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Harvesting Mutual Information Behind a Black Hole Horizon

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The effect of black holes on entanglement harvesting–the process of extracting entanglement from the quantum vacuum–has been of considerable interest over the past decade. Research involving stationary Unruh-DeWitt (UDW) detectors in a (2+1)-dimensional black hole spacetime (the BTZ black hole) has uncovered phenomena such as entanglement shadows, entanglement amplification through black hole rotation, and differences between bipartite and tripartite entanglement. For a (1+1)-dimensional Schwarzschild black hole, two UDW detectors could harvest entanglement from the scalar quantum vacuum even when separated by an event horizon. The dynamical problem of harvesting entanglement as detectors cross the event horizon is substantially more difficult. To this end, we calculate the mutual information between two UDW detectors coupled to a massless quantum scalar field, with the detectors starting at rest and falling radially into a non-rotating (2+1)-dimensional BTZ black hole. The trajectory of the detectors includes regions where both detectors are switched on outside of the horizon; where one detector is switched on inside of the horizon while the other switches on outside; and where both detectors switch on inside of the horizon. We investigate different black hole masses, detector energy gaps, widths and temporal separations of the detector switching functions, and field boundary conditions. This study is the first to examine correlation harvesting across an event horizon for a black hole spacetime that satisfies Einstein's equations.

Keyword-1

mutual information

Keyword-2

black holes

Keyword-3

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