Quantum Code Zoo

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A zoo of quantum code

CONTENTS

I. INTRODUCTION

II. QUANTUM CODE ZOO

easy list of quantum code

Whatever code you find, let's find a place for it in this list

- fermion codes
- bosonic codes
  - GKP codes
  - cat codes
- CWS
  - Stabilizer codes
    - CSS codes
      - QHP codes
        - toric codes
        - HQHP codes
          - toric codes in higher-Dimension
      - Quantum bicycle codes
      - Homological product codes
      - Lifted product codes
      - Fiber bundle codes
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    - non-CSS codes
      - rotated surface codes
      - Quantum XYZ product codes
  - Subsystem codes
    - Subsystem product codes
      - Subsystem hypergraph product codes
        - Bacon Shor codes
  - Concatenated codes
    - Shor's codes

unclassified

- quantum hyperbicycle codes[1]

III. GLOSSARY AND REFERENCES

This section has a one-liner explanation for each codes, plus necessary notes, in alphabet order

Bacon Shor codes

BCH codes

Binomial codes

Bosonic codes

Cat codes

CSS codes: Two classical codes that one contains the other; A stabilizer code with X-type and Z-type check operators.

Concatenated cat codes: Concatenated codes with cat code as the inner code and another qubit code as the outer code

Concatenated codes: A multi-layer structure where the logical qubits of one code are used as the physical qubits of another code.

Color codes:

Cubic codes: toric codes in 3D

Data syndrome codes: when measurement error are considered, it adds extra bits to the code, hence called data syndrome codes. It is similar to space-time codes.

Fiber bundle codes

Gottesman-Kitaev-Preskill (GKP) codes [2]: encode a qubit into an oscillator, that is, continuous variable. It could be a qudit as well.

Higher-dimensional quantum hypergraph product codes:

Homological product codes

Hypercubic codes: toric codes in 4D

Lifted product codes

Stabilizer codes: A subspace stabilized by an abelian subgroup of the Pauli group.

Quantum bicycle codes:

Quantum convolutional codes:

Quantum Hamming codes: A $[[7, 1, 3]]$ CSS code.

Quantum Hypergraph Product (QHP) codes: A CSS code defined by the hypergraph product of two graphs, which corresponds to two classical codes.

Quantum pin codes

Quantum XYZ product codes

Rotated surface codes

Shor's codes

Space-time codes: Multiple measurements will add a temporal dimension to the code.

Steane codes: A $[[5, 1, 3]]$ code

Subsystem codes

Subsystem product codes

Subsystem hypergraph product codes

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Surface codes: constructed from any tessellation of an arbitrary surface or a higher-dimensional manifold. Generalization of the toric codes.

Surface-GKP codes: A concatenated code with GKP code as the inner code, and surface code as the outer code.

Tensor network codes [3]: Define stabilizer code using a tensor, which maps the physical qubits to logical qubits.

Toric codes: The code is defined on a periodic square lattice, that is, a torus. The check operators are weight-4 vertex operators and plaquette operators. The logical operators are nontrivial cycles on the torus.

IV. SIMILAR PROJECTS

Quantum Algorithm Zoo `https://quantumalgorithmzoo.org/`

Quantum protocol Zoo `https://wiki.veriqloud.fr/index.php?title=Protocol_Library`

[1] A. Kovalev and L. Pryadko, Quantum hyperbicycle low density parity check codes with finite rate, arXiv **1212**.

[2] D. Gottesman, A. Kitaev, and J. Preskill, Encoding a qubit in an oscillator, Physical Review A **64**, 012310 (2001).

[3] T. Farrelly, R. J. Harris, N. A. McMahon, and T. M. Stace, Tensor-network codes, arXiv preprint arXiv:2009.10329 (2020).