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Entanglement spectrum in Spin Chains[1] RONNY THOMALE, Princeton University, Princeton NJ 08544, DANIEL P. AROVAS, University of California at San Diego, La Jolla, California 92093, B. ANDREI BERNEVIG, Princeton University, Princeton, NJ 08544 — We show that the entanglement spectrum can be used to define topological order in *gapless* systems for which usual methods such as torus degeneracy fail. The gap *fully* separates a series of generic, high 'entanglement energy' levels, from a *flat* band of levels with specific multiplicities that uniquely define the ground-state, and remains finite in the thermodynamic limit. We pick the appropriate set of quantum numbers, and then partition the system in this space. Despite the fact that the Laughlin state is bulk gapped while the antiferromagnetic spin chain state is bulk gapless, we show that the $S = 1/2$ Heisenberg antiferromagnet in one dimension has an entanglement spectrum almost identical to that of the Laughlin Fractional Quantum Hall state in two dimensions, revealing the nature of their low-energy edge and bulk excitations respectively.

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