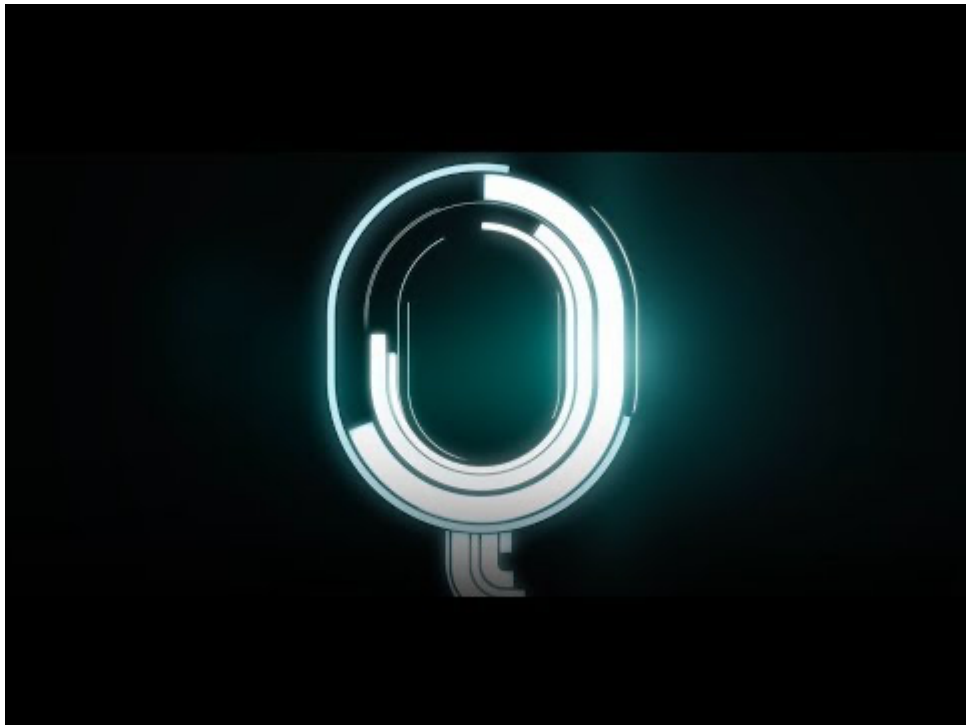
Quantum Computing: An Introduction

What do you think this is?



What your computer think that is….

- The classical bits = specific combination of zeros and ones
- One bit contains a single binary value — either “0” or “1”

Classical World

- There are only 10 types of people in the world: those who understand binary, and those who don't.

- (Another joke)
  - Why do mathematicians confuse Halloween and Christmas?
    - Because 31 Oct = 25 Dec.

