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GORDON RESEARCH CONFERENCES *frontiers of science*
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Nancy Ryan Gray, Ph.D.
Director

**2011 GORDON RESEARCH CONFERENCE
on QUANTUM CONTROL OF LIGHT & MATTER**

FINAL PROGRESS REPORT

DEPARTMENT OF ENERGY
GRANT NO. DE-SC0006541

The Gordon Research Conference on QUANTUM CONTROL OF LIGHT & MATTER was held at Mount Holyoke College, South Hadley, Massachusetts, July 31 – August 5, 2011. The Conference was well-attended with 119 participants (attendees list attached). The attendees represented the spectrum of endeavor in this field coming from academia, industry, and government laboratories, both U.S. and foreign scientists, senior researchers, young investigators, and students. Of the 119 attendees, 42 voluntarily responded to a general inquiry regarding ethnicity which appears on our registration forms. Of the 42 respondents, 19% were Minorities – 5% Hispanic, 14% Asian and 0% African American. Approximately 14% of the participants at the 2011 meeting were women.

In designing the formal speakers program, emphasis was placed on current unpublished research and discussion of the future target areas in this field. There was a conscious effort to stimulate lively discussion about the key issues in the field today. Time for formal presentations was limited in the interest of group discussions. In order that more scientists could communicate their most recent results, poster presentation time was scheduled. Attached is a copy of the formal schedule and speaker program and the poster program. In addition to these formal interactions, "free time" was scheduled to allow informal discussions. Such discussions are fostering new collaborations and joint efforts in the field.

Thank you for your support of this Conference. As you know, in the interest of promoting the presentation of unpublished and frontier-breaking research, Gordon Research Conferences does not permit publication of meeting proceedings. If you wish any further details, please feel free to contact me. Thank you.

Sincerely,
Ronald Kosloff, Conference Chairperson
HEBREW UNIVERSITY JERUSALEM

Quantum Control of Light & Matter
July 31 - August 5, 2011
Mount Holyoke College
South Hadley, MA

Chairs: **Ronald B. Kosloff & Gustav G. Gerber**

Vice Chairs: **Thomas C. Weinacht & Misha Ivanov**

Quantum control of light and matter is the quest to steer a physical process to a desirable outcome, employing constructive and destructive interference. Three basic questions address feasibility of quantum control:

- The problem of controllability, does a control field exist for a preset initial and target state?
- Synthesis, constructively finding the field that leads to the target.
- Optimal Control Theory: optimizing the field that carries out this task.

These continue to be the fundamental theoretical questions to be addressed in the conference. How to realize control fields in the laboratory is an ongoing challenge. This task is very diverse viewing the emergence of control scenarios ranging from attoseconds to microseconds. How do the experimental observations reflect on the theoretical framework? The typical arena of quantum control is an open environment where much of the control is indirect. How are control scenarios realized in dissipative open systems? Can new control opportunities emerge? Can one null decoherence effects? An ideal setting for control is ultracold matter. The initial and final state can be defined more precisely. Coherent control unifies many fields of physical science. A lesson learned in one field can reflect on another. Currently quantum information processing has emerged as a primary target of control where the key issue is controlling quantum gate operation. Modern nonlinear spectroscopy has emerged as another primary field. The challenge is to unravel the dynamics of molecular systems undergoing strong interactions with the environment. Quantum optics where non-classical fields are to be generated and employed. Finally, coherent control is the basis for quantum engineering. These issues will be under the limelight of the Gordon conference on Quantum Control of Light and Matter.

SUNDAY

2:00 pm - 9:00 pm Arrival and Check-in ([Office Closed 6:00 pm - 7:00 pm](#))

6:00 pm Dinner

7:30 pm - 7:40 pm Welcome / Introductory Comments by GRC Site Staff

ULTRACOLD CONTROL

Discussion Leader: **Matthias Weidemüller** (Universitaet Heidelberg)

7:40 pm - 8:00 pm **Jun Ye** (JILA / NIST and University of Colorado)

"Precision Quantum Metrology - Probing and Controlling Ultracold Matter with Novel Light Source"

8:40 pm - 8:50 pm Discussion

8:50 pm - 9:20 pm **Phillip Gould** (University of Connecticut)
"Coherent Control of Ultracold Collisions and Ultracold Molecular Formation"

