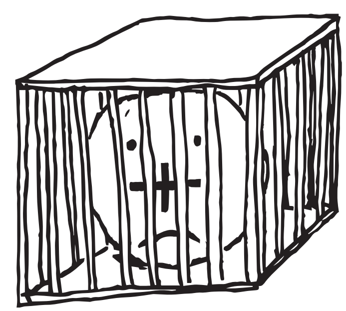
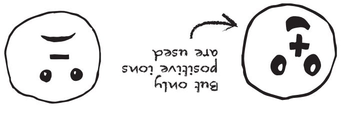
Trapped Ion Quantum Computers

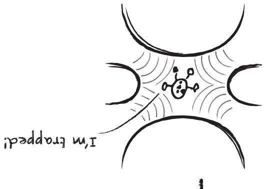


Ion Traps

Ions are charged atoms that can be used as qubits



But we need to hold our qubits in place!

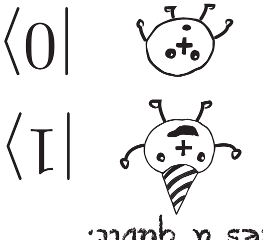


We accomplish this with an **ion trap**, which consists of rapidly osciallating electric fields

Qubits

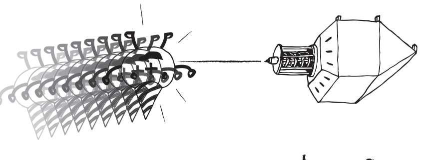
If an ion has enough energy, it can become "excited"

This, along with the unexcited (ground) state, makes a qubit!

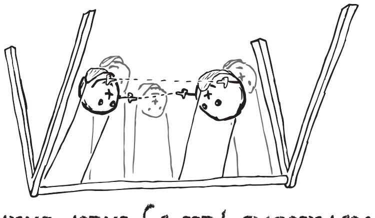


Quantum Gates

Fine-tuned lasers can control the state of a single qubit



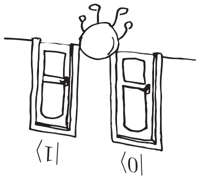
To perform 2-qubit operations, trapped ions interact via vibrations felt by their charges



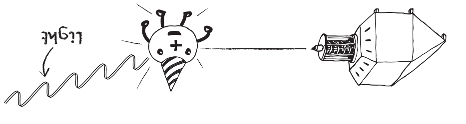
And they can even become entangled!!

Measurement

Shining a different laser at an ion will cause any previous superposition to collapse



An excited ion will emit light when hit by the laser, but a ground state ion will not



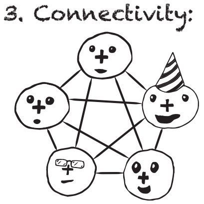
If we detect light, then we know the measured value of the qubit is $|1\rangle$

Advantages

1. Stability:

2. Accuracy:

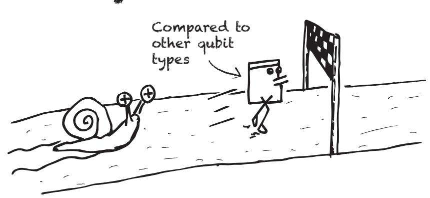
3. Connectivity:



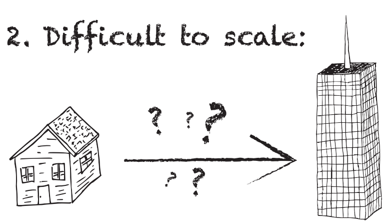
It's easy to entangle many qubits together!

Challenges

1. Fairly slow:



2. Difficult to scale:



Due to complexity of many lasers, vacuums, and trapped ions

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