PROGRAM FOR COURSE: BLACK HOLES IN GENERAL RELATIVITY AND BEYOND

LECTURER: DIEGO RUBIERA-GARCIA

LESSON 1 (Thursday, April 14th, 10-12 am): BASIC CONCEPTS FOR BLACK HOLES

Metric; connection; Christoffel symbols; curvature; Einstein equations and variational principle; event horizons; trapped surfaces; spherically symmetric vacuum space-times.

LESSON 2 (Friday, April 15th, 10-12 am): THE CLASSICAL THREESOME OF BLACK HOLES

Schwarzschild black hole; Birkhoff's theorem; properties of Schwarzschild metric; interior solutions and Oppenheimer-Volkoff equation; Reissner-Nordström black holes; properties of Reissner-Nordström metric; static axisymmetric space-times; Kerr black holes; properties of Kerr metric.

LESSON 3 (Monday, April 18th, 10-12 am): SPACE-TIME SINGULARITIES

Understanding space-time singularities; curvature divergences; geodesic completeness; global hyperbolicity; Raychaudhuri equation and focusing of geodesics; energy conditions; Penrose singularity theorem; congruence of geodesics; strong and weak singularities.

LESSON 4 (Tuesday, April 19th, 10-12 am): EXOTIC BLACK HOLES

Black holes supported by non-linear electromagnetic fields; Born-Infeld black holes; horizon and singularity structure; wormholes; exotic energy-matter sources.

LESSON 5 (Thursday, April 21th, 10-12 am): BLACK HOLES BEYOND GENERAL RELATIVITY

f(R) theories; Gauss-Bonnet and Lovelock gravities; metric-affine formulation; resolving black hole singularities?.

Not included in this course: gravitational collapse; astrophysical properties; thermodynamics.