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TITLE:
Absence of Anderson localization in class-A Dirac systems: a lattice perspective

ABSTRACT:
Anderson localization is a cornerstone concept in modern condensed matter physics. For electronic systems, the ten-fold way symmetry classification establishes a well defined catalogue; for a given class, defined in terms of a few discrete symmetries, a given universal behaviour is expected regarding the effect of disorder.
The symmetry class-A, to which standard quantum Hall systems belong, is perhaps one of the best studied: disorder is essential to the quantum Hall regime, with theory and experiment in very good agreement. Quantum anomalous Hall insulators (or Chern insulators) also belong to class-A. The universal behaviour is expected to be the same, and recent experiments are in line with this prediction. From the theoretical modelling point of view, quantitative differences are expected, due, for instance, to distinct model distributions used for a disordered potential. But no qualitatively different behaviour is envisaged. Well... Maybe we should revise our prejudices.
Here we present results for the celebrated Haldane model, the prototypical class-A Chern insulator, when Anderson disorder applies selectively to one sub-lattice only. We show that the quantum anomalous Hall system evolves to an anomalous Hall metal as disorder is increased. Surprisingly, the metal never turns into an Anderson insulator, even for the higher values of disorder simulated. Not only is this suggesting that a mobility edge is present, which is not common in class-A systems, but it also indicates that the metal is the final state in the phase digram as disorder is increased, which is totally unexpected in class-A. By comparing with other lattice realizations we try to identify the key ingredients. An essential one turns out to be the finite Berry curvature of the system even for strong disorder. Such finite Berry curvature is reminiscent of the clean (massive) Dirac system limit which describes the Haldane model at low energies.

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