Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Classification of topological insulators and superconductors in three spatial dimensions SHINSEI RYU, Department of Physics, University of California, Berkeley, ANDREAS SCHNYDER, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, AKIRA FURUSAKI, RIKEN, ANDREAS LUDWIG, Depatment of Physics, University of California, Santa Barbara — We systematically study topological phases of insulators and superconductors (or superfluids) in 3D. We find that there exist 3D topologically non-trivial insulators or superconductors in five out of ten symmetry classes introduced in seminal work by Altland and Zirnbauer within the context of random matrix theory, more than a decade ago. One of these is the recently introduced Z_2 topological insulator in the symplectic (or spin-orbit) symmetry class. We show there exist precisely four more topological insulators. For these systems, all of which are time-reversal invariant in 3D, the space of insulating ground states satisfying certain discrete symmetry properties is partitioned into topological sectors that are separated by quantum phase transitions. Three of the above five topologically non-trivial phases can be realized as time-reversal invariant superconductors, and in these the different topological sectors are characterized by an integer winding number defined in momentum space. When such 3D topological insulators are terminated by a 2D surface, they support stable surface Dirac (Majorana) fermion modes.

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Date submitted: 18 Nov 2008 Electronic form version 1.4