

Winter Graduate School On  
Atomic, Molecular and Optical Physics:  
Ultracold and Ultrafast Atomic Physics



**January 8-20, 2012**

*at Biosphere 2 Conference Center in Arizona*

Welcome to the inaugural meeting of the Atomic, Molecular and Optical Physics Winter Graduate School! We hope that you are as excited as we are about this new initiative of the AMO community, and that you will have a terrific and fruitful time at the school.

This year's program focuses on ultracold and ultrafast AMO physics, and we are delighted to have renowned researchers who are undisputed world leaders in this field and outstanding teachers. We are grateful for their willingness to invest the considerable amount of time required to prepare and present their lectures. Among the lecturers are two Nobel laureates and two MacArthur Fellows.

Our primary goal for this school is to enable and encourage informal interactions as well as formal discussions during the next two weeks. We hope that you will take advantage of the unique setting of the Biosphere 2 campus and its relaxed and informal environment to interact extensively with the lecturers. Most of them will be able to spend several days with us, and a primary motivation to do so has simply been to have ample time to interact with you. So, don't miss this opportunity!

We have several outings planned, as well as lab tours to the University of Arizona AMO labs. So, it's not just all work and no play. More on this in the coming days...

On Thursday, January 12, we will have a poster session in the afternoon. This is an opportunity for you to present your research and receive feedback from the faculty at the school, and your fellow students. The posters can stay up throughout the rest of the two weeks and they will be reviewed and rated by the lecturers. At the end of the second week, the person who gets the highest rating will receive a prize. Another event that you are sure to enjoy is a special presentation by Dr. Richard Wiener of Research Corporation, who will give you very useful information for the day when you first become a faculty member. Following the talk will be a discussion Q&A with Dr. R. Wiener and Dr. Wendell Hill from the National Science Foundation. Make sure not to miss this talk!

*Enjoy!*

Pierre Meystre

Hossein Sadeghpour

## ORGANIZERS



### HOSSEIN SADEGHPOUR

ITAMP Director  
Senior Scientist at the Harvard-Smithsonian  
Center for Astrophysics

#### Research Interests:

Theoretical AMO physics, collision of cold and ultracold atoms and molecules in traps, ultracold neutral atomic and cold non-neutral antihydrogen plasmas, formation of ultralong range Rydberg molecules, formation of first molecules, and heating in ion microtraps.



ITAMP began life in 1989 at the Harvard-Smithsonian Center for Astrophysics. It is the only theoretical AMO "user facility" in the United States. It hosts workshops (3-days) and topical group meetings (1-4 weeks), and visitors (short- and long-term), sponsors a speaker series called the Joint Atomic Physics and Quantum Optics Colloquium held in Harvard Physics, and a postdoctoral fellowship program. ITAMP workshops are web-cast, when possible, and beginning with this year, workshop lectures are available on the ITAMP YouTube channel. There are on average 4-5 workshops each year. A Call for Proposal to organize workshops and a list of workshops & topical groups are available at <http://itamp.harvard.edu>. The postdoctoral program has been a recognized success, placing energetic fellows into junior positions at universities and national labs.

ITAMP thrives in the larger Cambridge-area AMO physics ecosystem, drawing upon the considerable depth and breadth of experimental expertise at Harvard & MIT, nearby BU, UMASS, UCONN and Yale. It has close association with CUA (Center for Ultracold Atoms) and ITC (Institute for Theory and Computation in astrophysics). Workshops, speakers, visitors and postdoc fellows are jointly organized or shared among these institutes. The mission of ITAMP continues to be furthering the cause of theoretical AMO physics by providing resources, scientific and administrative expertise, enhancing collaborative efforts between theory and experiment, and advocating for theoretical AMO.

## ORGANIZERS



### PIERRE MEYSTRE

Regents Professor of  
Physics & Optical Sciences  
The University of Arizona

**Research Interests:** Quantum Optics: Cavity quantum electrodynamics, laser and maser theory, statistical properties of radiation. Cavity optomechanics, Atomic physics: Ultracold atoms, matter-wave optics, degenerate quantum gases, Bose-Einstein condensation, nonlinear atom optics of Bose and Fermi systems. Quantum acoustics: Cavity optomechanics: beyond

the ground state, hybrid systems, quantum measurements. Sustainable energy: Solar energy production and storage, smart grid management modeling and applications at the Biosphere 2 "model city"



**B2 Institute** The B2 Institute is a think tank and research incubator that addresses scientific Grand Challenges whose solutions require the combined expertise of a broad range of scientific fields and diverse interdisciplinary talents. Building on The University of Arizona's reputation as a trailblazer in interdisciplinary research, it provides a non-traditional structure that facilitates interaction. Its current focal points include the water energy nexus, STEM education, and ultimately the development of interconnected 'Discovery Ecosystems' that will facilitate collaborations toward the solution of major problems.

