Theme Keynote Lecture

"Molecular Imaging with PET, A Revolution in Biological Research and Practice of Medicine"

Abass Alavi, M.D.

University of Pennsylvania School of Medicine
Philadelphia, PA, USA

9:40
Saturday, 5 September
Grand Ballroom – Salon A

Abstract

Since the introduction of 18F-Fluorodeoxyglucose (FDG) in 1976 by investigators at the University of Pennsylvania, the medical community has witnessed a revolution in modern imaging. Concurrent with the introduction of FDG, significant advances were made in PET instrumentation, which was pioneered by researchers at Washington University. The success of PET in general and FDG in particular has led the way for significant applications of this technology in a variety of disorders and diseases. Furthermore, the introduction of PET/CT over the past decade has further enhanced the role of this powerful modality in medicine. FDG has had an unparalleled impact on practice of medicine for over three decades. Currently, FDG-PET is considered the study of choice for managing patients with a multitude of malignancies at different stages of this devastating disease. The role of FGD-PET is increasingly recognized for detection of infection and inflammation in orthopedic infections. There is ample evidence for successful use of FDG in detecting atherosclerosis, clots, and muscle dysfunction. Innovative PET tracers have been introduced for research and clinical applications. These techniques allow examining complex processes from receptor imaging to angiogenesis to tumor hypoxia. Most major pharmaceutical companies have adopted PET for developing new drugs in an accelerated fashion. PET has enhanced the concept of personalized medicine to become a reality as we have entered into the 21st century. Therefore, without any equivocation, one can state that PET has brought about a revolution in medicine with an impact that is extraordinary and far reaching. This technology provides sound and logical grounds for decision making and improving outcomes for serious disorders such as cancer and cardiovascular disorders.

Biographical Sketch

Abass Alavi is a Professor of Radiology and Neurology at the University of Pennsylvania School of Medicine, and the Chief of Nuclear Medicine at the University of Pennsylvania Medical Center. He is also Medical Director of the Positron Emission Tomography (PET) Center at the Hospital of the University of Pennsylvania and an internationally recognized expert in modern imaging techniques and the clinical applications of PET imaging for the detection of cancer and other serious disorders including dementia, seizures, cardiovascular disease, and infection. Dr. Alavi's contributions to the field of nuclear medicine, and in particular his work in PET, earned him the 2004 Georg Charles de Hevesy Nuclear Medicine Pioneer Award from the Society of Nuclear Medicine. He also received an honorary doctor of science degree from the University of the Sciences in Philadelphia, and an honorary doctoral degree from the University of Bologna. Dr. Alavi is associated with the Alavi-Mandell Awards, which recognize trainees and young scientists who publish articles as senior authors in the Journal of Nuclear Medicine, and the Bradley-Alavi Student Fellowship Awards. He also serves on the Society of Nuclear Medicine's Education and Research Foundation Board of Directors and is involved in numerous Society activities.

Theme Keynote Lecture

"Magnetic Resonance Elastography"

Richard L. Ehman, M.D.

Mayo Clinic
Rochester, MN, USA

14:15
Friday, 4 September
Grand Ballroom – Salon A

Abstract

Many disease processes cause profound changes in the mechanical properties of tissues. This accounts for the efficacy of palpation for detecting abnormalities and provides motivation for developing practical methods to quantitatively image tissue elasticity. Magnetic Resonance Elastography (MRE) is an emerging imaging technique that uses a specialized phase-contrast MRI technique to visualize propagating acoustic waves generated by surface drivers, inertial effects, acoustic radiation pressure, or endogenous mechanisms. MRE acquisition sequences are capable of visualizing waves of less a micron in amplitude in vivo. Inversion algorithms are used to process the wave data to generate maps of properties such as stiffness, viscosity, attenuation, and anisotropic behavior, providing access to a new range of previously unexplored tissue imaging biomarkers. Human studies have demonstrated that it is feasible to quantitatively image the mechanical properties of normal skeletal muscle, gray and white matter in the brain, thyroid, myocardium, kidney, liver, and skin. Preliminary clinical studies have used the technique to demonstrate and evaluate tumors of the breast, brain, thyroid, and liver. The first established clinical application of the technology is for detection of hepatic fibrosis. Emerging evidence suggests that in addition to being safer, more comfortable, and less expensive, MRE is at least as accurate as liver biopsy for this diagnosis. In the expanding field of the mechanobiology, MRE provides access to a new and largely unexplored range of quantitative biomarkers.

