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# Exact ground state of multi-orbital Fermion model and topological structure transition

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A multi-component electron model on a lattice is constructed whose ground state exhibits a spontaneous ordering which follows the rule of map-coloring used in the solution of the four color problem [1]. The number of components is constrained by the Euler characteristics of a certain manifold, $\mathcal{M}$, into which the lattice is embedded. Combining the concept of chromatic polynomials with the Heawood-Ringel-Youngs theorem [2], we derive an index theorem relating the degeneracy of the ground state with a hidden topology of the lattice. We propose a novel structural transition, topological structure transition, realized for a fixed number of components and electron concentration. In this transition there is a variation of the manifold $\mathcal{M}$ into another manifold $\mathcal{M}'$. The transition is characterized by the set of manifolds $(\mathcal{M}, \mathcal{M}')$. For a given random lattice, the ground state properties are essentially determined by the topological structure of the higher surface into which the lattice is embedded irreducibly, and not by the original lattice structure in real space (hence the adjective "hidden"). The ground state is then classified by the hidden topology.

[1] See, for example, T.R. Jensen and B. Toft, Graph Coloring Problems, Wiley-Intersciences Publication, New York, 1995.
[2] P.J. Heawood, Quart. J.Pure Appl. Math. **24**, 332 (1890); G. Ringel and J.W.T. Youngs, Proc. Natl. Acad. Sci. USA **60**, 438 (1968).