Topological quantum order: stability under local perturbations

Sergey Bravyi, Matthew Hastings, Spyridon Michalakis

(Submitted on 3 Jan 2010)

We study zero-temperature stability of topological phases of matter under weak time-independent perturbations. Our results apply to quantum spin Hamiltonians that can be written as a sum geometrically local commuting projectors on a D-dimensional lattice with certain topological order conditions. Given such a Hamiltonian H_0 we prove that there exists a constant threshold \epsilon>0 such that for any perturbation V representable as a sum of short-range bounded-norm interactions the perturbed Hamiltonian H=H_0+\epsilon V has well-defined spectral bands originating from O(1) smallest eigenvalues of H_0. These bands are separated from the rest of the spectrum and from each other by a constant gap. The band originating from the smallest eigenvalue of H_0 has exponentially small width (as a function of the lattice size).
Our proof exploits a discrete version of Hamiltonian flow equations, the theory of relatively bounded operators, and the Lieb-Robinson bound.

Comments: 41 pages, 1 figure
Subjects: **Quantum Physics (quant-ph)**; Statistical Mechanics (cond-mat.stat-mech); Mathematical Physics (math-ph)
Cite as: **arXiv:1001.0344v1 [quant-ph]**

Submission history

From: Sergey Bravyi [view email]
[v1] Sun, 3 Jan 2010 01:30:48 GMT (37kb)

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