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Floquet Code

Establishing Connection between Floquet Code and Toric Code

Yusheng Zhao

HKUST(GZ)

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THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY (GUANGZHOU)

Outline

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Floquet Code needs more attention

- Study of Fault-tolerant quantum computation: **Quantum Memory** and logical operations
- Design of quantum memory concerns the following properties of a **Quantum Error Correction Code** [1]

  a) Code distance
  b) Ease of implementing logical gates
  c) Tradeoffs between the number of logical qubits and distance

- Surface code is not optimal by standard a) and c) [2] but has higher threshold in practice [3] due to **low-weight measurement** (Figure 2) and **lower connectivity** hardware requirements compare to many families of qLDPC codes [4, 5]
- Floquet code is a family of codes that pushes these strength of surface code even further [6]

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Floquet Code has good qualities

- **Threshold** of $0.2\% - 0.3\%$ without native **weight-2 measurement** [6][1]
- Thershold of $1.5\% - 2.0\%$ with native weight-measurements [6]
- Photon loss threshold: 6.4% on photonic platform [7]
- Code Overhead: $\lim_{n\to\infty} \frac{k}{n} \to \frac{1}{2}$ on qudit codes [8]
- $5.6\times$ fewer physical qubits are needed to implement Floquet code at depolarizing noise of 0.1% compare to surface code [4]

[1] $0.5\% - 0.7\%$ for surface code

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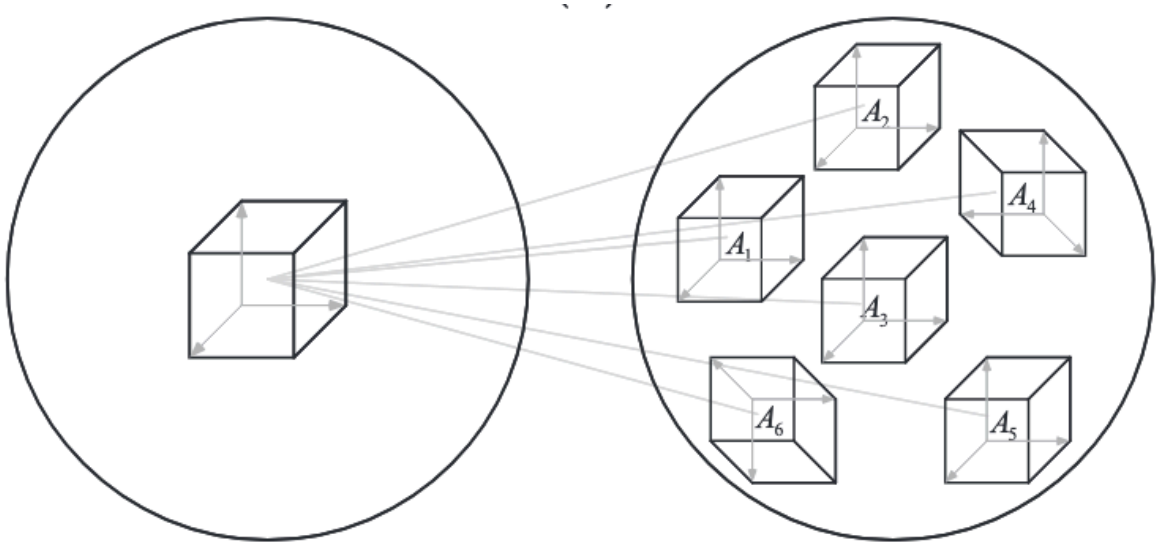
Stabilizer Code

Example: [[4,2,2]] Code

- Stabilizers: $X_1X_2X_3X_4$ and $Z_1Z_2Z_3Z_4$



- Logical Operators: $\tilde{X}_1 = X_1X_2$, $\tilde{X}_2 = X_1X_3$, $\tilde{Z}_1 = Z_1Z_3$ and $\tilde{Z}_2 = Z_1Z_2$

Subsystem Code

Example: [[4,1,2]] Code

Subsystem Code

Floquet Code:

