Hybrid Discontinuous Galerkin Methods with Vector Valued Finite Elements

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In this talk we discuss some recent finite element methods for solid mechanics and fluid dynamics. Here, the primary unknowns are H^1-vector fields. We show that it can be useful to treat the normal continuity and tangential continuity of the vector fields differently. One example is to construct exact divergence-free finite element spaces for incompressible flows, which leads to finite element spaces with continuous normal components. An other example is structural mechanics, where tangential continuous finite elements lead to locking free methods.
Keeping one component continuous, we arrive either at $H(curl)$-conforming, or $H(div)$ conforming methods. The other component is treated by a discontinuous Galerkin method. We discuss a generic technique to construct conforming high order finite element spaces spaces for $H(curl)$ and $H(div)$, i.e., Raviart Thomas and Nedelec - type finite elements. By this construction, we can easily build divergence-free finite element sub-spaces.