



National Aeronautics and
Space Administration



Dynamical Logical Qubits in the Bacon-Shor Code

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Based on work with Eleanor Rieffel (NASA)
Manuscript appearing on the arXiv soon

General Idea

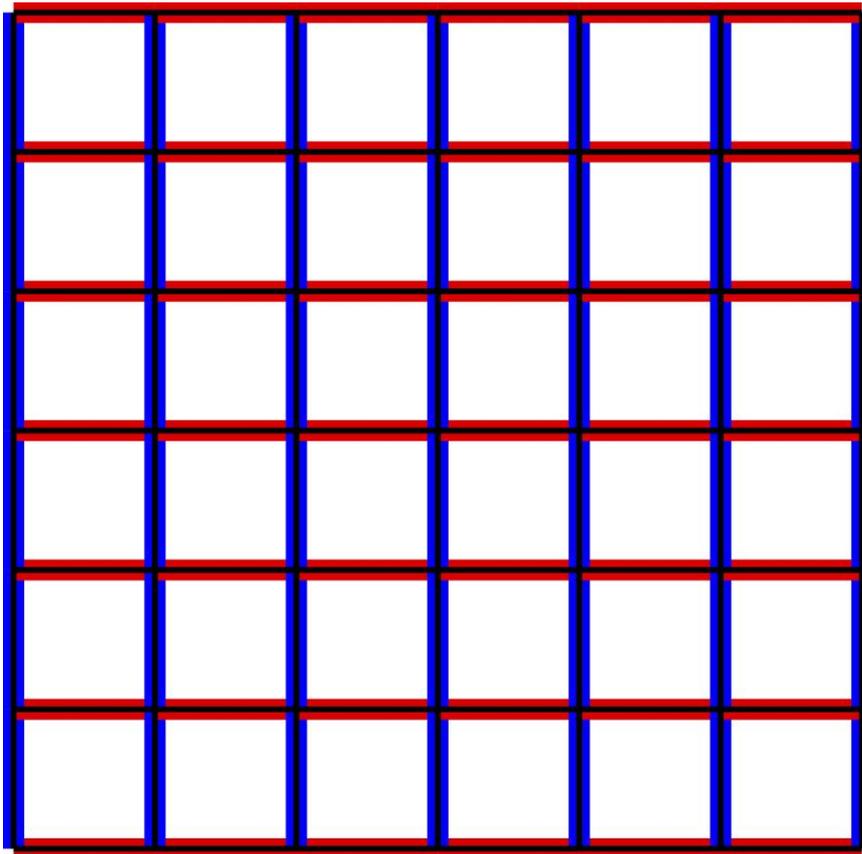
- Floquet codes identify a dynamically evolving subspace of the physical Hilbert space^[1]
- Most examples involve a tri-valent, tri-colorable (typically hexagonal) lattice
- Usually involve descriptions of embedded toric codes, non-trivial automorphisms between electric and magnetic operators
- Floquetify-ing the Bacon-Shor subsystem code^[2]
 - Simple square lattice architecture
 - Naturally equipped with a boundary
 - Using nothing more than *virtual* qubit operators
 - Add as many dynamical qubits as the lattice size, and target distance, allows

[1] M. B. Hastings and J. Haah, Dynamically Generated Logical Qubits, Quantum 5, 564 (2021)

[2] D. Bacon, Operator quantum error-correcting subsystems for self-correcting quantum memories, Phys. Rev. A 73, 012340 (2006)



