PyZX: Quantum circuit optimization using the ZX-calculus

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F-PYZX

Quantum computation

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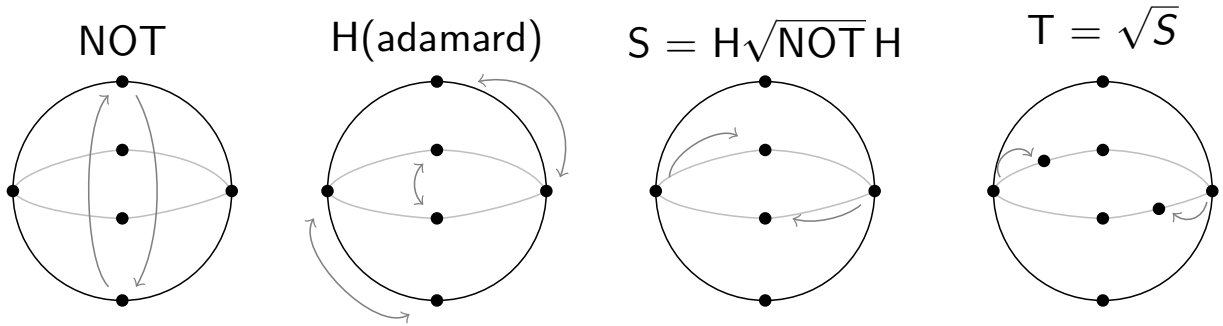

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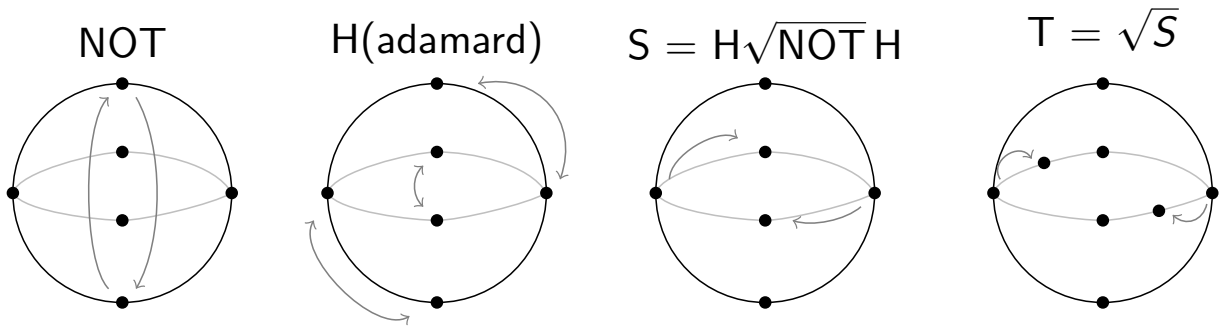

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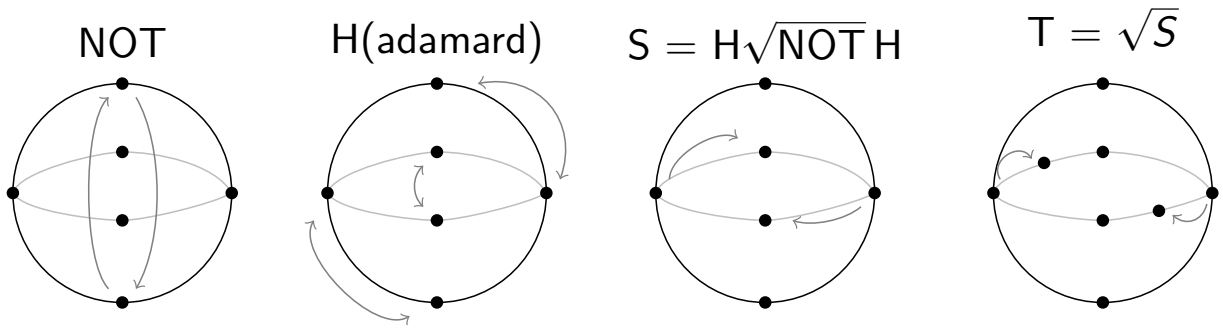

