Fractional Chern Insulators – A Novel Perspective on the Fractional Quantum Hall Effect

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Abstract

The fractional quantum Hall effect (FQHE), known since the 1980ies, has received a novel perspective due to theoretical investigations of partially filled flat electronic bands with non-zero Chern number. Indeed, a completely filled band with a non-zero Chern number reveals an integer form of the (anomalous) quantum Hall effect, the transverse conductance given by the Chern number times the quantum of conductance. The discovery of the closely related quantum spin Hall effect in time-reversal symmetric systems has corroborated this link between Chern bands and the quantum Hall effect. As in the case of the quantum Hall effect, one may thus expect a fractional version of the quantum anomalous Hall and the quantum spin Hall effects, once the bands are just partially filled. Recent numerical studies have given credit to this scenario even if no physical systems are yet available.

The aim of this paper is to illustrate the common underlying mechanisms between the fractional quantum Hall effect and the fractional version of the anomalous quantum Hall effect (also called fractional Chern insulator) and the quantum spin Hall effect. In the case of a sufficiently flat Berry curvature, one finds indeed the same underlying algebraic structure in the form of the magnetic translation group. A criterion for the flatness of the Berry curvature, in relation with hidden massive Dirac points, is given as well as possible ways to handle an arbitrary Berry curvature.

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