$$31_8 = 25_{10}$$

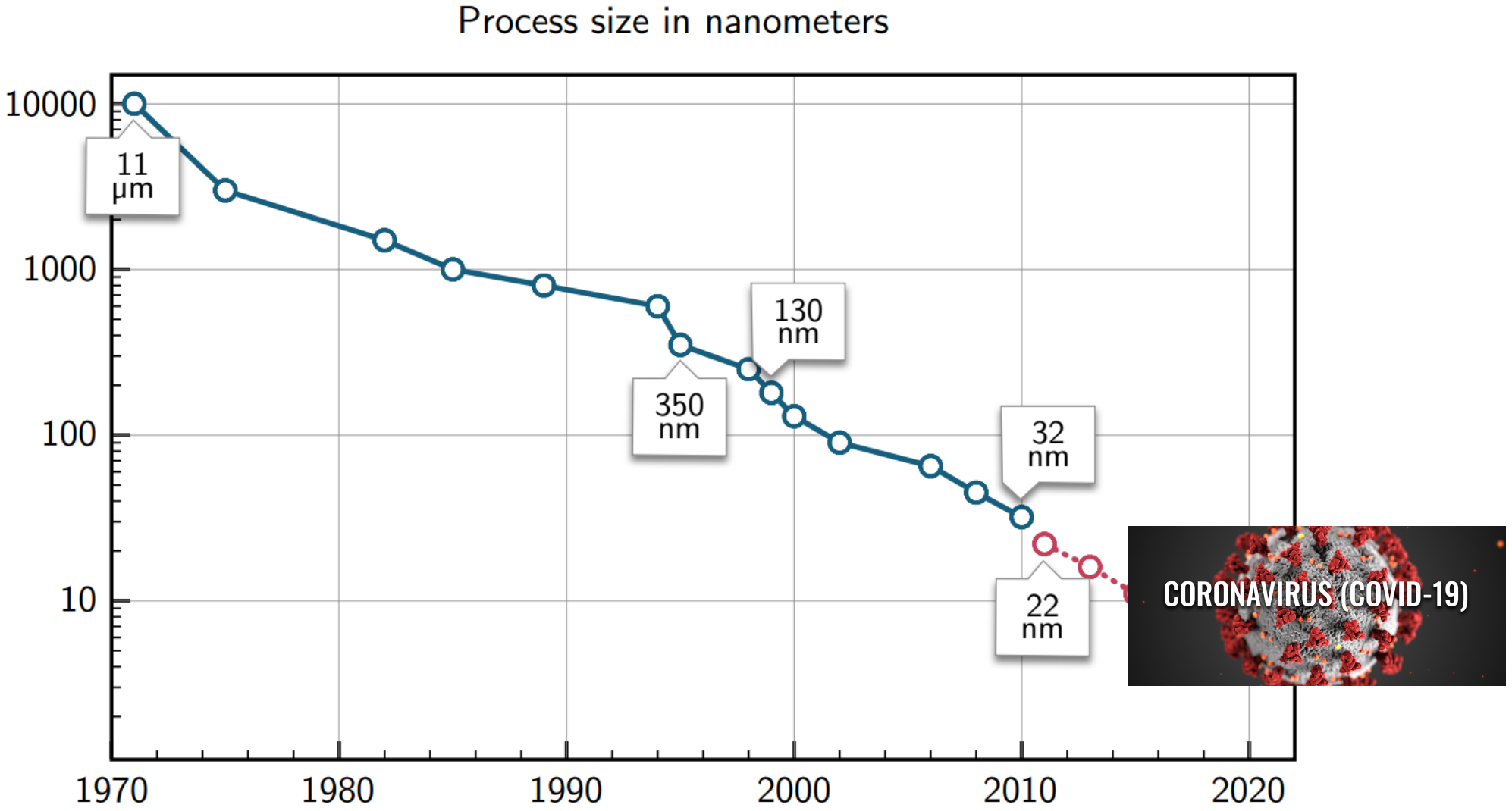
Quantum Computer

