POLITECNICO DI TORINO

DISMA Dipartimento di Scienze Matematiche G. L. Lagrange

ECCELLENZA 2018 • 2022

Wednesday the 27 March 2019 at 10:00
Politecnico di Torino, DISMA, Aula Buzano (third floor)

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An optimization-based approach for simulations in poro-fractured domains

Prof. Claudio Canuto introduces the seminar

Abstract

Flow simulations in fractured porous materials are extremely challenging for the geometrical complexity and multi-scale nature of the domain. Fractures are regions characterised by a dramatic change of material properties, with one spatial dimension, the thickness, which is usually orders of magnitude smaller than the others. Fractures might significantly impact relevant flow characteristics, and therefore, their explicit representation is to be preferred to the use of up-scaling techniques defining homogenised properties. According to the Discrete Fracture and Matrix (DFM) model, fractures in a porous material can be represented as planar interfaces of co-dimension one in a bulk material, thus overcoming the difficulty in the simultaneous representation of both the scale of fracture thickness and of domain size. Nevertheless, fractures can form an intricate network of intersections, thus generating extremely challenging computational domains. In DFM models, fluid flow is described by the 3D Darcy's law in the bulk domain and by an averaged Darcy's law on a reference system tangential to each fracture, coupled by fracture/matrix and fracture/fracture interface conditions. In this framework, standard numerical simulations of flow in poro-fractured media are based on finite element discretisations on meshes conforming to the interfaces, to enforce the matching conditions. However, as fractures can arbitrarily intersect each other, a variety of hard-to-mesh geometrical entities might be generated. This geometrical complexity can severely limit the applicability of such numerical methods, due to the impossibility of generating a good-quality conforming mesh.

In this talk, Dr Scialò will present and analyse a new approach for the simulation of the flow in fractured porous materials. The presented method is based on the numerical optimisation to enforce matching conditions at fracture/matrix and fracture/fracture interfaces such that no mesh conformity is needed. The solution is the minimum of a cost functional, which expresses the error in the fulfilment of interface conditions, constrained by multi-dimensional Dacy's law in the bulk domain and on the fractures. The resulting method is extremely flexible and robust, thus providing a viable option for simulations on large scales.

Biography

Stefano Scialò is tenure-track Assistant Professor at the Department of Mathematical Sciences "G. L. Lagrange". He received his Master Degree in Aerospace Engineering in 2007, and the PhD degree in Mathematics for Engineering in 2014, both from Polito di Torino. Following his PhD studies, he was first a postdoctoral fellow and then Assistant professor at the DISMA. His research interests include flow simulation in complex geometries, development and analysis of both discretisation strategies on non-conforming meshes and polygonal/polyhedral numerical methods, uncertainty quantification techniques, PDE-constrained optimization, high-performance computing techniques.

At the end of the seminar, Dr Onorato will illustrate the opportunities provided by ERC grants.

Save the date for the next event: April 02, 2019. *More info on www.polito.it/disma-excellence*