Final Report for Period: 07/2009 - 06/2010
Submitted on: 07/11/2010
Principal Investigator: Kuzmich, Alex M.
Award ID: 0703030
Organization: GA Tech Res Corp - GIT
Submitted By:
Kuzmich, Alex - Principal Investigator
Title:
Telecommunication wavelength quantum repeater

Project Participants

Senior Personnel

Name: Kuzmich, Alex
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kennedy, T.A. Brian
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Chapman, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Jenkins, Stewart
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Radnaev, Alexander
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Dudin, Yaroslav
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Kim, Soo
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Gibbons, Michael
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Jen, Richard
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Collins, Odell
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: Lan, Shau-Yu
Worked for more than 160 Hours: Yes
Contribution to Project:

Undergraduate Student

Name: Naylor, David
Worked for more than 160 Hours: No
Contribution to Project:

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities:

Major activity is in a developing elements of a quantum repeater that is capable to function over telecommunication fiber networks. Our approach utilizes cold samples of rubidium atoms confined in optical dipole traps. We are using acousto-optical scanning of a cold sample to independently address a large number of memory elements.

Findings:

1) We have achieved long (300 seconds) lifetime of atoms trapped in optical lattices. We have explored limitation to the lifetime due to heating arising from laser frequency and amplitude noise.
2) We have loaded optically thick samples of cold atoms into a YAG-laser based optical dipole trap. We have created single spin excitations in this cold sample and observed memory times longer than in free-falling samples.
3) We have been able to create independent elements of a quantum memory array in a rubidium sample (up to 12), and realized matter-light

entanglement using an arbitrary pair of the elements as the matter qubit.
4) We have achieved long (>6 ms) quantum memory lifetimes and used these to realize a high-quality source of deterministic single photons.

Training and Development:
Graduate and undergraduate students are being trained in modern AMO and electronics techniques.

Outreach Activities:
1) Organized a visit, with demonstrations, to the School of Physics for a pre-K class.
2)Organized laboratory visits and demonstrations for elementary school classes.

Journal Publications

Gibbons, MJ; Kim, SY; Fortier, KM; Ahmadi, P; Chapman, MS, "Achieving very long lifetimes in optical lattices with pulsed cooling", PHYSICAL REVIEW A, p. , vol. 78, (2008). Published, 10.1103/PhysRevA.78.04341

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

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; 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

Books or Other One-time Publications

S.-Y. Lan, R. Zhao, D. Jenkins, O. A. Collins, Y. O. Dudin, A. G. Radnaev, C. J. Campbell, D. N. Matsukevich, T. A. B. Kennedy and A. Kuzmich
, ""Atomic Ensemble Quantum Memories," S.-Y. Lan, R. Zhao, S. Proceedings of the XXI International Conference on Atomic Physics (2008)", (2009). Book, Published
Editor(s): R. Cote, P. L. Gould, M. Rozman, and W. W. Smith
Collection: Proceedings of the XXI International Conference on Atomic Physics (2009)
Bibliography: pp. 88-97

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:
the work supported by this grant provides a foundation for long-distance quantum networks over optical fibers.

Contributions to Other Disciplines:

Contributions to Human Resource Development:
Graduate and undergraduate students have been trained in AMO science.
Two Ph. D. dissertation have been defended based on work supported by this grant:
1) Shau-Yu Lan, 'Matter-Light entanglement with cold atomic ensembles', 2008,advisor- A. Kuzmich. Current Position: Postdoctoral fellow,

University of California at Berkeley.
2) Soo Yeon Kim, 'Cold Single Atoms for Cavity QED Experiments'
Advisor: Michael Chapman
Current Position: Process Technology Development Engineer,
Intel Corporation, Oregon

Contributions to Resources for Research and Education:

Resources from this research program have been used in two undergraduate laboratory courses: Optics (M. Chapman) and Advanced Lab (A.Kuzmich).

Contributions Beyond Science and Engineering:

Conference Proceedings

Categories for which nothing is reported:

Organizational Partners

Any Web/Internet Site

Any Product

Contributions: To Any Other Disciplines

Contributions: To Any Beyond Science and Engineering

Any Conference