Researchers Suggest Quantum Dots as Media for Teleportation

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According to recent research, tiny clusters of atoms known as quantum dots may be excellent media for quantum teleportation, a physics phenomenon in which information – in the form of a quantum state, a very specific mathematical "signature" of an atom – can be transmitted almost instantaneously to a distant location without having to physically travel through space. Teleportation is one facet of quantum information science, a developing field that could have a major impact on computing and communications.

Here, researchers focus on semiconductor quantum dots containing as few as a thousand atoms of a semiconducting element, such as silicon, and having diameters as small as one nanometer. They are often referred to as "artificial atoms" because their behavior can be quite similar to a single atom.

For example, a semiconductor quantum dot's electrons can be confined in a way similar to how a single atom's electrons are bound. Therefore, a quantum dot can be described by a single quantum state, despite consisting of hundreds or thousands of atoms.

Researchers Leong Chuan Kwek and K.W. Choo of Nanyang Technological University in Singapore modeled a teleportation system consisting of two quantum dots. They first investigated how the fidelity of the teleportation process would be affected by quantum "entanglement" – when two or more quantum states have to be described with reference to each other, even when spatially separated.

The model revealed that the entanglement of the dots is proportional to the fidelity: as one increases, the other increases. Kwek and Choo then developed general equations that would yield a suitable magnetic field, dot-to-dot distance, and temperature (which would all depend on the size of the dots and other variables) such that the fidelity of the system would be better than the average fidelity of non-quantum communications.

"Our work provides some preliminary estimates on the way self-assembled quantum dots might be fabricated in terms of inter-dot distances for experiments at room temperature," Kwek told *PhysOrg.com*.

He and Choo also studied how the system would handle "decoherence," the often unavoidable interaction of a quantum system with its environment, which compromises the transfer process. Decoherence is one major issue facing quantum computing. Two decoherence models show, however, that the quantum-dot system could still function under a moderate amount of decoherence.

Finally, the researchers used the model to study a quantum-state transfer or swapping of states between two quantum dots, an ability necessary for quantum information processing. They determined that a "perfect" transfer is possible using a quantum-dot teleportation system, meaning that the transferred quantum state is exactly the same as the initial quantum state of the first dot.

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