JQI/Maryland Duke Illinois

MURI: Quantum-Optical Circuits of Hybrid Quantum Memories

Michigan UCSD NRL

Objectives:

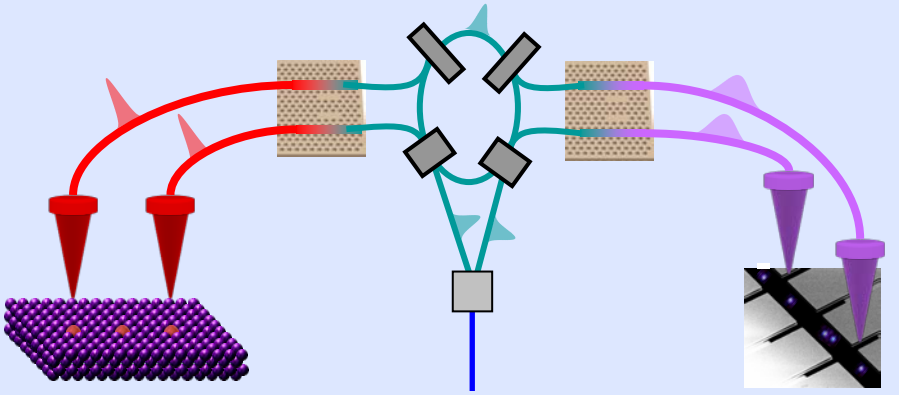
- Investigate hybrid entanglement between disparate quantum systems
- Develop tools and devices for single photon manipulation and interconversion
- Develop theoretical tools, error correction protocols for quantum communication between asymmetric channels

Approach:

- Isolated atomic qubits (trapped atoms and ions) as stable quantum memories
- Quantum dots for fast local quantum processing
- Photons for quantum communication and channel conversion
- Multi-laboratory collaborations

Technical Success:

- Demonstration of entanglement between matter and photons
- Enhanced photon collection from atoms/ions
- Faithful and efficient single photon wavelength and/or mode conversion



Solid-state quantum processor

Integrated optics:
- photonic bandgap materials
- parametric downconversion
- fiber and MEMS switchyards

Atomic quantum memory

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Application / Outcome:

- Project initiated Sept 2009
- Website: **http://qcircuitmuri.jqi.umd.edu/**

Payoff:

- Potential route for large-scale quantum communication/computing

Follow on successes:

- Quantum repeater circuits
- Potential Hybrid quantum processor
- New types of quantum-limited or close proximity sensor technology

Remaining technology gaps:

- Reliable atom and ion trap chips
- Integrated optics with atom/ion trap chips
- Efficient single photon modulators, detectors, and other devices in the ultraviolet