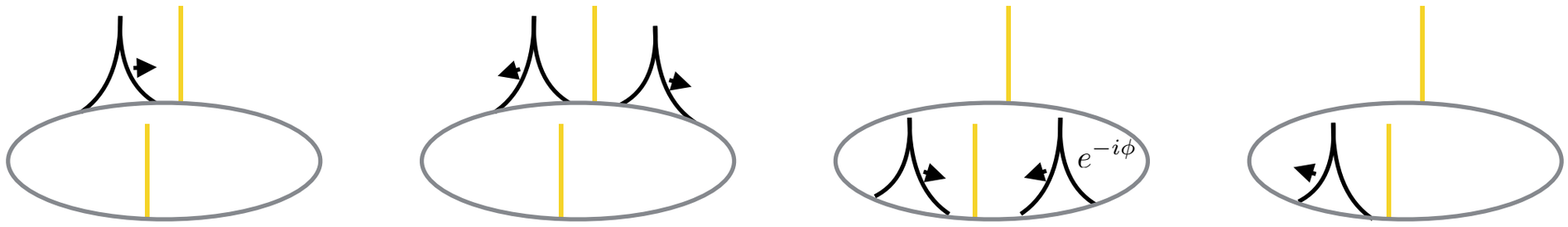
Soliton interferometry in atomtronic circuits.



