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A New Quantum Protocol for Superluminal Classical Communication leading to Superluminal Teleportation

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Abstract: We propose a new quantum protocol for instantaneous and simultaneous transmission of classical information to faraway locations. This new quantum protocol achieves instantaneous and simultaneous transfer of the "same" classical information in terms of certain desired sequence of classical bits from the data transmission center to different faraway locations from the data transmission center. Further, these locations are not only faraway from data transmission center but also could be located faraway from one another too. This new quantum protocol thus serves as a superluminal communicator for sending any desired classical information. This classical information to be transmitted is not known a priory to the data transmission center and it arrives there from time to time for transmission purpose when Alice at data transmission center and other participants have already gone faraway from one another. We further show that the instantaneous part of the ability to transmit the classical information in terms of a sequence of classical bits also enables one to achieve instantaneous teleportation of a quantum state to some (single) chosen faraway location which was impossible for the teleportation protocol [3] because there was no quantum protocol available to achieve superluminal communication of classical information in terms of classical bits. Alice understands about the two classical bits that are needed to send to Bob after Alice's partial measurement of the qubits in her possession. These two classical bits that arrive after partial measurement of the two qubits in her possession by Alice, either 00, or 01, or 10, or 11, are needed by Bob, now stationed at some faraway location, to complete the teleportation protocol [3]. Our new quantum protocol for superluminal classical communication makes these needed qubits available to Bob instantaneously to successfully complete the teleportation protocol [3] instanttaneously.

Keywords: Entanglement, Superluminal Classical Communication, Superluminal Quantum Teleportation

1 Introduction

Entanglement is a resource of great utility in quantum computation and quantum information. Schrodinger described it as follows: "I would not call [entanglement] one but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought."[1]. Being usually fragile to environment, entanglement is robust against conceptual and mathematical tools that struggle with the task of deciphering its rich structure [2]. Entanglement is a fundamental resource of nature which is comparable in importance to energy, information, entropy, or any other equally fundamental resource. Quantum entanglement describes the strong correlation that exists among different parts of composite quantum systems even after the parts of these composite quantum systems may get spacelike separated from one another. The so called teleportation of any arbitrary quantum state from one party to other party [3] has been verified experimentally. This quantum teleportation is not only a theoretical idea but has been verified in the teleportation experiments between two locations separated over the distance of the order of hundred kilometers [4,5,6,7,8,9]. Recently a team of Chinese scientists have extended this range to about 1400 kilometers [10].

In this paper we propose a new quantum protocol to instantaneously and simultaneously transmit any desired classical information in terms of any desired sequence of classical bits from Alice stationed at a data transmission center to all the other recipients, located at different faraway locations from Alice. These participants are situated at the locations which are faraway not only from Alice but also could be faraway from one another too. Thus, the proposed quantum protocol makes use of the entangled shared states and the nonlocal influences to transmit the desired known classical information in terms

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of a sequence of classical bits, simultaneously and instantaneously, from Alice sitting at the data transmission center to different distant locations, faraway from data transmission center and could be faraway from one another too.

We will also see that the new quantum protocol proposed here for the classical data transmission can be used as an aid in the well-known quantum teleportation protocol [3]. The quantum teleportation protocol [3] requires to transmit two classical bits from Alice to Bob to complete the teleportation protocol successfully. This was so far impossible to do faster than the velocity of light. But the new quantum protocol proposed here for the classical data transmission can achieve the classical data transmission in terms of a data sequence of classical bits instantaneously. This makes possible the instantaneous transmission of two classical bits from Alice to Bob for Bob to successfully complete the teleportation protocol [3] instantaneously. In short, the proposed quantum protocol will work as a superluminal communicator to pass two classical bits that appear during the Bell basis measurement by Alice to the now faraway Bob to perform required operation, and as a consequence makes possible the instantaneous teleportation of a quantum state from Alice to Bob.

2 Preliminaries:

We now give some preliminaries required for the proposed quantum protocol for superluminal classical communication.

