Metodi geometrici in teoria della relatività
[Geometrical Methods in the Theory of Relativity]

"Laurea Magistrale in Matematica"

Number of Credits: 6 CFU – **Teaching Hours**: 42 - "**Settore Scientifico Disciplinare**": MAT/03 – **Semester:** 1st

Teacher: Marco Mamone Capria, PhD – Dipartimento di Matematica e Informatica - Phone: 075 585 5006 – E-mail: mamone@dmi.unipg.it

Language: Italian

General Outline
The theory of relativity as an application of the pseudo-Euclidean geometry, of differential geometry and group theory to physics. The treatment pays attention to the historical and critical development of formalism and theories, and to the ways mathematical tools help to clarify conceptual issues.

Detailed program
General outline of the foundations of physics in its historical and critical development. The universe from a topological and geometrical point of view. The principle of relativity in classical physics. Newtonian space-time. The origins of special relativity. Derivations of the Lorentz transformations. Affine pseudo-Euclidean geometry. The Poincaré group and its subgroups. Minkowski space-time. Proper time. Relativistic dynamics. Collisions. Mass-energy equivalence. About the pedagogy of special relativity for high school. Relationship of special relativity and quantum mechanics. Relativistic electromagnetism. An outline of standard cosmological relativity.

Aims
The main objectives of the course are:
1) a rigorous understanding of spatial relativity, as compared to classical physics and to some aspects of quantum mechanics and general relativity;
2) getting acquainted with the notion of space-time, including a working knowledge of space-time diagrams, both for their importance in physics and as a valuable example of applied 4-dimensional geometry;
3) an introduction to the historical issues concerning such momentous changes in the foundations of physics as that occurred with the relativity revolution.
The course is also suitable for would-be high-school mathematics and physics teachers.

References
R. D'Inverno, Introducing Einstein's Relativity, Cambridge University Press, 1992
M. Mamone Capria (a cura di), Physics Before and After Einstein, IOS, 2005.
A. Sudbery, Quantum Mechanics and the Particles of Nature: An Outline for Mathematicians, Cambridge University Press, 1986.
Lecture notes by the teacher.

Background
Basic concepts of linear algebra and multivariate calculus. Elements of classical physics.

Teaching methods

Classes -- Office hours -- Lecture notes.

Other information
Please check the office hours at the web-site http://www.dmi.unipg.it/mamone/, or just contact the teacher to arrange a meeting.

Examination
Oral examination (in any language previously agreed upon with the teacher), including some simple written problems. The examination starts with an in-depth treatment on a topic chosen by the student, followed by a number of questions on the rest of the program.