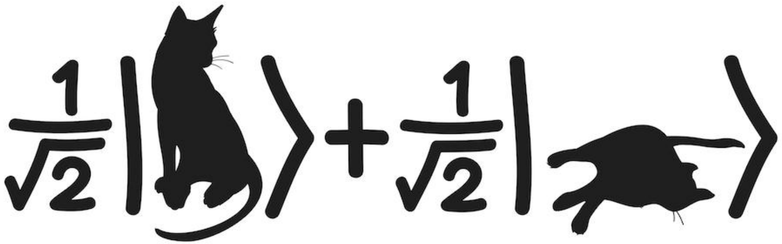
Quantum Mechanics & Quantum Computation



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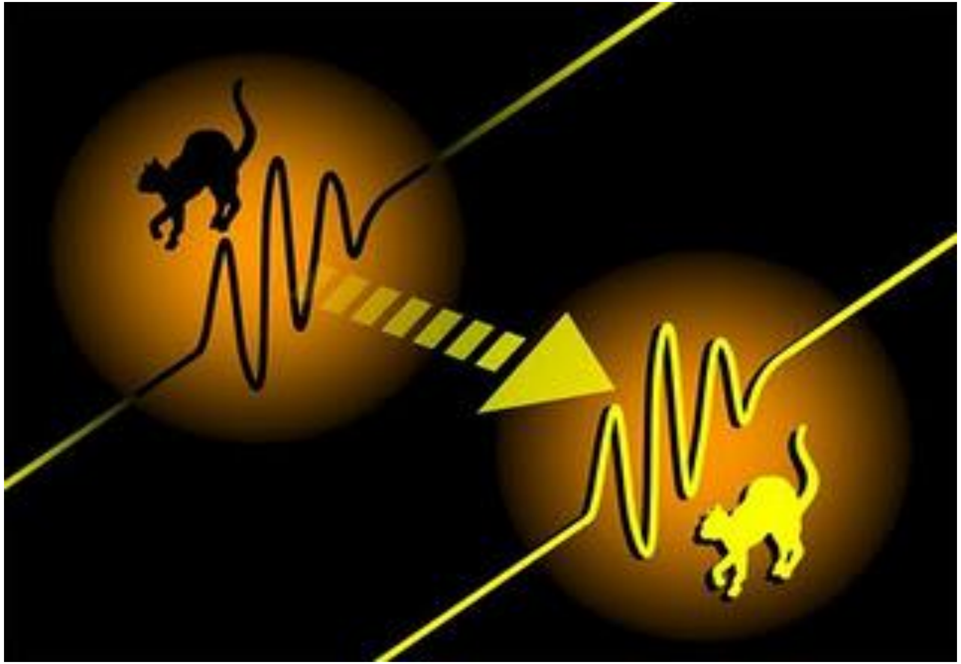
Lecture 6: Quantum Circuits and Teleportation

Teleportation (part 1)

Quantum teleportation

- It is impossible to clone quantum information, but it is possible to **teleport** a quantum state to another location.



Quantum teleportation

- It is impossible to clone quantum information, but it is possible to **teleport** a quantum state to another location.