Among the 2-qubit states the well-known four Bell basis states, $|\beta_{ij}\rangle, i, j \in \{0,1\}$, are the maximally entangled states. They are defined as

$$|\beta_{00}\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$$

$$|\beta_{01}\rangle = \frac{1}{\sqrt{2}}(|01\rangle + |10\rangle)$$

$$|\beta_{10}\rangle = \frac{1}{\sqrt{2}}(|00\rangle - |11\rangle)$$

$$|\beta_{11}\rangle = \frac{1}{\sqrt{2}}(|01\rangle - |10\rangle)$$

Both these sets of states, the (2-qubit) computational basis states and the (2-qubit) Bell basis states, form orthonormal basis so that any 2-qubit pure quantum state can be expressed in terms of them.

Also, the four Bell basis states, $|\beta_{ij}\rangle, i, j \in \{0,1\}$, and the four computational basis states, $|ij\rangle, i, j \in \{0,1\}$ are inter convertible into each other through the following invertible matrix, A , which is also unitary, i.e. $A^{-1} = A^{+}$ where the matrix A^{+} denotes the conjugate transpose of the matrix A.

The matrix A is as given below:

$$A = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & -1 \\ 0 & 1 & -1 & 0 \end{bmatrix}$$

and the Bell basis and the computational basis are inter convertible and are related by the following matrix equations:

$$\begin{bmatrix} |\beta_{00}\rangle \\ |\beta_{01}\rangle \\ |\beta_{10}\rangle \\ |\beta_{11}\rangle \end{bmatrix} = A \begin{bmatrix} |00\rangle \\ |01\rangle \\ |10\rangle \\ |11\rangle \end{bmatrix}$$

and

$$\begin{bmatrix} |00\rangle \\ |01\rangle \\ |10\rangle \\ |11\rangle \end{bmatrix} = A^{+} \begin{bmatrix} |\beta_{00}\rangle \\ |\beta_{01}\rangle \\ |\beta_{10}\rangle \\ |\beta_{11}\rangle \end{bmatrix}$$

One can easily extend the idea and define the Bell basis states for the 3-qubit states. For the 3-qubit case we will have eight Bell basis states $|\beta_{ijk}\rangle, i, j, k \in \{0,1\}$ and they are related to eight computational basis states, $|ijk\rangle, i, j, k \in \{0,1\}$ through the following matrix equation:

$$\begin{bmatrix} |\beta_{000}\rangle \\ |\beta_{001}\rangle \\ |\beta_{010}\rangle \\ |\beta_{011}\rangle \\ |\beta_{100}\rangle \\ |\beta_{101}\rangle \\ |\beta_{110}\rangle \\ |\beta_{111}\rangle \end{bmatrix} = B \begin{bmatrix} |000\rangle \\ |001\rangle \\ |010\rangle \\ |011\rangle \\ |100\rangle \\ |101\rangle \\ |110\rangle \\ |111\rangle \end{bmatrix}$$

where the matrix B is as given below:

$$B = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \\ 0 & 1 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 1 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 \end{bmatrix}$$

It is easy to check that like the matrix A defined above the 8×8 matrix B is also invertible and unitary, i.e.B^{-1} exists and $B^{-1} = B^{+}$ where the matrix B^{+} denotes the conjugate transpose of the matrix B.

A further generalization is also possible. We can proceed on the similar lines and define orthonormal Bell basis containing 2^n Bell basis states for n-qubit case, namely,$|\beta_{i_1 i_2 \cdots i_n}\rangle, i_1, i_2, \cdots, i_n \in \{0,1\}$ and relate them with the corresponding n-qubit computational basis states, namely, $|i_1 i_2 \cdots i_n\rangle$ such that $i_1, i_2, \cdots, i_n \in \{0,1\}$, through a $2^n \times 2^n$ matrix which will be also invertible and unitary.

A formula for writing an n-qubit Bell basis state in terms of n-qubit computational basis states is as given below:

$$|\beta_{i_1 i_2 \cdots i_n}\rangle = \frac{1}{\sqrt{2}}(|0 i_2 i_3 \cdots i_n\rangle$$

$$+(-1)^{i_1}|1(1-i_2)(1-i_3)\cdots(1-i_n)\rangle)$$

Using this relation one can easily construct the transformation matrix of size $2^n \times 2^n$ to express n-qubit Bell basis states in terms of corresponding n-qubit computational basis states. One can further see that as in the previous cases this matrix will also be invertible and unitary.

