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Entanglement entropy in quantum black holes

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We discuss the entanglement entropy for a massive Klein-Gordon field in two Schwarzschild-like quantum black hole spacetimes, also including a nonminimal coupling term with the background scalar curvature. To compute the entanglement entropy, we start from the standard spherical shell discretisation procedure, tracing over the degrees of freedom residing inside an imaginary surface. We estimate the free parameters for such quantum metrics through a simple physical argument based on Heisenberg uncertainty principle, along with alternative proposals as asymptotic safety, trace anomaly, and graviton corpuscular scaling. Our findings reveal a significant decrease in entropy compared to the area law near the origin for the quantum metrics. In both scenarios, the entanglement entropy converges to the expected area law sufficiently far from the origin. We then compare these results to the entropy scaling in regular Hayward and corrected-Hayward spacetimes to highlight the main differences with such regular approaches.

Primary authors: BELFIGLIO, Alessio (Università di Camerino); LUONGO, Orlando (University of Camerino, Physics Division); MANCINI, Stefano (University of Camerino, Physics Division); TOMASI, sebastiano (università degli studi di camerino)

Presenter: TOMASI, sebastiano (università degli studi di camerino)

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