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Bidirectional and Asymmetric Quantum Controlled Teleportation

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Abstract We propose a new protocol of bidirectional and asymmetric quantum controlled teleportation, using a maximally seven-qubit entangled state as the quantum channel. That is to say Alice wants to transmit an arbitrary single qubit state (an arbitrary two-qubit state) to Bob and Bob wants to transmit an arbitrary two-qubit state(an arbitrary single state) to Alice via the control of the supervisor Charlie.

Keywords Bidirectional and Asymmetric quantum controlled teleportation · Seven-qubit maximally entangled state

1 Introduction

Quantum Teleportation is a process of transferring an unknown state to a spatially distant receiver with the help of shared entanglement and some classical information. Quantum Teleportation is regarded as one of the most striking results of quantum information theory. Since Bennett et al. [1] presented the creative protocol of quantum teleportation through an entangled channel of Einstein-Podolsky-Rosen (EPR) pair between the sender and the receiver in 1993. Many theoretical protocols of quantum teleportation have been presented [2–31], experimental development of teleportation has also been reported. Thereinto, one branch of the extension is controlled teleportation first presented by Karlsson and Bourennane in 1998 [32]. Yang et al. presented a multiparty controlled teleportation protocol to teleport multi-qubit quantum information via entanglement [33]. In particular, Zha et al. [34] presented the first bidirectional quantum controlled teleportation(BQCT) protocol by employing five-qubit cluster state as the quantum channel in 2013, After that, BQCT has received great attention, some BQCT protocols have been devised based on different kinds of entangled states [35–38].

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In this paper, we present a scheme of bidirectional and asymmetric quantum controlled teleportation in which a seven-qubit maximally entangled state [39].Quantum channel initially shared by the sender (receiver) Alice, Bob and supervisor Charlie. Suppose that Alice has particle a in an unknown state, she wants to transmit the state of particle a to Bob; at the same time, two particle b_1, b_2 belong to Bob in an unknown state, he wants to transmit the state of particle b_1 and b_2 to Alice. To achieve this scheme, besides appropriate unitary transformation and classical communications, it is necessary that three parties perform proper measurement, that is, Alice and Bob take the Bell measurement respectively, Charlie carries out single qubit von Neumann measurement.

2 Bidirectional and Asymmetric Quantum Controlled Teleportation

Our scheme can be described as follows. Suppose Alice has an arbitrary single qubit a in a unknown state, which is described by

$$|\varphi\rangle_a = x|0\rangle + y|1\rangle \tag{1}$$

with $|x|^2 + |y|^2 = 1$ and that Bob has qubit b_1b_2 in an unknown state

$$|\varphi\rangle_{b_1b_2} = a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle \tag{2}$$

with $|a|^2 + |b|^2 + |c|^2 + |d|^2 = 1$.

Now Alice wants to transmit the state of qubit a to Bob and Bob wants to transmit the state of qubits b_1b_2 to Alice. Assume that Alice, Bob and Charlie share a maximally seven-qubit entangled state, which has the form

$$\begin{aligned}
|\psi_M\rangle_{1234567} = & \frac{1}{4\sqrt{2}}[(|0000000\rangle + |0000011\rangle + |0001101\rangle + |0001110\rangle) \\
& + (|0010001\rangle - |0010010\rangle + |0011100\rangle - |0011111\rangle) \\
& + (-|0100101\rangle - |0100110\rangle + |0101000\rangle + |0101011\rangle) \\
& + (|0110100\rangle - |0110111\rangle - |0111001\rangle + |0111010\rangle) \\
& + (-|1000100\rangle - |1000111\rangle + |1001001\rangle + |1001010\rangle) \\
& + (|1010101\rangle - |1010110\rangle - |1011000\rangle + |1011011\rangle \\
& + (|1100001\rangle + |1100010\rangle + |1101100\rangle + |1101111\rangle) \\
& + (|1110000\rangle - |1110011\rangle + |1111101\rangle - |1111110\rangle)]
\end{aligned} \tag{3}$$

