Statistical and Applied Mathematical Sciences Institute
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2003–04 Program on Multiscale Model Development and Control Design

Program Goals

Multiscale analysis is ubiquitous in the modeling, design, and control of high performance systems utilizing novel material architectures. In applications including quantum computing, nanopositioning, granular flows, artificial muscle design, flow control, liquid crystal polymers, and actuator implants to stimulate tissue and bone growth, it is necessary to develop multiscale modeling hierarchies ranging from quantum to system levels for time scales ranging from nanoseconds to hours. Control techniques must be designed in concert with the models to guarantee the symbiosis required to achieve the novel design specifications. A crucial component of multiscale analysis is the development of homogenization techniques to bridge disparate temporal and spatial scales. This is necessitated by the fact that even with projected computing capabilities, monoscale models are prohibitively large to permit feasible system design or control implementation.

Activities

Workshops. There will be three major workshops:

- Tutorials and Opening Workshop: January 17Ű-21, 2004;
- Workshop on Multi-Scale Phenomena in Soft-Matter, Nano-Materials February 15Ű17, 2004; and
- Workshop on Fluctuations and Continuum Equations in Granular Flow April 15Ű-17, 2004.

Additional miniworkshops, to be scheduled, will address specific issues associated with multiscale modeling, homogenization, large scale simulation, reduced-order system models, and robust control design and implementation.

Research. The program will provide a forum to investigate nano, micro and mesoscale modeling methodologies, deterministic and statistical homogenization techniques for macroscopic model construction, reduced-order techniques for real-time implementation of system models, and commensurate robust control designs for advanced material architectures. Facets of the multiscale analysis will focus on the problem of optimal material design at the microscopic level given macroscopic performance criteria. To accommodate the uncertainty inherent to all phases of the model and control development, deterministic and stochastic techniques will be investigated in concert.

Opportunities to Participate

SAMSI–University Fellows, appointed for a semester or the entire year, will help lead the research, as well as join academic life at a SAMSI partner university; see www.samsi.info/univfellows200210.html for further information. Salary and timing are ideal for senior sabbatical visitors with partial funding from their home institutions.

Long-term Research Visitors will participate in the research; support for expenses is available.

Postdoctoral Fellows can be appointed for two or more years; see www.samsi.info/postdoc200210.html for information and application instructions.

Workshop Attendees both inform the course of the research and have early access to the results, and may receive support for expenses. Workshops will be announced individually on the SAMSI Web site.

For further information, write to multi@samsi.info. Members of underrepresented groups are especially encouraged to apply.

Scientific Committee

M. Gregory Forest (North Carolina at Chapel Hill), Doina Cioranescu (Université Pierre et Marie Curie), Alan Gelfand (Duke; Co-Chair), David Schaeffer (Duke), Murti Salapaka (Iowa State), Ralph Smith (NCSU; Chair), Christopher Wikle (Missouri), Margaret Wright (NYU)

About SAMSI

The Statistical and Applied Mathematical Sciences Institute (SAMSI) is a national institute whose vision is to forge a new synthesis of the statistical sciences and the applied mathematical sciences with disciplinary science to confront the very hardest and most important data- and model-driven scientific challenges. SAMSI achieves profound impact on both research and people by bringing together researchers who would not otherwise interact, and focusing the people, intellectual power and resources necessary for simultaneous advances in the statistical sciences and applied mathematical sciences that lead to ultimate resolution of the scientific challenges.

SAMSI is a partnership of Duke University, North Carolina State University (NCSU), the University of North Carolina at Chapel Hill (UNC), and the National Institute of Statistical Sciences (NISS), in cooperation with the Mathematical Sciences Research Institutes program of the Division of Mathematical Sciences at the National Science Foundation and in collaboration with the William R. Kenan, Jr. Institute for Engineering, Technology and Science. SAMSI is located at the NISS building in Research Triangle Park, North Carolina.