Massachusetts Institute of Technology
Department of Physics

CONDENSED MATTER THEORY SEMINAR

An exotic spin model from quantum codes

Jeongwan Haah
MIT

Abstract: A 3+1D spin model will be presented. This spin model exhibits a previously unexpected topological quantum order, in which ground states are locally indistinguishable, pointlike excitations are immobile, and the immobility is not affected by small perturbations of the Hamiltonian. The degeneracy of the ground state, though also insensitive to perturbations, is a complicated number-theoretic function of the system size, and the system bifurcates into multiple noninteracting copies of itself under real-space renormalization group transformations. The degeneracy, the excitations, and the renormalization group flow can be analyzed using a framework that exploits the spin model's symmetry and some associated free resolutions of modules over polynomial algebras.

It demonstrates for the first time that a reliable quantum memory at finite temperature is possible, at least to some extent. When quantum information is encoded into a highly entangled ground state of this model and subjected to thermal errors, the errors remain easily correctable for a long time without any active intervention, because a macroscopic energy barrier keeps the errors well localized. As a result, stored quantum information can be retrieved faithfully for a memory time which grows exponentially with the square of the inverse temperature. In contrast, for previously known types of topological quantum storage in three or fewer spatial dimensions the memory time scales exponentially with the inverse temperature, rather than its square.

12:00 noon
Tuesday, October 1, 2013
Cosman Room
Room 6C-442