Quantized Hall conductance in a one-dimensional atomic gas

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Mesoscopic electronic wires can exhibit a quantized conductance whenever a finite number of transverse modes are occupied [1]. Quantum transport measurements have been investigated in ultracold atom experiments, obtaining results that are analogous to the ones of solid-state physics [2]. Through a suitable engineering of the optical confining potentials, atomic reservoirs have been coupled with quasi-1D wires or 1D lattices and quantum transport of neutral matter has been observed [3, 4]. Interestingly, the dimensionality of such systems can be increased upon introducing motion along an additional "synthetic" dimension: As proposed in Ref. [5], this can be realized by shaking the confining potential, and interpreting the resulting coupling between harmonic-oscillator levels as hopping along a fictitious lattice. Under certain conditions, the corresponding effective Hamiltonian is that describing a 2D tight-binding model in the presence of a synthetic magnetic field, thus exhibiting the quantum Hall effect. We explore such a setting in view of measuring the quantized Hall conductivity associated with the corresponding topological edge modes. This works proposes an intriguing manner by which 2D topological physics can be accessed in 1D setups, with direct experimental consequences.

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