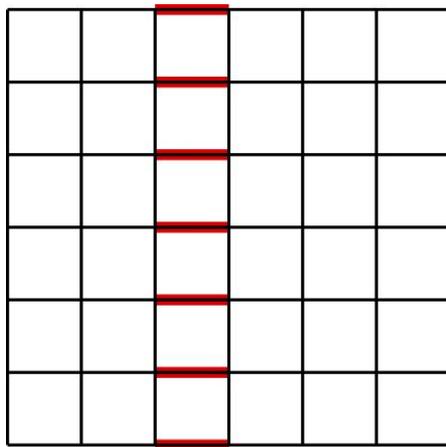
Bacon-Shor code



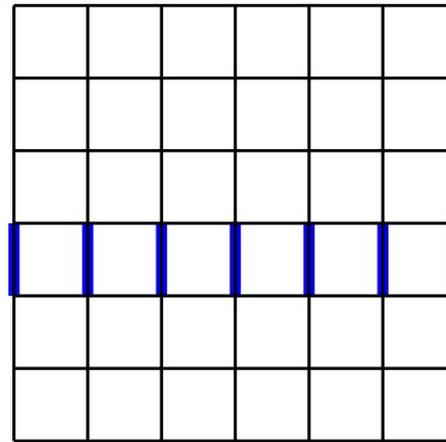
Gauge group generated by all
nearest-neighbor 2-body

- XX checks (red, horizontal)
- ZZ checks (blue, vertical)