One can easily build the quantum circuit to obtain the n-qubit Bell basis state. By operating this quantum circuit on the computational basis state, $|x_1 x_2 \cdots x_n\rangle$, one will obtain the desired Bell basis state, $|\beta_{x_1 x_2 \cdots x_n}\rangle$.

One can build this quantum circuit by carrying out the following steps:

(i) INPUT: Start with the computational basis state, $|x_1 x_2 \cdots x_n\rangle$.

(ii) Operate the Hadamard gate, H, on the first qubit $|x_1\rangle$.

(iii) Operate the CNOT gates, $C_{12}, C_{13}, C_{14}, \cdots, C_{1n}$ with the first qubit, namely, $H|x_1\rangle$ as the control qubit and respectively $|x_2\rangle, |x_3\rangle, |x_4\rangle, \cdots, |x_n\rangle$ as the target qubits.

(iv) OUTPUT: One arrives at the desired Bell basis state, $|\beta_{x_1 x_2 \cdots x_n}\rangle$.

It is interesting to note that the computational basis state, $|x_1 x_2 \cdots x_n\rangle$, is a separable state while the Bell basis state, $|\beta_{x_1 x_2 \cdots x_n}\rangle$, is an entangled state, in fact maximally entangled state.

3 A Quantum Protocol for Transmitting "Same" Information to multiple Number of Recipients:

In this section we discuss the new quantum protocol for transmitting the information in the form of a sequence of classical bits (zeros and ones) arranged in a particular order from Alice at data transmission center to all the recipients located at faraway locations. There are several recipients situated faraway from data transmission center and also from each other and suppose we want to transmit the "identical" information to all, bit by bit, in terms of classical bits, instantaneously and simultaneously.

Is it possible to fulfill this task successfully?

The answer to this question is YES. In this section we will describe how the new quantum protocol developed here to transmit the classical information can pass this classical information, not only correctly but also instantaneously and simultaneously, in terms of classical bits from Alice to all the recipients located at different distant locations.

For the sake of simplicity we first consider here the simple case where Alice stationed at data transmission center will manage to transmit, bit by bit, the "same" data sequence $s_1, s_2, \cdots, s_m$ where $s_i \in \{0,1\}$, to all the recipients say $P_1, P_2, P_3, \cdots, P_n$ which are faraway not only from Alice but from each other too.

The proposed quantum protocol proceeds as follows:

Initially, Alice and all the participants are together at the data transmission center and when they are together at the data transmission center they prepare several copies of the following two types of "Generalized" Bell basis states $|\Delta_1\rangle$ and $|\Delta_2\rangle$:

$$|\Delta_1\rangle = |\beta_{0(j_1 j_2 \cdots j_u)(j_1 j_2 \cdots j_u)\cdots(j_1 j_2 \cdots j_u)}\rangle,$$

shared by Alice and all the other participants of the protocol say $P_1, P_2, P_3, \cdots, P_n$. The first qubit of each of these "Generalized" Bell basis states is with Alice, the next group of r qubits represented above as $(j_1 j_2 \cdots j_u)$ is the first group of r qubits and it is in the possession of participant P_1 (as a ket $|j_1 j_2 \cdots j_u\rangle$.) The next group of r qubits represented above as $(j_1 j_2 \cdots j_u)$ and it is in the possession of participant P_2 (as a ket $|j_1 j_2 \cdots j_u\rangle$,) and so on. The last group of last r qubits represented above as $(j_1 j_2 \cdots j_u)$ and it is in the possession of participant P_n (as a ket $|j_1 j_2 \cdots j_u\rangle$.) Similarly,

$$|\Delta_2\rangle = |\beta_{0(k_1 k_2 \cdots k_v)(k_1 k_2 \cdots k_v)\cdots(k_1 k_2 \cdots k_v)}\rangle,$$

shared by Alice and all the other participants of the protocol say $P_1, P_2, P_3, \cdots, P_n$. The first qubit of each of these "Generalized" Bell basis states is with Alice, the group of next r qubits, as above, represented as $(k_1 k_2 \cdots k_v)$ is the first group of r qubits and it is in the possession of participant P_1 (as a ket $|k_1 k_2 \cdots k_v\rangle$.) The next group of r qubits represented above as $(k_1 k_2 \cdots k_v)$ and it is in the possession of participant P_2 (as a ket $|k_1 k_2 \cdots k_v\rangle$,) and so on. The last group of last r qubits represented above as $(k_1 k_2 \cdots k_v)$ and it is in the possession of participant P_n (as a ket $|k_1 k_2 \cdots k_v\rangle$.)

