DY 10: Internal Symposium: Controlling Dirty Bosons: Disorder Effects on BECs

Time: Tuesday 9:30–12:15 Location: MA 001

Invited Talk DY 10.1 Tue 9:30 MA 001

Localization of interacting ultra cold atoms in a disordered potential — •Alain Aspect[1], David Clément[1], Pierre Lugan[1], Philippe Bouyer[2], Gora Shlyapnikov[1], and Laurent Sanchez-Palencia[1] — [1]Institut d'Optique, Palaiseau, France — [2]LPTMS, Orsay, France

Ultra cold atoms can be placed in disordered potentials produced by laser speckle. Such a correlated potential is very well mastered on the experimental side, and perfectly characterized so that relevant theoretical treatments can be developped. It is a useful toy model to study Anderson localization, and test the influence of interactions.

We will present experimental and theoretical results on 1D localization for a Bose Einstein Condensate placed in a laser speckle disordered potential, as a function of relevant parameters: amplitude and correlation length of the disordered potential, healing length of the BEC...

DY 10.2 Tue 10:00 MA 001

Coherent backscattering of Bose-Einstein condensates from 2D disorder potentials — •Peter Schlagheck — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany

We investigate the quasi-stationary transport of Bose-Einstein condensates through two-dimensional disorder potentials of finite thickness. Our numerical approach is based on the integration of the Gross-Pitaevskii equation in presence of a source term that simulates the continuous injection of matter waves onto the disorder potential. For noninteracting atoms, the constructive interference between reflected semiclassical paths and their time-reversed counterparts leads to a weak localization phenomenon, namely the enhanced backreflection of atoms into the direction that is opposite to the incident beam. We show that this peak of coherent backscattering is inverted and transformed into a dip by the presence of a weak interaction between the atoms. This anti-localization phenomenon is reproduced by analytical calculations of the transport process and can be related to similar nonlinear effects in the scattering of light through disordered atomic media.

Invited Talk DY 10.3 Tue 10:25 MA 001

Ultracold atoms near nanofabricated surfaces — •Jozsef Fortagh — Physikalisches Institut der Universität Tübingen, Auf der Morgenstelle 14, 72076 Tübingen

The research field of ultracold atomic quantum gases in microscopic traps has seen enormous advances within the last few years. State of the art chip fabrication technology is used to realize trapping potentials of various geometries for cold atoms, to control the distance between atoms and a solid surface with high precision, and to construct model potentials for degenerate Bose and Fermi gases. Imperfect fabrication of the field generating elements enters as a disorder in the trapping potential. This may offer novel experimental access to the physics of disordered systems. At the same time, fundamental electromagnetic interactions between atoms and the chip surface become manifest in the attractive Casimir-Polder force between atoms and the surface, and decoherence of atomic spins. These effects have been observed in experiments. I will review experimental techniques on manipulating cold atoms at nanofabricated surfaces, recent experiments on atom-surface interactions, and model experiments on atom interferometry.

Reference:

"Magnetic Microtraps for Ultracold Atoms", J. Fortágh and C. Zimmermann, Rev. Mod. Phys. 79, 235 (2007).

DY 10.4 Tue 10:55 MA 001

Collective Excitations in a Trapped Bose-Einstein Condensate with Weak Quenched Disorder — •Gianmaria Falco[1], Axel Pelster[2], and Robert Graham[2] — [1]Department of Physics, Cologne University, Zülpicher Straße 77, 50937 Köln, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

We study how the collective mode frequencies of a condensate in a harmonic trap are shifted by the presence of additional weak quenched disorder. To this end we apply the Huang-Meng theory [1,2] to an inhomogeneous condensate in the Thomas-Fermi approximation [3]. This approach describes how local condensates in the minima interfere with the superfluid property of the condensate. We work out in detail the consequences for the hydrodynamic equations. In case of a Gaussian correlated disorder correlation we find that the negative shifts of the collective frequencies for the monopole and the dipole mode decrease rapidly with increasing correlation length. Thus, our theory makes it possible to experimentally test the predictions of the Huang-Meng theory.

[1] K. Huang and H.F. Meng, Phys. Rev. Lett. **69**, 644 (1992)

[2] G.M. Falco, A. Pelster, and R. Graham, Phys. Rev. A **75**, 063619 (2007)

[3] G.M. Falco, A. Pelster, and R. Graham, Phys. Rev. A **76**, 013624 (2007)

Invited Talk DY 10.5 Tue 11:20 MA 001

Disorder in ultracold Fermi-Bose quantum gas mixtures — •Klaus Sengstock — Institut für Laserphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

The physics of ultracold gases and Bose-Einstein condensates allows various connections to other fields of physics. Especially the physics of degenerate quantum gases in optical lattices shows similarities to condensed matter systems. Prominent examples are the Mott-insulator transition and e.g. the ferromagnetic and polar phases of Bose Einstein condensates in lattices as well as effects of disorder.

This talk will give an overview on quantum gas physics in optical lattices and focus on the simultaneous trapping of mixtures of fermionic and bosonic atoms in optical lattice potential. We observe e.g. a strong influence of a small concentration of fermionic Potassium atoms on the coherence properties of bosonic Rubidium atoms in a 3D-optical lattice.

DY 10.6 Tue 11:50 MA 001

DMRG Studies of Disordered Bosons — •Ulrich Schollwöck — Institut für Theoretische Physik C, RWTH Aachen

The DMRG method has emerged as a very powerful tool to characterize the phase diagrams of strongly interacting one-dimensional systems with disorder, namely in the case of bosons. In this talk I will present various complementary approaches to study disorder effects in bosonic systems and discuss the phase diagram of a disordered Bose-Hubbard model with a box distribution as well as new results related to other forms of disorder distributions.