Quantum Computing

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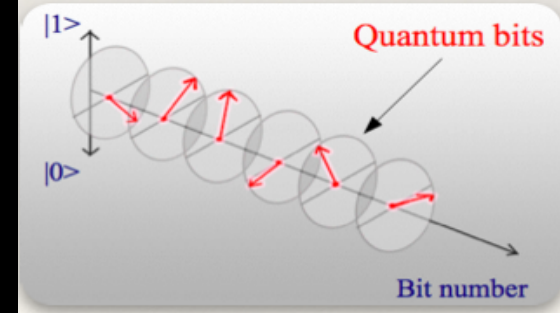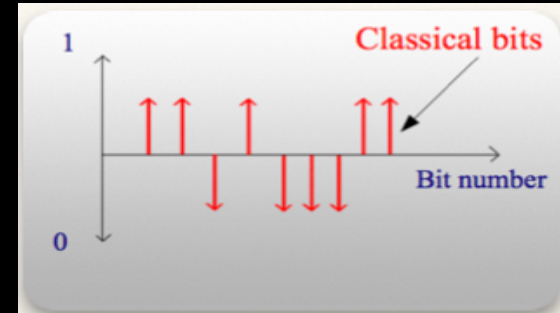Corey Howman   Peter Walker
Marco Veglia

What is it?

- The act of computing data using the principles of quantum mechanics to our advantage
- A Quantum Computer uses Qubits instead of classical bits

What is a Qubit?

QUantum BIT

- Similar in concept to a standard bit
- Can hold not only the status '0' and '1' but superposition of both states |0>+B|1>
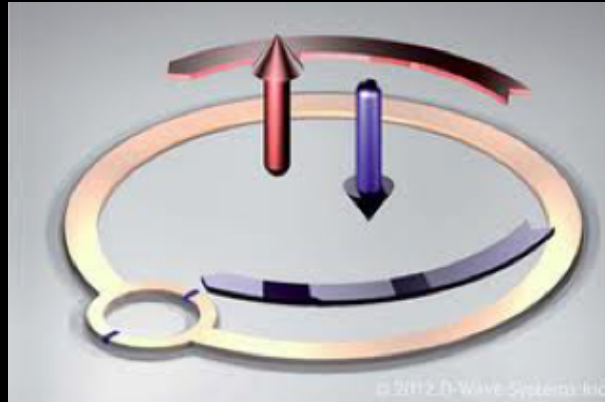
How Qubits are Used

- Superposition allows for us to store many combinations in very few qubits
  - 4 classical bits, 2^4 combinations
    - **4 x 2^4 bits** to hold ALL combinations
  - 4 qubits, all are in superposition
    - **4 qubits** to hold ALL combinations

Current Qubit Technologies

- Electron Spin
  - Magnetic moment of an electron
- SQUIDs
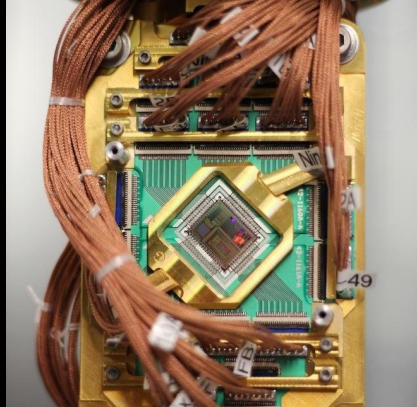 - **S**uperconducting **QU**antum **I**nterference **D**evice

Obstacles

- Decoherence
- Expenses of Quantum Computer's necessary environment
  - SQUIDs must be kept at 20-80 milliKelvin
  - Electrons are hard to hold on to
- Effective use of quantum source code

Current Projects

- D-Wave Two
  - Google and NASA
- NMR Quantum Computers
  - IBM

Why is it so special?

- Quantum computing could be the beginning of…
  - Incredible Problem Solving
  - Optimization
  - Artificial Intelligence
  - Deep Space Travel

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Problem Solving Potential

- A quantum computer can be used to quickly solve problems with many solutions
  - Qubits will "store" all of the potential solution, and become the most correct one when computed upon
 - The Travelling Salesman

Optimization

- One Quantum Computer has the potential to solve problems all of Google's data centers can't together
- Will lead to faster services for questions concerning travel plans, drug synthesis, database mining, etc.

Basis for Artificial Intelligence

- Robots hear and see better than we do, but cannot process new sounds and images.
- Quantum Computing will allow them to process this information like a human, making connections and inferences
- They will be able to act human

Deep Space Travel

- Quantum Computers will let us explore the quantum level of the world
  - Could lead to advances in space travel technology
- Optimization will let us find new habitable worlds
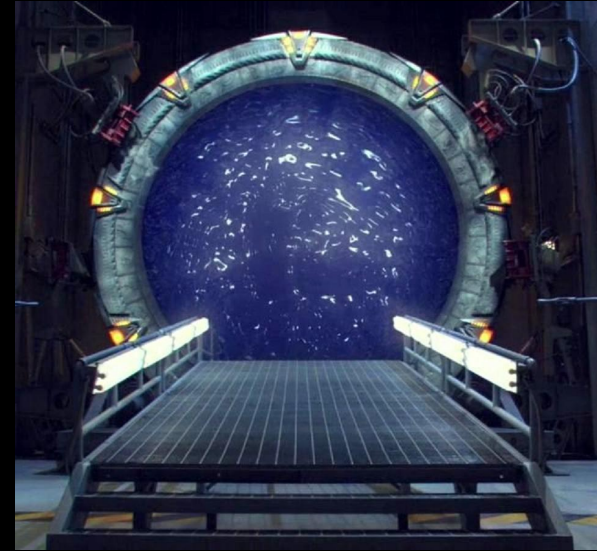
Not All Sunshine and Roses

- Can single-handedly make every firewall and encryption in the world obsolete.
- Would expose everyone to malicious attacks

How Far Away?

- Still in developmental stage
- Require lots of specialized equipment and a very controlled environment
- Source code is still not fully developed
- It may be scalable, but not reducible

Questions?