Bose-Einstein Condensates in Strongly Disordered Traps — THOMAS NATTERMANN\textsuperscript{1} and VALERY POKROVSKY\textsuperscript{2} — 1\textsuperscript{1}Institut für theoretische Physik der Universität zu Köln \textsuperscript{2}Department of Physics, Texas A&M University, USA

A Bose-Einstein condensate in an external potential consisting of a superposition of a harmonic and a random potential is considered theoretically. From a semi-quantitative analysis we find the size, shape and excitation energy as a function of the disorder strength. For positive scattering length and sufficiently strong disorder the condensate decays into fragments each of the size of the Larkin length $L$. This state is stable over a large range of particle numbers. The frequency of the breathing mode scales as $1/L^2$. For negative scattering length a condensate of size $L$ may exist as a metastable state. These findings are generalized to anisotropic traps.

Ultracold bosons in lattices with disorder created by \textit{heavy} impurities — Konstantin V. Krutitsky\textsuperscript{1, 2}, Michael Thorwart\textsuperscript{1}, Reinhold Egger\textsuperscript{2}, and Robert Graham\textsuperscript{3} — 1\textsuperscript{1}Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany — 2\textsuperscript{2}Institut für Theoretische Physik IV, Heinrich-Heine-Universität Düsseldorf, Germany

Quantum phases of ultracold bosons with repulsive interactions in optical lattices in the presence of disorder are investigated. The disorder is assumed to be caused by the interaction of the bosons with impurity atoms having a large effective mass. The system is described by the Bose-Hubbard Hamiltonian with on-site energies which have a discrete probability distribution. The phase diagram at zero temperature is calculated using several methods like a strong-coupling expansion, an exact numerical diagonalization, a Bose-Fermi mapping, as well as two different versions of a mean-field theory.

Dipole Oscillations of a Bose-Einstein Condensate in Presence of Defects and Disorder — Thomas Paul, Matthias Albert, Nicolas Pavloff, and Patricio Liebouet — Laboratoire de Physique Théorique et Modèles Statistiques, Université Paris Sud

We study the dipole oscillations of a weakly interacting BEC, confined in a harmonic cigar-shaped trap with a tight transverse confinement but a shallow axial trapping frequency in presence of an external defect or random potential. Our main result is a new, global picture characterizing the dynamical properties of the dipole oscillations, where different regimes of condensate dynamics are observed: For small-amplitude dipole oscillations we demonstrate that the BEC-flow is superfluid and the dipole oscillations are almost undamped, but the external potential induces a small shift of the oscillations frequency. When the center of mass motion reaches a critical velocity the superfluid behavior breaks down and one enters a regime of dissipative dynamics characterized by a strong damping of the dipole oscillations.

Many-body diffusion in disordered potentials — Sandro Wimberger — Institut für Theoretische Physik, Universität Heidelberg, D-69120 Heidelberg

Ongoing experiments with Bose-Einstein condensates are studying the quantum transport of ultracold atoms in disordered potentials. Going beyond the currently investigated regimes, we predict a crossover between regular and quantum chaotic dynamics as a function of the disorder strength. Our spectral approach is based on the Bose-Hubbard model describing the motion of strongly interacting bosonic atoms in deep potentials. Our statistical predictions on the spectral properties are readily observable by monitoring the evolution of typical experimental initial states.

Disorder physics in atomic mixtures — Oleksandr Fialko and Klaus Ziegler — Universität Augsburg

Mixtures of different atomic species represent complex quantum systems with competing degrees of freedom. They can be created either by filling two types atoms in an optical lattice [1, 2] or by allowing an atomic cloud to form molecules due to attractive interatomic interactions [3-4]. The competing degrees of freedom can lead to competing quantum phases, phase transitions, phase separation, and correlation induced disorder. We discuss various systems with elastic and inelastic scattering, quantum phases, and the possibility of Anderson localization.
We develop a systematic extension of the usual site decoupling mean field theory for the disordered Bose Hubbard model, extending the self-consistency condition to account for disorder induced inhomogeneity of the mean field parameter, by using a probability distribution. This method is capable of describing the Bose glass in the thermodynamic limit at $T=0$ and recovers the usual MFT in the limit of vanishing disorder, as well as the arithmetically averaged MFT in the limit of infinite dimensions, where the Bose glass border shifts to $J_Z=0$. Phase diagrams are presented for a box disorder distribution and the limit of strong disorder is discussed.