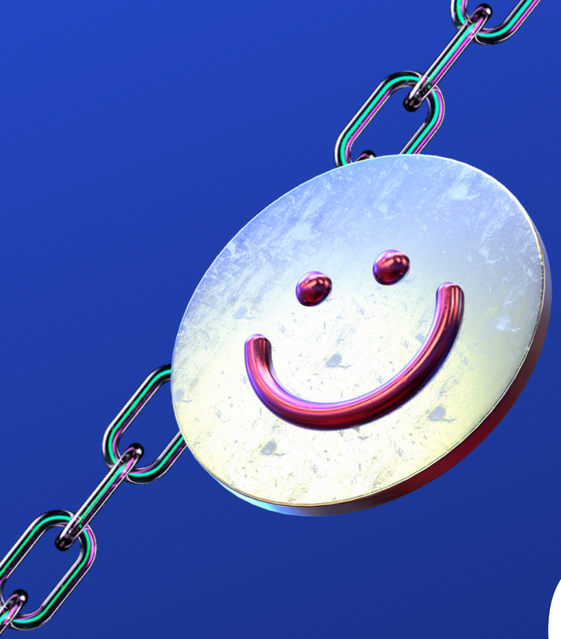
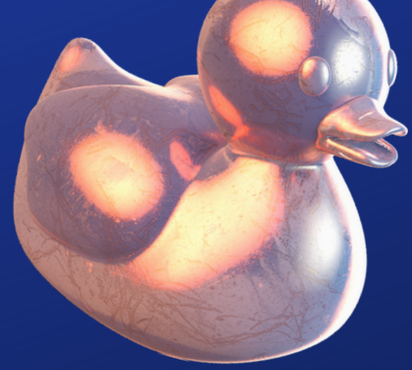
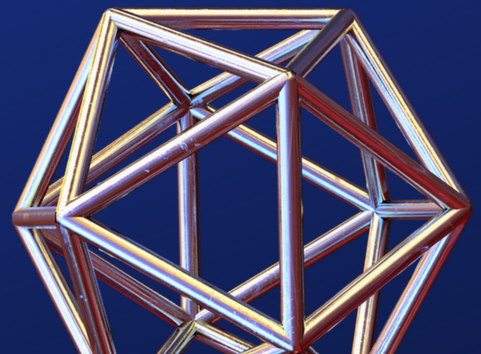


