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XFEM for heterogeneous porous media with networks of fractures

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ABSTRACT

Subsurface flows are strongly influenced by the presence of heterogeneities in the porous medium, in particular by the presence of layers with different permeabilities and fractures or faults that can act as preferential paths or barriers for the flow. In this framework geometric conformity can represent a strict constraint for the generation of the grid, resulting in very small and distorted elements. In this work an XFEM approach is used to handle the non-conformity between the fractures, or layers [5], and the grid of the surrounding porous medium. We consider the case of an arbitrary network of intersecting fractures [3, 4], represented as objects of co-dimension one, deriving consistent and effective interface conditions to impose at the intersections. This new model allows for jumps of pressure across the intersection, thus permitting to describe more accurately the flow when fractures are characterized by different properties, while the models already present in literature impose pressure continuity [1, 2]. To obtain a method that is as flexible as possible, in the view of future realistic applications, we employ the XFEM on two levels. First of all, we allow the grid of the medium to be non-conforming with the fractures. Moreover, we allow the grids of the fractures to be arbitrary, *i.e.* non-matching at the intersection, and handle the pressure and velocity jumps at the intersection points. Furthermore the elements of the mesh that are crossed by more than one fracture require an additional enrichment of the finite element space.

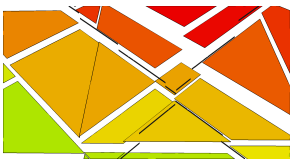

Figure 1: Intersection of $2D$ and $1D$ grids.

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