Q 32: Materiewellenoptik

Zeit: Mittwoch 14:00–15:15 Raum: Audi-B

Q 32.1 Mi 14:00 Audi-B

Berry phase in atom optics — •Polina V. Mironova, Maxim A. Efremov, and Wolfgang P. Schleich — Institut für Quantenphysik, Universität Ulm, D-89069 Ulm, Germany

The Berry phase is determined only by the parameter space topology and hence cannot be disturbed significantly by noise. It can be used to construct robust quantum gates. We suggest a scheme to observe the Berry phase using the atomic external degrees of freedom. We consider two consecutive interactions of an atom with a near-resonant standing light waves. An atom is scattered by a standing wave, which is formed by two red-detuned traveling light waves, with wave vectors $\mathbf{k}_1$ and $\mathbf{k}_2$, $|\mathbf{k}_1| = |\mathbf{k}_2| = k$, $\measuredangle(\mathbf{k}_1, \mathbf{k}_2) = 2\alpha$. Afterwards, the atom is scattered by a second standing wave, which is formed by two blue-detuned traveling light waves, with wave vectors $\mathbf{k}'_{1,2} \updownarrows \mathbf{k}_{1,2}$. We assume that both interactions turn-on and turn-off adiabatically. Within the rotating wave approximation and the adiabatic approximation on the atomic center-of-mass motion we obtain that the dynamical phase is cancelled out and the final state of the atom differs from the initial state of the atom only by twice the familiar Berry phase, which depends on the atomic external degrees of freedom. Therefore, the scattering picture is determined by the atomic center-of-mass position.

Q 32.2 Mi 14:15 Audi-B

BEC and guided atom-optics in dipole potentials — •Oliver Wille, Johannes Küber, Thomas Lauber, and Gerhard Birkl — Institut für Angewandte Physik, Technische Universität Darmstadt, Schlossgartenstraße 7, 64289 Darmstadt

In our ATOMICS (ATom Optics with MICro Structures) experiment, we achieved BEC by loading Rb-atoms directly from a magneto-optical trap into a crossed dipole trap created by a 1070nm fiber laser and evaporatively cool to quantum degeneracy by lowering the power of the two trapping beams. The fully optical setup has the advantage of being independent of the magnetic properties of the atoms and allows to impose arbitrary magnetic fields.

We want to study the coherence properties of a BEC in dipole potentials created by microfabricated optical elements illuminated with a red detuned laser field. Micro-optical elements are available in various shapes including micro lens arrays, cylindrical lens arrays and ring shaped lenses. With these micro lenses it is possible to build waveguides, beam splitters or toroidal trapping potentials. With coherent transport and splitting of a wave packet it is possible to create integrated atom interferometers and even more complex configurations.

As a second line of experiments, we plan to investigate the dynamics of matter waves in different 1D potential geometries including spatially limited optical lattices and Fabry-Perot like structures.

Q 32.3 Mi 14:30 Audi-B

Focussing a Helium atom beam by reflection from a concave surface — •Christian Schewe, Bum Suk Zhao, Gerard Meijer, and Wieland Schöllkopf — Fritz-Haber-Institut, Berlin

Results of 1-dimensional focussing of a Helium-atom beam reflected from a concave, cylindrical surface are presented. The atomic beam is created by a supersonic expansion and collimated by a skimmer and two slits, variable in size (5-20 μm). For grazing incident angles of a few milliradian the beam is coherently reflected by quantum reflection [1]. Beam profiles at the focus are measured by cutting off the intensity by scanning a knife edge with a piezo (analogy to waist measurement by a razor blade in laser optics). The width of the focus is limited by the source size, by spherical aberration and by diffraction effects. We tune the deBroglie-wavelength by changing the temperature of the atom beam source to see how diffraction influences the focus' width and shape. The smallest focus achieved so far is 1.0±0.1 μm.

[1] Zhao et al., Phys. Rev. A, 78 010902(R), (2008).

Q 32.4 Mi 14:45 Audi-B

Atom Interferometry using Large Momentum Transfer Beam Splitters — •Sven Herrmann, Sheng-wey Chiow, Holger Müller, and Steven Chu — Physics Department, 382 Via Pueblo Mall, Varian 226, Stanford, CA 94305, USA

Light-pulse atom interferometers have been used for precision measurements e.g. of the fine-structure constant α, the local gravitational acceleration g, the Sagnac effect, or Newton's gravitational constant. A way to increase the sensitivity of these measurements is to increase the splitting between the interferometer arms by using large-momentum transfer (LMT) beam splitters. Here, we present two realizations of such LMT beam splitters and their application in simultaneous conjugate Ramsey Borde interferometers in an atomic Cs-fountain, aiming to measure the photon recoil and thus the fine structure constant.

First, we have used multi-photon Bragg diffraction of atomic wave packets at an optical lattice as a beam splitter. Up to $30\hbar k$ can be transferred in a single diffraction. Second, we have embedded such beam splitters between de- and accelerating sections of Bloch oscillations. With both beam splitters we demonstrate interferometry with a splitting of up to $24\hbar k$. Such beam splitters combined from Bragg diffraction and Bloch oscillations should ultimately allow to significantly increase the momentum splitting by increasing the number of Bloch oscillations. This opens the door to much improved precision measurements using atom interferometry.

Q 32.5 Mi 15:00 Audi-B

Atom Interferometry in a mobile setup to measure local gravity — •Alexander Senger, Malte Schmidt, and Achim Peters — Humboldt Universität zu Berlin, Institut für Physik, AG Optische Metrologie, Hausvogteiplatz 5-7, 10117 Berlin

GAIN (Gravimetric Atom Interferometer) is a new design for a mobile and robust gravimeter, which is based on interfering ensembles of laser cooled ^{87}Rb atoms in an atomic fountain configuration. With a targeted accuracy of a few parts in 10^{10} for the measurement of local gravity, g, this instrument would offer about an order of magnitude improvement in performance over the best currently available absolute gravimeters. Together with the capability to perform measurements directly at sites of geophysical interest, this will open up the possibility for a number of interesting applications.

We present first results of the operational interferometer setup and discuss the next steps necessary to achieve full accuracy. These will involve a thorough examination of the systematic effects, which are outlined briefly.