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: Jan 21, 2021 (Friday)
Time: 16:00-17:00pm (Hong Kong Time)
Zoom Link: https://cuhk.zoom.us/j/92775210812

High-dimensional McKean-Vlasov diffusion and the well-posedness of kinetic models of dilute polymers

Speaker: Professor Endre Süli
University of Oxford

Abstract: Linear polymer chains submerged in a viscous incompressible fluid are frequently modelled as chains of massless beads connected with elastic springs, where each spring in the resulting bead-spring-chain model represents several hundreds of atoms in the central backbone chain of a polymer molecule. Such kinetic models of dilute polymeric fluids couple the incompressible Navier-Stokes equations to a high-dimensional Fokker-Planck equation. In the simplest case, the elastic springs in the model are assumed to be Hookean springs. We report new PDE-analytic results, aimed at dispelling certain misconceptions in the mathematical literature associated with the PDE-analysis of Hookean bead-spring chain models. By performing a rigorous derivation of the model from first principles, we show in particular that, when the flow domain is bounded, the configuration space for the Hookean bead-spring chain model is also bounded (rather than unbounded, as is commonly stated in the literature), and that the Fokker-Planck equation featuring in the model is uniformly parabolic, containing a centre-of-mass diffusion term (rather than mixed hyperbolic-parabolic with no centre-of-mass diffusion term). These observations have significant impact on the construction and mathematical analysis of numerical methods for the approximate solution of high-dimensional Hookean bead-spring chain models. We also provide a rigorous proof of a formal asymptotic argument by Schieber and Öttinger (J. Schieber and H. C. Öttinger, The effects of bead inertia on the Rouse model, J. Chem. Phys. 89 (1988), no. 11), asserting that, in the small-mass limit for the beads, the model results in equilibration in momentum space. Our proofs rely on entropy/entropy dissipation estimates combined with various weak compactness and compensated compactness techniques.

Bio: Prof. Süli is a Professor of Numerical Analysis at University of Oxford and Professor Hospitus Universitatis Carolinae Pragensis at Charles University in Prague. Prof. Süli got his Ph.D at University of Belgrade in 1985. He was a fellow of Linacre College at Oxford from 1985-2005, University Lecturer in Numerical Analysis from 1985-96, Reader in Numerical Analysis from 1996-99 at University of Oxford, and has been Professor of Numerical Analysis since 1999. His research interests focus on mathematical and numerical analysis of nonlinear PDEs, particularly kinetic models for polymers, Navier-Stokes-Fokker-Planck systems and non-Newtonian fluid flow models, implicitly constituted material models, free-discontinuity problems, computational modelling of fracture, adaptive algorithms for PDEs, multiscale finite element methods, etc. Prof. Süli has been co-director of the EPSRC Centre for Doctoral Training in PDEs at Oxford since 2014, and Associate Head of Department, Mathematical Institute, University of Oxford since 2020. He has joined over 90 invited and plenary lectures at international conferences between 1985 and 2020, including an invited speaker at International Congress of Mathematicians, Madrid in 2006. Among his prestigious awards, Prof. Süli is an elected fellow of the IMA, elected member of the European Academy of Sciences, elected SIAM fellow, elected member of the Academia Europaea and elected fellow of the Royal Society. He has supervised more than 30 doctoral students at Oxford and on editorial board of numerous leading journals.