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Untangling time scales in entanglement growth in the disordered Fermi Hubbard model

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Many-body localization impedes the spread of information encoded in initial conditions, providing a intriguing counter point to continuing efforts to understand the approach of quantum systems to equilibrium and also opening the possibility of diverse non-equilibrium phases.
While much work in this area has focused on systems with a single degree of freedom per site, motivated by rapid developments in cold atom experiments, we focus on the Fermi Hubbard model, with both spin and charge degrees of freedom. To explore the spread of information between these in the presence of disorder, we compare the time dependence of the entanglement entropy with the time dependence of the charge and spin correlations, and in addition we rewrite the Hamiltonian in terms of charge and spin-specific integrals of motion, allowing us to distinguish time scales associated with charge-charge, spin-spin, and charge-spin correlations.

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