Tage Erlander Award Conference "Frontiers of Condensed Matter Physics"

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What can we learn from quantum entanglement spectra?

Tuesday 04 Jan 2011 at 11:50 (00h50')

I will summarize some recent developments in the study of quantum entanglement spectra. I will also discuss work performed in collaboration with R. Thomale and A. Bernevig on entanglement spectra in spin chains. Typically, bipartite entanglement entropy and spectra have been studied in the case of spatial partitions, i.e. A denotes the left half of a spin chain and B the right half, and the eigenvalues of the reduced density matrix of the A component comprise the entanglement spectrum (ES). We find that for the spin-half Heisenberg model that a remarkable structure in the ES is revealed if the partition is performed in momentum space, i.e. A = left-movers and B = right-movers. Further classifying the entanglement eigenstates by total crystal momentum, we observe a universal low-lying portion of the ES with specific multiplicities separated from a higher-lying nonuniversal set of levels by an entanglement gap, similar to what was observed by Li and Haldane (2008) for the fractional quantum Hall effect. Indeed, the momentum space ES for the Heisenberg chain is understood in terms of the proximity of the Haldane-Shastry model, which corresponds to a fixed point with no nonuniversal corrections, and whose ground state is related to the Laughlin state. We further explore the behavior of the ES as one tunes through the dimerization transition in a model with next-nearest-neighbor exchange.

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