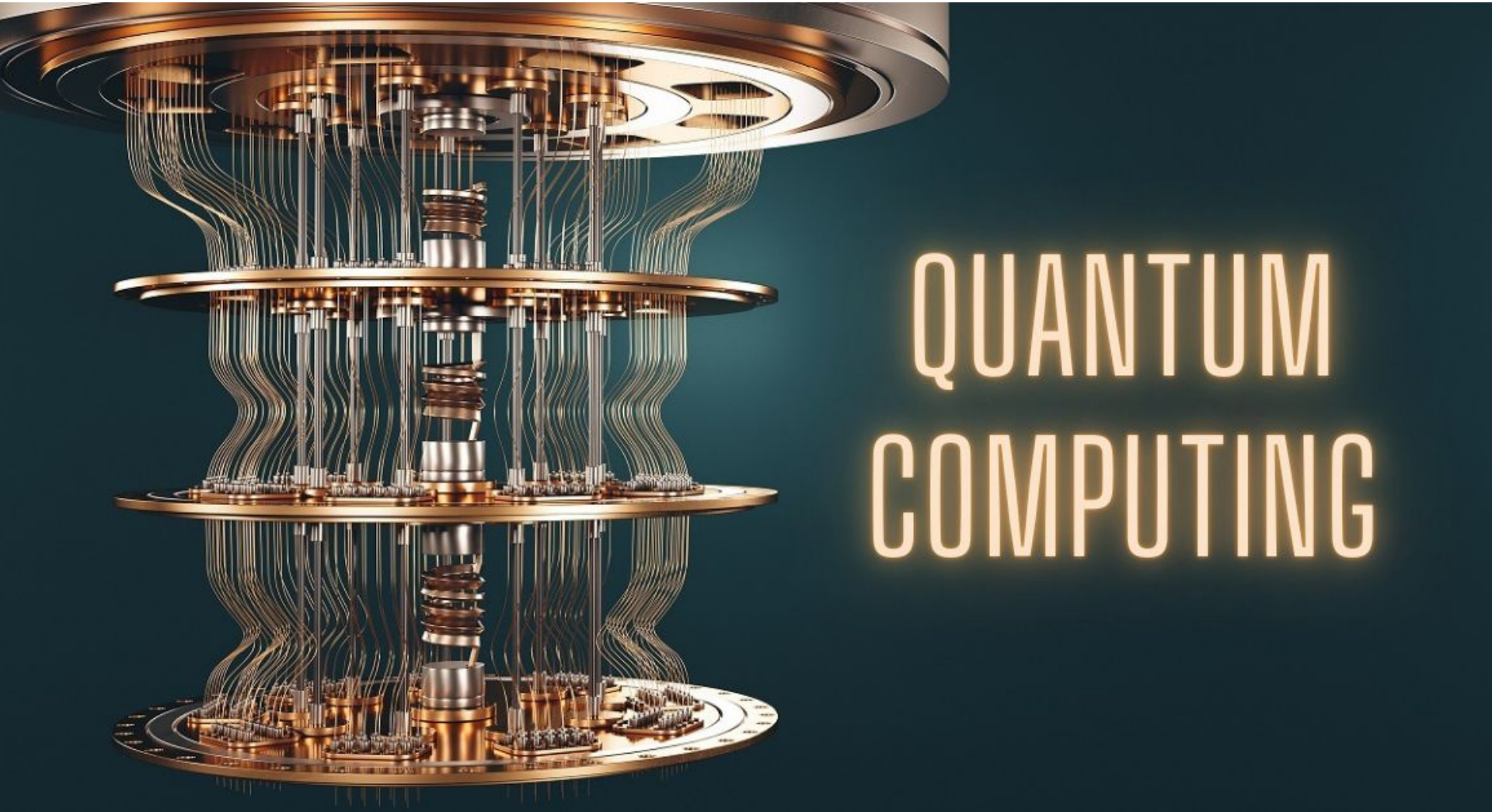
Hi,
I am SUMAIYAH

Email : Sumaiyah@nu.edu.pk

Office : In front of CS Secretariat

This is CS4084!