Alice

Bob

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle \longrightarrow$$

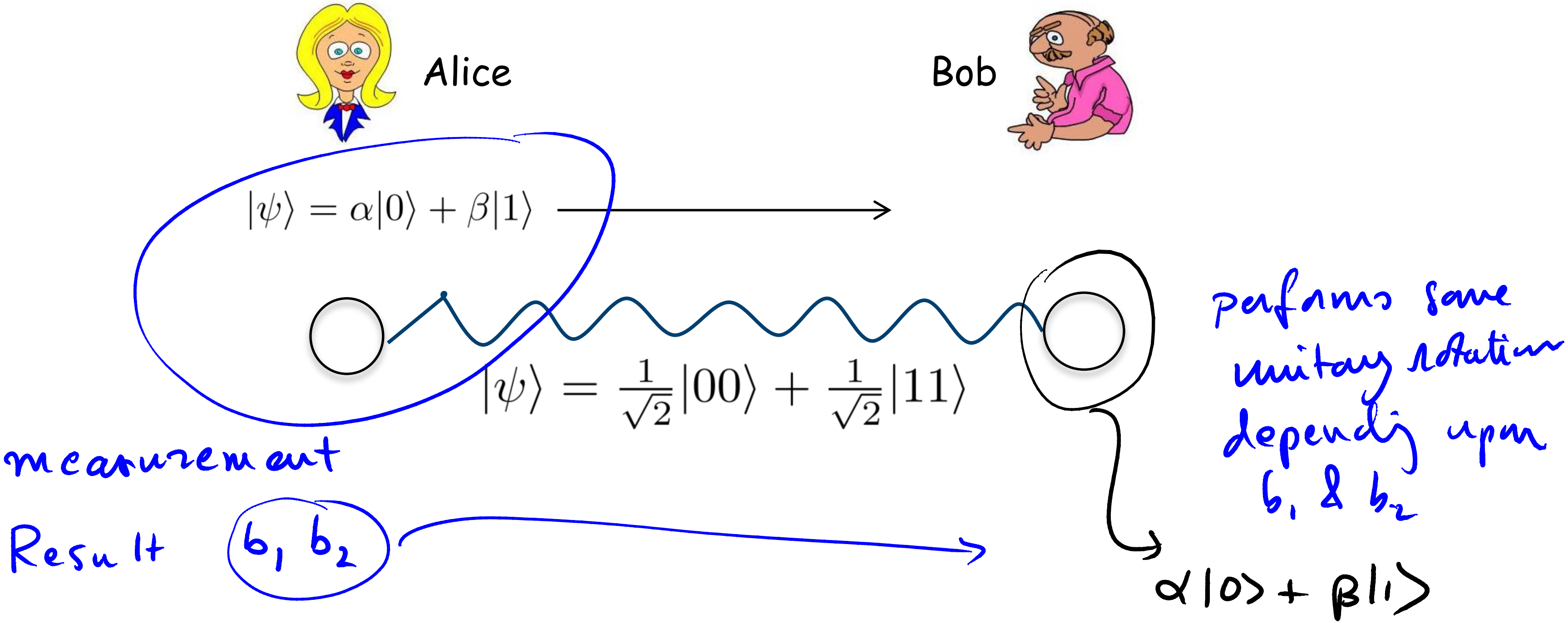
Figure out α, β

0 w.p. $|\alpha|^2$ $|0\rangle$

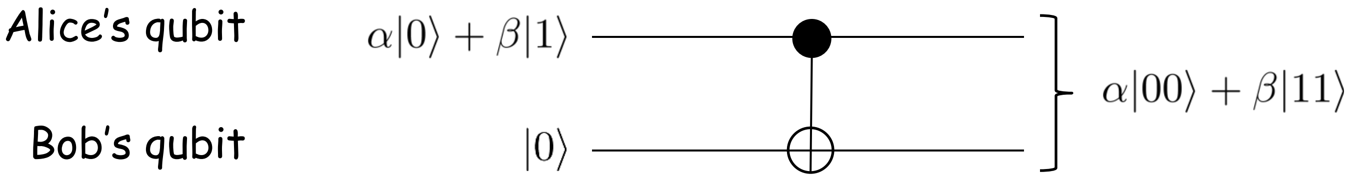
1 w.p. $|\beta|^2$ $|1\rangle$

Quantum teleportation

- It is impossible to clone quantum information, but it is possible to **teleport** a quantum state to another location.



Assume CNOT



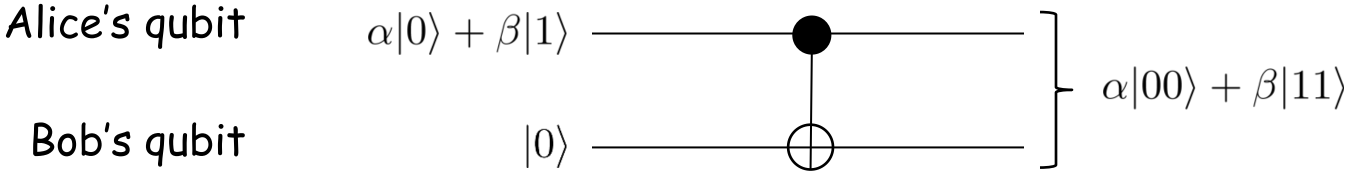
Now we want to disentangle, leaving α and β in the second qubit.

Idea: measure the first qubit.

$$0 \longrightarrow |0\rangle \otimes |0\rangle$$
$$1 \longrightarrow |1\rangle \otimes |1\rangle$$

information is lost.

Assume CNOT



Now we want to disentangle, leaving α and β in the second qubit.

Idea: measure the first qubit. Choose a different basis?

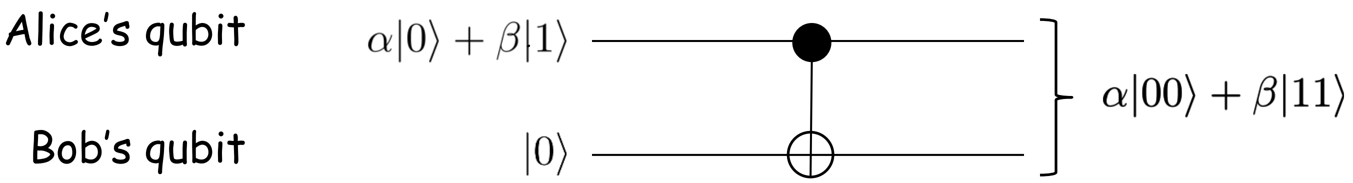
$$\alpha|00\rangle + \beta|11\rangle = \alpha\left(\tfrac{1}{\sqrt{2}}|+\rangle + \tfrac{1}{\sqrt{2}}|-\rangle\right)(|0\rangle) + \beta\left(\tfrac{1}{\sqrt{2}}|+\rangle - \tfrac{1}{\sqrt{2}}|-\rangle\right)(|1\rangle)$$

$$= \tfrac{1}{\sqrt{2}}|+\rangle\left(\alpha|0\rangle + \beta|1\rangle\right) + \tfrac{1}{\sqrt{2}}|-\rangle\left(\alpha|0\rangle - \beta|1\rangle\right)$$

$+ \quad \alpha|0\rangle + \beta|1\rangle$ ✓

$- \quad \alpha|0\rangle - \beta|1\rangle$ ✓ $\quad Z$

Assume CNOT



Challenge: create the entangled state $\alpha|00\rangle + \beta|11\rangle$ without quantum communication between Alice and Bob!