MESOSCOPIC PHYSICS OF ULTRACOLD ATOMS (SYUA)

gemeinsam veranstaltet von den Fachverbänden
Atomphysik (A),
Quantenoptik und Photonik (Q),
Halbleiterphysik (HL),
Tiefe Temperaturen (TT) und
Dynamik und Statistische Physik (DY)

Peter Schmelcher
Theoretische Chemie
Universität Heidelberg
Im Neuenheimer Feld 229
69120 Heidelberg

Klaus Richter
Institut für Theoretische Physik
Universität Regensburg
93040 Regensburg

E-Mail: peter.schmelcher@tc.pci.uni-heidelberg.de

ÜBERSICHT DER HAUPTVORTRÄGE UND FACHSITZUNGEN

(Hörsaal HU Audimax)

Hauptvorträge

SYUA 1.1	Mi	11:00	(HU Audimax)	**Atom Chips: Mesoscopic Physics with Cold Atoms**, Jörg Schmiedmayer
SYUA 1.2	Mi	11:30	(HU Audimax)	**Atomic Matter Waves in Magnetic Micro Potentials**, Claus Zimmermann
SYUA 1.3	Mi	12:00	(HU Audimax)	**Nonlinear resonant transport of Bose-Einstein condensates**, Peter Schlagheck
SYUA 1.4	Mi	12:30	(HU Audimax)	**Atomic Quantum Dots in a Bose-Einstein-Condensate**, Wilhelm Zwerger
SYUA 2.1	Mi	14:00	(HU Audimax)	**BEC of 6Li2 molecules: Exploring the BEC-BCS crossover**, Johannes Hecker-Denschlag
SYUA 2.2	Mi	14:30	(HU Audimax)	**Nonlinear matter waves in periodic potentials: From Adiabaticity to Zener**, Oliver Morsch
SYUA 2.3	Mi	15:00	(HU Audimax)	**Ultracold atomic gases in optical lattices: A bridge between Quantum Optics and Condensed Matter Physics**, Luis Santos
SYUA 2.4	Mi	15:30	(HU Audimax)	**Superfluid-insulator transition in a moving system of interacting bosons**, Eugene Demler

Fachsitzungen

SYUA 1	**Atom Chip Physics**	Mi 11:00–13:00	HU Audimax	SYUA 1.1–1.4
SYUA 2	**Optical Lattices**	Mi 14:00–16:00	HU Audimax	SYUA 2.1–2.4

Fachsitzungen

– Hauptvorträge –

SYUA 1 Atom Chip Physics

Zeit: Mittwoch 11:00–13:00 Raum: HU Audimax

Hauptvortrag SYUA 1.1 Mi 11:00 HU Audimax

Atom Chips: Mesoscopic Physics with Cold Atoms — •Jörg Schmiedmayer — Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany

In mesoscopic quantum electronics, electrons move inside semiconductor structures and are manipulated using potentials where at least one dimension is comparable to the de-Broglie wavelength of the electrons. Similar potentials can be created for neutral atoms moving microns above surfaces using charged and current carrying structures nano-fabricated onto a surface. We will give an overview of the experiments studying the manipulation of cold thermal atoms and BECs on Atom Chips. Atoms can be held and manipulated in strongly confining traps and guides using magnetic, electric and optical fields. Using our atom chips, lithographically fabricated into high quality evaporated Gold layers, previously observed huge disorder potentials are orders of magnitude smaller in our experiments. With Bose-Einstein condensates as a sensitive probe, we could study the spatial variation of magnetic potentials down surface distances in the mikrometer range. A series of experiments are performed by looking at various topics in mesoscopic and 1-d physics of degenerate quantum gases in, and far from, thermal equilibrium.

Hauptvortrag SYUA 1.2 Mi 11:30 HU Audimax

Atomic Matter Waves in Magnetic Micro Potentials — •Claus Zimmermann — Physikalisches Institut, Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen, Germany

With micro fabricated current conductors on the surface of a substrate it is possible to trap atoms in magnetic potentials of almost arbitrary geometry. Since also Bose-Einstein condensates can be loaded into such micro traps the vision of an integrated atom optics becomes realistic. First versions of matter wave interferometers for sensitive detection of forces and accelerations have been demonstrated recently, but also integrated quantum gates for quantum information processing are conceivable. Furthermore, the close distance to the surface of the substrate makes the atoms a sensitive probe for surface effects.

