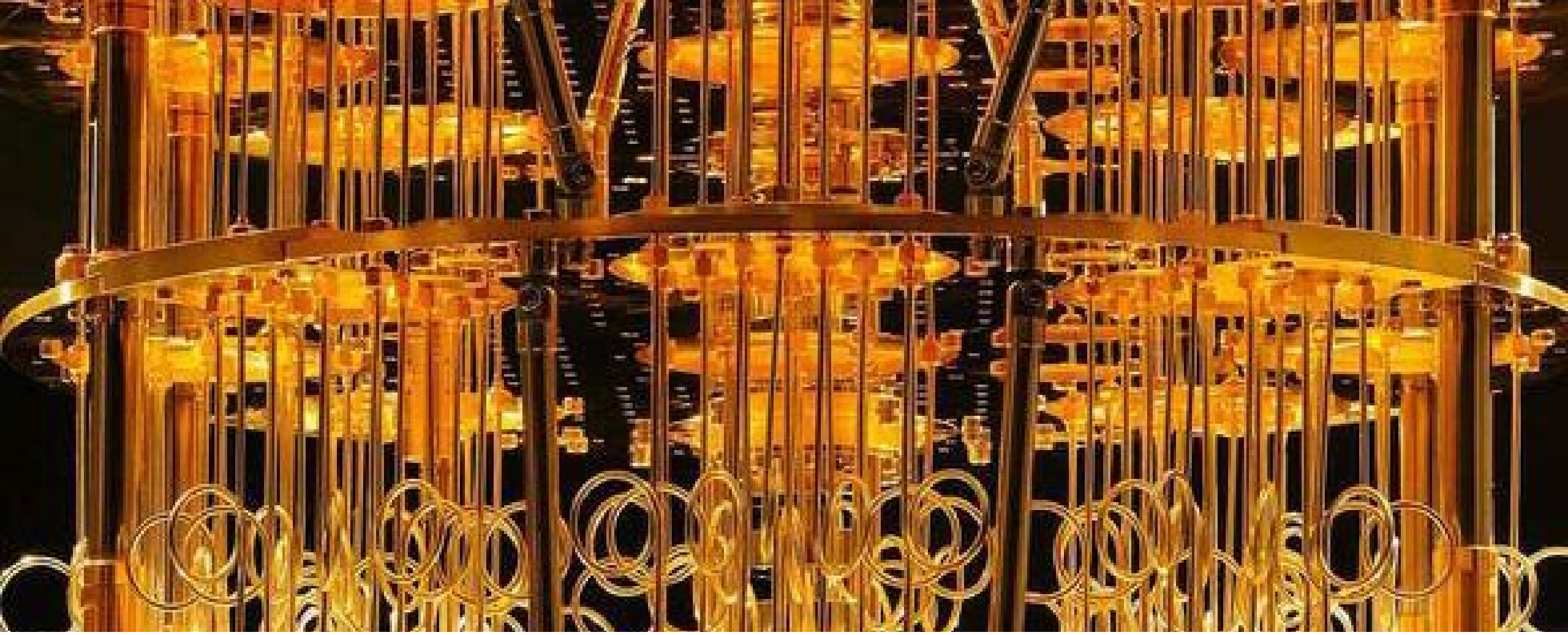


QUANTUM COMPUTING

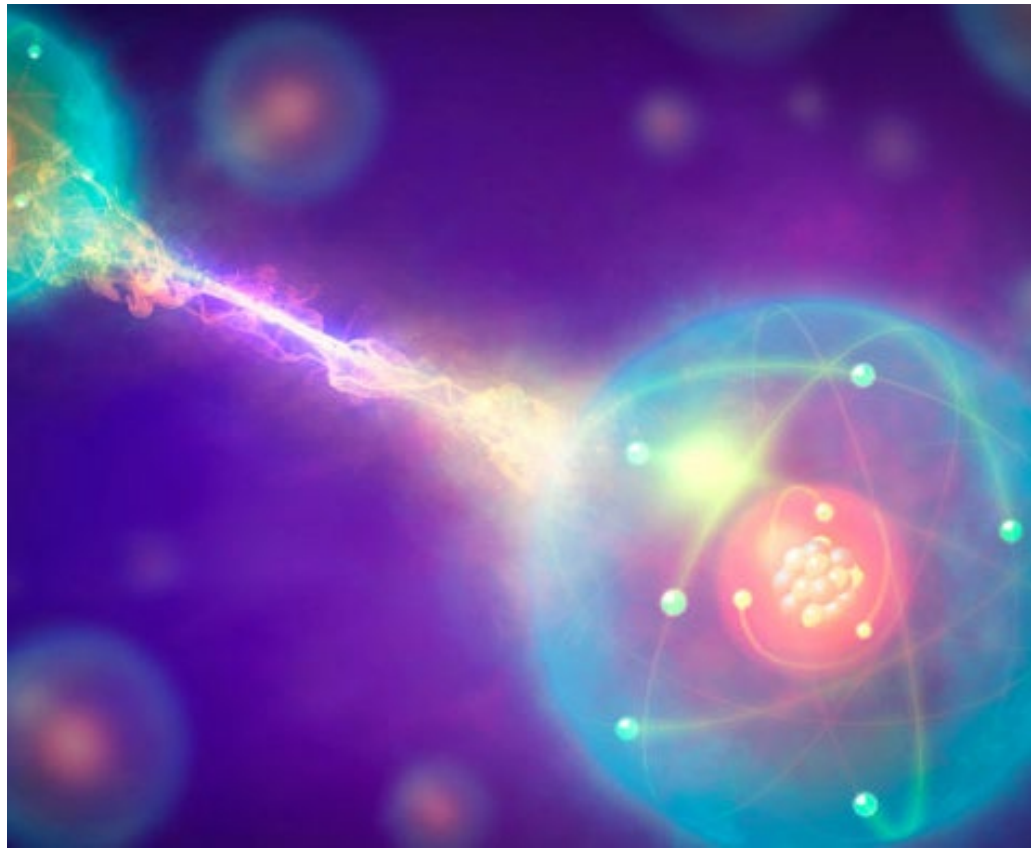
Lecturer: Mark Gillan

SUPERPOWERED BITS

- Unlike regular computers with 0s and 1s, quantum computers use qubits.
- Qubits can be 0, 1, or both at the same time (superposition), enabling parallel processing on a mind-boggling scale.
- Imagine solving millions of equations simultaneously, that's the power of **superposition**!