Biographical Sketch

Dr. Richard Ehman is Professor of Radiology at the Mayo Clinic and serves as vice-chair of the Mayo Clinic Rochester Executive Board and is a member of the Mayo Clinic Board of Governors and the Mayo Clinic Board of Trustees. He divides his time between clinical practice, education, and research. His main clinical activity is Magnetic Resonance Imaging. His research program is focused on developing new imaging technologies. He received his M.D. from the *University of Saskatchewan, Canada* in 1979, completed residency training in Diagnostic Radiology at the *University of Calgary* in 1983 and then undertook a research fellowship at the *University of California, San Francisco*. He joined the Mayo Clinic staff in 1985. Dr. Ehman has been Principal Investigator of several NIH grants and holds more than 30 US and foreign patents for his inventions. He was awarded the Gold Medal of the *International Society for Magnetic Resonance in Medicine* in 1995 for his research contributions, an honorary Doctor of Science Degree by the *University of Saskatchewan* in 2000, and the Outstanding Researcher Award of the *Radiological Society of North America* in 2006. He has served as Chair of the *Radiology and Nuclear Medicine Study Section* of the NIH, and is currently a member of the Advisory Council of the *National Institute of Biomedical Imaging and Bioengineering* of the NIH. He is an Associate Editor of *Magnetic Resonance in Medicine*, and a member of the editorial boards of several other journals. He served as President of the *International Society for Magnetic Resonance in Medicine* in 2002-2003.

Theme Keynote Lecture

"Biomedical Imaging and Optical Biopsy Using Optical Coherence Tomography"

James G. Fujimoto, Ph.D.

Massachusetts Institute of Technology
Cambridge, MA, USA

9:40
Friday, 4 September
Grand Ballroom – Salon A

Abstract

Optical coherence tomography (OCT) is an emerging imaging modality which can generate high resolution, cross-sectional and three dimensional images of microstructure in biological systems. OCT is analogous to ultrasound B mode imaging, except that it uses light instead of sound. Imaging is performed by measuring the echo time delay of backscattered light. The penetration depth of OCT imaging is limited by attenuation from optical scattering to ~2 to 3 mm in most tissues however image resolutions of 1-15 um may be achieved. OCT functions as a type of "optical biopsy" enabling in situ visualization of tissue microstructure with resolutions approaching that of conventional histopathology. Imaging can be performed in real time without the need to remove and process a specimen as in conventional biopsy. OCT technology utilizes advances in photonics and fiber optics such as femtosecond broadband lasers, high speed wavelength swept lasers and line scan camera technologies. Recent developments using Fourier domain detection achieve dramatic improvements in resolution and imaging speed. Three dimensional, volumetric imaging with extremely high voxel density is now possible, enabling microstructure and pathology to be visualized and rendered in a manner analogous to MR imaging. OCT is rapidly becoming a clinical standard in ophthalmology, where it can image retinal pathology with unprecedented resolutions. OCT is also being developed for other applications ranging from cancer detection in endoscopy, to intravascular imaging in cardiology. This presentation will review OCT technology and its applications.

Biographical Sketch

Dr. James G. Fujimoto is Professor of Electrical Engineering and Computer Science at Massachusetts Institute of Technology. His research interests include the development and application of femtosecond laser technology and studies of ultrafast phenomena. He is also active in biomedical optics, including the development of optical coherence tomography imaging. Dr. Fujimoto was awarded the Baker Award of the National Academy of Sciences in 1990, the Discover Magazine Award for Technological Innovation in medical diagnostics in 1999, and was co-recipient of the Rank Prize in Optoelectronics in 2002. He was elected to the National Academy of Engineering in 2001, the American Academy of Arts and Sciences in 2002, and the National Academy of Sciences of 2006. Dr. Fujimoto is a Fellow of the OSA, APS, and IEEE. He was program co-chair for the Conference on Lasers and Electro Optics CLEO in 2002 and general co-chair for CLEO in 2004. Dr. Fujimoto has been general co-chair of the SPIE BIOS symposium since 2003 and is co-chair of the conference Coherence Domain Optical Methods in Biomedical Science and Clinical Applications since 2000. He was also co-chair of the European Conferences on Biomedical Optics in 2005. Dr. Fujimoto was a member of the board of directors of the Optical Society of America from 2000 to 2003. Dr. Fujimoto was co-founder of Advanced Ophthalmic Devices, the company that transferred OCT to Carl Zeiss for ophthalmic imaging and co-founder of LightLabs Imaging, a joint venture with Carl Zeiss in the area of endoscopic and cardiovascular OCT imaging that was acquired by Goodman, Ltd. in 2002.

