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Homological Order in Three and Four dimensions: Wilson Algebra, Entanglement Entropy and Twist Defects[1] ABHISHEK ROY, XIAO CHEN, JEFFREY TEO, University of Illinois at Urbana-Champaign — We investigate homological orders in two, three and four dimensions by studying Z_k toric code models on simplicial, cellular or in general differential complexes. The ground state degeneracy is obtained from Wilson loop and surface operators, and the homological intersection form. We compute these for a series of closed 3 and 4 dimensional manifolds and study the projective representations of mapping class groups (modular transformations). Braiding statistics between point and string excitations in (3+1)-dimensions or between dual string excitations in (4+1)-dimensions are topologically determined by the higher dimensional linking number, and can be understood by an effective topological field theory. An algorithm for calculating entanglemnent entropy of any bipartition of closed manifolds is presented, and its topological signature is completely characterized homologically. Extrinsic twist defects (or disclinations) are studied in 2,3 and 4 dimensions and are shown to carry exotic fusion and braiding properties.

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