IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 13, Issue 6 Ser. I (Nov. – Dec. 2021), PP 82-84
www.Iosrjournals.Org

Quantum entanglement: Defining future of information communication

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Abstract: *Quantum physics is the branch of physics which deals with the study of nature of particles at fundamental level. Behavior and nature of these finest particles will reveal the fundamental principles responsible for the control of natural phenomenon. Quantum entanglement is a phenomena in which two particles are connected to each other in such a way that study ofa variable in one particle gives knowledge about the same variable in the other particle. Quantum entanglement is considered as invisible link between distant quantum objects through which one affect the other instantly. In entangled states, information is not transmitted but information is shared. Quantum computing and quantum internet is related to use of shared information.Quantum physics provides a large scope for research through which new principles and concepts will be discovered in future. Existing concepts may also be transformed on the basis of experimental results and analysis. This paper deals with the studies on the advancement in the field of quantum entanglement and theories related to it.*

Keywords: *Quantum entanglement, Bell inequality, telepathy, quantum information, communication.*

I. Introduction

In 1935first time, A.Einstein et al proposed the theory of quantum entanglement theoretically. Einstein, Podolsky, Rosen (EPR) presented the EPR paradox in a research paper entitled : Can quantum -mechanical description of physical reality be considered complete?[1].Since then scientists around the globe are working to prove the entanglement experimentally. When particles such as electrons,photons, molecules etc interact each other physically with any interactive force and then become separated. They linkup in this way that their states remain linked after being separated by a large distance in space. After this particles show same quantum state in which particles are known as entangled particles. Entanglement of particles or systems represent a special relationship between eachother. If quantum state of one particle is known then quantum state of any other particle can be obtained.If two systems are entangled then properties of one system cannot be studied separately without consideringthe other entangled system.

In another words, Quantum entanglement as a phenomenon is considered as a result of another phenomena known as quantum superposition. Quantum entanglement has been a topic of much interest among the researcher hence many attempts were done by the researchers in which quantum entanglement in photons[2] electrons[3] and diamonds[4] have been studied. There are various types of entanglement reported by the researchers in their studies.

It is considered that Entanglement has the potential which can be used to achieve impossible tasks in near future with the advancement in this field. Applications of entanglement are in quantum teleportation, quantum computing, quantum cryptography etc. Advancement in quantum technologies will empower aero-space engineering, simulations, numerical weather prediction, securing the financial transactions, cyber security, health agriculture, education and all other important sectors. Free space quantum communication technique is used to transfer data through the light photons. It provides ultrahigh security communication technique which cant be hacked.

II. Methodology and discussion

This theoretical work presents overview about quantum entanglement which is available in both form natural as well as manmade. An attempt has been done to explore it as a resource for future technologies and defines future of quantum communication based on work done so far in this direction. To carry out study of entanglement, any special crystal is used to generate pair of entangled particles from single entity. Then both entangled particles are sent off to different places where both are studied separately for the same property (i.e. spin) which is studied at the time of their generation. Despite being at different locations, most of the pairs show that properties are correlated to each-other. Similarly entanglement can be studied for more than one particles.

III. Entanglement in nature : Background

Entanglement is natural characteristics of those bodies which had opportunity in past to interact with each other on any way and after some time from interaction they are separated from each other.Here bodies may be living organism or non -living things.

3.1 Entanglement in twins

Twins can also be supposed in position of entangled bodies up to some extent[5].In which few twins are considered to have in strong twin bond and rest twins are said to have in weak twin bond. Generally it is observed that joy and sorrow are felt by the most of the twins simultaneously although they are separated spatially.

3.2 Telepathy

The phenomena in which peoples mind can communicate their thoughts without speaking, writing etcmay be result of the term telepathy. If people have very close relation to each other or have a higher spiritual intelligence, then telepathic communication can occur between them. This type of telepathy between people is the result of entanglement. Our inner soul is the super receiver and transmitter of the special types of information.For example, communication between mother and baby is always happens without any device which is also a result of some kind of entanglement. In other case, Sometimes it is seen that communication between wife and husband is considered as a result of entanglement up to some extent. In these cases, one heart which may be considered as transmitter is generating thought process and these thoughts are realized by other heart which can be considered as receiver. Any other person who is emotionally attached with each other can communicate each other without being in contact. Telepathy between hearts and telepathy between minds both are different. Emotions and thoughts are read by someone else in the telepathy between minds.