GCR:wzj3vua


QUANTUM
COMPUTING

Marks Distribution

Mid 1 = 15

Mid 2 = 15

Assignments = 10

Project = 10

Final = 50

Motivation

universities that are teaching quantum computing in CS degree

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Public International Best

From sources across the web

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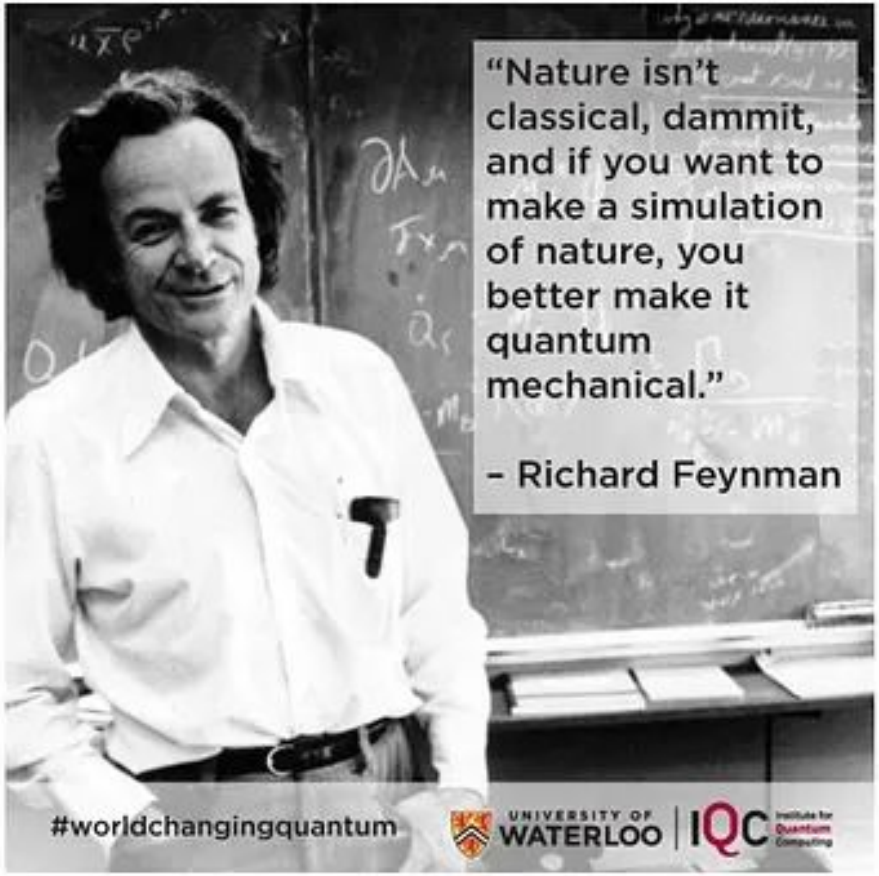
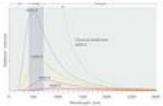
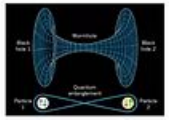

"Nature isn't classical, dammit, and if you want to make a simulation of nature, you better make it quantum mechanical."
– Richard Feynman
#worldchangingquantum
UNIVERSITY OF WATERLOO
IQC Institute for Quantum Computing

Theoretical Foundations

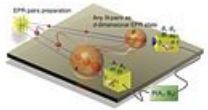
1900 — Planck's Quantum Hypothesis



1935 — The EPR Paradox



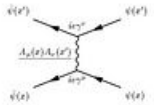
1964 — Bell's Inequality



1970 — Birth of Quantum Information Theory

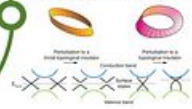
1980 — First Conference on Physics and Computation

1981 — Feynman's Quantum Computer Proposal



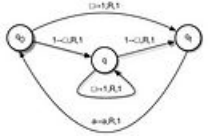
Emergence

1982 — Discovery of Topological Quantum order



Development

1984 — Benioff's Quantum Turing Machine



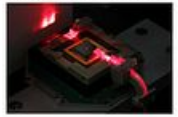
1985 — Deutsch's Universal Quantum Computer

1994 — Shor's Algorithm

1994 — Grover's Algorithm

1996 — DiVincenzo Criteria For Quantum Computer

2000 — First Trap Ion Quantum Computer



Race

2004 — Circuit QED Demo.

2007 — The Transmon Superconducting Qubit

2007 — D-Wave One Quantum Annealer

2013 — Rigetti Computing

2016 — Microsoft Station Q

2019 — Google Quantum Supremacy

2020 — IBM Quantum Roadmap

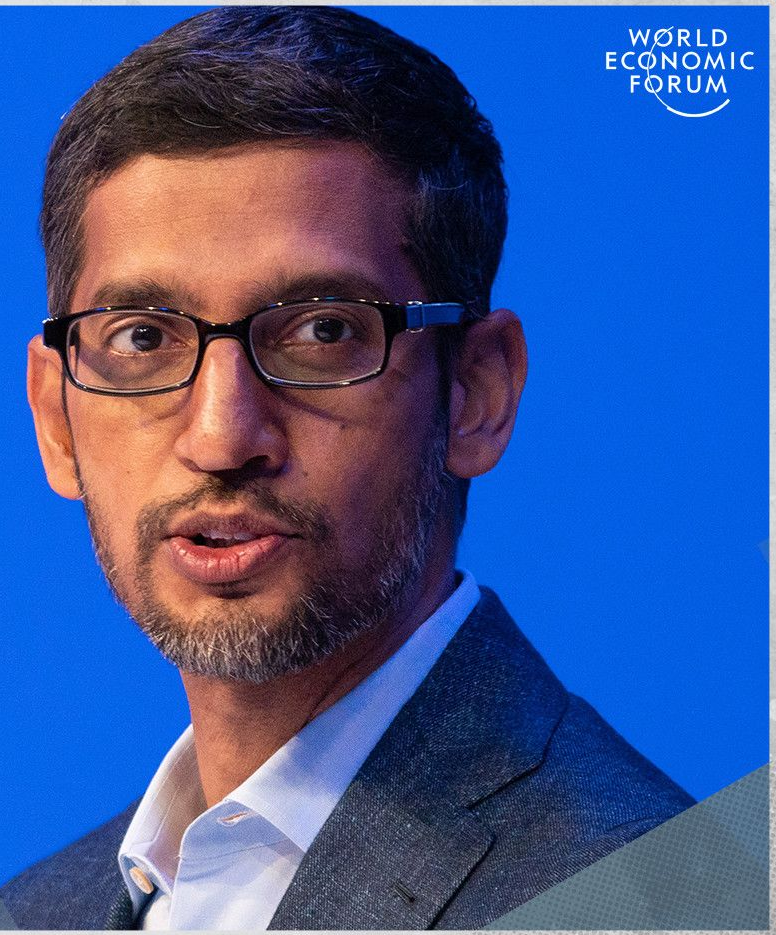
2021 — Company Booming

IONQ, Honeywell, PsiQuantu, XANADU

2022 — Quantumpedia's Founding

Ongoing Advancements

“Nature at a fundamental level works in a quantum way.”

