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Dynamics of entanglement entropy and particle number distribution in disordered, free fermionic systems RAZMIK UNANYAN, MAXIMILIAN KIEFER-EMMANOUILIDIS, University of Kaiserslautern, JESKO SIRKER, University of Manitoba, MICHAEL FLEISCHHAUER, University of Kaiserslautern
— The information contained in a quantum state ρ is quantified by the entanglement entropy $S = -\mathrm{tr}(\rho \ln \rho)$, which is difficult to measure. For systems with particle number conservation, S is the sum of the number entropy, S_N, and the configuration entropy, S_{conf}, which have been measured recently in a cold-gas experiment [1]. We here show that for systems of non-interacting fermions, including the case of disorder, the time evolution of the second Renyi entropy $S^{(2)} = -\ln \mathrm{tr}(\rho^2)$ is determined by the exponent of corresponding number entropies. As a consequence in free fermionic systems a dynamical growth of entanglement is always related to a slower growth of the number entropy. We numerically illustrate this for different tight-binding fermionic models including the case of off-diagonal disorder for which the entanglement entropy shows an ultra slow, double logarithmic growth in time and give an outlook to interacting systems showing many-body localization.
A. Lukin, *et al. Probing entanglement in a many-body localized system*, Science **364**, 256 (2019).

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