

Who's New

In the last three years eleven new faculty have joined the Division of EAS. They bring a host of novel research approaches and programs to the Division and the Institute as a whole. Below are short profiles of each, as well as a list of the most recent Moore Scholars who have enriched our research community by bringing new insights and building new connections.

New Faculty

José Andrade

Associate Professor of Civil and Mechanical Engineering



Professor Andrade's research objective is to develop a fundamental understanding of the multiscale and multiphysical behavior of porous media, with special application to geologic materials (e.g., soils, rocks) and engineered infrastructure materials (e.g., cements). With this objective in mind, the aim is to establish frameworks by which the microstructural features of porous materials affect macroscopic material properties. The main tools are mechanics, physics, computational mechanics, and advanced experimentation. Some current applications deal with reactive flow in deformable porous media for sustainable energy (e.g., CO₂ sequestration), mechanics and physics of granular materials for resilient infrastructure (e.g., liquefaction, landslides), and nanoscale modeling of calcium silicate hydrate (C-S-H) for sustainable construction materials (cements). This interdisciplinary research has various areas of synergy: environmental engineering, geotechnics, geosciences, physics, mechanics and computation, and structural engineering. José Andrade was born in Ecuador, South America, and immigrated to the United States at the age of 18 to obtain his BS in Civil Engineering at the Florida Institute of Technology. In 2001, Andrade received a fellowship to pursue his graduate studies at Stanford University. In 2006, he received his PhD in Civil Engineering with an emphasis on Geomechanics and then immediately joined the Theoretical and Applied Mechanics Group at Northwestern University as an Assistant Professor. Andrade is the recipient of several honors and awards including the 2006 Zienkiewicz Medal

in Computational Mechanics and a 2010 National Science Foundation (NSF) CAREER Award. He was a participant in the U.S. National Academy of Engineering Frontiers of Engineering meeting. Andrade's work is currently funded by NSF, US Department of Energy (DOE), and Air Force Office of Scientific Research (AFOSR).

Guillaume Blanquart

Assistant Professor of Mechanical Engineering



Professor Blanquart's research focuses on the modeling of multi-physics and multi-scale fluid mechanics problems resulting from the interaction between combustion processes and turbulent flows. At the center of the work are fundamental problems such as the formation of pollutants, the effects of turbulence on the dynamics of nano-particles and liquid droplets, and various hydrodynamic and flame instabilities. To build a better understanding of these complex flows, the research relies on high-fidelity numerical simulations and targets all scales, from the quantum level to the size of a vehicle, and all types of flows, from homogeneous mixtures to turbulent flows. For instance, the formation of soot particles is studied at the molecular level where the interactions between hydrocarbon species lead to the inception of the first soot particle, and throughout the cycle of an engine where the particles are transported in the turbulent field and slowly oxidized away by chemical reactions. The applications are diverse and include internal combustion engines, gas turbines, flow around reentry vehicles, inertial confinement fusion, fires, and the paint industry. Blanquart received his BS and his first MS in Applied Mathematics from École Polytechnique, France, in 2002. He received a second MS

in Aeronautics and Astronautics in 2004 and his PhD in Mechanical Engineering in 2008, both from Stanford University. He continued as a Postdoctoral Scholar under the supervision of Professor Heinz Pitsch at Stanford University before joining Caltech.

Simona Bordoni

Assistant Professor of Environmental Science and Engineering



Professor Bordoni is an atmospheric dynamicist interested in monsoons and tropical circulations. Using observations and models, her research investigates fundamental dynamical mechanisms that are implicated in the existence of monsoon systems, their location, and their different geographical features, and that might help understand how monsoons change in changing climates. In an ongoing project, she has, for instance, been able to simulate monsoons in a water-covered earth, showing that thermal contrasts between land and ocean, traditionally viewed as the fundamental cause of monsoon circulations, are not necessary for monsoon development. Bordoni received an Italian Laurea in Physics from the University of Rome Tor Vergata in 1996. She completed her PhD in Atmospheric Sciences at the University of California in Los Angeles in 2007, and later in the same year she was a Moore Postdoctoral Scholar at Caltech. She then worked at the National Center for Atmospheric Research as a Postdoctoral Fellow in the Advanced Study Program. Bordoni is the recipient of the American Geophysical Union James R. Holton Award 2009, the UCLA Bjercknes Memorial Award 2005, and a NASA Graduate Student Fellowship in Earth System Science 2003–2006.

