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：

Riesz Bases of Wavelets and Applications to Numerical Solutions of Elliptic Equations

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计算数学所报告厅

摘要：**Partial differential equations are usually solved numerically by a certain discretization method such as the finite element method or the finite difference method. The discretization method gives rise to a large system of linear equations, often a linear system of over one million equations. For such a large system of linear equations, direct methods are impractical. Thus, efficient iteration schemes are needed for numerical solutions of large systems of linear equations.**

In this talk, we propose a multi-level iteration scheme based on wavelets for numerical solutions of elliptic equations. For the energy norm, our algorithm requires no more than two iterations to find numerical solutions of elliptic equations that achieve the level of discretization error. For example, it only takes 0.5 second on a modest personal computer for our

algorithm to solve the biharmonic equation (an elliptic equation of fourth order) over the 1024 x 1024 grid. Note that the resulting linear system has more than one million equations.

Our numerical algorithm is based on a solid theoretic foundation. Indeed, we develop a fairly general theory for Riesz bases of Hilbert spaces equipped with various norms. Under the guidance of the general theory, we are able to construct simple but useful Riesz bases of wavelets for certain Sobolev spaces. The condition numbers of the stiffness matrices associated with the wavelet bases are relatively small and uniformly bounded. Consequently, a good wavelet basis together with a multi-level technique guarantees that our algorithm is optimal for numerical solutions of elliptic equations.

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