The B2 Conference Center provides an ideal venue to carry out that mission through a combination of seminars, conferences, workshops, retreats, summer and winter schools, as well as other events that promote the sharing of ideas between natural and social scientists, educators, policy makers, and the general public.

Located in the beautiful Catalina Mountains foothills, the B2 Conference Center comprises a fully networked Campus Village of 28 Santa Fe-style casitas holding 106 double-capacity sleeping rooms and a number of double-occupancy offices. Complete with in-suite kitchens, living areas, and high-speed internet access, the 3-5 bedroom casitas are all in easy walking distance and provide the perfect place to unwind and socialize in-between or after meetings.

## EVENTS

We have planned excursions and events during the week and a sign up sheet will be available. Payment for all admissions are due at sign up.

- Wednesday 1/11: Hike to Romero Pools (weather permitting) [http://arizona.sierraclub.org/trail\\_guide/Hike23.htm](http://arizona.sierraclub.org/trail_guide/Hike23.htm)
- Thursday 1/12: Dr. Richard Wiener from the Research Corporation for Science Advancement will give a talk on "Research Funding Opportunities and Effective Grant Writing for Early-Career Physics Faculty." Following the talk will be a discussion Q&A with Dr. R. Wiener and Dr. Wendell Hill from the National Science Foundation.
- Saturday 1/14: Arizona Sonora Desert Museum <http://www.desertmuseum.org/> (entrance fee)
- Sunday 1/15: San Xavier Mission <http://www.sanxaviermission.org/> and the Titan Missile Museum <http://www.titanmissilemuseum.org/index.php> (entrance fee)
- Wednesday 1/18: AMO lab visits, University of Arizona



*The Winter School is supported by  
the Research Corporation for Science Advancement.*

For a hundred years, Research Corporation for Science Advancement has followed trends in science and education, funded scientific research, and helped scientists solve some of the great questions in the history of science. RCSA is a foundation for the advancement of science that provides catalytic and opportunistic funding for innovative scientific research and the development of academic scientists, which will have a lasting impact on science and society. RCSA provides catalytic funding for grants, conferences and advocacy to support:

- \* Early career faculty
- \* Innovative ideas for transformative research
- \* Integration of research and science teaching
- \* Interdisciplinary research
- \* Building tomorrow's academic cultures

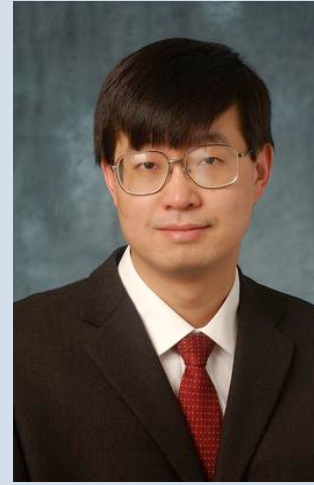


*Funding for student travel support is provided through a grant from the National Science Foundation*

ITAMP/B2 Institute Winter Graduate School on AMO Physics January 8-20, 2012

Sun	Mon	Tue	Wed	Thu	Fri	Sat
8	9	10	11	12	13	14
	8am Breakfast	8am Breakfast	8am Breakfast	8am Breakfast	8am Breakfast	8am Breakfast
	9am Lecture I: Ye	9am Lecture I: Pu	8:30am Lecture I: Gaarde	8:30am Lecture I: Phillips	9am Lecture I: Lukin	9am Arizona Sonora Desert Museum (ticket not included in registration)
	10:45 Lecture II: Gaarde	10:45 Lecture II: Ye	10:15 Lecture II: Deutsch	10:15 Lecture II: Becker	10:45 Lecture II: Becker	12:15 Lunch
	12:15 Lunch	12:15 Lunch	12:00 Lunch	12 Lunch	12:15 Lunch	
	2pm Lecture III: Deutsch	2pm Lecture III: Krems	1pm Hike to Romero Pools	1:30pm Lecture III: Krems	2pm Student Free Time 1 <sup>st</sup> week Lecturers depart	
4pm Registration	3:45pm Lecture IV: Pu	3:45pm Lecture IV: Glauber		3:15pm Lecture IV: Lukin		
6pm Reception & Dinner	6pm Dinner	6pm Dinner	5pm Dinner	5pm Before Dinner Talk: Dr. Richard Wiener	6pm Dinner	6pm Dinner
			6pm Transportation to Tucson	6:30pm Dinner		
				7:30 Student Poster Session		

