

A beginner's guide to

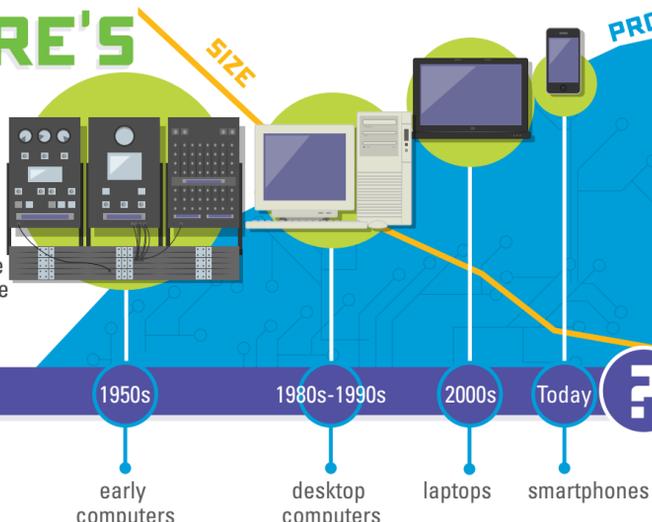
QUANTUM INFORMATION TECHNOLOGY

A TECHNOLOGICAL REVOLUTION IS UNDER WAY

Scientists are now harnessing the properties of quantum mechanics, the theory that describes the atomic world, to develop information technologies of unprecedented power and precision that promise to change the world. Canada is a world-leader in quantum information research. Here's a primer on this technological quantum leap.

MOORE'S LAW:

As computers get smaller, they get more powerful; microchips double in power and halve in size every 18 months.



HOW MUCH SMALLER CAN WE GO? Within a decade or so, microchips will shrink to the size of an atom, and Moore's Law will hit its limit. This is the

QUANTUM SCALE

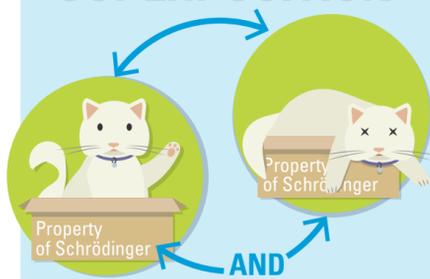
At this tiny scale, the laws of physics flip from "classical" to "quantum," and ...

QUANTUM MECHANICS TAKES HOLD!



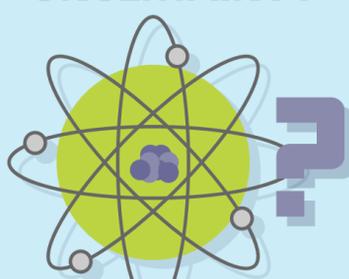
Things in the quantum world behave very differently than they do at larger "classical" scales.

SUPERPOSITION



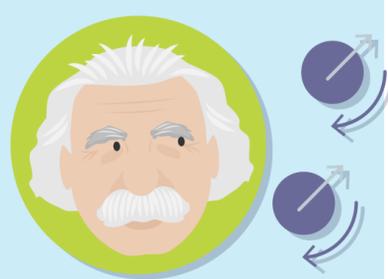
Quantum objects can be in a "superposition" of states — essentially here **and** there, up **and** down, on **and** off.

UNCERTAINTY



Quantum law: you can't observe a system without altering it.

ENTANGLEMENT



Quantum objects can be "entangled," or strongly correlated with each other, even over large distances. Einstein called this "spooky."

We can harness quantum phenomena to create ...

QUANTUM INFORMATION TECHNOLOGIES

QUANTUM COMPUTERS



Classical binary bits have a value of either 1 or 0.

Quantum bits, called qubits, can be both 1 **and** 0.

Quantum computers operate on superpositions of states, drastically speeding up some tasks.

CAN TAKE SHORT CUTS TO MAKE INCREDIBLY FAST CALCULATIONS

QUANTUM CRYPTOGRAPHY

Capitalizes on the quantum law that observing a quantum system disturbs it: Instant eavesdropper detection!



IS ULTRA-SECURE TO PROTECT PRIVACY

QUANTUM SENSORS

Exploit quantum mechanics for unprecedented precision —



from super-high-res medical imaging to components of quantum computers.

WILL ACHIEVE THE GREATEST SENSITIVITY ALLOWED BY NATURE

We do not yet know all the technologies that will emerge from quantum information. But we do know they'll be

UNPRECEDENTED AND POWERFUL.



CANADA IS AT THE FOREFRONT OF THE QUANTUM FRONTIER.

THE FUTURE IS QUANTUM

Visit PerimeterInstitute.ca and the Institute for Quantum Computing at iqc.uwaterloo.ca to find out more about quantum computing research in Canada.