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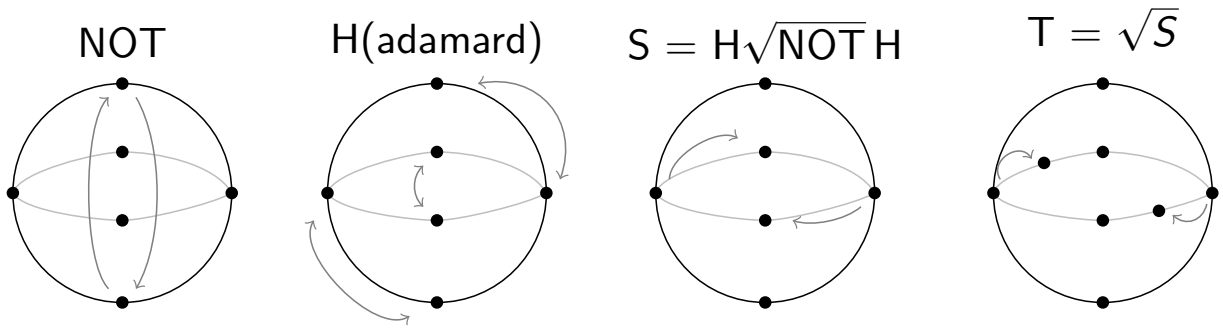

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- These are all the gates you need.
- Our objective is to minimize number of gates needed.
- Specifically T-gates.

Circuit diagrams

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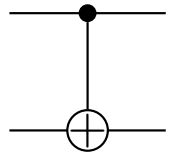
CNOT $=$ 

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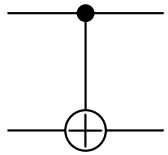
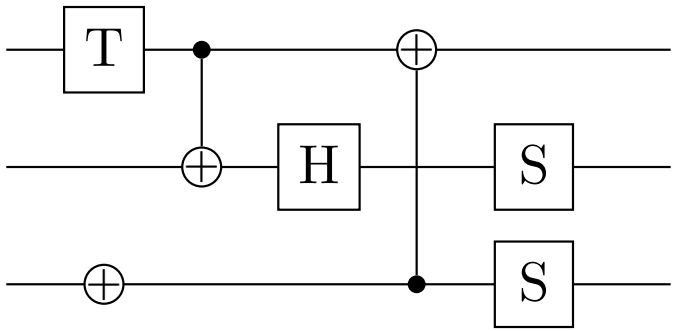
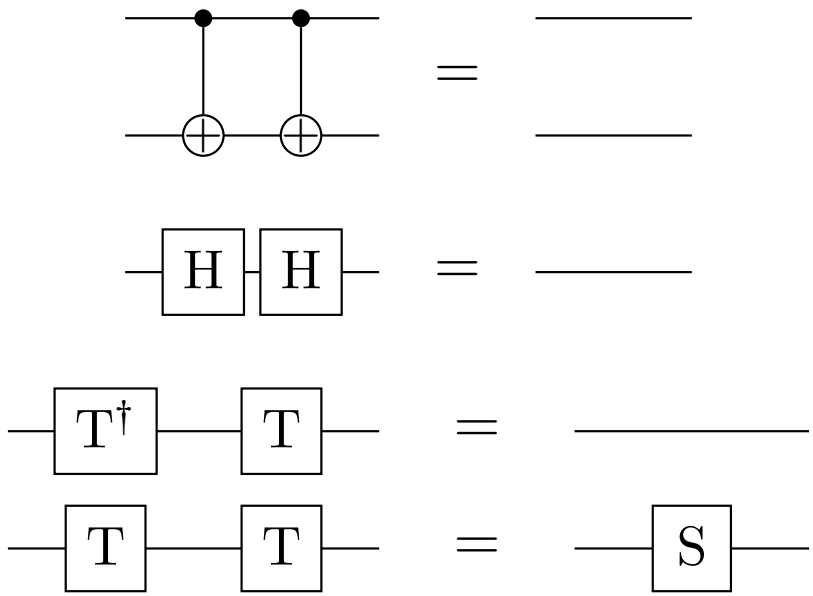
CNOT $=$ 