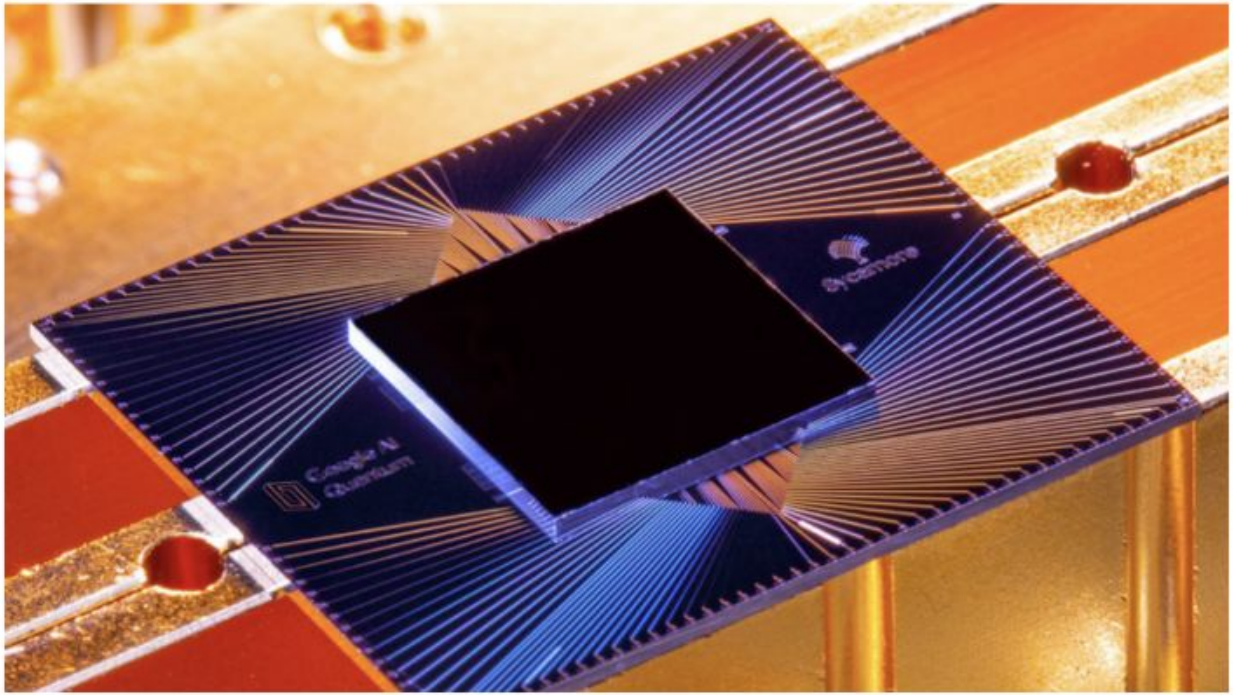


Sundar Pichai
CEO, Alphabet

NEWS QUANTUM PHYSICS

Google officially lays claim to quantum supremacy

A quantum computer reportedly beat the most powerful supercomputers at one type of calculation



nature

Article | Published: 23 October 2019

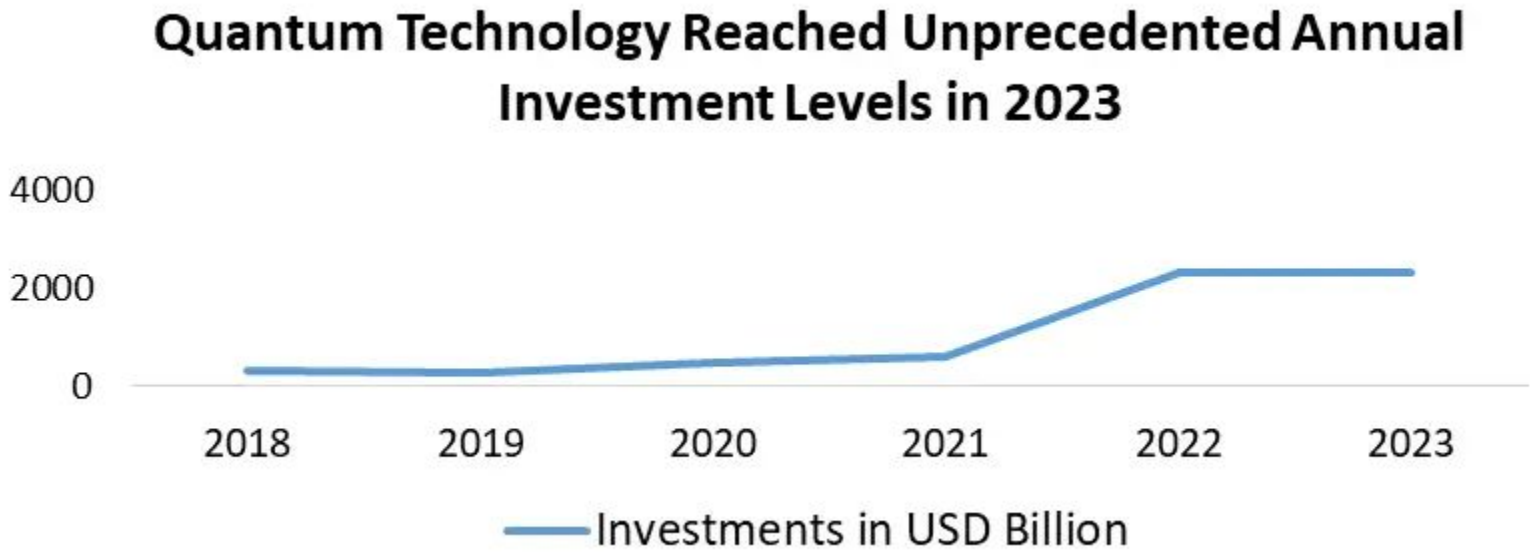
Quantum supremacy using a programmable superconducting processor

