From Many-Body Localisation to Thouless Quantum Pumps - New Frontiers for Ultracold Quantum Gases

Immanuel Bloch*[1,2]

[1]Max-Planck-Institut fur Quantenoptik (MPQ) – Hans-Kopfermann-Str. 1 Garching, Germany
[2]Ludwig-Maximilians-Universität [München] (LMU) – Germany

Abstract

Ever since the original proposal of Anderson localization, the question of whether localization can be maintained in the presence of interactions has intrigued a generation of condensed matter physicists. Most recently, the question could be answered affirmatively by identifying a "many-body localized" phase for interacting particles. The phase transition does not occur in the ground state of the system, but in a broad band of highly excited states. The MBL phase is associated with the breakdown of ergodicity, and thereby renders the most fundamental assumption of statistical physics invalid. In my talk I will report on several recent experiments carried out in our team to identify both the MBL phase, to characterize its coupling to the environment and to elucidate characteristic features at the transition point.
In the second part of my talk, I will discuss the experimental realization of a Thouless Quantum Charge Pump with strongly interacting bosonic particles in optical superlattices. The Thouless pump can be regarded as a dynamical version of the integer quantum Hall effect, and I will show how the associated topological invariant can be measured through the in-situ quantized displacement of the atom cloud.

*Speaker