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The many body localization transition: A dynamical phase transition beyond standard paradigms

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I review recent progress on the understanding of many-body localization, i.e., the phenomenon of absence of thermalization in interacting, disordered quantum systems. After discussing the restricted domain of existence of strict manybody-localization (the role of spatial dimension, symmetries, the presence of a continuum), I will present a real space renormalization group analysis which offers a microscopic scenario for the unusual dynamical phase transition which occurs as a localized system is tuned into an ergodic regime. While the transition is associated with a diverging time scale for thermalization, most spatial correlators remain short range at the critical point. The latter goes hand in hand with the discontinuous evolution of expectation values of local observables. These features distinguish the transition sharply from standard critical phenomena.