The qubits 1,3 and 5 belong to Alice, qubit 7 belongs to Charlie and qubits 2,4 and 6 belong to Bob,respectively,the quantum channel can be expressed as:

$$\begin{aligned}|\psi_M\rangle_{A_1B_1A_2B_2A_3B_3C_1} &= \frac{1}{4\sqrt{2}}[(|000000\rangle + |000111\rangle - |001001\rangle + |001110\rangle \\ &-|010011\rangle + |010100\rangle + |011010\rangle + |011101\rangle \\ &-|100010\rangle + |100101\rangle - |101011\rangle - |101100\rangle \\ &+|110001\rangle + |110110\rangle + |111000\rangle - |111111\rangle) \otimes |0\rangle \\ &+(|000001\rangle + |000110\rangle + |001000\rangle - |001111\rangle \\ &-|010010\rangle + |010101\rangle - |011011\rangle - |011100\rangle \\ &-|100011\rangle + |101010\rangle + |101101\rangle + |100100\rangle \\ &+|110000\rangle + |110111\rangle - |111001\rangle + |111110\rangle) \otimes |1\rangle]\end{aligned} \tag{4}$$

The initial state of the total system can be expressed as

$$|\psi\rangle_S = |\varphi\rangle_a \otimes |\varphi\rangle_{b_1b_2} \otimes |\psi_M\rangle_{A_1B_1A_2B_2A_3B_3C_1} \tag{5}$$

In order to realize Bidirectional And Asymmetric Quantum Controlled Teleportation, Alice performs an unitary operator on qubits A_1, A_2 and A_3. The unitary transformation $U_{A_1A_2A_3}$ is given by

$$U_{A_1A_2A_3} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} \tag{6}$$

Therefore, the state of the total system becomes

$$\begin{aligned}|\psi'\rangle_t = U_{A_1A_2A_3}|\psi\rangle_S &= \frac{1}{4\sqrt{2}}|\varphi\rangle_a|\varphi\rangle_b[(|000000\rangle + |010010\rangle + |100100\rangle \\ &+ |110110\rangle + |001001\rangle + |011011\rangle + |101101\rangle \\ &+ |111111\rangle)]|0\rangle + [(|000001\rangle - |010011\rangle \\ &- |100101\rangle + |110111\rangle - |001000\rangle + |011010\rangle \\ &+ |101100\rangle + |111110\rangle)_{A_1A_2A_3B_1B_2B_3}|1\rangle_{C_1}\end{aligned}$$

Then Alice performs a Bell-state measurement on particles (a, A_3) and tells Bob and Charlie her measurement result via classical channel. At the same time, Bob carries out a four-qubit Von Neumann measurement on particles $(b_1b_2B_1B_2)$ and tell Alice and Charlie his measurement result via classical channel.The Bell states are given by

$$|\phi^{\pm}\rangle = \frac{1}{\sqrt{2}}(|00\rangle \pm |11\rangle), |\psi^{\pm}\rangle = \frac{1}{\sqrt{2}}(|01\rangle \pm |10\rangle) \tag{7}$$