LECTURERS



JUN YE

Fellow, National Institute of Standards and Technology  
JILA and Professor Adjoint, Dept. of Physics, University of Colorado

**Research Interests:** Light-matter interactions, novel atomic and molecular materials in the quantum regime, control with laser fields, stable lasers with optical coherence time exceeding 10 s. Precision phase control applied to a train of ultrashort pulses. New technologies in high-precision laser spectroscopy, ultracold atoms and molecules, optical frequency metrology,

quantum control, ultrafast lasers, precision measurement, and quantum physics, ultracold strontium atoms confined in optical lattices, atomic clocks and quantum information science, precise control of optical frequency combs, extreme nonlinear optics, ultracold molecules for tests of fundamental physics, ultracold chemical reactions, strongly interacting quantum systems.

LECTURERS



MARTIN ZWIERLEIN

Assistant Professor of Physics  
MIT

**Research Interests:** Ultracold atomic gases, models of many-body physics relevant for condensed matter, nuclear and astrophysics, Fermi polarons, strongly interacting Fermi gases.

## LECTURERS



### HAN PU

Associate Professor in the Department of Physics and Astronomy Rice University

**Research Interests:** Bose-Einstein Condensation of atoms and molecules, Quantum Degenerate Fermi Gas and Bose-Fermi Mixtures, Atom Optics, Quantum Optics

## LECTURERS



### TOM WEINACHT

Associate Professor of Physics Stony Brook State University New York

**Research Interests:** Experimental atomic physics; molecular dynamics.

ITAMP/B2 Institute Winter Graduate School on AMO Physics January 8-20, 2012						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
15	16	17	18	19	20	21
8am Breakfast	8am Breakfast	8am Breakfast	8am Breakfast	8am Breakfast	8am Breakfast	
9am San Xavier Mission	9am Lecture I: Bucksbaum	9am Lecture I: Jessen	9am Lecture I: Bucksbaum	9am Lecture I: DiMauro	9am Lecture I: Weinacht	
	10:45 Lecture II: Phillips	10:45 Lecture II: Murnane	10:45 Lecture II: Weinacht	10:45 Lecture II: Greiner	10:45 Lecture II: Sadeghpour	
12:15 Lunch	12:15 Lunch	12:15 Lunch	12:15 Lunch	12:15 Lunch	12:15 Lunch	
	2pm Lecture III: Greiner	2pm Lecture III: DiMauro	2pm AMO lab visits at the University of Arizona	2pm Lecture III: Zwieterlein	2pm	2pm School is closed
3pm Reception Event	3:45pm Lecture IV: Murnane	3:45pm Lecture IV: Zwieterlein		3:45pm Lecture IV: Jessen	4pm Departures for Students and Lecturers	
5pm School Dinner	6pm Dinner	6pm Dinner	6pm Dinner	6pm Dinner		
		7pm Student Poster Session		7:30 Public Lecture at 7:30 in Tuscon	7:30 pm Student Poster Session	

## LECTURERS



### ANDREAS BECKER

Associate Professor  
Department of Physics  
Fellow of JILA  
University of Colorado at Boulder

**Research Interests:** Ultrafast atomic, molecular and optical theory. Theoretical analysis and numerical simulation of ultrafast processes in atoms, molecules and clusters interacting with intense laser pulses.

## LECTURERS



### MIKHAIL D. LUKIN

Professor of Physics  
Harvard University

**Research Interests:** Quantum optics, quantum information science and atomic physics. Fundamental quantum systems consisting of interacting photons, atoms, molecules, and novel applications of such systems.

## LECTURERS



### PHIL BUCKSBAUM

Marguerite Blake Wilbur Professor in Natural Science  
Professor of Physics, Applied Physics, and Photon Science  
Director, Stanford PULSE Institute  
Stanford University and SLAC National Accelerator Laboratory  
Menlo Park, CA

**Research Interests:** Fundamental light-matter interactions. Control of quantum systems using ultrafast and short wavelength laser fields.

