Opportunities in the Science, Applications, and Technology of Intense Ultrafast Lasers

Committee

Philip H. Bucksbaum

Chair

PHILLIP H. BUCKSBAUM (NAS) is the Marguerite Blake Wilbur Professor in Natural Science appointed to the Departments of Physics, Applied Physics, and Photon Science; as well as Director of the Photon Ultrafast Laser Science and Engineering Institute at Stanford University. Dr. Bucksbaum received his Ph.D. in Physics from the University of California at Berkeley in 1980. Following a postdoctoral year at Lawrence Berkeley National Laboratory, he joined the staff of Bell Telephone Laboratories in New Jersey, first as a postdoc at Holmdel, and later as a member of the technical staff at Murray Hill. He was appointed Professor of Physics at the University of Michigan in 1990, where he became the Otto Laporte Collegiate Professor in 1998 and the Peter Franken University Professor in 2005. At Michigan, he also was the Associate Director for Science at the Center for Ultrafast Optical Science, and the Director of the FOCUS Center, a National Science Foundation Physics Frontier Center. In 2006, Bucksbaum moved to the SLAC National Accelerator Laboratory and Stanford University, and in 2009, he became the Marguerite Blake Wilbur Professor in Natural Science. He has joint appointments in the Physics Department, the Applied Physics Department, and the SLAC Photon Sciences Department, and he served as Department Chair of Photon Science from 2007-2010. He also currently directs the Chemical Sciences Research Division at SLAC. Dr. Bucksbaum has more than 200 publications. He has contributed to several areas of atomic physics and ultrafast science, including strong-field laser-atom interactions, Rydberg wave packets, ultrafast quantum control, and ultrafast X-ray physics. Most recently, he has helped to pioneer ultrafast research at X-ray free electron lasers. He has served on several NRC committees, including as chair of the Board on Physics and Astronomy, Co-Chair of the Committee on AMO2010 – An Assessment of and Outlook for Atomic Molecular and Optical Science, and Committee on Atomic, Molecular, and Optical Sciences (CAMOS). He has been a member of numerous advisory committees, including for the Department of Energy Division on Basic Energy Sciences and the National Institute of Standards and Technology’s Committee for Physics. Dr. Bucksbaum is currently the Past President of the Optical Society of America. He has served on the Editorial Board of Physical Review Letters, and was the founding editor of the American Institute of Physics Virtual Journal of Ultrafast Science. At Stanford and SLAC, he has served as Chair of the Photon Science faculty and also Director of the Chemical Science Division. He is a member of the National Academy of Sciences.

Riccardo Betti

Member

RICCARDO BETTI is the Professor of Physics and Mechanical Engineering and of Physics and Astronomy, Director of the Fusion Science Center of Extreme States of Matter and Fast Ignition, and Scientist at the Laboratory for Laser Energetics at the University of Rochester. He received his Ph.D. from MIT in 1992 in nuclear engineering. His primary expertise is in the theory of high-temperatures plasmas, be they inertially or magnetically confined for fusion. Dr. Betti is a member of the interdisciplinary High Energy Density Plasma program at Rochester's Laboratory for Laser Energetics. His research focuses on the kinetic and magnetohydrodynamic stability studies of tokamak plasmas both analytically and numerically; he also studies the hydrodynamic stability of the imploding capsules for inertial confinement fusion. Dr. Betti is a member of DOE's Fusion Energy Sciences Advisory Committee and was the vice chair of a recent DOE review of inertial fusion energy, as well as many other review panels. Dr. Betti served as a member and chair of the NRC's Plasma Science Committee, the Committee on the Prospects for Inertial Confinement Fusion Energy Systems, and the Board on Physics and Astronomy. Dr. Betti is a fellow of the American Physical Society.

John L. Collier

Member

JOHN COLLIER is the director of the Central Laser Facility (CLF) at the Rutherford Appleton Laboratory in Oxfordshire, UK. The CLF is a partnership between its staff and the large number of members of UK and European universities who use the specialised laser equipment provided to carry out a broad range of experiments in physics, chemistry and biology, and is organized under the UK Science and Technology Facilities Council. He received his Ph.D. in 1985. His research interests are in laser-driven acceleration of particles and plasmas and high intensity lasers.