and the four-qubit Von Neumann measurement are given by

$$
\begin{aligned}
|\phi^0\rangle &= \frac{1}{2}(|0000\rangle + |0101\rangle + |1010\rangle + |1111\rangle)\\
|\phi^1\rangle &= \frac{1}{2}(|0000\rangle - |0101\rangle + |1010\rangle - |1111\rangle)\\
|\phi^2\rangle &= \frac{1}{2}(|0000\rangle + |0101\rangle - |1010\rangle - |1111\rangle)\\
|\phi^3\rangle &= \frac{1}{2}(|0000\rangle - |0101\rangle - |1010\rangle + |1111\rangle)\\
|\phi^4\rangle &= \frac{1}{2}(|0001\rangle + |1011\rangle + |0100\rangle + |1110\rangle)\\
|\phi^5\rangle &= \frac{1}{2}(|0001\rangle + |1011\rangle - |0100\rangle - |1110\rangle)\\
|\phi^6\rangle &= \frac{1}{2}(|0001\rangle - |1011\rangle + |0100\rangle - |1110\rangle)\\
|\phi^7\rangle &= \frac{1}{2}(|0001\rangle - |1011\rangle - |0100\rangle + |1110\rangle)\\
|\phi^8\rangle &= \frac{1}{2}(|0010\rangle + |1000\rangle + |0111\rangle + |1101\rangle)\\
|\phi^9\rangle &= \frac{1}{2}(|0010\rangle + |1000\rangle - |0111\rangle - |1101\rangle)\\
|\phi^{10}\rangle &= \frac{1}{2}(|0010\rangle - |1000\rangle + |0111\rangle - |1101\rangle)\\
|\phi^{11}\rangle &= \frac{1}{2}(|0010\rangle - |1000\rangle - |0111\rangle + |1101\rangle)\\
|\phi^{12}\rangle &= \frac{1}{2}(|0011\rangle + |1001\rangle + |0110\rangle + |1100\rangle)\\
|\phi^{13}\rangle &= \frac{1}{2}(|0011\rangle + |1001\rangle - |0110\rangle - |1100\rangle)\\
|\phi^{14}\rangle &= \frac{1}{2}(|0011\rangle - |1001\rangle + |0110\rangle - |1100\rangle)\\
|\phi^{15}\rangle &= \frac{1}{2}(|0011\rangle - |1001\rangle - |0110\rangle + |1100\rangle)
\end{aligned}
$$

The outcomes of measurement performed by Alice and Bob. The state of qubits A_1, A_2, B_3 and C_1 are shown in Table 1 (there are sixty four results and only sixteen of them to be shown).

In Table 1, the state $|\chi^i\rangle(i = 0, \cdots, 63)$are give by

$$
\begin{aligned}
|\chi^0\rangle_{A_1A_2B_3C_1} = {} & [(a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle)_{A_1A_2}(x|0\rangle + y|1\rangle)_{B_3}|0\rangle_{C_3}\\
&+(a|00\rangle - b|01\rangle - c|10\rangle + d|11\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|1\rangle_{C_3}]
\end{aligned}
$$

$$
\begin{aligned}
|\chi^1\rangle_{A_1A_2B_3C_1} = {} & [(a|00\rangle - b|01\rangle + c|10\rangle - d|11\rangle)_{A_1A_2}(x|0\rangle + y|1\rangle)_{B_3}|0\rangle_{C_3}\\
&+(a|00\rangle + b|01\rangle - c|10\rangle - d|11\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|1\rangle_{C_3}]
\end{aligned}
$$