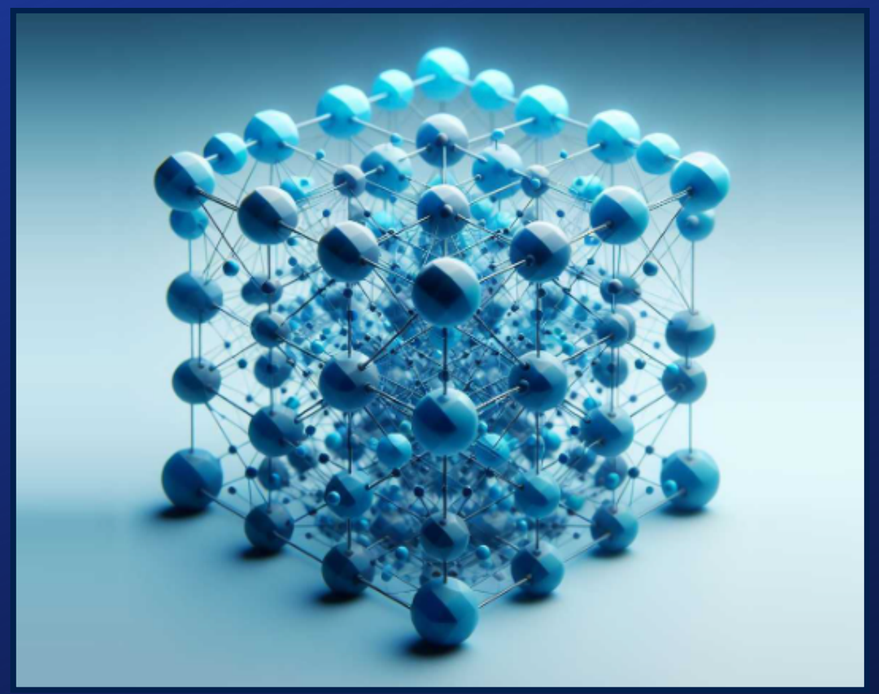


QUERA

SOMETHINQ

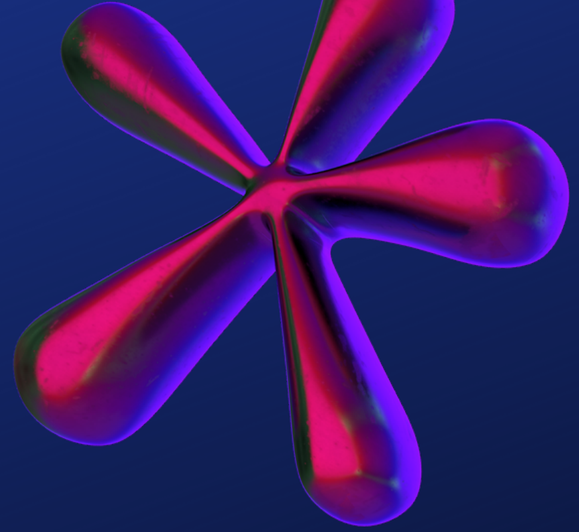
QUANTUM SCAR REVIVAL





CONTENT

QUANTUM SCAR



Introduction

Quantum scars are fascinating natural phenomena and arguably the first new discovery provided by fully implemented quantum computers.
It’s a system with oscillatory non-ergodic behavior, leading it to oscillate between states determined by initial conditions. This phenomenon leads to long-time coherent dynamics in a format somewhat similar to the behavior of a damped oscillator.

To set up a quantum scar, we must first prepare a many-body quantum system.

- Given a "kick" of energy = process called "quenching", after which it evolves according to a fixed time-based Hamiltonian operator.
- While system's initial evolution is incoherent and unpredictable, it eventually converges into a state similar to the initially prepared system.
- The many-body system continues to evolve--through this evolution it oscillates back to the initial state, and back to the evolution convergent state, back and forth until the system gradually loses coherence.

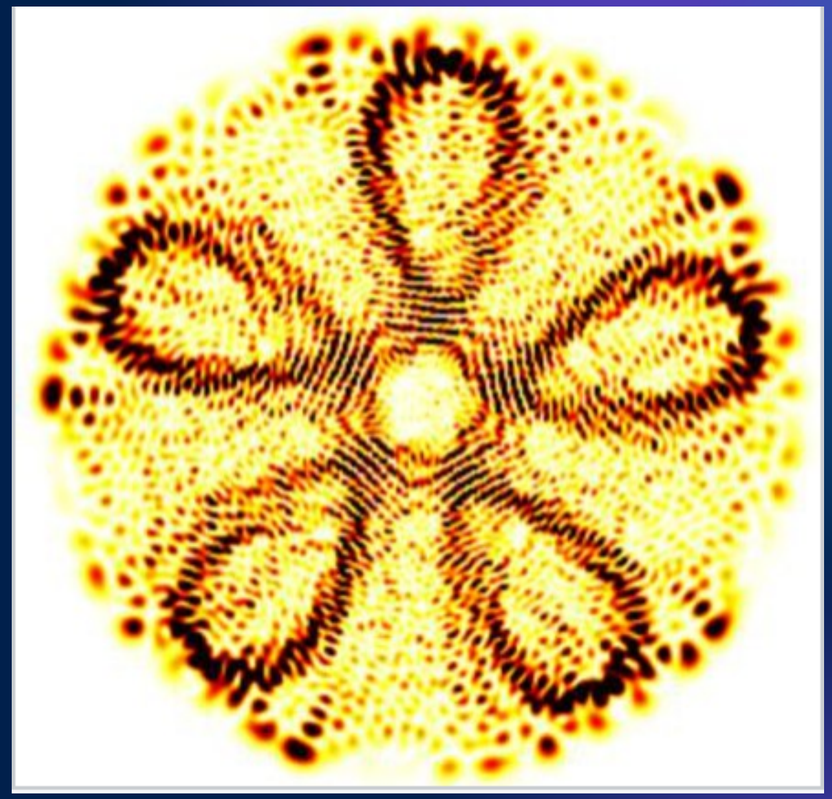
The generalized Hamiltonian operator governing this kind of system can be exemplified by:

$$H = \frac{\Omega(t)}{2}(|g\rangle\langle r| + |r\rangle\langle g|) \equiv \frac{\Omega(t)}{2}\sigma_x$$

where σ_x is the state flipping operator $|g\rangle\langle r| + |r\rangle\langle g|$ that transforms the ground state $|g\rangle$ to the excited Rydberg state$|r\rangle$ and vice versa.