Frank Arute, Kunal Arya, Ryan Babbush, Dave Bacon, Joseph C. Bardin, Rami Barends, Rupak Biswas, Sergio Boixo, Fernando G. S. L. Brandao, David A. Buell, Brian Burkett, Yu Chen, Zijun Chen, Ben Chiaro, Roberto Collins, William Courtney, Andrew Dunsworth, Edward Farhi, Brooks Foxen, Austin Fowler, Craig Gidney, Marissa Giustina, Rob Graff, Keith Guerin, ... John M. Martinis ✉ + Show authors

Nature **574**, 505–510 (2019) | Cite this article

Abstract

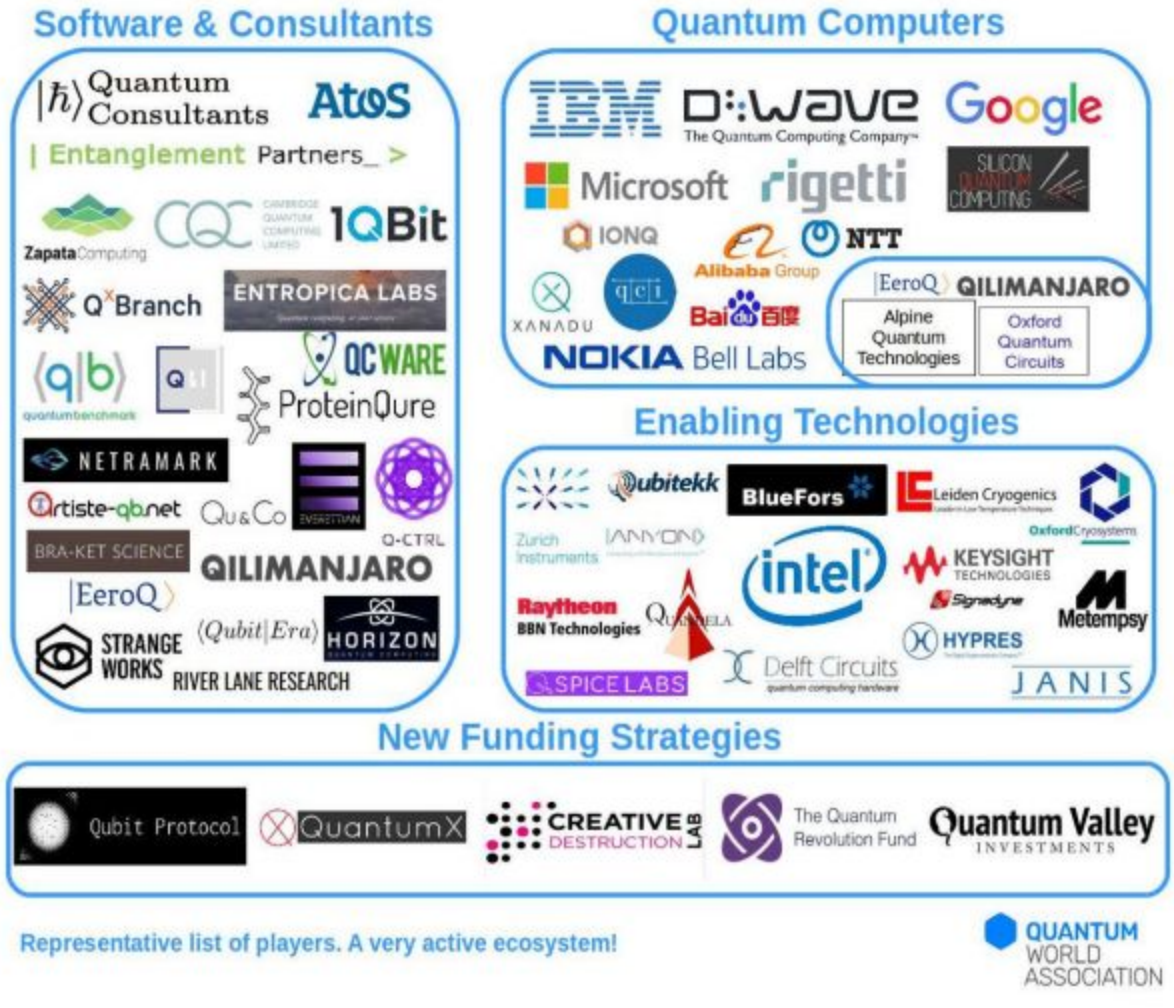
The promise of quantum computers is that certain computational tasks might be executed exponentially faster on a quantum processor than on a classical processor[1]. A fundamental challenge is to build a high-fidelity processor capable of running quantum algorithms in an exponentially large computational space. Here we report the use of a processor with programmable superconducting qubits[2,3,4,5,6,7] to create quantum states on 53 qubits, corresponding to a computational state-space of dimension 2^{53} (about 10^{16}). Measurements from repeated experiments sample the resulting probability distribution, which we verify using classical simulations. Our Sycamore processor takes about 200 seconds to sample one instance of a quantum circuit a million times—our benchmarks currently indicate that the equivalent task for a state-of-the-art classical supercomputer would take approximately 10,000 years. This dramatic increase in speed compared to all known classical algorithms is an experimental realization of quantum supremacy[8,9,10,11,12,13,14] for this specific computational task, heralding a much-anticipated computing paradigm.



