

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 comments regarding this burden estimate 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 4/30/99	3. REPORT TYPE AND DATES COVERED Annual Technical 1/1/98 - 12/31/98	
4. TITLE AND SUBTITLE Quantum Chaos in Rydberg Atoms		5. FUNDING NUMBERS N00014-96-1-0484	
6. AUTHOR(S) Prof. Daniel Kleppner		8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Research Laboratory of Electronics Massachusetts Institute of Technology 77 Massachusetts Avenue Cambridge, MA 02139			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research Ballston Centre Tower One 800 North Quincy Street Arlington, VA 22217-5660		10. SPONSORING/MONITORING AGENCY REPORT NUMBER 96PRO271300	
11. SUPPLEMENTARY NOTES The view, 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.			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited.		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) We have carried out a study of physics in the semiclassical regime. Recently we extended the technique of recurrence spectroscopy to the time domain. This work has been published in "Extracting classical trajectories from atomic spectra," M.R. Haggerty, and J.B. Delos, Neal Spelmeyer and Daniel Kleppner, Phys. Rev. Lett. 81, 1592-1595 (1998).			
14. SUBJECT TERMS			15. NUMBER OF PAGES
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL

The **RESEARCH LABORATORY of ELECTRONICS**
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
77 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS 02139-4307

March 30, 1999

Dr. Peter J. Reynolds, ONR 331
Program Officer
Office of Naval Research
Ballston Center Tower One
800 North Quincy Street
Arlington, VA 22217-5660

In accordance with the terms of the Office of Naval Research Grant No. N00014-96-1-0484, I am sending you the following material:

Type of Material: Annual Technical Report
Title: Quantum Chaos in Rydberg Atoms
Submitted by: Professor Daniel Kleppner
Period Covered: January 1, 1998 - December 31, 1998
Number of Copies: Three plus form 298
Distribution: Navy Distribution List (3)

Thank you. Please contact me if you have any questions or comments.

Mary S. Greene
RLE Financial Assistant, Room 36-437

cc: Prof. Kleppner (1)
ACO, Boston, MA
A.F. Favaloro, E19-702
File (1)

OSP 64341

Enclosures

19990506 036

GRANT NO N00014-96-1-0484
QUANTUM CHAOS IN RYDBERG ATOMS
January 1, 1998- December 31, 1998
Daniel Kleppner, Principal Investigator

ANNUAL TECHNICAL REPORT

We have carried out a study of physics in the semiclassical regime. Recently we extended the technique of recurrence spectroscopy to the time domain. This work has been published in

"Extracting classical trajectories from atomic spectra," M.R. Haggerty, and J.B. Delos, Neal Spellmeyer and Daniel Kleppner, Phys. Rev. Lett. **81**, 1592-1595 (1998).

In a separate experiment we investigated extending the semiclassical closed orbit theory to a process whose origin is entirely quantum mechanical: tunneling. We studied the continuum photoexcitation spectrum of Rydberg states of lithium in an electric field under conditions for which the escaping electron must tunnel through the potential barrier, and also for which it could escape over the barrier. We applied scaled energy spectroscopy to the system, making it possible to relate the spectrum to the classical orbits. When tunneling is important, new classical orbits can originate by an entirely non-classical process. It has turned out to be possible to understand the system theoretically and reproduce the spectrum in great detail, including both sharp tunneling resonances and broad above-barrier structures. The work is being prepared for publication in the paper

"Recurrence Spectroscopy of Above-Barrier States," Vladimir Kondratovicheh, John. B. Delos, Neal Spellmeyer and Daniel Kleppner, to be published.

ATTACHMENT NUMBER 1

REPORTS AND REPORT DISTRIBUTION

REPORT TYPES

- (a) Performance (Technical) Report(s) (Include letter report(s)) Frequency: Annual
- (b) Final Technical Report, issued at completion of Grant.
NOTE: Technical Reports must have a SF-298 accompanying them.
- (c) Final Financial Status Report (SF 269)
- (d) Final Patent Report (DD 882)

REPORTS DISTRIBUTION		
ADDRESSEES	REPORT TYPES	NUMBER OF COPIES
Office of Naval Research Program Officer Peter J. Reynolds ONR 331 Ballston Centre Tower One 800 North Quincy Street Arlington, VA 22217-5660	(a) & (b) w/(SF-298's)	3
Administrative Grants Officer OFFICE OF NAVAL RESEARCH REGIONAL OFFICE BOSTON 495 SUMMER STREET ROOM 103 BOSTON, MA 02210-2109	(c), (d) & SF-298's only for (a) & (b)	1
Director, Naval Research Laboratory Attn: Code 2627 4555 Overlook Drive Washington, DC 20375-5326	(a) & (b) w/(SF-298's)	1
Defense Technical Information Center 8725 John J. Kingman Road STE 0944 Ft. Belvoir, VA 22060-6218	(a) & (b) w/(SF-298's)	2
Office of Naval Research Attn: ONR 00CC1 Ballston Centre Tower One 800 North Quincy Street Arlington, VA 22217-5660	(d)	1

If the Program Officer directs, the Grantee shall make additional distribution of technical reports in accordance with a supplemental distribution list provided by the Program Officer. The supplemental distribution list shall not exceed 250 addresses.