UNIVERSITÀ DELLA CALABRIA

MANY PARTICLE SIGNATURE OF A MOBILITY EDGE IN A BICHROMATIC LATTICE

PHYSICAL REVIEW A 95, 033605 (2017)

Jacopo Settino

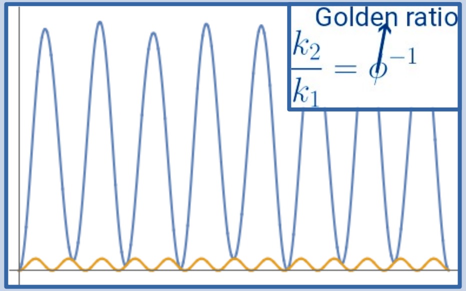
Frank Hekking Memorial Workshop, Les Houches, 28 Jen 2018

1

Incommensurability

What is a bichromatic lattice?

$$V(x) = V_1 sin^2(k_1 x) + V_2 sin^2(k_2 x + \phi)$$



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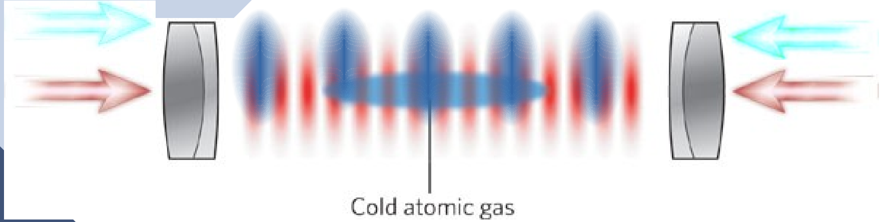

Phase Transition

Tight Binding Approximation **($V_1 >> E_r$)**

MAPPING

ANDRÉ–AUBRY MODEL

$$\hat{H} = \Delta \sum_j \cos(2\pi\tau j)|j\rangle\langle j| - J\sum_j (|j+1\rangle\langle j| + |j\rangle\langle j+1|)$$

Disorder

Wannier states

Hopping

Phase Transition

Tight Binding Approximation $(V_1 \gg E_r)$

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Incommensurability

Wannier states

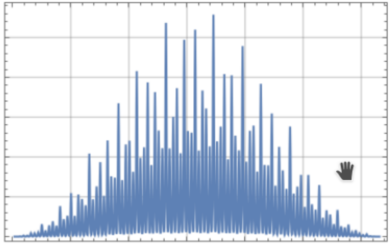
Hopping

Phase Transition

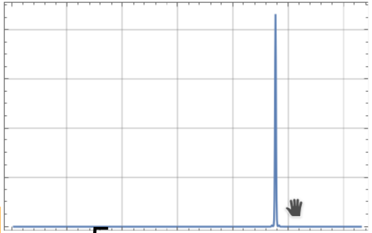
Matal to Insulator

2 J = Δ

Delocalized



Localized

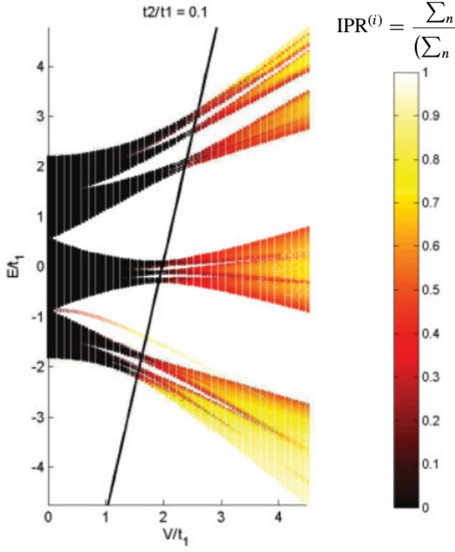


Mobility Edge

ANDRÉ–AUBRY NNN MODEL

$$\begin{pmatrix} t_2(u_{n+2} + u_{n-2}) + t_1(u_{n+1} + u_{n-1}) \\ +V\cos(2\pi\alpha n + \delta)u_n \end{pmatrix} = Eu_n$$

$$\mathrm{IPR}^{(i)} = \frac{\sum_n |u_n^{(i)}|^4}{\left(\sum_n |u_n^{(i)}|^2\right)^2}$$