Note that when Alice and all the participants were together at the data transmission center they prepared several copies of the above mentioned "Generalized" Bell basis states, $|\Delta_1\rangle$ and $|\Delta_2\rangle$.

All the participants $P_1, P_2, P_3, \cdots, P_n$ who will be the recipients of information transmitted from the data transmission center by Alice then go away to their respective faraway locations along with their qubits while Alice always stays at the data transmission center.

Alice is then provided with the classical information in terms of a sequence of classical bits $s_1, s_2, \cdots, s_m$ where $s_i \in \{0,1\}$. This sequence of classical bits is to be transmitted bit by bit to all the faraway recipients in the same order as given, i.e. firstly the value of the classical bit s_1, which is given to Alice, to transmit to all the participants, $P_1, P_2, P_3, \cdots, P_n$, who have now gone faraway from Alice as well as from each other, instantaneously and simultaneously. Secondly, Alice is given s_2 to transmit to all participants, instantaneously

and simultaneously, and so on, till finally Alice has to transmit s_m to all the participants, instantaneously and simultaneously.

Note that the main task for Alice is to manage to transmit this information in terms of a known sequence of classical bits $s_1, s_2, \cdots, s_m$ where $s_i \in \{0,1\}$, such that it is transmitted to all the faraway recipients and each bit transmitted by Alice must reach all the recipients instantaneously and simultaneously.

We now explain what information we have associated with the following sequences of classical bits (zeros and ones), namely, (i) $j_1 j_2 \cdots j_u$ and (ii) $k_1 k_2 \cdots k_v$. We have chosen these sequences such that the sequence "$j_1 j_2 \cdots j_u$" stands for the information, say "BLUE SKY", and the sequence

"$(1-k_1)(1-k_2)\cdots(1-k_v)$" stands for the information, say "BRIGHT SUN". Similarly, the information associated by us with the following sequences

"$(1-j_1)(1-j_2)\cdots(1-j_u)$" and "$k_1 k_2 \cdots k_v$" is "COMPLEMENT of BLUE SKY" and "COMPLEMENT of BRIGHT SUN" respectively. Note that

"COMPLEMENT of the COMPLEMENT = ORIGINAL".

Note that Alice will receive the information in terms of an ordered sequence of zeros and ones after all other participants will go away to their respective faraway locations and Alice wants to convey the same information just now received to her i.e. the sequence of classical bits $s_1, s_2, \cdots, s_m$ say, where $s_i \in \{0,1\}$. This information is to be conveyed by Alice to all the faraway recipients, instantaneously and simultaneously.

Suppose $s_1 = 0$. In this case Alice will measure partially the state $|\Delta_1\rangle$ among the several copies available to her in computational basis. As a result of this measurement the state $|\Delta_1\rangle$ will collapse either into state

$$|\psi_1\rangle = |0(j_1 j_2 \cdots j_u)(j_1 j_2 \cdots j_u)\cdots(j_1 j_2 \cdots j_u)\rangle$$

or into state

$$|\psi_2\rangle = |1((1-j_1)(1-j_2)\cdots(1-j_u))((1-j_1)(1-j_2)\cdots (1-j_u))\cdots(1-j_1)(1-j_2)\cdots(1-j_u))\rangle$$

As a consequence of this partial measurement by Alice in the computational basis she will find the single qubit in her possession to be collapsed into either $|0\rangle$ or $|1\rangle$, and correspondingly all the remote participants will see their state of r qubits in their possession collapsed into either $|j_1 j_2 \cdots j_u\rangle$ or $|(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$ which conveys the information "BLUE SKY" or its COMPLEMENT to all the remote participants and it is already told to all the remote participants (when they all were together with Alice) that the information "BLUE SKY" or its COMPLEMENT corresponds to $s_1 = 0$. In other words, a CONVENTION is made prior to the separation from each other of Alice and all other participants when they were together that the outcome of measurement equal to "BLUE SKY" or its COMPLEMENT corresponds to $s_1 = 0$. Note that the COMPLEMENT may be something meaningful arrangement of letters or it could be be some meaningless arrangement of letters in the language.