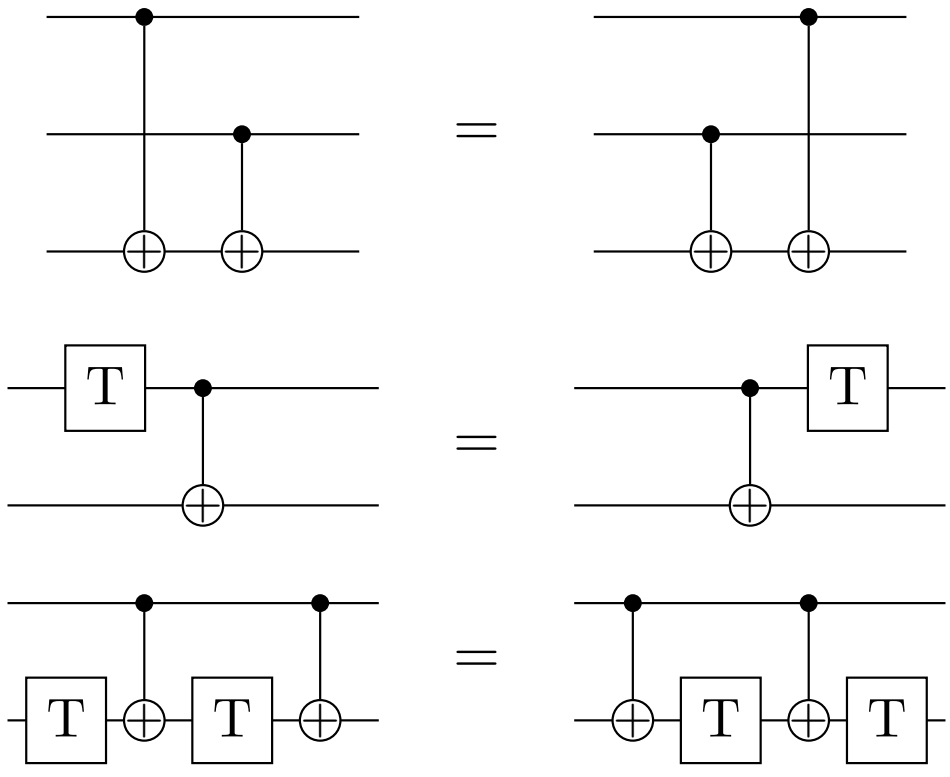
An example quantum circuit:



