Colloquia

Archives: Spring 2015

Department of Electrical and Computer Engineering Colloquia: Tufts University

Halligan Hall, Tuesdays from 2:50 pm to 4:15 pm (refreshments at 2:50, talk begins at 3:00) unless otherwise noted.

All seminars are open to the public. Our seminars are a great opportunity to see the results of exciting new research by faculty, students, or other institutions, or just to get a sense of what the ECE Department is all about. For comments or questions, or if you would like to receive email notifications of upcoming colloquia, please send us an email.

Organizers: Shuchin Aeron and Tom Vandervelde

January 20, 2015
Halligan 102 | 3:00–4:15 pm
Mid-Infrared Quantum Cascade Lasers and Applications
Speaker: Claire Gmachl, Ph.D., Dept. of Electrical Engineering & MIRTHE, Princeton University

Abstract:
Quantum Cascade (QC) lasers are a rapidly evolving mid-infrared and THz, semiconductor laser technology based on intersubband transitions in multiple coupled quantum wells. The lasers' strengths are their wavelength tailorability, high performance and fascinating design potential.

We will first give a brief introduction into QC lasers followed by a discussion of several recent highlights, such as the quest for high performance QC lasers and the implementation of unconventional laser schemes and new materials for intersubband devices. We will also briefly touch on several applications, such as field campaigns of QC laser-based sensing, and our recent work in non-invasive in vivo glucose sensing.

With respect to spectral innovations, a spectrally broadband QC laser based on a 'continuum-to-continuum' design will be presented. When this laser is put into an external cavity, a wide, continuous single-mode tuning range of well over 400 cm-1 is achieved. Next we explore opportunities for obtaining single-mode and tunable emission without the need of dispersive gratings. Tunable Asymmetric Mach Zehnder cavities have all shown great potential for achieving single-mode emission at reduced fabrication complexity and cost.

Opportunities exist for broadening the spectral availability of Quantum Cascade lasers through the adoption of new material systems beyond the conventional InP- or GaAs-based ternary alloys. We will review our recent work in II-VI and III-nitride intersubband devices.

Finally, we provide a quick overview on QC laser applications; a recent advance is the demonstration of non-invasive glucose monitoring in vivo with near clinical accuracy.

The work presented is mostly supported by MIRTHE (NSF-ERC) with smaller contributions from other sources; the work has been conducted in collaboration with many valued colleagues in our own research group and across MIRTHE.

Speaker Bio:
Claire Gmachl received the Ph.D. degree (sub auspicies praesidentis) in electrical engineering from the Technical University of Vienna, Austria, in 1995. In 1996, she joined Bell Laboratories, Lucent Technologies,

Murray Hill, NJ, to work on Quantum Cascade lasers and microcavity devices. In 2003, Gmachl joined Princeton University as an Associate Professor in the Department of Electrical Engineering and adjunct faculty to PRISM; since July 2007 she is Full Professor at Princeton University, and a Eugene Higgins Professor of Electrical Engineering since 2011. Her group's research is focused on mid-infrared photonics, especially Quantum Cascade lasers, mid-infrared intersubband materials and devices, and applications. Gmachl is the Director of MIRTHE, the NSF Engineering Research Center on Mid-InfraRed Technologies for Health and the Environment, established in 2006. Gmachl has authored and co-authored more than 250 publications, has given more than 100 invited presentations at conferences and seminars, and holds 26 patents. She has received a 2014 President's Award for Distinguished Teaching, the SEAS Distinguished Teaching Award 2013, an E-council/GEC Excellence in Teaching Award in 2012, and a Princeton University graduate mentoring award in 2009; she was an Associate Editor for Optics Express and a member of the IEEE/LEOS Board of Governors. Gmachl is a 2005 MacArthur Fellow and a member of several professional societies.

February 3, 2015
Halligan 102 | 3:00–4:15 pm
The entrepreneurial process of commercializing semiconductor Innovations
Speaker: Dr. Bunmi Adekore, Ph.D., North Carolina State University

Abstract:
Industry expansion of wide band gap (WBG) semiconductors continue with expected strong growth in 2015. Widespread adoption of AlGaInN based blue and ultraviolet light emitting devices; SiC based power electronics for variety of applications; in tandem represent a market share approaching $20B. Novel WBG materials, devices and processing innovation now enable the commercialization of next generation electronic devices such as AlGaN, ZnMgO based HEMTs and JFETs as well as piezo-electric energy harvesters with disruptive cost-performance advantages. Materials synthesis routes, device architecture and fabrication approaches as well as the innovation commercialization process will be introduced and discussed.

