From the DDFV ideas to Nodal Discrete Duality (NDD) schemes on general meshes

Andreianov Boris *
Institut Denis Poisson, Université de Tours, France
boris.andreianov@univ-tours.fr

Quenjel El Houssaine
Chaire de Biotechnologie de CentraleSuplec, France
el-houssaine.quenjel@centralesupelec.fr

Abstract

The DDFV schemes are particularly successful in quality approximation of gradients and fluxes for nonlinear and linear anisotropic diffusion operators on general meshes. They possess however a few serious flaws, in particular

- the global coupling of center and nodal unknowns, which results in higher numerical costs (especially in 3D) as compared to many alternative approaches
- the necessity to adapt the scheme to jump-discontinuous diffusion tensors (the m-DDFV construction)
- the necessity to introduce a penalization of the difference between the solution on the primal and on the dual mesh, for the sake of convergence analysis of many problems, including convection-diffusion and reaction-diffusion ones.

The NDD scheme, developed by E.H. Quenjel et al. on general 2D meshes by adapting the DDFV ideas, is free of the three above mentioned drawbacks. This has a price, in particular the conservativity of the fluxes is relaxed in the NDD framework (but a kind of local conservativity is witnessed through the Discrete Duality feature). We present the 2D NDD construction using both nodal and center unknowns; we highlight the elimination of the center unknowns as well as the three core features that NDD schemes share with the DDFV schemes. Then we present two 3D NDD constructions, and on this occasion we revisit the 2D CVFE (Control Volume Finite Element) scheme, producing an unconditionally coercive 2D CVFE scheme on general meshes.