https://www.maximizemarketresearch.com/market-report/global-quantum-computing-market/27533/

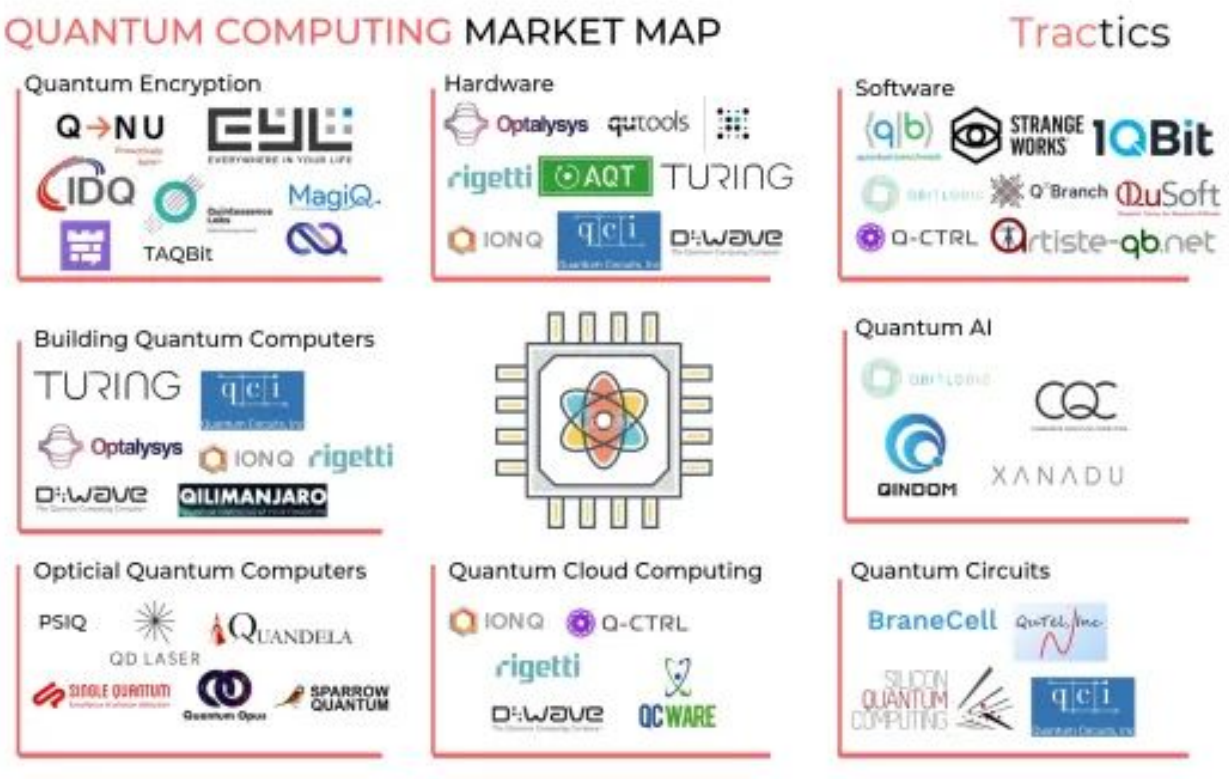
Large Companies are involved

In a growing ecosystem of startups and incumbents



Representative list of players. A very active ecosystem!

QUANTUM WORLD ASSOCIATION



https://research.aimultiple.com/quantum-computing-companies/

This course is:

