

REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

Public Reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comment regarding this burden estimates or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188,) Washington, DC 20503.

1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE 10/29/02	3. REPORT TYPE AND DATES COVERED Final Technical Report 07/01/00--06/30/02	
4. TITLE AND SUBTITLE Manipulating Optically Dark States for Quantum Logic			5. FUNDING NUMBERS DAAD19-00-1-0380 (G)	
6. AUTHOR(S) K. Birgitta Whaley				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of California, Berkeley Department of Chemistry, 406 Latimer Hall #1460 Berkeley, CA 94720-1460			8. PERFORMING ORGANIZATION REPORT NUMBER P-41224-PH-QC	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U. S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.				
12 a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.			12 b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) We have investigated the use of optically dark states for quantum information processing. We have developed a systematic theoretical approach relating atomic dark states to decoherence-free subspaces and have shown that single qubit manipulations on such dark states are possible to realize with realistic pulse times. We have found a multi-atom dark state in N-atom/cavity systems that can be used to develop an adiabatic ramping scheme to produce N-photon states on demand.				
14. SUBJECT TERMS dark states decoherence-free subspaces atom-cavity systems optical lattices			15. NUMBER OF PAGES 2	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OR REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION ON THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL	

NSN 7540-01-280-5500

Standard Form 298 (Rev.2-89)
Prescribed by ANSI Std. Z39-18
298-102

REPORT DOCUMENTATION PAGE (SF298)
(Continuation Sheet)

Final Progress Report

Statement of Problem Studied

The aim of this project was to develop theoretical methods to take advantage of optically dark atomic states for quantum information processing. One focus was on establishing the relationship between such atomic dark states and decoherence-free subspaces, and providing a systematic route to the former. Another focus was on developing ways to manipulate such dark states for quantum logic and related processing. The third focus was to develop a quantum wave function approach for simulation of coupled qubits.

Summary of Significant Results

1. Establishment of a systematic theory for atomic dark states in terms of decoherence-free subspace theory. This allows a simple and systematic approach to determine the existence of, to search for, and to identify dark states in atomic systems.
2. Development of procedure for one-qubit operations on atomic dark states within finite time pulses.
3. Identification of new N-atom dark states that can be manipulated by adiabatic ramping schemes to allow deterministic production of N-photon Fock states from an N-atom/cavity system.
4. Development of efficient quantum wave function approach for simulation of coupled qubit arrays and implementation in algorithmic fidelity study of 9 coupled qubits with a 3-qubit encoding.

List of Publications

D. M. Bacon, Ph.D. Thesis, University of California, Berkeley, (2001)
"Decoherence, Control and Symmetry in Quantum Computers"

D. M. Bacon and K. B. Whaley, "Qubit operations on atomic dark states," manuscript in preparation

K. Brown, K. Dani, D. M. Stamper-Kurn, and K. B. Whaley, "Deterministic Fock State Generation," to be submitted to *Physical Review B*

S. Myrgren and K. B. Whaley, "Implementing a quantum algorithm with exchange-coupled quantum dots: A feasibility study," manuscript in preparation

List of Participating Scientific Personnel and Degrees Earned

K. Birgitta Whaley, Professor
David Bacon, graduate student (Ph.D. 2001)
Simon Myrgren, graduate student
Keshav Dani, graduate student
Kenneth Brown, graduate student
Dan M. Stamper-Kurn, Professor

Report of Inventions

N/A

MASTER COPY: PLEASE KEEP THIS "MEMORANDUM OF TRANSMITTAL" BLANK FOR REPRODUCTION PURPOSES. WHEN REPORTS ARE GENERATED UNDER THE ARO SPONSORSHIP, FORWARD A COMPLETED COPY OF THIS FORM WITH EACH REPORT SHIPMENT TO THE ARO. THIS WILL ASSURE PROPER IDENTIFICATION. NOT TO BE USED FOR INTERIM PROGRESS REPORTS; SEE PAGE 2 FOR INTERIM PROGRESS REPORT INSTRUCTIONS.

MEMORANDUM OF TRANSMITTAL

U.S. Army Research Office
ATTN: AMSRL-RO-BI (TR)
P.O. Box 12211
Research Triangle Park, NC 27709-2211

- | | |
|--|---|
| <input type="checkbox"/> Reprint (Orig + 2 copies) | <input type="checkbox"/> Technical Report (Orig + 2 copies) |
| <input type="checkbox"/> Manuscript (1 copy) | <input checked="" type="checkbox"/> Final Progress Report (Orig + 2 copies) |
| | <input type="checkbox"/> Related Materials, Abstracts, Theses (1 copy) |

CONTRACT/GRANT NUMBER: **DAAD19-00-1-0380 (G)**

REPORT TITLE: **Final Technical Report 07/01/00--06/30/02
Manipulating Optically Dark States for Quantum Logic**

is forwarded for your information.

SUBMITTED FOR PUBLICATION TO (applicable only if report is manuscript):

N/A

Sincerely,

Bigitta Wkeleg