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A P1-bubble Virtual Element Method for mixed dimensional models with frictional contact at matrix fracture interfaces

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This work deals with the discretization of processes coupling a Darcy flow in a fractured/faulted porous medium, the mechanical deformation of the matrix domain surrounding the fractures, and the mechanical behavior of the fractures. Such coupled models are of paramount importance in a broad range of subsurface processes like geothermal systems or geological storage. Fractures or faults will be represented as a network of planar surfaces leading to the so-called mixed-dimensional models. Small displacements and a linear elastic behavior are considered in the matrix domain. Our objective is to design a discretization adapted to polyhedral meshes in order to cope with the geometrical complexity of faulted geological systems, and preserving the energy estimates of the coupled system. It combines a Finite Volume discretization of the flow model with a mixed formulation for the contact mechanics based on a first order Virtual Element Method for the displacement field and a face-wise constant discretization of the surface tractions. Virtual bubbles are added to the displacement space at the fracture faces in order to guarantee the stability of the contact terms.

Références

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