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Numerical difficulties in the simulation of flow in deformable porous media

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Numerical simulation of problems in physics and engineering represents one of the most important fields of applied sciences, being the natural ground for application of the most recent techniques of numerical analysis. Mathematical models describing such problems often require the solution of partial differential equations. To this end, discretizations based on finite differences, finite volumes or finite elements are considered to adequately approximate the continuous problem, properly capturing and retaining the characteristics of the underlying physical processes.

Coupling of fluid flow and mechanical deformation within a porous media is an important multi-physics problem appearing in many applications, ranging from geomechanics and petrol engineering to biomechanics and food processing, more recently. Such coupling was already modelled in the early one-dimensional work of Terzaghi [1], whereas the general three-dimensional mathematical formulation was established by Maurice Biot in several pioneering publications (see [2] and [3]). Numerical simulation is mandatory for real applications and therefore, a careful study of the poroelasticity model is necessary.

Throughout this talk, we will introduce the mathematical formulation of the physical model and the governing equations for the poroelasticity problem. We will focus on the numerical difficulties that appear in its numerical solution. More concretely, we will treat mathematical and practical aspects of models for poroelasticity, with an emphasis on a stable numerical discretization of the coupled system of partial differential equations.

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References

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