Bacon-Shor code



X-type

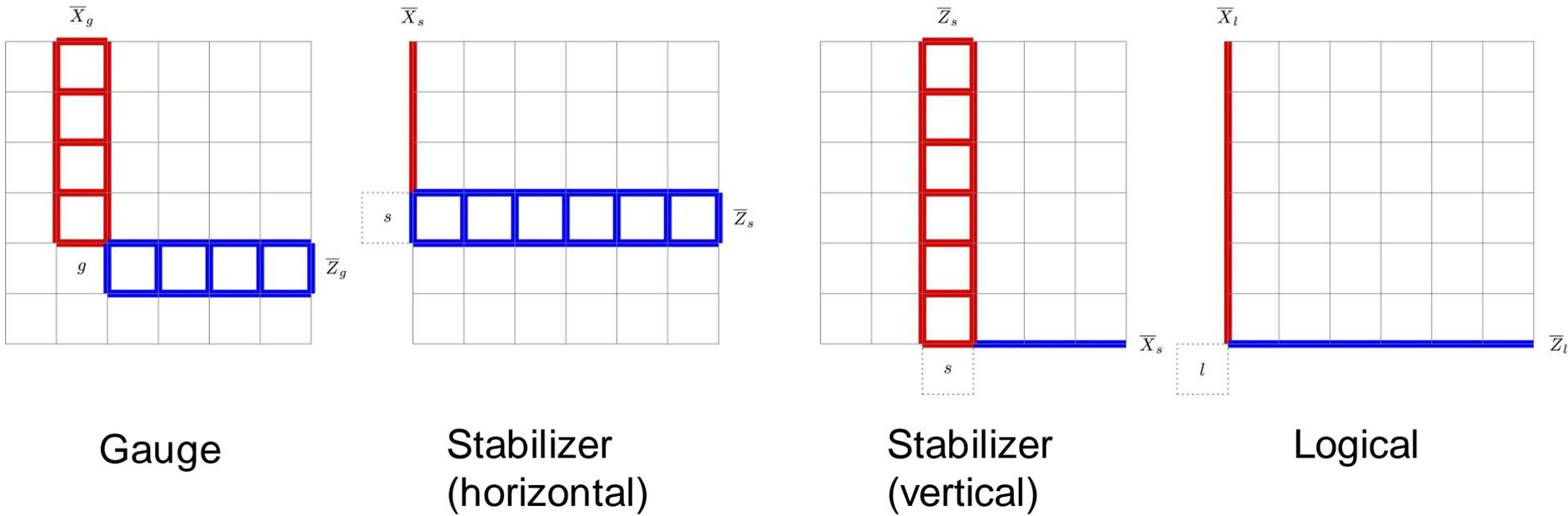


Z-type

Stabilizers

Bacon-Shor code

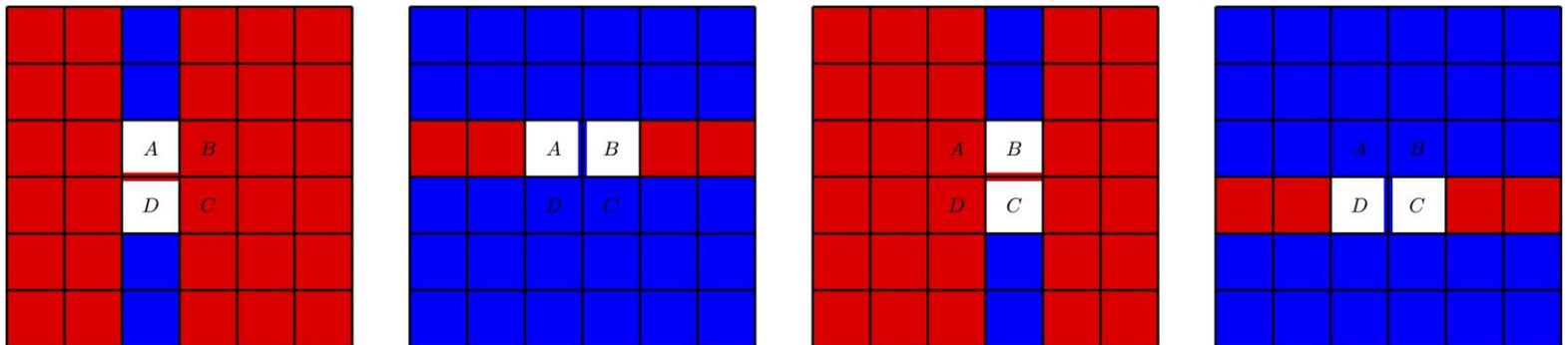
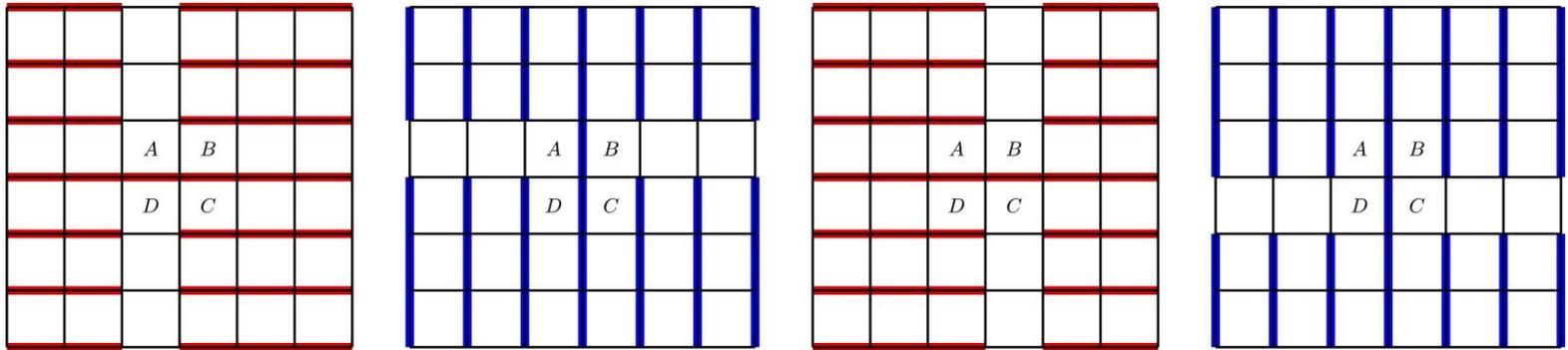
Virtual qubit operators