Note that we have made a convention that whatever outcome we may get, namely, "BLUE SKY" or its either meaningful or meaningless COMPLEMENT, we have decided a priory that such outcome corresponds to $s_1 = 0$. Thus Alice has managed to convey to all the remote participants that $s_1 = 0$ by partially measuring in the computational basis a copy of the state $|\Delta_1\rangle$ among the several copies available to her.

Suppose $s_1 = 1$. In this case Alice will measure the first qubit of the state state $|\Delta_2\rangle$ in her possession, i.e. measure partially the first qubit in her possession of the state $|\Delta_2\rangle$ among the several copies available to her in the computational basis. As a result of this measurement the state $|\Delta_2\rangle$ will collapse either into state

$$|\phi_1\rangle = |0(k_1 k_2 \cdots k_v)(k_1 k_2 \cdots k_v)\cdots(k_1 k_2 \cdots k_v)\rangle$$

or into state

$$|\phi_2\rangle = |1((1-k_1)(1-k_2)\cdots(1-k_v))((1-k_1)(1-k_2)\cdots (1-k_v))\cdots((1-k_1)(1-k_2)\cdots(1-k_v))\rangle$$

Now, as a consequence Alice will see her qubit as $|0\rangle$ or $|1\rangle$ and correspondingly all the remote participants will see their state as either $|k_1 k_2 \cdots k_v\rangle$ or $|(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$ which conveys the information: a "COMPLEMENT of BRIGHT SUN" or "BRIGHT SUN" to all the remote participants and it is already told to all the remote participants, when they all were together with Alice, that the information "BRIGHT SUN" or its COMPLEMENT corresponds to $s_1 = 1$. In other words, a CONVENTION is made prior to the separation from each other of Alice and all other participants when they were together that the outcome of measurement equal to "COMPLEMENT of BRIGHT SUN" or "BRIGHT SUN" corresponds to $s_1 = 1$. Thus Alice has thus managed to convey to all the remote participants that $s_1 = 1$ by partially measuring in the computational basis a copy of the state $|\Delta_2\rangle$ among the several copies available to her.

By repeating these actions one can then transmit $s_2, s_3, \cdots, s_m$ where $s_i \in \{0,1\}$, and thus the entire sequence can be transmitted, bit by bit, to all the recipients, instantaneously and simultaneously.

4 A Quantum Protocol for Superluminal Teleportation:

The quantum teleportation protocol [3] involves two parties, Alice and Bob. Alice starts with a single qubit

quantum state, $|\psi\rangle = a|0\rangle + b|1\rangle$, in her possession which is unknown to her except that $|a|^2 + |b|^2 = 1$. Alice and Bob also start out by sharing between them a Bell state, $|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[|00\rangle + |11\rangle]$ such that the first qubit of this Bell state is in the possession of Alice and the second qubit of this Bell state is with Bob. Suppose that Alice wants to teleport the single qubit state $|\psi\rangle$ in her possession to Bob. The joint state of three qubits is

$$|\Gamma_1\rangle = |\psi\rangle|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[a|000\rangle + a|011\rangle + b|100\rangle + b|111\rangle].$$

