國立中山大學應用數學系
學術演講

講　者：Professor Todd James Arbogast
Mathematics Department, The University of Texas at Austin, USA

講　題：Two Families of H(Div) Mixed Finite Elements on Quadrilaterals of Minimal Dimension

時　間：2015/07/16（星期四）15：30 ~ 16：30

地　點：理學院四樓理 SC 4011 室

茶　會：15:00 於理 SC 4010 室 (系辦公室)

摘要

We develop two families of mixed finite elements on quadrilateral meshes for approximating(u,p) solving a second order elliptic equation in mixed form. Standard Raviart-Thomas (RT) and Brezzi-Douglas-Marini (BDM) elements are defined on rectangles and extended to quadrilaterals using the Piola transform, which are well-known to lose optimal approximation of div u. Arnold-Boffi-Falk (ABF) spaces rectify the problem by increasing the dimension of RT, so that approximation is maintained after Piola mapping. Our two families of finite elements are uniformly inf-sup stable, achieve optimal rates of convergence, and have minimal dimension. The elements for u are constructed from vector polynomials defined directly on the quadrilaterals, rather than being transformed from a reference rectangle by the Piola mapping, and then supplemented by two (one for the lowest order) basis functions that are Piola mapped. One family has full H(Div)-approximation (u, p, and div u are approximated to the same order like(RT) and the other has reduced H(Div)-approximation (p and div u are approximated to one less power like BDM). The two families are identical except for inclusion of a minimal set of vector and scalar polynomials needed for higher order approximation of div u and p, and thereby we clarify and unify the treatment of finite element approximation between these two classes. The key result is a Helmholtz-like decomposition of vector polynomials, which explains precisely how a divergence is approximated locally. We develop an implementable local basis and present numerical results confirming the theory.

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