## LECTURERS



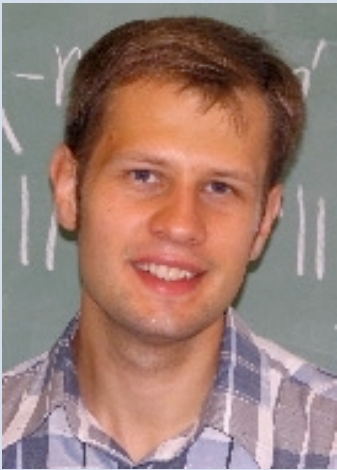
### WILLIAM D. PHILLIPS

Leader of the Laser Cooling and Trapping Group of NIST's Physical Measurement Laboratory  
Distinguished University Professor  
University of Maryland.  
Co-Director of the Joint Quantum Institute

1997 Nobel Prize in Physics *"for development of methods to cool and trap atoms with laser light."*

**Research Interests:** Laser-cooling and cold-atom experiments, laser cooling and trapping; Bose-Einstein condensation; atom optics; collisions of cold atoms; cold atoms in optical lattices; quantum information processing; quantum simulation of the behavior of complex systems; cold-atom analogs to condensed matter. .

## LECTURERS



### ROMAN KREMS

Associate Professor  
Department of Chemistry  
The University of British Columbia

**Research Interests:** Ultracold matter, quantum dynamics of molecules and molecular interactions, scattering theory, molecular spectroscopy, and dynamics of molecules in external electromagnetic fields.

## LECTURERS



### IVAN H. DEUTSCH

Professor, Regents' Lecturer  
Associate Chair for Graduate Affairs  
The University of New Mexico

**Research Interests:** Quantum optics/atomic physics: laser cooling and trapping, optical lattices, quantum computation, coherent control, quantum dissipative systems. Nonlinear optics, optical solitons, photon fluids.

## LECTURERS



### MARGARET MURNANE

Distinguished Professor  
Department of Physics and ECE  
Fellow of JILA  
University of Colorado at Boulder

2000 McArthur Fellow

**Research Interests:** Atomic and Molecular Physics, Chemical Physics, Nanoscience, Optical Physics. Extreme nonlinear optical process of high-harmonic generation, whereby light from an ultrafast laser can be coherently upshifted, resulting in a tabletop laser-like (coherent) light source in

the soft x-ray region.

## LECTURERS



### LOUIS F. DIMAURO

Edward and Sylvia Hagenlocker Chair and  
Professor of Physics  
Ohio State University

**Research Interests:** Experimental ultra-fast and strong-field physics, generation, measurement and applications of attosecond x-ray pulses.

## LECTURERS



### METTE GAARDE

Associate Professor of Physics  
Department of Physics & Astronomy  
Louisiana State University  
Baton Rouge, LA

**Research Interests:** Production of ultrafast coherent VUV and XUV light in the form of high order harmonics and attosecond pulses by a gas of atoms or molecules, and more generally the effects of propagating intense, ultrafast laser pulses through a macroscopic medium.

## LECTURERS



### MARKUS GREINER

Associate Professor in Physics  
Harvard University  
2011 McArthur Fellow

**Research Interests:** Ultracold atoms, Strongly correlated many-body quantum systems, Condensed matter and quantum information physics. Highly entangled states in optical lattices. Fermionic atoms, quantum systems of bosonic and fermionic atoms in optical lattices, novel quantum gas microscope, novel strongly correlated quantum states.

## LECTURERS



### ROY J. GLAUBER

Mallinckrodt Professor of Physics  
Harvard University  
2005 Nobel Prize in Physics  
*"for his contribution to the quantum theory of optical coherence."*

**Research Interests:** Quantum mechanical behavior of trapped wave packets; interactions of light with trapped ions; atom counting-the statistical properties of free atom beams and their measurement; algebraic methods for dealing with fermion statistics; coherence and correlations of bosonic atoms near the Bose-Einstein condensation; the theory of continuously monitored photon counting-and its reaction on quantum sources; the fundamental nature of "quantum jumps"; resonant transport of particles produced multiply in high-energy collisions; the multiple diffraction model of proton-proton and proton-antiproton scattering.

## LECTURERS



### POUL S. JESSEN

Professor and Chair of  
Quantum Information and Control,  
College of Optical Sciences  
University of Arizona

**Research Interests:** Physics of complex quantum systems, quantum measurement and control, quantum chaos and the quantum to classical transition in open quantum systems. Quantum information and quantum computation. Entanglement engineering and its use in precision measurement.