Restricted Spin Set Lattice Models: A Route to Topological Order

1 R. ZACHARY LAMBERTY, Cornell University, STEFANOS PAPANIKOLAOU, Yale University, C.L. HENLEY, Cornell University — A typical lattice gauge model configuration consists of elements of a finite symmetry group $G$ placed on directed edges of a two-dimensional lattice. We consider generalized models which are defined by instead only allowing elements from a subset $S \subset G$ consisting of certain classes of group elements. The subset restriction can be regarded as a new (but discrete) tunable model parameter, providing a novel pathway to topologically ordered phases. Taking a small allowed set $S$, we can realize well understood critical models (e.g. the square lattice ice model or dimer covering); in contrast, for large enough $S$ the configuration ensemble realizes a form of topological order. Using a sequence of sets $S_1 \subset S_2 \subset \ldots$, we can “interpolate” from one kind of state to the other. This is confirmed by Monte Carlo simulations, measuring two characteristic properties: (1) the distribution of separations between two (possibly deconfined) topological defects, and (2) the relative probabilities of different sectors (sub-ensembles with inequivalent products of the group elements around the periodic boundary conditions). We also discuss how to construct quantum-mechanical extensions of these models.

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