

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 Δ 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 Δ . 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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