

From UV to IR, tracking information loss in open quantum systems

The unification of quantum information science and high energy physics has created a new experimental frontier, where understanding environmental decoherence is a critical challenge. We present a novel framework that, for the first time, formulates the problem of calculating decoherence of spin-spin correlation from final state radiation as a systematically improvable effective field theory calculation. Our central discovery is that renormalization group evolution itself constitutes a quantum channel, driving a Markovian loss of information. This work yields the first analytical, all orders prediction for entanglement suppression at colliders as a function of detector resolution, providing an essential tool for future precision tests of quantum mechanics at the energy frontier.

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