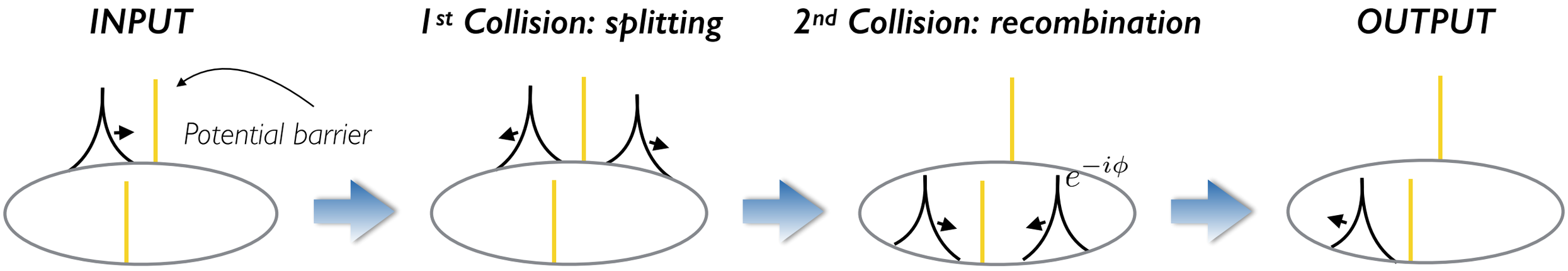
Piero Naldesi

LPMMC - Laboratoire de Physique et Modélisation des Milieux Condensés

Grenoble

Introduction - Solitons Interferometry in ATOMTRONIC circuits

Mach-Zehnder interferometer with solitons



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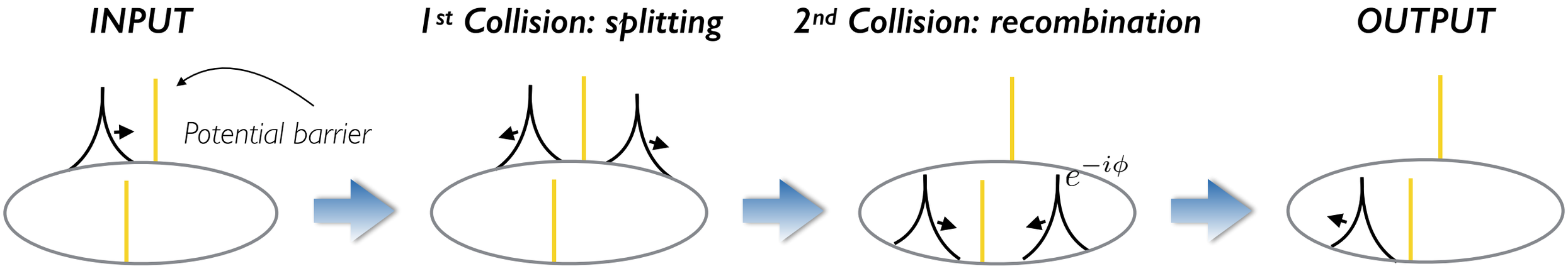
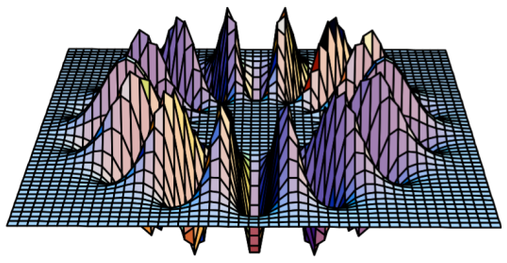
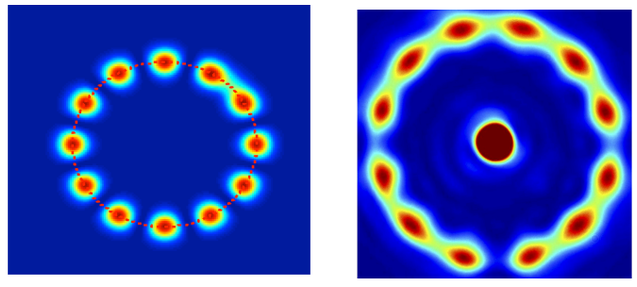


Atomtronic devices provide the best framework for experiments with ultra-cold gases in a ring geometry



Amico, Osterloh, Cataliotti, PRL 2005.



Ring-shaped optical lattices

Amico, Aghamalyan, Aukstol, Crepatz, Kwek, Dumke SREP 2014.

Aghamalyan, Nguyen, Auksztol, Gan, Martinez Valado, Condylis, Kwek, Dumke, Amico NJP 2016

Aghamalyan, Cominotti, Rizzi, Rossini, Hekking, Minguzzi, Kwek, Amico, NJP 2015.

Bosons with attractive interaction in a lattice - Bose-Hubbard Model

$$\hat{H}(U) = -J \sum_{j=-L/2}^{L/2} \left(b_j^\dagger b_{j+1} + b_{j+1}^\dagger b_j \right) + \frac{U}{2} \sum_{j=-L/2}^{L/2} \hat{n}_j \left(\hat{n}_j - 1 \right)$$

attractive interactions $U < 0$

N-particles problem is not exactly solvable: still a lot of open questions!

