Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

A Tensor Network Framework for Topological Order in Higher Dimensions BURAK SAHINOGLU, University of Vienna, MICHAEL WALTER, Stanford University, DOMINIC WILLIAMSON, University of Vienna — We present a general scheme for constructing topological lattice models in any space dimension using tensor networks. Our approach relies on finding "simplex tensors" that satisfy a finite set of tensor equations. Given any such tensor, we construct a discrete topological quantum field theory (TQFT) and local commuting projector Hamiltonians on any lattice. The ground space degeneracy of these models is a topological invariant that can be computed via the TQFT, and the ground states are locally indistinguishable when the ground space is nondegenerate on the sphere. Any ground state can be realized by a tensor network obtained by contracting simplex tensors. Our models are exact renormalization fixed points, covering a broad range of models in the literature. Lastly, we identify symmetries on the virtual level of the tensor networks of our models that generalize the topological invariance properties beyond fixed point models. This framework combined with recent tensor network techniques is convenient for studying excitations, their statistics, phase transitions, and ultimately for classification of gapped phases of many-body theories in 3+1 and higher dimensions.

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Date submitted: 06 Nov 2015 Electronic form version 1.4