space time geometry of black holes. The course is geared towards students intending to continue into a Ph.D thesis on General Relativity, Quantum Gravity or String Theory.

Pre-requisites : Special and General Relativity PHY 407. Exceptional motivation and commitment to understanding the advanced aspects of General Relativity and related issues is required.

Evaluation: A one semester review project with a 30 minutes Seminar and a maximum 10 page (references and title/abstract extra) report with marks 50 + 50.

Report: Should be in standard e-print arXiv paper format single column and references should be in standard format as in arXiv papers (Check a paper from the arXiv). There has to be a brief Abstract and a short Introduction with Sections. Maximum 10 pages (without references and abstract)

Seminar: Will be of strictly 30 minutes duration in standard PDF format. It should be professionally structured and organized (Check Seminar files online). Avoid detailed calculations unless necessary. Highlight the Physics.

Texts and References:

1. Geometry, Topology and Physics by M. Nakahara
2. Space Time and Geometry by Sean Caroll (also Appendix)
3. Gravitation and Cosmology by R M Wald (Appendix)
4. Large Scale Structure of Space Time by S. W. Hawking and G. F. R. Ellis
5. A Relativists Toolkit by Eric Poisson

Consultation or Discussion: Please make appointment by email sengupta@iitk.ac.in. For emergency only call my mobile number given on my website http://home.iitk.ac.in/˜sengupta

Tips: Compulsory attendance of all classes and substantial effort towards a successful execution of the assigned one semester reading project. A well prepared and organized professional level seminar on the project and a well organized report as per specifications mentioned earlier.

Lecture Plan : 42 Lectures

• Mappings, Functions, Vector and Tensor Spaces. Topological and Metric Spaces. (4)

• Differential Geometry: Manifolds, Tangent and Cotangent Spaces, Vectors and Tensors, Differential Forms, Derivatives and Lie Derivatives, Connections, Parallel Transport and Curvature. (8)

• Energy Momentum Tensor,Geodesic Congruences and Energy Conditions, Raychaudhuri Equations for Geodesic Congruences . (6)

• Surfaces, Extrinsic Curvature and Gauss Codazzi Equations (6)

• Lagrangian formulation and Field Equations. (3)

• Black Holes, Kruskal Diagrams and Penrose Diagrams. (3)

• Charged Reissner-Nordstrom Black Holes (6)

•Rotating Kerr and Rotating/Charged Kerr Newman Black Holes. (6)