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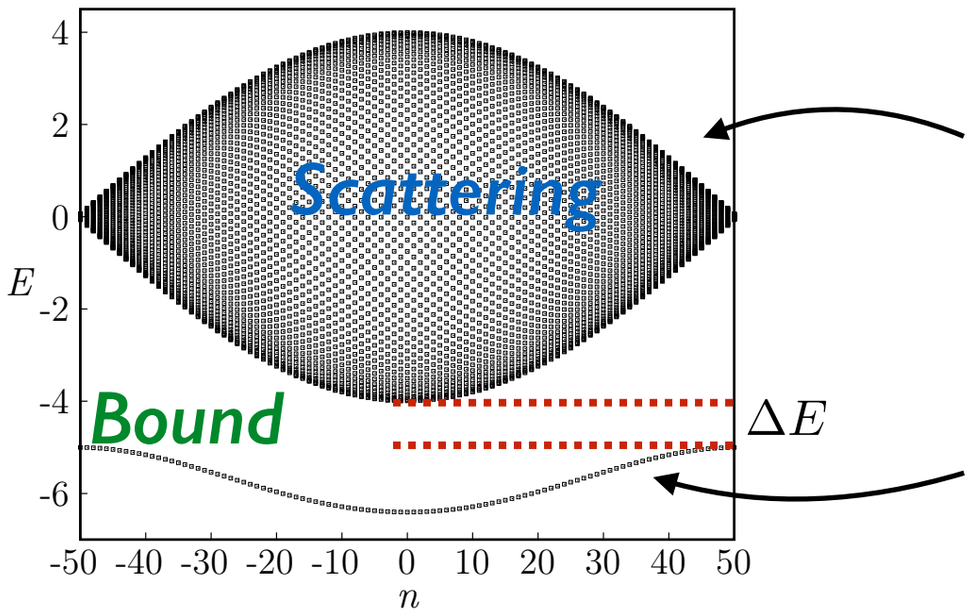
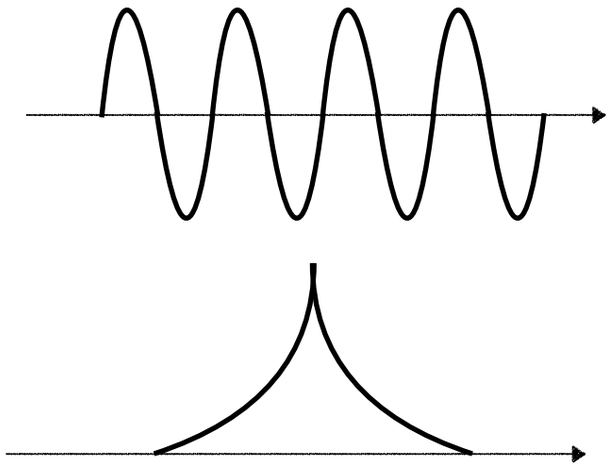


Scattering states



Bound states

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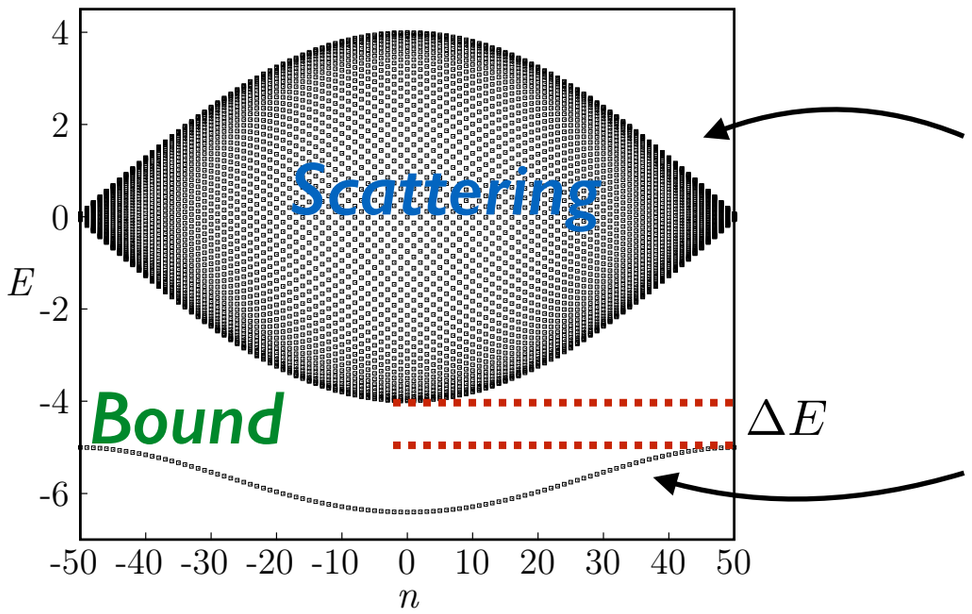

