

Recent results dynamics

Lack of thermalization in lattice gauge theories

Titas Chanda, Jakub Zakrzewski, Maciej Lewenstein, Luca Tagliacozzo
Phys. Rev. Lett. 124, 180602 (2020)

Abelian QED 2

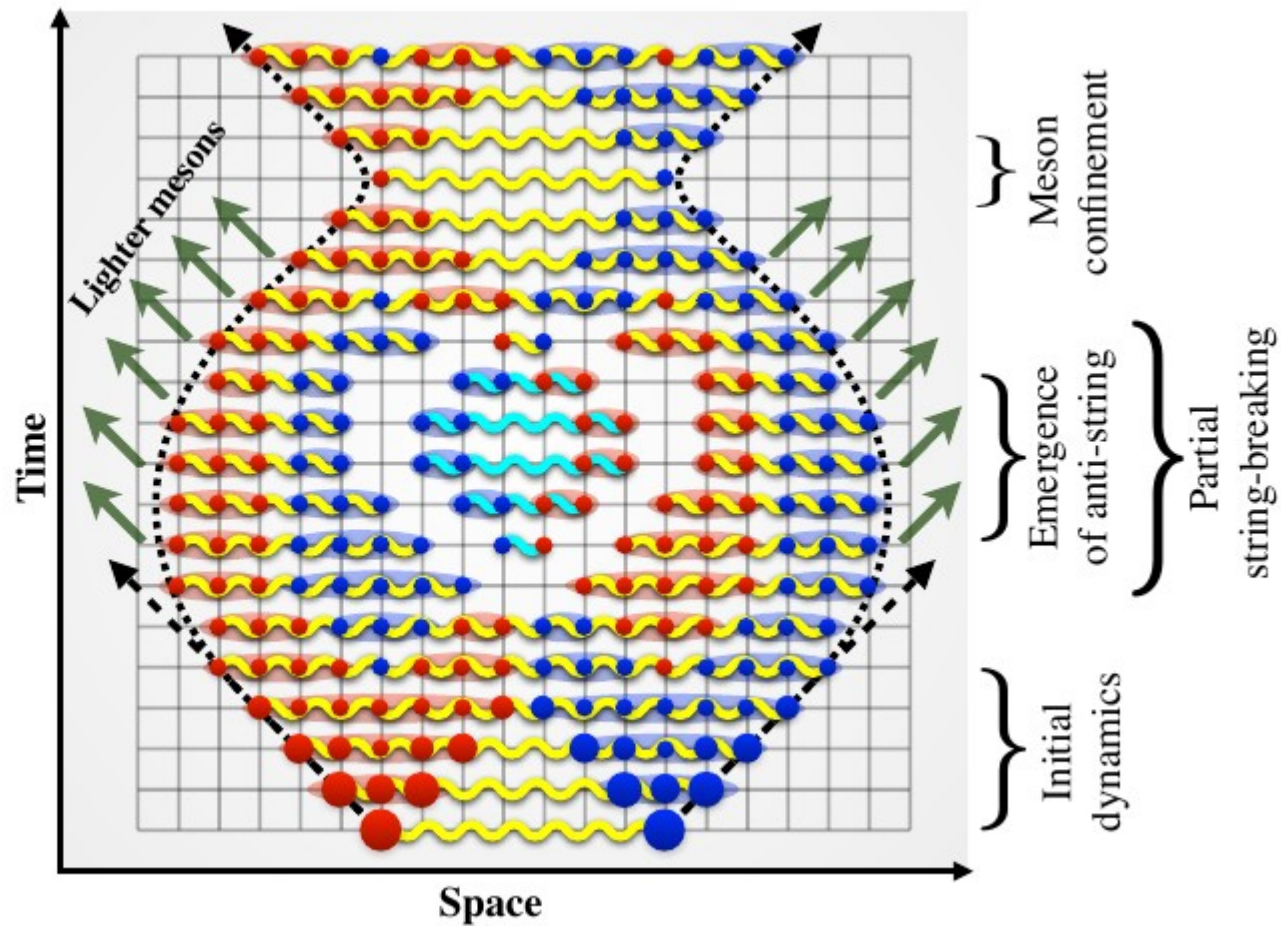
$$\begin{aligned} \hat{H} = & \sum_j \hat{L}_j^2 + 2 \left(x \left((m/q)^2 + 2x \right) \right)^{1/2} \sum_j (\hat{a}_j^\dagger \hat{a}_j + \hat{b}_j \hat{b}_j^\dagger) \\ & - \frac{x^{3/2}}{\left((m/q)^2 + 2x \right)^{1/2}} \sum_j \left[(\hat{a}_{j+1}^\dagger + \hat{b}_{j+1}) \hat{U}_j (\hat{a}_j + \hat{b}_j^\dagger) + \text{h.c.} \right], \end{aligned} \tag{1}$$

