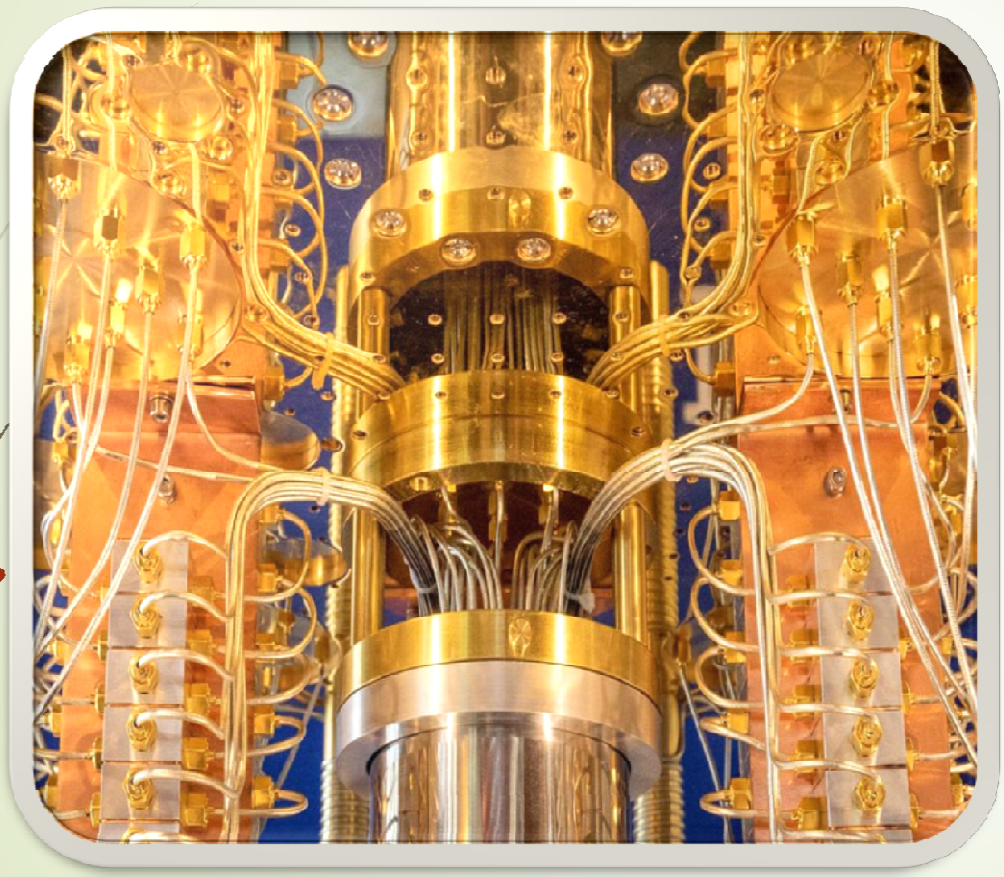
Quantum computation



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Quantum computers

- Computers which use Atoms to perform calculations based on quantum theory .
- These computers encode information as quantum bits Called as qubits .
- Qubits refer to atoms, ion,Photons, electrons etc with their respective Devices to work together and acts as computers.

History

- Quantum computing began with finding its essential elements. In 1981, Paul Benioff at Argonne National Labs came up with the idea of a computer that operated with quantum mechanical principles. It is generally accepted that David Deutsch of Oxford University provided the critical idea behind quantum computing research. In 1984, he began to wonder about the possibility of designing a computer that was based exclusively on quantum rules, publishing a breakthrough paper a few months later.

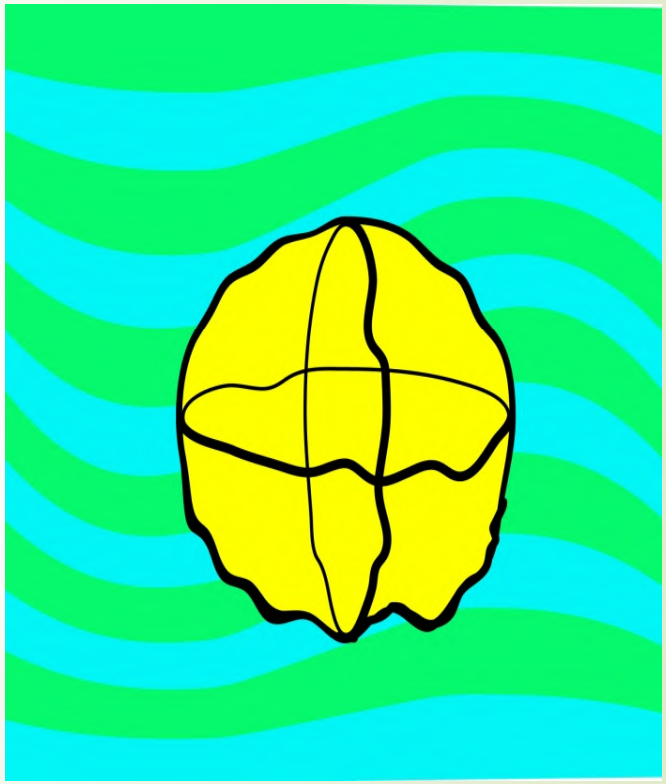
Why quantum computers?

