COURSE ANNOUNCEMENT
Mathematics 5756 (Autumn)
Mathematics 5757 (Spring)

Course Name: Modern Mathematical Methods in Relativity Theory I, II (a.k.a. "Applied Differential Geometry")

Class Number: 10219 or 11884

Time: Autumn 2012: MWF 12:40pm

Credits: 3 per semester

Prerequisites:

Calculus and linear algebra (e.g. Math 568 and/or 501).

A physics course (e.g. Physics 133 or higher).

No prior knowledge of tensor calculus is assumed. However, we do assume a mature attitude towards mathematics and physics.

Audience: Undergraduate and graduate

Goal and Purpose:

a) To assimilate the mathematical chapters of our primary text ("*Gravitation*" by MTW, see references below), thus to develop an appreciation and the modern machinery for the mathematical framework of the laws of physics from the spacetime perspective. The development will focus on

   (1) the underlying differential geometric framework of spacetime, and

   (2) the formulation (arising from classical mechanics, fluid dynamics, and wave mechanics) of its properties.

b) To develop an appreciation as to why and how mathematics is the language of physical science, in particular of those aspects of physics dealing with processes of extreme violence (relativistic hydrodynamics, relativistic laser-matter interaction, high energy density physics, gravitational collapse in flat or curved spacetimes).

Website: `http://www.math.ohio-state.edu/~gerlach/math5756`

DESCRIPTION

Math 5756 (Autumn):

- A rapid course in special relativity: spacetime geometry, event horizons and accelerated frames;
- tensors, metric geometry vs symplectic geometry;
- exterior calculus, Maxwell field equations;
- manifolds, Lie derivatives, and Hamiltonian dynamics in phase space;
- parallel transport, torsion, tensor calculus;
- curvature and Jacobi's equation of geodesic deviation;

- Cartan's two structural equations, metric induced properties, and Cartan-Misner curvature calculus.

Math 5757 (Spring):

- Geodesics: Hamilton-Jacobi theory, the principle of constructive interference;
- stress-energy tensor: hydrodynamics in curved spacetime and Einstein field equations;
- some of their solutions: stars, black holes, gravitational collapse, geometry and dynamics of the universe;
- vector harmonics, tensor harmonics, acoustic and gravitational waves in violent relativistic backgrounds.

Textbooks:

(a) *Gravitation* by C. W. Misner, K. S. Thorne, and J. A. Wheeler.

(b) Selections from *Mathematical Methods of Classical Mechanics* by V. I. Arnold.

(c) Selections from *Lecture Notes on Elementary Topology and Geometry* by I. M. Singer.

(d) Selections from *Spacetime Physics*, 2nd edition, by E. Taylor and J.A. Wheeler

I am glad to answer any questions.
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