The USC *Smart Energy Summit*
Friday January 27, 2012, 8.30am start
ACB 238 (second floor West Wing of Ahmanson Center)
Location information at the following websites:
http://dornsife.usc.edu/distance-learning-studio-classrooms/
http://web-app.usc.edu/maps/

This Smart Energy Summit is aimed at developing an understanding of future possible research directions and opportunities. The presentations will be video recorded. Slides presented will also be made available and incorporated into a workshop proceedings document. Location of breakout room is ACB 431.

Agenda:

8.30am	Coffee
8.50am	Welcome and remarks from Dean of Engineering, Dean Yortsos
9.00am	**Rich Carlin** (ONR), Fuel Cells: Thermodynamic Engine to a Sustainable Energy Future
9.30am	**Khalil Amine** (ANL), Advanced High Energy and High Power Battery Systems for Automotive Applications
10.00am	**Martin Gundersen (USC)** and **Dan Singleton,** Transient Plasma Applications
10.30am	Coffee break
11.00am	**Bedros Afeyen** (Polymath Research Inc.), Controlling Plasma Instabilities: A Multidisciplinary Approach
11.30am	**Keith Bradley** (ANL), Nuclear Energy: Where do we go from here?
12.00pm	**Roger Ghanem** (USC), Challenges and Opportunities in being Predictive for Complex Interacting Systems.
12.30pm	Lunch (sandwiches and salads provided)
1.30pm	**Habib Najm** (Sandia NL), Analysis and Reduction of Power Grid Models under Uncertainty
2.00pm	**Zhifeng Ren** (Boston College), Electron and Phonon Engineering in Nanostructured Thermoelectric Materials
2.30pm	**Mike Campbell** (Logos Technology), Perspectives and opportunities for Renewable Energy and National Security
3.00pm	Coffee break
3.30pm	Commercial opportunities
4.00pm	Discussion
5.00pm	Wrap-up

9.00am

Fuel Cells: Thermodynamic Engine to a Sustainable Energy Future

Richard T. Carlin
Office of Naval Research

Abstract

Fuel cells operating on hydrogen and other appropriate fuels provide many advantages for meeting Department of Defense (DoD) needs: long endurance mobile platforms, reduced fossil fuel dependence, and increased facility energy efficiency. Representative DoD applications will be briefly discussed. Less recognized is the multifaceted role fuel cells can play in implementing sustainable, reliable electrical grids and micro-grids. Integration of fuel cell systems with renewable electrical generation (wind, photovoltaic, geothermal, etc.) facilitates high-percentage renewable penetration; enhances grid and micro-grid power management; provides efficient electrical power generation from biomass; provides easily scalable micro-grid energy storage; and enables long-endurance distributed backup power. Fuel cells, therefore, are a single, highly reliable, thermodynamically efficient engine providing energy storage, power management, power generation, secured backup power, and more.

Biography

Dr. Richard T. Carlin is Department Head for the Sea Warfare and Weapons Department at the Office of Naval Research (ONR). As Department Head, Dr. Carlin overseas a broad range of S&T programs for surface ships, submarines, and undersea weapons with an annual budget of approximately $400M per year. Immediately prior to his current position, he was the Director for the Undersea Weapons and Naval Materials Division with responsibilities in undersea weapons and countermeasures, advanced energetics, structural materials, materials for power systems, and maintenance reduction technologies. During his career at ONR, he also served as the Acting Chief Scientist in 2004 and as Director for the Mechanics and Energy Conversion Division from 2001 to 2005. Dr. Carlin joined ONR in 1997 as the Program Officer for Electrochemistry S&T and Undersea Weapons Propulsion with programs covering numerous electrochemical and thermal power technologies. Dr. Carlin serves as the Department of the Navy's Power & Energy S&T Focus Area executive and is the Navy S&T representative on various energy advisory groups, including Naval Task Force Energy. In September 2010, he was appointed to the DoE Hydrogen and Fuel Cell Technical Advisory Committee.

Before joining ONR, Dr. Carlin held several positions in academia, industry, and government. These included Senior Research Chemist at Air Products and Chemicals carrying out research on gas-separation membranes; a chemistry faculty appointment at the University of Alabama in Tuscaloosa performing research on ionic liquids as solvents and electrolytes; and federal service as the Electrochemistry Division Chief at the Frank J. Seiler Research Laboratory located at the United States Air Force Academy leading research on the use of ionic liquids as electrolytes for batteries, supercapacitors, and metal-alloy electrodeposition.

