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Topological Charge Pumping with Cold Atoms

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More than 30 years ago, Thouless considered an interesting phenomenon of quantum transport of an electron gas in an infinite one-dimensional periodic potential, driven in a periodic cycle. The charge pumped by this Thouless pump is a topological quantum number and does not depend on a smooth change of parameters. Importantly, this charge pumping shares the same topological origin as the integer quantum Hall effect. In spite of the importance in a topological quantum physics, this Thouless pump has never been realized in any system. In this study, we successfully realize the Thouless topological pump by exploiting the controllability of ultracold atoms in an optical superlattice. The charge pumping is detected as a shift of the center of mass of an atomic cloud measured with in situ absorption imaging. We extract the Chern number of the system from the average shift of the center of mass per pumping cycle. The topological nature of the pump is revealed by the clear dependence on the topology of the pumping trajectories in parameter space of our superlattice. We will describe the detail of our experiments using fermionic ytterbium atoms and also discuss the prospects of our research.