Columbia University
Department of Mathematics

2990 Broadway at 117th St
New York, NY 10027

2016 SPRING TERM LECTURE SERIES

Sergiu Klainerman

(Columbia University and Princeton University)

"INTRODUCTION TO THE MATHEMATICAL THEORY OF BLACK HOLES"

This is meant to be an introduction to the beautiful mathematical theory of Black Holes. The audience is expected to have some familiarity with the basic concepts in Riemannian Geometry and the basic properties of differential equations, such as the local existence result for ODE's and the elementary properties of the standard Laplace, Heat and Wave equations (as exposed, for example, in the PDE books of F. John and C. Evans).

1. What is a Black Hole ? I will give a succinct presentation of the basic features of the Kerr family of black holes as explicit, stationary solutions of the Einstein Vacuum Equations (EVE) and define the general concept of a black hole. We will explain, of course, the meaning of all the above mentioned words.
2. Basic tools in the theory of nonlinear wave equations. Modulo diffeomorphisms the Einstein equations are hyperbolic, in fact they can be expressed as a system of quasilinear wave equations. It thus make sense to discuss the basic tools in the study of nonlinear wave equations: energy, Morawetz and dispersive estimates as well as various strategies to apply them to nonlinear equations. We shall also discuss the vectorfield method and the null condition and apply them to simple model problems.
3. Basic problems in the mathematical theory of Black Holes. Will discuss the problems of rigidity, stability and formation of Black Holes and the most important known results.
4. Recent results on the rigidity problems
5. Recent results on the problem of stability
6. Results on the formation of Black Holes

Room Math 507, Wednesdays 2:40 PM - 4:00 PM
Starting date: Wednesday, February 3, 2016