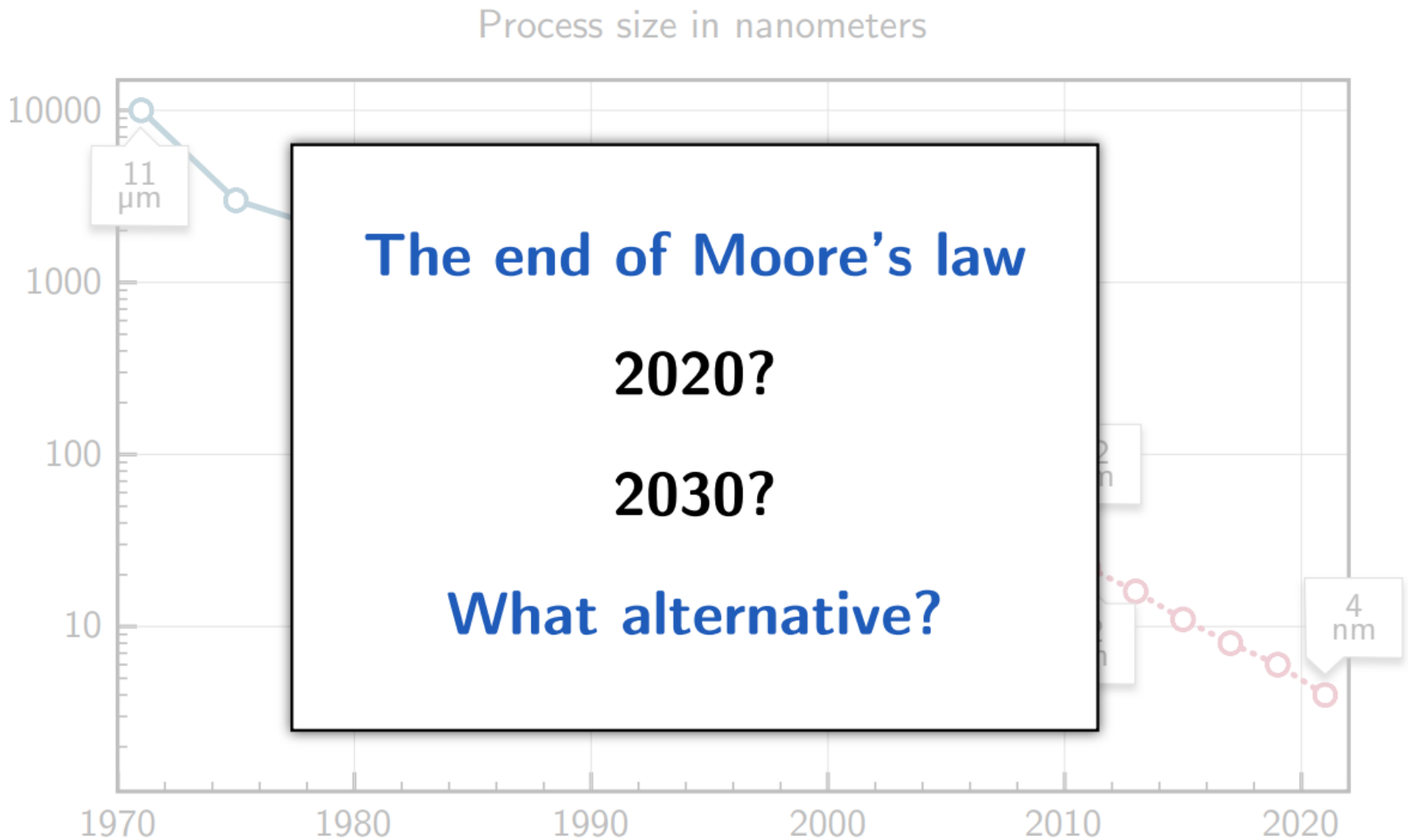
- What is Quantum Computer? Why we need Quantum Computer?

