

# 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 104, 10000 (2007))

### Methods of investigation

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

- algebraic renormalization
- Floquet-Lanczos algorithm
- full diagonalization and matrix renormalization
- variational approaches
- time-dependent perturbation theory
- exact 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  $F_c = \frac{1}{2} \sqrt{2J^2 - K^2}$
- typical exchange of character of  $F_c$  (interacting case:  $\sqrt{J^2 - K^2}$  hidden)



Manifold

### On the dynamics: EF's diffusion!

Through  $E_c$ ...

- many-body avoided crossing is visible at deep Lattices. One can observe a negative diffusion,  $D(F) = -D_0 + \frac{1}{2} J^2$



The total conductance  $G(F)$  is a function of the diffusion coefficient  $D(F)$  and the transmission function  $T(E)$  of the subsystems located in eq. (1)  $G(F) = \frac{1}{2} \int_{-\infty}^{\infty} T(E) D(F) dE$

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Kirchhoff-Institut, INF 227