Sujet de stage de Master 1

Service de *Physique de l'Univers, Champs et Gravitation*

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Charged black holes, extremality and near-horizon throats (I. Basile)

Black holes are among the most fascinating objects that we know about in the universe. They embody deep connections between gravity, thermodynamics, quantum mechanics and information theory, and they have been a cornerstone of theoretical research since their discovery. The simplest type of black hole, dating back to Schwarzschild, already features many interesting phenomena, while in our universe we mostly expect quasi-neutral rotating Kerr black holes. From a theoretical point of view, electrically charged black holes are often very interesting, albeit not particularly realistic. We will explore them in detail, deriving the corresponding spacetime geometry and electromagnetic field configuration along with their effect on probe charges. Then we will investigate one of the most peculiar features of these black holes: the extremal limit, where the charge is largest. Extremal black holes exhibit intriguing characteristics, including a peculiar geometry in the vicinity of the event horizon, and they remarkably allow a simple construction of multi-black hole solutions due to the absence of mutual forces. If time permits, we could explore the basics of black-hole entropy and thermodynamics.

The aim of this internship is:

- To acquire familiarity with widespread and active areas of research in modern high-energy theoretical physics;
- To acquire technical fluidity and intuition in (pseudo-)Riemannian geometry, connecting exotic objects to more mundane ideas about charge and mass.

Prerequisites: concepts acquired in General Relativity (MAB1) and Electrodynamics.

Charged black holes are treated in many standard books on General Relativity. In addition to these, I can recommend:

[1] Lecture notes in General Relativity by David Tong,
https://www.damtp.cam.ac.uk/user/tong/gr.html.
[2] Lecture notes in General Relativity by Matthias Blau,
http://www.blau.itp.unibe.ch/newlecturesGR.pdf.