Theme Keynote Lecture

"The VPH/Physiome Project: A Role for EMBS?"

Peter Hunter, Ph.D.

University of Auckland
Auckland, New Zealand

14:15
Saturday, 5 September
Grand Ballroom – Salon A

Abstact

The Physiome Project[1,2,3], an internationally collaborative effort to provide an integrative multi-scale modeling framework for computational physiology, has recently been boosted by a European initiative called the 'Virtual Physiological Human' (VPH)[4]. The combined VPH/Physiome Project aims to link biochemical network systems biology models and biophysically and anatomically based bioengineering models to medical imaging and biomedical signal analysis. The primary achievements so far are the development of markup languages (CellML, FieldML), freely accessible model repositories based on the markup languages, and open source computational tools for authoring, visualizing, executing and analyzing these models[5]. In addition to describing these standards and illustrating their applications, the talk will discuss current efforts to develop metadata standards for annotating model components (parameters and variables) with terms from existing ontologies such as GO[6], FMA[7] and OPB[8] that describe the biological, anatomical and biophysical meaning of these components. This development is benefitting from a collaboration with the systems biology SBML community[9]. A new standard for encoding time-varying biomedical signals and associated metadata, called BiosignalML and being developed by the EMBS Technical Committee on 'Computational Biology and the Physiome', will also be described.

Biographical Sketch

Peter Hunter completed an engineering degree in 1971 in Theoretical and Applied Mechanics (now Engineering Science) at the University of Auckland, New Zealand, a Master of Engineering degree in 1972 (Auckland) on solving the equations of arterial blood flow and a DPhil (PhD) in Physiology at the University of Oxford in 1975 on finite element modeling of ventricular mechanics. His major research interests since then have been modelling many aspects of the human body using specially developed computational algorithms and an anatomically and biophysically based approach which incorporates detailed anatomical and microstructural measurements and material properties into the continuum models. The interrelated electrical, mechanical and biochemical functions of the heart, for example, have been modelled in the first 'physiome' model of an organ. He is currently a Professor of Engineering Science, Director of the Bioengineering Institute at the University of Auckland, and a Director of Computational Physiology at Oxford University. He is an elected Fellow of the Royal Society.

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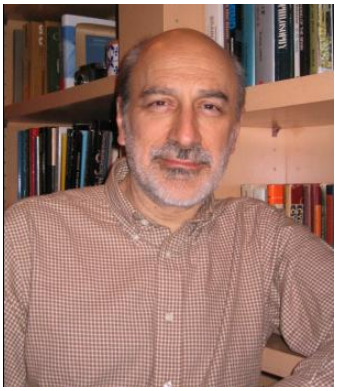
[1] Hunter, P.J. and Borg, T.K. Integration from proteins to organs: The Physiome Project. *Nature Reviews Molecular and Cell Biology*. Vol 4, pp 237-243, 2003.
[2] Hunter, P.J. and Nielsen, P.M.F. A strategy for integrative computational physiology. *Physiology*. 20,316-325, 2005.
[3] Hunter, P.J., Crampin, E.J. and Nielsen, P.M.F. Bioinformatics, multiscale modelling and the IUPS Physiome Project. *Briefings in Bioinformatics*. 9 (4), 333-343, 2008.
[4] www.vph-noe.eu
[5] www.cellml.org; www.fieldml.org
[6] www.geneontology.org
[7] http://sig.biostr.washington.edu/projects/fm/AboutFM.html
[8] http://bioportal.bioontology.org/ontologies/38990
[9] www.sbml.org

Theme Keynote Lecture

"Toward Cognitive NeuroProsthesis"



Jose C. Principe, Ph.D.

University of Florida
Gainesville, Florida, USA

10:25
Thursday, 3 September
Grand Ballroom – Salon A

Abstract
The first generations of motor BMIs were simply signal translators (from multielectrode array recordings to kinematic variables). Recently we proposed a new co-adaptive close loop paradigm for BMIs based on reinforcement learning. The subject's (a rodent) motor cortical neural activity is translated into a value function for a computer agent (CA) running Q learning that controls the actions of a robot to deliver a water reward to the subject. Preliminary results show that the subject and the agent are able to cooperate and improve their joint performance across task difficulty. We will briefly describe the prerequisites to design cognitive neuroprosthesis, address the computational modeling challenges and describe current tests as well as future design directions.

