

# Quantum Teleportation

Basically taking advantage of

"entanglement". In simple words,

entanglement means when we know

result of one of qubit in a

pair, the other's <sup>state</sup> can be determined.

It is as if, the particles had contained

some hidden information (or) after

the measure one particle has sent

result of one to the other, immediately.

Problem suppose there is a entangled pair.

Say  $|B_{00}\rangle$



Alice

1 qubit  
of the pair



Bob

other  
qubit of pair

Alice wants to send  $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$

Alice's plan:- entangle her qubit with the  
 $|\psi\rangle$  and perform some operations

$$|1\rangle |00\rangle$$

$$(\alpha|0\rangle + \beta|1\rangle) \cdot \frac{(|00\rangle + |11\rangle)}{\sqrt{2}}$$

$$\frac{1}{\sqrt{2}} (\alpha|0\rangle \cdot (|00\rangle + |11\rangle) + \beta|1\rangle \cdot (|00\rangle + |11\rangle))$$

↓ CNOT gate  
 (if 1st bit  $|0\rangle$ , target as its is  
 if 1st bit  $|1\rangle$ , flip the target)

$$\frac{1}{\sqrt{2}} (\alpha|0\rangle \cdot (|00\rangle + |11\rangle) + \beta|1\rangle \cdot (|10\rangle + |01\rangle))$$

as it is                      flip

↓ H gate

$$|0\rangle \rightarrow (|0\rangle + |1\rangle)/\sqrt{2}$$

$$|1\rangle \rightarrow (|0\rangle - |1\rangle)/\sqrt{2}$$

$$\frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} (\alpha(|0\rangle + |1\rangle) \cdot (|00\rangle + |11\rangle) + \beta(|0\rangle - |1\rangle) \cdot (|10\rangle + |01\rangle))$$

$$= \frac{1}{2} \left[ |00\rangle \cdot (\alpha|0\rangle + \beta|1\rangle) + |01\rangle \cdot (\alpha|1\rangle + \beta|0\rangle) + |10\rangle \cdot (\alpha|0\rangle - \beta|1\rangle) + |11\rangle \cdot (\alpha|1\rangle - \beta|0\rangle) \right]$$

2 I) Now Alice measures her qubit  
if its 00

then she tells that its 00, and  
Bob has to do nothing

TS) Now if Alice measurement yields 11,  
then Bob's qubit will have state

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

To get the desired state

Bob applies X-gate, which makes it  
 $\alpha |0\rangle + \beta |1\rangle$

So, basically based on Alice's result

Bob performs certain operation to

get the desired state. Note that

the classical communication is necessary

btw Bob and Alice, bcoz Bob has

to if he has to not do anything

(like I) or apply some gate (like II)

or some other gate based on result.

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