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From UV to IR, tracking quantum information loss at colliders

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Understanding decoherence during the evolution from high-energy (UV) to low-energy (IR) scales is a critical challenge for the new frontier of quantum information science at colliders. In this talk, I will present a novel framework that treats Renormalization Group (RG) flow itself as the engine of decoherence. By combining Soft-Collinear Effective Theory (SCET) with open quantum system techniques, we demonstrate that RG evolution constitutes a quantum channel where the scale, not time, drives a Markovian loss of information. Applying this to $e^+e^- \to \ell^+\ell^-$, we derive the first analytical prediction for entanglement suppression from final-state radiation. This work provides an essential tool for future precision quantum measurements and offers a new, operational perspective on the Renormalization Group.

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