Floquet-Bacon-Shor code

Measurement schedule

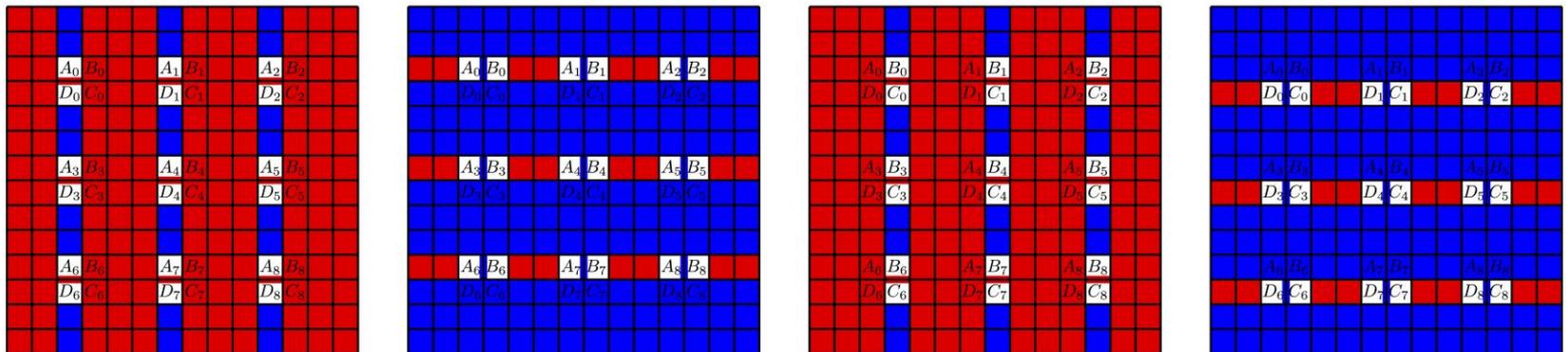
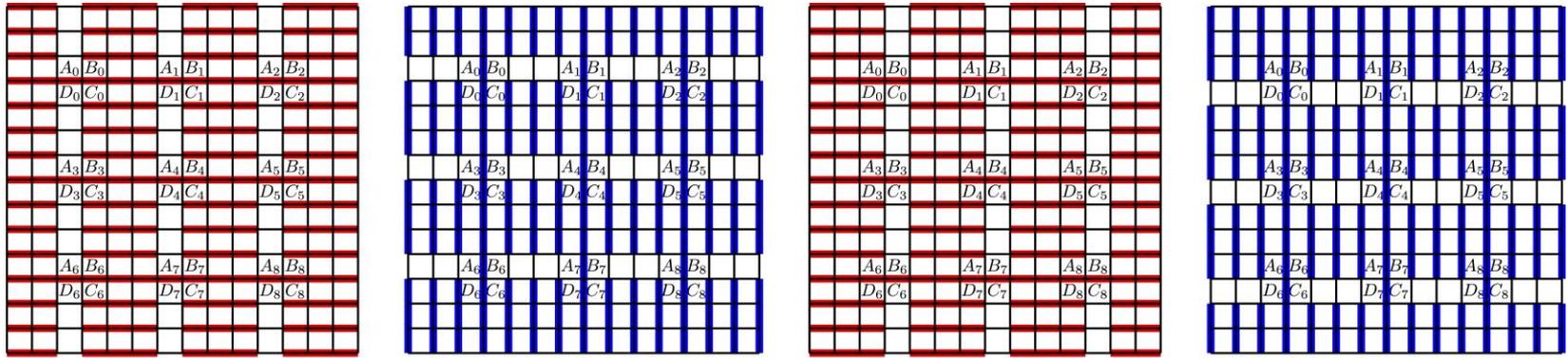


Instantaneous Stabilizer Groups (ISGs)



Floquet-Bacon-Shor code

Measurement schedule



Instantaneous Stabilizer Groups (ISGs)



Conclusions

- **Bacon-Shor code can be Floquet-fied using only subsystem structure**
- **Floquet codes can be constructed from subsystem codes by introducing gauge defects**
- **Decoding hypergraph may require beyond MWPM/UF techniques**
- **Like the parent Bacon-Shor code, the Floquet-Bacon-Shor family of codes does not possess a threshold**



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