At the leading edge of a new technology, discipline, and industry

A programming-first approach

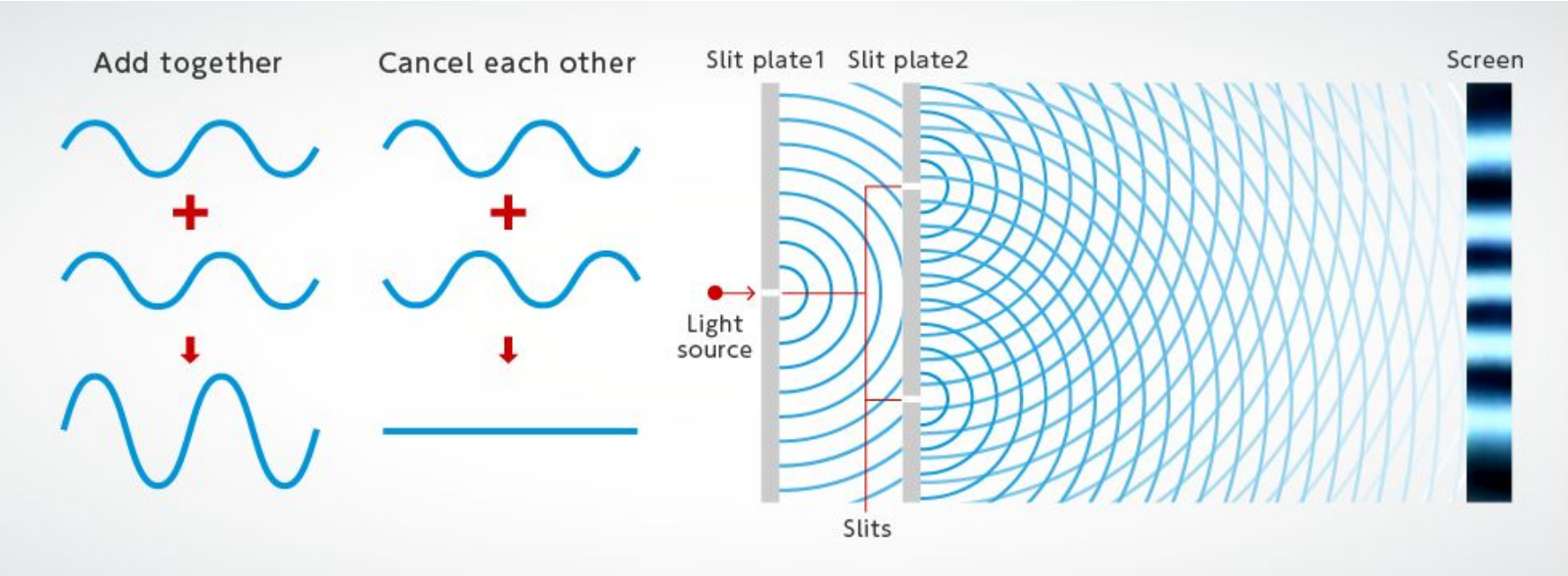
A great way to challenge yourself to think about computation in a totally new way

A way to learn “just enough” quantum physics

An **experiment!**

A dive in history

Is light a wave? - Young's interference experiment

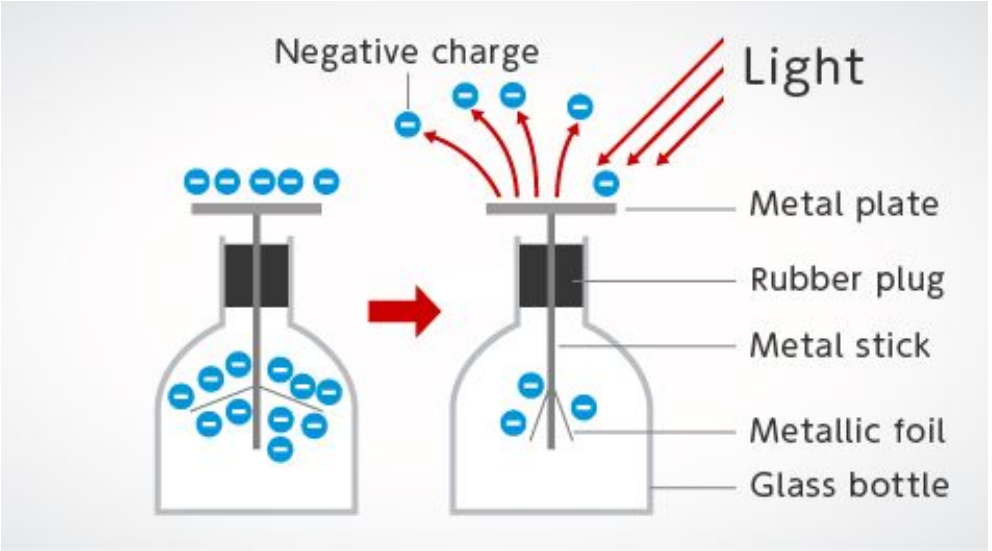


Is light a particle? - Einstein's light quantum hypothesis

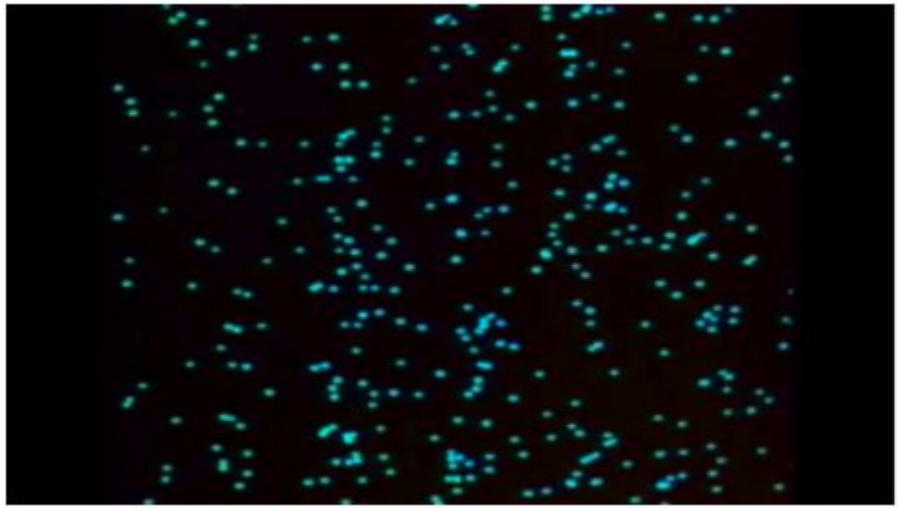
Einstein asserted that light is a particle containing energy corresponding to their wavelength.

