A new perspective on gravitational perturbations of spherically symmetric spacetimes

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The key result of Schwarzschild black hole perturbation theory is that at linear level the general perturbation can be given in terms of only two (axial/polar) master scalars satisfying scalar wave equation on the Schwarzschild background [1] with Regge-Wheeler [2] and Zerilli [3] potentials for axial and polar sectors respectively (more precisely, this holds for any multipole $\ell \geq 2$; the monopole $\ell = 0$ and dipole $\ell = 1$ cases need some special treatment). This remarkable result is usually obtained by tedious manipulations with linearized Einstein equations (cf. [3]). I will show that this classical result can be easily obtained starting with the *ansatz* that all gauge invariant characteritics of perurbations (for a given $\ell > 1$ multipole) are given in terms of master scalar and its derivatives, where the master scalar satisfies a scalar wave equation (with a potential) on the background solution. This new perspective can be easily extended beyond linear approximation [4] where it was used to provide the evidence for the existence of globally regular, asymptotically-AdS, time-periodic solutions of Einstein equations [5]. It can be also easily generalised to include matter, either in the form of some fundamental fields [6] (studied in the AdS/CFT context) or effective perfect fluid approximation (for example in the context of cosmological perturbations [7]).

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