#TheBestWayToQuantum

Bloqade - Efficiently Emulating and Operating Neutral-Atom Quantum Computers

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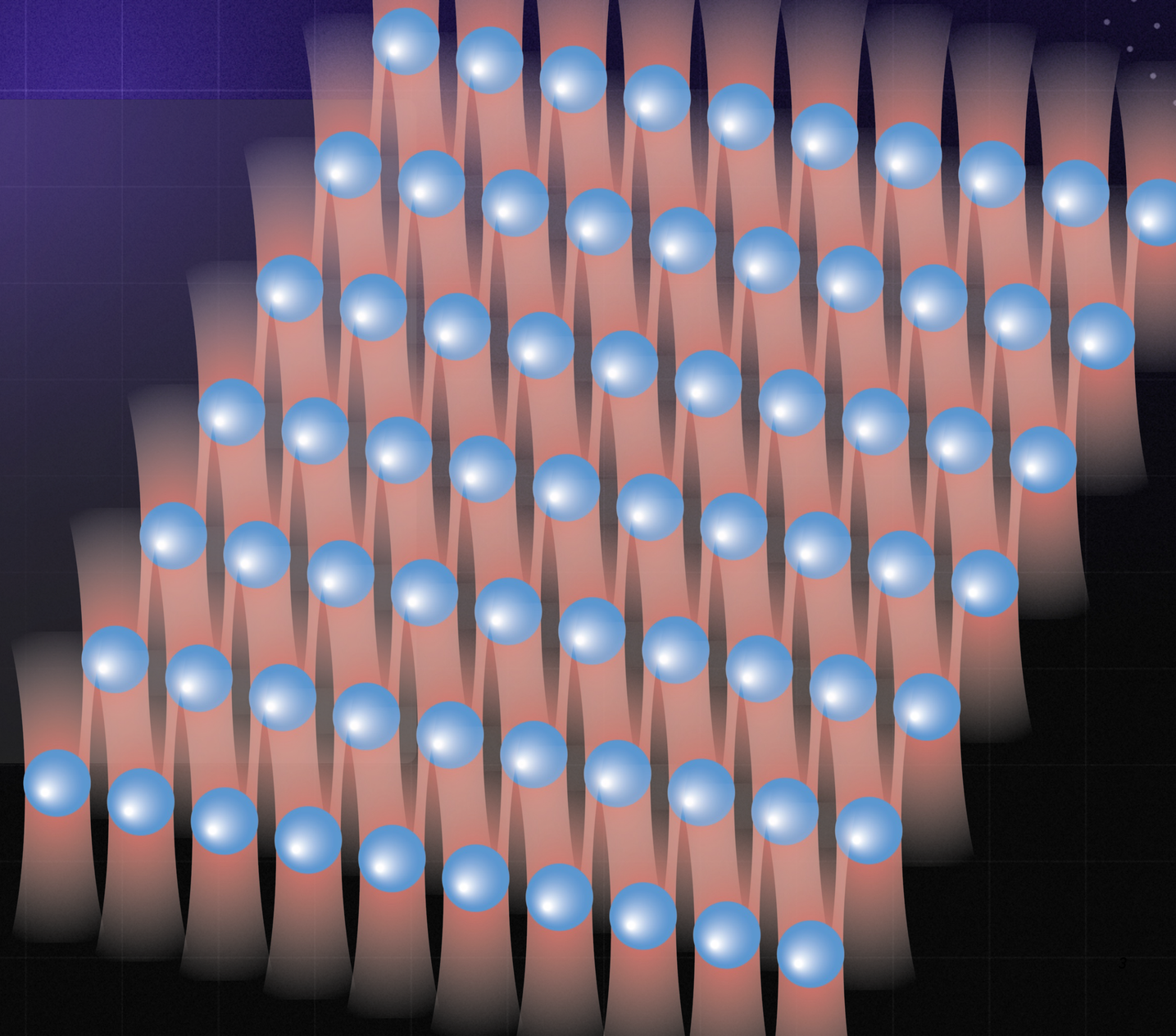
The Neutral-Atom Quantum Processor

- Densely packed qubits (atoms)
- Efficient qubit control
- Flexible problem encoding
- The new way to think scalable quantum computing!



