

CQD Kolloquium – Poster Session

Transport in a Many-Body Wannier-Stark Setup

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Ultra-cold atoms in optical lattices

Ultra-cold atoms in optical lattices are systems showing rich and complex behaviour

- Bose-Einstein condensates are easily created and loaded into optical lattices
- physical parameters can be controlled almost at will and many different Hamiltonians realized
- quantum effects can be studied in detail



We focus on ultra-cold bosons in deep optical lattices, which allow to realize the Wannier-Stark Hamiltonian for interacting particles.

(Proc. Natl. Acad. Sci. USA 107, 11000 (2010))

Methods of investigation

We use different theoretical methods to investigate various topics in transport problems and the influence of different parameters on the number of interactions. These methods are:

- algebraic renormalization
- Floquet-Lanczos algorithm
- full diagonalization and matrix renormalization
- variational approaches
- time-dependent perturbation theory
- dual effective models
- compare results with exact results (DMRG)

(J. Stat. Mech. P02016 (2012))

On the band coupling: avoided crossings

- Single particle's Wannier-Stark spectrum
- the tilt F is the control parameter
- single particle avoided crossing at this $F_c = \frac{1}{2} \sqrt{2t^2 - 4V^2}$
- typical exchange of character of F_c counteracting case: $V > t$ hidden



Manifold



- spectral analysis
- density of avoided crossings $\rho(F) = \frac{dN}{dF}$
- crossover between regions with ρ_c : a few and many avoided

On the dynamics: EF's diffusion!

Through E_c ...

- many-body avoided crossing is crucial of deep Luttinger-Liquid states
- negative diffusion: $D(F) = -D_0 \ln |F - F_c|$



The total conductance $G(F)$ is the diffusion exponent on the $D(F) = -D_0 \ln |F - F_c|$

of the subdimension function $\ln |G(F) - G_c| = -D_0 \ln |F - F_c|$

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Kirchhoff-Institut, INF 227