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Azita Emami-Neyestanak

Assistant Professor of Electrical Engineering



Professor Emami's research interests are in high-performance integrated circuits and systems. She is interested in developing new analog, digital, and architecture-level solutions for building complex systems in highly scaled technologies. In particular, she focuses on mixed-signal design for efficient

and low-power data communication in advanced integrated systems, using both electrical and optical signaling techniques. The ultra-low-power and low-area circuits at the interfaces will have a great impact on the performance of multi-processors, biomedical devices, and sensor networks. She is currently working on efficient integrated biomedical implants for neural recording and stimulations. Novel integration techniques, which allow 3D structures, are also among her research interests. Emami received her BS in Electrical Engineering from Sharif University of Technology, Tehran, Iran, in 1997 with honors. She received both her MSc in 1999 and her PhD in Electrical Engineering in 2004 from Stanford University, where she received the Solid-State Fellowship. She was with the IBM T. J. Watson Research Center from 2004 to 2006 and with Columbia University (as an Assistant Professor) from 2006 to 2007. Emami received the NSF Faculty Early Career Development (CAREER) Award for her research on "Data Communication in Advanced Integrated Systems" in 2008 and the Okawa Foundation Research Grant award in 2010.

Julia Greer

Assistant Professor of Materials Science and Mechanics



The key focus in Professor Greer's research is the development of innovative experimental approaches to assess mechanical properties of materials with nano-scale dimensions. One such approach involves fabrication of nanopillars with different initial microstructures, ranging in diameter from below 100 nm to 1 micron by using Focused Ion Beam (FIB)-based and E-beam lithography/electroplating approaches. Their strengths are subsequently measured in a one-of-a-kind in-situ imaging and mechanical deformation instrument, SEMentor, comprised of Scanning Electron Microscope (SEM) and Nanoindenter. This allows for precise control of displacement and loading rates, as well as for simultaneous video capture of the deformation process. The powerful capability of simultaneous mechanical (and, if needed, electrical) data collection while performing real-time imaging of sample morphology evolution has enabled the discovery of a unique mechanical response observed in a variety of material classes. In a striking deviation from classical mechanics, she has ob-

served size-dependent strengths, discrete deformation signatures, and unusual deformation processes. She postulates that these intriguing phenomena arise from effects of free surfaces and serve as the fundamental reason for the observed differences in their plastic deformation from bulk.

Greer received her SB in Chemical Engineering with a minor in Advanced Music Performance from Massachusetts Institute of Technology (1997) and PhD in Materials Science and Engineering from Stanford University, working on nano-scale plasticity of gold (2005). She has also worked at Intel Corporation in a mask micro-fabrication facility (2000-03) and was a Postdoctoral Fellow at the Palo Alto Research Center, PARC (2005-07), where she studied organic flexible electronics. Greer is a recipient of the NASA Tech Briefs award (2010), DARPA Young Faculty Award (2009), Technology Review's Top Young Innovator Under 35 Award (TR-35, 2008), the NSF CAREER Award (2007), the Gold Materials Research Society's Graduate Student Award (2004), and American Association of University Women Fellowship (2003). She was one of 100 invited participants in the National Academy of Engineering's Frontiers of Engineering Symposium (2009) and was recently featured as a "Rising Star" in *Advanced Functional Materials* (2009). Julia joined Caltech in 2007. She is also a concert pianist. Her most recent performances include a violin-piano recital in the Lagerstrom Chamber Series (2009) and the Brahms Concerto No. 2 as a soloist with the Redwood Symphony (2006).

