Keynote: Extreme Photonics

Prof. Nader Engheta
H. Nedwill Ramsey Professor
University of Pennsylvania

Abstract: Recent development in nanotechnology, nanoscience, optical physics, and materials science and engineering has provided opportunities to construct structures with unprecedented attributes and characteristics in manipulating waves and fields. We have been exploring a series of phenomena related to the wave-matter interaction in platforms with extreme scenarios, such as one-atom-thick optical structures based on graphene photonics, optical lumped nanocircuitry ("optical metatronics") which is a circuit paradigm with light at the nanoscale, near-zero-index photonics in materials with effective permittivity and/or effective permeability exhibiting values near zero, photonic doping, slow energy velocity, geometry-independent resonant structures, nonreciprocal vortices at subwavelength scales, optical information processing and computing with waves in specialized materials, large anisotropy and nonlinearity, "low-index" photonics, and more. The "extreme photonics" is an exciting platform with unconventional features and functionalities for quantum-based and wave-based paradigms in wave dynamics. I will discuss some of our ongoing work in these areas, will present some of the opportunities and challenges, and will forecast some future directions and possibilities.

Biography: Nader Engheta is the H. Nedwill Ramsey Professor at the University of Pennsylvania in Philadelphia, with affiliations in the Departments of Electrical and Systems Engineering, Bioengineering, Materials Science and Engineering, and Physics and Astronomy. He received his B.S. degree from the University of Tehran and his M.S and Ph.D. degrees from Caltech. His current research activities span a broad range of areas including photonics, metamaterials, nano-optics, graphene optics, electrodynamics, imaging and sensing inspired by eyes of animal species, microwave and optical antennas, and physics and engineering of fields and waves.

He has received several awards for his research including the *2017 William Streifer Scientific Achievement Award* from the IEEE Photonics Society, the *2015 Gold Medal from SPIE, the 2015 Fellow of US National Academy of Inventors (NAI), the 2014 Balthasar van der Pol Gold Medal* from the International Union of Radio Science (URSI*),* the *2017 Beacon of Photonics Industry Award* from the Photonics Media, *the 2015 Vannevar Bush Faculty Fellowship Award* from US Department of Defense, the *2012 IEEE Electromagnetics Award, the 2015 IEEE Antennas and Propagation Society Distinguished Achievement Award, the 2015 Wheatstone Lecture in King's College London,* the *2013 Inaugural SINA Award in Engineering, 2006 Scientific American Magazine 50 Leaders in Science and Technology*, the *Guggenheim Fellowship*, and the *IEEE Third Millennium Medal.* He is a Fellow of seven international scientific and technical organizations, i.e., IEEE, OSA, APS, MRS, SPIE, URSI, and American Association for the Advancement of Science (AAAS). He has received the honorary doctoral degrees from the Aalto University in Finland in 2016, from the University of Stuttgart, Germany in 2016, and from Ukraine's National Technical University Kharkiv Polytechnic University in 2017.

Invited Talk: Polarization dynamics in ultrafast fiber lasers for dual-output femtosecond Thulium laser

Prof. Michelle Sander
Department of Electrical and Computer Engineering
Boston University

Abstract: Dual-output ultrafast lasers pave a promising pathway towards compact single sources for high precision metrology and dual comb spectroscopy. Based on polarization vector soliton dynamics, an innovative compact fiber laser with co-generated, orthogonally polarized interlaced pulses will be presented. Depending on an intracavity polarization controller setting, the cavity birefringence can be modified, and scalar as well as vector solitons induced. Further, self-organized multiple pulsing operation will be discussed in turn-key, compact thulium fiber lasers. Novel states at higher pump power than for the single pulsing regime are studied and detailed noise characteristics recorded that underline the stability and the self-organization of multiple pulses in the cavity. With operation the eye-safe wavelength region from 1.7 µm to 2.2 µm, these femtosecond thulium fiber lasers are attractive for applications in gas/environmental sensing, biomedical diagnosis and surgery and nonlinear conversion.

Biography: Dr. Michelle Sander is an assistant professor in the Department of Electrical and Computer Engineering at Boston University and an affiliated faculty with the Materials Science and Engineering Division. She is a member of the BU Photonics Center, the BU-BUMC Cancer Center, the Center for Neurophotonics and the BU Nanotechnology Center. She received her PhD in Electrical Engineering from the Massachusetts Institute of Technology in the Optics and Quantum Electronics Group. Previously, she received a German Diploma degree in Electrical Engineering and a Master of Science degree from the Georgia Institute of Technology. Her research interest include the development of innovative novel ultrafast fiber, characterization of femtosecond dynamics and applications to vibrational spectroscopy and biomedical imaging. Dr. Sander received an AFOSR Young Investigator Award, is the recipient of two BU Dean's Catalyst Awards and the BU Nanotechnology Innovation Center Award. In 2017, she serves as an OSA Ambassador.

