MATH-IMS Joint Applied Mathematics Colloquium Series
The Chinese University of Hong Kong

This MATH-IMS Joint Colloquium Series is organized by Center for Mathematical Artificial Intelligence (CMAI), under Department of Mathematics and Institute of Mathematical Sciences (IMS) at The Chinese University of Hong Kong. The colloquium series focuses on mathematics and applications of artificial intelligence, big data and related topics.

Date: Nov 19, 2021 (Friday)
Time: 10:00-11:00am (Hong Kong Time)
Zoom Link: https://cuhk.zoom.us/j/92775210812

On the numerical solution of two-phase flows in porous media

Speaker: Professor Beatrice Riviere
Rice University

Abstract: Simulations of two-phase flows in heterogeneous porous media at the Darcy scale are important in the understanding of flow and transport processes in subsurface. Applications include storage of carbon dioxide in saline aquifers and production of hydrocarbons from oil and gas reservoirs. Mathematical models are based on conservation of mass for each fluid phase and are characterized by systems of nonlinear coupled partial differential equations. Beside the nonlinearity, challenges in the numerical analysis arise from the unboundedness or degeneracy of some of the PDE coefficients. In this talk, we describe numerical methods for solving the incompressible two-phase flow problem. First, we formulate and analyze a finite element method with mass lumping and upwinding. Convergence of the scheme in the general case of degenerate phase mobilities and unbounded capillary pressure, is obtained via a compactness argument. In the second part of the talk, we formulate an interior penalty discontinuous Galerkin method and define flux limiters that yield bound preserving discrete saturations. Maximum principle of the post-processed saturations is proved. Both proposed numerical methods are shown to be robust and accurate for modeling flows in highly heterogeneous media.

Bio: Beatrice Riviere is a Noah Harding Chair and Professor in the Department of Computational and Applied Mathematics at Rice University. She has worked extensively on the formulation and analysis of numerical methods applied to problems in porous media and in fluid mechanics. Her current research deals with the development of high-order methods in time and in space for multiphase multicomponent flows (in rigid and deformable media); the modeling of pore scale flows for immiscible and miscible components; the numerical model of chemical species transport in networks of blood vessels; the development of PDE-based neural networks for image segmentation and the design of iterative solvers for discontinuous Galerkin methods. She is the author of more than one hundred scientific publications in numerical analysis and scientific computation. Her book on the theory and implementation of discontinuous Galerkin methods is highly cited. Prof. Riviere is a SIAM Fellow (Class of 2021). She has been actively involved with SIAM for several decades. She currently serves as the President of the SIAM TX-LA Section. She was an elected Chair of the SIAM Activity Group on Geosciences from 2019 to 2020. Prof. Riviere is an AWM Fellow (Class of 2022). She is also an active member of AWM and USACM. She serves on the editorial boards of SIAM Journal on Scientific Computing, Results in Applied Mathematics and Advances in Water Resources.