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Lattice Quantum Hall Effect LAYLA HORMOZI, Joint Quantum Institute, NIST and University of Maryland, GUNNAR MOLLER, University of Cambridge, STEVEN SIMON, University of Oxford — We study the groundstate of a two-dimensional system of interacting ultra-cold atoms (bosons and fermions), trapped in the periodic potential of an optical lattice, under the influence of a strong synthetic magnetic field. In the absence of inter-particle interactions, the energy spectrum is depicted by the Hofstadter butterfly — a fractal structure seemingly very different from the Landau levels in the continuum. However, when the number of flux quanta per lattice cell is close to a rational fraction, the energy splittings in the Hofstadter butterfly resemble Landau levels. Inspired by this similarity we establish a mapping between the wavefunctions of the non-interacting system in the lattice near rational fractions and the corresponding wavefunctions in the continuum. Using these single-particle wavefunctions we calculate pseudopotential coefficients for the interacting system. These effective interaction potentials can then be used to construct trial wavefunctions for the groundstate of the interacting system on a lattice. For the case of bosons with contact interaction, in addition to the interaction obtained by Palmer et al. [1], we find anomalous terms in the pseudopotential coefficients resembling the umklapp process.
[1] R. N. Palmer, A. Klein and D. Jaksch, Phys. Rev. A 78, 013609 (2008).

Layla Hormozi
Joint Quantum Institute, NIST and University of Maryland

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