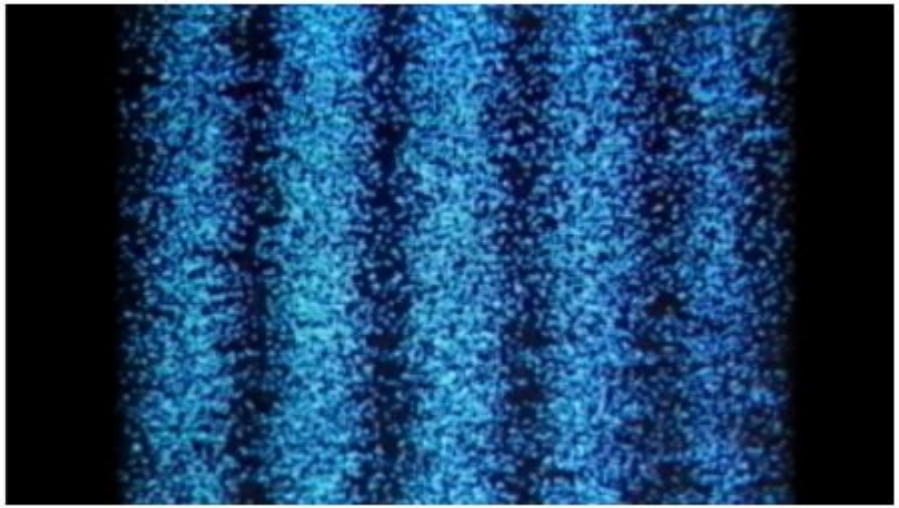
The photoelectric effect is a phenomenon where irradiating a blue light on metal emits electrons from it. However, red light does not cause electron emission from metal no matter how long or how intense the light is applied.

light = "photons (light quanta)" since it has the properties not only of a wave but also of a particle.



Duality of Photons





Planck's Law

Electromagnetic radiation from heated bodies is not emitted as a continuous flow but is made up of discrete units or quanta of energy, the size of which involves a fundamental physical constant (Planck's constant).

$$E = h\nu$$

$$E = \frac{hc}{\lambda}$$

$E = energy$

$h = Planck's\ constant$

$c = speed\ of\ light$

$\lambda = wavelength$

De Broglie

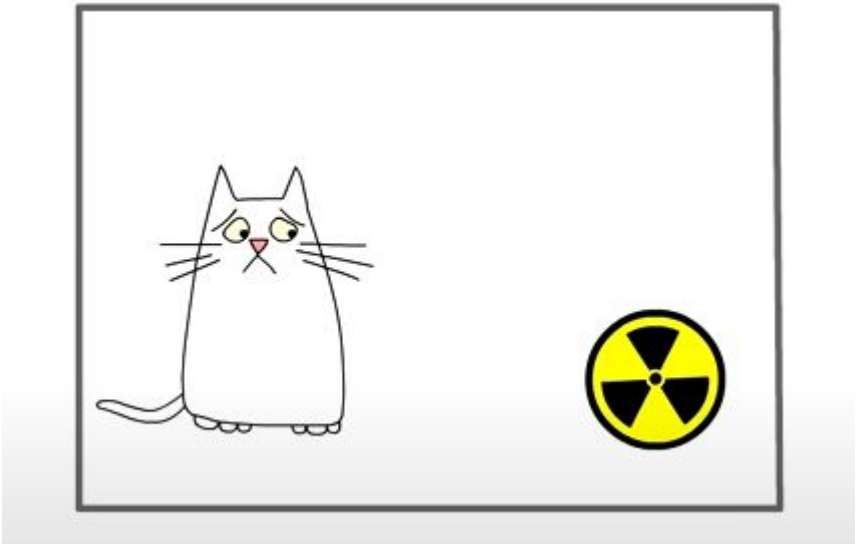
1924

Quantum mechanics assumes matter to be both like a wave as well as a particle at the sub-atomic level.

