Events

Current Events
Lectures
Events Archive

Frontiers of Scientific Computing Lecture Series

Multiscale Discretizations for Flow, Transport and Mechanics in Porous Media

Mary Fanett Wheeler, The University of Texas at Austin

Center for Subsurface Modeling, Institute for Computational Engineering and Sciences,

Johnston Hall 338
May 01, 2007 - 01:30 pm

Abstract:
A fundamental difficulty in understanding and predicting large-scale fluid movements in porous media is that these movements depend upon phenomena occuring on small scales in space and/or time. The differences in scale can be staggering. Aquifers and reservoirs extend for thousands of meters, while their transport properties can vary across centimeters, reflecting the depositional and diagenetic processes that formed the rocks. In turn, transport properties depend on the distribution, correlation and connectivity of micron sized geometric features such as pore throats, and on molecular chemical reactions. Seepage and even pumped velocities can be extremely small compared to the rates of phase changes and chemical reactions. The coupling of flow simulation with mechanical deformations is also important in addressing the response of reservoirs located in structurally weak geologic formations. We will focus on the mortar mixed finite element method (MMFE) which was first introduced by Arbogast, Cowsar, Wheeler, and Yotov for single phase flow and later extended to multiphase flow by Lu, Pesyznska, Wheeler, and Yotov for multiphase flow and more recently by Wheeler to transport. The MMFE method is quite general in that it allows for non-matching interfaces and the coupling of different physical processes in a single simulation. This is achieved by decomposing the physical domain into a series of subdomains (blocks) axnd using independently constructed numerical grids and possibly different discretization techniques in each block. Physically meaningful matching conditions are imposed on block interfaces in a numerically stable and accurate way using mortar finite element spaces. The mortar approach can be viewed as a subgrid or two scale approach. Moreover, the use of mortars allows one to couple MFE and discontinuous Galerkin approximations in adjacent subdomains. In this presentation we will discuss theoretical a priori and a posteriori results and computational results will be presented.

Speaker's Bio:
After 24 years at Rice University, Professor Mary Fanett Wheeler, a world-renowned expert in massive parallel-processing, arrived at The University of Texas in the Fall of 1995 with a team of 13 interdisciplinary researchers, including two associate professors, three research scientists, three postdoctoral researchers, and four Ph.D. students. Professor Wheeler is not completely new to UT, however, having received a B.S., B.A., and M.S. degrees from here before transferring to Rice for her Ph.D. under the direction of Henry Rachford and Jim Douglas, Jr. Drs. Rachford and Douglas, both of whom conducted some of the first applied mathematics work in modeling engineering problems, have greatly influenced her career. She correctly theorized that parallel algorithms would spur a technological revolution, offering a multitude of applications in the fields of bioengineering, pharmaceuticals and population dynamics. Her reputation as a first class researcher has led to several national posts, including serving on the Board of Mathematical Sciences, on the Executive Committee for the NSF's Center for Research on Parallel Computation and in the National Academy of Engineering. Housed in the Texas Institute for Computational and Applied Mathematics (TICAM) on the UT campus, Professor Wheeler has brought a level of prominence to UT that many believe will bring us into the forefront of applied mathematics. Dr. Wheeler's own research interests include numerical solution of partial differential systems with application to the modeling of subsurface and surface flows and parallel computation. Her numerical work includes formulation, analysis and implementation of finite-difference/finite-element discretization schemes for nonlinear coupled pde's as well as domain decomposition iterative solution methods. Her applications include reservoir engineering and contaminant transport in groundwater and bays and estuaries.

This lecture has a reception.