Secure Quantum Key Distribution Network with Bell States and Local Unitary Operations

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Quantum communication (QC) is one of the most important branches of quantum information. It takes advantage of some basic principles in quantum mechanics to accomplish the task of transmitting secret message securely. This novel accomplishment of communication has great power for the development of information field. Since Bennett and Brassard published their first QKD scheme in 1984 (BB84)[1], a great number of theoretic models have been proposed. Experiments have demonstrated the practical of QC and have a significant development. With the development of theoretics and experiment, the multi-user quantum key distribution (MUQKD)[2–4] on a passive optical network become a research hotspot. In this Letter, we introduce an MUQKD scheme with EPR pairs following the ideas in quantum dense coding [5]. In this scheme, the users on the network need only perform single-particle measurement and exploit a decoy photons technique, replacing some of the particles in the original QIC with those whose states are unknown for others, to guarantee its security. The information is encoded on the four local unitary operations which change the original state $|\phi^+\rangle$ into four Bell states, respectively. Decoy photons technique are used to make the efficiency and the capacity of this MUQKD scheme maximum, as the same as those in Ref. [4]. Moreover, it does not require the users to store the quantum states received and only one particle in each EPR pair runs through the quantum channel, which makes this MUQKD scheme more convenient for practical application. Our scheme do a good job in the loop and star topological structure of network.

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