$$|\chi^2\rangle_{A_1A_2B_3C_1} = [(a|00\rangle + b|01\rangle - c|10\rangle - d|11\rangle)_{A_1A_2}(x|0\rangle + y|1\rangle)_{B_3}|0\rangle_{C_3} + (a|00\rangle - b|01\rangle + c|10\rangle - d|11\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^3\rangle_{A_1A_2B_3C_1} = [(a|00\rangle - b|01\rangle - c|10\rangle + d|11\rangle)_{A_1A_2}(x|0\rangle + y|1\rangle)_{B_3}|0\rangle_{C_3} + (a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{19}\rangle_{A_1A_2B_3C_1} = [(a|01\rangle + b|00\rangle + c|11\rangle + d|10\rangle)_{A_1A_2}(x|0\rangle - y|1\rangle)_{B_3}|0\rangle_{C_3} + (-a|01\rangle + b|00\rangle + c|11\rangle - d|10\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{20}\rangle_{A_1A_2B_3C_1} = [(a|01\rangle - b|00\rangle + c|11\rangle - d|10\rangle)_{A_1A_2}(x|0\rangle - y|1\rangle)_{B_3}|0\rangle_{C_3} + (-a|01\rangle - b|00\rangle + c|11\rangle + d|10\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{21}\rangle_{A_1A_2B_3C_1} = [(a|01\rangle + b|00\rangle - c|11\rangle - d|10\rangle)_{A_1A_2}(x|0\rangle - y|1\rangle)_{B_3}|0\rangle_{C_3} + (-a|01\rangle + b|00\rangle - c|11\rangle + d|10\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{22}\rangle_{A_1A_2B_3C_1} = [(a|01\rangle - b|00\rangle - c|11\rangle + d|10\rangle)_{A_1A_2}(x|0\rangle - y|1\rangle)_{B_3}|0\rangle_{C_3} + (-a|01\rangle - b|00\rangle - c|11\rangle - d|10\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{39}\rangle_{A_1A_2B_3C_1} = [(a|10\rangle + b|11\rangle + c|00\rangle + d|01\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|0\rangle_{C_3} + (-a|10\rangle + b|11\rangle + c|00\rangle - d|01\rangle)_{A_1A_2}(-x|0\rangle + y|1\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{40}\rangle_{A_1A_2B_3C_1} = [(a|10\rangle - b|11\rangle + c|00\rangle - d|01\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|0\rangle_{C_3} + (-a|10\rangle - b|11\rangle + c|00\rangle + d|01\rangle)_{A_1A_2}(-x|0\rangle + y|1\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{41}\rangle_{A_1A_2B_3C_1} = [(a|10\rangle + b|11\rangle - c|00\rangle - d|01\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|0\rangle_{C_3} + (-a|10\rangle + b|11\rangle - c|00\rangle + d|01\rangle)_{A_1A_2}(-x|0\rangle + y|1\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{42}\rangle_{A_1A_2B_3C_1} = [(a|10\rangle - b|11\rangle - c|00\rangle + d|01\rangle)_{A_1A_2}(x|1\rangle + y|0\rangle)_{B_3}|0\rangle_{C_3} + (-a|10\rangle - b|11\rangle - c|00\rangle - d|01\rangle)_{A_1A_2}(-x|0\rangle + y|1\rangle)_{B_3}|1\rangle_{C_3}]$$

$$|\chi^{60}\rangle_{A_1A_2B_3C_1} = [(a|11\rangle + b|10\rangle + c|01\rangle + d|00\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|0\rangle_{C_3} + (a|11\rangle - b|10\rangle - c|01\rangle + d|00\rangle)_{A_1A_2}(-x|0\rangle - y|1\rangle)_{B_3}|1\rangle_{C_3}]$$

Table 1 The outcomes of measurement performed by Alice and Bob, the state of qubits (A_2, B_1, C_1, C_2, C_3)

