Quantum Computing

I - Is it possible to maintain the state of a qubit in a physical shell or hardware?

A qubit is a unit of quantum information, analogous to a classical bit but with a critical difference: it can exist in a superposition of two states, measured probabilistically. Unlike classical bits, which are strictly 0 or 1.

However, maintaining a qubit's state is challenging because it requires isolation from environmental noise. Current solutions include:

Superconducting circuits.

Trapped ions or atoms, confined and manipulated with electromagnetic fields.

Topological qubits, which aim for inherent error resistance.

The mentioned solutions are not fully implemented and operate under strict conditions.

II - How to change, measure and control the state of a Qubit?

Once a qubit is confined, isolated, and measurable, **controlling its state** becomes the next critical challenge. Reliable manipulation of qubit states is essential for building a functional quantum computer, enabling advancements such as:

- Secure quantum communication (e.g., quantum cryptography).
- Faster algorithms.
- High data storage.

Manipulate its state include:

Microwave pulses applied via control lines on the chip;
Laser pulses of specific frequencies manipulate ion energy states;
Magnetic fields or electric pulses alter electron spin states.

III - What unsolvable problems could quantum computing address that classical computing cannot?

Quantum computing can solve problems that classical computers would take far too long to address—data security, database time research (O(N) -> (math.sqrt(O)), prime number factorization being good examples. However, the full implementation of quantum computers could also create short-term challenges. These machines would be capable of decrypting conventionally encrypted information in a fraction of the time, potentially disrupting the balance of power among nations.

Quantum chemistry requires simulating the behavior of quantum molecules, and quantum computers can significantly enhance knowledge in this area. This advancement could accelerate the development of new medicines, using algorithms such as Phase Estimation.

Quantum simulation can be used to predict the behavior of materials that may become **superconductors—materials with almost no resistance.** Applications include improving solar cells and discovering alternatives to silicon with better efficiency.

Currently, some research focuses on solving the Schrödinger and Heisenberg equations, particularly in calculations **involving vectors and matrix interactions in linear algebra.**

Quantum computing could improve **food manufacturing**, for example, by making the production of fertilizers from nitrogen more efficient.

It may also help **stabilize superheated hydrogen** to create a viable fusion reactor.

Quantum computers can also be used to **simulate climate change** patterns and model complex systems such as some kinds of **black holes**.

How many Qubit can be set to an IBM simulation of quantum computing?

The limit seems to depend on the RAM and CPU limits, but the classical simulation supports around 30 qubits. According to ChatGPT real IBM computers can set more than 1000 qubits.

Cryptography
Molecules modeling - create medicines faster and more efficient

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