Q 37: Quantengase (Tunneln I)

Zeit: Mittwoch 12:00–13:00 Raum: 6J

Gruppenbericht Q 37.1 Mi 12:00 6J

Resonant tunnelling of Bose-Einstein condensates in periodic potentials — •Sandro Wimberger[1,2], Donatella Ciampini[1], Oliver Morsch[1], Riccardo Mannella[1], and Ennio Arimondo[1] — [1]CNR-INFM and Dipartimento di Fisica "Enrico Fermi", Università degli Studi di Pisa, Largo Bruno Pontecorvo 3, I-56127 Pisa — [2]Dipartimento di Fisica, Politecnico di Torino, Corso Duca degli Abruzzi 24, I-10129 Torino

Resonantly enhanced tunnelling (RET) results from the interplay between quantum tunnelling and the discrete energy states of particles confined in potential wells. In spite of the fundamental nature of this effect and the practical interest, it has been difficult to observe experimentally. Since the 1970s, much progress has been made in constructing superlattice structures in which RET of electrons was demonstrated for the first time in 1974. Here we show that resonant tunnelling can be observed using Bose-Einstein condensates in accelerated optical lattice potentials. The near-perfect control over the parameters of this system allows us to prepare the condensates with arbitrary initial conditions and also to study theoretically and experimentally the effects of nonlinearity and a loss of coherence. Our approach can be generalized to studying noise and thermal effects in resonant tunnelling and underlines the usefulness of Bose-Einstein condensates in optical lattices as model systems for the solid state.

Q 37.2 Mi 12:30 6J

Correlated tunneling dynamics of atom pairs in double wells — •Simon Fölling[1], Patrick Cheinet[1], Stefan Trotzky[1], Artur Widera[1], Torben Müller[2], and Immanuel Bloch[1] — [1]Inst. für Physik, Johannes Gutenberg-Universität, D-55099 Mainz — [2]Institute for Quantum Electronics, ETH Zürich, CH-8093 Zürich

The interplay between the atom-atom interaction and the mobility is the dominant parameter governing the dynamics of many strongly correlated systems of ultracold atoms. The most elementary realization of such a system is a set of two potential wells occupied by two interacting atoms which can tunnel through the central barrier. By superimposing the periodic potentials of two standing light waves with a periodicity of 382.5nm and 765nm and controllable relative intensity and phase, we create a one-dimensional array of double wells with adjustable tunnel coupling. Additional standing waves on the two orthogonal axes provide axial confinement, creating a three-dimensional array of up to 10^5 double wells occupied by one to two ^{87}Rb atoms each. By initially loading only one side of each double well before initiating the tunneling dynamics, we can directly observe the dynamics of single atoms as well as of atom pairs. Since the ratio of the tunneling matrix element J and the on-site repulsive interaction U between two atoms can be modified in a wide range, the crossover from a tunneling- to an interaction-dominated regime can be observed. Here, the independent motion of two atoms changes to a correlated tunnel process of the pairs.

Q 37.3 Mi 12:45 6J

Spontaneous emergence of angular momentum Josephson oscillations in coupled annular Bose-Einstein condensates — •Igor Lesanovsky and Wolf von Klitzing — Institute of Electronic Structure and Laser, Foundation for Research and Technology -Hellas, P.O. Box 1527, GR-71110 Heraklion, Greece

We investigate the nonlinear dynamics of two coupled annular Bose-Einstein condensates. We demonstrate that for certain values of the coupling strength a non-rotating state with uniform density is unstable with respect to fluctuations in higher angular momentum modes. We analytically derive the two-branched Bogoliubov spectrum and show that there exist distinct regions of instability enabling one to selectively occupy certain angular momentum modes. Carrying out a numerical propagation of the Gross-Pitaevskii equation we observe after a sufficiently long evolution time the spontaneous emergence of angular momentum Josephson oscillations which break the chiral symmetry of the initial state.

[1] I. Lesanovsky and W. v. Klitzing, preprint:quant-ph/0609133 (2006)