● Positive charge
(more particles)

● Negative charge
(more antiparticles)

Positive
electric field

Negative
electric field

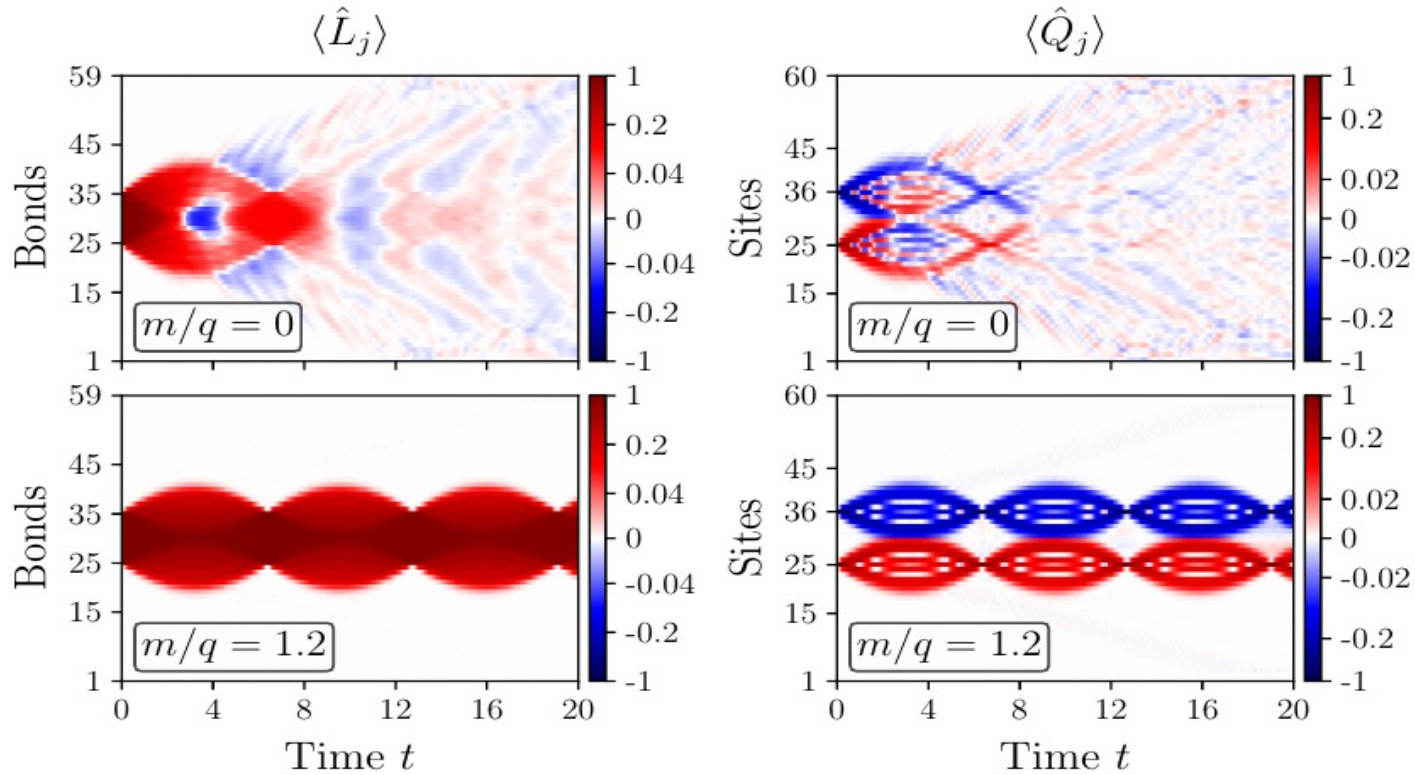


Quench protocol

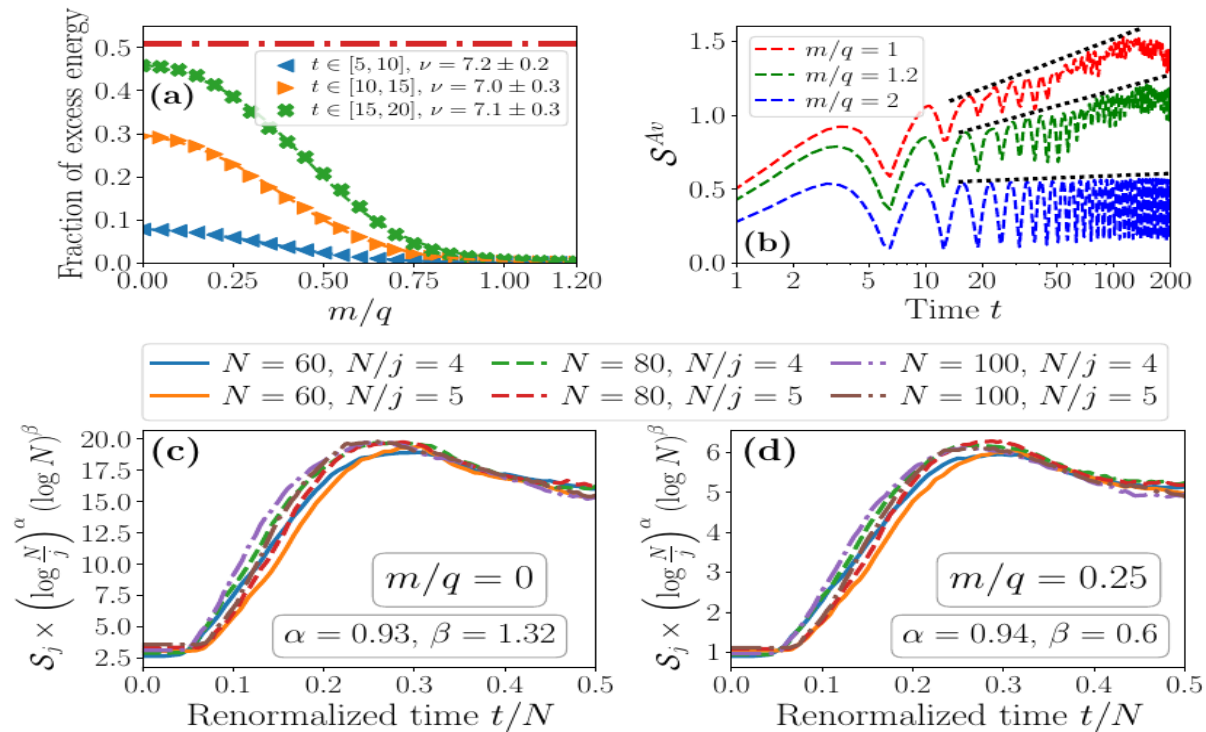
- We obtain the ground state of H with MPS
- Act with the operator

$$\hat{M}_R \equiv \left(\hat{a}_{\frac{N}{2}-R}^\dagger + \hat{b}_{\frac{N}{2}-R} \right) \left[\prod_{j=\frac{N}{2}-R}^{\frac{N}{2}+R} \hat{U}_j^\dagger \right] \left(\hat{a}_{\frac{N}{2}+R+1} + \hat{b}_{\frac{N}{2}+R+1}^\dagger \right) \quad (2)$$

