

Floquet Code

Definition and Low-weight Measurement

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Floquet Code needs more attention

- “Quantum error-correcting codes are a key ingredient for fault-tolerant quantum computation.” [1]
- Design of quantum error correction codes concerns the improvement of [2]
 - 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) [3] but has higher threshold in practice [4] due to **low-weight measurement** and **lower connectivity** hardware requirements compare to many families of qLDPC codes [5, 6]
- Floquet code is a family of codes that pushes these strength of surface code even further [7]

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Floquet Code has good quality

- Threshold of 0.2% – 0.3% without native weight-2 measurement compare to 0.5% – 0.7% for surface code [7]
- Threshold of 1.5% – 2.0% with native weight-measurements [7]
- 6.4% on photonic platform [8]
- $\frac{k}{n} \rightarrow \frac{1}{2}$ on qudit codes [9]
- 5.6x fewer physical qubits are needed to implement Floquet code at depolarizing noise of 0.1% [5]

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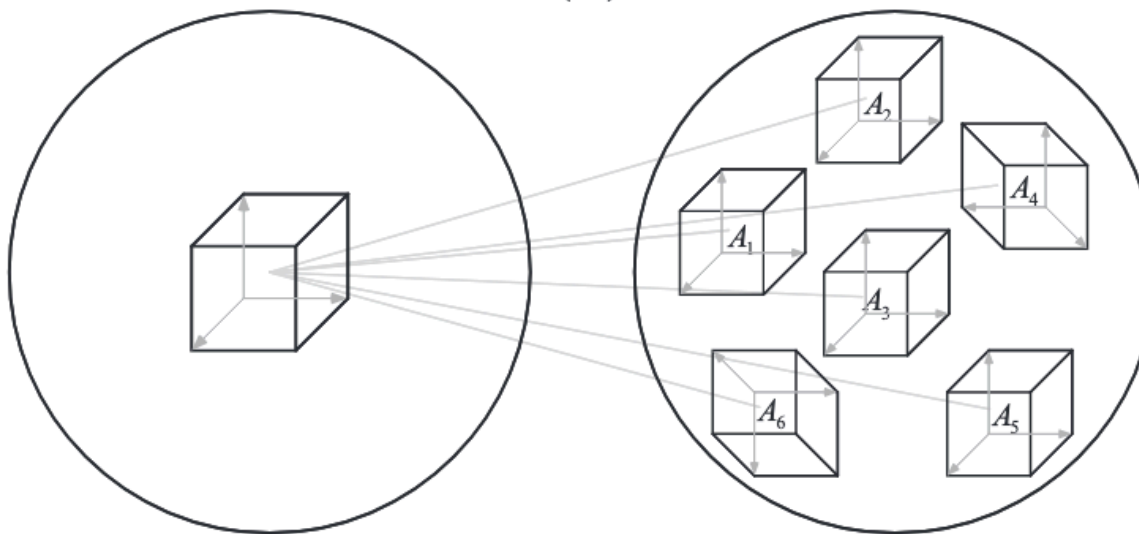
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Overview of Quantum Error Correction

- Quantum error correction consists of encoding, syndrome extraction, error detection and correction.
- Quantum Error Correction is determined by encoding method and error syndromes.
- Floquet code differs from static code in syndrome extraction

Encoding

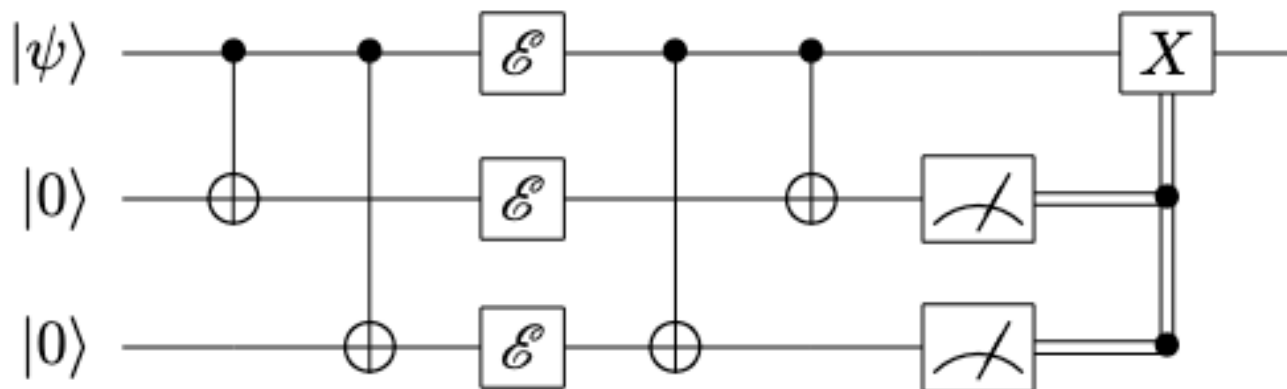
- Encoding process is a linear map of input logical state from a smaller Hilbert space to a subspace of larger Hilbert space.
- Errors map states from one subspace to another.



Encoding

Static Code: Repetition Code

- Encoding: $|0\rangle \rightarrow |000\rangle$ and $|1\rangle \rightarrow |111\rangle$
- Protects from X error but not Z error



Encoding

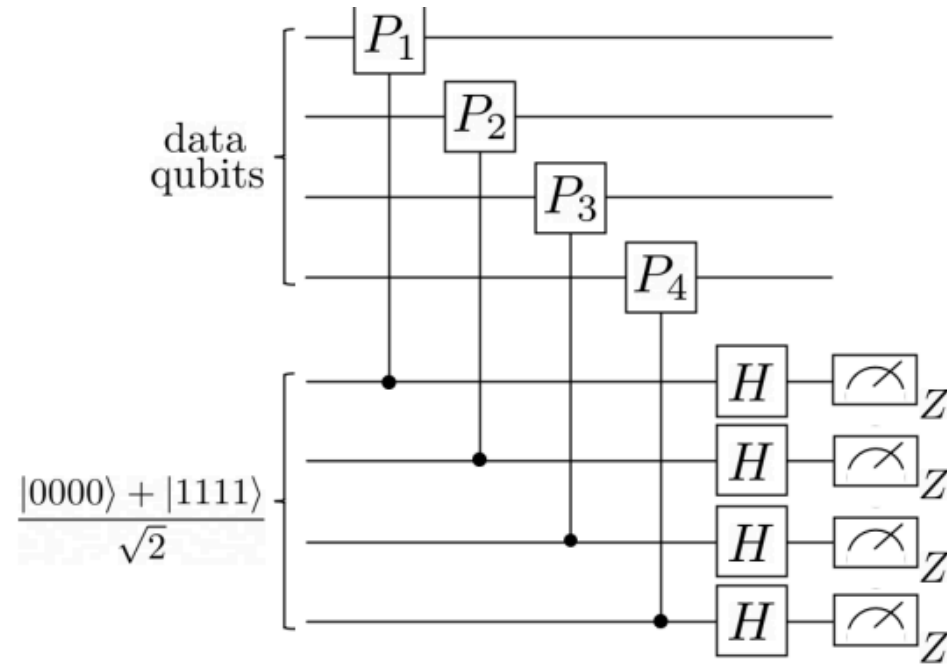
Floquet Code:

Syndrome Extraction

- Syndrome extraction is the process of determining which subspace the state is in.

Syndrome Extraction

Static Code: Shor-style Measurement



Syndrome Extraction

Floquet Code: Weight-2 Measurement

how is it equivalent to static code syndrome measurement?

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What are needed to define a Floquet code?

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.”

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