Quantum Communication Over Flawed Networks may be Possible

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If successfully implemented, quantum communication could be an extremely secure method of transmitting information – but there are major roadblocks to pass. Recently, physicists suggested a way, at least in theory, to overcome perhaps the biggest of these problems: making quantum communication possible over "real life" networks with serious imperfections, such as leakage, and across distances greater than 10 kilometers.

All of the issues slowing the progress of quantum communication have to do with the foundation of quantum communication, a phenomenon called "quantum entanglement." Quantum entanglement occurs when two quantum-information carriers, such as photons, are aware of each other's existence and know each other's particular quantum state despite never having previously interacted and being physically separate. It is one peculiar effect of the strange, mysterious world of quantum physics.

Currently, photon channels, such as fiber-optic cables, are the only realistic choice for quantum communication. However, creating high-fidelity quantum entanglement between photons at two distant locations becomes exponentially more difficult as the distance between them increases, seriously impeding the real-life implementation of quantum communication. Extending the range to practical distances remains a challenge on many levels.

But, as they discuss in a recent paper in *Physical Review A*, physicists from Nanjing University in China propose a quantum-communications network in which producing entanglement over a long distance is conceptually possible.

The basic network they suggest is made of a sending node and receiving node coupled to a quantum channel (such as a fiber optic cable) that contains an optical circulator, a fiber-optic component that allows signals to simultaneously travel in both directions down a fiber.

Inside the sending and receiving nodes are a quantum dot (typically a very tiny cluster of atoms that behaves as a single atom in the quantum sense) in a microcavity. Each dot can be in one of three quantum states: a ground state, an excited state, and an intermediate state. Each state is a qubit, or quantum bit, the most basic piece of quantum information, like how a “0” or “1” form a bit of computer storage.

These qubits are stationary. The scheme also includes a “flying qubit,” a mobile piece of quantum information, that moves between them.

The flying qubit in this case is a pulse of light with a specific shape. The pulse acts as something like a middle man, initially being entangled with the sending qubit but swapping its entanglement with the receiving qubit, thus leaving the sending and receiving qubits entangled.

This scheme, when its parameters are properly and meticulously tweaked, avoids some of the issues that arise in other methods that have been proposed and, the scientists say, can yield fidelities that are almost perfect.

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