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Opto-electronic Quantum Tele-Communications Based on Spins in Semiconductors

by

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SUMMARY

The transmission of quantum information over long distances will allow new forms of data security, based on quantum cryptography. These new technologies rely for security on the quantum "uncertainty principle" and on the long distance transmission of "quantum entanglement". A new type of tele-communications device called the "quantum repeater" can allow the faithful transmission of quantum information over worldwide distances, in spite of the inevitably severe losses while propagating along optical fibers.

In a quantum repeater, information is stored in the quantum state of a semiconductor electron spin, while complementary entangled information is transmitted as a photon down the optical fiber. This long-range entanglement permits the execution of the teleportation algorithm, which accurately transmits a quantum state over long distances.

The basis for an opto-electronic quantum repeater is an entanglement preserving InP photodetector with special selection rules, in which polarization information from a photon is transferred to spin polarization information of a photo-electron, and vice versa. Nevertheless, the algorithm requires that the photo-electron be transferred to a group IV semiconductor for long time storage since there is rapid loss of quantum information in III-V semiconductors.

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This paper reviews the experimental status of semiconductor quantum repeaters, including the spin resonance transistor logic gates, and the experimental detection of single photons in a manner that preserves their spin information.