Advanced GR and QFT in Curved Spacetimes
Syllabus 2018

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Lectures (Room 135, MB SISSA):
Lecture hours: 11:30-13:00 with exceptions. Check schedule APP

Advanced GR and QFT in curved spacetimes:

This is a second term course of the SISSA curriculum in astroparticle physics. The course will consist of 14 lectures of 1h30' hours each. The aim of the course is to provide advanced knowledge in and introduce students to QFT in curved spacetimes topics.

Textbooks (incomplete list):

Advanced GR:

"General Relativity", R.M. Wald,
"Spacetime and Geometry", S.Carrol
"A relativist toolkit", E. Poisson
"Gravitation", T. Padmanabhan

QFT in curved spacetime:

"Quantum fields in curved space", N.C. Birrell & P.C.W. Davies
"Vacuum effects in strong fields", A.A. Grib, S.G. Mamayev, V.M. Mostepanenko
"Introduction to quantum effects in Gravity", V.F. Mukhanov and S. Winitzki

Warning: I normally use material from papers and lecture notes available from the arXiv. When necessary I'll tell you where to find this extra material (or in case do not hesitate to ask).

Exam: There will be one final exam (dates to be fixed), which will take the form of a black board short lecture on a subject of the course chosen by the student and approved by the instructor.

Extra Help: If you need help, get it as soon as possible. I will be available before/after each lecture, or in my office (SISSA room 507, fifth floor MB) during office hours or at any other time by appointment (just email me in advance).

Tentative Plan of the Course

Lectures	Subject
Advanced GR	
I	• Foundations, axiomatic derivation of Local Lorentz invariance, EP
II	• Manifolds, Curvature, Intrinsic vs Extrinsic curvature
III	• Lie Derivative, Killing vectors
IV	• Geodesic deviation eq., Raychauduri eq., • En. Conditions
V	• Lagrangian Formulation and Action principle for GR (metric+Palatini)
VI	• Alternative Gravitation theories
VII	• Global methods – Carter Penrose diagrams - BH theory: singularities and event horizons.
VIII	• Killing Horizons, Surface Gravity definition, Cauchy Horizons, Cosmological Horizons
IX	• Trapped Surfaces, Trapping Horizons, • Singularity theorems
X	• Kerr BH and the Penrose process
XI	• From BH mechanics to BH Thermodynamics
QFT in Curved Spacetime	
XII	• QFT in CS intro
XIII	• Casimir Effect, Unruh effect
XIV	• Moving Mirrors and Hawking radiation
XV	• Hawking radiation: Info and Transplanckian problems
XVI	• Semiclassical gravity, RSET
XVII	• Semiclassical collapse & BH Entropy interpretations
XVIII	• Wormholes, Warp Drives and Time Machines