



ULTRACOLD POLAR MOLECULES: NEW PHASES OF MATTER FOR QUANTUM INFORMATION AND QUANTUM CONTROL

**Paul Julienne
MARYLAND UNIV COLLEGE PARK**

**06/04/2019
Final Report**

DISTRIBUTION A: Distribution approved for public release.

**Air Force Research Laboratory
AF Office Of Scientific Research (AFOSR)/ RTB1
Arlington, Virginia 22203
Air Force Materiel Command**

DISTRIBUTION A: Distribution approved for public release.

REPORT DOCUMENTATION PAGE			<i>Form Approved</i> OMB No. 0704-0188		
<p>The 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 the burden, to Department of Defense, Executive Services, Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p> <p>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.</p>					
1. REPORT DATE (DD-MM-YYYY) 04-06-2019		2. REPORT TYPE Final Performance		3. DATES COVERED (From - To) 15 Jul 2009 to 14 Jul 2015	
4. TITLE AND SUBTITLE ULTRACOLD POLAR MOLECULES: NEW PHASES OF MATTER FOR QUANTUM INFORMATION AND QUANTUM CONTROL			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER FA9550-09-1-0617		
			5c. PROGRAM ELEMENT NUMBER 61102F		
6. AUTHOR(S) Paul Julienne			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) MARYLAND UNIV COLLEGE PARK 3112 LEE BLDG COLLEGE PARK, MD 20742 - 5100 US				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AF Office of Scientific Research 875 N. Randolph St. Room 3112 Arlington, VA 22203				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL/AFOSR RTB1	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-AFOSR-VA-TR-2019-0148	
12. DISTRIBUTION/AVAILABILITY STATEMENT A DISTRIBUTION UNLIMITED: PB Public Release					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The research project for this grant under the MURI program aimed to understand and exploit the formation, collisions and ultracold chemistry, and the electric, magnetic and electromagnetic field control of weakly and strongly bound states of ultracold molecules and to use the novel control features of these systems to produce and characterize new phases of quantum matter and to find ways of realizing scalable quantum logic and computation with ultracold molecules. Effective exploitation of the new scientific and technological opportunities with ultracold molecules requires an integration of experimental and theoretical efforts involving atomic and molecular physics, few-body physics, the condensed matter physics of quantum degenerate atomic and dipolar molecular gases, quantum chemistry, and quantum information science.					
15. SUBJECT TERMS QUANTUM, CONTROL					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON METCALFE, GRACE
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) 703-696-9740



DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)

May 10, 2019

MEMORANDUM FOR RECORD

TO: Director, AFOSR/RT
FROM: AFOSR/RTB1
SUBJECT: Missing Final Technical Report for FA9550-09-1-0617

1. No Final Technical Report has been obtain for grant number FA9550-09-1-0617. I have attempted on multiple occasions (emails on 3/6/19 and 4/12/19) to reach the Principal Investigator and his/her organization to obtain the Final Technical Report but was unsuccessful. This grant ended 7/14/15, well before I arrived at AFOSR in 2017, and was recently transferred to me from the previous program officer Dr. Tatjana Curcic.
2. The research project for this grant under the MURI program aimed to understand and exploit the formation, collisions and ultracold chemistry, and the electric, magnetic and electromagnetic field control of weakly and strongly bound states of ultracold molecules and to use the novel control features of these systems to produce and characterize new phases of quantum matter and to find ways of realizing scalable quantum logic and computation with ultracold molecules. Effective exploitation of the new scientific and technological opportunities with ultracold molecules requires an integration of experimental and theoretical efforts involving atomic and molecular physics, few-body physics, the condensed matter physics of quantum degenerate atomic and dipolar molecular gases, quantum chemistry, and quantum information science.
3. My contact details are DSN 314-235-9740 or grace.metcalfe@us.af.mil

METCALFE.G
RACE.D.1284
546250

Digitally signed by
METCALFE.GRACE.D.1
284546250
Date: 2019.05.17
11:46:51 -04'00'

GRACE METCALFE, PHD
Program Manager, Atomic and Molecular Physics

cc: AFRL STINFO

MEMORANDUM FOR AFRL/AFOSR

I approved the waiver for technical reports for this particular grant to DTIC as the afore-signed program manager has demonstrated due diligence in his/her attempt in obtain the required deliverable documents. This is in accordance with AFRLI 61-201 dated 9 February 2016 and AFRL guidance regarding unobtainable deliverables.

PARRA.ENRIQU  Digitally signed by
PARRA.ENRIQUE.N.1385154778

E.N.1385154778  Date: 2019.05.17 15:28:07

Enrique Parra, PhD
Acting Director, AFOSR/RT