科学计算与生物医学工程交叉应用论坛

暨第三届计算心脏学国际研讨会

程序册

资助单位

国家天元数学西北中心

西北工业大学国际合作处

主办单位

西北工业大学

承办单位

西北工业大学理学院

西北工业大学计算科学研究中心

西北工业大学-格拉斯哥大学心脏学计算与应用国际联合实验室

SofTMech: EPSRC Centre for Multiscale Soft Tissue Mechanics

会议信息

科学计算与生物医学工程交叉应用论坛暨第三届计算心脏学国际研讨会由**国家天元数学西北中心、西北工业大学国际合作处**资助, 西北工业大学主办, 西北工业大学理学院、西北工业大学计算科学研究中心、西北工业大学-格拉斯哥大学心脏学计算与应用国际联合实验室、SofTMech承办, 将于2018年5月31日至6月3日在西北工业大学国际会议中心举行。会议旨在汇聚海内外专家学者，搭建科学计算与生物医学工程的交流平台，聚焦相关学术前沿及研究热点，促进相关领域的交叉与融合。

学术委员会主席: 徐宗本

组委会: 崔俊芝（联合主席）、聂玉峰（联合主席）、凤小兵、Luo Xiaoyu、蔡力

会议联系人: 蔡力 (caili@nwpu.edu.cn)

会议地点: 西北工业大学国际会议中心第一会议室

一　会议日程安排

5月31日：报到（西北工业大学正禾宾馆）			
6月1日：学术活动（西北工业大学国际会议中心第一会议室）			
时间	报告人	题目	主持人
08:00–08:30	开幕式、合影		聂玉峰
08:30–09:20	**Fu Yibin**	**Evaluation of the Gent, Gent-Gent, and Ogden material models using inflation of a plane membrane**	凤小兵
09:20–10:10	**Wang Qi**	**Numerical approximations to thermodynamically consistent nonequilibrium models**	
10:10–10:30	茶歇		
10:30–11:20	刘子顺	**Recent development for the mechanics of soft materials and machines–The study on hydrogel and shape memory polymer materials**	**Luo Xiaoyu**
11:20–12:10	应文俊	**Solution of the bidomain equations with a composite backward differentiation formula**	
12:20–14:00	午餐（西北工业大学正禾宾馆）		
14:00–14:50	凤小兵	**A variational approach for reverse engineering genetic regulatory networks**	刘子顺
14:50–15:40	**Luo Xiaoyu**	**On the chordae structure and dynamic behaviour of the mitral valve**	
15:40–16:00	茶歇		
16:00–16:50	**Xu Jiake**	**EGFL protein expression and function as novel angiogenic factors**	应文俊
16:50–17:40	沈晓芹	**Mathematical modelling for human heart valves**	
18:00–20:00	晚宴		

6月2日：学术活动（西北工业大学国际会议中心第一会议室）			
时间	报告人	题目	主持人
08:30–09:20	Ren Weiqing	Modelling rare events in complex systems	Fu Yibin
09:20–09:50	荆菲菲	Stabilized finite element methods for a blood flow model of arteriosclerosis	
09:50–10:10	茶歇		
10:10–11:00	王岗	临床信息化与数据挖掘	Ren Weiqing
11:00–11:50	Gao Hao	Mathematical modelling acute myocardial infarction based on magnetic resonance imaging	
12:00–14:00	午餐（西北工业大学正禾宾馆）		
14:00–14:30	李义宝	Cell growth and cytokinesis using the immersed boundary method	Gao Hao
14:30–15:00	马幸双	猪心脏二尖瓣腱索的生物力学性能及本构方程研究	
15:00–15:30	朱光宇	新型膨聚四氟乙烯(ePTFE)双叶主动脉瓣的数值仿真及体外实验研究	
15:30–16:00	茶歇		
16:00–16:30	齐楠	Multiscale single cell mechanical model based on fluid structure interaction	蔡力
16:30–16:50	郭巍	Anisotropic mesh adaptation for convection-dominated problems based on bubble-type local mesh generation	
16:50–17:10	申尚昆	深度学习在偏微分数值解方向的研究现状	
17:10–17:30	王永恒	基于混合IB/LS方法的左心室FSI数值模拟	
17:30–17:50	孙晔	A fully discrete implicit-explicit finite element method for solving the FitzHugh-Nagumo model	
17:50–18:10	Wang Danyang	Self-excited oscillations in collapsible channel flow	
18:10–18:20	闭幕式		聂玉峰
18:30–20:00	晚宴		
6月3日：自由讨论交流、离会			