Rewriting the above quantum state we have

$$|\Gamma_1\rangle = |\psi\rangle|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[|00\rangle a|0\rangle + |01\rangle a|1\rangle$$

$$+|10\rangle b|0\rangle + |11\rangle b|1\rangle].$$

By expressing the computational basis states made up of first two qubits $|00\rangle, |01\rangle, |10\rangle, |11\rangle$ in the above equation in terms of the standard Bell basis states $|\beta_{00}\rangle, |\beta_{01}\rangle, |\beta_{10}\rangle, |\beta_{11}\rangle$ where $|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[|00\rangle + |11\rangle]$, $|\beta_{01}\rangle = \frac{1}{\sqrt{2}}[|01\rangle + |10\rangle]$, $|\beta_{10}\rangle = \frac{1}{\sqrt{2}}[|00\rangle - |11\rangle]$, and $|\beta_{11}\rangle = \frac{1}{\sqrt{2}}[|01\rangle - |10\rangle]$ we get

$$|\Gamma_1\rangle = |\psi\rangle|\beta_{00}\rangle = \frac{1}{2}[|\beta_{00}\rangle(a|0\rangle + b|1\rangle) + |\beta_{01}\rangle(a|1\rangle$$

$$+b|0\rangle) + |\beta_{10}\rangle(a|0\rangle - b|1\rangle) + |\beta_{11}\rangle(a|1\rangle - b|0\rangle)].$$

It is easy to check further that the above equation can also be expressed as follows:

$$|\Gamma_1\rangle = |\psi\rangle|\beta_{00}\rangle = \frac{1}{2}[|\beta_{00}\rangle(I|\psi\rangle) + |\beta_{01}\rangle(X|\psi\rangle)$$

$$+|\beta_{10}\rangle(Z|\psi\rangle) + |\beta_{11}\rangle(X.Z|\psi\rangle)],$$

where I, X, Z are standard Pauli operators.

Now, if Alice will perform the partial measurement on the first two qubits in her possession, i.e. if she will perform Bell basis measurement on the two qubits in her possession then any one out of the four Bell basis states $|\beta_{00}\rangle, |\beta_{01}\rangle, |\beta_{10}\rangle, |\beta_{11}\rangle$ will be the outcome with equal probability equal to $\frac{1}{4}$. After Bell basis measurement by Alice yielding one out of the four Bell basis states what the posteriory state (third qubit) Bob will have will depend on the outcome of Alice's Bell basis measurement. So, the next step of the well known protocol [3] is to convey the result of the Bell basis measurement done by Alice to Bob in terms of two classical bits over a classical channel so that Bob can perform the appropriate recovery operation for yielding the exactly identical copy of $|\psi\rangle$ as his qubit (third qubit).

Alternatively, we have the joint state of three qubits as

$$|\Gamma_1\rangle = |\psi\rangle|\beta_{00}\rangle = \frac{1}{\sqrt{2}}[a|000\rangle + a|011\rangle + b|100\rangle + b|111\rangle].$$

Now, if we operate the CNOT gate using the first qubit of $|\Gamma_1\rangle$ as the control qubit and the second qubit of $|\Gamma_1\rangle$ as the target qubit the state $|\Gamma_1\rangle$ changes to

$$|\Gamma_2\rangle = \frac{1}{\sqrt{2}}[a|000\rangle + a|011\rangle + b|110\rangle + b|101\rangle].$$

If Alice now will send the first qubit of the above state, $|\Gamma_2\rangle$ through the Hadamard gate the state $|\Gamma_2\rangle$ changes to

$$|\Gamma_3\rangle = \frac{1}{2}[|00\rangle(a|0\rangle + b|1\rangle) + |01\rangle(a|1\rangle + b|0\rangle)$$

$$+|10\rangle(a|0\rangle - b|1\rangle) + |11\rangle(a|1\rangle - b|0\rangle)].$$

It is easy to check further that the above equation can also be expressed as follows:

$$|\Gamma_3\rangle = \frac{1}{2}[|00\rangle(I|\psi\rangle) + |01\rangle(X|\psi\rangle)$$

$$+|10\rangle(Z|\psi\rangle) + |11\rangle(Z.X|\psi\rangle)],$$

where I, X, Z are standard Pauli operators.

