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Reduced fidelities for free fermions out of equilibrium

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Quantum fidelities—like entanglement measures—originated in quantum information theory but have since become powerful probes of emergent phenomena in quantum many-body systems. In out-of-equilibrium settings, the most prominent example is the Loschmidt echo (LE), which quantifies the fidelity between an initial state and its time-evolved counterpart after a quantum quench. The LE is notably sensitive to dynamical quantum phase transitions.
However, accessing the full LE experimentally is challenging in extended systems, as it requires global knowledge of the quantum state. In this talk, I will introduce the *reduced Loschmidt echo*: a local version of the LE, computable from reduced density matrices. Focusing on free fermions out of equilibrium, I will present analytical results showing that the reduced LE retains key features of the full LE and admits a quasiparticle picture in the hydrodynamic limit.
I will also discuss the *final-state fidelity*, a complementary quantity designed to probe late-time dynamics and thermalization. Like the reduced LE, it supports a quasiparticle description, and offers a natural way to detect quantum Mpemba effects.

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