二　邀请报告简介（按姓氏排序）

报告人 凤小兵 (University of Tennessee，西北工业大学)

报告题目

A variational approach for reverse engineering genetic regulatory networks

报告摘要

Understanding genetic regulatory networks at the system level is a fundamental issue in the post-genomic era. Recent advances in genome sequencing and emerging high-throughput technologies, such as DNA and protein chips and microarray technology, enable parallel measurement of the spatial-temporal expression levels of thousands of genes or proteins simultaneously. It has opened up great possibilities to unveil gene regulatory networks at the large scale. One of fundamental and difficult questions in systems biology is what information each genome or gene map encodes. Decoding genomes and making use of the discovered information has been the main focus of the post-genomic research and of systems biology. In this talk we shall first introduce both deterministic and stochastic differential equation (DE) based mathematical models for reverse engineering genetic regulatory networks which only use genomic information provided by microarray data. We shall then present a novel variational DE-modeling framework and efficient numerical methods for solving the proposed models. Finally, we shall also present some model validation results using both synthetic datasets and real world microarray datasets of E. Coli and Yeast. This is a joint work with Miun Yoon of the University of Tennessee at Knoxville, U.S.A.

报告人简介

美国田纳西大学（The University of Tennessee）数学终身教授，数学系副系主任，数学系研究生学部主任；西北工业大学长江讲座教授。1983年和1985年分别获西安交大计算数学学士和硕士学位，1992年获美国普度大学（Purdue University）应用和计算数学博学位。凤小兵教授长期从事线性，特别是非线性偏微分方程及其数值解法和算法的研究，并取得了一系列国际领先的成果。在“SIAM Review”，“SIAM J Numerical Analysis”，“Mathematics of Computation”，“Numerische Mathematik”等国际一流专业学术期刊上发表论文90余篇。

报告人 Fu Yibin (University of Keele)

报告题目

Evaluation of the Gent, Gent-Gent, and Ogden material models using inflation of a plane membrane

报告摘要

The Gent material model is the simplest extension of the neo-Hookean material model that can describe the finite extensibility of material. It has therefore been used as the basis for many other models to describe the response of biological tissues. However, it is known that its fitting to experimental results of uniaxial tension is not satisfactory for moderate values of stretch, and the Gent-Gent model was proposed to remedy this deficiency. In this paper we provide further evidence on the good performance of the Gent-Gent model by using it to study the inflation of a circular plane membrane. For this problem, the deformation near the pole is equibiaxial and the associated nominal tension is a monotonic function of the stretch, but the pressure as a function of the stretch has both a maximum and a minimum. The Gent and Gent-Gent models are first fitted to our own experimental data for the nominal tension, and then used to predict variation of the pressure with respect to the stretch. By comparison with the experimental data, it is shown that the Gent-Gent model gives much better predictions than the Gent model. Comparisons are also made with the Ogden material model.

报告人简介

英国 Keele大学数学系应用数学教授，IMA Journal of Applied Mathematics联合主编，Journal of Mechanics of Materials and Structures联合主编，Journal of Engineering Mathematics副主编。1982年长沙铁道学院获得学士学位，1984年由天津大学公派留学英国。1986年和1989年在University of East Anglia获得硕士和博士学位。1988-1991在Exeter大学做博士后，1991-1996在Manchester大学任讲师，1997-1999年在Keele大学做高讲，1999晋升为副教授，2001年晋升为教授。

报告人 Gao Hao (University of Glasgow)

报告题目

Mathematical modelling acute myocardial infarction based on magnetic resonance imaging

报告摘要

Although death rates from myocardial infarction (MI) are falling, the incidence of heart failure after acute-MI remains persistently high. LV dimensions and pump function change dynamically in the first few weeks post-MI. Left ventricular (LV) dysfunction after MI portends an adverse prognosis, which is responsible for nearly 70% of heart failure cases. In clinical practice, therapeutic decisions are informed by an evidence-base relating to LV ejection fraction (LVEF). However, on an individual basis, risk prediction using LVEF is limited as majority of patients who die prematurely have a normal or mildly reduced LVEF.