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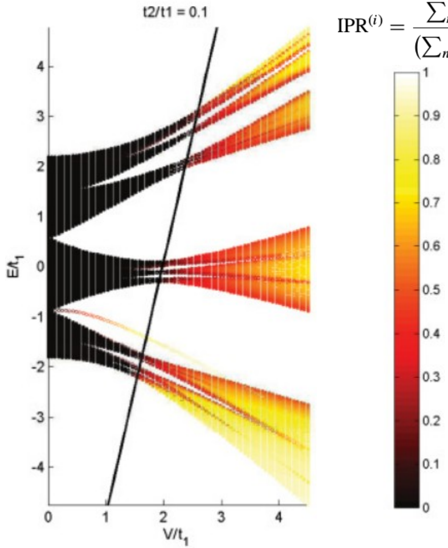
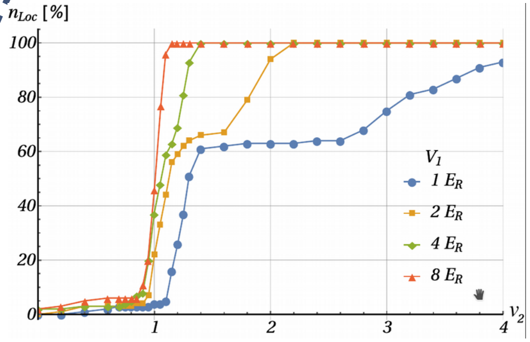
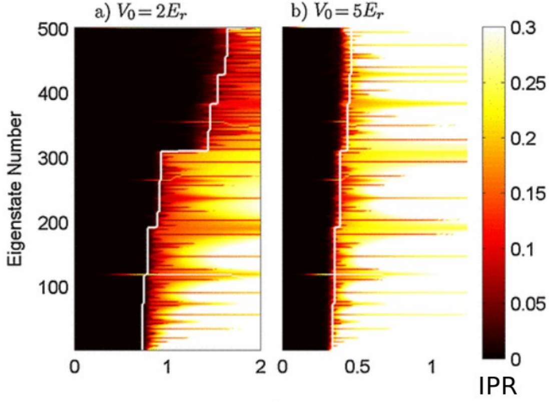
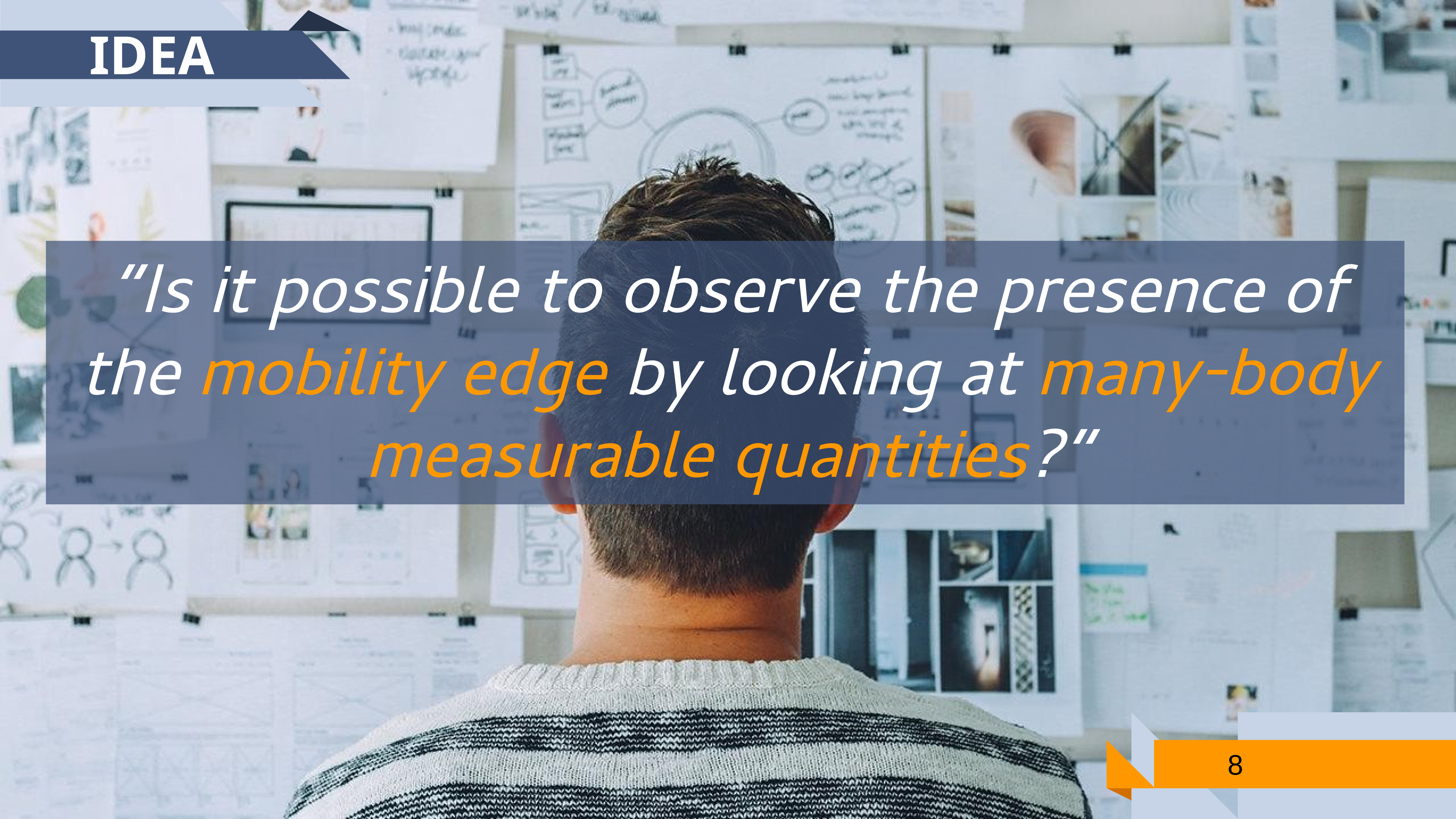