Dr. Carlin received his B.S. in Honors Chemistry from the University of Alabama in 1977, and his Ph.D. in Inorganic Chemistry from Iowa State University in 1982. Additionally, he was a postdoctoral fellow in Prof. Robert A. Osteryoung's electrochemistry research group at the State

University of New York at Buffalo. He has published over 100 technical papers including 57 reviewed papers and one book chapter, and he is also co-inventor on 7 United State patents.

His awards include the Senior Executive Service Presidential Meritorious Rank Award; Department of the Navy Superior and Meritorious Civilian Service Medals; 2010 Fuel Cell Seminar and Exposition Award; Assistant Secretary of the Navy (RD&A) Awards for the Rapid Transition of Foreveready Missile Battery and Lithium-Ion Polymer Battery; and the United States Air Force Materiel Command Science and Technology Achievement Award for the development of a novel dual graphite-intercalation battery concept.

10.00am

Advanced High Energy and High Power Battery Systems for Automotive Applications

Khalil Amine
Argonne National Laboratory

Abstract

To meet the high-energy requirement that can enable the 40-miles electric drive Plug in Hybrid Electric Vehicle (P-HEVs), long range electric vehicle (EV) and smart grid, it is necessary to develop very high energy and high power cathodes and anodes that when combined in a battery system must offer 5,000 charge-depleting cycles, 15 years calendar life as well as excellent safety characteristics. These challenging requirements make it difficult for conventional cathode materials to be adopted in P-HEVs and EVs. In this talk, we report several high-energy systems that offer the potential of enabling next generation PHEVs and EVs. After a brief description of lithium ion battery concept, we will disclose several strategies to increase significantly the energy density of lithium battery trough the development of novel functional materials. We will also describe some new approaches to improve the cycle life and safety of lithium batteries using advanced nanocoating at the particle level and functional electrolyte additives that play a significant role in stabilizing the interfaces during battery operation and abuse.

Biography

Dr. Khalil Amine is a Senior Fellow Scientist and the Manager of the Advanced Lithium Battery Technology group at Argonne National Laboratory, where he is responsible for directing the research and development of advanced materials and battery systems for HEV, PHEV, EV, satellite, military and medical applications. He is the founder and lead organizer and chair of the International Conference on Advanced Lithium Batteries for Automotive Applications. Among his many awards, Dr. Khalil is a 2003 recipient of Scientific America's Top Worldwide Research 50 Research Award, a 2009 recipient of the US Federal Laboratory Award for Excellence in Technology Transfer, and is the three-time recipient of the R&D 100 Award. In 2010, he was awarded the ECS Battery Technology award and the International Battery Association award. He holds or has filed over 120 patents, patent applications and has over 254 publications. From 1998-2008, Dr. Khalil was the most cited scientist in the world in the field battery technology.

11.00am

Controlling Plasma Instabilities: A Multidisciplinary Approach

Bedros Afeyan
Polymath Research Inc.

Abstract

Plasmas, which make up the fourth state of matter, are notoriously unstable and prone to losing their confinement. How can this be reversed? One method is to use advanced laser technology and stop and start the process in adaptive bursts until the desired ends are met. This is a sophisticated new methodology requiring a multidisciplinary approach to the science and engineering challenges. The theoretical underpinnings and experimental requirements and challenges will be described after an introduction to the canonical approaches to fusion power generation which have many technical challenges still facing them more than 60 years after research began in earnest. The aim is to show how theory, computation, and cutting edge technology from photonics and telecom can be brought to bear on the problem of high average power laser-matter coupling control, which might serve as a paradigm for other energy source research in need of ultrafast, high tech control tools and mechanisms. A key insight of this new technique is the need to combine stochastic and deterministic elements in the space-time construction of the laser pulses for optimal and adaptive control of instabilities.

Biography

Dr. Bedros Afeyan is a plasma physicist by training who started out in Electrical Engineering at Concordia University in Montreal as an undergraduate, worked at Chalk River Nuclear Labs in Ontario for two summers and received his Masters and PhD degrees from the Mechanical and Aerospace Engineering Department of the University of Rochester, in Rochester, NY, working on the nonlinear optics of plasmas. He has worked as a research associate at the University of Maryland, at Lawrence Livermore National Laboratory and at UC Davis, Livermore. His work has been mainly focused on laser-plasma interactions, inertial confinement fusion, magnetic fusion studies of turbulence, Z pinches, nonlinear optics in plasmas and semiconductors, wavelet and multiresolution analysis techniques applied to signal and image processing in high energy density plasma phenomena. He founded and runs a small research company in Pleasanton, CA, Polymath Research Inc. where they work on federal government, national lab and industry funded research. They specialize in nonlinear kinetic plasma physics, modern harmonic analysis applications, Vlasov simulations and wave-wave interaction problems. Polymath Research Inc. has also had long standing collaborations conducting experiments in laser matter interactions at Trident, in LANL and on the Omega laser at LLE.