Our brain is also considered as super computer having nerves system which can send information through signals and also able to receive the coming signals having some information through the sense organs.

IV. Quantum entanglement

There are several studies which supports entanglement and quantum entanglement for short and long distances in living and non-living things in which account of few studies is given here. In one case entanglement is studied in a biological system and work has been carried out to find out Necessary Conditions for entanglement in multi-chromophoric light harvesting complexes[6]. Temperature dependencies of entanglement is also attempted in this case. Practical utilization of entanglement is discussed in light harvesting complexes.

In another case entanglement studied between living bacteria and photons[7].In which it is concluded that bacterial and light modes show high entanglement.

Two different groups of researcher agreed upon the results obtained when two vibrating aluminium membranes of the drum are used to observe in entangled positions[8].

Entanglement state is studied between macroscopic mechanical and spin systems having spatial separation[9].Generation of entanglement was studied using propagation of light between these two separated systems.

Whether the information communication faster than speed of light is possible or not? This puzzle is unsolved yet.Physicists from various fields are continuously working hard to solve this puzzle through experiments using all possible concepts. Quantum technology and its associated fields of physics provide opportunities to the physicists to think and explore the mysteries of nature. Quantum entanglement is one of the famous phenomenon which has lot of scope in thedirection of solving this puzzle and it may be considered as milestone for achieving information communication faster than speed of light. A great deal of work has been done in this direction which shows that the entangled particles show instant variation. But through means of quantum entanglement the data transmitted from one place can be received in the same form at another place is not possible yet. This requires a proper mechanism to be devised. In absence of proper mechanism, faster than light (FTL) communication is looking at the quantum entanglement phenomenon which is considered as "spooky action at a distance" in words of famous scientist Einstein. Quantum entanglement has a lot to be discovered in near future to strengthen the knowledge and to contribute in the field of information communication.

4.1 Recent studies in quantum entanglement

Detailed discussion about the various aspects of quantum mechanics are given in the book [10].After EPR paradox, Bell inequality was given to explain the principle of locality.Zeilinger used two photons entanglement as well as three photon particles entanglement and found violation of Bell inequality which strengthen the quantum non-locality. Entangled photons and their applications were also discussed by A. Zeilinger[11].

Alain Aspect tested the Bell inequality using fast-switching acoustic-optic modulators and found violation of Bell inequality. Continuing the experimental work related to quantum entanglement, Alain Aspect again established the violation of Bell inequalities [12-13] which is great contribution in the field of quantum information science.

Experiments were carried out by so many other scientists with the entangled photons. They also established violation of Bell inequality. Results of these experiments again strengthen the concept of quantum entanglement and provides direction to work in future on this mission in this area. In near future, energy and storage related issues can be solved using entanglement of photons.

Long distance entanglement is also tested which will be milestone for the future quantum network. In one case,satellite based entanglement has been studied over 1200 kilometer distance[14].Instant information communication sharing between two entangled particles can be achieved easily despite being large distance between them. Information transmission is not established between them yet and information communication faster than speed of light is not achieved yet[15]. But nothing is impossible and physicists are working in this direction.

V. Conclusions

Scope of quantum mechanics is so large that it can't be explored completely. A famous scientist Richard Feynman said that if you think you understand quantum mechanics it means you don't understand quantum mechanics. In light of this, it is considered that information communication faster than speed of light is not possible yet but cant be rejected and should be explored in this directionthrough designing of proper mechanismusing principle of quantum entanglement.

Acknowledgement

The author is thankful to our college president Dr.(Mrs.) E.S.Charles and Principal Dr.(Mrs.) V. Prakash for support and encouragement.

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