Poster Abstract:

An Overview of the Quantum Communication Project at NIST

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The Quantum Communications Project performs fundamental and applied quantum optics research that serves to bridge the gap between fundamental device level physics, such as quantum transduction based on nonlinear optical crystal, and practical communication systems, such as quantum cryptographic networks. The project began early this century and by 2005 had developed NISTs first quantum key distribution (QKD) system with a record-high key generation rate, followed by a QKD network with one Alice and two Bobs in 2006. This award winning high speed QKD network demonstrated a secure transmission of streaming video signals with real time quantum encryption and decryption. More recently, the project has performed research and development in the area of long distance quantum communications such as quantum frequency transduction and quantum repeaters.

Quantum transduction uses non-linear optical crystals to convert the frequency of single photons while preserving their quantum state. Our contributions include the development of upconversion detectors; quantum interfaces; single photon spectroscopy; and tailored SPDC photon pair sources. The upconversion detectors convert telecom photons to the visible and near visible wavelengths and enable telecom wavelength QKD systems for longer distance operation. The quantum interface enables independent quantum elements to be integrated and can enable efficient conversion between flying qubits (photons) and stationary qubits (energy transitions in atoms). Our quantum transduction devices are currently being developed to interface telecom photons with an atomic quantum memory to form a quantum repeater for long distance quantum cryptography.

Quantum repeaters are indispensable modules for connecting distributed quantum systems to form a scalable architecture for an entanglement-based distributed quantum network. During these recent years, the NIST quantum communication project has focused on the development of the required building blocks for the realization of quantum repeaters as follows:

1. Active quantum interface based on PPLN technology: for generating non-degenerate entangled photon pairs, in which one photon is at a telecom wavelength and the other is at a desired atomic transition line with a narrowed linewidth and stabilized frequency.
2. Passive quantum interface based on PPLN technology: for converting existing single photons at the telecom wavelengths to a desired atomic transition line at visible or near visible wavelengths for quantum memory, or vice versa.
3. Photon pair sources based on four-wave mixing (FWM) in silica micro toroid: for generating narrowband photon pairs directly at an atomic transition line, which is required for quantum memory.
4. Photon interference studies: to prepare for Bell state measurements, and quantum teleportation.
5. Quantum memory: the key device to implement quantum repeaters, our research focuses on EIT quantum memory based on warm cells and cold Cesium atomic ensembles.
6. Quantum error correction and post processing algorithms.

Along with an historical review, a detailed overview of all current research efforts for quantum repeaters and quantum cryptographic networks at the NIST Quantum Communications Project will be presented in the poster.