Spontaneously Scalarized Kerr Black Holes in Extended Scalar-Tensor–Gauss-Bonnet Gravity

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Black holes are mysterious spacetime regions that populate the Universe. In Einstein's general relativity they are described by a canonical solution of the vacuum field equations found by Roy Kerr in 1963 and known as the "Kerr black hole". This black hole model is completely specified by the black hole mass and angular momentum (spin).

Although theoretically supported, the claim that astrophysical black holes abide by this canonical model is an hypothesis in need of observational confirmation.

The first image of a black hole released in 2019 by the Event Horizon Telescope collaboration provides new observational data to test the Kerr hypothesis. Einstein's general relativity, and the Kerr model are consistent with the data. But, within the present accuracy, how much can these data distinguish alternative black hole models that may be, theoretically, also viable?

In this letter the authors show how a spin selection effect may mask non-Kerrness. In a class of alternative models, which are dynamically viable, only small spin black holes deviate significantly from the canonical model, whereas high spin black holes are observationally indistinguishable, or exactly equal, to the Kerr model. This yields a novel and concrete realization of a richer landscape of black holes which may exhibit different properties only for certain ranges of mass or spin.

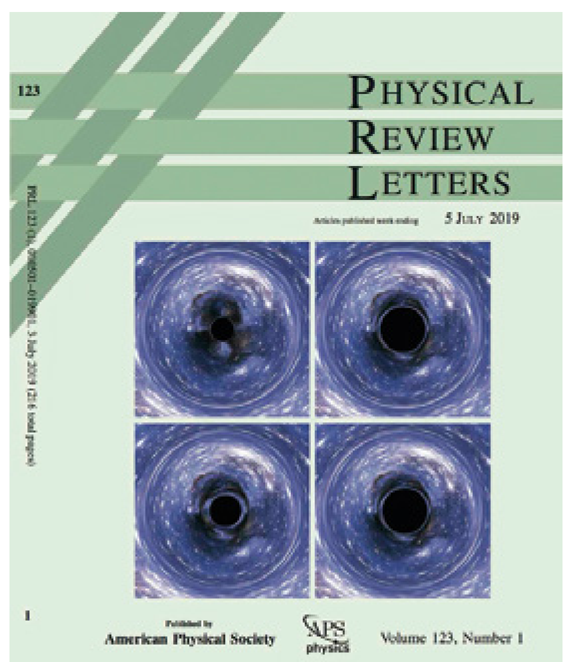

FIGURE 1
The figure, selected to feature on the cover of the journal issue wherein the paper was published, exhibts a comparison between the lensing properties of the canonical Kerr black hole (right columns) and the alternative model (left columns). The centre of each panel features the black hole "shadow", surrounded by a lensed sky. The top columns are for non-spinning black holes and the difference in the shadow size is notorious. The bottom columns are for slowly spinning black holes and the difference starts to become less noticeable.