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From the interior to the exterior of a nonrotating black hole: extension of a vacuum state.

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Black holes provide a natural arena to probe quantum effects in strong gravity, yet there remain many open questions about their interiors. We study a scalar field inside a nonrotating black hole and show how interior vacua can be extended to the exterior. As an example, we analyze a non-oscillating vacuum obtained by asymptotic Hamiltonian-diagonalization. The extended vacuum state reproduces the expected large-distance decay of fields in flat or asymptotically flat spacetimes, provided infrared modes are controlled. These results represent a first step toward potential applications to black hole perturbations and the study of quasinormal modes in the light of proper quantum field theory.

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