Aquila: our 256-qubit machine on Amazon Braket

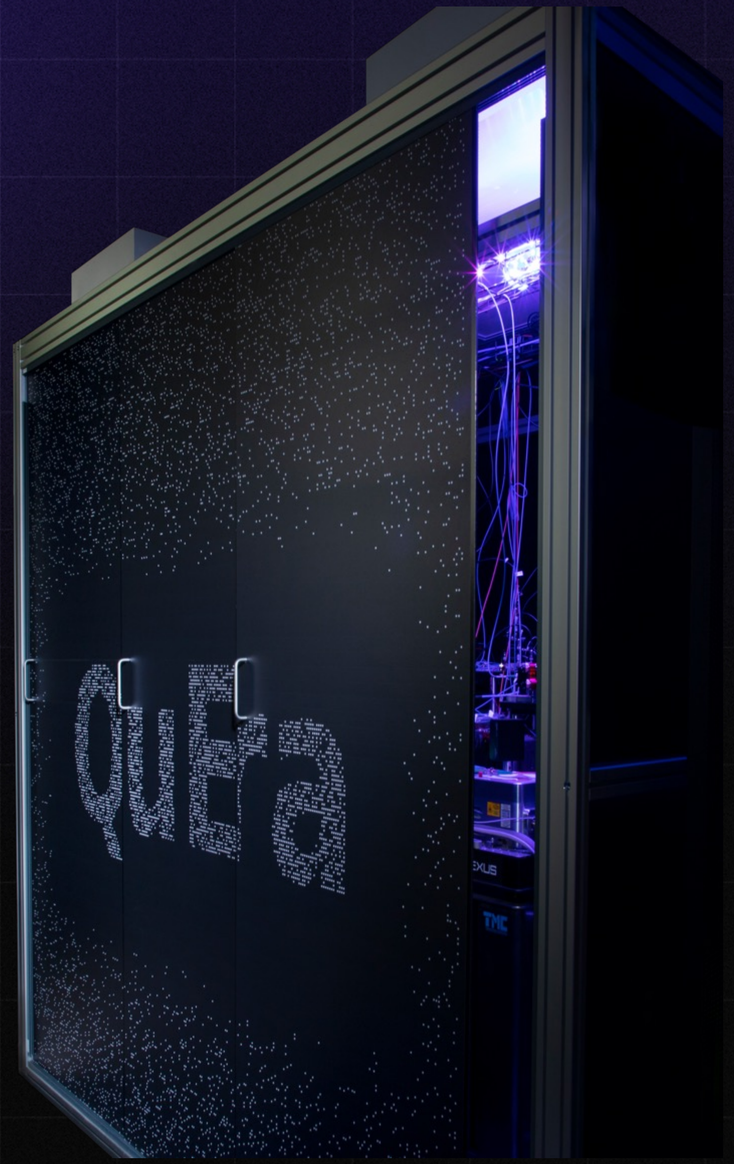
Quantum power

- 256 entangled neutral-atom qubits
- Coherence throughout the computation

Architecture

- Analog mode
- Field programmable qubit arrays (FPQA)™

Cloud accessible: aws



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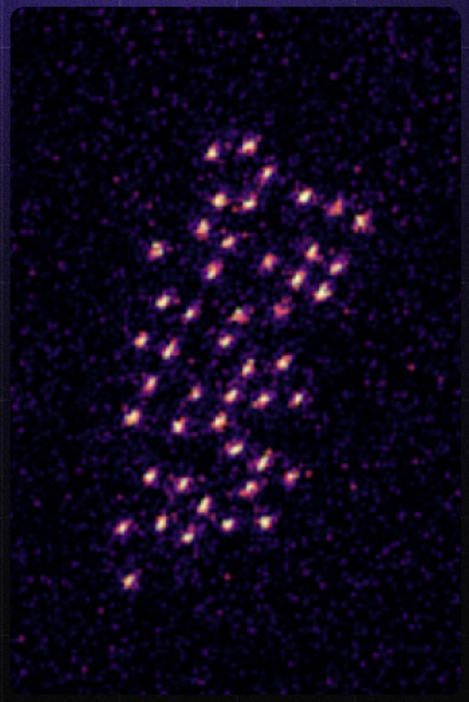
Key logic: Maximum Independent Set

