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Colorado State University

The Information Science & Technology Center

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Colorado State University's
Information Science and Technology Center (ISTeC)
presents <u>two</u> lectures by

Dr. Phillip Colella

Senior Staff Scientist
Applied Numerical Algorithms Group
Lawrence Berkeley National Laboratory

ISTeC Distinguished Lecture
in conjunction with the
Electrical and Computer Engineering Department and
Computer Science Department Seminar Series

"Models, Algorithms, and Software: Tradeoffs in the Design of High-Performance Computational Simulations in Science and Engineering"

Monday, April 9, 2012
Reception: 10:30 a.m.
Lecture: 11:00 – 12:00 noon
Location: Computer Science Building, Room 130

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Department of Mechanical Engineering Lecture
sponsored by ISTeC

"Volume-of-Fluid Methods for Partial Differential Equations in Irregular Domains"

Wednesday, April 11, 2012
Lecture: 4:00 – 5:00 p.m.
Location: TILT Building, Room 221

ABSTRACTS

"Models, Algorithms, and Software: Tradeoffs in the Design of High-Performance Computational Simulations in Science and Engineering"

Many important problems for DOE such as combustion, fusion, systems biology, and climate change, involve multiple physical processes operating on multiple space and time scales. In spite of the physical diversity of these problems, there is a great deal of coherence in the underlying mathematical representations. They are all described in terms of various versions of the elliptic, parabolic and hyperbolic partial differential equations (PDE) of classical mathematical physics. The enormous variety and subtlety in these applications comes from the way the PDE are coupled, generalized, and combined with models for other physical processes. The complexity of these models and the need to represent multiple scales lead to a diverse collection of requirements on the numerical methods, with many open questions about stability of coupled algorithms. Finally, the complexity of models and algorithms, combined with uncertainties about the correct combination to use, complicates the problem of designing high performance software. In this talk, I will attempt to describe the tradeoffs between the models, the discretizations, and the software in the development of high-performance computational simulations in science and engineering involving PDE, including some motivating applications, and the combination of analysis and computational experiments that are used to explore the design space.

"Volume-of-Fluid Methods for Partial Differential Equations in Irregular Domains"

We will give an overview of a set of methods being developed for solving classical partial differential equations (PDE) in irregular geometries, or in the presence of free boundaries. In this approach, the irregular geometry is represented on a rectangular grid by specifying the intersection of each grid cell with the region on one or the other side of the boundary. This leads to a natural conservative discretization of the solution to the PDE on either side of the boundary. When the boundary is a solid wall for a fluid these methods are often referred to as embedded boundary methods; more generally, they are called volume-of-fluid methods. Some of the recent developments in this area that we will discuss include: methods for elliptic free boundary value problems; automatic grid generation from implicit function representations of boundaries; high-order accurate methods; solving PDE on surfaces; and a software infrastructure issues involved in obtaining high performance, while supporting a high degree of programming flexibility. We will also discuss applications examples from several fields of science and engineering.

SPEAKER BIOGRAPHY

Phillip Colella is a senior staff scientist from Lawrence Berkeley National Laboratory. He has also worked at Lawrence Livermore National Laboratory, and is an adjunct professor at University of California, Berkeley. He is widely well known for his contributions in high-resolution finite-difference methods, adaptive mesh refinement, volume-of-fluid methods for irregular boundaries, and programming language and library design for parallel scientific computing. Colella is a member of the National Academy of Sciences since 2004 and Fellow of Society for Industrial and Applied Mathematics (SIAM). He is the recipient of many honors, including the Sidney Fernbach Award from the IEEE Computer Society in 1998, given each year to one person who has made "an outstanding contribution in the application of high performance computers using innovative approaches." He has also received the SIAM/ACM prize (with John Bell in Lawrence Berkeley National Laboratory) for computational science and engineering in 2003.

To arrange a meeting with the speaker, please contact Prof. Gao,Xinfeng at Xinfeng.Gao@colostate.edu or (970)491-1003.

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