9:20 pm - 9:30 pm Discussion

MONDAY

7:30 am - 8:30 am Breakfast

8:45 am Group Photo

CONTROLABILITY

9:00 am - 9:20 am Discussion Leader: **Paul Brumer** (University of Toronto)

9:20 am - 9:50 am **Hideo Mabuchi** (Stanford University)
"Principles and Applications of Coherent-Feedback Quantum Control"

9:50 am - 10:00 am Discussion

10:00 am - 10:30 am Coffee Break

10:30 am - 11:00 am **Niels Chr. Nielsen** (University of Aarhus)
"Optimal Control Applied to Design of NMR and MRI Experiments"

11:00 am - 11:10 am Discussion

11:10 am - 11:40 am **Ugo Boscain** (CNRS Palaiseau)
"Controllability of the Bilinear Schrödinger Equation"

11:40 am - 11:50 am Discussion

11:50 am - 12:20 pm **Dominique Sugny** (Lab Interdisciplinaire Carnot de Bourgogne)
"Optimal Control in Nuclear Magnetic Resonance: Theoretical Developments and Applications"

12:20 pm - 12:30 pm Discussion

12:30 pm Lunch

1:30 pm - 4:00 pm Free Time

4:00 pm - 6:00 pm Poster Session

6:00 pm Dinner

PHOTONS

7:30 pm - 7:50 pm Discussion Leader: **Mikhail D. Lukin** (Harvard University)
"Quantum control of atom-like systems in solid state"

7:50 pm - 8:30 pm **Yaron Silberberg** (Weizmann Institute of Science, Rehovot)
"Short pulses in scattering media: Shaping by temporal speckles"

8:30 pm - 8:40 pm Discussion

8:40 pm - 9:20 pm **Moshe Shapiro** (Weizmann Institute of Science, Rehovot)
"Use of Quantum Light to Control Material Processes and Entanglements"

9:20 pm - 9:30 pm Discussion

TUESDAY

7:30 am - 8:30 am Breakfast

9:00 am - 12:30 pm	COHERENT CONTROL
9:00 am - 9:20 am	Discussion Leader: Kenji Ohmori (Institute for Molecular Science, Okazaki) "Coherent Control; Present and Future"
9:20 am - 9:50 am	Beatrice Chatel (CNRS-University of Toulouse) "Robust Quantum Dot State Preparation via Adiabatic Passage With Chirped Ultrashort Pulses"
9:50 am - 10:00 am	Discussion
10:00 am - 10:30 am	Coffee Break
10:30 am - 11:00 am	Robert J. Levis (Temple University, Philadelphia) "The Consequence of Phase for Control"
11:00 am - 11:10 am	Discussion
11:10 am - 11:40 am	Nadav Katz (Jerusalem) "Controlling the superconducting qudit"
11:40 am - 11:50 am	Discussion
11:50 am - 12:20 pm	Aephraim M. Steinberg (University of Toronto) "Identifying and managing decoherence and loss, from photons to optical lattices"
12:20 pm - 12:30 pm	Discussion
12:30 pm	Lunch
1:30 pm - 4:00 pm	Free Time
4:00 pm - 6:00 pm	<u>Poster Session</u>
6:00 pm	Dinner
7:30 pm - 9:30 pm	CONTROL OF ATOMS AND MOLECULES
7:30 pm - 7:50 pm	Discussion Leader: Marcus Motzkus (Universitat Heidelberg) "Treating Complex Quantum Systems with Shaped Laser Pulses"
7:50 pm - 8:30 pm	Th. Baumert (University of Kassel) "Ultrafast Laser Control of Ionization on Prototypes and Corresponding Perspectives"
8:30 pm - 8:40 pm	Discussion
8:40 pm - 9:20 pm	David Tannor (Weizmann Institute, Rehovot) "Quantum Control of Chemical Reactions and Multi-electron Dynamics"
9:20 pm - 9:30 pm	Discussion
WEDNESDAY	
7:30 am - 8:30 am	Breakfast
9:00 am - 12:30 pm	ATOSECONDS
9:00 am - 9:20 am	Discussion Leader: Philip Bucksbaum (Stanford Linear Accelerator Center)
9:20 am - 9:50 am	Paul Corkum (NRC, Canada)