Choose possible locations of shops in Manhattan

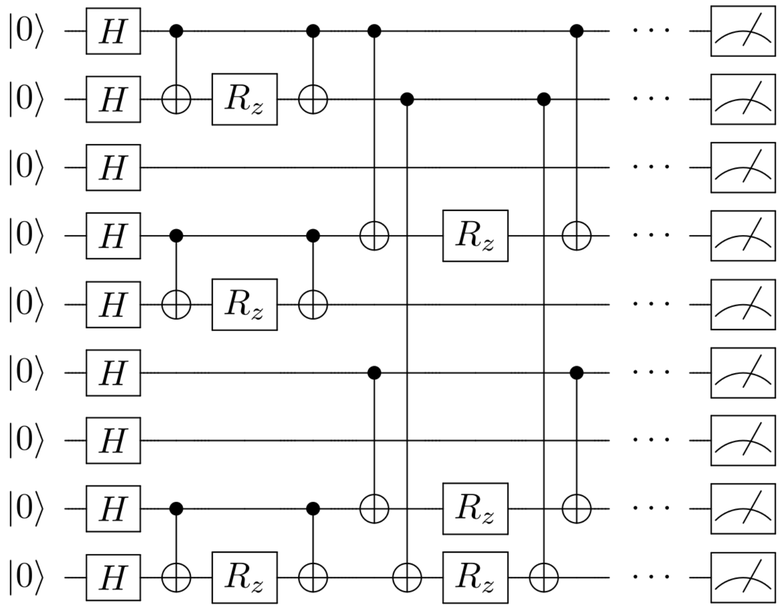
Define problem via arbitrary atom positions



Excite atoms to find answer

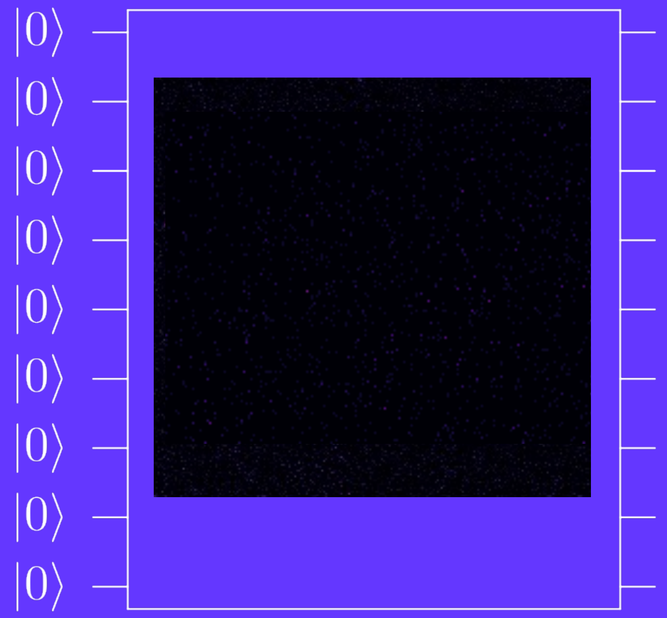
Analog and Digital operation modes

Digital gate-based mode



- Universal
- Not Efficient

Analog mode



- Efficient
- Not Universal

Hardware-efficient software

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Package to simulate and compute on neutral-atoms