Louis F. DiMauro

Member

LOUIS F. DIMAURO is the Edward E. and Sylvia Hagenlocker Chair of Physics and Professor of Physics in the Department of Physics at The Ohio State University. He is also a Guest Physicist at Lawrence Livermore National Laboratory and an Adjunct Professor of Physics at Stony Brook University. Dr. DiMauro received his Ph.D. in physics from the University of Conneticut in 1980. Prior to going to Ohio State, Dr. DiMauro was a chemist and senior scientist at Brookhaven National Laboratory for several years. Dr. Di Mauro's research interests lie in atomic, chemical and ultrafast optical physics, including: strong-field interactions, ultrafast laser physics, attosecond engineering, nonlinear optics, quantum control methods, many body physics, free electron laser physics, and fourth generation light sources. He is a fellow of the American Physical Society, the Optical Society of America, and the American Association for the Advancement of Science. Dr. DiMauro served on the executive committee of the APS Division of AMO Physics (DAMOP) from 2008-2011 include serving one year as chair.
He is the current chair of the NRC's Committee on Atomic, Molecular, and Optical Sciences.

Elsa M. Garmire

Member

ELSA GARMIRE (NAE) is the Sydney E. Junkins professor at the Thayer School of Engineering, Dartmouth College, where she was previously the Dean of Engineering. Her Ph.D. is from MIT in physics and her A.B. is from Harvard (Radcliffe), also in physics. Before Dartmouth she was Sydney Hogue Professor of Electrical Engineering at University of Southern California. She has over 50 years' experience in laser-related research, particularly nonlinear optics and photonics, with over 200 peer-reviewed archival publications. She is a member of NAE (and served as a councillor for 6 years), the American Academy of Arts and Sciences, the National Academy of Inventors and a National Associate of the National Academies. She is a fellow of IEEE, Optical Society of America, the American Physical Society, the Society of Women Engineers and was president of OSA. She has served on over 12 NRC committees; those related to lasers were the Committee on Active Electro-optic Sensing (2012-2013), Panel reviewing Sensors and Electron Devices for the Army Research Labs (2011-2012), Committee on Optical Science and Engineering (1995-1997), and NRC Committee on Future Opportunities in AMO Sciences (1991-1992). She also served on the Report Review committee for 6 years.

Jacqueline G. Gish

Member

JACQUELINE GISH (NAE) is retired Director of Advanced Technology, Northrop Grumman Aerospace Systems. She received her B.A. from UCLA, an M.A. in business administration from USC, and her Ph.D. in Chemical Physics from Caltech. During her long career at TRW/Northrop Grumman, she was a department manager, program manager, business development lead, and director of laser technology development. She developed diagnostics for plasma and laser programs and then led efforts on chemical and solid state lasers. She was elected a Fellow of the Directed Energy Professional Society (DEPS). She is a member of the National Academy of Engineering and was elected for her significant contributions to the development of high-energy lasers. She has served on the Air Force Studies Board and the Air Force Directed Energy Study and is currently on the NAE Implementing K-12 Engineering Education Board.

Thornton E. Glover

Member

ERNIE GLOVER is a program officer with the Gordon and Betty Moore Foundation’s Science Program, makes grants covering a wide range of topics across the physical sciences. Prior to joining the Moore Foundation Ernie spent nearly 20 years at the Lawrence Berkeley National Laboratory where, as a staff scientist at the Advanced Light Source, he helped pioneer ultrafast x-ray science by developing accelerator based femtosecond x-ray sources and applying them to problems in physics, chemistry, and biology. Over the years, Dr. Glover’s research has spanned a range of topics that include the first time domain measurement of femtosecond-duration soft x-ray pulses, studying how nanoparticles form during femtosecond laser ablation, demonstrating that light can be used to induce x-ray transparency and, most recently, demonstrating a technique that allows x-rays to selectively probe the chemically important valence electrons in a material. Dr. Glover attended Brown University as an undergraduate and received a Ph.D. in physics from the University of California at Berkeley, studying high power laser interactions with matter. His graduate thesis was titled “Non-equilibrium Plasmas Produced By Intense, Short Laser Pulses.”