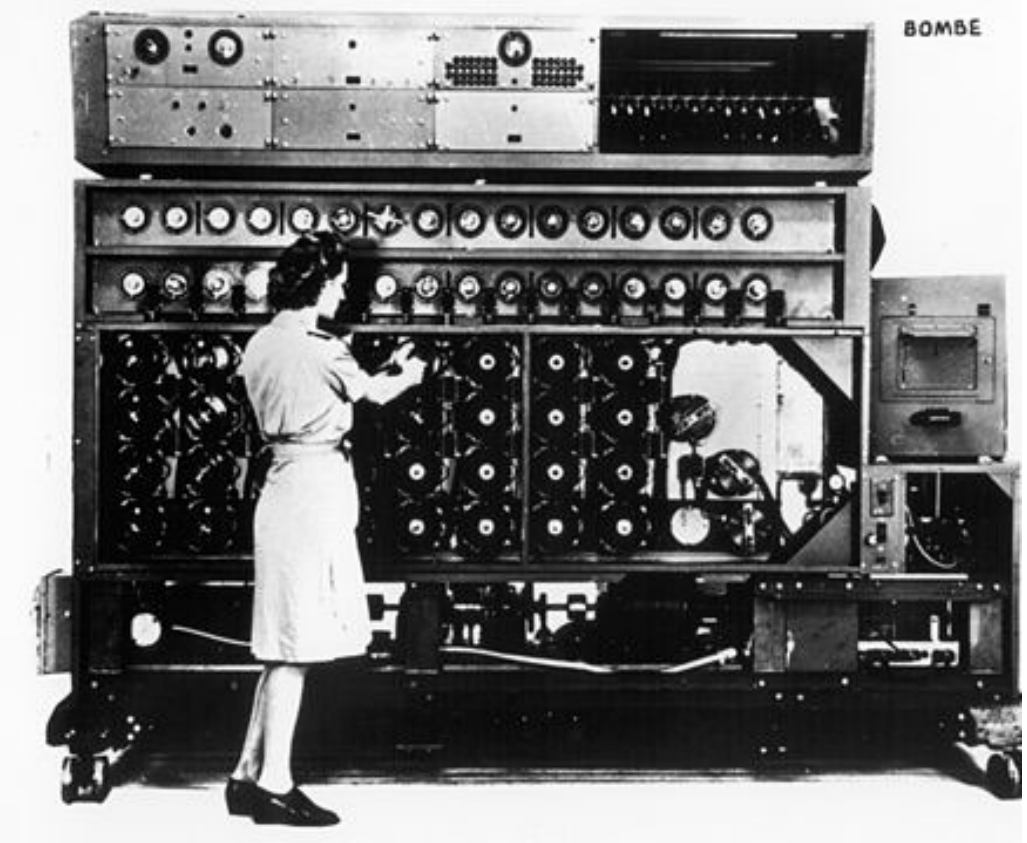
SPOOKY ENTANGLEMENT

- Qubits can be linked in a bizarre phenomenon called **entanglement**, where they act as one unit **regardless of distance**.
- Measuring one entangled qubit instantly affects the other, no matter how far apart they are. Spooky, right?
- This allows for instant communication and ultra-secure encryption methods.