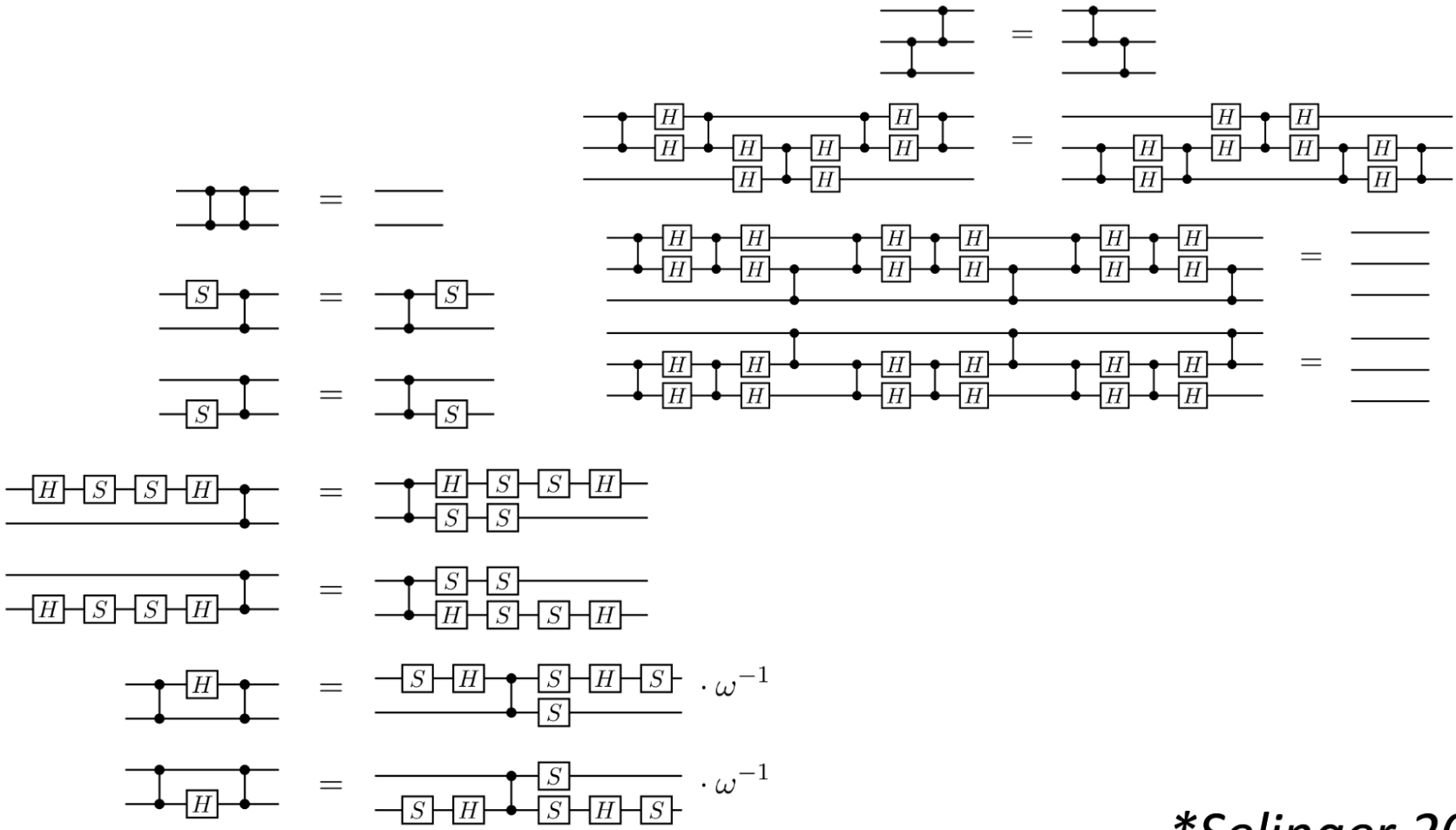
Circuit identities



Gate commutation



More circuit equalities



*Selinger 2015

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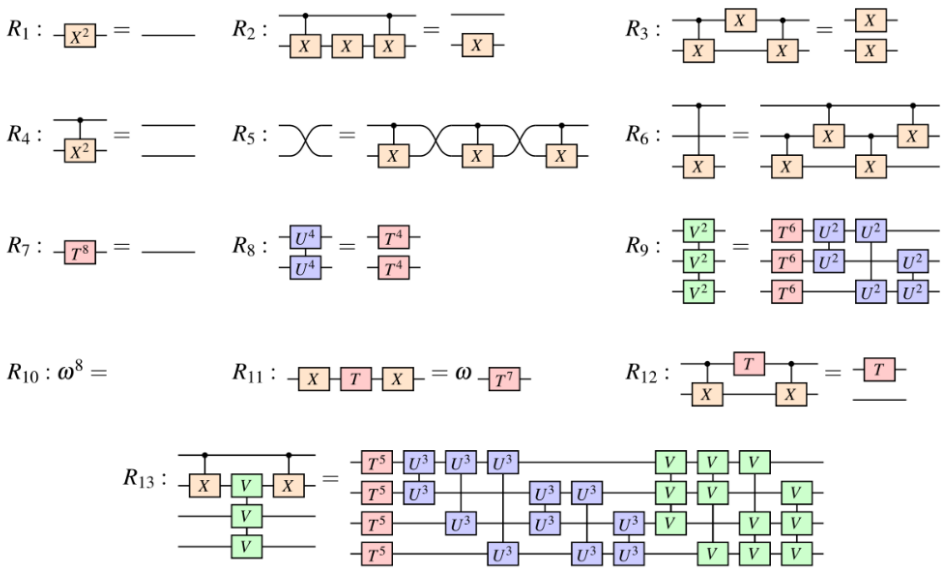