R. Andreas Krause

Assistant Professor of Computer Science



Professor Krause's research is in adaptive systems that actively acquire information, reason, and make decisions in large, distributed, and uncertain domains, such as sensor networks and the Web. The theoretical aspects of his work include statistical learning, Bayesian modeling, decision theory, and optimization. His group devises new algorithms with theoretical guarantees, builds models, analyzes large and complex data sets, and develops systems that can automatically acquire and reason about highly uncertain information. Example applications include monitoring earthquakes using community-held sensors, exploring biological ecosys-

tems using autonomous underwater vehicles, and studying how people make decisions under uncertainty. Krause received his Diplom in Computer Science and Mathematics from the Technical University of Munich, Germany (2004) and his PhD and MSc in Computer Science from Carnegie Mellon University (2008). At Caltech, he is a member of the Rigorous Systems Research Group, the Computation and Neural Systems faculty, and the Center for the Mathematics of Information. Krause is a recipient of an NSF CAREER award (2010) and the Okawa Foundation Research Grant (2009) recognizing top young researchers in telecommunications. His research on optimized information gathering received awards at several major conferences, as well as the best research paper award of the ASCE *Journal of Water Resources Planning and Management* (2009). He is also a passionate classical guitarist.

Katrina Ligett

Assistant Professor of Computer Science and Economics



The focus of much of Professor Ligett's work is on mathematical and computational approaches to fundamental problems in algorithmic game theory and in data privacy, with a particular emphasis on techniques from computational learning theory.

Nash equilibrium strategies are commonly used as a tool for studying selfish behavior in complex systems; the underlying assumption of this approach is that selfish players will find and settle at a Nash equilibrium despite working independently and competitively. In previous and ongoing work, Ligett explores alternative approaches to understanding selfishness, based on algorithms designed to learn. In many situations, understanding the outcomes of learning behaviors has provided new insight into the consequences of selfish play.

The goal of private data analysis is to allow the publication of broadly useful sanitized data while ensuring the privacy of the individuals represented in a database. Ligett's work in this area has provided novel algorithms that a database owner such as a hospital could use to release useful data to researchers, without compromising patient privacy.

Ligett received her ScB in Mathematics and Computer Science from Brown University (2004) and her PhD in Computer Science from Carnegie Mellon University

(2009). She is a recipient of the NSF Graduate Research Fellowship, the AT&T Labs Graduate Fellowship, the CIFellows Postdoctoral Fellowship, and the NSF Mathematical Sciences Postdoctoral Fellowship. She is currently a Postdoctoral Associate in the Computer Science Department at Cornell University and will join Caltech in Fall 2011 as an Assistant Professor of Computer Science and Economics.

Sergio Pellegrino

Joyce and Kent Kresa Professor of Aeronautics and Professor of Civil Engineering, and Jet Propulsion Laboratory Senior Research Scientist



Professor Pellegrino is interested in the mechanics of lightweight flexible structures and particularly in problems related to packaging and deployment. In recent years, one of his main interests has been deployable antennas made of ultra-thin composite materials that are constructed as a single piece, without any mechanical articulations. These structures are folded elastically and are able to self-deploy. Another area of his research has been concerned with the deployment and stability of stratospheric balloons.

Pellegrino received his Laurea in Civil Engineering from the University of Naples in 1982 and a PhD from the University of Cambridge in 1986. He joined the faculty at Cambridge in 1983, as an Assistant Lecturer, and then Lecturer, Reader, and Professor of Structural Engineering. He also served as the Deputy Head (Graduate Studies) of the Department of Engineering. He has held visiting research positions at the Institute for Space and Astronauti-

cal Science (Tokyo), the Nippon Telegraph and Telephone Corporation Spacecraft Structures Laboratory (Yokosuka, Japan), the European Space Technology Centre (Netherlands), the University of Colorado at Boulder, the University of Technology of Malaysia, and Stanford University.

Models of new deployable structures invented by Pellegrino were exhibited at “Contemporary Developments in Design Science: Buckminster Fuller Centennial,” New York 1995–96; “Building for the Future,” Istanbul 1996; “Les Ingenieurs du Siecle,” Centre Pompidou, Paris 1997; and the Farnborough Air Show in 2004. He is a Fellow of the Royal Academy of Engineering and a Chartered Structural Engineer.