Generic Tensor Networks

Solve solution space properties of maximum independent set and other problems

Unit-disk Mapping

Reduce arbitrary-graph optimizations to a 2D grid

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Utilities layer

Unit Handling
Built-in support for automatic physical unit conversion

Built-in Waveforms
Flexible, intuitive waveforms with various filters

Flexible Built-in Lattices
With convenient visualization

Rydberg Hamiltonian
Symbolic Expressions contain all system information

Back-ends layer

Quantum Hardware
Transformation and validation for easy access

ODE solvers
Generic, fast, and highly configurable

Krylov Solvers
Fast and generic

CPU Multithreading

GPU support

Integration with Yao
enable easy access to common quantum information processing functions

BLOQADE

Fast & Broad Adoption

Launch date: July 2022

arXiv:2211.00653
Condensed Matter Physics

arXiv:2303.02775
Quantum Computing Science

~1000 unique installations
134 Stars on GitHub! :-D

arXiv:2212.02476
High-energy Physics

Star 134

arXiv:2206.11970v2 (May '23)
Quantum Machine Learning

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Utility First!

```
atom1 = AtomList([(0.0, 0.0)])
clocks = 0.0:1e-2:1.5
prob1 = KrylovEvolution(zero_state(1), clocks, rydberg_h(atom1; Δ = 0, Ω =  2π * 2))
```

