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Quantum thermalization through entanglement

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Understanding how an isolated many-body state thermalizes and develops entropy is foundational to quantum statistical mechanics, yet appears antithetical to notions that we have about entropy. An evolving quantum state can develop observables that agree with thermal ensembles, yet the unitarity of quantum evolution preserves the purity of this full quantum state in time. Hence, a pure, and in this sense, zero entropy quantum state can dynamically become seemingly entropic and thermal. In this talk, I will describe our experimental studies of thermalization in a verifiably pure many-body state, and how the entropy induced by entanglement facilitates thermalization. I will describe our experimental method for measuring quantum purity, and thereby entanglement entropy, through the interference of two copies of a many-body state. By comparing the entanglement entropy we measure to the thermal entropy expected from an ensemble, I will illustrate how thermalization is manifest locally within a globally pure quantum state, and how these observations are related to the Eigenstate Thermalization Hypothesis.