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：

Combined Finite Element Methods for Multiscale Elliptic Problems with Singularities

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上午 **9:00-10:00**

报告地点：　数学院南楼二层

202 教室

Abstract:

In this talk, we introduce the combined finite element methods (FEM) to solve the multiscale problems which may have singularities in some special portions of the computational domain. For example, in the simulation of subsurface flow, singularities lie in the porous media with channelized features, or in near-well regions since the solution behaves like the Green function. The basic idea of combined FEMs is to utilize the standard finite element method directly on a fine mesh of the problematic part of the domain and using some special version of FEMs such as the oversampling multiscale finite element method (OMsFEM) or the Petrov-Galerkin version of oversampling MsFEM (OMsPGM) on a coarse mesh of the other part. The transmission condition across the interface is treated by the penalty technique. The combined FEM takes advantages of the FEM and OMsFEM/OMsPGM, which uses much less DOFs than the standard FEM and may be more accurate than the OMsFEM/OMsPGM for problems with singularities. Numerical examples with periodic and random highly oscillating coefficients, as well as the multiscale problems on the L-shaped domain, and multiscale problems with high contrast channels or well-singularities are presented to demonstrate the efficiency and accuracy of the proposed method. We also introduce a combined FEM to solve the elliptic problems posted in domains with rough boundaries. The key point of the method lies in the new scheme employing a weighted average in the definition of the bilinear form, which avoids the affection of the ratio of coarse-fine mesh sizes in the error estimate. We prove a quasi-optimal convergence in terms of elements since there is no whole H^2 regularity in the domain with rough boundaries. Numerical results are provided for elliptic equations in domains with non-oscillating or oscillating boundaries to illustrate the theoretical results.

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