		"Coherent control in high harmonic and attosecond Pulse generation"
9:50 am - 10:00 am	Discussion	
10:00 am - 10:30 am	Coffee Break	
10:30 am - 11:00 am	Lorenz Cederbaum (University of Heidelberg)	"Intermolecular Coulombic Delay and Ultrafast Energy Transfer"
11:00 am - 11:10 am	Discussion	
11:10 am - 11:40 am	Henry C. Kapteyn (University of Colorado)	"Coherent control in the VUV/EUV, and Attosecond science for x-ray generation"
11:40 am - 11:50 am	Discussion	
11:50 am - 12:20 pm	Yuki Yoshi Ohtsuki (Tohoku University, Sendai)	"Application of Nonresonant Optimal Control Simulation to Molecular Alignment / Orientation"
12:20 pm - 12:30 pm	Discussion	
12:30 pm	Lunch	
1:30 pm - 6:00 pm	Free Time	
6:00 pm	Dinner	
7:00 pm - 7:30 pm	<u>Business Meeting</u>	<i>Nominations for the next Vice Chair; Fill out Conference Evaluation Forms; Discuss future Site & Scheduling preferences; Election of the next Vice Chair</i>
7:30 pm - 9:30 pm	STRONG FIELD CONTROL	
7:30 pm - 7:50 pm	Discussion Leader: Herschel Rabitz (Princeton University)	"A Perspective on the Quantum Control Road Ahead"
7:50 pm - 8:30 pm	Albert Stolow (National Research Council, Ottawa)	"Molecules in intermediate to strong laser fields"
8:30 pm - 8:40 pm	Discussion	
8:40 pm - 9:20 pm	Louis F. DiMauro (Ohio State University)	"Scaling of Intense Laser-Atom Interactions"
9:20 pm - 9:30 pm	Discussion	
THURSDAY		
7:30 am - 8:30 am	Breakfast	
9:00 am - 12:30 pm	CONTROL OF COMPLEX SYSTEMS	
9:00 am - 9:20 am	Discussion Leader: Sanford Ruhman (Hebrew University, Jerusalem)	
9:30 am - 10:00 am	Chris Middleton (University of Wisconsin)	"Using mid-IR Pulse Shaping and Quantum Control to Optimize 2D IR Spectroscopy"
10:00 am - 10:30 am	Coffee Break	
10:30 am - 11:00 am	Jennifer Herek (University of Twente, The Netherlands)	

"Optimal Control CARS Spectroscopy and Imaging"

11:00 am - 11:10 am	Discussion
11:10 am - 11:40 am	Peter Hommelhoff (Garching) "Light-Field Control of Electrons Emitted from a Nanometric Metal Tip"
11:40 am - 11:50 am	Discussion
11:50 am - 12:20 pm	Vinod Kumarappan (Kansas State University) "Laser-induced alignment of asymmetric top molecules"
12:20 pm - 12:30 pm	Discussion
12:30 pm	Lunch
1:30 pm - 4:00 pm	Free Time
4:00 pm - 6:00 pm	<u>Poster Session</u>
6:00 pm	Dinner
7:30 pm - 9:30 pm	CONTROL AND QUANTUM INFORMATION
7:30 pm - 7:50 pm	Discussion Leader: Lorenza Viola (Dartmouth College, New Hampshire)
7:50 pm - 8:30 pm	Birgitta Whaley (UCAL, Berkeley) "Quantum Control of Light Harvesting"
8:30 pm - 8:40 pm	Discussion
8:40 pm - 9:20 pm	Joshua Combes (Dept of Physics & Astron., University of New Mexico) "Extracting information from quantum systems using Measurement and feedback control"
9:20 pm - 9:30 pm	Discussion

FRIDAY

7:30 am - 8:30 am	Breakfast
9:00 am	Departure

Quantum Control of Light & Matter (2011)

