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Numerical methods for porous media flow models

Abstract

Porous media flows appear in several fields of highest societal relevance, such as environmental engineering, energy resources management, or oil recovery. The underlying mathematical models can be expressed as evolution equations, having a nonlinear and possibly degenerate character. In many of the situations of practical relevance, the models are defined in heterogeneous or fractured media, involving homogeneous blocks.

Standard mathematical models for porous media flows are equilibrium-based, in the sense that they typically assume that quantities like the capillary pressure and the saturation are connected through an algebraic relationship. Such an assumption is, however, invalidated by several experimental works. More precisely, the standard porous media flow models results rule out the experimental results reported in works like the ones mentioned before. This motivates extending the standard models by incorporating non-equilibrium effects like dynamic capillarity or hysteresis.

In this presentation we first motivate the use of equilibrium or non-equilibrium of models and discuss briefly existing mathematical and numerical analysis results for such models. Then we propose a domain decomposition method combined with a linearization approach for solving the emerging, time discrete equations, defined in porous media with block type heterogeneities. The approach builds on the Schwarz non-overlapping decomposition scheme and on an L-type iterative linearization method.

This is a joint work with Kundan Kumar, Florian List, Stephan Lunowa, Koondanibha Mitra and Florin Adrian Radu.