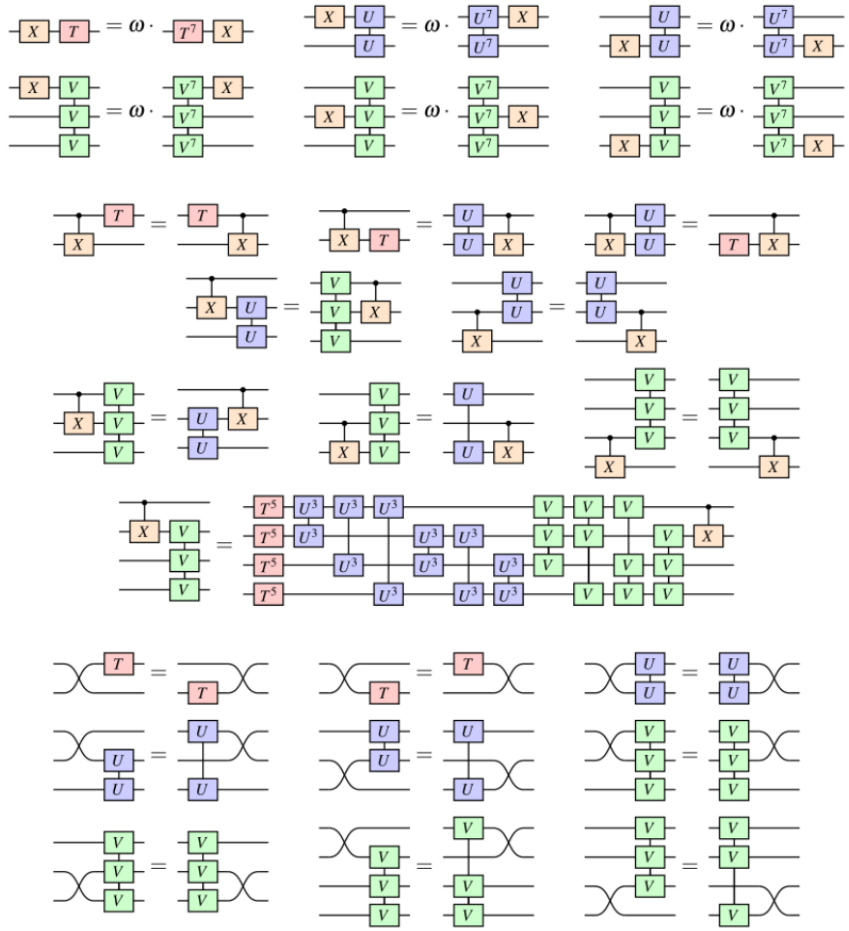

*Amy, Chen, & Ross 2018

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Enter ZX-diagrams

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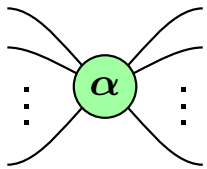
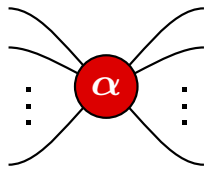
Z-spiders: 

X-spiders: 

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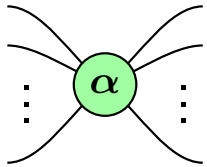
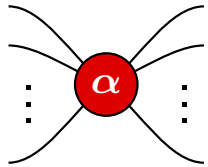
Z-spiders: 

X-spiders: 

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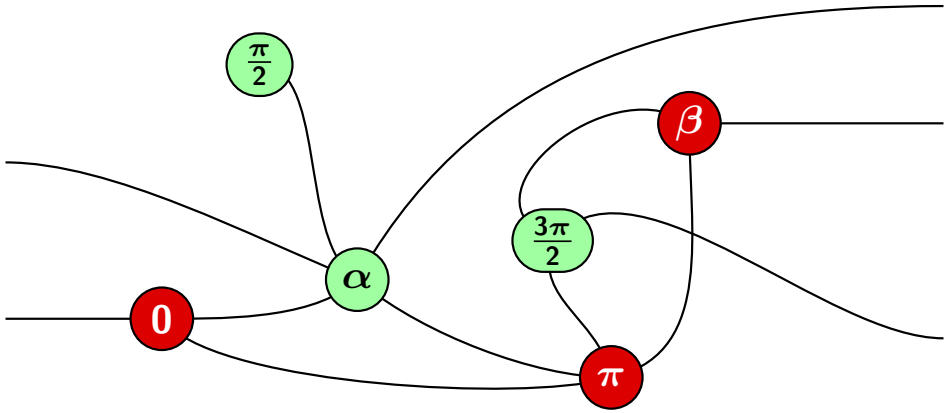

