# Algebraic Dynamic Multilevel method for multiphase flow in heterogeneous porous media with discrete Fractures (F-ADM)

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## Abstract

Accurate numerical simulation of multiphase flow in heterogeneous fractured porous media demands for high resolution computational grids in order to capture the complex nonlinear multiphase flow behaviour. Discrete representation of the fractures over the large-scale heterogeneous natural formations results in high-contrast linear systems with sizes which are beyond the scope of classical simulation schemes. Therefore, advanced scalable methods which are efficient and accurate for real-field applications are more than ever on demand. Note that simulation accuracy can be maintained if the heterogeneous parameters are accounted for at their provided (fine-scale) level, and excessive upscaling of the coefficients with no separation of the scales (nor REV) is avoided. Algebraic Dynamic Multilevel (ADM) [1] method has been recently developed for multiphase flow in heterogeneous (non-fractured) reservoirs. Here, we present an ADM method for multiphase flow in fractured heterogeneous porous media (F-ADM), with discrete fractures at the fine-scale resolution. This fine-scale discrete system is obtained based on the embedded discrete fracture modelling (EDFM) approach, which employs independent fine-scale grids for matrix and fractures. On this highly resolved fine-scale mesh, F-ADM imposes independent multilevel coarse grids for both matrix and lower-dimensional discrete fractures. The fully-implicit (or sequentially-implicit) discrete system is then mapped into the adaptive dynamic multilevel resolution for all unknowns (i.e. pressure and saturation). Local basis functions are introduced to map the solution from a level to its lower resolution; the assembly of which allows for mapping the solutions up and down between any resolutions. Because of its adaptive multilevel resolution, F-ADM develops an automatic integrated framework to homogenise or explicitly represent a fracture network at coarser levels. Several test cases, including multiphase flow in 3D heterogeneous media (an example is shown in Figure 1), are studied, where only a small fraction of the fine-scale grids is employed to find accurate complex nonlinear multiphase solutions.

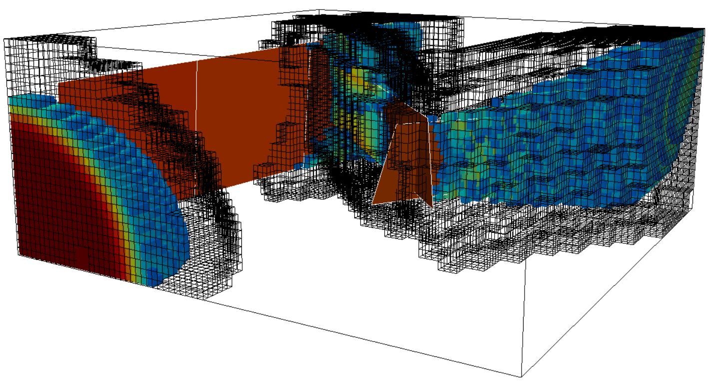

*Figure 1:* Saturation distribution for a 3D test case. Also shown are the active fine-scale grids for matrix.

## References

[1] M Cusini and B Fryer and C van Kruijsdijk and H Hajibeygi. Algebraic dynamic multilevel method for compositional flow in heterogeneous porous media, *Journal of Computational Physics*, **354**, 593–612, (2017).