Computational heart modelling has potential to close some of these gaps in risk prediction in individual patients, i.e. myocardial stiffness and contractility. In order to improve patient-specific modelling of myocardial mechanics following an acute-MI, we developed a finite element model of a human LV with MI morphologies derived directly from Late-Gadolinium enhanced (LGE) magnetic resonance (MR) images. The LV geometry is reconstructed from in vivo short-/long-axis cine images of a patient after acute-MI. A linear relationship between LGE intensity and myocardial passive stiffness and contractility is assumed. We assume that the passive myocardium obeys the Holzapfel-Ogden constitutive law with eight unknown material parameters. We approximate the LV end-diastolic pressure with a population-based value (15 mmHg) and assume that the LV peak systolic pressure is the same as the cuff-measured value. The full scar region (normalised LGE intensity ¿ 0.95) is considered to be passive and 50 times stiffer compared to the remote functional myocardium. To calibrate the passive stiffness, we inversely determine the eight unknown material parameters by matching the strain measurements estimated from MR images and the LV end-diastolic volume using a multi-step optimisation approach. We further match the LV EDP-EDV curve published previously. The myocardial contractility is determined by matching the systolic function, including the systolic peak circumferential strain and LVEF. We infer the myocardial contractility of this patient is around 180.8 kPa from our modelling, which is in the range of previously published human values. Finally, patient-specific myofibre stress distributions at end-diastole and end-systole are discussed in relation to the LV adverse remodelling.

In summary, our newly developed LV model by integrating MI pathology information directly from LGE MR images for estimating myocardial passive stiffness and contractility will be helpful in management of patients with acute-MI.

报告人简介

英国格拉斯哥大学数学与统计学院Research Fellow，英国EPSRC中心SofTMech的Co-Investigator，英国GlasgowHeart团队主要成员。2003年获复旦大学理论与应用力学专业本科学位，2006年获复旦大学生物力学专业硕士学位，2010年获英国布鲁奈儿大学计算生物力学专业博士学位，2010-2012年在英国格拉斯哥大学医学院从事博士后研究。主要研究方向为基于临床图像的个体化心脏建模，心血管、二尖瓣流固耦合计算，目前发表相关学术文章45篇，Google学术总引频次591，H-index为14。

报告人 荆菲菲 (西北工业大学)

报告题目

Stabilized finite element methods for a blood flow model of arteriosclerosis

报告摘要

In this talk, a blood flow model of arteriosclerosis, which is governed by the incompressible Navier–Stokes equations with a nonlinear slip boundary condition of friction type, is constructed and analyzed. By means of suitable numerical integration approximation for the nonlinear boundary term in this model, a discrete variational inequality for the model based on $\mathbf{P}_1 - P_1/P_0$ stabilized finite elements is proposed. Optimal error estimates for velocity and pressure are derived under the corresponding L_2, H_1-norms. Finally, a smooth problem test is reported to demonstrate the theoretically predicted convergence order and the expected slip phenomena, and the simulations of the bending and bifurcation of two common vascular structures in human body are displayed to illustrate the efficiency of the proposed method.

报告人简介

西北工业大学助理教授。 2017年6月博士毕业于西安交通大学计算数学专业，师从加拿大卡尔加里大学陈掌星教授，2018年3月入职西北工业大学应用数学系，主要研究方向：偏微分方程的数值解法、动脉硬化病人的血管瘤模型、高精度数值方法等。目前已在国际国内重要学术期刊发表学术论文7篇，参与国家自然科学基金面上项目2项、青年项目2项。

报告人 李义宝 (西安交通大学)

报告题目

Cell growth and cytokinesis using the immersed boundary method

报告摘要

Cell growth and division are fundamental phenomena that generate and maintain all life. The study of these phenomena is vital to understanding the basic processes of life by which an organism is built. To study cell growth and cytokinesis, we propose a mathematical model for the growth and division of a single cell and simulate this governing model using an immersed boundary method in three-dimensional space. In this talk, I am going to describe this modeling and implement the numerical algorithm on a fully three-dimensional space. Numerical simulations will be performed to show the efficiency of our method.