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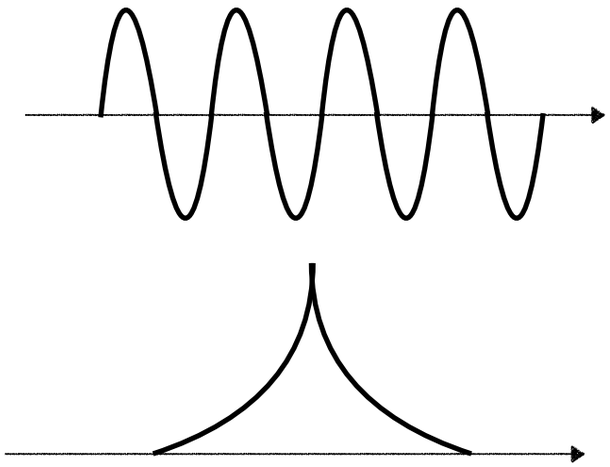


Bound states

N-particle problem

DMRG: Density Matrix Renormalization Group

S. R. White, PRL 69 2863 (1992) *S. R. White, PRB 48 10345 (1993)* *A. Feiguin, S. R. White, PRB, 72, 020404 (2005)*

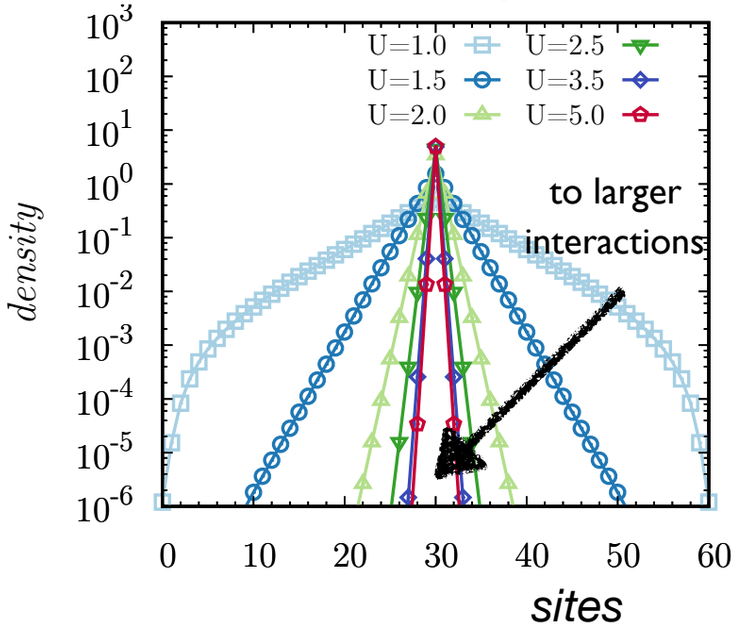
Numerical technique for ground state and firsts excited states in lattice systems.

IDEA: describe the system with only the most relevant states in the density matrix

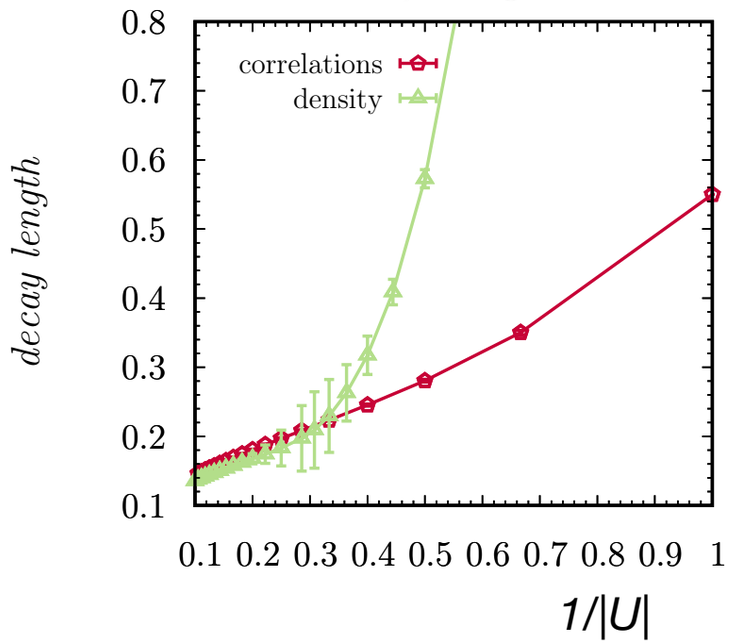
Results: density, correlations & fragmentation

Characterisation of solitons from the decay of density and density-density correlations.