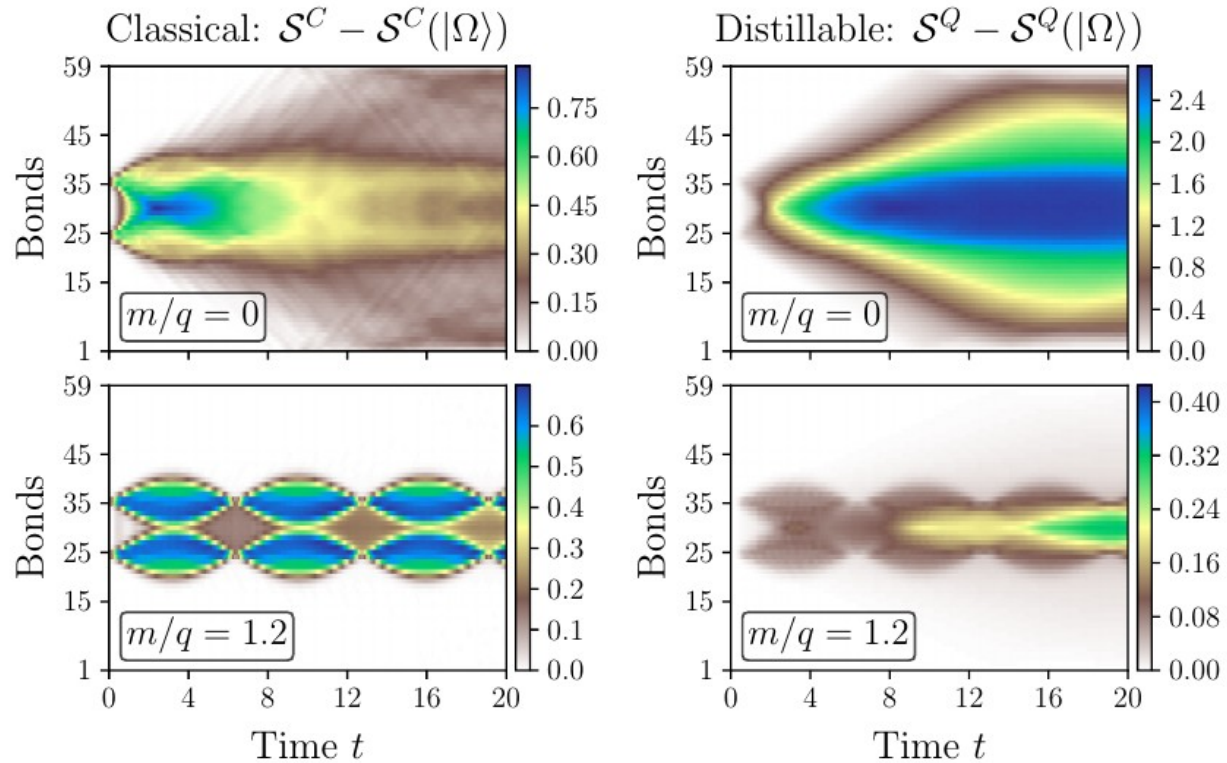
Numerical results



Entanglement entropy



Entropies contributions



Recent results static

Robust Z_2 deconfined phase

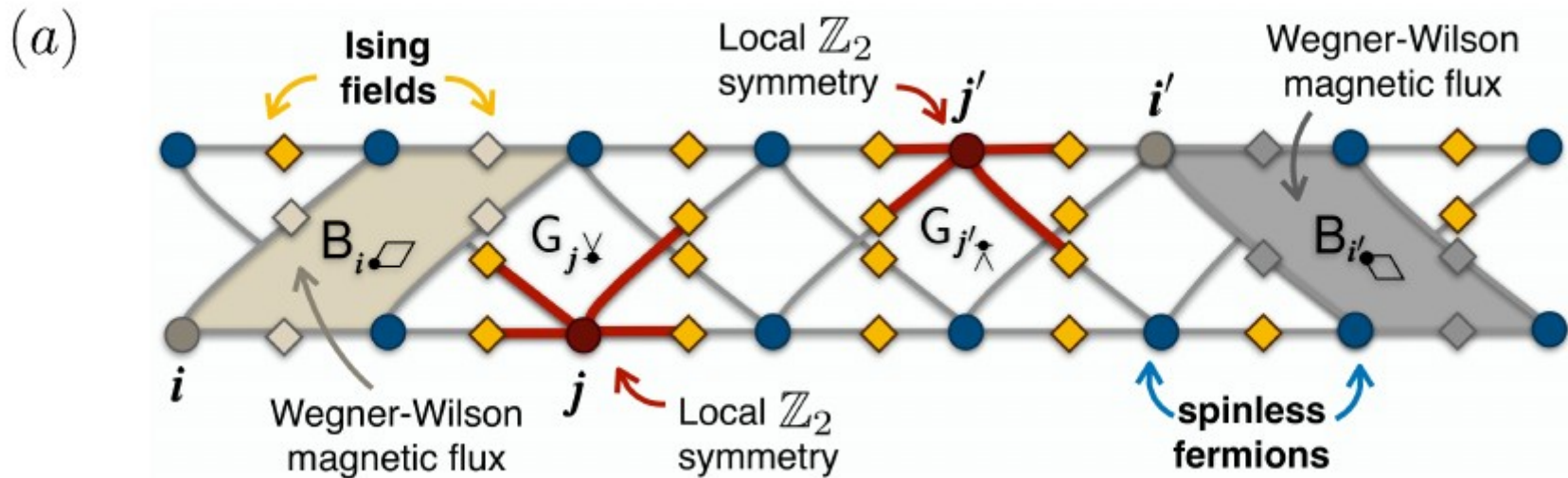
arXiv:2002.06013

Daniel González-Cuadra, Luca Tagliacozzo, Maciej Lewenstein, Alejandro Bermudez

Ladder

- Fermions coupled to \mathbb{Z}_2 gauge fields

$$H_{\text{CI}}(t, \Delta, h) = \sum_i \sum_{(i,j)} \left(-t c_i^\dagger \sigma_{(i,j)}^z c_j - h \sigma_{(i,j)}^x \right) + \frac{\Delta}{2} \sum_i s_i c_i^\dagger c_i,$$



