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Higher order multipoint flux mixed finite element methods on quadrilaterals and hexahedra

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We develop higher order multipoint flux mixed finite element (MFMFE) methods for solving elliptic problems on quadrilateral and hexahedral grids that reduce to cell-based pressure systems. The methods are based on a new family of mixed finite elements, which are enhanced Raviart-Thomas spaces with bubbles that are curls of specially chosen polynomials. The velocity degrees of freedom of the new spaces can be associated with the points of tensor-product Gauss-Lobatto quadrature rules, which allows for local velocity elimination and leads to a symmetric and positive definite cell-based system for the pressures. We prove optimal k-th order convergence for the velocity and pressure in their natural norms, as well as (k+1)-st order superconvergence for the pressure at the Gauss points. Moreover, local postprocessing gives a pressure that is superconvergent of order k+1 in the full L2-norm. Numerical results illustrating the validity of our theoretical results are included.

References

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Primary authors: AMBARTSUMYAN, Ilona (University of Pittsburgh); KHATTATOV, Eldar (University of Pittsburgh); LEE, Jeonghun (The University of Texas at Austin); YOTOV, Ivan (University of Pittsburgh)

Presenter: YOTOV, Ivan (University of Pittsburgh)

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