Department of Applied Physics

Philip H. Bucksbaum

Marguerite Blake Wilbur Professor of Photon Science, Applied Physics, and Physics

Directory Link
Personal Website
Research Group Link

Research areas:
AMO Physics, Laser Physics, Ultrafast Science, X-Ray Physics

Description

Lasers and Accelerators

I work in many areas of ultrafast laser science and technology, and also work in areas that are related to x-ray free electron laser performance and science applications. The PULSE Institute is devoted to science and applications of these sources and as PULSE Director I encourage this. I have taught lecture courses and laboratory courses in laser science and optical science, although I have never developed my own courses in those subjects. I am particularly interested in two areas of laser technology that relate directly to my research in quantum control. The first is the production of high harmonics from strongly driven molecules and atoms. This is a source of sub-femtosecond pulses. The second area of particular interest right now is optical pulse shaping of extremely short wavelength radiation, in the ultraviolet to soft x-ray range, in order to produce sources of interest in ultrafast atomic physics.

Nanoscience and Quantum Engineering

One of my principal research themes is ultrafast quantum control. This is the engineering of electromagnetic fields to guide quantum evolution in atomic, molecular, and chemical systems. I have taught, and would like to teach again, an advanced graduate course in quantum control, emphasizing the application of learning search algorithms, optimal control theories, statistical analysis, and pulse shape engineering to quantum systems. My recent work in quantum control has involved control of photoisomerization in two systems: Bacteriorhodopsin; and cyclohexadiene. I have also a long history of studies of control in Rydberg wave packets, and in atoms driven by strong lasers. My most extensive work is the interaction of atoms and molecules with laser fields of greater than one volt per angstrom. I got into this field shortly after the discovery of above-threshold ionization, and my students and I have made

Selected Publications

- High-order harmonic phase in molecular nitrogen
- Control of retinal isomerization in bacteriorhodopsin in the high-intensity regime
- Relation of high harmonic spectra to electronic structure in N2
- Ultraintense X-Ray Induced Ionization, Dissociation, and Frustrated Absorption in Molecular Nitrogen
- Double Core-Hole Production in N_2: Beating the Auger Clock
- Time-resolved pump-probe experiments at the LCLS
- First lasing and operation of an angstrom-wavelength free-electron laser
- Auger Electron Angular Distribution of Double Core-Hole States in the Molecular Reference Frame
- Femtosecond electronic response of atoms to ultra-intense x-rays

very many contributions to the current good level of understanding of the role of ponderomotive forces in these systems, and the application of quantum-classical correspondence to these phenomena. My current interest in this area is in ultrastrong x-ray fields and their interaction with atoms and molecules; and the use of strong fields to produce special and useful nonstationary states of atoms and molecules.

Condensed Matter Physics

I have an interest in elemental condensed systems in extreme environments produced by laser interactions. I have studied extremely undercooled silicon, and I am currently reviving my interest in this due to new opportunities to study ultracold systems at LCLS. I also worked for several years in the field of ultrafast vuv photoemission spectroscopy, and transient studies of ultrafast excitations and phase transitions using x-ray probes.

Biophysics

My interest in biophysics is in the area of quantum control in rhodopsin, and this might also be extended to some other biologically relevant systems in the future.

Courses Taught

Introduction to Atomic Processes

More Faculty in This Theme

See all >>

David A. Reis

John D. Fox

Robert L. Byer

Tor O. Raubenheimer

Ronald D. Ruth

Sami Tantawi