Marshall G. Jones

Member

MARSHALL JONES (NAE) is a Principal Engineer at GE Global Research. He received his Ph.D. from the University of Massachussets in Mechanical Engineering in 1974. Prior to joining GE he was a development engineer at Brookhaven National Laboratory. His research has addressed laser material processing, laser device development, and development of high power laser transmission in fiber optics. His awards include the SUNY Honorary Doctor of Science (1885), University of Massachusetts Chancellor Metal (1987), American Welding Society's Professor Dr. Rene Wasserman Memorial Award (1998), GE Coolidge Fellowship (2002), and Arthur Schawlow Award (2007). He is a member of the American Society of Mechanical Engineers, the Laser Institute of America, and the National Academy of Engineering. He has served on the NRC committees entitled "Unit Manufacturing Process Research" (1991) and "Panel on the Assessment of NIST programs" (1993).

Henry Kapteyn

Member

HENRY C. KAPTEYN (NAS) is a professor in the Department of Physics and a fellow of JILA, at the University of Colorado. He received his Ph.D. in physics from the University of California at Berkeley in 1989, in the field of x-ray and short-wavelength laser physics. Previously, he was an associate professor in the Electrical Engineering and Computer Science (EECS) Department at the University of Michigan, and an assistant and then associate professor of Physics at Washington State University. His work at WSU, done in collaboration with Prof. Margaret Murnane, resulted in the development of a new generation of lasers which make it straightforward to produce light pulse of less than ten femtoseconds duration. At Michigan, he continued this research in demonstrating novel techniques for generation short-duration light pulses in the deep-ultraviolet and soft x-ray regions of the spectrum. This work opened a new region of the electromagnetic spectrum to fundamental studies using coherent ultrashort light pulses. He is currently applying this technology to studies of dynamic processes in atomic, molecular, and materials systems, as well as for technological applications such as nanoscale-resolution imaging. This work has resulted in a number of advances in fundmental science, including the first demonstration of coherent manipulation of atoms on the attosecond time scales, and the first studies of "radiation femtochemistry" where the dynamics of a molecular exposed to ionizing radiation were for the first time followed in real-time. Prof. Kapteyn has received a number of awards including the National Science Foundation Young Investigator award in 1992, the Optical Society of America's Adolph Lomb Medal in 1993, and as co-recipient with Prof. Margaret Murnane of the 2009 Ahmed Zewail Award in Ultrafast Science and Technology of the American Chemical Society. Prof. Kapteyn is a Fellow of the Optical Society of America (OSA), the American Physical Society (APS), and the American Association for the Advancement of Science (AAAS). He is a member of the NAS.

Andrew J. Lankford

Member

ANDREW LANKFORD is Professor of Physics at the University of California, Irvine, since 1990. He served as Chair of the UCI Department of Physics and Astronomy 2002-2007. He previously held research positions at the Stanford Linear Accelerator Center (1981-1990) and Lawrence Berkeley Laboratory (1978-1981), and as a Scientific Associate at CERN, the European laboratory for particle physics (2009-2011). His research is in the field of particle physics and is presently focused on searches for new fundamental particles and phenomena at the highest available laboratory energies. He is a graduate of Yale University (B.S. 1972, Math & Physics; Ph.D. 1978, Physics). He served on the NRC Committee on NASA's Beyond Einstein Program (2006-2007) and chaired the NRC Committee to Assess the Science Proposed for a Deep Underground Science and Engineering Laboratory (2010-2011). He has served on numerous national and international advisory panels in the fields of particle physics, nuclear physics, and cosmology, and he is at present Chair of the DOE/NSF High Energy Physics Advisory Panel (2012-).