CONTINUOS MODEL

$$V(x) = V_1 sin^2(k_1 x) + V_2 sin^2(k_2 x + \phi)$$







IDEA

"Is it possible to observe the presence of the mobility edge by looking at many-body measurable quantities?"

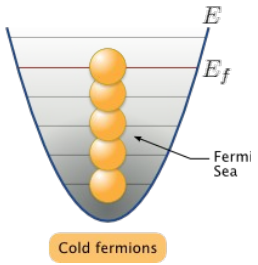
2

Many-body systems

- Noninteracting fermions
- Hardcore bosons

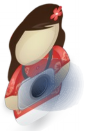
Non–interacting fermions

T=0



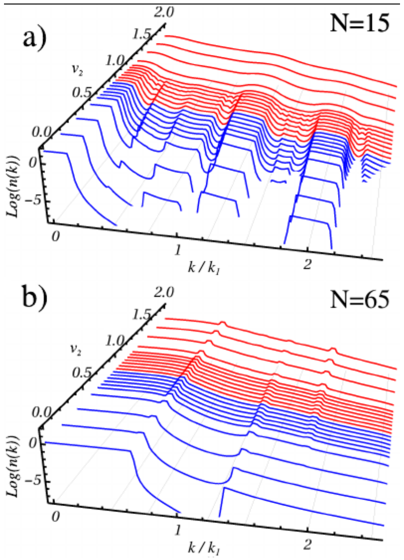
Reduced Single Particle Density Matrix

$$\rho_F(x,y) = \int dx_2 ... dx_N \Psi_F^*(x, ..., x_N) \Psi_F(y, ..., x_N)$$



Momentum distribution

$$n_F(k) = \frac{1}{2\pi} \int dx dy \exp^{ik(x-y)} \rho_F(x,y)$$



Non–interacting fermions

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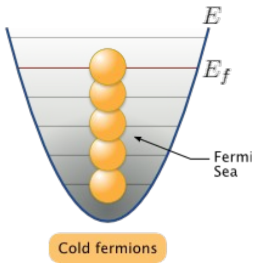

