Quantum Physics

Entanglement vs. gap for one-dimensional spin systems

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We study the relationship between entanglement and spectral gap for local Hamiltonians in one dimension. The area law for a one-dimensional system states that for the ground state, the entanglement of any interval is upper-bounded by a constant independent of the size of the interval. However, the possible dependence of the upper bound on the spectral gap Delta is not known, as the best known general upper bound is asymptotically much larger than the largest possible entropy of any model system previously constructed for small Delta. To help resolve this asymptotic behavior, we construct a family of one-dimensional local systems for which some intervals have entanglement entropy which is polynomial in 1/Delta, whereas previously studied systems, such as free fermion systems or systems described by conformal field theory, had the entropy of all intervals bounded by a constant times log(1/Delta).

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