Gauge constraints

$$G_{i\blacktriangledown} = (-1)^{c_i^\dagger c_i} \prod_{(i,j) \in i\blacktriangledown} \sigma_{(i,j)}^x, \quad G_{i\blacktriangleright} = (-1)^{c_i^\dagger c_i} \prod_{(i,j) \in i\blacktriangleright} \sigma_{(i,j)}^x,$$

And we define gauge sectors,

$$G_i |\psi\rangle = (-1)^{q_i} |\psi\rangle,$$

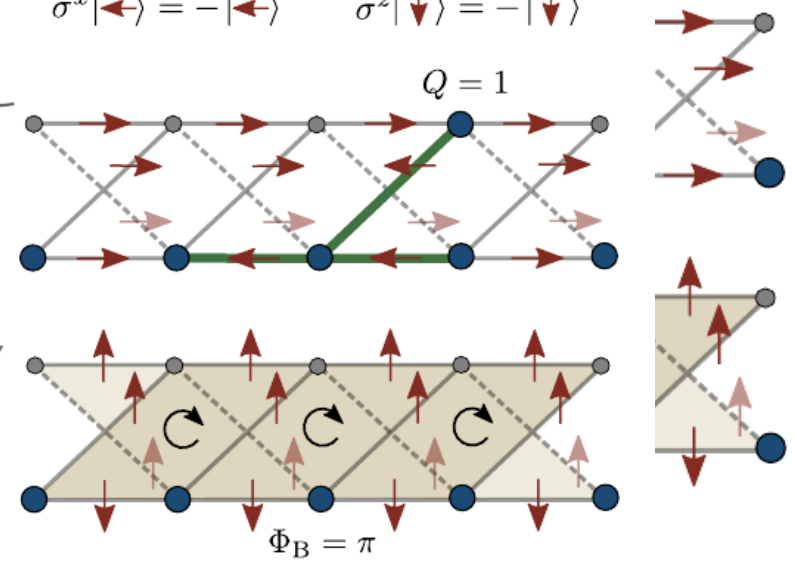
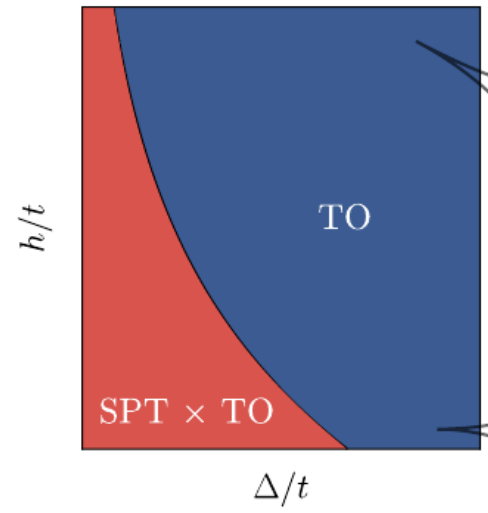
Phase diagram

(b)

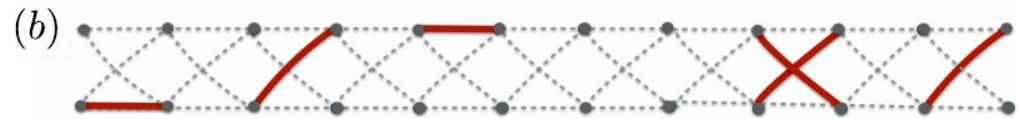
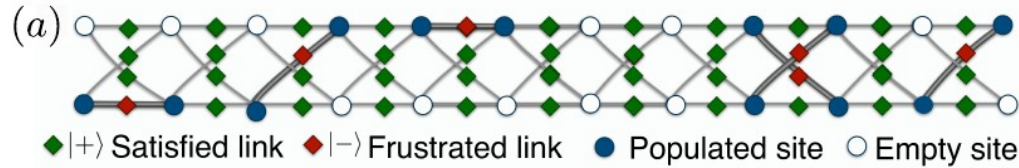
(c) $\sigma^x|\rightarrow\rangle = +|\rightarrow\rangle$ $\sigma^z|\uparrow\rangle = +|\uparrow\rangle$
 $\sigma^z|\downarrow\rangle = -|\downarrow\rangle$