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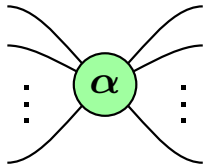
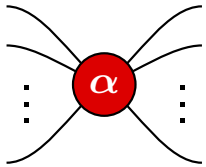
Z-spiders: 

X-spiders: 

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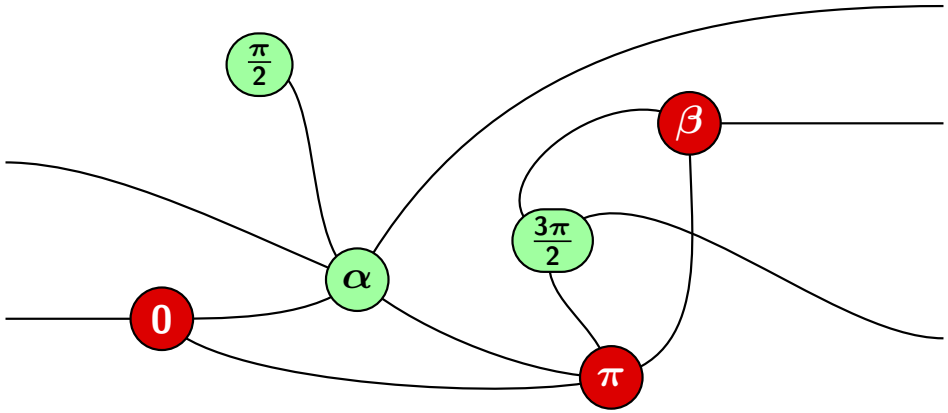

Note: "Only connectivity matters"

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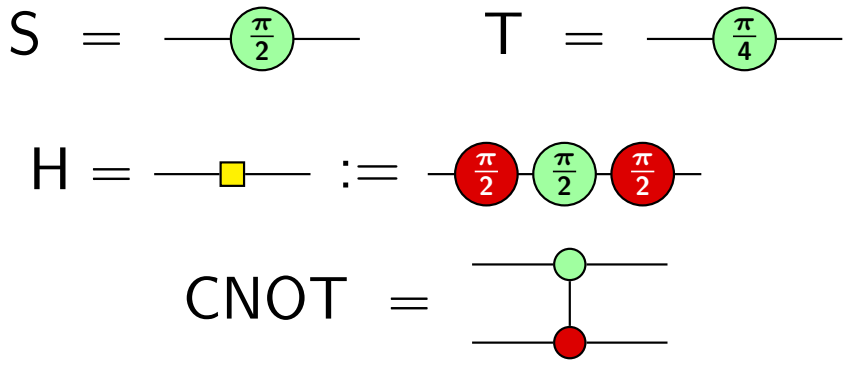