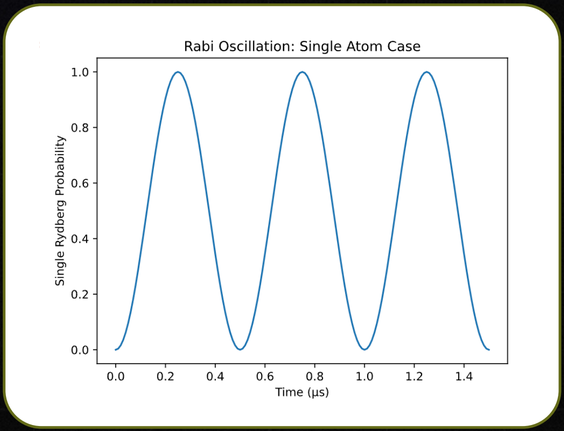
geometry

Initial register

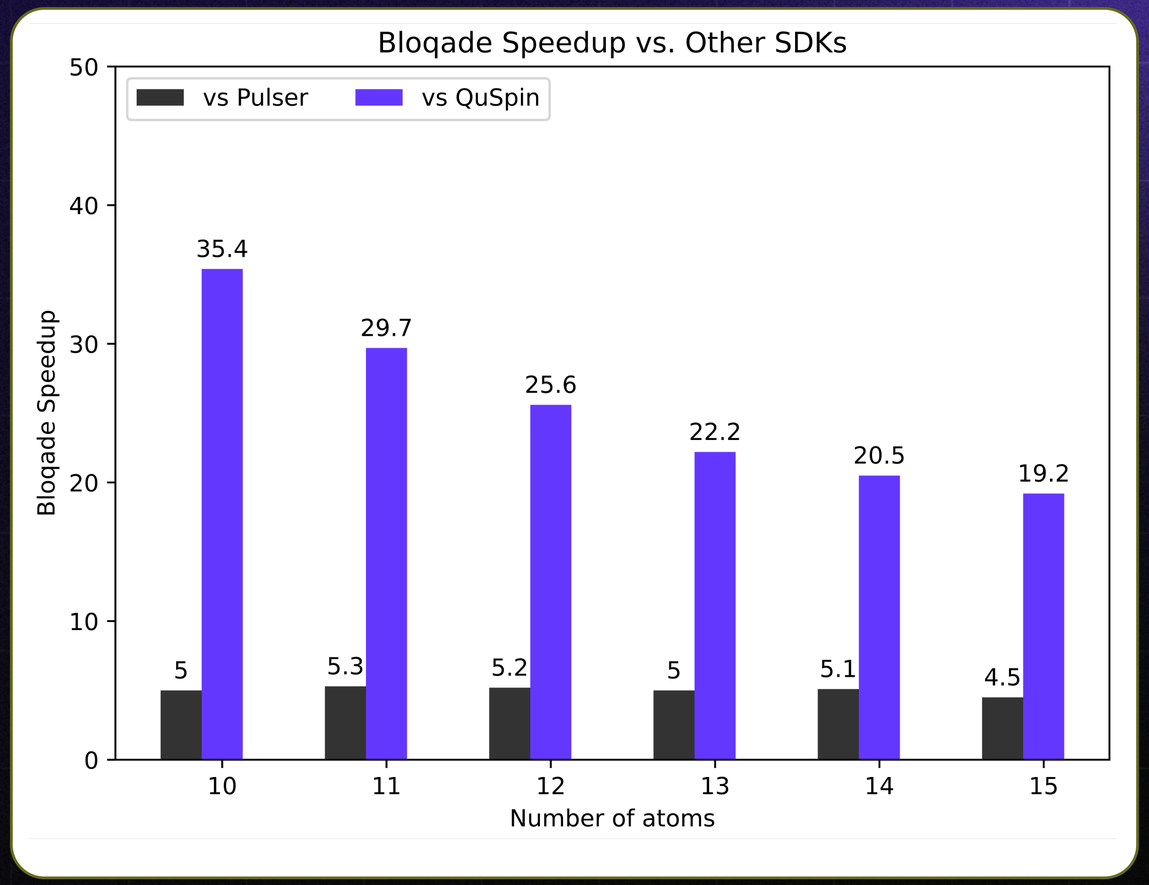
Hamiltonian call

Evolution method

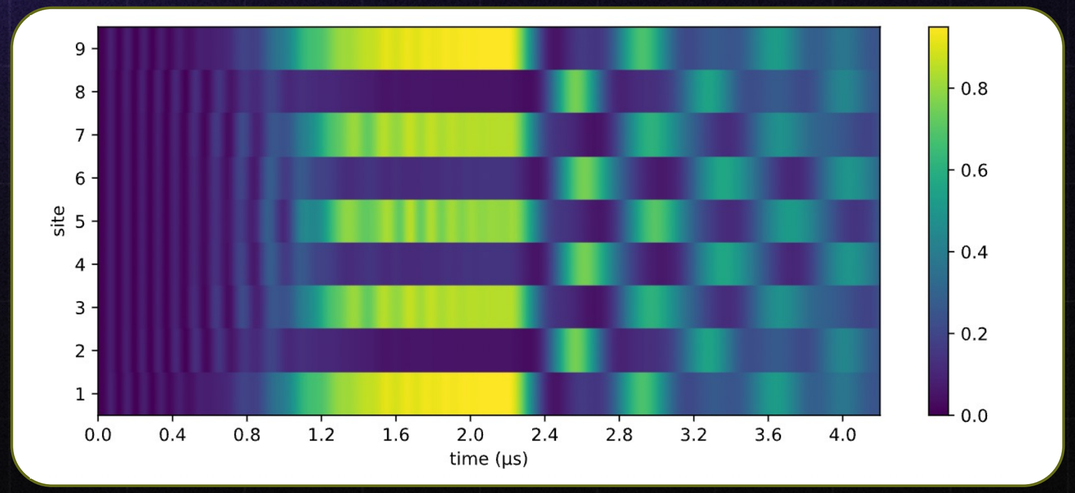
waveforms



Emulation Performance – YES!



Quantum dynamics benchmark: many-body scars
1D, 10-15 qubits



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Hardware Access – YES!

Define your problem (and emulate it if possible)

Transform to hardware

Validate

Tweak problem (if necessary)

Submit!

Retrieve data (and analyze it)

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Open Challenges

The analog simulation challenge: quantum dynamics

GPU, Multi-node/multi-GPU

GPU overhead: low performance

operating on “blockade” subspace: target simulations with ~100 atoms

Tensor-networks for analog

great success for digital, more limited in analog (TDVP,...)

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Getting Started

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Connect with us!

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aws

ACCESS AT AMAZON BRAKET (research credits available)

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