(b)

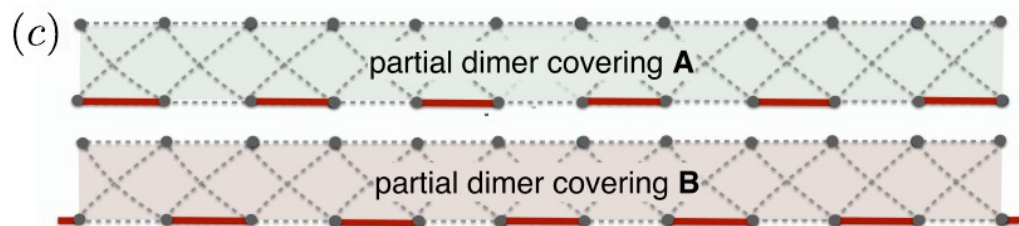
(c) $\sigma^x|\rightarrow\rangle = +|\rightarrow\rangle$ $\sigma^z|\uparrow\rangle = +|\uparrow\rangle$
 $\sigma^x|\leftarrow\rangle = -|\leftarrow\rangle$ $\sigma^z|\downarrow\rangle = -|\downarrow\rangle$



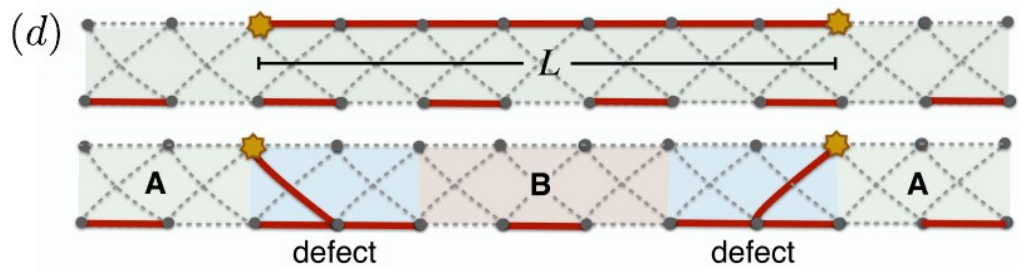
Soliton induced deconfinement



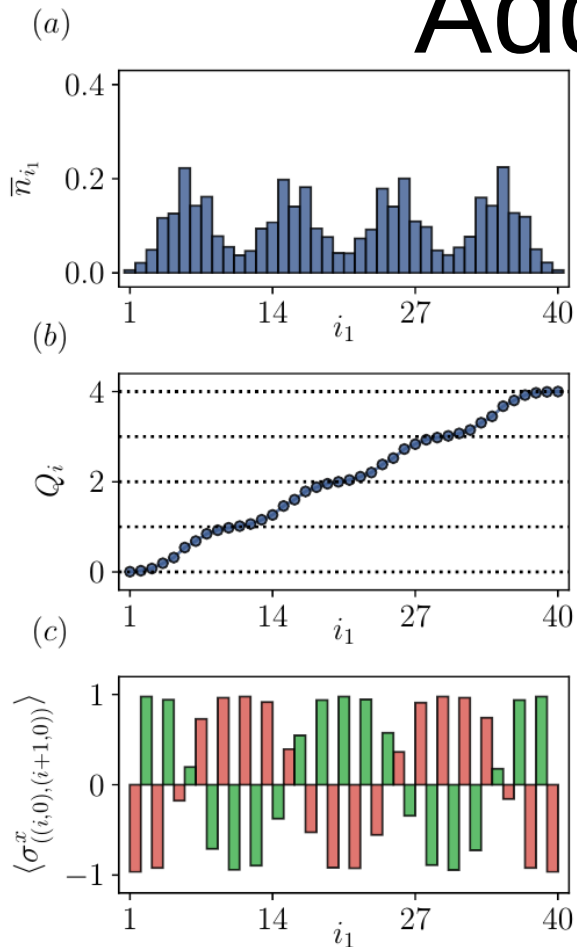
$\hbar \gg t, J$ and $\Delta = 0$ limit



$\Delta > 0$



Adding 4 fermions



- The extra occupation
- The electric field
- The integrated extra charge

$N = 44$ particles for $\Delta = 4t$, $h = 0.2t$ and $J = 0$,