Name	Organization	Participation	Status
ALLISON, THOMAS K	JILA, NIST AND THE U. OF COLORADO AT BOULDER	Poster Presenter	Registered
AM-SHALLEM, MORAG	THE HEBREW UNIVERSITY OF JERUSALEM	Poster Presenter	Registered
AMANKONA-DIAWOU, FELIX K	NORTHWESTERN UNIVERSITY	Poster Presenter	Registered
AMARAN, SAIESWARI	HEBREW UNIVERSITY	Poster Presenter	Registered
AMITAY, ZOHAR	TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY	Poster Presenter	Registered
AVISAR, DAVID	WEIZMANN INSTITUTE OF SCIENCE	Poster Presenter	Registered
BAUMERT, THOMAS G	UNIVERSITY OF KASSEL	Speaker	Registered
BOSCAIN, UGO	CMAP, ECOLE POLYTECHNIQUE CNRS	Speaker	Registered
BRAUN, HENDRIKE	UNIVERSITÄT KASSEL	Poster Presenter	Registered
BRIF, CONSTANTIN	SANDIA NATIONAL LABORATORIES	Poster Presenter	Registered
BRINKS, DAAN	ICFO - INSTITUTE OF PHOTONIC SCIENCES	Poster Presenter	Registered
BRIXNER, TOBIAS	UNIVERSITY OF WUERZBURG	Poster Presenter	Registered
BRUMER, PAUL W	UNIVERSITY OF TORONTO	Discussion Leader	Registered
BUCKSBAUM, PHILIP H	STANFORD LINEAR ACCELERATOR CENTER	Discussion Leader	Registered
CARINI, JENNIFER L	UNIVERSITY OF CONNECTICUT	Attendee	Registered
CEDERBAUM, LORENZ S.	UNIVERSITÄT HEIDELBERG	Speaker	Registered
CHATEL, BEATRICE	CNRS-UNIVERSITY OF TOULOUSE	Speaker	Registered
COLLINS, THOMAS A	STEVENS INSTITUTE OF TECHNOLOGY	Poster Presenter	Registered
COMBES, JOSHUA	THE CENTER FOR QUANTUM INFORMATION AND CONTROL	Speaker	Registered
CORKUM, PAUL	NATIONAL RESEARCH COUNCIL OF CANADA	Speaker	Registered
DIMAURO, LOUIS F	OHIO STATE UNIVERSITY	Speaker	Registered
DIMITRIJEVIC, JELENA	UNIVERSITY OF BELGRADE	Poster Presenter	Registered
EILAM, ASAFA	UNIVERSITY OF BRITISH COLUMBIA	Poster Presenter	Registered
EITAN, REUVEN	WEIZMANN INSTITUTE OF SCIENCE	Poster Presenter	Registered
FRUMKER, EVGENY EUGENE	NRC UOTTAWA	Poster Presenter	Registered

GEBREMEDHIN, DANIEL H	FLORIDA A & M UNIVERSITY	Poster Presenter	Registered
GEISSLER, DOMINIK	SUNY STONY BROOK	Poster Presenter	Registered
GINOSSAR, ERAN	YALE UNIVERSITY	Poster Presenter	Registered
GOTO, HARUKA	INSTITUTE FOR MOLECULAR SCIENCE	Poster Presenter	Registered
GOULD, PHILLIP L	UNIVERSITY OF CONNECTICUT	Speaker	Registered
GRACE, MATTHEW D	SANDIA NATIONAL LABORATORIES	Attendee	Registered
GREENMAN, LOREN	UNIVERSITY OF CALIFORNIA BERKELEY	Poster Presenter	Registered
GRINEV, TIMUR	UNIVERSITY OF TORONTO	Poster Presenter	Registered
GUPTA, ASHISH K	IIT GUWAHATI	Poster Presenter	Registered
HAN, ALEX CHAO	THE UNIVERSITY OF BRITISH COLUMBIA	Poster Presenter	Registered
HEREK, JENNIFER L.	UNIVERSITY OF TWENTE	Speaker	Registered
HOCKER, DAVID L	PRINCETON UNIVERSITY	Attendee	Registered
HOMMELHOFF, PETER	MAX-PLANCK-INST. FOR QUANTUM OPTICS	Speaker	Registered
HORTON, SPENCER L	STEVENS INSTITUTE OF TECHNOLOGY	Poster Presenter	Registered
JANG, HYOUNGUK	UNIVERSITY OF MARYLAND	Poster Presenter	Registered
KALITA, DHRUBA J	INDIAN INSTITUTE OF TECHNOLOGY, GUWAHATI	Poster Presenter	Registered
KALLUSH, SHIMSHON	ORT BRAUDE COLLEGE	Poster Presenter	Registered
KATZ, GIL	HEBREW UNIVERSITY	Poster Presenter	Registered
KATZ, NADAV	HEBREW UNIVERSITY OF JERUSALEM	Speaker	Registered
KHODJASTEH, KAVEH	DARTMOUTH COLLEGE	Poster Presenter	Registered
KONAR, ARKAPRABHA	MICHIGAN STATE UNIVERSITY	Poster Presenter	Registered
KOSLOFF, RONALD B	HEBREW UNIVERSITY JERUSALEM	Chair	Registered
KOTUR, MARIJA	STONY BROOK UNIVERSITY	Poster Presenter	Registered
KUMARAPPAN, VINOD	KANSAS STATE UNIVERSITY	Speaker	Registered
LAFORGE, FRANCOIS O	CHEMISTRY DEPT. PRINCETON UNIVERSITY	Poster Presenter	Registered
LEHMANN, STEFAN CS	VRIJE UNIVERSITEIT AMSTERDAM	Poster Presenter	Registered
LEVIS, ROBERT J	TEMPLE UNIVERSITY	Speaker	Registered
LI, HEBIN	JILA	Poster Presenter	Registered

