

# Gravitational-wave ringdown echoes from black holes in massive gravity

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LIGO's detection of the black hole quasinormal modes has proved the existence of the light rings outside the event horizon. Other sub-dominant long-lived modes depend on the existence and properties of the horizon, as well as the black hole hairs outside. These modes may reveal themselves in future gravitational-wave detectors as echoes. In this work, we study the ringdown of a de Sitter-Schwarzschild black hole in the dGRT theory of massive gravity. We find interesting signatures of ringdown echoes as we turn on the coupling between spacetime perturbations and the background vector field outside the black hole.

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