Taming Quantum Entanglement

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Abstract

Non-local quantum entanglement - "spooky action at a distance" - is the key feature that distinguishes quantum from classical systems. The entanglement-entropy provides a measure of entanglement and for many-body systems is intimately connected to the thermal-entropy. Out of equilibrium, in a driven system or after a quantum quench, entanglement spreads ballistically with maximal entropy attained at long times - that is, complete disorder reigns. But not (always!) with life on earth! Why? In this talk I will discuss several different mechanisms to tame entanglement growth; (i) by quenched disorder in systems exhibiting many-body localization, (ii) by coupling light quantum particles to heavy (almost classical) particles and (iii) by "looking repeatedly" at the system (i.e. making projective measurements) - a many-body quantum Zeno effect. In the latter case, I will explore a novel hybrid quantum circuit model consisting of both unitary gates and projective measurements, presenting evidence for a new quantum dynamical phase transition between a weak measurement phase and a quantum Zeno phase. Detailed steady-state and dynamic critical properties of this novel quantum entanglement transition will be described.