Now, if Alice will perform the partial measurement on the first two qubits in her possession, i.e. if she will perform the partial measurement on the two qubits in her possession in the computational basis then any one out of the four computational basis states $|00\rangle, |01\rangle, |10\rangle, |11\rangle$ will be the outcome with equal probability equal to $\frac{1}{4}$. After this partial measurement by Alice yielding one out of the four computational basis states what the posteriory state (third qubit) Bob will have will depend on the outcome of Alice's computational basis measurement. So, the next step of the well known protocol [3] is to convey the result of the computational basis measurement done by Alice to Bob in terms of two classical bits over a classical channel so that Bob can perform the appropriate recovery operation for yielding the exactly identical copy of $|\psi\rangle$ as his qubit (third qubit). Now, (without the knowledge of the quantum protocol for instantaneously transmitting the classical information, which we have developed in section 3 above) conveying the result of the computational basis measurement in terms of two classical bits from Alice to Bob over a classical channel cannot be done faster than the velocity of light which is the well-known experimentally verified upper limit to the velocity in the universe.

In order to manage the above said classical communication in terms of two classical bits say s_1, s_2, generated as a result of the computational basis measurement done by Alice, instantaneously, the following "Generalized" Bell basis states will be prepared when Alice and Bob were together. When together, Alice and Bob will prepare sufficiently many copies of the following "Generalized" Bell basis states, $|\alpha_1\rangle$ and $|\alpha_2\rangle$:

$$|\alpha_1\rangle = |\beta_{0j_1j_2\cdots j_u}\rangle$$

The first qubit of each of the copy of these "Generalized" Bell basis states, $|\alpha_1\rangle$, is with Alice, and the group of next r

qubits represented above as $j_1 j_2 \cdots j_u$ in each of that copy is in the possession of Bob.

$$|\alpha_2\rangle = |\beta_{0k_1k_2\cdots k_v}\rangle$$

As above the first qubit of each of the copy of these "Generalized" Bell basis states, $|\alpha_2\rangle$, is with Alice, and the group of next r qubits represented above as $k_1k_2\cdots k_v$ in each of that copy is in the possession of Bob.

Now, as in done in section 3, We have chosen these sequences such that the sequence "$j_1 j_2 \cdots j_u$" stands for the information, say "BLUE SKY", and the sequence "$(1-k_1)(1-k_2)\cdots(1-k_v)$" stands for the information, say "BRIGHT SUN".

Suppose $s_1 = 0$. In this case Alice will measure partially the state $|\alpha_1\rangle$ among the several copies available to her in the computational basis. As a result of this measurement the state $|\alpha_1\rangle$ will collapse either into state

$$|\mu_1\rangle = |0 j_1 j_2 \cdots j_u\rangle$$

or into state

$$|\mu_2\rangle = |1(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$$

As a consequence of this partial measurement by Alice in the computational basis she will find the single qubit in her possession to be collapsed into either $|0\rangle$ or $|1\rangle$, state and correspondingly Bob will see his state of r qubits in his possession collapsed into either $|j_1 j_2 \cdots j_u\rangle$ or $|(1-j_1)(1-j_2)\cdots(1-j_u)\rangle$ which conveys the information "BLUE SKY" or the "COMPLEMENT of BLUE SKY" to Bob and it is already told to Bob when Alice and Bob were together that the information "BLUE SKY" or the "COMPLEMENT of BLUE SKY" corresponds to $s_1 = 0$. Note that the COMPLEMENT may be by chance a meaningful arrangement of letters or it could be be some meaningless arrangement of letters in the language.

Note that we have made a convention that whatever outcome we may get, namely, "BLUE SKY" or its either meaningless or meaningful COMPLEMENT, we have decided a priory that such outcome corresponds to $s_1 = 0$. Thus Alice has managed to convey to Bob that $s_1 = 0$ by partially measuring in the computational basis a copy of the state $|\alpha_1\rangle$ among the sufficiently many copies available to her.

Suppose $s_1 = 1$. In this case Alice will measure partially the state $|\alpha_2\rangle$ among the several copies available to her in the computational basis. As a result of this measurement the state $|\alpha_2\rangle$ will collapse either into state

$$|\nu_1\rangle = |0 k_1 k_2 \cdots k_v\rangle$$

or into state

$$|\nu_2\rangle = |1(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$$

As a consequence of this partial measurement Alice will see her qubit as $|0\rangle$ or $|1\rangle$ and correspondingly Bob will see his state as either $|k_1k_2\cdots k_v\rangle$ or $|(1-k_1)(1-k_2)\cdots(1-k_v)\rangle$ which conveys the information: a "COMPLEMENT of BRIGHT SUN" or "BRIGHT SUN" to Bob and it is already told to Bob when Alice and Bob were together that the information "COMPLEMENT of BRIGHT SUN" or "BRIGHT SUN" corresponds to $s_1 = 1$. Thus Alice has managed to convey to Bob that $s_1 = 1$ by partially measuring in the computational basis a copy of the state $|\alpha_2\rangle$ among the sufficiently many copies available to her.

