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Entanglement and Stability of Quantum Matter: from Spin-liquids to Many Body Localization

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Quantum entanglement often serves as a fruitful order parameter to characterize quantum phases and phase transitions. However, recent developments have lead to a completely new role for quantum entanglement: the nature of quantum entanglement also places strong constraints on the structure of *phase diagrams* itself. Specifically, the universal part of entanglement provides a natural ordering for critical systems whereby a critical, scale-invariant phase can be unstable only if the instability reduces entanglement. In this talk, I will elucidate implications of the aforementioned general relation between entanglement and critical phases for a wide variety of challenging problems in condensed matter physics. I will first discuss general arguments on why a large class of gapless quantum spin-liquids, which possess exotic properties such as emergent fermions and photons, must be stable. In a similar vein, I will show that certain quantum transitions must lie beyond a simple Landau order parameter description. Finally, I will discuss a generalization of such arguments to disordered quantum systems in the context of many-body localization transition. Specifically, I will show that at a continuous many-body localization transition, the system is necessarily ergodic.