# Qubit Fidelity of CSS Codes under General Neutral Atom Noise

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## 1 Introduction

Neutral atoms caught in arrays of optical tweezers provide a promising architecture for scalable quantum computers:

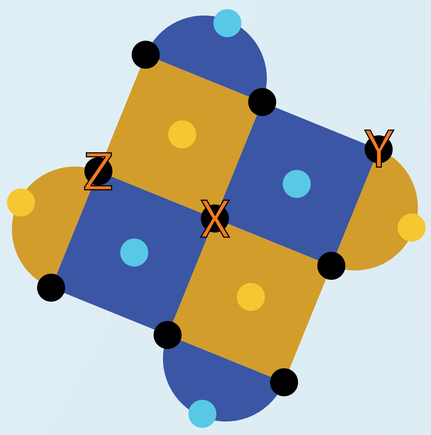
- Flexible geometries - reconfigurable arrays
- Long lifetimes

Quantum error correction (QEC) is crucial for constructing high-quality **logical qubits.** Minimal qubit fidelity requirements for QEC are calculated from **second order phase transitions** in a mathematically equivalent $Z_2$ lattice gauge theory[1][2].

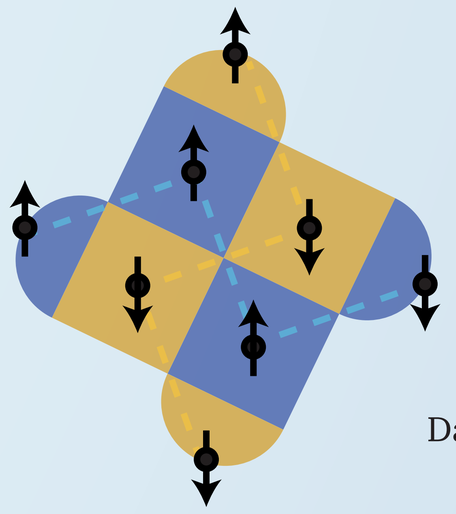
In this work, we characterise the performance of topological codes for a $^{88}$Sr neutral atom quantum computer by using a variety of mappings.

## 2 Statistical mapping

Quantum Error Correction

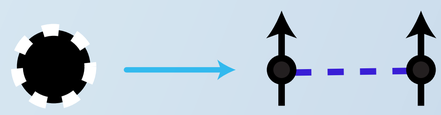



Statistical Gauge Model



Stabiliser qubit »» Classical spin

Data qubit »» Random $Z_2$ coupling

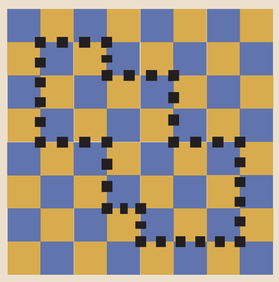


Coupling: J = {-1,0,1}

Mappings

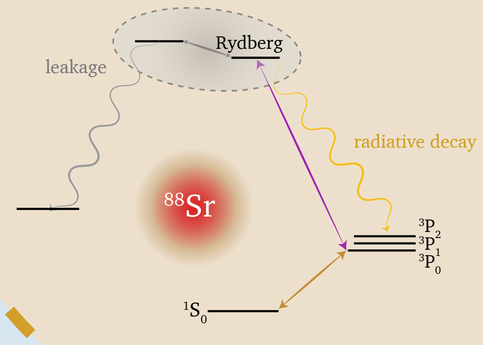
### Random Plaquette Gauge Model

RPGM for measurement errors
Coupling: J = {-1,1}
Order parameter: Wilson loop W[τ]



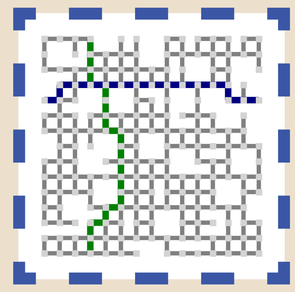
### Full Neutral Atom Model

Full model with fragile Rydberg state
Coupling: J = {-1,0,1}




### Erasure Model of Percolation

Erasures cause topological defects
Coupling: J = {0,1}
Order parameter: ∏



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## 3 Summary

Neutral atoms benefit from erasure conversion. Quantum memory fidelity constraints are given by:

THIS POSTER IS INCOMPLETE AS SIMULATIONS ARE STILL GOING

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