By repeating these actions Alice can also transmit the value of s_2 to Bob and thus the values of the classical bits, s_1, s_2 that appeared due to Bell basis measurement by Alice can be transmitted to Bob instantaneously and using these bits Bob will manage to change the (third) qubit in his possession into the desired state, $|\psi\rangle$, by performing the required appropriate operation. The desired state, $|\psi\rangle$, which was initially with Alice and got destroyed during her Bell basis measurement, will thus be made to reincarnate by Bob after instantaneously receiving the desired classical bits, s_1, s_2 using our new quantum protocol.

5 Conclusion

The ideas developed in section 3 provides a new technique for instantaneously and simultaneously transmitting any piece of newly generated classical information to faraway locations in the universe from Alice to all other faraway participants. By preparing and sharing other appropriate generalized Bell basis states and fixing appropriate associated conventions to interpret their meaning after the measurements it will be possible for anyone among Alice and other participants $P_1, P_2, \cdots, P_n$ to communicate any newly formed fresh classical information in terms of an ordered sequence of classical bits at his /her place to all other faraway participants, instantaneously and simultaneously. Thus, this ability will provide us a means to remain connected through instantaneous and simultaneous exchange of desired classical information with distant parts of the universe. In short, this new quantum protocol serves as a superluminal communicator for everybody to transmit any desired classical information to any distant locations in the universe and that too instantaneously and simultaneously. The outcome of this protocol is not only very important and useful but also very strange and shocking. This is so because in this protocol what information is to be sent to various participants, situated faraway from one another, is not known a priory. Here anybody can send any information generated long after all the participants have got separated from one another and also anybody can send any new information that will come into existence in future at his place to all these distant participants, spacelike separated from one another. The other important application of this new quantum protocol for superluminally communicating any desired classical

information in terms of classical bits, ordered in any desired sequence, is in achieving superluminal teleportation of quantum state from Alice to Bob as is seen above in section 4.

References

[1] E. Schrodinger, Probability relations between separated systems. *Proc. Cambridge Philos. Soc.*, 32:446-452, (1936).
[2] Yszard Horodecki, Pawel Horodecki, Michal Horodecki, Karol Horodecki, Quantum Entanglement, *arXiv quant-ph*, 0702225v1, (2007).
[3] C. H. Bennett, G. Brassard, C. Crepeau, R. Jozsa, A. Peres, and W. K. Wootters, Teleporting an unknown quantum state via dual classical and Einstein-Podolsky-Rosen channels, *Phys. Rev. Lett.*, 70, 1895-1899, (1993).
[4] D. Bouwmeester, et al., Experimental quantum teleportation, *Nature*, 390, 575 (1997).
[5] J. Yin, et al., Quantum teleportation and entanglement distribution over 100 kilometre freespace channels, *Nature*, 488, 185–188 (2012).
[6] X. S. Ma, et al., Quantum teleportation over 143 kilometres using active feed-forward, *Nature*, 489, 269–273 (2012).
[7] O. Landry, J. A. W. van Houwelingen, A. Beveratos, H. Zbinden, N. Gisin, Quantum teleportation over the swisscom telecommunication network, *J. Opt. Soc. Am.*, B 24, 398–403 (2007).
[8] Q. C. Sun, et al., Quantum teleportation with independent sources and prior entanglement distribution over a network, *Nat.Photon.*, 10,671-675 (2016).
[9] R. Valivarthi, et al., Quantum teleportation across a metropolitan fibre network, *Nat. Photon.*, 10, 676–680 (2016).
[10] J. G. Ren, et al., Ground-to-satellite quantum teleportation, *Nature*, 549, 70–73 (2017).