Howard M. Milchberg

Member

HOWARD MILCHBERG is Professor in the Physics and Electrical Engineering Departments at the University of Maryland, College Park. He received his Ph.D. from Princeton University in Astrophysical Sciences in 1985. After receiving his Ph.D., Dr. Milchberg moved to AT&T Bell Laboratories (1985-87) and then joined the faculty of University of Maryland in 1988. His research interests include nonlinear optics, laser and optical physics, interaction of intense electromagnetic fields with atoms, solids, and plasmas, and the generation and application of relativistic charged particles and coherent and incoherent short wavelength radiation. He has held a National Research Council of Canada Postgraduate Fellowship, an NSF Presidential Young Investigator Award and has received the APS Excellence in Plasma Physics Research Award. He is a fellow of the American Physical Society and the Optical Society of America. Three of his graduate students have been awarded the APS-DPP doctoral dissertation award.

Stephen V. Milton

Member

STEPHEN V. MILTON is a professor in the Department of Electrical and Computer Engineering at Colorado State University. He received a bachelor's degree in physics from the University of California-Davis and a Ph.D., in physics from Cornell University. His recent research interests include making accelerator and beam systems more efficient and more compact. Prior to joining Colorado State, Dr. Milton was the director of the 155M Euro FERMI@Elettra Free-Electron Laser project in Italy, during which time he concurrently served as a senior scientist at Argonne National Laboratory. Before taking on the FERMI director role, he led the design, engineering, and construction of the $55 million magnetic device undulator line for the Linac Coherent Light Source, the world's first x-ray FEL, at SLAC National Accelerator Laboratory. Dr. Milton also led the Argonne FEL, also known as the Low Energy Undulator Test Line, the world's first Self-Amplified Spontaneous Emission FEL to achieve saturation at visible through ultraviolet wavelengths.

Peter F. Moulton

Member

PETER MOULTON (NAE) is a senior staff member at MIT Lincoln Laboratory. Dr. Moulton received his Ph.D. from MIT in 1975. Dr. Moulton founded and managed what became Q-Peak, Inc. in Bedford, MA, from 1985 to 2012. He stayed there as a principal research scientist until 2015. From 1970-1985 he was at MIT Lincoln Laboratory, starting with graduate study and then becoming a staff member. His fields of interest include solid state lasers, both bulk and fiber, as well as nonlinear optics, and he has conducted fundamental and applied research in these areas, as well as commercial product development. He is the inventor of the Ti:sapphire laser (in 1982), which remains the leading technology for intense ultrafast lasers. He is a fellow of the OSA, the IEEE, the SPIE and the Military Sensing Symposia, has been awarded the R.W. Wood Prize from the OSA, the IEEE William Streifer and Photonics Awards, and was elected to the National Academy of Engineering in 2000. He served as a committee member on the NRC "Review of Advancements in Active Electro-Optical Systems to Avoid Technological Surprise Adverse to U.S. National Security," which issued a report in 2014.

C. Kumar N. Patel

Member

C. KUMAR PATEL (NAS/NAE) is president and CEO of Pranalytica, a company located in Santa Monica, CA, specializing in high power quantum cascade lasers and applications. He received his Ph.D. in electrical engineering from Stanford in 1961. Dr. Patel is the inventor of the carbon dioxide, carbon monoxide, and the Spin-Flip Raman lasers. He pioneered the use of these and other lasers to measure trace gases in difficult environments. He was at AT&T Bell Laboratories for thirty-two years and was Executive Director of the Physics Division and of the Materials Research Division. Under his leadership, Bell Labs produced some of the most critical technologies for optical communications. The quantum cascade laser was also invented in Physics Division during his leadership. From 1993 to 1999 he was the Vice Chancellor for Research at UCLA. Dr. Patel was elected to the National Academy of Science in 1974 and the National Academy of Engineering in 1978. Dr. Patel has received every major scientific honor in the United States. He received the National Medal of Science given by the President of the United States in 1996. In 2012, he was inducted into the National Inventors' Hall of fame. In recognition of the CO2 laser's importance to the medical field, he has been elected as an Honorary Member of the Gynecologic Laser Surgery Society in 1980 and in 1985 he was elected an Honorary Member of the American Society for Laser Medicine and Surgery.