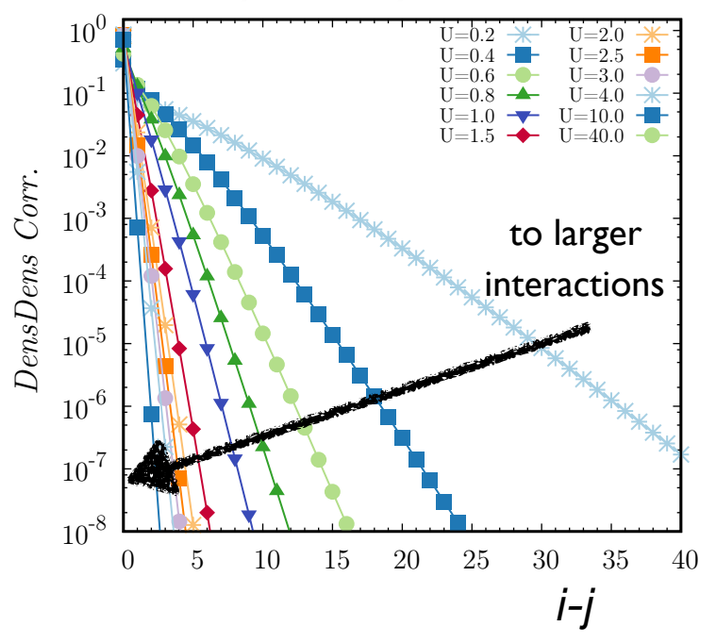
density



decay length



density-density correlations



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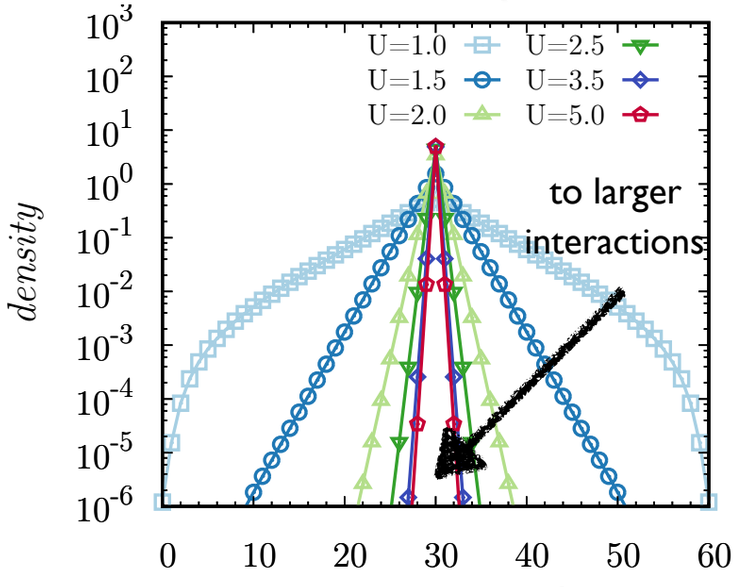

