Leading higher-derivative corrections to Kerr geometry

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Abstract

We compute the most general leading-order correction to Kerr solution when the Einstein-Hilbert action is supplemented with higher-derivative terms, including the possibility of dynamical couplings controlled by scalars. The model we present depends on five parameters and it contains, as particular cases, Einstein-dilaton-Gauss-Bonnet gravity, dynamical Chern-Simons gravity and the effective action coming from Heterotic Superstring theory. By solving the corrected field equations, we find the modified Kerr metric that describes rotating black holes in these theories. We express the solution as a series in the spin parameter χ, and we show that including enough terms in the expansion we are able to describe black holes with large spin (we use an expansion up to order χ^{14}, which is accurate for $\chi < 0.7$). We study several properties of the corrected black holes, such as geometry of the horizon and the ergosphere, surface gravity, light rings and scalar hair. Some of the corrections violate parity, and we show in those cases plots of horizons and ergospheres without $\mathbb{Z}_2$ symmetry.

References

[1] P. A. Cano and A. Ruiprez, arXiv:1901.01315 [gr-qc].