Biographical Sketch
José C. Príncipe is a Distinguished Professor of Electrical and Biomedical Engineering and the BellSouth Professor at the University of Florida. He is also the Founder and Director of the Computational NeuroEngineering Laboratory (CNEL) at the University of Florida. He joined the University of Florida in 1987 after an eight-year appointment as Professor at the University of Aveiro in Portugal. Dr. Príncipe holds degrees in electrical engineering from the University of Porto (Bachelor), Portugal, and the University of Florida (M.Sc. and Ph.D.), USA, and a Laurea Honoris Causa degree from the Universita Mediterranea in Reggio Calabria, Italy. Dr. Príncipe's interests lie in nonlinear non-Gaussian optimal signal processing and modeling and in biomedical engineering. He received the Career Achievements Award and Service Award from IEEE EMBS, and Gabor Award from the International Neural Network Society. Dr. Príncipe is a Fellow of the IEEE and AIMBE, past President of the International Neural Network Society, and past Editor-in-Chief of IEEE Transactions of Biomedical Engineering, as well as a former member of the Advisory Science Board of the FDA. He is the Editor-in-Chief of IEEE Reviews in Biomedical Engineering. Dr. Principe is author of more than 400 refereed publications.

Theme Keynote Lecture

"Useful Signals from Motor Cortex"

Andrew Schwartz, Ph.D.

University of Pittsburgh
Pittsburgh, PA, USA

9:40
Thursday, 3 September
Grand Ballroom – Salon A

Abstract

Over the years, we have shown that detailed predictive information of the arm's trajectory can be extracted from populations of single unit recordings from motor cortex. Using drawing movements as a behavioral paradigm, these signals have been shown to contain instantaneous velocity information and many of the invariants describing animate movement. Furthermore, this technique can be used to study visuo-perceptual processes taking place as objects are drawn. By developing techniques to record these populations and process the signal in real-time, we have been successful in demonstrating the efficacy of these recordings as a control signal for intended movements in 3D space. Having shown that closed-loop control of a cortical prosthesis can produce very good brain-controlled movements in virtual reality, we have been extending this work to robot control. We are using an anthropomorphic robot arm with our closed-loop system to show how monkeys can control the robot's movement with direct brain-control in a self-feeding task. The animals control the arm continuously in 3D space to reach out to the food and retrieve it to their mouths. Since the recorded signals are a high fidelity representation of the intended behavior and contain features of animate movement, neural prosthetic devices derived from this technology are capable of producing agile, natural movement. Current experiments are designed to extract wrist, hand and finger movement from populations of cortical activity and use this to control a mechanical facsimile of the appendage.

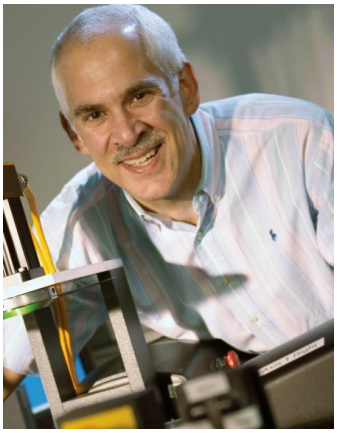
Recently we have been using the brain-control paradigm to examine learning as it takes place across the network of recorded neurons. Our paradigm allows us to drive neurons to adapt new tuning functions and we can track this process continuously as it takes place. This shows that there are distinct global and local processes taking place as subjects regulate their neural activity when learning to operate novel tools.

Biographical Sketch

Dr. Schwartz received his Ph.D. from the University of Minnesota in 1984. He then went on to a postdoctoral fellowship at the Johns Hopkins School of Medicine where he worked with Dr. Apostolos Georgopoulos, who was developing the concept of directional tuning and population-based movement representation in the motor cortex. In 1988, Dr. Schwartz began his independent research career at the Barrow Neurological Institute in Phoenix. There, he developed a paradigm to explore the continuous cortical signals generated throughout volitional arm movements. This was done using monkeys trained to draw shapes while recording single-cell activity from their motor cortices. After developing the ability to capture a high fidelity representation of movement intention from the motor cortex, Dr. Schwartz teamed up with engineering colleagues at Arizona State University to develop cortical neural prosthetics. The work has progressed to the point that monkeys can now use these recorded signals to control motorized arm prostheses to reach out grasp a piece of food and return it to the mouth. Dr. Schwartz moved from the Barrow Neurological Institute to the Neurosciences Institute in San Diego in 1995 and then to the University of Pittsburgh in 2002, where he is a Professor of Neurobiology. In addition to the prosthetics work, he continues to use systems approaches to study basic mechanisms of volitional performance.

