Scalar perturbations and quasinormal modes of hairy black holes

OBJECTIVES

- Investigating the scalar perturbations of GD hairy black hole.
- Comparing the spectrum of scalar perturbations of GD hairy black holes to the well-known results of the Schwarzschild black hole, looking for possible preliminary signatures of GD hairy black holes.

ABSTRACT

The behavior of hairy black hole solutions, obtained by the gravitational decoupling (GD) method, is investigated under scalar perturbations. The numerically generated wave solutions are derived for a range of values for the GD hairy black hole parameters, with higher-frequency modes very sensitive to them. The results are confronted with the corresponding ones for the Schwarzschild solution, whose deviations from it demonstrate a unique physical identification of GD hairy black holes.

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METHODS

As the exact solution of the quasinormal modes is not easy to obtain analytically, we applied approximation methods to derive them. Therefore, we applied the third-order WKB approximation and the Mashhoon method to compute the quasinormal frequencies.

IMPORTANT RESULT

• GD hairy black holes do have a unique signature, regarding the quasinormal modes, encoded in the GD parameter α .

RESULTS

We solved numerically the equation that describes a scalar perturbation. The results are shown below, where the absolute value of the wave function was numerically found.



Figure 1: Absolute values of the wave profile Ψ_1 as a numerical solution, as a function of the light-cone coordinate v, for several values of GD parameter α . The plot on the right side has logarithm scale.

CONCLUSIONS

- The GD parameter α governing GD hairy black holes decreases the damping rate of the modes, irrespectively the value of ℓ is. It yields a GD hairy black hole that behaves as a better oscillator, when compared to the Schwarzschild standard case.
- It was noticeable that despite the significant deviation of the frequencies of the quasinormal modes for increasing α , the wave deviation from the Schwarzschild case is relatively small, although it indicates a signature of GD hairy solutions.

ACKNOWLEDGEMENTS

This work is funded by the Coordination of Superior Level Staff Improvement (CAPES).