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Perturbations of spinning black holes beyond General Relativity using Modified Teukolsky formalism

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Black hole (BH) perturbation theory is crucial in computing the quasinormal modes (QNMs) emitted by general binary BH merges and the gravitational waves (GWs) of extreme-mass-ratio-inspirals (EMRIs). These GWs carry essential information about the geometry around BHs and any potential deviations from General Relativity (GR). In recent years, there have been extensive studies of perturbations of BHs in modified gravity, but only for non-rotating or slowly rotating BHs. Building on the Teukolsky formalism in GR, I will present a new formalism developed in arXiv:2206.10652 to study perturbations of BHs with arbitrary spin in modified gravity. I will first prescribe how to derive the modified Teukolsky equation following an effective field theory description of gravity theories beyond GR. I will then discuss the connection between this formalism in beyond-GR theories to the nonlinear Teukolsky formalism in GR, the latter of which has been applied extensively to study radiation reaction and self-force. More specifically, I will discuss how these pre-developed techniques, such as metric reconstruction, in the study of radiation reaction in GR can be applied to studying BH perturbations in modified gravity. At the end of my talk, I will show how one may use this formalism to compute QNMs and study EMRIs in some specific modified gravity theories.

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