The basics of topological pumping

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Pumps are transport mechanisms in which directed currents result from a cycling evolution of the potential. Thouless pointed out that pumping can have topological origin when considering the motion of quantum particles in spatially and temporally periodic potentials. It is the dynamic counterpart to the quantized Hall effect. In this lecture I will give an introduction to the basic idea of topological pumping and show how this fundamental concept is implemented in cold atoms experiments.

The art of topological pumping

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The fate of topological transport in the presence of interactions between particles raises fundamental questions on the role of geometry in quantum many-body physics. Advances in topological pumps have now made it possible to address these questions in the highly controlled setting of cold atoms. In this lecture insights from recent experiments will be discussed. By tuning the interactions in a Thouless pump, the breakdown point of pumping was studied. By pumping over long distances in an external potential, topological boundaries – signified by a reversal of the quantised Hall drift – were observed and studied, including an interaction induced boundary.