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Black holes as probes of ultralight dark matter

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We consider the phenomenological nightmare scenario where dark matter is only coupled gravitationally, thinking of black holes as probes. We choose to focus on wave dark matter because an oscillating massive scalar endows a black hole with hair, whose profile we study by taking a fully analytic approach. We describe the field profile for a wide range of parameters, including rotating dark matter.

We then include the self-gravity of the scalar, focusing on the case where dark matter forms a soliton in the center of the galaxy. We discuss the consequences of imposing causal boundary conditions at the horizon, which are usually neglected.

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