Entanglement spectrum of topological band insulators on the Lieb lattice

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Recently, topological insulators have garnered an immense interest due to unique electronic structure and promising applications in the context of quantum Hall effect [1]. Chern insulators are time-reversal symmetry breaking band insulators exhibiting a nonzero Hall conductance. Topologically ordered systems manifest non-local correlations and therefore can be investigated by employing different entanglement measures. The reduced density matrix for a particular subsystem in a real space can be determined from the correlation matrix [2, 3], which is defined as a two-point correlation function.

In this work, we study a free fermion Chern insulator on the two-dimensional Lieb lattice in a cylinder geometry through entanglement spectrum. Within the tight binding approximation, the Lieb lattice has a flat (but trivial) band in the middle of the energy spectrum. However, a topological phase transition can be induced by the presence of spin-orbit coupling and staggered sublattice potential. For various model parameters, we examine the eigenvalues and the trace of the correlation matrix for both trivial and non-trivial phases. The effect of the flux threading on a Chern insulator is shown. Localization of edge states is also discussed.

[1] N. Regnault, and B. A. Bernevig, *Phys. Rev. X* **1**, 021014 (2011).
[2] A. Alexandradinata, T. L. Hughes, and B. A. Bernevig, *Phys. Rev. B* **84**, 195103 (2011).
[3] M. Legner, and T. Neupert, *Phys. Rev. B* **88**, 115114 (2013).
[4] T. L. Hughes, E. Prodan, and B. A. Bernevig, *Phys. Rev. B* **83**, 245132 (2011).
[5] A. M. Turner, Y. Zhang, and A. Vishwanath, *Phys. Rev. B* **82**, 241102(R) (2010).