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Scalar perturbations of Kerr black-holes in hybrid metric-Palatini gravity

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It is shown that the Kerr solution exists in the generalized hybrid metric-Palatini gravity theory and that for certain choices of the function $f(R,\mathcal{R})$ that characterizes the theory, the Kerr solution can be stable against perturbations on the scalar degree of freedom of the theory. We start by verifying which are the most general conditions on the function $f(R,\mathcal{R})$ that allow for the general relativistic Kerr solution be also a solution of this theory. We perform a scalar perturbation in the trace of the metric tensor, which in turn imposes a perturbation in both the Ricci and Palatini scalar curvatures. To first order in the perturbation, the equations of motion, namely the field equations and the equation that relates the Ricci and the Palatini curvature scalars, can be rewritten in terms of a 4th order wave equation for the perturbation δR which can be factorized into two 2nd order massive wave equations for the same variable. The usual ansatz and separation methods are applied and stability bounds on the effective mass of the Ricci scalar perturbation are obtained. These stability regimes are studied case by case and specific forms of the function $f(R,\mathcal{R})$ that allow for a stable Kerr solution to exist within the perturbation regime studied are obtained.

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