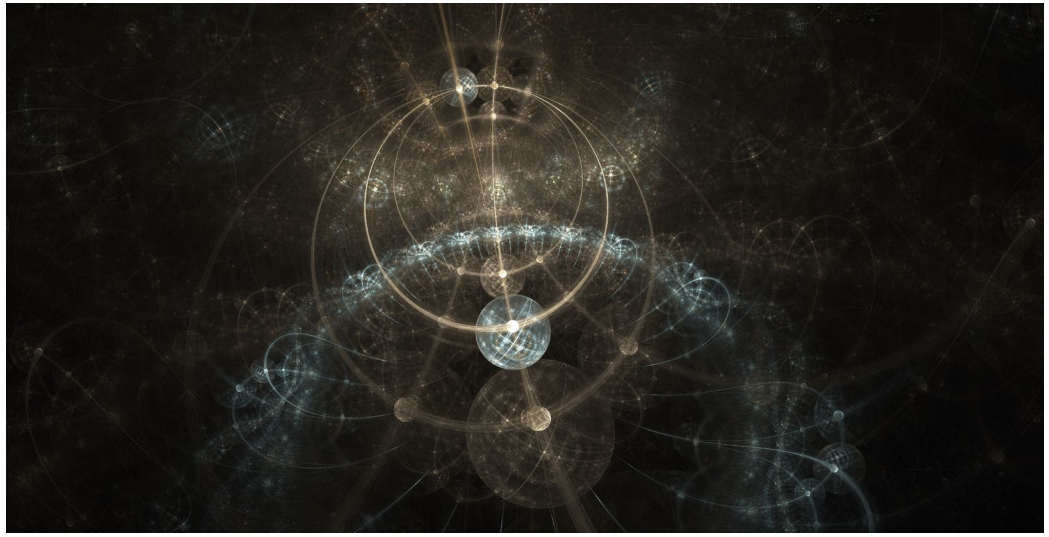


CRACKING THE CODE

- Some encryption methods used today could be vulnerable to quantum computers.
- Shor's algorithm, a quantum algorithm, can factor large numbers that are currently used in encryption keys.
- This is why developing new, quantum-resistant encryption methods is crucial.



QUANTUM SUPREMACY



- In 2019, Google achieved "quantum supremacy" by completing a task faster than any classical supercomputer.
- This was a major milestone, demonstrating the potential of quantum computers to solve problems beyond the reach of traditional machines.
- Imagine simulating complex molecules or designing new materials, the possibilities are endless.

COLD AS ICE

- Qubits are delicate and easily disrupted, requiring extremely cold temperatures to function properly.
- D-Wave quantum computers operate at a chilly **-460°F**, just a whisper above absolute zero!
- This keeps the qubits in a stable state and prevents errors from creeping in.

EXPONENTIAL SPEED

- The speed of a quantum computer compared to a traditional computer depends heavily on the specific problem being solved. For some problems, like certain types of simulations and optimizations, quantum computers can achieve exponential speedup compared to classical computers.
- However, it's important to note that this exponential speedup is not universal. Not all problems benefit from quantum computing, and for some tasks, there is no quantum speedup at all.

- Google's Sycamore quantum computer achieved "**quantum supremacy**" in 2019 by completing a specific task in 200 seconds, which would have taken the world's fastest supercomputer at the time 10,000 years.
- D-Wave quantum computers are designed for optimization problems and can sometimes find solutions in seconds that would take traditional computers years.

NUMBER OF QUBITS

- The largest quantum computers, such as those from IBM and Google, use superconducting wires cooled to extremely low temperatures for their quantum bits, or qubits. The record-breaking machine from California-based start-up Atom Computing, which has **1180 qubits,** uses neutral atoms trapped by lasers in a 2-dimensional grid.
- More qubits generally equate to more processing power, but maintaining stability and error correction becomes increasingly challenging with larger numbers.
- IBM has unveiled the first quantum computer with **more than 1,000 qubits** — the equivalent of the digital bits in an ordinary computer. But the company says that it will now focus on making its machines more error-resistant rather than larger.

QUANTUM COMPUTING MACHINES