We require quantum computers to solve problems that would not be solved classical computers or super computers.

- Problems like breaking encryption or mapping a molecule's structure can require sorting through millions of possibilities.
- Superposition is one of the properties of a quantum computer that enables it to work faster by considering many possibilities at once, sorting through sets of probable outcomes that converge on the correct answer.

Application of quantum computers...

- Big data
- Cryptography
- Machine learning
- Medicine and material



Uncertainty

The quantum uncertainty in the position of a particle (referred to in the Heisenberg Uncertainty Principle) is due to

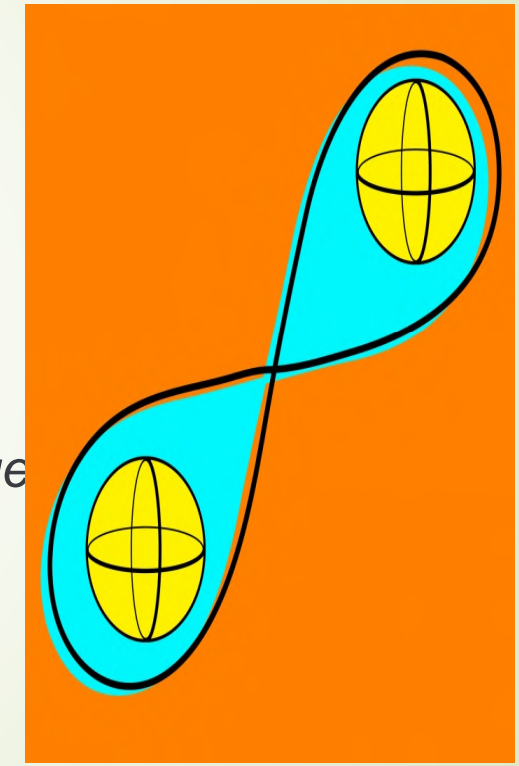
A. The fact that the particle's wavefunction is spread out in space.

B. Inaccurate measuring instruments.

C. Our lack of knowledge of where the particle is.

Application

- *Cybersecurity*
- *Drug Development*
- *Financial Modeling*
- *Better Batteries*
- *Cleaner Fertilization*
- *Traffic Optimization*
- *Weather Forecasting and Climate Change*
- *Artificial Intelligence*
- *Solar Capture*
- *Electronic Materials Discovery*



- Advanced Cryptography- With quantum computing, the decryption of today's infeasible -to-break encryption becomes trivial, leading to a strong digital protection
- Pattern Matching- Matching patterns and predicting the behaviour of not only complex solutions but also molecules will be a great breakthrough.
- Medical Research- With quantum computing, the possibility of finding new drugs with slight difference in their makeup witing the billion possibilities is now a reality leading cost cut and time to market and encouraging chemists to make new discoveries.
- Forecasting- Predicting & forecasting scenarios based on complex data sets with more accuracy and less time taken for simulations.
- AI & ML- Can speed up machine learning and optimize efforts towards a more efficient functioning of AI.

Universal Quantum Computer

- Universal Quantum Computing requires entanglement for every qubit included in the system.
- Use Cases → Secure Computing, Machine Learning, Criptography, Quantum Chemistry, Material Science, Optimization Problems, Sampling Quantum Dynamics, Searching.
- Scope → Wider scope
- Computing Power → Very High

The Universal Computing is the great challenge in quantum computing. It has the potential to be exponentially faster than traditional computers for a number of applications in the world of science and also in the world of business.

General terminology in QC

- Qubits show quantum properties like **superposition** and **entanglement**.
- Qubits can represent numerous possible combinations of 1 and 0 at the same time. This ability to simultaneously be in multiple states is called **superposition**. Qubits are "**entangled**" means the two members of a pair exist in a single quantum state. Changing the state of one of the qubits will instantaneously change the state of the others

Quantum Operations

Quantum Gates

- A basic quantum circuit working on one or more qubits
- It's equivalent to digital circuits logical gates lógicas