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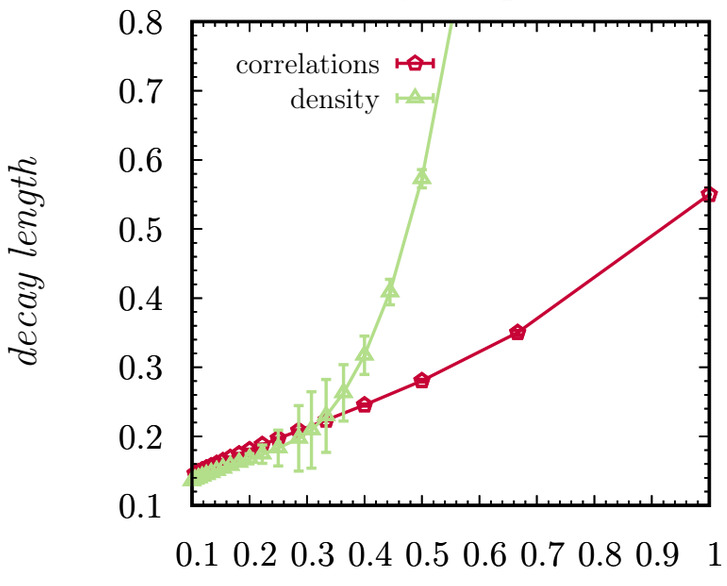
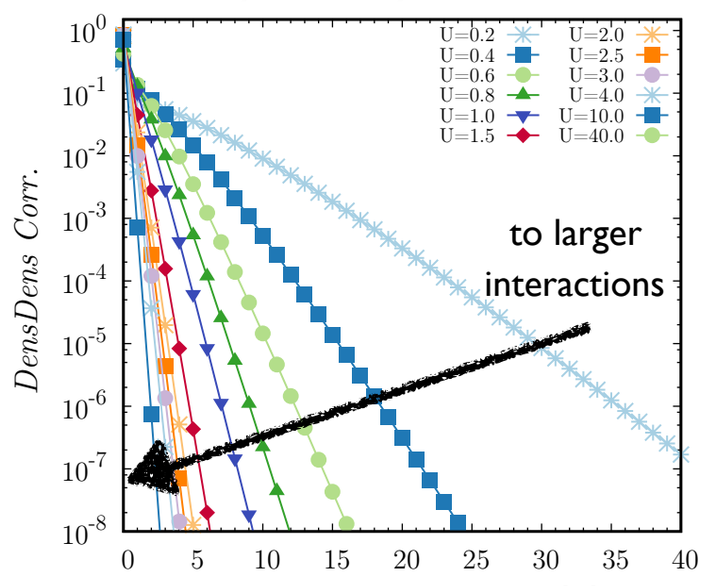
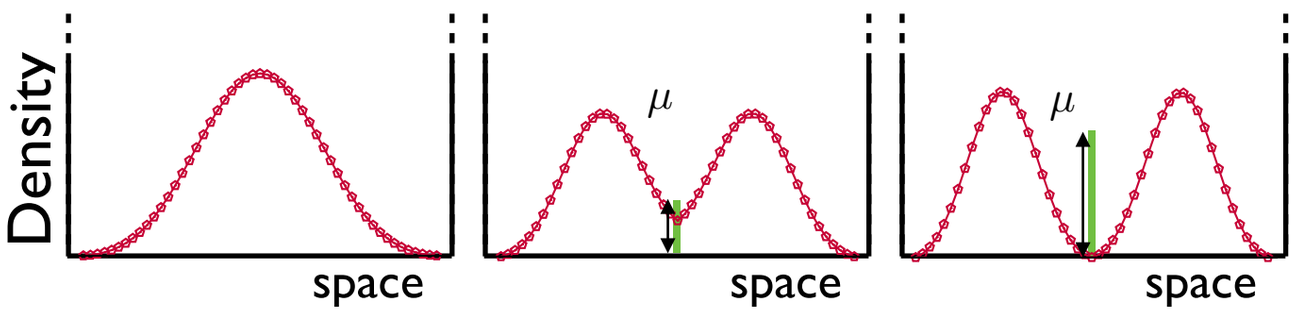


density-density correlations



Splitting of a soliton in a fragmented state by a potential barrier.



$$|\psi\rangle = \sum_{\alpha=0}^{N} c_\alpha \, |N-\alpha\rangle_L |\alpha\rangle_R$$