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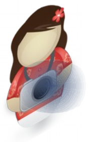

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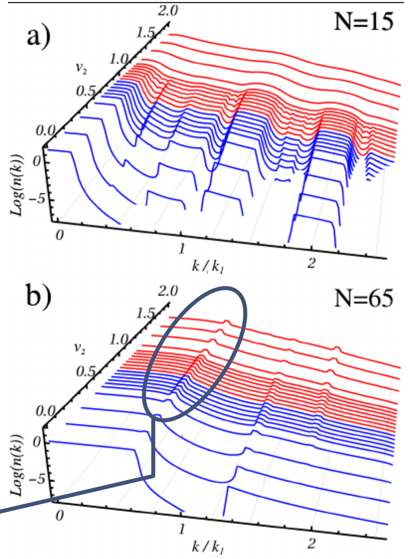
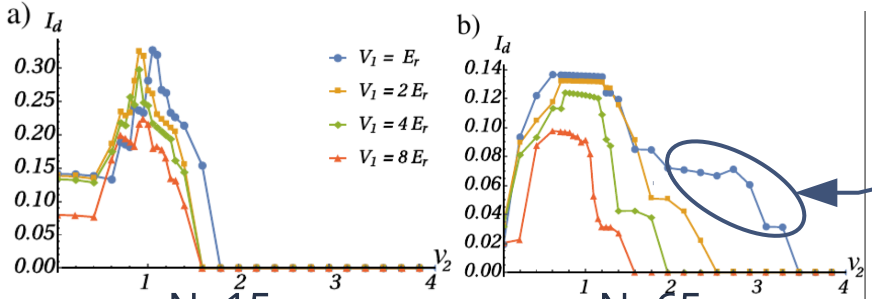


Intensity of peaks



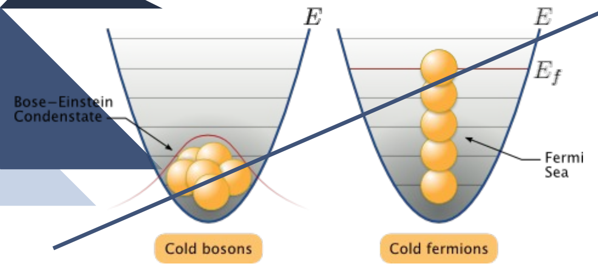
N=15 N=65

Hardcore Bosons

Strogly interacting

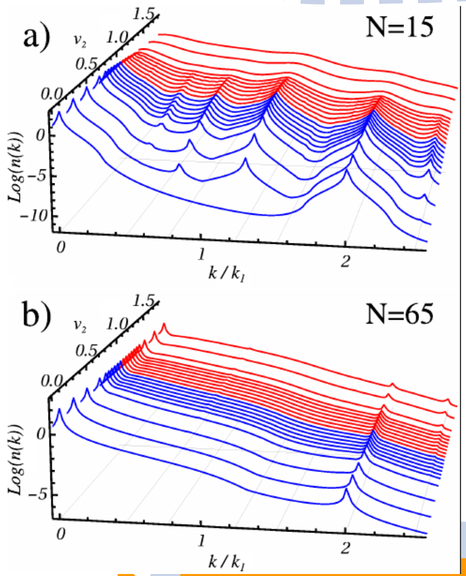
$U_{ij} = g\ \delta(x_i - x_j) \qquad g \to \infty$

T=0



$$\Psi_B = A\Psi_F \quad A = \prod_{1\le i<j\le N} \mathrm{sgn}(x_i - x_j)$$

Momentum distribution



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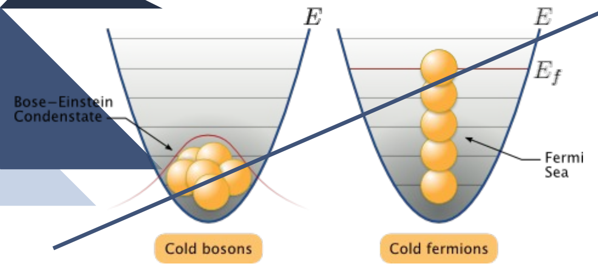