Theme Keynote Lecture

"Towards A Completely Biological Living Heart Valve Replacement"



Robert Tranquillo, Ph.D.

University of Minnesota
Minneapolis, MN, USA

13:30
Saturday, 5 September
Grand Ballroom – Salon A

Abstract
A tissue-engineered heart valve (TEHV) is considered a promising alternative for valve replacement, especially in pediatric patients. A fibrin gel scaffold provides for the possibility of a completely biological TEHV, while being conducive to extracellular matrix deposition by entrapped tissue cells. We have demonstrated the feasibility of fabricating a fibrin-based TEHV using neonatal human dermal fibroblasts, including leaflets with structural and mechanical anisotropy similar to native leaflets. A novel controlled cyclic stretch bioreactor is presented to enhance the mechanical and functional properties of the TEHVs. Using incremental strain amplitude stretching, the fibrin-based TEHV was conditioned in the bioreactor for 3 weeks, yielding improved tensile properties and collagen deposition compared to statically-cultured valves. The tensile stiffness (modulus) and anisotropy (measured as ratio of leaflet modulus in circumferential to radial directions) in the leaflets was comparable to values for the sheep pulmonary valve leaflet. In addition, the TEHV could withstand pressures up to 150 mmHg with a root compliance comparable to sheep pulmonary artery at physiological pressures. Bi-leaflet TEHV were implanted in the pulmonary artery of two sheep for 4.5 weeks with the pulmonary valve either left intact or rendered incompetent by leaflet excision. Echocardiography immediately after implantation showed functional coapting leaflets, with normal right heart function. It was also performed just prior to explantation, revealing functional leaflets although with moderate regurgitation in both cases and a partial detachment of one leaflet from the root in one case. The explanted leaflets had thickness and tensile properties comparable the implanted leaflets. There was endothelialization on the lumenal surface of the TEHV root. These preliminary results are unprecedented for a TEHV developed from a biological scaffold; however, many issues remain to be surmounted.

Biographical Sketch
Prof. Tranquillo received his Ph.D. in Chemical Engineering in 1986 from the University of Pennsylvania. He was a NATO Postdoctoral Fellow at the Center for Mathematical Biology at Oxford for one year before beginning his appointment in the Department of Chemical Engineering & Materials Science at the University of Minnesota in 1987. He has served as the head of the new Department of Biomedical Engineering since its inception in 2000. Prof. Tranquillo has used a combined modeling and experimental approach to understand cell behavior, in particular, directed cell migration and cell-matrix mechanical interactions. More recently, his research program has focused on the role of cell behavior in cardiovascular and neural tissue engineering applications. His research has resulted in over 70 peer-reviewed publications. Prof. Tranquillo is a Fellow of the American Institute of Medical and Biological Engineering and the Biomedical Engineering Society, and a Distinguished McKnight University Professor.

Theme Keynote Lecture

"Frontiers in Biomedical Imaging with Ultrahigh Magnetic Fields"

Kamil Ugurbil, Ph.D.

University of Minnesota
Minneapolis, MN, USA

13:30
Friday, 4 September
Grand Ballroom – Salon A

Abstract

In the last decade and a half, imaging of cellular processes *in vivo* has been identified as an indispensible capability for biomedical research. Today, numerous different technologies are employed in pursuit of imaging processes such as *organ function*, *intracellular chemistry*, *tissue perfusion*, *oxygen utilization*, *gene expression, and enzyme activity* in intact animals and humans. In this effort, magnetic resonance imaging (MRI) has evolved as a powerful tool. MRI has proven to be rich in information content but has inherently poor detection sensitivity, which imposes a fundamental limitation on this methodology. Starting in the early nineties, there has been a concerted effort to explore ever-increasing field strengths to overcome this limitation. Higher magnetic fields, however, pose numerous serious challenges for imaging biological objects the size of the human head and especially the human torso. However, with appropriate engineering and methodological solutions, human imaging at 7 and 9.4 Tesla has been shown to be feasible and advantageous, providing enhancements that include improved signal-to-noise (SNR) ratio and, in many applications, significantly improved anatomical and functional contrast. These engineering developments and unique applications such a functional imaging in the brain at the level of elementary computational units will be discussed.