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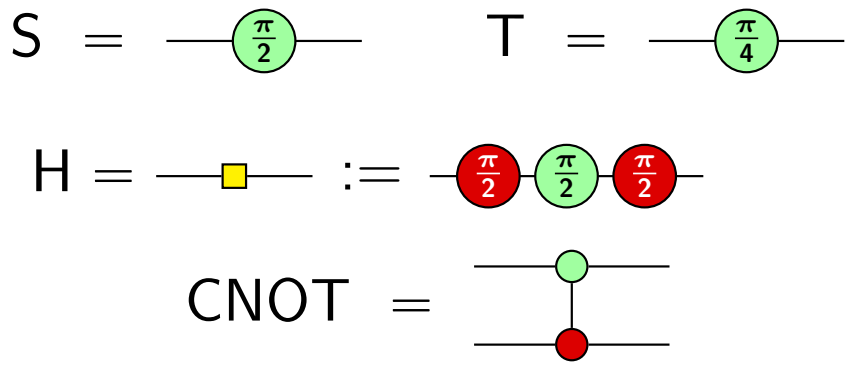
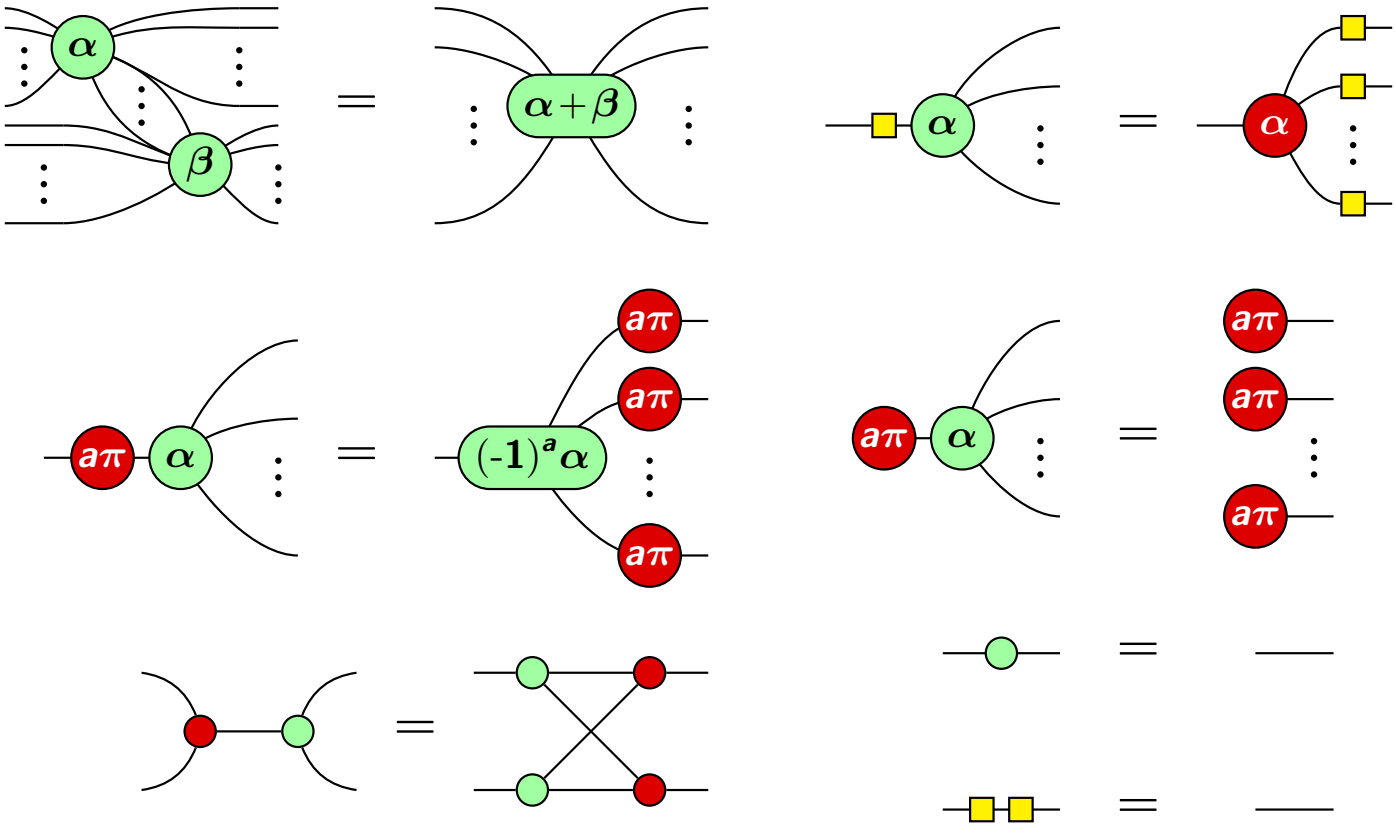


Theorem

Any linear map between qubits can be represented as a ZX-diagram.

Rules for ZX-diagrams: The ZX-calculus



$\alpha, \beta \in [0, 2\pi]$, $a \in \{0, 1\}$

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If two ZX-diagrams represent the same computation, then they can be transformed into one another using the previous rules (and one additional one).

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So instead of dozens of circuit equalities,
we just have a few simple rules.

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- Visualisation: Jupyter and Matplotlib.
- Documentation: Sphinx
- Numpy for various things.

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- Work in progress.

Demonstration time

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- Closer integration with other frameworks/libraries.

Thank you for your attention