Speaker Bio:
Dr. Adekore received his B.Sc., magna cum laude; and, Ph.D in Materials Science and Engineering and Electronic Engineering from North Carolina State University in 1999 and 2003 respectively. Dr. Adekore was a department of defense multi-university research initiative (DOD-MURI) post doctoral scholar at Hanscom Air Force Research Laboratories where he led efforts in solvus-thermal crystallization of III-Nitrides and II-VI compounds. He has been a lead scientist on projects involving III-V materials hetero-integration onto silicon for high speed applications. His current technological contributions include the crystallization and fabrication of optical and electronic devices of III-Nitrides and II-VI compound semiconductors.

As an entrepreneur, Dr. Adekore's has been involved in founding and leading hardware companies in clean-tech, semiconductor engineering and in bio-medical devices. He has authored and co-authored several scientific publications in the arena of wide band gap semiconductor materials and a member of scientific organizations including the Materials Research Society (MRS), American Society of Metals, American Association of Crystal Growth and the Institute of Electrical and Electronic Engineers (IEEE). He is passionately committed to a clean energy economy by materials enabled technologies in the United States and emerging economies.

February 10, 2015
Halligan 102 | 3:00–4:15 pm
Robust Matrix Completion for Online Subspace Estimation and Tracking
Speaker: Hassan Mansour, Ph.D., University of British Columbia (UBC), Vancouver, Canada

Abstract:
Recent SVD-free matrix factorization formulations have enabled rank minimization for systems with millions of rows and columns, paving the way for matrix completion for extremely high dimensional data. In this

talk, we discuss robust matrix completion and subspace tracking algorithms that use factorized matrix decomposition with a pre-specified rank to detect and track a low rank subspace from incomplete measurements and in the presence of sparse noise. We demonstrate the performance of our algorithm for video background subtraction.

Speaker Bio:
Hassan Mansour is a member of the research staff in the Multimedia Group at Mitsubishi Electric Research Laboratories, Cambridge, MA. He received his M.A.Sc. (2005) and Ph.D. (2009) from the Department of Electrical and Computer, University of British Columbia (UBC), Vancouver, Canada where he conducted research on scalable video coding and transmission. He then pursued a postdoctoral fellowship in the Departments of Mathematics, Computer Science, and Earth and Ocean Sciences at UBC working on theoretical and algorithmic aspects of compressed sensing and its application to seismic imaging.

February 17, 2015
Halligan 102 | 3:00–4:15 pm
Towards Large-Scale Zero-Shot Recognition in Similarity Spaces
Speaker: Dr. Ziming Zhang, Ph.D., Boston University

Abstract:
In the era of big data, large-scale learning has been attracting more and more attention, such as large-scale image classification. Collecting such big data, however, may be very challenging itself. Zero-shot learning, as a special case of transfer learning, provides us an efficient automatic tool to apply the classifiers in one domain (e.g. natural language processing (NLP)) to another (e.g. images). In this talk, I will present a novel zero-shot learning framework to bridge the gap between the source and target domains based on within-domain similarity or cross-domain similarity. Structured learning is utilized to formulate our framework. Using this framework, I will show three different applications: (1) zero-shot image classification, (2) person re-identification, and (3) kinship recognition. In all these tasks, our method can significantly outperform the current state-of-the-art on different benchmark datasets.

Speaker Bio:
Dr. Ziming Zhang received an MS degree in 2010 from School of Computing Science at Simon Fraser University, Canada. Later he received a PhD degree in Computer Science from Oxford Brookes University, UK, under the supervision of Prof. Philip H. S. Torr in 2013. Currently he is holding a research position in Boston University, MA. His research areas includes object recognition and detection, machine learning, optimization, large-scale information retrieval, visual surveillance, and medical imaging analysis. His works have been published at top conferences such as CVPR, ECCV, and NIPS.

March 3, 2015
Halligan 102 | 3:00–4:15 pm
Light Matters: Photonics for health, consumer, and communication
Speaker: Shrenik Deliwala, Ph.D., Analog Devices

Abstract:
In today's talk, we will discuss photonics at Analog Devices and specifically on the work done at ADI for health care. I will provide general overview as well as some specific examples of our work such as ultra-low power and yet high SNR designs.

