数学与系统科学研究院

计算数学所学术报告

报告人：**Prof. George Em Karniadakis**

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报告题目**:**

Fractional Spectral and Spectral Element Methods

邀请人**:** 唐贻发 研究员

报告时间**: 2013** 年 **11** 月 **14** 日（周四）

下午 **16:00-17:00**

报告地点**:** 科技综合楼三层 **311**

计算数学所报告厅

Abstract:

We have developed Discontinuous Petrov-Galerkin (DPG) methods for time- and space- Fractional PDEs . We present exponentially accurate and efficient DPG methods for global discretization of both the temporal and spatial terms, instead of employing traditional low-order time-integration methods. To this end, we first develop a DPG method, where we carry out the time-integration using a single time-domain spectral method (SM), and we perform the spatial discretization using the Discontinuous Spectral Element Method (DSEM). This scheme also leads to a more efficient time-integration when the time-derivative is integer-order. We develop the SM-DSEM scheme based on a new spectral theory for fractional Sturm-Liouville problems (FSLPs), recently presented in (Zayernouri & Karniadakis, JCP, 2013). We choose the corresponding space-time bases from the span of tensor product of the introduced eigenfunctions. Specifically, we employ the eigenfunctions of the FSLP of first kind (FSLP-I), called Jacobi polyfractonomials, as temporal bases. We also employ the corresponding asymptotic eigensolutions to FSLP-I, which are Jacobi polynomials, as spatial basis. Next, we construct a different test function space, defined as the span of tensor product of polyfractonomial eigenfunctions of the FSLP of second kind (FSLP-II), as the temporal test functions, and the corresponding *asymptotic* eigensolutions to FSLP-II, as the spatial ones. Subsequently, we extend the SM-DSEM to the second DPG method, called DSEM-DSEM, in which both time-integration and spatial discretization are performed in an hp-element fashion. Our numerical tests confirm the expected exponential/algebraic convergence, respectively, in corresponding p- and h-refinements in various test-cases, and show a four-order of magnitude speed-up compared to finite-difference discretizations.

Short Bio.:

George Em Karniadakis is the Charles Pitts Robinson and John Palmer Barstow Professor of Applied Mathematics, Brown University. He is also Research Scientist at MIT (Mechanical Engineering) and the Director of the new Collaboratory on Mathematics for Mesoscopic Modelimg of Materials (CM4) – a Department of Energy Center at USA. He has published three books and more than 200 research papers on computational mathematics, stochastic modeling, uncertainty quantification, microfluidics, turbulence, biophysics, and parallel computing. He is fellow of SIAM, APS and ASME. He received the CFD award (2007) and the J. Tinsley Oden Medal (2013) by the US Association in Computational Mechanics. His h-index is 59 and he has been cited more than 17,000 times.

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