Plan

- After determining the problem at hand, our plan was to test different shapes (chain, square, and a closed chain circle) on our simulation to compare and determine which one had a better revival probability, before testing on hardware.



Perturbation-induced quantum skipping scar in a disordered quantum well w/ an external magnetic field

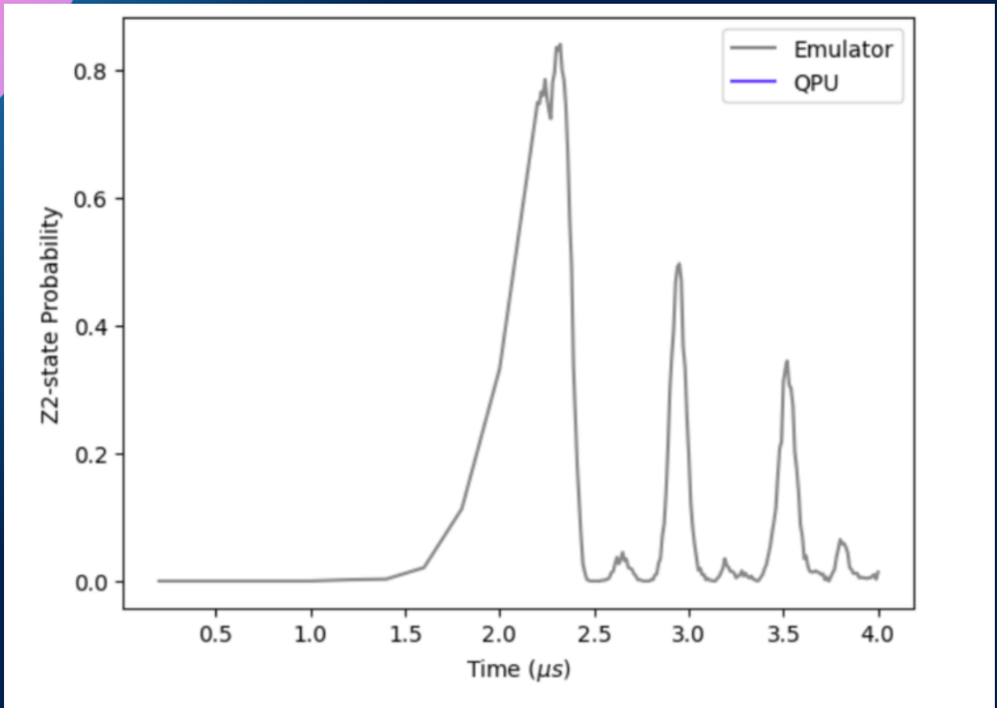
Method

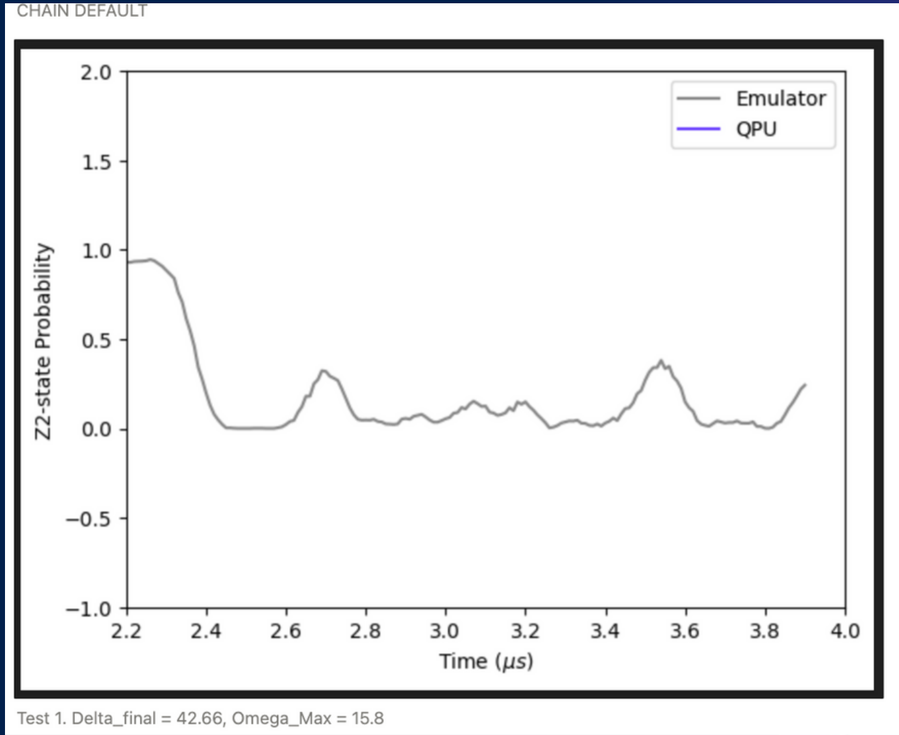
- Implemented “detuning” to code a way to tune a laser (that’ll be eventually connected to hardware
- The laser excites the energy states of atoms from ground to Rydberg state and makes them bigger, which contributes to the process of "quench."_