LI, XUAN	UNIVERSITY OF BRITISH COLUMBIA	Poster Presenter	Registered
LIM, JONGSEOK	KAIST	Poster Presenter	Registered
LONG, RUIXING	PRINCETON UNIVERSITY	Poster Presenter	Registered
LUKIN, MIKHAIL	HARVARD UNIVERSITY	Discussion Leader	Registered
MABUCHI, HIDEO	STANFORD UNIVERSITY	Speaker	Registered
MACHNES, SHAI	ULM UNIVERSITY	Poster Presenter	Registered
MALINOVSKAYA, SVETLANA	STEVENS INSTITUTE OF TECHNOLOGY	Poster Presenter	Registered
MALINOVSKY, VLADIMIR	STEVENS INSTITUTE OF TECHNOLOGY	Poster Presenter	Registered
MAO, XIANGLEI	LAWRENCE BERKELEY NATIONAL LABORATORY	Attendee	Registered
MARKMANN, ANDREAS	YALE UNIVERSITY	Poster Presenter	Registered
MATHUR, ANSHU B	UNIVERSITY OF TEXAS M.D. ANDERSON CANCER CENTER	Attendee	Registered
MEIER, ADAM M	NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY	Poster Presenter	Registered
MIDDLETON, CHRIS T	UNIVERSITY OF WISCONSIN-MADISON	Speaker	Registered
MOTZKUS, MARCUS A	UNIVERSITAT HEIDELBERG	Discussion Leader	Registered
MURNANE, MARGARET M	UNIVERSITY OF COLORADO	Attendee	Registered
NIELSEN, NIELS C	UNIVERSITY OF AARHUS	Speaker	Registered
ODHNER, JOHANAN	TEMPLE UNIVERSITY	Poster Presenter	Registered
OHMORI, KENJI	INSTITUTE FOR MOLECULAR SCIENCE	Discussion Leader	Registered
OHTSUKI, YUKIYOSHI	TOHOKU UNIVERSITY	Speaker	Registered
PACHON, LEONARDO A	UNIVERSITY OF TORONTO	Poster Presenter	Registered
PARKER, SHANE M	NORTHWESTERN UNIVERSITY	Poster Presenter	Registered
PICON ALVAREZ, ANTONIO	JILA, UNIVERSITY OF COLORADO AT BOULDER	Poster Presenter	Registered
PRIOR, YEHIAM	WEIZMANN INSTITUTE OF SCIENCE	Poster Presenter	Registered
RABITZ, HERSCHEL	PRINCETON UNIVERSITY	Discussion Leader	Registered
RAITH, PHILIPP	MAX-PLANCK-INSTITUT FUR KERNPHYSIK	Poster Presenter	Registered
RANGAN, CHITRA	UNIVERSITY OF WINDSOR	Poster Presenter	Registered