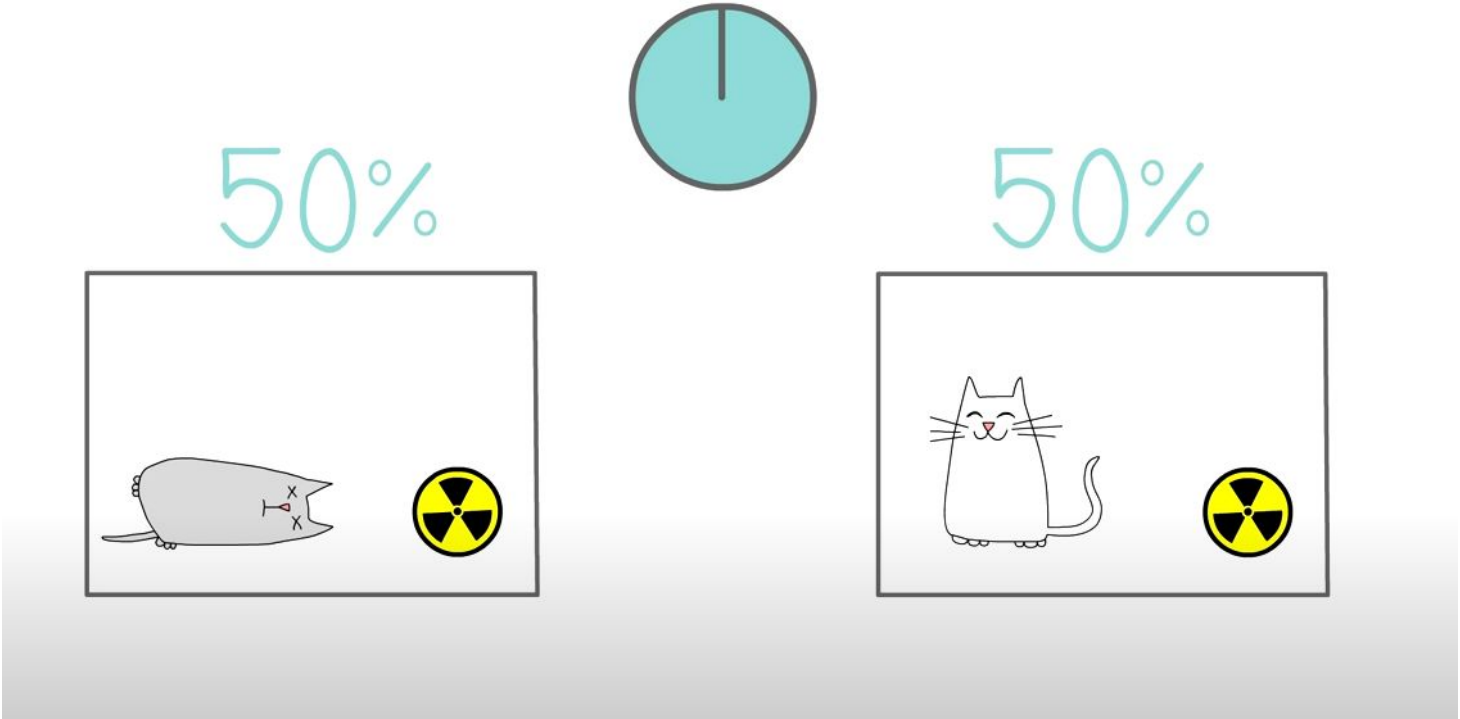
The De Broglie equation states that every particle that moves can sometimes act as a wave, and sometimes as a particle.

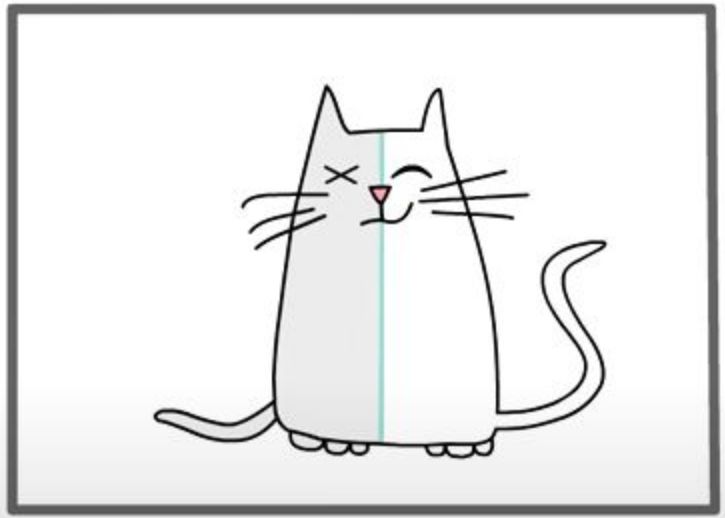
$$\lambda = \frac{h}{mv}$$

Schrödinger's cat Experiment 1935



Schrödinger's cat Experiment





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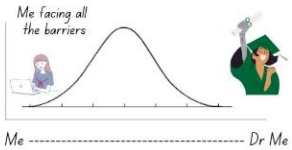

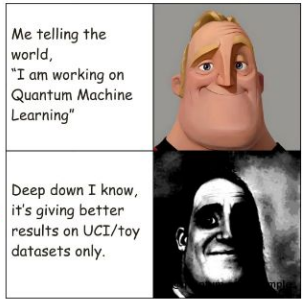

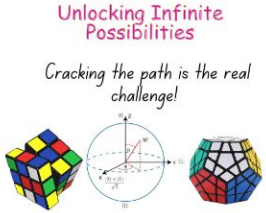

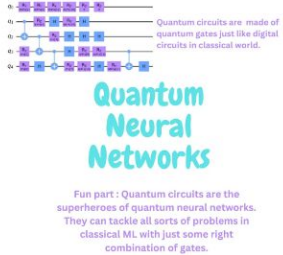

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https://photonterrace.net/en/photon/duality/#:~:text=Einstein%20asserted%20that%20light%20is,intense%20the%20light%20is%20applied.

https://www.youtube.com/watch?v=UjaAxUO6-Uw