- Frequent debugging
  - “Break the code”
  - Testing different values
  - Changing distances between points (in our geometry)

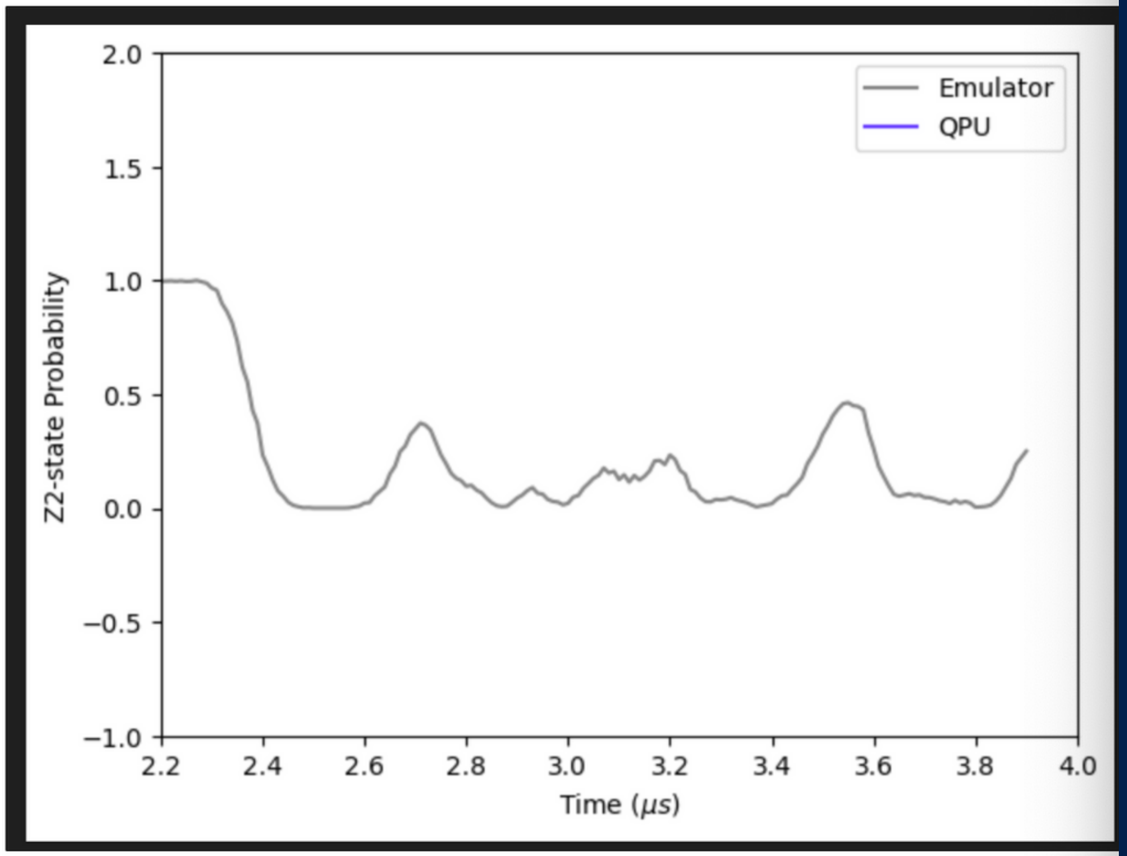
- Referencing resources
  - Quera Qbook
- Translating into psuedo-code.

