

Final Report for Period: 06/2010 - 05/2011

Submitted on: 07/18/2011

Principal Investigator: Kuzmich, Alex M.

Award ID: 0802076

Organization: Georgia Tech Research Corp

Submitted By:

Kuzmich, Alex - Principal Investigator

Title:

Robust matter-light entanglement generation and distribution

Project Participants

Senior Personnel

Name: Kuzmich, Alex

Worked for more than 160 Hours: Yes

Contribution to Project:

Post-doc

Name: Jenkins, Stewart

Worked for more than 160 Hours: Yes

Contribution to Project:

Graduate Student

Name: Lan, Shau-Yu

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Dudin, Yaroslav

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Radnaev, Alexander

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Zhao, Ran

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Campbell, Corey

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Li, Lin

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Anquez, Martin

Worked for more than 160 Hours: Yes

Contribution to Project:

Undergraduate Student**Name:** Naylor, David**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Marchenkova, Anastasia**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Blumoff, Jacob**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Agha, Amin**Worked for more than 160 Hours:** Yes**Contribution to Project:****Technician, Programmer****Other Participant****Research Experience for Undergraduates****Organizational Partners****Other Collaborators or Contacts**

We collaborate with Professor Brian Kennedy and his group.

Activities and Findings**Research and Education Activities:**

We have worked on advancing the state of the art in quantum information processing with cold trapped neutral atoms.

Findings:

We have:

- 1) Increased quantum memory time by more than two orders of magnitude, in excess of 6 milliseconds.
- 2) We have implemented multiplexing of a dozen memory elements into a cold atomic sample.
- 3) We have increased the memory time for atom-light entanglement to over 3 milliseconds.
- 4) We have performed continuous observation of the matter-light system.
- 5) We have proposed two-photon laser compensation of Stark hyperfine broadening. Experimental implementation of this scheme resulted in

quantum memory times in excess of 0.1 second.

6) We have investigated magnetic compensation of Stark hyperfine shifts. Using this method, we observed storage of coherent light for longer than 0.32 second, and storage of spin-wave qubit for longer than 0.1 second.

7) We have realized low-noise, high-efficiency wavelength conversion between telecom and near-infrared light. By doing so, we realized entanglement of long-lived memories and telecom light.

Training and Development:

Graduate and undergraduate students have been trained.

Outreach Activities:

1) Group members have delivered talks and poster presentations at Universities and conferences.

2) The PI organized the graduate student symposium at DAMOP-2011 in Atlanta, GA.

3) The PI took part in organizing the undergraduate student symposium at DAMOP-2011.

4) The PI took part in organizing the high-school teachers day at DAMOP-2011.

Journal Publications

Lan, SY; Radnaev, AG; Collins, OA; Matsukevich, DN; Kennedy, TAB; Kuzmich, A, "A Multiplexed Quantum Memory", OPTICS EXPRESS, p. 13639, vol. 17, (2009). Published,

Dudin, YO; Jenkins, SD; Zhao, R; Matsukevich, DN; Kuzmich, A; Kennedy, TAB, "Entanglement of a Photon and an Optical Lattice Spin Wave", PHYSICAL REVIEW LETTERS, p. , vol. 103, (2009). Published, 10.1103/PhysRevLett.103.02050

Campbell, CJ; Steele, AV; Churchill, LR; DePalatis, MV; Naylor, DE; Matsukevich, DN; Kuzmich, A; Chapman, MS, "Multiply Charged Thorium Crystals for Nuclear Laser Spectroscopy", PHYSICAL REVIEW LETTERS, p. , vol. 102, (2009). Published, 10.1103/PhysRevLett.102.23300

Zhao, R; Dudin, YO; Jenkins, SD; Campbell, CJ; Matsukevich, DN; Kennedy, TAB; Kuzmich, A, "Long-lived quantum memory", NATURE PHYSICS, p. 100, vol. 5, (2009). Published, 10.1038/NPHYS115

Dudin, YO; Radnaev, AG; Zhao, R; Blumoff, JZ; Kennedy, TAB; Kuzmich, A, "Entanglement of Light-Shift Compensated Atomic Spin Waves with Telecom Light", PHYSICAL REVIEW LETTERS, p. , vol. 105, (2010). Published, 10.1103/PhysRevLett.105.26050

Dudin, YO; Zhao, R; Kennedy, TAB; Kuzmich, A, "Light storage in a magnetically dressed optical lattice", PHYSICAL REVIEW A, p. , vol. 81, (2010). Published, 10.1103/PhysRevA.81.04180

Radnaev, AG; Dudin, YO; Zhao, R; Jen, HH; Jenkins, SD; Kuzmich, A; Kennedy, TAB, "A quantum memory with telecom-wavelength conversion", NATURE PHYSICS, p. 894, vol. 6, (2010). Published, 10.1038/NPHYS177

Zhao, R; Jenkins, SD; Campbell, CJ; Matsukevich, DN; Chaneliere, T; Kennedy, TAB; Kuzmich, A, "Continuous quantum measurement of a light-matter system", PHYSICAL REVIEW A, p. , vol. 81, (2010). Published, 10.1103/PhysRevA.81.03180

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

We have improved the state of the art in quantum memory.

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Graduate and undergraduate students have been trained.

Contributions to Resources for Research and Education:

The results of the project have been incorporated into Advanced Laboratory course for undergraduates at Georgia Tech.

Contributions Beyond Science and Engineering:

Conference Proceedings

Categories for which nothing is reported:

Organizational Partners

Any Book

Any Web/Internet Site

Any Product

Contributions: To Any Other Disciplines

Contributions: To Any Beyond Science and Engineering

Any Conference