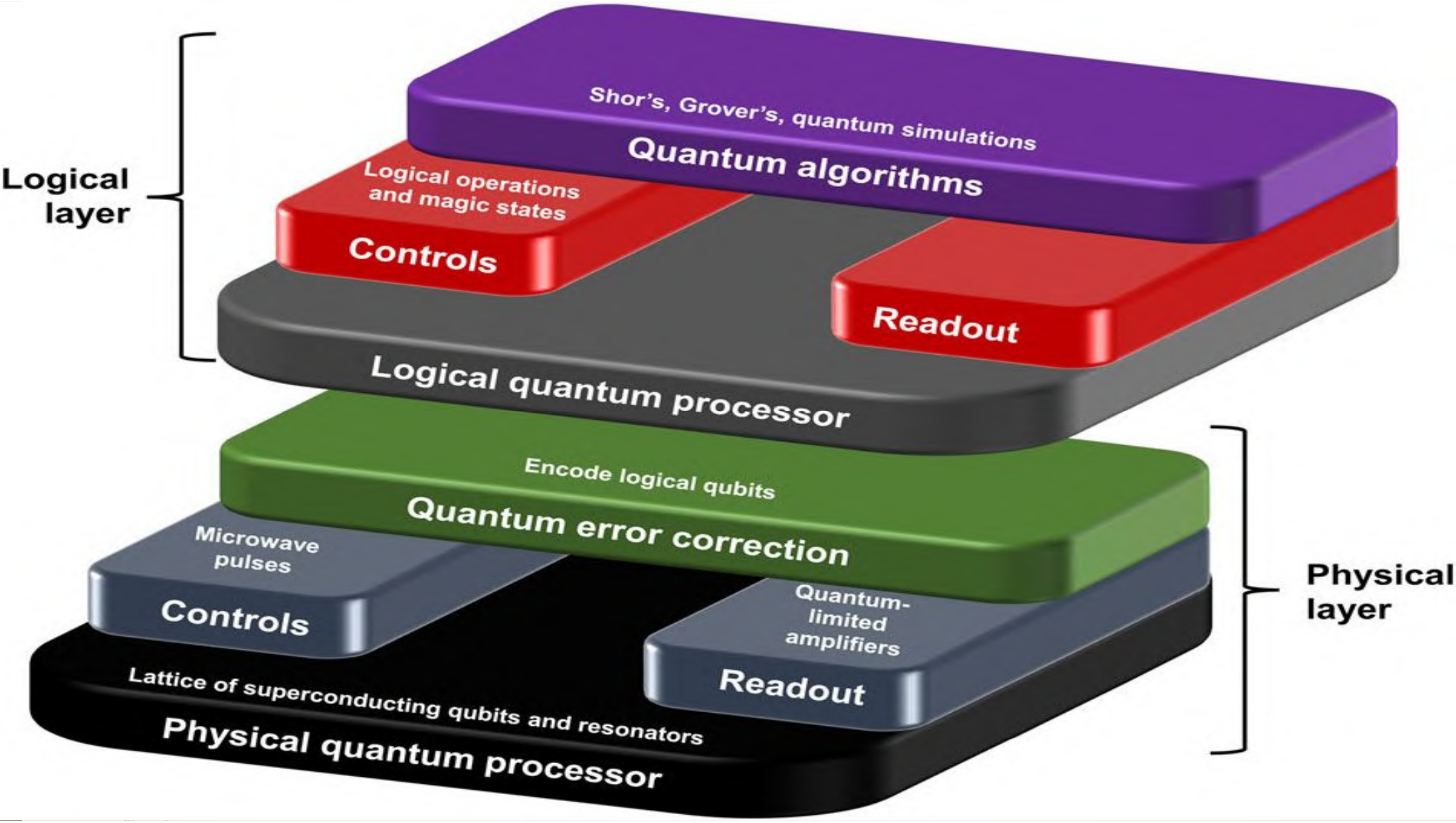
$$H = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

Hadamard Gate

1. Quantum Gates are reversible
2. Mathematically thery are represented by unitary matrixes
3. Los qubits on which they act must retain their quantum identity

$$CNOT = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

Controlled-NOT gate


Logical layer
Shor's, Grover's, quantum simulations
Quantum algorithms
Logical operations and magic states
Controls
Readout
Logical quantum processor
Encode logical qubits
Quantum error correction
Microwave pulses
Controls
Quantum-limited amplifiers
Readout
Lattice of superconducting qubits and resonators
Physical quantum processor
Physical layer

Why quantum computers are better for future?

- The power consumption of quantum computer remains same but you can increase the capacity of computer in qbits
- Since chiller power requirement in high these computer cannot be used for normal application. They are used for High capacity computing.
- Presently only D wave from Canada is success in making commercial quantam computer
- All other companies are doing research on it.
- So guys start learning quantam computer programming . It's the future.

Basic Features of quantum computers...