Keith Schwab

Associate Professor of Applied Physics



Professor Schwab’s main research directions are to explore fundamental quantum behavior in mechanical structures, the quantum limits of measurements, and the boundary between the classical and quantum world. His research group utilizes and combines techniques from ultra-low temperature physics, ultra-sensitive electronic, microwave, and optical measurement, and nanoscale fabrication and material science. His current work is focused on producing and measuring the quantum ground state of a mechanical device and measuring motion that avoids the limitations of the Heisenberg Uncertainty Principle. His group collaborates widely with atomic and optical physics groups and has produced micro-fabricated single-atom traps and advanced opto-mechanical structures. Schwab received his BA in Physics from the University of Chicago (1990) and his PhD in Physics from the University of California, Berkeley (1996). He was a Sherman Fairchild Distinguished Scholar with Professor Michael Roukes at Caltech where he measured the quantum limit for heat transport. In 2000, he joined the National Security Agency and led a research group to probe the quantum limits of electrical and mechanical structures. He joined the Department of Physics at Cornell University in 2006, and arrived to Caltech in January of 2009. He has received a number of awards for his work, most notably, he was named a Young Global Leader by the World Economic Forum and has attended and contributed to the



annual meetings in Davos, Switzerland in 2005, 2007, and 2008. He is interested in broad issues of national and global security and has appeared on PBS as a panelist for a Fred Friendly Seminar in 2008.

Joel Tropp

Assistant Professor of Applied and Computational Mathematics



Professor Tropp's research focuses on algorithms for solving computationally difficult problems that arise in applied mathematics, statistics, electrical engineering, and computer science. In particular, he studies how constraints on data complexity can be used to develop new techniques for signal acquisition and processing. This area encompasses classical problems, such as variable selection in regression, as well as recent advances, such as compressive sampling. Other applications include inverse problems, machine learning, and data mining.

Tropp studied at the University of Texas at Austin. In

1999, he received his BS in Mathematics and his BA in Plan II Liberal Arts Honors. He completed his MS and PhD in Computational Applied Mathematics in 2001 and 2004 with funding from an NSF graduate fellowship. From 2004 to 2007, Tropp was appointed by the University of Michigan at Ann Arbor as T. H. Hildebrandt Research Assistant Professor. His postdoctoral work was supported by an NSF Mathematical Sciences Postdoctoral Research Fellowship.

Adam Wierman

Assistant Professor of Computer Science



Professor Wierman's research interests are in improving computer system design through the use of analytic modeling and performance analysis. His main focus is on scheduling and resource allocation decisions in computer systems. However, he has also been involved with the design of manufacturing, telecommunication protocols, and the electricity grid. In order to provide performance analysis of computer systems, his work draws on tools that are traditionally used in the operations research community, in particular stochastic modeling, queueing theory, and game theory. However, standard stochastic and queueing models are often not appropriate for computer science applications, and thus a key component of his research is the development of new stochastic models and analytic techniques. Wierman received his PhD (2007) and MS (2004) in Computer Science from Carnegie Mellon University under the supervision of Mor Harchol-Balter. He received his BS with University Honors in Computer Science and Mathematics with minors in Psychology and Statistics from Carnegie Mellon University (2001). He is a recipient of an NSF CAREER award, an Okawa Foundation Research Award, a Siebel Scholars Award, and multiple teaching awards, including the Caltech ASCIT Teaching Award, the Alan J. Perlis Student Teaching Award, and the Carnegie Mellon University Graduate Student Teaching Award. His doctoral dissertation also received multiple awards including the Carnegie Mellon Distinguished Dissertation Award. In addition, he recently served as a visiting researcher at the EURANDOM Institute in the Netherlands and a visiting fellow at the Isaac Newton Institute at Cambridge University.



Interior space of the Walter and Leonore Annenberg Center for Information Science and Technology

Moore Scholars

The Moore Distinguished Scholars program was established by Gordon and Betty Moore to invite researchers of exceptional quality who are distinguished at both the national and international levels to visit the California Institute of Technology for three to six months. There are no teaching or other obligations during the appointment, allowing Moore Scholars to focus on research.



Fazle Hussain

University of Houston Cullen Distinguished Professor; Director, Institute of Fluid Dynamics and Turbulence



Linda F. Nazar

University of Waterloo Professor of Chemistry, and Professor of Electrical Engineering



Lyle N. Long

Pennsylvania State University Distinguished Professor of Aerospace Engineering and Mathematics; Director, Computational Science Graduate Minor Program



Krishna V. Palem

Rice University Kenneth and Audrey Kennedy Professor of Computing



Eric Mjolsness

University of California, Irvine Professor of Information and Computer Science, and Professor of Mathematics