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**

(Division of Applied Mathematics, Brown University

& Department of Mechanical Engineering, MIT)

报告题目：

Solving and Discovering Differential Equations via Machine Learning

邀请人：　唐贻发研究员

报告时间：**2017 年 12 月 22 日（周五）**

上午 10:00--11:00

报告地点：　数学院南楼七层

702 教室

报告摘要：

In the last 30 years I have pursued the numerical solution of partial differential equations (PDEs) for

diverse application in mechanics and soft matter using spectral and spectral elements methods for diverse applications, starting from deterministic PDEs in complex geometries, to stochastic PDEs for uncertainty quantification, and to fractional PDEs that describe non-local behavior in disordered media and viscoelastic materials. More recently, I have been working on solving PDEs in a fundamentally different way. I will present a new paradigm in solving linear and nonlinear PDEs from noisy measurements without the use of the classical numerical discretization. Instead, we infer the solution of PDEs from noisy data, which can represent measurements of variable fidelity. The key idea is to encode the structure of the PDE into prior distributions and train Bayesian nonparametric (Gaussian process, GP) regression models on available noisy data. The resulting posterior distributions can be used to predict the PDE solution with quantified uncertainty, efficiently identify extrema via Bayesian optimization, and acquire new data via active learning. Moreover, I will present how we can use this new framework to

learn PDEs from noisy measurements of the solution and the forcing terms. Alternatively, we can solve PDEs using optimized deep neural networks (dNN) by encoding the PDE directly into the network. I will present both approaches and compare the relative performance of GPs and dNNs.

Bio: George Karniadakis received his S.M. and Ph.D. from Massachusetts Institute of Technology. He was appointed Lecturer in the Department of Mechanical Engineering at MIT in 1987 and subsequently he joined the Center for Turbulence Research at Stanford / Nasa Ames. He joined Princeton University as Assistant Professor in the Department of Mechanical and Aerospace Engineering and as Associate Faculty in the Program of Applied and Computational Mathematics. He was a Visiting Professor at Caltech in 1993 in the Aeronautics Department and joined Brown University as Associate Professor of Applied Mathematics in the Center for Fluid Mechanics in 1994. After becoming a full professor in 1996, he continues to be a Visiting Professor and Senior Lecturer of Ocean/Mechanical

Engineering at MIT. He is a Fellow of the Society for Industrial and Applied Mathematics (SIAM, 2010-), Fellow of the American Physical Society (APS, 2004-), Fellow of the American Society of Mechanical Engineers (ASME, 2003-) and Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA, 2006-). He received the Ralf E Kleinman award from SIAM (2015), the J. Tinsley Oden Medal (2013), and the CFD award (2007) by the US Association in Computational Mechanics. His h-index is 83 and he has been cited over 35,500 times. He recently received the Alexander von Humboldt Award. He is an associate editor for SIAM J. Sci. Comp., SIAM Reviews, SIAM J. Uncertainty Quantification, J. Comput. Physics, M3AS, and Calcolo.

（受交叉课题资助）

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