数学与系统科学研究院

计算数学所学术报告

报告人：　**Prof. Qinghai Zhang**

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报告题目：

A Fourth-order Cut-cell Method for Elliptic and Parabolic Problems on Irregular Domains with Structured Rectangular Grids

邀请人：　郑伟英 研究员

报告时间：**2019** 年 **11** 月 **14** 日（周四）

下午 **14:00-15:00**

报告地点：　数学院南楼二层

212 教室

Abstract:

Classical finite-difference and finite-volume discretizations on structured rectangular grids lead to highly efficient numerical solvers for partial differential equations, yet one disadvantage of this approach is its difficulty in dealing with irregular and moving boundaries. In our previous work, we have proposed a series of fourth-order finite-volume methods for solving the Poisson equation, the convection-diffusion equation, and the incompressible Navier-Stokes equations. In this talk, we focus on how to augment our previous solvers to domains with irregular boundaries. First, the irregular interface are represented by cubic splines, and a Boolean algorithm computes for each control volume the open area of the fluid, where the cell-averaged unknowns are defined. Second, we choose for each cut cell a set of nearby cells to discretize spatial operators; this is an open problem called poised-lattice generation in approximation theory. We solve this problem by reducing it to an exact cover problem and coupling the algorithm X [3] with techniques involving the heredity principle of quasi-determinants [2, 1]. Third, the complete decouple of spatial discretization from time integration in the GePUP formulation [4] admits a straightforward treatment of the irregular interface by replacing regular stencils with poised lattices. The resulting linear systems are efficiently solved by geometric multigrids. Finally, we will discuss how to generalize the case of static boundaries to that of moving boundaries.

References

[1] I. Gelfand, S. Gelfand, V. Retakh, and R. L. Wilson. Quasideterminants. Adv. Math., 193:56–141, 2005.

[2] A. Heyting. Die theorie der linearen Gleichungen in einer Zahlenspezies mit nichtkommutativer Multiplikation. Math. Ann., 98:465–490, 1928.

[3] D. Knuth. Dancing links. Millennial Perspectives in Computer Science, 187:159, 2000.

[4] Q. Zhang. GePUP: Generic projection and unconstrained PPE for fourth-order solutions of the incompressible Navier-Stokes equations with no-slip boundary conditions. J. Sci. Comput., 67:1134–1180, 2016.

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