

Advanced Topics in Astrophysics
Numerical Relativity with Neutrinos I
PHYS 642
Fall 2019

Prerequisites: PHYS 615 – 616

Instructor: Anthony Mezzacappa
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MF: 2:30 – 3:20, Nielsen 306
W: 2:30 – 3:20, Nielsen 306 (makeup classes)

Office Hours: F: 3:30-5:30

Syllabus

- I. Nonrelativistic Kinetic Theory
- II. Mathematical Foundations of General Relativistic Kinetic Theory
- III. General Relativistic Kinetic Theory
- IV. The 3+1 Formulation of General Relativity
- V. The 3+1 Formulation of General Relativistic Kinetic Theory
- VI. The Initial Value Problem in the 3+1 Formulation of General Relativity

Grading

Grading will be based on class participation, homework assignments, and class assignments/presentations.

Primary Sources

Kinetic Theory:

Cercignani and Kremer, *The Relativistic Boltzmann Equations: Theory and Applications*
Liboff, *Kinetic Theory: Classical, Quantum, and Relativistic Descriptions*

Mathematical Foundations:

Frankel, *The Geometry of Physics: An Introduction*
Nash and Sen, *Topology and Geometry for Physicists*
Schutz, *Geometrical Methods of Mathematical Physics*

3+1 Formulation of General Relativity:

Baumgarte and Shapiro, *Numerical Relativity: Solving Einstein's Equations on a Computer*
Gourgoulhon, *3+1 Formalism in General Relativity: Bases of Numerical Relativity*

General Relativistic Kinetic Theory:

Cardall and Mezzacappa, *Conservative formulations of general relativistic kinetic theory*, PRD **68**, 023006 (2003)
Cardall, Endeve, and Mezzacappa, *Conservative 3+1 general relativistic Boltzmann equation*, PRD **88**, 023011 (2013)
Cardall, Endeve, and Mezzacappa, *Conservative 3+1 general relativistic variable Eddington tensor radiation transport equations*, PRD **87**, 103004 (2013)