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Clines and the analytic structure of black hole perturbations

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We revisit black hole perturbations through Heun differential equations, focusing on Frobenius power-series solutions near regular singularities and their connection formulas. Central to our approach is the notion of a cline in the complex plane, which organizes singular points of the differential equations and remain invariant under Möbius transformations. Building on the cline structure we identified in black hole horizons, we carry out a systematic reduction and relocation of poles in the differential equation to obtain explicit representations of the solutions. We illustrate our approach by extracting the scalar perturbation solutions for the 7-dimensional Myers-Perry black hole and deriving the static scalar tidal Love numbers. These results suggest that clines expose a Möbius-invariant order within black hole perturbations, rendering black hole perturbation problems remarkably tractable.

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