Biographical Sketch

Kamil Ugurbil is a Professor in the Departments of Radiology, Neurosciences, and Medicine, the McKnight Presidential Endowed Chair of Radiology, and the Director of the Center for Magnetic Resonance Research (CMRR) at the University of Minnesota. Dr. Ugurbil was educated at Columbia University, New York, where he received A.B. and Ph.D. degrees in physics and chemical physics, respectively. He worked at AT&T Bell Laboratories after receiving his Ph.D. in 1977, and subsequently returned to Columbia University in 1979 as an Assistant Professor. In 1982, he moved to the University of Minnesota where he started the in vivo magnetic resonance imaging and spectroscopy research effort, which ultimately led to the creation of CMRR. His current research interests include the development of ultrahigh magnetic resonance methodology for MR imaging and spectroscopy, high specificity and high resolution mapping of brain function using MR methods and ultra high magnetic fields, mechanisms of coupling of MR detectable signals to brain activity, oxidative-metabolism in the brain and neurochemistry, and cardiac bioenergetics- regulation of oxidative phosphorylation and mechanical work. Dr. Ugurbil was inducted into the American Academy of Arts and Sciences in 2005 and elected into the National Academy of Sciences (USA) - Institute of Medicine in 2007.

Theme Keynote Lecture

"Photoacoustic Tomography: High-resolution in vivo Imaging of Optical Contrast at New Depths"

Lihong V. Wang, Ph.D.

Washington University in St. Louis
St. Louis, WA, USA

10:25
Friday, 4 September
Grand Ballroom – Salon A

Abstract

We develop biophotonic technologies for functional and molecular imaging by physically combining non-ionizing electromagnetic and ultrasonic waves via energy transduction. Key applications include early-cancer detection and functional imaging. Electromagnetic waves in the non-ionizing spectral region provide rich tissue contrast but do not penetrate tissue in straight paths as x-rays do. Consequently, high-resolution pure optical imaging (e.g., confocal microscopy, two-photon microscopy, and optical coherence tomography) of biological tissue is limited to depths within one optical transport mean free path (~1 mm in the skin). Ultrasonic imaging, on the contrary, provides good image resolution but suffers from strong speckle artifacts as well as poor contrast in early-stage tumors. We have developed ultrasound-mediated imaging modalities by combining electromagnetic and ultrasonic waves synergistically to overcome the above problems. In photoacoustic tomography (PAT), a pulsed laser beam illuminates the biological tissue and generates a small but rapid temperature rise, which causes the emission of ultrasonic waves as a result of thermoelastic expansion. The short-wavelength ultrasonic waves are then detected to form high-resolution tomographic images. Thermoacoustic tomography (TAT) is similar to PAT except that low-energy radio-frequency pulses, instead of laser pulses, are used. Although the long-wavelength radio-frequency waves diffract rapidly, the short-wavelength ultrasonic waves provide high spatial resolution.

Biographical Sketch

Lihong Wang studied for his Ph.D. degree at Rice University, Houston, Texas under the tutelage of Drs. Robert Curl, Richard Smalley and Frank Tittel. Dr. Wang has authored and co-authored two books, including one of the first textbooks in the field of biomedical optics, published close to 200 peer-reviewed journal articles, and delivered ~200 keynote, plenary, and invited talks. He is the editor for the first comprehensive book on biomedical photoacoustic tomography, and serves on the editorial board of the Journal of Biomedical Optics. Currently he serves as an equal co-chair for the International Biomedical Optics Society. He has served as a study section chair or grant reviewer for NIH, NSF, etc., and is currently a chartered member on an NIH study section. His research on non-ionizing biophotonic imaging has been funded by NIH with more than $20M (Dr. Wang as the principal investigator on 12 grants), NSF, and other funding agencies. He was a recipient of the NIH FIRST award and NSF CAREER award. His laboratory invented or discovered frequency-swept ultrasound-modulated optical tomography, dark-field confocal photoacoustic microscopy (PAM), optical-resolution PAM, photoacoustic Doppler sensing, photoacoustic reporter gene imaging, focused scanning microwave-induced thermoacoustic tomography, exact reconstruction algorithms for photoacoustic or thermoacoustic tomography, sonoluminescence tomography, Mueller-matrix optical coherence tomography, optical coherence computed tomography, and oblique-incidence reflectometry. In particular, PAM has reached super-depth for biochemical, functional, and molecular imaging in living tissue at high resolution. His Monte Carlo model of photon transport in scattering media has been used worldwide. Dr. Wang is a Fellow of IEEE, AIMBE, OSA, and SPIE.