Hauptvortrag SYUA 1.3 Mi 12:00 HU Audimax

Nonlinear resonant transport of Bose-Einstein condensates — •Peter Schlagheck — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany

The rapid progress of atom chip technology opens the perspective for experiments that probe the transport of Bose-Einstein condensates through mesoscopic waveguides. Particularly interesting in this context is the propagation of the condensate through a double barrier potential created by a sequence of two constrictions in the waveguide, which can serve as a Fabry-Perot interferometer for the condensate. We show that resonant is suppressed in interaction-induced regimes of bistability, where multiple scattering states exist at the same chemical potential and the same incident current. We demonstrate, however, that a temporal control of the external potential can be used to circumvent this limitation and to obtain enhanced transmission near the resonance on experimentally realistic time scales.

Hauptvortrag SYUA 1.4 Mi 12:30 HU Audimax

Atomic Quantum Dots in a Bose-Einstein-Condensate — •Wilhelm Zwerger — Institut für Theoretische Physik, Technikerstraße 25, 6020 Innsbruck, Austria

We discuss a possible realization of atomic quantum dots formed by single atoms in a tight optical trap which are coupled to a superfluid reservoir via laser transitions. Quantum interference between the collisional interactions and the laser induced coupling to the phase fluctuations of the condensate results in a tunable interaction of an effective two state system to a dissipative phonon bath. It allows to completely switch off the coupling to the environment. Embedding the trapped atoms in an atomic wire of cold bosonic atoms, a dissipative phase transition may be crossed beyond which Rabi oscillations entirely disappear.

SYUA 2 Optical Lattices

Zeit: Mittwoch 14:00–16:00 Raum: HU Audimax

Hauptvortrag SYUA 2.1 Mi 14:00 HU Audimax

BEC of 6Li2 molecules: Exploring the BEC-BCS crossover — •Johannes Hecker-Denschlag — Universität Innsbruck, Technikerstrasse 25, A-6020 Innsbruck, Austria

We report on recent experiments with an ultracold degenerate Fermi gas of 6Li atoms. We start with Bose-Einstein condensation of Li2 molecules in an optical trap. Using a Feshbach resonance we can then investigate the BEC-BCS crossover where the molecular condensate is transformed into a strongly interacting gas of fermions. We probe the crossover with several methods like measurements of the trapped cloud size, collective oscillation excitations and binding energy measurements with radio frequency. In these measurements we have been able to show the existence of a pairing gap on the BCS side of the resonance. This strongly suggests the presence of a superfluid phase on the BCS side of the crossover.

Hauptvortrag SYUA 2.2 Mi 14:30 HU Audimax

Nonlinear matter waves in periodic potentials: From Adiabaticity to Zener — •Oliver Morsch — Dipartimento di Fisica, via Buonarroti 2, I-56127 Pisa, Italy

Since the early days of laser cooling, optical lattices have been a versatile toolbox for atomic physics. These periodic one-, two- or three-dimensional structures allow the creation of light-bound atomic crystals which can be easily tailored and manipulated. The advent of Bose-Einstein condensates in 1995 led naturally to the extension of optical lattice studies to the regime of nonlinear coherent matter waves. In this seminar, I shall briefly review the efforts made in that direction and then report on experiments done in our laboratory in Pisa. After some general observations on the dynamics of loading a condensate into an optical lattice, I shall present studies of nonlinear effects in Landau-Zener tunneling and of dynamical instabilities of a nonlinear matter wave inside a periodic potential.

Hauptvortrag SYUA 2.3 Mi 15:00 HU Audimax

Ultracold atomic gases in optical lattices: A bridge between Quantum Optics and Condensed Matter Physics — •Luis Santos — Institut für Theoretische Physik III, Universität Stuttgart, Pfaffenwaldring 57 V, 70550 Stuttgart, Germany

During the last few years a new research field has rapidly developed, namely that of strongly-correlated atomic gases. This new field constitutes a fascinating bridge between quantum optics, atomic physics and condensed-matter physics. In this talk I will review our recent works on the physics of ultracold atomic gases in optical lattices. I will discuss in particular atomic mixtures in optical lattices, disordered lattices, and coupled 2D gases in 2D optical lattices.

Hauptvortrag SYUA 2.4 Mi 15:30 HU Audimax

Superfluid-insulator transition in a moving system of interacting bosons — •Eugene Demler — Lyman Laboratory, Department of Physics, Harvard University, MA 02138, USA

Stability of superfluid currents in a system of strongly interacting ultracold atoms in an optical lattice will be discussed. It will be shown that the system undergoes a dynamic, irreversible phase transition at a critical phase gradient that depends on the interaction strength between atoms. Smearing of the transition boundary in low dimensional systems by quantum fluctuations will be discussed. Implications of the results to realistic experiments will be reviewed.