$\mathbf{H}$(div)-conforming flux approximations based on general partitions and a multiscale model for Darcy's flows

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The importance of $\mathbf{H}$(div)-conforming approximations is well recognized for conservative mixed formulations of multiphysics systems. There exists in the literature a variety of such approximation spaces, which are usually restricted to standard element geometries. We describe the principles in the construction of more general $\mathbf{H}$(div)-conforming contexts, the partitions allowing polygonal (polyhedral) local subdomains. Given a finite dimensional normal flux space Λ_c, piecewise defined over a partition of the mesh skeleton, the approximation spaces keep fixed the face flux components constrained by Λ_c, but the internal flux components and the potential approximations inside the subdomains may be enriched in different extents: with respect to internal mesh size, internal polynomial degree, or both. Some applications of these constrained space configurations are discussed for the mixed formulation of Darcy's flows, an unified error analysis holding for them. Specially, the focus is on a multiscale approach, the functions in Λ_c playing the role of Neumann boundary conditions (normal fluxes) for local mixed finite element problems in each subdomain to be solved in the downscaling stage.