UNIVERSITY OF CALIFORNIA, SANTA BARBARA

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO


SANTA BARBARA • SANTA CRUZ

# Geometry, Topology, and Physics Seminar

# Quantum Codes from High-Dimensional Manifolds

**Matt Hastings**
**Microsoft Research**

Thursday, February 9, 2017, 3:30 p.m.
Ellings Hall 2250

**Please note unusual day, time, and location.**

**Abstract:** Quantum error correcting codes are closely related to homology theories, and tools from topology are very useful in constructing quantum error correcting codes. One of the major problems in quantum error correcting codes is to construct codes with large distance and with low weight parity check operators, two concepts that I will explain in this talk. This question is closely related to the question of $Z_2$ systolic freedom. The current state of the art results for quantum codes are much worse than those for classical codes, with the two best results being due to Freedman, Meyer, and Luo using a family of 3 manifolds with varying topology, and due to Bravyi and Hastings, combining the idea of a product of chain complexes with randomized constructions from coding theory. In this talk, I will outline a possible way to obtain close-to-optimal results, using codes based on a family of high-dimensional tori. The main technical results will have to do with Rankin invariants of random lattices. The conjectured code distance depends on a geometrical conjecture: roughly, that for the torus $R^n/\Lambda$, with $\Lambda$ a lattice, using the Euclidean metric, the least area representative of nontrivial $Z_2$ homology is a hyperplane (or at least does not have area super-exponentially smaller than a hyperplane).

This seminar is part of the NSF/UCSB 'Research Training Group' in Topology and Geometry. Information about future meetings can be found at http://www.math.ucsb.edu/~drm/GTPseminar/