SFB/TRR 21 - Seminar

4. December 2013, Ulm

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(Universität Wien)

Scaling of the entanglement spectrum in one-dimensional systems

We discuss the scaling of the entanglement spectrum and of the Rényi block entropies and their universal aspects in the ground state of gapped and gapless one-dimensional quantum spin models. In all cases, the scaling exhibits an oscillatory behavior that terminates at the factorization point and whose frequency is universal. In general, the transition occurring at the factorizing field between two different scaling regimes of the entanglement spectrum corresponds to a quantum transition to the formation of finite-range, ordered structures of quasidimers, quasitrimers, and quasipolymers. This entanglement-driven transition is superimposed to and independent of the long-range magnetic order in the broken symmetry phase. Therefore, it conforms to recent generalizations that identify and classify the quantum phases of matter according to the structure of ground-state entanglement patterns. We characterize this form of quantum order by a global order parameter of entanglement defined as the integral, over blocks of all lengths, of the Rényi entropy of infinite order. Equivalently, it can be defined as the integral of the bipartite single-copy or geometric entanglement. The global entanglement order parameter remains always finite at fields below the factorization point and vanishes identically above it. The anomalous scaling of the Rényi entropies below the factorization point is also shown to closely related to a sequence multipartite-to-bipartite entanglement conversions that occur in correspondence of parity transitions between the entangled eigenstates associated to the largest eigenvalue of the block reduced density matrices in the ground state.

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