11.30am

Nuclear Energy: Now What?

Keith Bradley
Argonne National Laboratories

Abstract

For the past several decades, nuclear energy has proven to be one of the most reliable and cost-effective methods of producing base-load power in both the US and abroad. A growing interest in reducing Man's so-called carbon footprint suggested a resurgence in modern nuclear power — a renaissance period. But the renaissance has stalled. But the considerable merits of nuclear power remain robust and provide considerable technical opportunities for cutting-edge R&D. A snapshot of the current state of nuclear energy research and a discussion of the numerous opportunities will be provided.

Biography

Keith Bradley is Technical Director, Advanced Modeling and Simulation - Nuclear Engineering Division, Argonne National Laboratory (http://www.ne.anl.gov/). Keith Bradley has nearly 30 years of experience in national security and advanced nuclear energy research and development. Currently, he manages a complex-wide program in advanced modeling and simulation for the DOE Office of Nuclear Energy. The program develops next-generation predictive simulation capability to advance nuclear power. Most of Bradley's career has been spent in the area of national security, with particular emphasis on nuclear capabilities and threats. Previously he worked at Lawrence Livermore and Los Alamos National Laboratories, studying the physics of nuclear weapons, technology development for nuclear nonproliferation, and R&D to advance and protect civilian nuclear fuel cycles. Bradley also worked closely with teams who were developing next-generation simulation tools, and was subsequently chosen to lead a similar program for the Office of Nuclear Energy.

12.00pm

Challenges and Opportunities in being Predictive for Complex Interacting Systems

Roger Ghanem
USC

Abstract

With mobility of people, information, goods and financial instruments on the rise, it is increasingly difficult to decouple the operation of any components of the complex system making up the urban environment. This interaction gains is clearly exacerbated by international protocols for managing anthropogenic factors of climate change. The stability, let alone optimality of such complex system are far from assured, and involve a coupled dynamics on a multitude of time scales. In this environment, the ability to be predictive, or even anticipative, may hold the key for resilience and even optimality. In this talk I will describe some research challenges and opportunities that are pertinent to this goal.

Biography

Roger Ghanem is Professor and the Gordon S. Marshall Professor in the Viterbi School of Engineering at the University of Southern California where he holds appointments in the Departments of Aerospace & Mechanical Engineering and Civil & Environmental Engineering. His recent research focuses on stochastic modeling, analysis, and computations for multiscale and multiphysics problems. Ghanem has received numerous recognitions for his research and teaching including awards from the US National Associated for Computational Mechanics, the International Association for Structural Safety and Reliability and ASCE. Ghanem is the founding Chair of the USACM Committee on UQ and the Programs Director for the SIAM SIAG on UQ and serves on the NRC Committee on the Mathematical Foundations of Uncertainty Quantification and V&V. He currently serves as the President of the Engineering Mechanics Institute of ASCE.

1.30pm

Analysis and Reduction of Power Grid Models under Uncertainty

Habib Najm
Sandia National Laboratories

Abstract

The increased utilization of alternative energy sources requires that evolving power grid systems be designed with inherent robustness towards variability and uncertainty in generation capacity. Developing smart grid designs that are stable in the face of uncertain power generation requires efficient predictive grid models that account for relevant uncertainties. Accordingly, there is a need for effective methods for analysis of uncertain nonlinear grid dynamics, and for model reduction strategies that allow the efficient modeling and optimization of grid designs.

I will describe some of our recent mathematical and algorithmic developments that are aligned with this broad goal. Focusing on dynamical analysis and reduction of ordinary differential equation (ODE) systems, I will outline our use of computational singular perturbation methods, founded on an eigenanalysis framework, including both their traditional application in deterministic ODE systems and their extension to uncertain systems. Specifically, I will discuss our recent work on stochastic eigenanalysis in ODE systems using polynomial chaos methods for the probabilistic representation of uncertain variables. I will illustrate these developments in model ODE systems. I will also explore the use of these stochastic dynamical analysis results for goal-oriented ODE model reduction. I will conclude with a discussion of key challenges in this overall landscape.

Biography

Habib Najm is a Distinguished Member of the Technical Staff at Sandia National Laboratories in Livermore, CA. His research includes the development of numerical algorithms and codes for computation and analysis of chemically reacting flow, and the development of uncertainty quantification techniques with general application in computational science.