- Quantum History

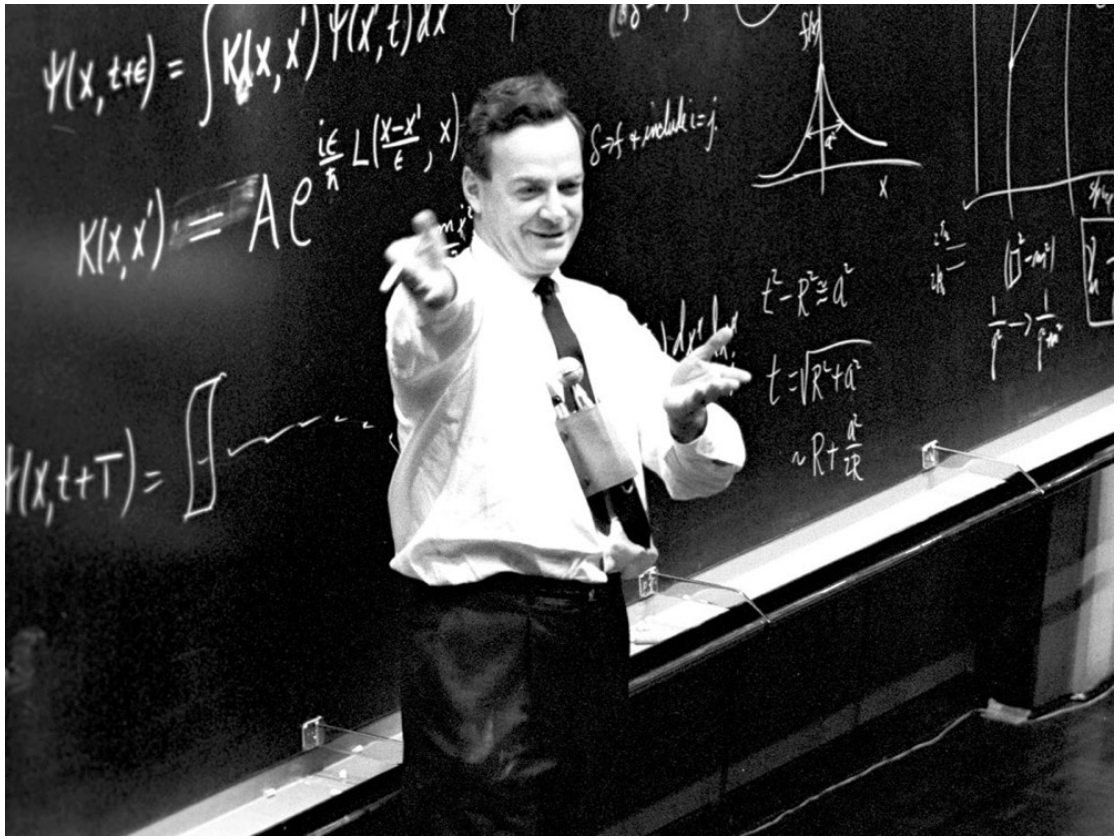
- Quantum Computers Explained

Moore's Law


Process size in nanometers
10000
1000
100
10
1970
1980
1990
2000
2010
2020
11 µm
350 nm
130 nm
32 nm
22 nm
CORONAVIRUS (COVID-19)


Process size in nanometers
10000
1000
100
10
11
µm
4
nm
1970
1980
1990
2000
2010
2020
The end of Moore's law
2020?
2030?
What alternative?

Why Quantum Computing?



Richard Feynman

Simulating Physics with Computers

Richard P. Feynman

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Received May 7, 1981

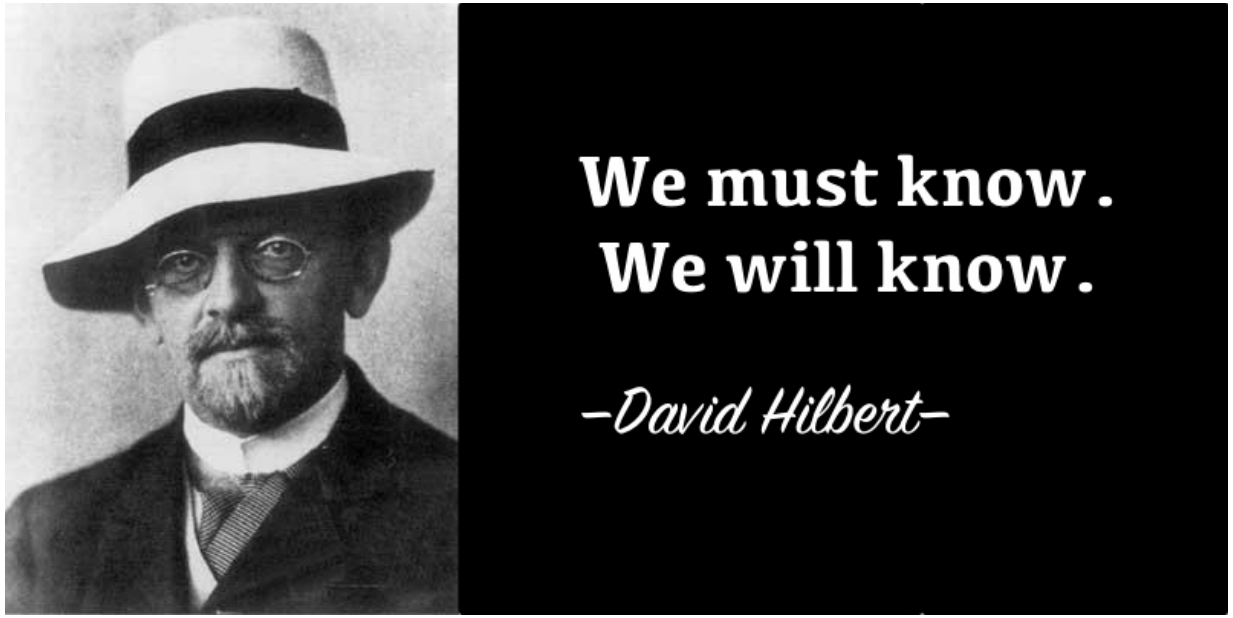
"…nature isn't classical, dammit, and if you want to make a simulation of nature, you'd better make it quantum mechanical, and by golly it's a wonderful problem, because it doesn't look so easy."

"Let the computer itself be built of quantum mechanical elements which obey quantum mechanical laws."

IBM Quantum Experience

- IBM Quantum Computer
- Qiskit

  - Qiskit is an open source SDK for working with quantum computers at the level of pulses, circuits and algorithms.



We must know, we will know.

