Einstein Telescope @ IJCLab
Black Holes in Modified Gravity: Astonishing aspects

Based on the recent paper:

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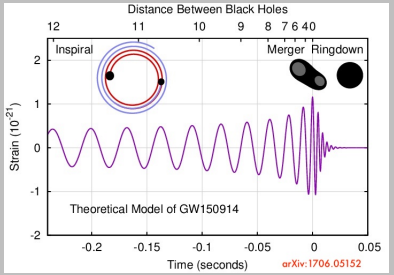
Christos Charmousis, Simon Iteanu, David Langlois, Karim Noui

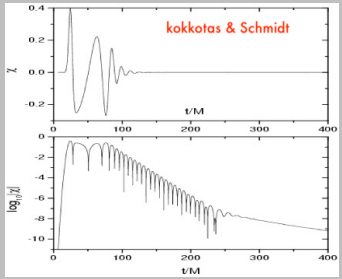
Black Holes in General Relativity

No Hair Theorem : Stationary Black Holes (under few assumptions) are caracterised by their mass M, their spin J (and their charge Q)

It makes BH simple objects but extremely subtle... and puzzling (information loss) !

From the point of view of Gravitational Waves : inspiral vs. ringdown



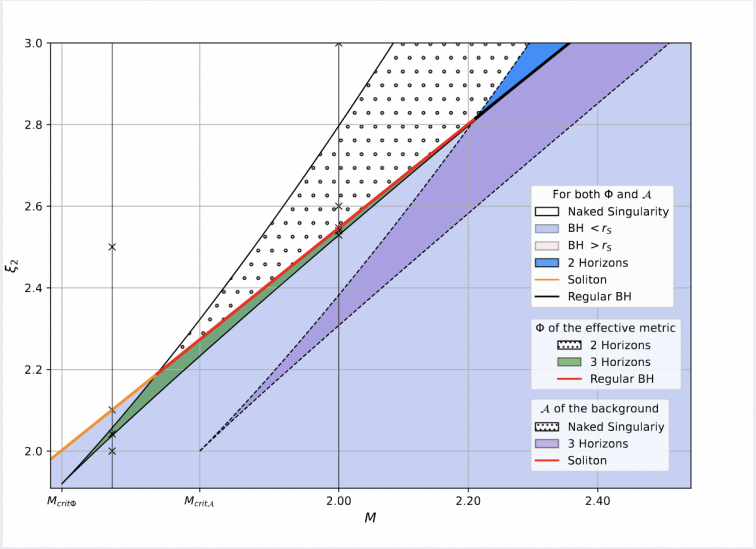


Intriguing features of compact objects in Modified Gravity

- Black Holes can become hairy : they are surrounded by scalar hairs
- Solitons : Like Stars with no horizons
- Regular Black Holes : no singularity inside the black hole
- Naked Singularity : a singularity not hidden by a horizon

Few results : Classification of solutions in a specific class of modified theories of gravity
Questions : Do these solutions exist ? Could they be stable ?
One road to the answer : Study their perturbations and then the emitted GW...

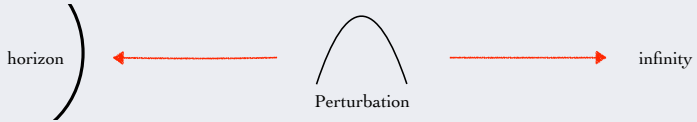
“Phase diagram” of compact objects



Perturbating Disformed Black Holes : Astonishing aspects

Perturbations in GR in a nutshell : Two (GW) modes whose dynamics is goverrned by a Schrodinger-like equation of the form : $-\psi''(r) + [V(r) - \omega^2]\psi(r) = 0$

Boundary conditions : the wave falls (in-going) into the BH's horizon and escape (out-going) at spatial infinity $\Longrightarrow$ Quasi-Normal Modes Spectrum

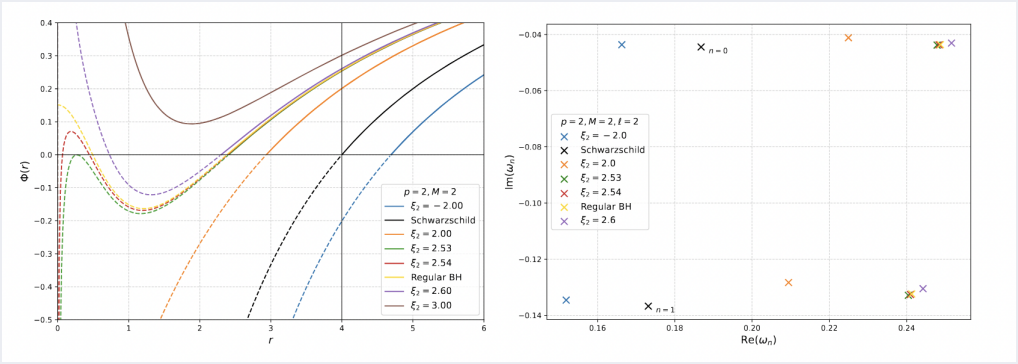


Perturbations in Modified gravity (still in a nutshell) :

GW and photon might not see the same horizon : they might not experience the same Black Hole ! Even the two modes might see two different horizons !

$\Longrightarrow$ There is a new physics to be understood !

Axial Spectrum of few compact objects



What next ?

Physical Consequences of different horizons for different species :

- Energy extraction or super-radiance ?
- Unstability of the BH solution ?
- Specific features of the BH Spectrum ?