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Darboux covariance: a hidden symmetry of perturbed Schwarzschild Black Holes

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Perturbation theory of vacuum spherically-symmetric spacetimes is a crucial
tool to understand the dynamics of black hole perturbations. In spherical symmetry the equations for the perturbations can be decoupled in terms of (gauge-invariant) master functions that satisfy 1+1 wave equations. By working in a completely general perturbative gauge, we determine and characterize the full space of master equations describing the dynamics of vacuum spherically-symmetric spacetimes. The outcome of the study is that for each parity we have two branches of solutions with similar features. One of the branches includes the known results: In the odd-parity case, the most general master function is an arbitrary linear combination of the Regge-Wheeler and the Cunningham-Price-Moncrief master functions whereas in the even-parity case it is an arbitrary linear combination of the Zerilli master function and another master function that is new to our knowledge. The other branch is very different since it includes an infinite collection of potentials which in turn lead to an independent collection master of functions. In the case of perturbed Schwarzschild black holes, all these master equations are shown to be connected via Darboux transformations thus revealing the presence of a hidden symmetry, Darboux covariance, which preserves the spectrum of quasinormal modes and the continuous spectrum associated with black hole scattering processes. This picture is further shown to share a deep connection with the Korteweg-de Vries equation and inverse scattering methods which leads to an infinite hierarchy of conserved quantities.

Which topic best fits your talk?

GW Theory and Fundamental Physics

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