$U_{i\,j} = g\ \ \delta(x_i - x_j)$ $\qquad g \rightarrow \infty$

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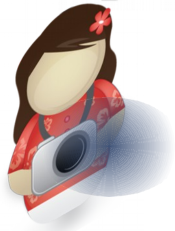

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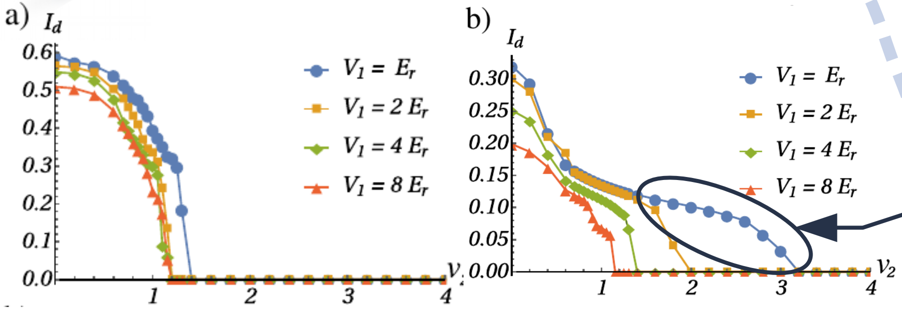
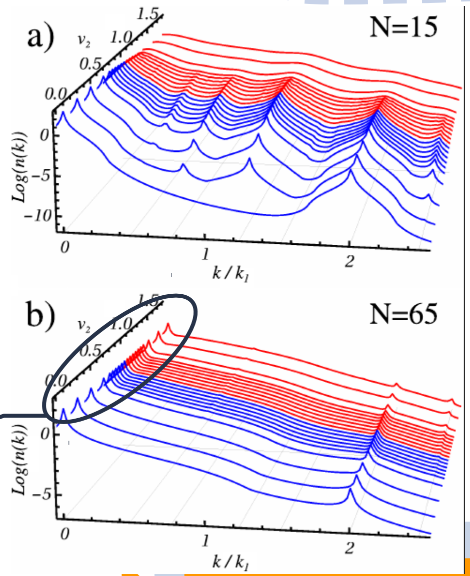
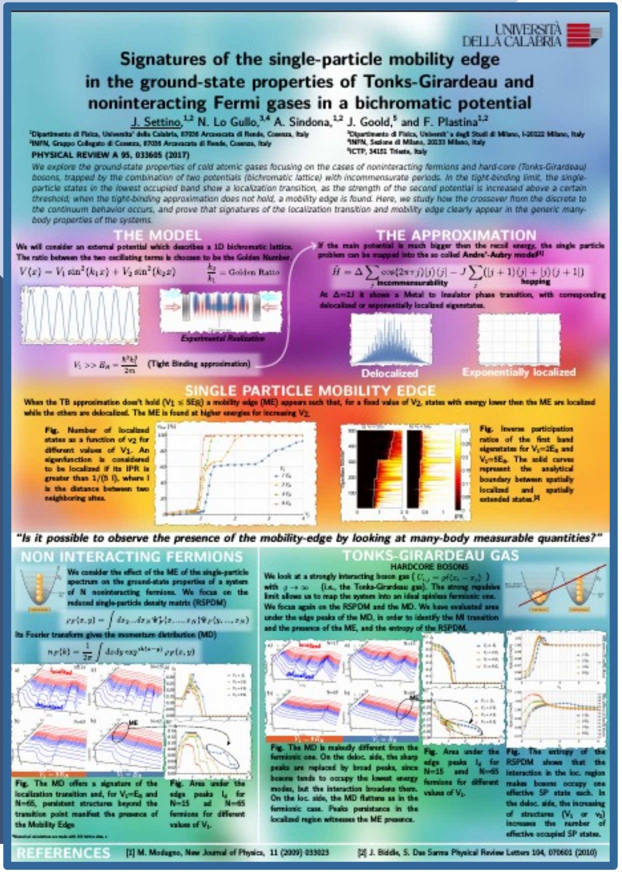




THANK YOU!



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