Speaker Bio:
Shrenik Deliwala has been working on various photonic projects at ADI. These include high speed communication, gesture sensing, photodiode arrays for CT scanners, and measurement of biometric signals. He is the principal author of more than 15 refereed papers and over 47 patents in the field of silicon optics, optical communication, interferometry, and imaging.

March 10, 2015
Halligan 102 | 3:00–4:15 pm
Adaptive Zero-Voltage-Switching Full Bridge DC-DC Converters with Reduced Conduction Losses
Speaker: Dr. Alireza Safaee, Ph.D., Osram Sylvania Inc.

Abstract:
High frequency operation of dc-dc converters allows smaller passive components and higher power density, provided that soft switching of the converter is maintained for all the operating conditions. Due to the highest duration of conduction in all the switches, phase shift modulation is a preferred modulation scheme in high frequency full bridge dc-dc converters. In such converters the leakage inductance of the transformer is often very low, and consequently the leading switch leg loses it desirable soft switching feature at light load or high input voltage conditions. Robust and low-cost auxiliary circuits are capable of guaranteeing the soft switching in the entire operational conditions which enable the converter to process and deliver power efficiently over very wide load variations. To gain higher efficiencies it is desirable to minimize the current through the auxiliary circuits. Here a general overview of the operational principle, control method and design procedure of the standard single-inductor auxiliary circuits will be discussed. Also a novel category of robust passive auxiliary circuits will be introduced with the same soft switching functionality with a minimum of 20% reduction in rms current and 65% reduction in switching frequency variation compared to the standard single-inductor counterparts.

Speaker Bio:
Alireza Safaee received the B.Sc. degree in electrical engineering from Isfahan University of Technology, M.Sc. in solid state physics from Sharif University of Technology, Ph.D. in electrical power systems from University of Quebec and the second Ph.D. in power electronics from Queens University, Canada. From 1997 to 2005, he was a senior design engineer and later a design manager at Manabe Taghzyeh Electronic Company, Tehran, Iran, where his teams developed several types of chargers, inverters, stabilizers, and UPS systems for more than 1000 communication sites and power plants. From 2011 to June 2014, he was an electrical analyst at Bombardier Transportation Inc., Kingston, Ontario, Canada. He is currently a principal power electronics researcher in Osram Sylvania, Massachusetts, USA. He is the author of more than 30 scientific papers and the holder of 10 granted and pending U.S. patents. His current research interests include power electronics, magnetic design, resonant and soft-switching converters, and their control methods toward applications in aviation, renewable energy systems and lighting solutions. He is a senior member of IEEE and the recipient of the "Research Excellence Award" from IEEE, as well as the chair of power electronics society in IEEE Kinston section, Region 7.

March 24, 2015
Halligan 102 | 3:00–4:15 pm
Nanoelectronics and Optoelectronics at the Atomically Thin Limit
Speaker: Swastik Kar, Ph.D., Assistant Professor, Physics Department, Northeastern University

Abstract:
The success of graphene has led to research in a whole array of newly developed, atomically thin, single- and few-layered materials. In this talk, the potential for new generation optoelectronics on graphene-based systems, as well as 2D atomically thin systems beyond graphene will be explored. We will see how, by utilizing the ultrahigh mobility and the unique density of states of graphene, it is possible to develop extremely sensitive and tunable photodetectors for a broad range of applications. Next, we will present two dimensional alloys, and structurally modulated in-plane and vertically assembled 2D materials. 2D alloys are a new tribe of atomically thin material which allow the formation of structural inhomogeneity at the atomic scale within the same atomically thin plane, which creates an interesting new play-field for electronics and optics. In this context, we will present our recent work on atomically thin layers of boron, nitrogen, carbon and oxygen. Moreover, Structurally patterned atomically thin sheets represent another new concept, whereby two different types of 2D materials can form within a single layer, with atomically thin junctions. We will present our recent developments on atomically thin MoS2-MoSe2 heterolayers and periodic

structures. These materials are not only exciting fundamentally, but also possess the potentials for advanced nano-applications. Finally, we will talk about our recent work on the tunable optical properties and light emission from few-layered and nano-plated structures of bismuth selenide. These new generations of materials and systems have immense potentials for revolutionizing materials science in the next decade.

