Sujet de stage de Master 1

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

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The BTZ black hole (A. Campoleoni)

Certain properties of general relativity depend on the number of space-time dimensions. In particular, in three space-time dimensions all solutions of Einstein's equations have constant curvature. This implies, e.g., that if the cosmological constant vanishes all solutions correspond *locally* to Minkowski space. In spite of this, in 1992 Banados, Teitelboim and Zanelli (BTZ) found, surprisingly, a black hole solution in three-dimensional gravity with a negative cosmological constant. How is this possible? The key is that the BTZ black hole differs from Anti de Sitter space - which is the analogue of Minkowski space in the presence of a negative cosmological constant - only in its *global* properties. Still, it displays an event horizon and it shortly became a privileged theoretical laboratory for studying of the key properties of black holes in a simplified context.

The goals of this internship are:

- Apply the concepts acquired during the course of General Relativity (MAB1) in a context at the forefront of current research in theoretical physics;
- Rederive the BTZ solution, understand its global properties and, if time will allow it, understand how the BTZ black hole can be considered as a thermal object with non-vanishing entropy.

Prerequisites: course of General Relativity (MAB1).

References that will be used:

[1] M. Banados, C. Teitelboim and J. Zanelli, *The Black hole in three-dimensional space-time*, Phys. Rev. Lett. 69 (1992), 1849-1851 [arXiv:hep-th/9204099].

[2] M. Banados, M. Henneaux, C. Teitelboim and J. Zanelli, *Geometry of the (2+1) black hole*, Phys. Rev. D 48 (1993), 1506-1525 [erratum: Phys. Rev. D 88 (2013), 069902] [arXiv:gr-qc/9302012].

[3] S. Carlip and C. Teitelboim, *Aspects of black hole quantum mechanics and thermodynamics in (2+1)-dimensions*, Phys. Rev. D 51 (1995), 622-631 [arXiv:gr-qc/9405070].