我們必須知道，我們必將知道。

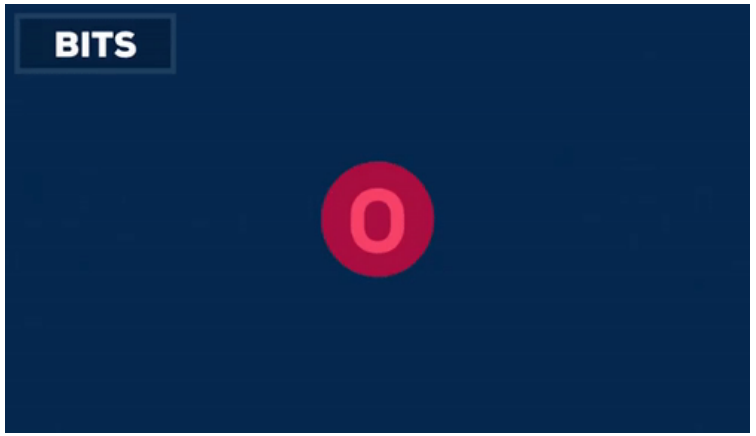
David Hilbert.

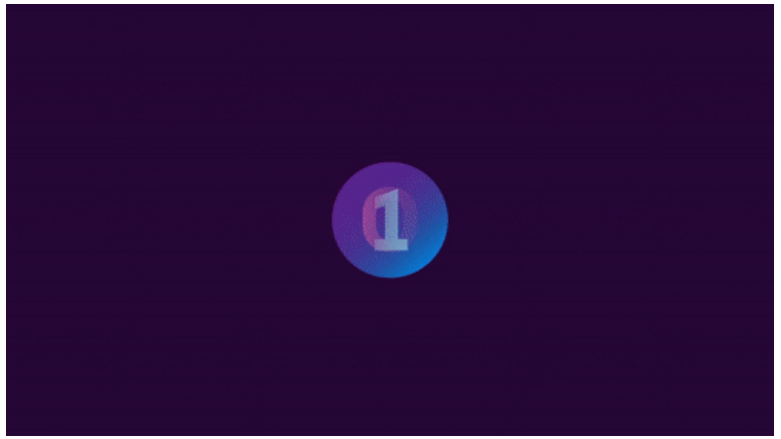
Quantum Properties

- Superposition
- Entanglement
- Interference

Superposition

- Superposition refers to a combination of states we would ordinarily describe independently. To make a classical analogy, if you play two musical notes at once, what you will hear is a superposition of the two notes.

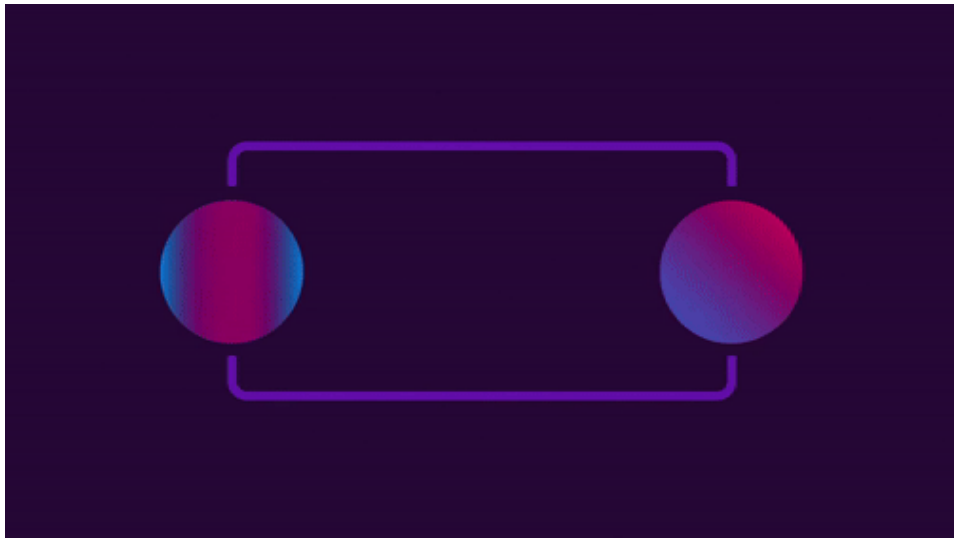




Entanglement

- Entanglement is a famously counter-intuitive quantum phenomenon describing behavior we never see in the classical world. Entangled particles behave together as a system in ways that cannot be explained using classical logic.

Measurement of one system is correlated with the state of the other system



Interference

- Finally, quantum states can undergo interference due to a phenomenon known as phase. Quantum interference can be understood similarly to wave interference; when two waves are in phase, their amplitudes add, and when they are out of phase, their amplitudes cancel.