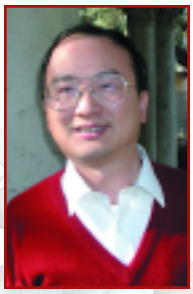
Applied and Computational Mathematics

Executive Officer: Professor Thomas Yizhao Hou



The Applied Mathematics Option was established in the mid-1960s. It consisted of a small group of outstanding applied mathematicians whose expertise and research spanned a variety of areas, with a strong emphasis in fluid mechanics and related fields.

The composition and research direction of the option has changed significantly during the last eight years, starting with the hire of Professor Thomas Hou in 1993 and Professor Oscar Bruno in 1995, and gathering further momentum with the hires of Professor Niles Pierce in 1999 and Professor Emmanuel Candes in 2000. Together with Donald Cohen, the Charles Lee Powell Professor of Applied Mathematics, Professor Daniel Meiron (Associate Provost for Information & Information Technology), and Professor Peter Schröder, this mix of faculty provides new strengths in computational electromagnetics, computational molecular biology, multi-resolution analysis and image processing, statistical estimation, mathematical modeling and simulation of materials science, asymptotic and perturbation theory, computational fluid mechanics, and numerical analysis.

Implicit in the faculty's current research endeavors lies a healthy and concerted shift in emphasis with a significant focus: the study of scientific and engineering systems whose behavior is determined by phenomena at multiple scales. Further emphasis in this area will enable Caltech to take a leadership role in the field of multiscale analysis and simulation in a manner that has not yet been identifiably achieved by any mathematics department worldwide. The option has recently renamed itself Applied and Computational Mathematics to reflect this new scope.

Thomas Yizhao Hou, Professor of Applied and Computational Mathematics, is one of the leading experts in analysis and simulation of multiscale and free-boundary problems. In his eighteen-year research career, his interests have centered on developing and analyzing effective numerical methods for vortex dynamics, interfacial flows, and multiscale problems. In recent years, he and his coworkers have developed an effective multiscale numerical method which combines multiscale modeling and simulation in a systematic and integrated fashion. This method can be used to study pollution transport and secondary oil recovery in multiscale heterogeneous porous media. More recently, Hou and Gang Hu (PhD '01) have resolved a long-outstanding open problem: singularity formation induced by the three-dimensional Kelvin-Helmholtz instability. The understanding of the Kelvin-Helmholtz instability is important in many fluid dynamics applications. Contrary to conventional wisdom, they found that when viewed in appropriate physical variables and coordinates, the three-dimensional problem is essentially the same as the corresponding two-dimensional problem. This was very surprising and was considered a major breakthrough in the field. Dr. Gang Hu, who received the Carey distinguished dissertation award in ACM for the year, has switched gears and is now working for Lehman Brothers on Wall Street; but he has recently reported back to Hou that his modeling and simulation training at Caltech have proved very useful in the real world.

Professor Hou was born in Canton, China, and studied at the South China Institute. Upon obtaining his PhD from UCLA in 1987, he joined the Courant Institute as a post-doctoral scholar, and then became a faculty member in 1989. He moved to the applied math option at Caltech in 1993 and became executive officer in 2000. Hou was awarded the Wilkinson Prize in Numerical Analysis and Scientific Computing in 2001, the Francois N. Frenkiel Award from the American Physical Society in 1998, and the Feng Kang Prize in Scientific Computing in 1997. He is an invited plenary speaker for the 2003 International Congress of Applied and Industrial Mathematics; was an invited speaker of the International Congress of Mathematicians in Berlin in 1998; and was a Sloan Foundation Research Fellow from 1990 to 1992.

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