Invited Talk: Structural colors and ultrasonics by light interaction with nanostructures

Prof. L. Jay Guo
Department of Electrical and Computer Engineering
University of Michigan

Abstract: Controlling light transmission, absorption and reflection are essential for a wide range of engineering applications. Structural colors can be realized by using ordinary metal and dielectric materials, and can benefit compact and high efficiency displays and imagers, building integrated photovoltaics, and new vehicle coatings with unique visual effect. Light interacting with low density carbon nanotubes (CNTs) could conceal the 3D attributes of an object; similar principle can be applied to create broadband RF absorptions. The guiding principles will be introduced, with an emphasis on structural simplicity, and scalability to practical manufacturing.

Light interacting with CNT/polymer composite can be used to generate strong ultrasound signals via optoacoustic effect, which could lead to non-invasive and high-precision therapeutic applications in the future. Using similar concept, a new THz detection scheme is developed by "listening to" the sound wave generated by the nano-material absorbing the THz energy. Compact, room-temperature and real-time THz detector can be realized.

Biography: L. Jay Guo started his academic career at the University of Michigan in 1999, and has been a full professor of Electrical Engineering and Computer Science since 2011, and affiliated with Applied Physics program, Mechanical Engineering, Macromolecular Science and Engineering. He has more than 200 refereed journal publications with over 25,00 citations, and ~ 20 US patents. Many published work from his lab have been featured by numerous media. He was the recipient of the Research Excellence Award from the College of Engineering at UM and Outstanding Achievement Award from the EECS department. He served on a number of international conference program committees related to nanotechnologies and photonics. His group's researches include polymer-based photonic devices and sensor applications, organic and hybrid photovoltaics, plasmonic nanophotonics, nanoimprint-based and roll to roll nanomanufacturing technologies.

Invited Talk: New Optical Tools for Bladder Cancer Diagnostics

Prof. Audrey Bowden
Electrical Engineering Department
Stanford University

Abstract: The Stanford Biomedical Optics group, led by Professor Audrey Bowden, aims to develop and deploy novel optical technologies to solve interdisciplinary challenges in the clinical and basic sciences. In short, we use light to image life -- and in so doing, illuminate new paths to better disease diagnosis, management and treatment. In this talk, I will discuss our recent efforts to design, fabricate and/or construct new hardware, software and systems-level biomedical optics tools to facilitate early detection of bladder cancer, which hold an unfortunate distinction as the 5th most common cancer in men and the most costly of all cancers per patient lifetime. Our efforts span development of new fabrication techniques for 3D tissue-mimicking phantoms, new strategies for creating large mosaics and 3D models of endoscopic data, as well as new algorithms and imaging scopes for use with optical coherence tomography.

Biography: Audrey K (Ellerbee) Bowden is an Associate Professor of Electrical Engineering and Bioengineering at Stanford University. She received her BSE in EE from Princeton University, her PhD in BME from Duke University and completed her postdoctoral training in Chemistry and Chemical Biology at Harvard University. During her career, Dr. Bowden served as an International Fellow at Ngee Ann Polytechnic in Singapore and as a Legislative Assistant in the United States Senate through the AAAS Science and Technology Policy Fellows Program sponsored by the OSA and SPIE. She is a member of the OSA, a Senior Member of SPIE and is the recipient of numerous awards, including the Air Force Young Investigator Award, the NSF Career Award and the Hellman Faculty Scholars Award. She is a former Associate Editor of IEEE Photonics Journal, a member of numerous professional committees, and her research interests include biomedical optics, microfluidics, and point of care diagnostics.

Invited Talk: Brilluoin microscopy for tissue and cell biomechanics

Prof. Giuliano Scarcelli
Department of Bioengineering
University of Maryland

Abstract: Brillouin microscopy is an intriguing solution to the non-invasive measurement of material mechanical properties without contact. In Brillouin light scattering, the interaction of light with intrinsic mechanical vibrations of material, allows to read out mechanical information optically via the spectral analysis of the scattered light. Brillouin spectroscopy has long been employed as a non-contact method for mechanical testing but its poor temporal resolution limited the analysis to few points per sample. In the past years, by developing a spectrometer with several orders of magnitude improved throughput and extinction, we created a Brillouin imaging technology, where contrast is based on the longitudinal elastic modulus.
At the tissue level, we have focused on ocular tissue biomechanics, in particular to corneal ectatic disorders. Corneal biomechanics is central in the development of ectasia. Therefore the biomechanical characterization of the cornea is crucial to understand the progression of keratoconus and thus improve its early diagnosis and management. Beyond tissue applications, we recently developed high-resolution Brillouin microscopy to map intracellular elasticity through increased spectrometer sensitivity, extinction and throughput. Here, we show that Brillouin microscopy is able to map the longitudinal elastic modulus with sub-cellular three-dimensional resolution in a non-contact and non-invasive fashion.

Biography: Giuliano Scarcelli is a physicist specialized in optical science and technology development. He obtained his PhD in quantum optics from UMBC under Prof. Yanhua Shih. Before joining College Park, Giuliano was at the Wellman Center for Photomedicine of Harvard Medical School for eight years, first as a postdoc in Prof. Yun's Lab, then as an instructor and assistant professor. He maintains a visiting faculty position at Harvard Medical School. Giuliano has been the recipient of several awards such as the "Exceptional by example" award for outstanding PhD studies, the Tosteson Postdoctoral Fellowship, the Human Frontier Science Program Young Investigator Award, the NIH Quantitative Career Award, and the Harvard University "Teaching excellence" award.