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Entanglement entropy area law in dynamical and quantum-corrected black holes

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Entanglement entropy in dynamical and quantum-corrected black hole spacetimes offers a key diagnostic of quantum correlations across horizons, motivating studies of its scaling and time evolution near these critical surfaces. We investigate the entanglement entropy scaling with the horizon area in two settings. In the first analysis, we consider a massive scalar field with nonminimal curvature coupling in Schwarzschild-like quantum-corrected metrics, employing a spherical-shell discretization and parameter estimation anchored in uncertainty-principle constraints and quantum-gravity models. We find entropy suppression near the regularized singularity and the asymptotic restoration of the area law. In the second study, we discretize a massless scalar field on a time-dependent Oppenheimer–Snyder collapse background. We observe nontrivial time-dependent deviations from the canonical area law as the collapse goes on. Together, these results elucidate the interplay between dynamical evolution, UV regularization, and horizon entanglement.

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