Advances in the application of periodic and stochastic homogenisation to transport models and multi-physics simulation in porous media

Themes:
Fundamental theories of porous media

Organizer: Matteo Icardi
University of Warwick, m.icardi@warwick.ac.uk,

Co-Organizers

Andro Mikelić
Université Lyon, andro.mikelic@univ-lyon1.fr

Nadja Ray
Friedrich-Alexander-Universität Erlangen-Nürnberg, ray@math.fau.de

Markus Schmuck
Heriot-Watt University, m.schmuck@hw.ac.uk

Florian Theil
University of Warwick, f.theil@warwick.ac.uk

Tuomo Kuusi
Aalto University, tuomo.kuusi@aalto.fi

Scott Armstrong
Associate Professor
Courant Institute of Mathematical Sciences
New York University, scotta@cims.nyu.edu

Abstract

Nowadays, a renewed effort in the development of model reduction and upscaling techniques is needed to keep pace and combine with increasingly used data-driven approaches. Classical homogenisation theory deals with the rigorous derivation of macroscopic equations, by using mathematical analysis to prove the convergence of micro-scale models (e.g. Stokes flow) to a certain "homogenised" macroscopic (e.g. Darcy) equations. This has found an enormous interest among the mathematical community in the last decades, and was successfully transferred to many porous media, fluid dynamics, and material science problems. More recently, thanks to novel developments in computational methods and stochastic analysis, interesting applications and connections with numerical methods (such as multiscale solvers) and statistical techniques (e.g., random porous structures, uncertainty quantification) are emerging. On the other hand, new and more complex multi-physics problems arise where the problem of upscaling faces new challenges. In this minisymposium we aim to gather researchers in applied mathematics, computational sciences,
materials science, physics, and engineering to discuss recent advances of homogenisation theory and related applications. A particular (but not exclusive) focus will be devoted to:
- homogenisation theory and upscaling for electrokinetic phenomena, deformable media, and reactive transport in porous media
- applicable stochastic homogenisation approaches for random porous materials and connection with uncertainty quantification
- multiscale computational techniques to simplify and automatise the upscaling
- efficient parametrisation and characterisation of problems where scales are not fully separable
- applications to environmental, engineered, and biological porous media

References: