Extracting maximal entanglement

from linear cluster states

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Quantum networks

Focus on linear networks

Linear cluster states

$$|\mathrm{L}\rangle_n = \prod_i CZ_{i,i+1}|+....+\rangle$$

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$|\mathrm{L}\rangle_N$

GHZ states

$$|\mathrm{GHZ}\rangle_n = |0\ldots0\rangle + |1\ldots1\rangle$$

GHZ STATES

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$|\mathrm{GHZ}\rangle_n$

Goal

- Map $|\mathrm{L}\rangle_n$ to $|\mathrm{GHZ}\rangle_k$

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- Using only local measurements and rotations

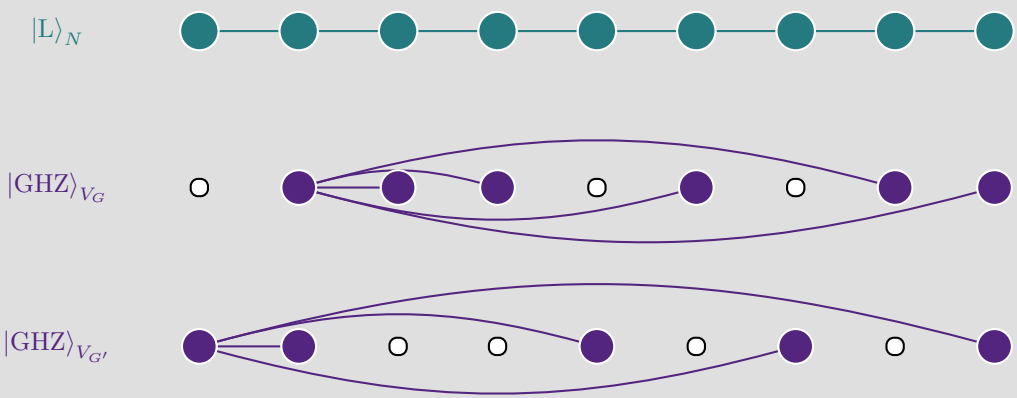
Goal

- Map $|\mathrm{L}\rangle_n$ to $|\mathrm{GHZ}\rangle_k$
- What k are possible?

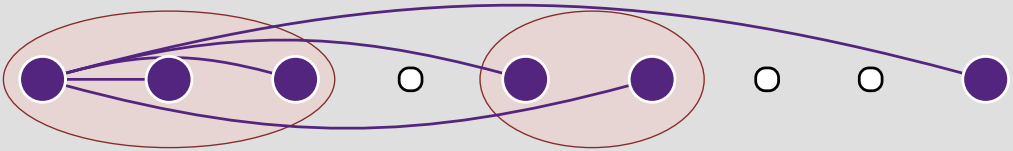
Goal

- Map $|\mathrm{L}\rangle_n$ to $|\mathrm{GHZ}\rangle_k$
- What *node selections* are possible?

Node selections?



Islands



Impossibility results

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- No islands of size ≤ 3

Impossibility results

- 2-islands only at the *edge*

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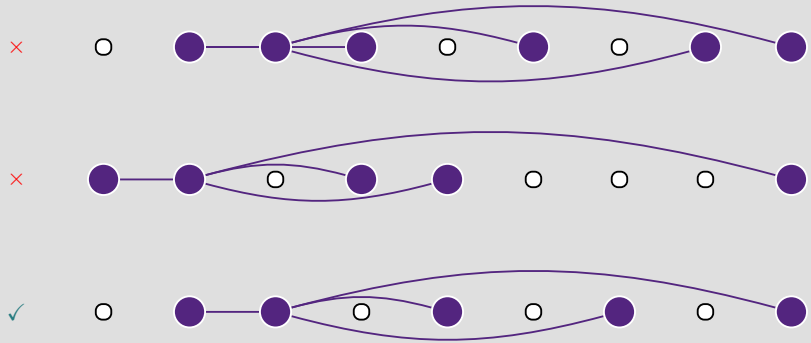
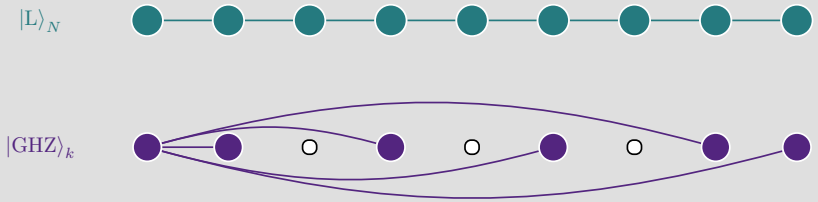
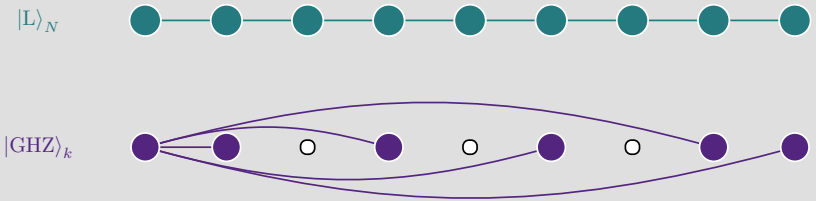


Upper bound

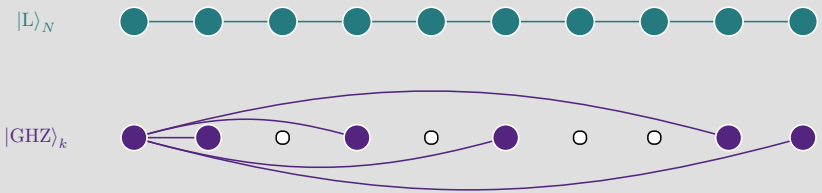


Upper bound



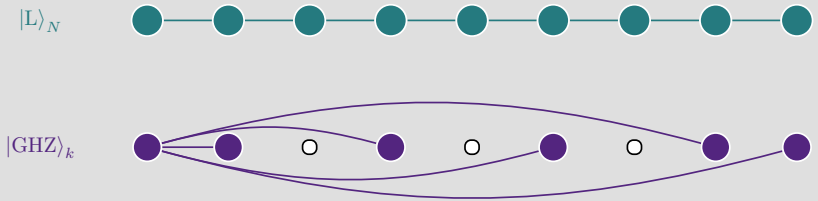
- $k \leq \frac{n+3}{2}$ (odd n)

Upper bound



- $k \leq \frac{n+3}{2}$ (odd n)
- $k \leq \frac{n+2}{2}$ (even n)

Upper bound



- $k \leq \frac{n+3}{2}$ (odd n)
- $k \leq \frac{n+2}{2}$ (even n)

$\rightarrow$ $k \leq \lfloor \frac{n+2}{3} \rfloor$

Maximal pattern

- Measure every node in σ_x basis

[1] See https://github.com/hahnfrederik/Extracting-maximal-entanglement-from-linear-cluster-states

Maximal pattern

- Measure every node in σ_x basis
- Rotations are fairly straightforward[1]

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Other subsets

Other subsets

- Only constraint is the 2-island

Other subsets

- Shrink the linear cluster state

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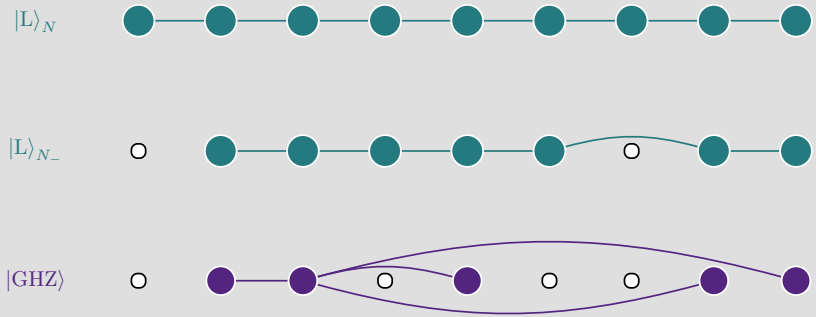
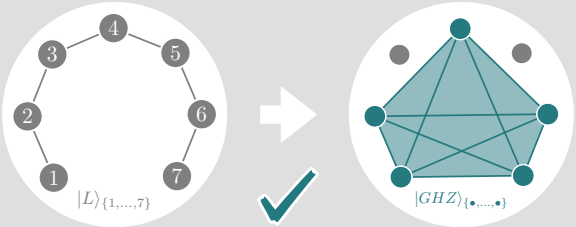
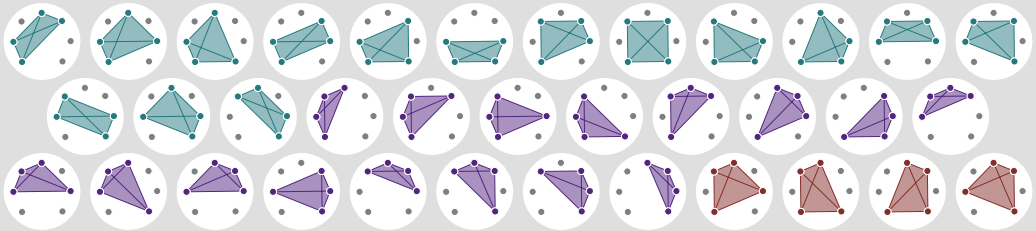
- Shrink the linear cluster state



(Small caveat at the edges)

7-PARTITE LINEAR CLUSTER STATE





Outlook

- Different ways to GHZ states
- Higher-dimensionsal (cluster) states
- When is this useful?

Thank you