数学与系统科学研究院

计算数学所学术报告

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报告题目：

A Unified Framework of Finite Element Methods for 2nd Order Elliptic Problems

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报告地点：　科技综合楼三层

311 报告厅

Abstract:

In this talk, we present an overview for the design of different finite element methods (FEMs) using a unified framework. This framework covers a variety of finite element methods, including conforming and nonconforming FEMs, mixed FEMs, hybrid FEMs, discontinuous Galerkin (DG) methods, hybrid DG methods and weak Galerkin methods. We illustrate the main idea using a model second order elliptic boundary problem, which admits two main variational formulations, namely the primal and mixed formulation respectively. The primal formulation requires certain continuity for the primal variable u, namely $u\in H^1_0(\Omega)$, while the mixed formulation requires certain continuity for the (mixed) flux variable $\boldsymbol{p} \in H({\rm div})$. The design of finite element methods then amounts to an appropriate approximation of the aforementioned continuity requirements for either u or $\boldsymbol{p}$. There are roughly four different ways to approximately impose these continuity requirements: (1) strongly (conforming); (2) weakly (nonconforming); (3) by Lagrangian multiplier (hybrid or stabilized hybrid), and (4) by penalization (discontinuous Galerkin). The resulting four different types of finite element methods can then be fully described by the notion of DG-gradient, DG-divergence, and the restriction operators.

As a result, all technical details of these finite element methods can be {\em fully described} by simply using two tables. Here, the DG-derivatives are dual to certain weak-derivatives introduced by Wang and Ye (2013), and are reduced to classical weak derivatives for distributions when the underlying finite element spaces are in some sense conforming.This general framework recovers most of the existing finite element methods of different types in a unified and coherent fashion. In particular, it also reveals a special type of DG methods, known as the mixed DG method, which does not seem to be available in existing literature. As this appears to be a new method, an in-depth analysis of its stability and convergence is given.

欢迎大家参加！