

# **PhD research proposal**

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**Research theme : Modification of gravity: Black hole and star solutions and their phenomenology**

**Theme : Black holes and stars in modified gravity**

General Relativity is a very successful and well-tested theory able to account for most of the observed gravitational phenomena as well as for various experimental and observational tests of gravity. However, General Relativity (GR) cannot be the final/full theory of gravity. It is an effective theory, valid at certain energy/distance scales. Indeed at high energies spacetime is highly curved and thus GR must be modified in the ultraviolet to a quantum theory of gravity. Furthermore, recent observational data point towards the tantalizing possibility that GR may even be modified at very large distances or very low energy (infrared) scales. Finally, forthcoming experiments and recent observations like gravity waves will put tight constraints on deviations from GR but will also point towards novel phenomena and puzzles. The scientific theme of this PhD proposal is to study modifications of gravity on the classical level and at different scales, ranging from black holes to cosmology. The study will include general scalar tensor models and Lorentz breaking theories, such as Horava gravity. The former are a generic modification of GR at low energies since most gravity theories-massive gravity, higher dimensional gravity, bigravity etc-acquire a scalar-tensor limit. The latter, Horava gravity, seeks to modify GR at high energies by assuming breaking of Lorentz invariance at very high energies. In our recent research a novel approach to construct black hole and star solutions has been proposed, which consistently takes into account the cosmological evolution of the scalar degree of freedom. The aim of the thesis will be to pursue these ideas further in both weak and strong gravity regimes: to include matter solutions in this approach, study stability of stars and black holes, investigate cosmological evolution and observational consequences as compared to GR.