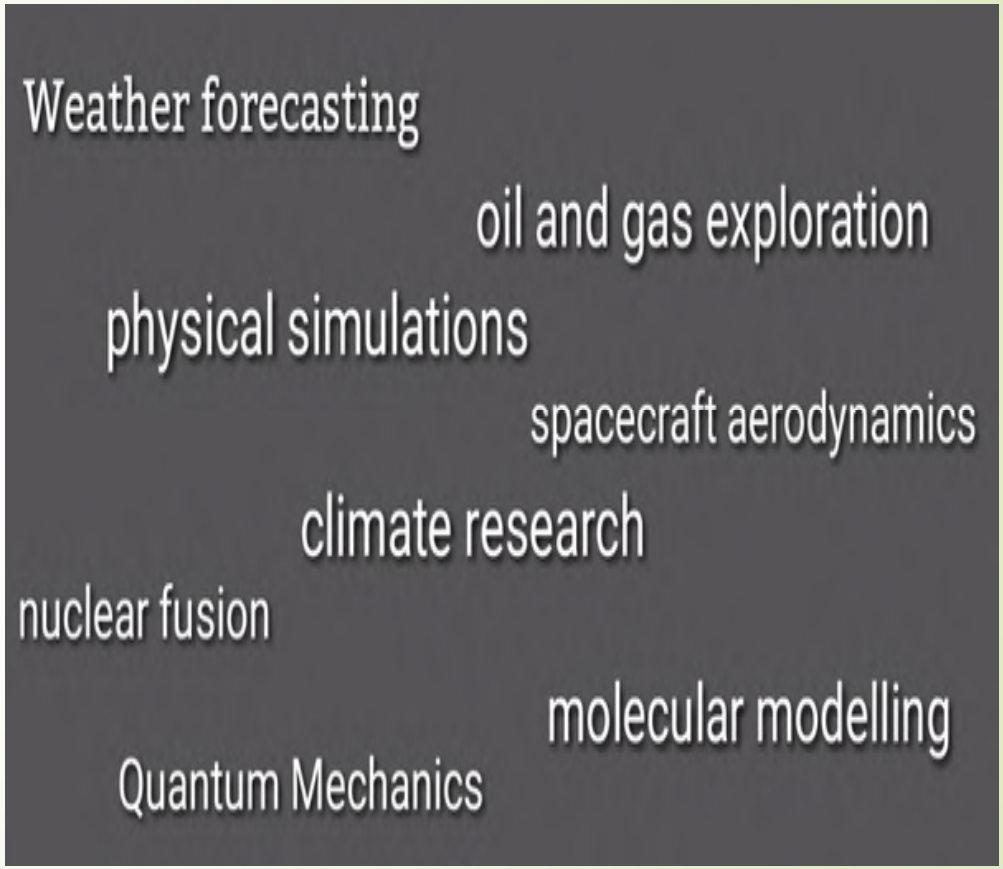
- They are based on **Photonics**(Quantum Physics), rather than Classical Digital Electronics.
- Massless photons and light beams are capable of enhancing speed as compared to electron based Digital Electronic Computers.
- They may greatly enhance **Artificial Intelligence**.
- They are bound to help much in deep learning.
- They even can make use of **Nanotechnology**, so there can be great reduction in size.

D-Wave ultimately hopes to make its quantum computer available via the cloud much like IBM, which has launched the Q program for paid quantum computing services. IBM announced the Q program last week and plans to build a 50-qubit quantum computer in the coming years as part of the service

Big data

Big Data

- Big data refers to humongous amount of data (in TeraByte or PetaByte), generated in very short duration of time.
- To make sense out of this data, quantum computers can be utilized.
- For example, Google tracks our activities - which sites you visit, which videos you watch or upload, which icons on a website you click, what you purchase, what commands you give to your Google Assistant, what places you visited, reads your gmails.
- Then Google runs big data models(like MapReduce) to predict your interests, improve its voice recognition and AdSense.



- **Machine Learning**
  - Most machine learning algorithms are iterative in nature, i.e. you have to repeat the same algorithm for chaning values.
  - Quantum computers can fastly complete iterations and save lot of time & effort.
- **Cryptography**
  - Cryptography works on the principle of encrytion and decryption.
  - To encrypt a message (i.e to change appearance of message), a key is used and to decrypt (i.e. to retrieve the message) anti-key is used.
  - For example, on WhatsApp your message are end-to-end encrypted. That means that no third-party can read the original message.
  - **Generating New Drugs & Materials**
- a. There are many materials around us. Suppose we try to synthesize new materials by mixing them - 2 at a time, then 3 at a time and so on.
- b. These large permutations can be generated and simulated very fastly by a quantum computer

Conclusion

- So if i conclude then i may say that Quantum Computing is not just about Physics,Mathematics or Computer Science instead it is a system that actually consists of Both the three parts , which exhibits the same ratio as Quantum Computing uses Quantum Physics concepts + it uses complex mathematics algorithms as well as it is all about boosting the computing power of a computers.

Thank you!