1. What is qubit?

Quantum-bit: the basic unit of information in a quantum computer

Superposition

Isolated electron

A bit that has probability of being any state

Bit property determined by quantum

1. What is quantum computer?

A computer account where the fundamental computational unit in **qubit**.

Machine uses **quantum operations** -> what quantum operations are and what they do

Single unit + single operation -> can be see as a quantum computer

A quantum bit counts for much more than a classical bit.

1. What is a quantum simulator?

A classical computer which simulates how quantum physics / computer works (WRONG)

It permits the study of quantum systems that are difficult to do with a supercomputer

Quantum system which simulates another quantum system. -> help doing impossible work

1. What are the main obstacles / problems to quantum information processing today?

Quantum error correction

Errors correction – sensitive to the environments,

One per million secs ->

Error rate 0.5 in apple system ->

One over 100 in quantum operations

Qubit quality

Qubit control

Around 52 qubits – biggest public quantum computer

Decoherence

1. What real world applications are quantum computers expected to have and in what sense do they outperform a classical computer?

Decoding data / encryption -> 1994

Quantum chemistry -> calculating probability, simulating quantum physics (material science, new molecules)

Quantum machine learning

Linear algebra faster on quantum com

2014, 18 yrs old found quantum simulation with same linear algebra assumption

Speed up

Specific problem -> not equitable

Qubits

1. Classical bits vector space boring
2. Extend to quantum states
3. Normalization

The power of quantum computer to solve certain problems faster comes from exploiting Non-product state

Bell states

Entangle states

Non-product state -> entangle

Cannot be separated

Exercise Session

[pb@mafb.ku.dk](mailto:pb@mafb.ku.dk)