SFB/TRR 21 - Seminar

28. Oktober 2010, Ulm

CO.CO.MAT

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From localization to coherence: A tunable Bose-Einstein condensate in disordered potentials

Anderson localization of ultracold atoms in disordered optical lattices, i.e. the transition from extended to exponentially localized states, was recently demonstrated for non-interacting samples. With the addition of atomic interactions, such a system becomes more complicated and is more difficult to describe theoretically. The effects of the disorder are expected to be gradually suppressed by repulsive interactions, and the possibility of different quantum phases arises. We employ a Bose-Einstein condensate of potassium, where the interaction can be tuned from negligible to large values via a Feshbach resonance and use a quasi-periodic lattice potential as a model of a controllable disordered system. This allows us to study the interplay of disorder and repulsive interactions in detail. We characterize the entire delocalization crossover through the study of the average local shape of the wavefunction, the spatial correlations, and the phase coherence. Three different regimes are identified and compared with theoretical expectations: an exponentially localized Anderson glass, the formation of locally coherent fragments, as well as a coherent, extended state. We also study the expansion dynamics of the system for which we observe a crossover from localization to subdiffusive expansion for increasing interactions.

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