Statistical Physics Seminar

February 13th, 2019.
Wednesday, 11.00

ELTE TTK Northern Building 2.54

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Wigner SZFI

Kitaev's Toric Code Model: Topological Quantum Excitations and how they hide Quantum Information

I will give an elementary introduction to Kitaev's Toric Code model [1], which forms the basis of the "surface code" version of topological quantum computing [2] that IBM, Google, and Rigetti are trying to implement. The Toric Code is an exactly solvable Hamiltonian for spin-1/2's living on edges of a planar graph, with n-body-interactions between spins that share a plaquette or a vertex. The interaction terms all commute, and so can be interpreted as counting the number (mod 2) of elementary excitations on each plaquette and at each vertex. These excitations can be created, moved, and fused, by acting on the state of the system with unitary operators. The excitations are topological similarly to vortices in superfluids: they can be created and destroyed only pairwise in the bulk, but can be "brought in" or "pushed out" at suitable boundaries of the planar graph. In this sense, boundaries of holes can store topological excitations at no energy cost, which ensures topological degeneracy of the ground state, and can be used to hide and - to a certain extent - manipulate quantum bits.

[1]: Alexei Kitaev, Chris Laumann: Topological phases and quantum computation, Les Houches lecture notes, arXiv:0904.2771
[2]: Fowler et al: Surface codes: Towards practical large-scale quantum computation, Phys. Rev. A 86, 032324 (2012)

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