Speaker Bio:
Prof. Kar has a PhD in physics from IISc Bangalore, India, and held several postdoctoral appointments before joining the Physics Department of Northeastern University in 2010. He has extensive experience in nanomaterials synthesis, their characterizations, and applications development in nanoelectronics, optoelectronics, and various sensor, detectors, and energy devices. His most recent areas of interest involve development of carbon nanotubes, graphene, and 2D materials beyond graphene for advanced applications. He has authored/co-authored over 50 peer-reviewed Journal papers, including in Journals such as Nature Materials, Nature Photonics, Nature Nanotechnology, Nature Communications, Physical Review Letters, Nano Letters etc. He received the NSF Early Career Award in 2014.

March 31, 2015
Halligan 102 | 3:00–4:15 pm
Tackling Big Data with MATLAB
Speaker: Adam Filion, M.S., Mathworks

Abstract:
Are the data sets you need to analyze becoming uncomfortably large to work with in memory? Are they taking too long to compute? Are you finding it challenging to scale your algorithms to big data sets? In this seminar, you will learn strategies and techniques for handling large amounts of data in MATLAB. New big data capabilities in MATLAB R2014b will be highlighted.

Speaker Bio:
Adam Filion holds a BS and MS in Aerospace Engineering from Virginia Tech where his research involved nonlinear controls of spacecraft and periodic orbits in the three-body problem. After graduating he joined the MathWorks Engineering Development Group in 2010 and moved to Application Engineering in 2012. He currently focuses on data analytics, machine learning and big data.

April 7, 2015
Halligan 102 | 3:00–4:15 pm
Astronomy, Telescopes and Exoplanets
Speaker: Professor Robert A. Gonsalves, Emeritus Professor and former Chair of Electrical and Computer Engineering at Tufts

Abstract:
From antiquity until the Renaissance, astronomers used clever geometric tricks to explain how the universe works - with some success. Ptolemy's earth-centric model guided ships for 15 centuries! Then thinkers like Copernicus and Kepler used common sense to propose a sun-centric model for our solar system; Galileo used his telescope to confirm these ideas (making the Pope angry); and Newton, in his grand tome, "Principia," used math to explain the motion of all known planets.

When the Hubble Space Telescope was put into orbit above the earth's turbulent atmosphere, it allowed us to look way beyond our milky way galaxy. At nearly the same time scientists and engineers tamed the atmosphere's "tremors," as Newton called them, by using Adaptive Optics (AO). This made earth-based astronomy much more powerful. Now the search is on to find "Goldilocks" exoplanets, those planets orbiting a distant sun at just the right distance from its sun to support life as we know it. In this talk we give some of the history of astronomy and will emphasize the math, science and algorithms which have expanded our celestial knowledge and have produced new technologies to make our planet a better place to live.

Speaker Bio:
Robert A. Gonsalves is an Emeritus Professor and former Chair of Electrical and Computer Engineering at Tufts. His research is in image processing with applications in the graphic arts, medicine, astronomy, and historical images. In 1990 he helped NASA fix the Hubble Space Telescope by calculating a prescription to correct a flaw in the HST's optics. He was an advisor on image processing for Frontline's 1993 program on the Kennedy assassination and for NASA on the optics for the Next Generation Space Telescope. He is a Fellow of the International Society for Optics and Photonics and the winner of Tufts' Leibner Award for teaching and advising.

April 14, 2015
Halligan 102 | 3:00–4:15 pm
Wireless Power Transfer Research at MERL
Speaker: Bingnan Wang, Mitsubishi Electric Research Laboratories (MERL)

Abstract:
Wireless power transfer (WPT), in particular, near field resonant coupling based technology, has attracted a lot of interest in recently years, due to many promising applications such as wireless charging for portable devices. In this talk, we present our research on WPT, which focuses on the development of WPT technologies with improved performance and better flexibility than existing ones. We show that metamaterials can be used to improve the coupling coefficient and increase the power transfer efficiency. Resonantly coupled coil arrays can be used to extend the range of WPT, and provide power continuously to a moving device. We also show that a multi-coil system with LLC circuit configuration is suitable for wireless charging to multiple devices of different power requirements.

Speaker Bio:
Bingnan Wang is a Principal Member of Research Staff at Mitsubishi Electric Research Labs (MERL) in Cambridge, MA. He has been with MERL since fall of 2009. His research focuses on electromagnetic materials, structures and their applications. His research topics include wireless power transfer, photonic devices, sensing, and metamaterials. Before that, he obtained his B.S degree in Physics from Fudan University, China, in 2003, and Ph.D. degree from Iowa State University in 2009, also in Physics.