Entanglement spectrum studies of systems with flat bands with nontrivial topology

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We investigate properties of systems with nontrivial topology of energy bands using entanglement spectrum. Such systems are important due to the concept of fractional Chern insulators [1,2]. It has opened up a new possibility of obtaining fractional quantum Hall effect without a net magnetic Field. A system appropriate for a fractional Chern insulator should characterize by a topologically nontrivial flat energy band. Several possibilities, like the Kagome lattice model with spin-orbit coupling or the ruby lattice model, have been studied [3]. While most of these systems exhibit nontrivial topology by default, obtaining flat energy bands is not straightforward and can be done theoretically for example by introducing density-density repulsion [3].

One of the tools that allows us to study their properties is quantum entanglement, which reveals nonlocal correlations in the system [4]. We will focus on the analysis of entanglement spectrum. The fundamental property that distinguishes topologically trivial from nontrivial systems is spectral flow, which is a manifest for a spatial entanglement cut. Various lattices with flat bands modeled by appropriate choice of model parameters will be studied. A lattice originally with an energy band with a trivial topology in the middle of the energy spectrum, but with the topology altered by a specific external potential will be also considered [5]. We will focus on single particle properties, and many-body effects for fractionally filled bands. We will analyze the connection between entanglement and quantum Hall physics.

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