POLITECNICO DI TORINO

DISMA Dipartimento di Scienze Matematiche G. L. Lagrange

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Politecnico di Torino, DISMA, Aula Buzano (third floor)

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Flexible discretizations for mixed-dimensional Darcy-type flows in fractured porous media

Prof. Claudio Canuto introduces the seminar

Abstract

Basement rocks are common formations where is possible to host geothermal systems. The presence of a well-connected network of fractures is pivotal to exploit such systems in an environmental-friendly and economical way, as it allows the water to flow, been heated and then extracted from the production wells. Generally, the connectivity of the system and its efficiency are related. However, the geothermal system can be confined by geological barriers or zones of low permeability. Simulation and modelling are thus crucial to assess the viability of a design for fractured geothermal reservoirs.

Fractures are (sub-)planar discontinuities where the rock has been broken, and represent conduits or barriers for fluid flow. Fracture intersections can have a significant impact and may behave differently from the surrounding fractures. Since fracture aperture is orders of magnitude smaller than other characteristic sizes, a mixed-dimensional representation is preferable to the full three-dimensional one. As regards numerics, fractures may impose severe constraints on the meshes, possibly resulting in a high number of cells and low-quality grids. Dr Fumagalli will present the mixed virtual element method, which is locally mass conservative, robust to high permeability jumps, able to handle polytopes. Then, a new framework able to handle the heterogeneity in term of geometrical conformity will also be presented. On the contrary, by using the extended finite elements a local enrichment of the functional spaces allows fracture grids to be completely non-matching with the background rock matrix, increasing the flexibility and applicability of the method. Some examples of both single and multi-phase flows will be given. Finally, in discrete fracture networks (in which the impact of the surrounding host rock is neglected) the flow exchange between fractures takes place at the intersections, and thus an adequate representation of the geometry is crucial for the simulation accuracy. In the presence of multiple fractures, an upscaling technique is essential to speed up the simulations, and Dr Fumagalli will present a numerical technique able to substitute local fracture effects by representative quantities.

Biography

Dr Fumagalli obtained his PhD from Politecnico di Milano (2012), and then he worked as Post-doc at the Politecnico di Milano, the IFP - Energies nouvelles, and the University of Bergen. Starting from the Ph.D., the central thread of his research is the introduction, extension, and analysis of advanced mathematical models and non-standard numerical schemes to increase the knowledge of flow and transport in fractured porous media.