From artificial graphene to the topological Haldane model

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Ultracold gases open new avenues to realize and explore key models of quantum physics, which may or may not have a counterpart in solid-state physics. Using a set of interfering laser beams we created a honeycomb potential for a fermionic quantum gas and identified the Dirac points, which can be moved within the Brillouin zone and made to appear and disappear. Going further beyond what is presently possible in solid-state experiments, we realized the topological Haldane model on the honeycomb lattice. It features topologically distinct phases of matter and provides a mechanism through which a quantum Hall effect can appear as an intrinsic property of a band-structure, rather than being caused by an external magnetic field. We realized the Haldane model in a periodically modulated honeycomb lattice and characterized its topological band-structure. I will further report on our observation of quantized conductance in the transport of neutral atoms. This fundamental phenomenon has so far not been observed with neutral matter. In our isolated atom device we enter a regime in which the mean free path is larger than the system size.