REICH, DANIEL	UNIVERSITAT KASSEL	Poster Presenter	Registered
REN, XIAOMING	KANSAS STATE UNIVERISTY	Poster Presenter	Registered
RENAUD, NICOLAS	NORTHWESTERN.EDU	Attendee	Registered
RIOFRIO, CARLOS A	UNIVERSITY OF NEW MEXICO	Poster Presenter	Registered
ROGERS, CHARLES E	UNIVERSITY OF CONNECTICUT	Attendee	Registered
ROMANOV, DMITRI A	TEMPLE UNIVERSITY	Poster Presenter	Registered
RUHMAN, SANFORD	HEBREW UNIVERSITY	Discussion Leader	Registered
RUPNIK, KRESIMIR	LOUISIANA STATE UNIVERSITY	Poster Presenter	Registered
SCHOLAK, TORSTEN	UNIVERSITY OF TORONTO	Poster Presenter	Registered
SENSION, ROSEANNE J	UNIVERSITY OF MICHIGAN	Poster Presenter	Registered
SHAH, JAY D	MICHIGAN STATE UNVERSTY	Poster Presenter	Registered
SHAPIRO, MOSHE	UNIVERSITY OF BRITISH COLUMBIA	Speaker	Registered
SILBERBERG, YARON	WEIZMANN INSTITUTE OF SCIENCE	Speaker	Registered
SONNTAG, MATTHEW D	NORTHWESTERN UNIVERSITY	Poster Presenter	Registered
SPECTOR, LIMOR S	STANFORD UNIVERSITY	Poster Presenter	Registered
STEINBERG, AEPHRAIM M	UNIVERSITY OF TORONTO	Speaker	Registered
STOLOW, ALBERT	NATIONAL RESEARCH COUNCIL CANADA	Speaker	Registered
SU, JING	UNIVERSITY OF COLORADO AT BOULDER	Poster Presenter	Registered
SUGNY, DOMINIQUE	ICB	Speaker	Registered
SUN, LUYAN	YALE UNIVERSITY	Attendee	Registered
TAKEI, NOBUYUKI	INSTITUTE FOR MOLECULAR SCIENCE	Poster Presenter	Registered
TAKEMOTO, NORIO	DEPARTMENT OF CHEMICAL PHYSICS, WEIZMANN INSTITUTE	Poster Presenter	Registered
TANNOR, DAVID	WEIZMANN INSTITUTE	Speaker	Registered
THANOPULOS, IOANNIS	NATIONAL HELLENIC RESEARCH FOUNDATION	Poster Presenter	Registered
TRALLERO, CARLOS A	JAMES R. MACDONALD	Poster Presenter	Registered
URSREY, DUSTIN R	KANSAS STATE UNIVERSITY	Poster Presenter	Registered
VAN RHIJN, ALEXANDER CW	UNIVERSITY OF TWENTE	Poster Presenter	Registered
VINJANAMPATHY, SAI	UNIVERSITY OF MASSACHUSETTS,	Poster	Registered

	BOSTON	Presenter	
VIOLA, LORENZA	DARTMOUTH COLLEGE	Discussion Leader	Registered
WANG, XIAOTING	UMASS BOSTON	Poster Presenter	Registered
WANG, JIN	UNIVERSITY OF MICHIGAN	Poster Presenter	Registered
WEATHERFORD, CHARLES A	CENTER FOR PLASMA SCIENCE AND TECHNOLOGY	Poster Presenter	Registered
WEIDEMUELLER, MATTHIAS	UNIVERSITAET HEIDELBERG	Discussion Leader	Registered
WEINACHT, THOMAS C	STONY BROOK UNIVERSITY	Vice Chair	Registered
WHALEY, K. BIRGITTA	UNIVERSITY OF CALIFORNIA, BERKELEY	Speaker	Registered
YANG, HUAN	CALIFORNIA INSTITUTE OF TECHNOLOGY	Poster Presenter	Registered
YE, JUN	JILA/NIST AND UNIVERSITY OF COLORADO	Speaker	Registered
YOUNG, KEVIN C	SANDIA NATIONAL LABORATORIES	Poster Presenter	Registered
YUAN, HAIDONG	HARVARD UNIVERSITY	Attendee	Registered
ZOHRABI, MOHAMMAD	KANSAS STATE UNIVERSITY	Poster Presenter	Registered

119 Attendees