Q 20: Quantum Gases: Bosons III

Time: Tuesday 11:00–12:15 Location: P/H2

Q 20.1 Tue 11:00 P/H2

Negative Differential Conductivity in an Interacting Quantum Gas — •Bodhaditya Santra[1], Ralf Labouvie[1], Simon Heun[1], Sandro Wimberger[2], and Herwig Ott[1] — [1]Research Center OPTIMAS and Fachbereich Physik, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institut f ür Theoretische Physik, Universität Heidelberg, 69120 Heidelberg, Germany

Negative differential conductivity (NDC) is a widely exploited mechanism in many areas of research dealing with particle and energy transport. We experimentally realize such a many body quantum transport system based on ultracold atoms in a periodic potential. We prepare our system by loading Bose condensed ^{87}Rb in a 1D optical lattice with high atom occupancy per lattice site. Subsequently, we remove all the atoms from a central lattice site. While the atoms from neighboring sites tunnel into the empty site, we observe NDC in the resulting current voltage characteristics and investigate the microscopic mechanism behind it.

Q 20.2 Tue 11:15 P/H2

Strong field-induced multiphoton processes in driven lattices — •Malte Weinberg, Christoph Ölschläger, Simon Prelle, Klaus Sengstock, and Juliette Simonet — Institut für Laserphysik, Universität Hamburg

Periodic inertial forcing of ultracold quantum gases in optical lattices provides a powerful tool for the coherent manipulation of motional degrees of freedom in quantum many-body systems.

Here, we present systematic studies on the emergence of excitationsin these driven systems for various forcing strengths and lattice dimensionalities. We identify the observed resonances with multiphoton transitions between the two lowest energy bands in excellent agreement with *ab initio* calculations. The pure and well-controllable environment of atomic ensembles in driven optical lattices allows for the investigation of quantized high-order excitations which are hardly accessible in other physical systems.

Q 20.3 Tue 11:30 P/H2

Design and geometry dependence of effective Hamiltonians in driven lattices — •Albert Verdeny[1,2] and Florian Mintert[1,2] — [1]Department of Physics, Imperial College London, London SW7 2AZ, United Kingdom — [2]Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität, 79104 Freiburg, Germany

Driven lattices permit to engineer effective Hamiltonians with well-controllable tunneling properties. We discuss the design of such effective Hamiltonians and identify fundamental constraints imposed by the underlying lattice geometry. With the specific example of a hexagonal lattice we show how suitably chosen driving forces overcome limitations of monochromatic driving and permit to realize systems with non-trivial topological properties.

Q 20.4 Tue 11:45 P/H2

Measuring the Chern number of Hofstadter bands with ultracold bosonic atoms — •Michael Lohse[1,2], Monika Aidelsburger[1,2], Christian Schweizer[1,2], Marcos Atala[1,2], Julio Barreiro[1,2], Sylvain Nascimbène[3], Nigel Cooper[4], Immanuel Bloch[1,2], and Nathan Goldman[3,5] — [1]Fakultät für Physik, LMU München, Germany — [2]MPQ Garching, Germany — [3]Collège de France & LKB, CNRS, UPMC, ENS, Paris, France — [4]T.C.M. Group, Cavendish Laboratory, Cambridge, UK — [5]CENOLI, Faculté des Sciences, Université Libre de Bruxelles, Belgium

Sixty years ago, Karplus and Luttinger pointed out that quantum particles moving on a lattice could acquire an anomalous transverse velocity in response to a force, providing an explanation for the unusual Hall effect in ferromagnetic metals. A striking manifestation of this transverse transport was then revealed in the quantum Hall effect, where the plateaus depicted by the Hall conductivity were attributed to a topological invariant characterizing Bloch bands: the Chern number. Until now, topological transport associated with non-zero Chern numbers has only been revealed in electronic systems. Here we use studies of an atomic cloud's transverse deflection in response to an optical gradient, in combination with the determination of the band populations to measure the Chern number ν of artificially generated Hofstadter bands; for the lowest band we obtain an experimental value of $\nu_{\text{exp}} = 0.99(5)$. This result, which constitutes the first Chern-number measurement in an atomic system, is facilitated by an all-optical artificial gauge field scheme, generating uniform flux in optical superlattices.

Q 20.5 Tue 12:00 P/H2

Observation of chiral superfluid order by matter wave heterodyning — •Thorge Kock[1], Arne Ewerbeck[1], Carl Hippler[1], Matthias Ölschläger[1], Wen-Min Huang[1,2], Ludwig Mathey[1,2], and Andreas Hemmerich[1,2] — [1]Institut für Laser-Physik, Universität Hamburg — [2]The Hamburg Centre for Ultrafast Imaging

We present a demonstration of time reversal symmetry breaking for atoms Bose- Einstein condensed in the second Bloch band of a bipartite optical square lattice. A double layer chiral superfluid is formed after splitting the condensate with a blue-detuned laser beam. In a ballistic expansion process the two layers are superimposed and imaged after 25 ms time of flight. The Bragg maxima thus observed exhibit interference patterns, which provide direct information on the formation of chiral order and the presence and character of low energy excitations.