Alices result	Bob's result	the state of qubits (A_1, A_2, B_3, C_1)
$\|\phi^+\rangle_{aA_3}$	$\|\phi^0\rangle_{b_1b_2B_1B_2}$	$\|\chi^0\rangle_{A_1A_2B_3C_1}$
$\|\phi^+\rangle_{aA_3}$	$\|\phi^1\rangle_{b_1b_2B_1B_2}$	$\|\chi^1\rangle_{A_1A_2B_3C_1}$
$\|\phi^+\rangle_{aA_3}$	$\|\phi^2\rangle_{b_1b_2B_1B_2}$	$\|\chi^2\rangle_{A_1A_2B_3C_1}$
$\|\phi^+\rangle_{aA_3}$	$\|\phi^3\rangle_{b_1b_2B_1B_2}$	$\|\chi^3\rangle_{A_1A_2B_3C_1}$
$\|\phi^-\rangle_{aA_3}$	$\|\phi^4\rangle_{b_1b_2B_1B_2}$	$\|\chi^{19}\rangle_{A_1A_2B_3C_1}$
$\|\phi^-\rangle_{aA_3}$	$\|\phi^5\rangle_{b_1b_2B_1B_2}$	$\|\chi^{20}\rangle_{A_1A_2B_3C_1}$
$\|\phi^-\rangle_{aA_3}$	$\|\phi^6\rangle_{b_1b_2B_1B_2}$	$\|\chi^{21}\rangle_{A_1A_2B_3C_1}$
$\|\phi^-\rangle_{aA_3}$	$\|\phi^7\rangle_{b_1b_2B_1B_2}$	$\|\chi^{22}\rangle_{A_1A_2B_3C_1}$
$\|\psi^+\rangle_{aA_3}$	$\|\phi^8\rangle_{b_1b_2B_1B_2}$	$\|\chi^{39}\rangle_{A_1A_2B_3C_1}$
$\|\psi^+\rangle_{aA_3}$	$\|\phi^9\rangle_{b_1b_2B_1B_2}$	$\|\chi^{40}\rangle_{A_1A_2B_3C_1}$
$\|\psi^+\rangle_{aA_3}$	$\|\phi^{10}\rangle_{b_1b_2B_1B_2}$	$\|\chi^{41}\rangle_{A_1A_2B_3C_1}$
$\|\psi^+\rangle_{aA_3}$	$\|\phi^{11}\rangle_{b_1b_2B_1B_2}$	$\|\chi^{42}\rangle_{A_1A_2B_3C_1}$
$\|\psi^-\rangle_{aA_3}$	$\|\phi^{12}\rangle_{b_1b_2B_1B_2}$	$\|\chi^{60}\rangle_{A_1A_2B_3C_1}$
$\|\psi^-\rangle_{aA_3}$	$\|\phi^{13}\rangle_{b_1b_2B_1B_2}$	$\|\chi^{61}\rangle_{A_1A_2B_3C_1}$
$\|\psi^-\rangle_{aA_3}$	$\|\phi^{14}\rangle_{b_1b_2B_1B_2}$	$\|\chi^{62}\rangle_{A_1A_2B_3C_1}$
$\|\psi^-\rangle_{aA_3}$	$\|\phi^{15}\rangle_{b_1b_2B_1B_2}$	$\|\chi^{63}\rangle_{A_1A_2B_3C_1}$

$$\begin{aligned}|\chi^{61}\rangle_{A_1A_2B_3C_1} = [&(a|11\rangle - b|10\rangle + c|01\rangle - d|00\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|0\rangle_{C_3} \\ &+(a|11\rangle + b|10\rangle - c|01\rangle - d|00\rangle)_{A_1A_2}(-x|0\rangle - y|1\rangle)_{B_3}|1\rangle_{C_3}]\end{aligned}$$

$$\begin{aligned}|\chi^{62}\rangle_{A_1A_2B_3C_1} = [&(a|11\rangle + b|10\rangle - c|01\rangle - d|00\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|0\rangle_{C_3} \\ &+(a|11\rangle - b|10\rangle + c|01\rangle - d|00\rangle)_{A_1A_2}(-x|0\rangle - y|1\rangle)_{B_3}|1\rangle_{C_3}]\end{aligned}$$

$$\begin{aligned}|\chi^{63}\rangle_{A_1A_2B_3C_1} = [&(a|11\rangle - b|10\rangle - c|01\rangle + d|00\rangle)_{A_1A_2}(x|1\rangle - y|0\rangle)_{B_3}|0\rangle_{C_3} \\ &+(a|11\rangle + b|10\rangle + c|01\rangle + d|00\rangle)_{A_1A_2}(-x|0\rangle - y|1\rangle)_{B_3}|1\rangle_{C_3}]\end{aligned}$$

For example, if Alice's measurement outcomes is $|\phi^-\rangle_{aA_3}$, Bob's measurement outcomes is $|\phi^5\rangle_{b_1b_1B_2B_2}$, the collapsed state of qubits A_1, A_2, B_3 and C_1 is $|\chi^{20}\rangle_{A_1,A_2,B_3,C_1}$.

