Sujet de stage de Master 1

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

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<u>Petrov's classification and selected solutions of Einstein's equations</u>
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Outside of any compact object, Einstein's equations set the Ricci tensor, that is the trace of the Riemann tensor, to zero. Therefore, different solutions are characterised by different Weyl tensors, corresponding to the traceless projection of the Riemann curvature tensor.
All possible Weyl tensors, and thus all possible gravitational fields, can be classified on the basis of a set of algebraic properties, and thus in a way that does not depend on any particular coordinate system. This is Petrov's classification, that splits all possible gravitational fields in vacuum in six classes.
Gravitational fields belonging to different Petrov's classes have very different properties and interpretations and each class already contains a variegated spectrum of solutions. After having understood the bases of Petrov's classification, the internship will proceed with the study of the Taub-NUT solution, which fits within the same class as the Schwarzschild one but display several peculiarities, and of the Robinson-Trautman one, which exemplify the properties of another Petrov class.

The goals of this internship are:

- Apply the concepts acquired during the course of General Relativity (MAB1) in a wider context.
- Familiarise with more refined formulations of General that are used in the modern research on the subject.

Prerequisites: course of General Relativity (MAB1).

References that will be used:

[1] J. B. Griffiths and J. Podolsky, Exact Space-Times in Einstein's General Relativity, Cambridge University Press (2010).

[2] H. Stephani, D. Kramer, M. Maccallum, C. Hoenselaers, E. Herlt, Exact Solutions of Einstein's Field Equations, Cambridge University Press (2003).