Percolation Transitions in Interacting Many-Body Flatband Systems

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Many-Body Flatband Localization

$$\hat{\mathcal{H}} = \hat{\mathcal{H}}_{\text{sp}} + V\hat{\mathcal{H}}_{\text{int}}$$
$$= \sum_{\mathbf{l}} \hat{C}_{\mathbf{l}}^{\dagger T} H_0 \hat{C}_{\mathbf{l}} + V \sum_{\langle \mathbf{l_1}, \mathbf{l_2} \rangle} \sum_{a,b} J_{a,b}^{\mathbf{l_1},\mathbf{l_2}} \hat{n}_{\mathbf{l_1},a} \hat{n}_{\mathbf{l_2},b}$$

Many-body flatband localization

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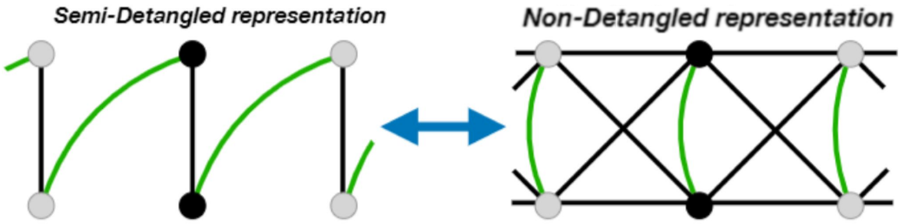
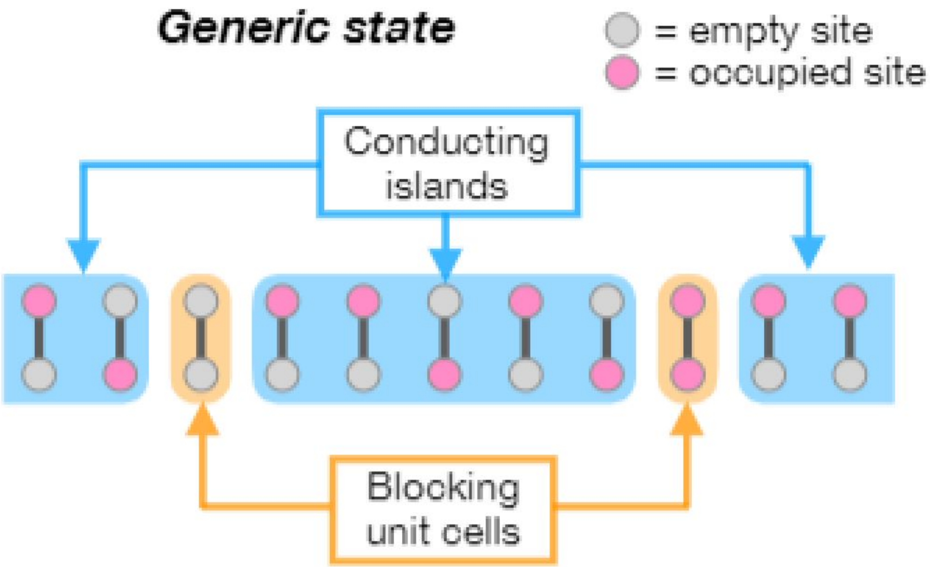
$$\hat{\mathcal{H}} = \sum_l (\hat{a}_l,\ \hat{b}_l)^\dagger \begin{pmatrix} s & t \\ t & s \end{pmatrix} \begin{pmatrix} \hat{a}_l \\ \hat{b}_l \end{pmatrix} + V \sum_l \hat{n}_{b,l} \hat{n}_{a,l+1}$$



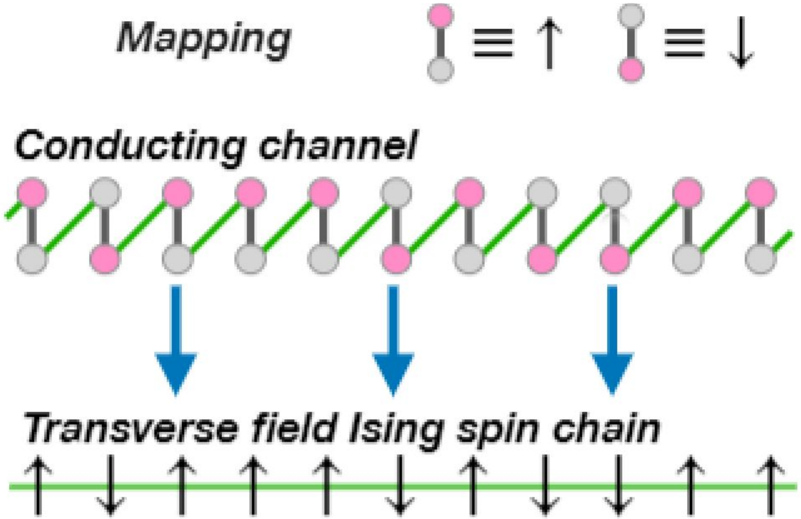
No particles transport

What about transport in general?

