GRADUATE COURSES Fall 2015

Institut Henri Poincaré
11, rue Pierre et Marie Curie, Paris

COURSE : On The Mathematical Theory of Black Holes

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Abstract. The lectures will focus on some of the key issues of mathematical theory of black holes, i.e. rigidity, stability and collapse. The first two issues can be neatly summarized by two well known conjectures. The rigidity conjecture identifies the class of stationary, asymptotically flat solutions to the Einstein vacuum equations (or more general field equations) as the explicit Kerr family. The second asserts that these solutions must be stable under general dynamical perturbations. Though both rigidity and stability are taken for granted in modern astrophysics, they remain far from settled even at a heuristic level, not to speak of rigorous mathematical proofs. The third issue deals with the question of how black holes can form in the first place from regular initial conditions is intimately tied to the concept of trapped surfaces. In the lectures I plan to review the present state of understanding regarding these problems.

COURSE : An Introduction to Self-Gravitating Matter

Philippe LeFloch
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Abstract. This course offers an introduction to some aspects of the dynamics of compressible fluids and other matter models, as described by the (non-vacuum) Einstein equations of general relativity. On one hand, I will define and study a class of weakly regular spacetimes and solve the initial value problem for the Einstein-Euler equations, when the initial data set admits two Killing fields and has solely weak regularity. This theory allows for shock waves in the fluid and impulsive gravitational waves and, under the assumed symmetry, the causal geometry of the spacetime can be analyzed (geodesic completeness, crushing singularity property, formation of trapped surfaces). On the other hand, I will present the theory of massive scalar fields and establish that Minkowski spacetime is nonlinearly stable in presence of a massive field, provided the latter has sufficiently small mass. I will formulate the initial value problem for the Einstein-massive field system, when the initial slice is a small perturbation of an asymptotically flat, spacelike hypersurface in Minkowski space. This perturbation is then proven to disperse in future timelike directions, so that the Cauchy development of this (non-vacuum) spacetime is future geodesically complete.

These courses are part of the **Trimester Program "Mathematical general relativity"** *taking place at the* **Institut Henri Poincaré** *in order to celebrate the 100th anniversary of general relativity.*

See `http://philippelefloch.org` *for further informations.*

Schedule.

COURSE by S. Klainerman : 2pm-4 :30pm on Tuesdays, starting on October 13

COURSE by P. LeFloch : 2pm-4 :30pm on Fridays, starting on October 9

FINAL EXAMS during the week of December 14