Next, Charlie needs to perform a single qubit Von Neumann measurement on qubits (C_1) and then he sends the result of his measurement to Bob and Alice. By combining information from the Charlie, Alice and Bob can perform appropriate unitary operations on particles A_1A_2 and B_3 respectively to reconstruct the the original unknown state. The outcomes of measurements performed by Alice, Bob and Charlie and the corresponding Alice and Bob's operation are shown in Table 2 (there are 128 results and only thirty two of them related to the Table 1 are shown).

Table 2 The outcomes of measurements performed by Alice, Bob and Charlie and the corresponding Alice and Bobs operation

Alice and Bob's results	Charlie's results	Alice and Bob's operations
$\|\phi^+\rangle_{aA_3}\|\phi^0\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{0A_1A_2}\otimes I$
	$\|1\rangle_{C_1}$	$U_{3A_1A_2}\otimes i\sigma_{B_3y}$
$\|\phi^+\rangle_{aA_3}\|\phi^1\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{1A_1A_2}\otimes I$
	$\|1\rangle_{C_1}$	$-U_{2A_1A_2}\otimes i\sigma_{B_3y}$
$\|\phi^+\rangle_{aA_3}\|\phi^2\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{2A_1A_2}\otimes I$
	$\|1\rangle_{C_1}$	$-U_{1A_1A_2}\otimes i\sigma_{B_3y}$
$\|\phi^+\rangle_{aA_3}\|\phi^3\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{3A_1A_2}\otimes I$
	$\|1\rangle_{C_1}$	$U_{0A_1A_2}\otimes i\sigma_{B_3y}$
$\|\phi^-\rangle_{aA_3}\|\phi^4\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{4A_1A_2}\otimes \sigma_{B_3z}$
	$\|1\rangle_{C_1}$	$-U_{7A_1A_2}\otimes \sigma_{B_3x}$
$\|\phi^-\rangle_{aA_3}\|\phi^5\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{5A_1A_2}\otimes \sigma_{B_3z}$
	$\|1\rangle_{C_1}$	$-U_{6A_1A_2}\otimes \sigma_{B_3x}$
$\|\phi^-\rangle_{aA_3}\|\phi^6\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{6A_1A_2}\otimes \sigma_{B_3z}$
	$\|1\rangle_{C_1}$	$-U_{5A_1A_2}\otimes \sigma_{B_3x}$
$\|\phi^-\rangle_{aA_3}\|\phi^7\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{7A_1A_2}\otimes \sigma_{B_3z}$
	$\|1\rangle_{C_1}$	$-U_{4A_1A_2}\otimes \sigma_{B_3x}$
$\|\psi^+\rangle_{aA_3}\|\phi^8\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{8A_1A_2}\otimes \sigma_{B_3x}$
	$\|1\rangle_{C_1}$	$-U_{11A_1A_2}\otimes -\sigma_{B_3z}$
$\|\psi^+\rangle_{aA_3}\|\phi^9\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{9A_1A_2}\otimes \sigma_{B_3x}$
	$\|1\rangle_{C_1}$	$-U_{10A_1A_2}\otimes -\sigma_{B_3z}$
$\|\psi^+\rangle_{aA_3}\|\phi^{10}\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{10A_1A_2}\otimes \sigma_{B_3x}$
	$\|1\rangle_{C_1}$	$-U_{9A_1A_2}\otimes -\sigma_{B_3z}$
$\|\psi^+\rangle_{aA_3}\|\phi^{11}\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{11A_1A_2}\otimes \sigma_{B_3x}$
	$\|1\rangle_{C_1}$	$-U_{8A_1A_2}\otimes -\sigma_{B_3z}$
$\|\psi^-\rangle_{aA_3}\|\phi^{12}\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{12A_1A_2}\otimes i\sigma_{B_3y}$
	$\|1\rangle_{C_1}$	$U_{15A_1A_2}\otimes -I$
$\|\psi^-\rangle_{aA_3}\|\phi^{13}\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{13A_1A_2}\otimes i\sigma_{B_3y}$
	$\|1\rangle_{C_1}$	$-U_{14A_1A_2}\otimes -I$
$\|\psi^-\rangle_{aA_3}\|\phi^{14}\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{14A_1A_2}\otimes i\sigma_{B_3y}$
	$\|1\rangle_{C_1}$	$-U_{13A_1A_2}\otimes -I$
$\|\psi^-\rangle_{aA_3}\|\phi^{15}\rangle_{b_1b_2B_1B_2}$	$\|0\rangle_{C_1}$	$U_{15A_1A_2}\otimes i\sigma_{B_3y}$
	$\|1\rangle_{C_1}$	$U_{12A_1A_2}\otimes -I$