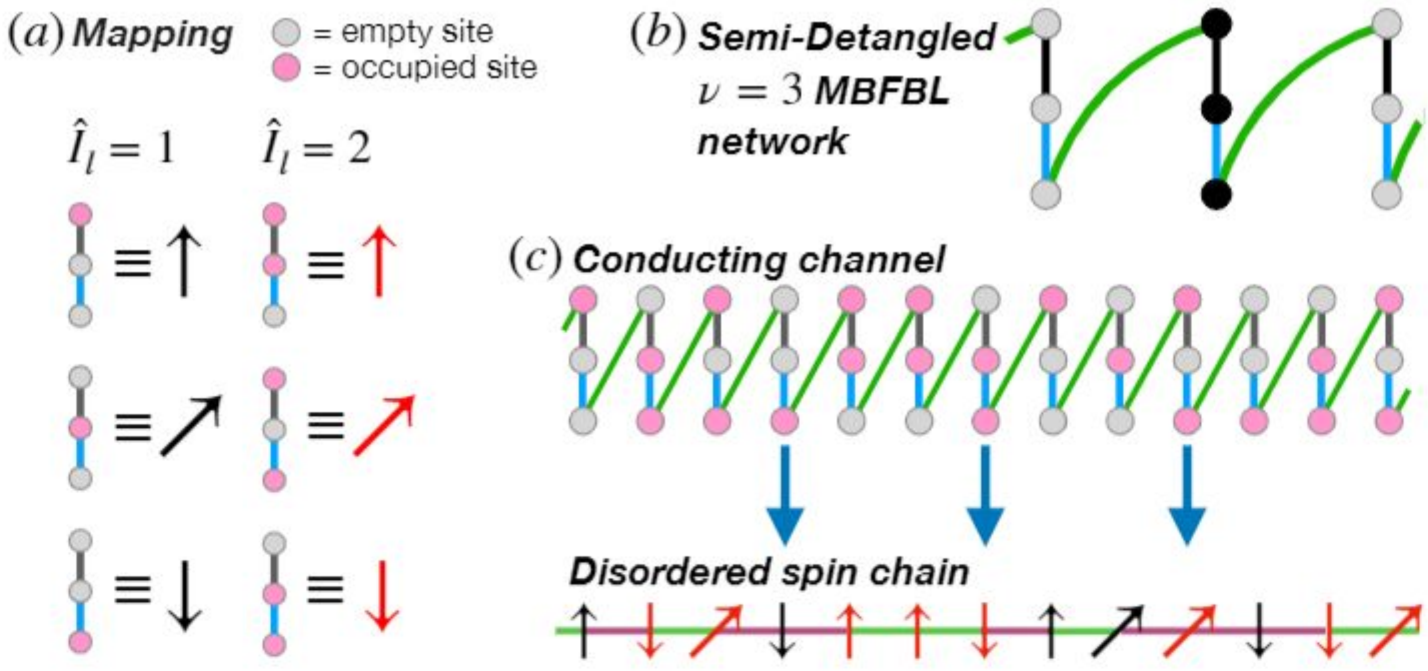
1D Many-Body Flatband Localization



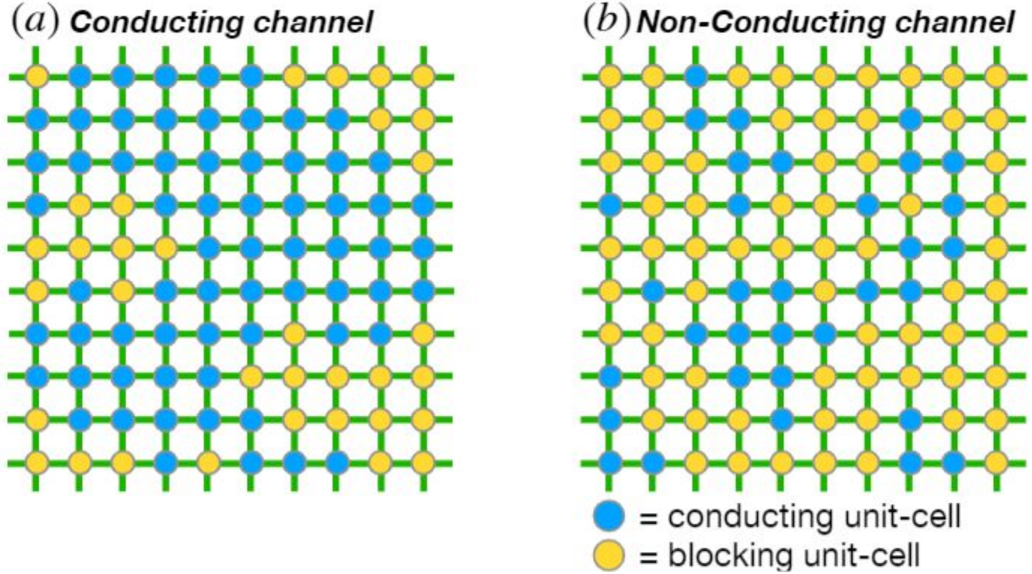
$$\mathcal{R} \sim \sqrt{L}2^{-L}$$



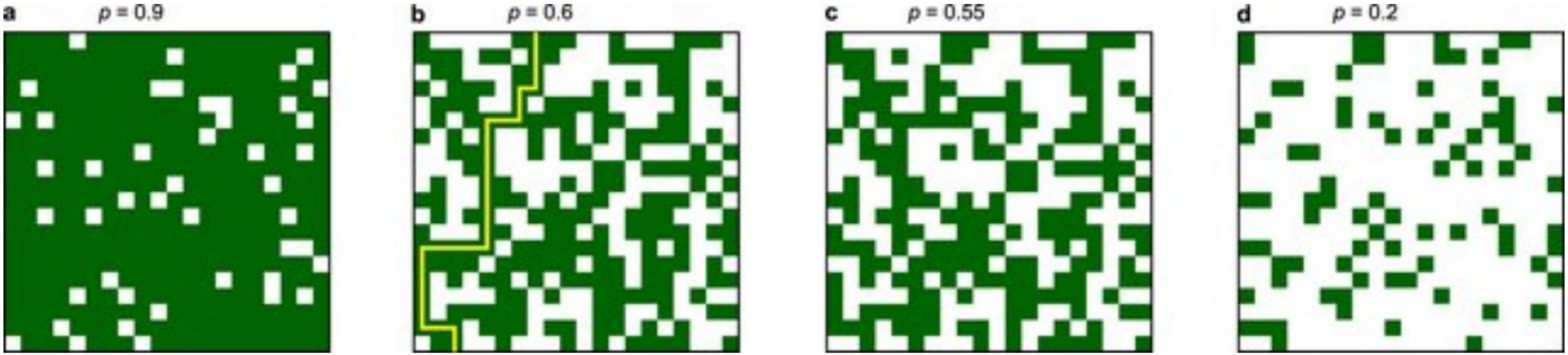
1D Many-Body Flatband Localization



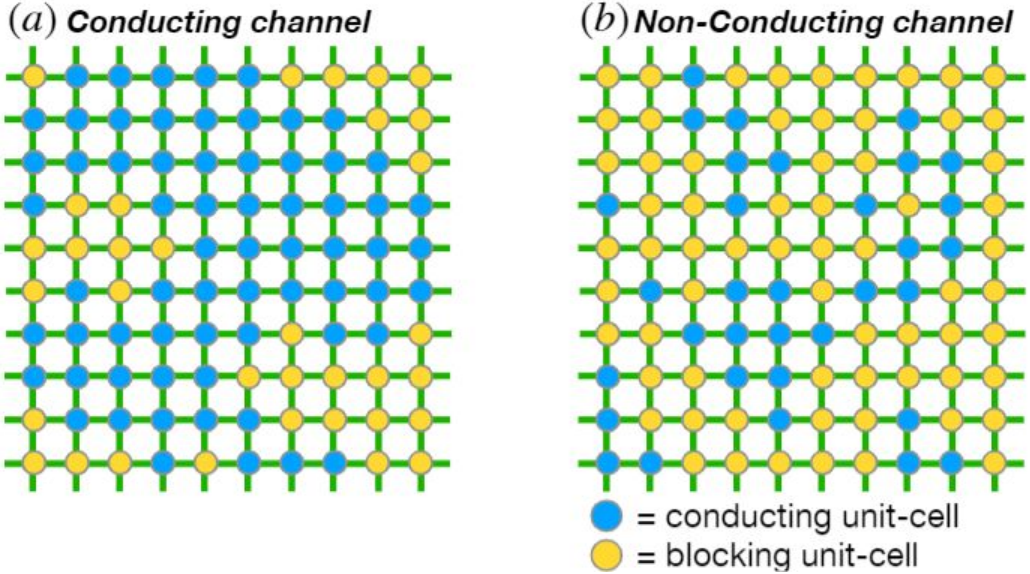
2D Many-Body Flatband Localization



Percolation Theory



2D Many-Body Flatband Localization



$$1 - \delta_{\mathrm{cr}}^{\nu} - (1 - \delta_{\mathrm{cr}})^{\nu} = p_{\mathrm{cr}}$$

Effective Disorder

1) Disorder in effective interaction
2) Different local “spins”
3) Percolation clusters’ fractal structure and dead ends

   (“quantum percolation”)

Conclusions

1) Disorder-free localization transition based on quantum percolations in interacting flat-band systems
2) Universal bound
3) Quantum transport can be additionally suppressed by effective disorder(s)