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Renormalization group studies of many-body localization[1]

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Quantum correlations do not usually persist for long in systems at finite energy density and disappear once the system thermalizes. But many-body localization offers an alternative paradigm, whereby quantum matter can evade the usual fate of thermal equilibrium and retain retrievable quantum correlations even at high energies. I will survey a dynamical renormalization group (RG) approach used to characterize the novel dynamics and entanglement structures, which develop in the localized phase in lieu of classical thermalization. Then I will present a theory of the transition between the ergodic and the many-body localized phase based on a novel RG framework. Here eigenstate entanglement entropy emerges as a natural scaling variable; the RG describes a change from area-law to volume law entanglement through an intriguing critical point, where the distribution of entanglement entropy becomes maximally broad. The ergodic phase established near the critical point is a Griffiths phase, which exhibits sub-diffusive energy transport and sub-ballistic entanglement propagation. The anomalous diffusion exponent vanishes continuously at the critical point. Before closing I will discuss recent progress in confronting the emerging theoretical understanding of many-body localization with experimental tests.

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