INITAL Results



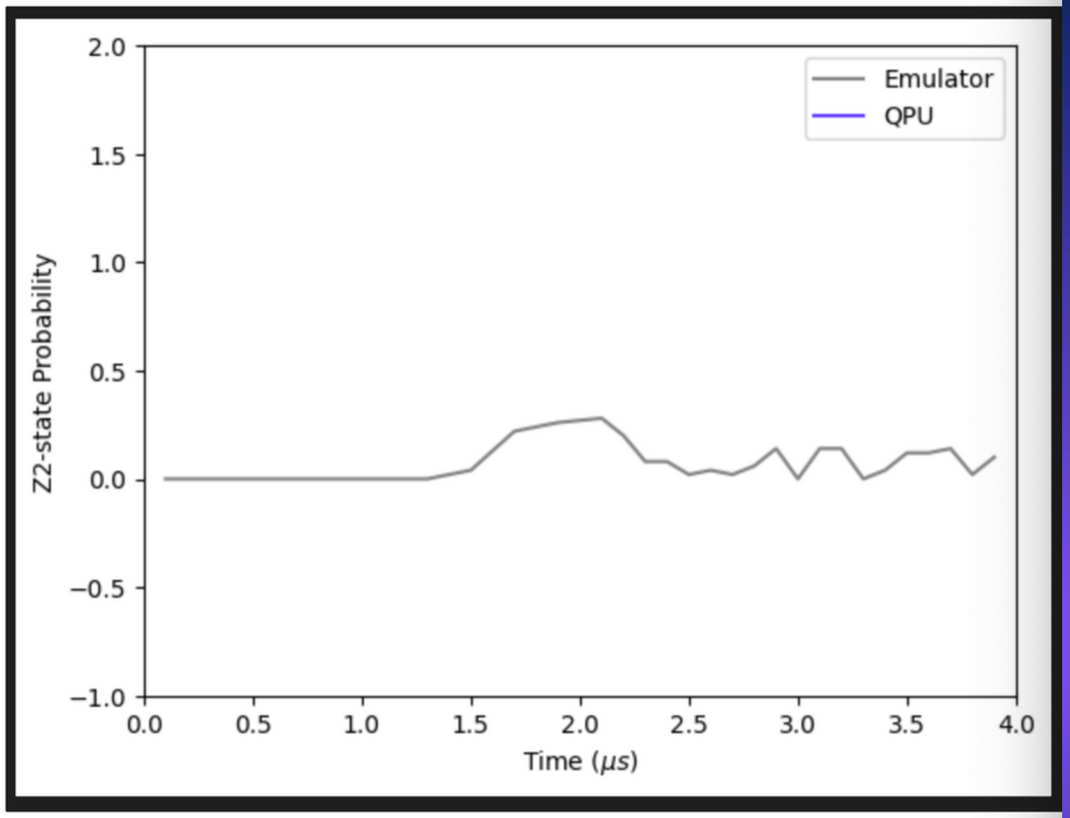


FINAL Results



Test 7, rehash of Test 3.

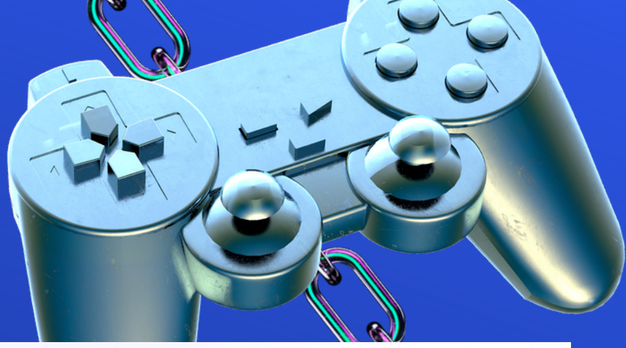
Our findings show a direct correlation between initial z2 state probability and recapitulation probability. However, even with 100% z2-state probability, our recap model still is outperformed by the chain.



APPENDED CYCLE TEST 1. DELTA_FINAL = 42.66, OMEGA_MAX 15.8

CONCLUSION

- Different geometries affect Hamiltonian
- Different factors affect the states we want
- Importance of Quantum Scarring & relation with decoherence
- Rydberg States- Higher omega acts as driving force to oscillate the rydberg state from ground to rydberg
- Hamiltonians & Many-body system -> guess & check is more efficient
- Decorated honeycombs did better than squares



$$H = \frac{\Omega}{2}\sigma_x \qquad |\psi(0)\rangle = |g\rangle$$

$$|\psi(t)\rangle = \cos\frac{\Omega}{2}t\,|g\rangle - i\sin\frac{\Omega}{2}t\,|r\rangle$$