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- Honeycomb Code on a hexagonal lattice is equivalent to Toric Code on a larger hexagonal lattice
- Floquet code has comparable quality as surface code but requires lower connectivity on hardware

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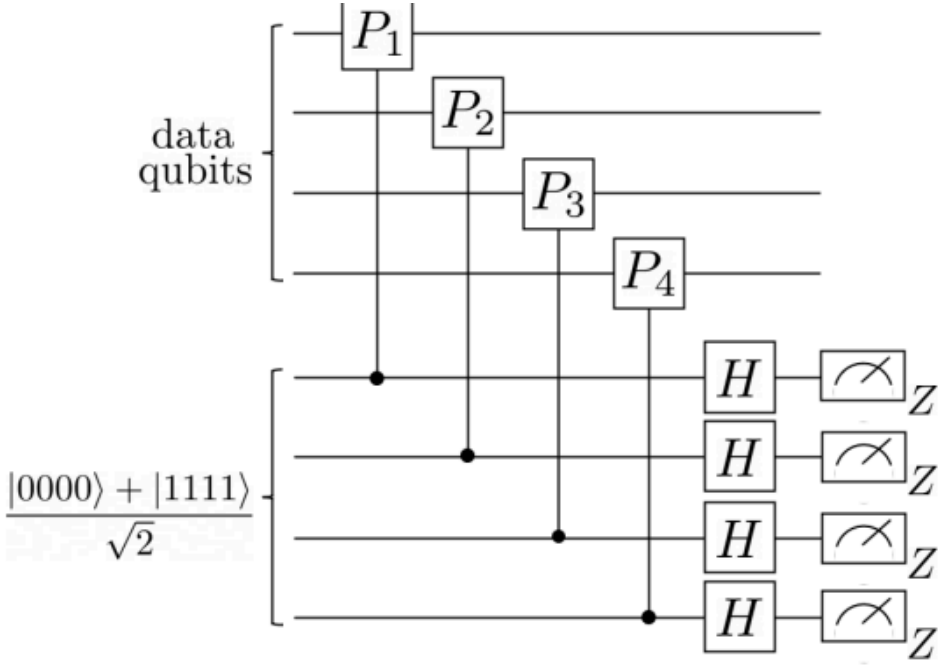
Terms

- “The **teraquop footprint** is the number of physical qubits required to create a logical qubit reliable enough to survive one trillion operations."

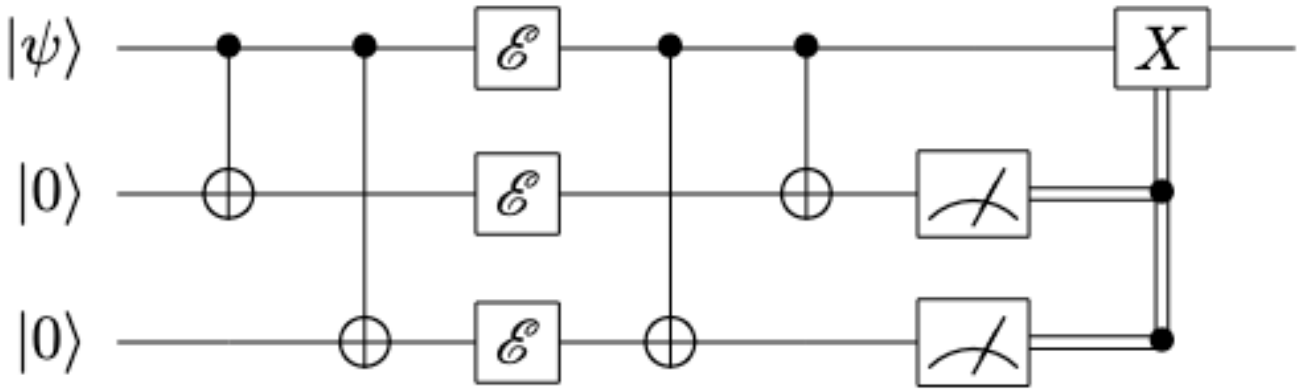
Terms

Static Code: Shor-style Measurement



Terms

Repetition Code: Encoding, Syndrome Extraction, and Error Correction



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