Curricular Unit

Advanced Physics Topics 1

Module

Black Holes (BH)

Type

Lecture course

Contact hours

18

Professor/Researcher in charge

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Summary of Contents

Black holes are thought to play a central role in various astrophysical processes. Moreover, over the last three decades, the study of black hole solutions, their classical and quantum properties and their interactions, has become an increasingly central topic in high energy physics and mathematical/physics models.

This is an introductory course on black hole physics covering the Schwarzschid, Reissner-Nordstrom and Kerr black holes, their physical and mathematical properties. The course assumes basic knowledge of General Relativity and will end with an overview of current research directions in black hole physics.

Course synopsis:

1 - Revision
1.1 Some facts about Newtonian gravity
1.2 Some facts about General Relativity

2 – Schwarzschild black holes
2.1 Derivation of the solution
2.2 Properties of the solution
2.2.1 Geometrical properties
2.2.2 Classical test motions
2.2.3 Black holes and white holes

3 - Reissner-Nordstrom-(Anti)-De-Sitter black holes
3.1 Derivation of the solution
3.2 Properties of the solution
3.2.1 Geometrical properties
3.2.2 Charged geodesics and the Majumdar-Papapetrou solution
3.3 Carter Penrose diagrams

4 - Kerr black holes
4.1 Motivation and presentation of the solution in various coordinate systems
4.2 Geometrical properties
4.3 Ergo-sphere, ergo-region and physical consequences

5 - A summary of important results in black hole physics
5.1 Uniqueness (and no-hair) theorems
5.2 Laws of black hole theormodynamics

6 - Overview of current research directions in black hole physics
6.1 Astrophysics
6.2 High energy physics
6.3 Mathematical physics

Evaluation

- Oral presentation of a research paper
- Take home written exam

Juri

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