2.00pm

Electron and Phonon Engineering in Nanostructured Thermoelectric Materials

Zhifeng Ren
Department of Physics, Boston College, Chestnut Hill, Massachusetts

Abstract

Thermoelectric materials in energy conversion, especially waste heat recovery, are more and more promising due to the recent breakthroughs in enhancing the dimensionless thermoelectric figure-of-merit (ZT) by nanostructuring approach. ZT enhancement involves both electron and phonon engineering at the atomic and nano scale. In this presentation, I will go through the principles of electron and phonon engineering and give a few examples to demonstrate the successful stories involving a few materials systems that are interest to power generation applications such as half-Heuslers, lead selenide, skutterudites, silicon-germanium alloys, etc., and also a successful case for potentially large scale application using thermoelectric materials.

Biography

Dr Zhifeng Ren is currently a professor of physics at Boston College. He obtained his PhD degree from the Institute of Physics Chinese Academy of Sciences in 1990, master degree from Huazhong University of Science and Technology in 1987, and bachelor degree from Sichuan Institute of Technology in 1984. He was a postdoc and then research faculty at SUNY Buffalo (1990-1999) before joining BC as an associate professor in 1999. He specializes in thermoelectric materials, solar thermoelectric devices & systems, photovoltaic materials & systems, carbon nanotubes and semiconducting nanostructures, nanocomposites, bio agent delivery and biosensors, and superconductors. He is a fellow of APS and AAAS, a recipient of R&D 100 award. He has published extensively, and was ranked the 49th of the top 100 Materials Scientists worldwide for the past decade 2000-2010. He has co-founded companies in the field of carbon nanotubes, thermoelectric materials, and photovoltaics.

2.30pm

Perspectives and opportunities for Renewable Energy and National Security

Mike Campbell
Logos Technology

Abstract

Providing sufficient energy, food and water for the world's growing population while at the same time preserving the fragile biosphere are the defining challenges of the 21st century. Such a challenge and the connection and interplay between energy, national and global security is evidenced today by the ongoing tension between the Iran and much of the world due to the its nuclear program, the resulting threat of increasing embargos and the possible interdiction of oil thru the Strait of Hormuz. While the DOD consumes only about 1% of the total US energy use, the Agency is the major "off-take customer for transportation fuel for the US Government (97%) and must heat/cool and provide electrical service to over 300,000 buildings. For bases and military actions outside the United States, logistics associated with delivering fuel is also a major concern. Motivated by both its strategic mission and the practical need for a reliable, domestic source of fuel, the DOD has initiated numerous programs for developing renewable fuels and reducing both its energy intensity and carbon footprint. For example, the stated DOD goal is to have 25% of its energy use supplied by renewable fuels by 2025. The presentation will highlight some recent examples of ongoing programs such as producing jet fuel from cellulosic feedstock and exploring the utility of modular nuclear reactors for forward and remote operating bases.

Biography

Dr. Michael Campbell is the Director of the Energy Division of Logos Technologies headquartered in Arlington, VA. He is responsible for all of the energy activities within Logos which include programs to develop cellulosic feedstocks into ethanol and jet fuel, to close the nuclear fuel cycle in advanced reactors, and in physics of fusion. He has contributed to the development and applications of high power solid-state lasers, nuclear energy (fission and fusion), plasma physics, hydrogen production and energy including biofuels. He is the winner of numerous awards including DOE's E. O. Lawrence Award, the American Nuclear Society's Edward Teller Award, and the American Physical Society's Excellence in Plasma Physics Award, Fusion Power Associate's Leadership Award, and DOE's Excellence in Nuclear Weapons Research. He is a Fellow of the American Physical Society and European Institute of Physics and has 4 patents with several pending. He has authored over 100 publications in major scientific journals. He has presented numerous plenary, invited and review talks at major conferences in the US and abroad and founded the leading international conference on Inertial Fusion and High Energy Density Science-IFSA (Inertial Fusion Science and Applications Conference). He has served on numerous National Academy of Sciences studies and has been a member of the Physics Division Advisory Committee (Los Alamos), Visiting Trustees of Laser Laboratory (University of Rochester), and the Program Committee for the Virtual National Laboratory for the Heavy Ion Fusion Program. He is on the Board of Directors of Evans and Southerland and presently consults for companies involved in fusion, fission, and directed energy lasers.

Campbell received his undergraduate degree at the University of Pennsylvania and advanced degrees at Princeton University and University of Western Sydney where he received the Dr.Sc degree (post Ph.D. degree).