In Table 2, $U_{0A_1A_2}\ldots U_{16A_1A_2}$ are given by

$$U_{0A_1A_2}=\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{pmatrix}U_{1A_1A_2}=\begin{pmatrix}1&0&0&0\\0&-1&0&0\\0&0&1&0\\0&0&0&-1\end{pmatrix}U_{2A_1A_2}=\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&-1&0\\0&0&0&-1\end{pmatrix}$$

$$U_{3A_1A_2}=\begin{pmatrix}1&0&0&0\\0&-1&0&0\\0&0&-1&0\\0&0&0&1\end{pmatrix} U_{4A_1A_2}=\begin{pmatrix}0&1&0&0\\1&0&0&0\\0&0&0&1\\0&0&1&0\end{pmatrix} U_{5A_1A_2}=\begin{pmatrix}0&1&0&0\\-1&0&0&0\\0&0&0&1\\0&0&-1&0\end{pmatrix}$$

$$U_{6A_1A_2}=\begin{pmatrix}0&1&0&0\\1&0&0&0\\0&0&0&-1\\0&0&-1&0\end{pmatrix} U_{7A_1A_2}=\begin{pmatrix}0&1&0&0\\-1&0&0&0\\0&0&0&-1\\0&0&1&0\end{pmatrix} U_{8A_1A_2}=\begin{pmatrix}0&0&1&0\\0&0&0&1\\1&0&0&0\\0&1&0&0\end{pmatrix}$$

$$U_{9A_1A_2}=\begin{pmatrix}0&0&1&0\\0&0&0&-1\\1&0&0&0\\0&-1&0&0\end{pmatrix} U_{10A_1A_2}=\begin{pmatrix}0&0&1&0\\0&0&0&1\\-1&0&0&0\\0&-1&0&0\end{pmatrix} U_{11A_1A_2}=\begin{pmatrix}0&0&1&0\\0&0&0&-1\\-1&0&0&0\\0&1&0&0\end{pmatrix}$$

$$U_{12A_1A_2}=\begin{pmatrix}0&0&0&1\\0&0&1&0\\0&1&0&0\\1&0&0&0\end{pmatrix} U_{13A_1A_2}=\begin{pmatrix}0&0&0&1\\0&0&-1&0\\0&1&0&0\\-1&0&0&0\end{pmatrix} U_{14A_1A_2}=\begin{pmatrix}0&0&0&1\\0&0&1&0\\0&-1&0&0\\-1&0&0&0\end{pmatrix}$$

$$U_{15A_1A_2}=\begin{pmatrix}0&0&0&1\\0&0&-1&0\\0&-1&0&0\\1&0&0&0\end{pmatrix}$$

3 Conclusion

In summary, we have put forward an ideal of bidirectional and asymmetric quantum controlled teleportation. In our scheme, Seven-qubit maximally entangled state is considered as the quantum channel, Alice and Bob are not only senders but also receivers. Based on local operations and classical communications. Firstly, Alice must carry out an unitary operation on her particles and then Alice makes Bell-state measurement and Bob makes a four-qubit Von Neumann measurement on the corresponding particles respectively, next Charlie performs a single qubit measurement on his particles, after that Alice and Bob can perform appropriate unitary transformations on target particles to achieve the bidirectional state teleportation. However,if one agent is dishonest, the receiver can not acquire the valid information.

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