A 28: Transport in ultracold gases and plasmas (jointly with Q)

Zeit: Freitag 11:00–12:30 Raum: 3C

Hauptvortrag A 28.1 Fr 11:00 3C

Nonlinear coherent transport of waves in disordered media — •Thomas Wellens[1] and Benoît Grémaud[2] — [1]Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3a, 79104 Freiburg — [2]Laboratoire Kastler Brossel, Université Pierre et Marie Curie, 4 place Jussieu, 75252 Paris Cedex 05

In general, transport of waves in disordered media cannot fully be described as a simple diffusion process, since wave interference effects lead to a reduction or even complete suppression of the diffusion constant (weak or strong localization) and the appearance of a coherent backscattering peak.

In this talk, I present a diagrammatic theory for treating the impact of nonlinearities on such disorder-induced localization phenomena [1]. The theory is applied to describe propagation of weakly interacting Bose-Einstein condensates in disordered potentials, on the one hand, and multiple scattering of light in nonlinear media, on the other one. In particular, the conditions under which nonlinear effects diminish or enhance the height of the coherent backscattering peak, and the consequences for the occurrence of Anderson localization of light and cold matter are discussed. Finally, I also talk about the possibility to incorporate quantum-mechanical many-body effects (for example multi-photon scattering processes from strongly driven two-level atoms), which generally lead to decoherence, thereby reducing the localization effects.

[1] T. Wellens and B. Grémaud, PRL (in press)

A 28.2 Fr 11:30 3C

One-Dimensional Rydberg Gas in a Magnetoelectric Trap — •Bernd Hezel[1], Michael Mayle[2], Igor Lesanovsky[3], and Peter Schmelcher[1,2] — [1]Physikalisches Institut, Universität Heidelberg, 69120 Heidelberg, Germany — [2]Theoretische Chemie, Universität Heidelberg, 69120 Heidelberg, Germany — [3]Institut für Theoretische Physik, Universität Innsbruck, 6020 Innsbruck, Austria

We study the quantum properties of Rydberg atoms in a magnetic Ioffe-Pritchard trap superimposed by a homogeneous electric field. Trapped Rydberg atoms in long-lived electronic states can be created with *permanent* electric dipole moments of several hundred Debye. The resulting dipole-dipole interaction in conjunction with the radial confinement gives rise to an effectively one-dimensional ultracold Rydberg gas with a macroscopic interparticle distance. Analytical expressions for the electric dipole moment and the required linear density of Rydberg atoms can be derived.

A 28.3 Fr 11:45 3C

Structural phase transitions in low-dimensional ion crystals — •Gabriele De Chiara[1], Shmuel Fishman[2], Tommaso Calarco[3], and Giovanna Morigi[1] — [1]Departament de Fisica, Universitat Autonoma de Barcelona, 08193 Bellaterra, Spain — [2]Physics Department, Technion, 32000 Haifa, Israel — [3]Institut für Quanteninformationsverarbeitung, Universität Ulm, D89069 Ulm, Germany

A chain of singly-charged particles, confined by a harmonic potential, exhibits a sudden transition to a zigzag configuration when the radial potential reaches a critical value, depending on the particle number. This structural change is a phase transition of second order, whose order parameter is the crystal displacement from the chain axis. We study analytically the transition using Landau theory and find full agreement with numerical predictions by J. Schiffer [Phys. Rev. Lett. 70, 818 (1993)] and Piacente et al. [Phys. Rev. B 69, 045324 (2004)]. Our theory allows us to determine analytically the system's behaviour at the transition point.

A 28.4 Fr 12:00 3C

Damped Bloch Oscillations of Bose Einstein Condensates in disordered gradient fields — •Sascha Drenkelforth, Georg Kleine Büning, Johannes Will, Wolfgang Ertmer, and Jan Arlt — Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover

Optical lattices are excellent tools to probe the nature of quantum degenerate Bose gases and serve as an ideal testing ground for theories originating in solid state physics.

One of the most peculiar effects in the framework of periodic potentials is the well known Bloch Oscillation (BO) of quantum particles. Under the influence of a constant force they undergo an oscillatory motion instead of a linear acceleration.

We report on our investigations of damped BO in optical lattices. The addition of disorder to the prior perfect optical lattice leads to an dephasing and therefore to a damping of the BO [1]. The experimental results show increased damping with stronger disorder and a strong broadening of the quasimomentum distribution during the time evolution of the BO.

These results promise a better understanding of the role of disorder in quantum transport experiments.

[1] Schulte et al., cond-mat/0707.3131(2007)

A 28.5 Fr 12:15 3C

Sympathetic Cooling of Ions using Laser-Cooled One-Component Plasmas — •Michael Bussmann[1], Ulrich Schramm[2], Peter Thirolf[1], Veli Kolhinen[1], Jerzy Szerypo[1], Juergen Neumayr[1], Michael Sewtz[1], and Dietrich Habs[1] — [1]Ludwig-Maximilians-Universitaet Muenchen, Am Coulombwall 1, 85748 Garching — [2]Forschungszentrum Dresden-Rossendorf, Bautzner Landstraße 128, 01328 Dresden

We present new simulation results on sympathetic cooling of ions for precision experiments. Using a laser-cooled one-component plasma of 10^5 $^{24}Mg^+$ ions it is possible to stop and sympathetically cool ions to mK temperatures. With the proposed cooling scheme fast and efficient cooling of rare nuclei for precision in-trap physics, e.g. subsequent mass measurements in Penning traps, becomes possible. In the talk we will give an overview of previous results before presenting new results on the stopping dynamics, especially the interplay of collective dynamics, plasma stability and recooling efficiency.

[1]Bussmann M. et al., European Physical Journal D 45(1) (2007) 129-132.

[2]Bussmann M. et al., Hyperfine Interactions 173(1-3) (2007) 27-34.