报告人简介

2013年2月在韩国高丽大学获得博士学位。之后进入韩国延世大计算工程系从事博士后研究员工作。 2014年7月进入西安交通大学大数据国家工程实验室。现为应用数学系副教授，应用数学系主任。主要从事偏微分高效算法的构造与析、多物理耦合的数值计算、三维图形/图像/形状优化等研究工作。自 2010年以来在国内外重要学术刊物，如 Computer Methods in Applied Mechanics and Engineering、Journal of Computational Physics、Pattern Recognition等发表论文44篇（第一作者29篇），其中已被SCI收录的论文39篇（第一作者27篇），属于一区文章7篇、二区文章10篇。论文SCI引用356次，单篇最高引用52次，个人H因子10，I10因子13（google scholar）。

报告人 刘子顺 (西安交通大学)

报告题目

Recent development for the mechanics of soft materials and machines–The study on hydrogel and shape memory polymer materials

报告摘要

In this presentation, I will review some of the recent works aligned with the direction of providing a better understanding of soft materials (gels, SMPs etc.). Then the transient deformation process of polymeric gels and numerical implementation for large deformation kinetics of polymeric gels are studied using the finite element method (FEM). The neutral and environmentally sensitive (such as temperature, pH-value, magnetics and light) hydrogels are investigated. For the SMPs study, we developed different constitutive models which can be used for different SMP materials and can be used for large strain large deformation analyses. To validate the model, simulated and predicted results are compared with experimental results. Finally, as many issues related to the mechanics of hydrogel and SMPs deformation behaviors remain open, we will list some outlines for plausible future directions in the research of computational mechanics of soft materials/machines. Furthermore, we will overview the recent development of computational mechanics in the study of soft materials and machines over the worldwide, especially; the advances of computational mechanics for soft materials in different research groups will be discussed and reviewed.

报告人简介

Dr. Zishun Liu is a Professor of Xi’an Jiaotong University (XJTU) and Executive Director of International Center for Applied Mechanics. Dr. Liu received B.Eng., M.Eng. degrees in Applied Mechanics and Solid Mechanics from XJTU, and M.Eng., Ph.D. degrees in Solid Mechanics from the National University of Singapore (NUS). He served on the faculty of XJTU between 1986 and 1994, and as Senior Scientist, Scientist, Senior Research Engineer, Capability Group Manager, Team Leader at Institute of High Performance Computing, Singapore (IHPC), and Associate Professor of NUS at various points from 1999 to 2012. As a visiting scientist, he worked in Max Planck Institute for Metals Research, Stuttgart, Germany and University of Glasgow, UK in 2005 and 2006 respectively. Now he holds Adjunct Professorships in NUS. He is also the General Secretary of Int. Association of Applied Mechanics (IAAM) and the Honorary President of Singapore Association of Computational Mechanics. His research interests are in the areas of Mechanics of Soft Materials, Computational Solid Mechanics & Biomechanics, Nanomechanics, Vibro-Acoustic.

He has published more than 140 SCI research papers.

Dr. Liu is an active member of various leadership roles in editorial boards and professional communities as follow: Dr. Liu is an Editor-In-Chief of Int. Journal of Applied Mechanics (SCI) and Editor-In-Chief of Int. Journal of Computational Materials Science and Engineering (SCI), Invited Associate Editor-in-Chief of Acta Mechanica Solida Sinica (SCI), Editor of Journal of Mechanics of Material and Structures (SCI), Associate Editor of Journal of Applied and Computational Mechanics (ESCI), as well as serves on a few editorial boards, including Editorial board member of Int. Journal of Computational Methods (SCI), Int. Journal of Structural Stability and Dynamics (SCI), Guest editor of Computational Materials Science; Guest editor of special issue of Structural Engineering and Mechanics; Editorial board member of Chinese Journal of Applied Mechanics; General Committee Member of Association of Asia-Pacific Computational Mechanics (APACM); General Member of the International Association for Computational Mechanics (IACM).

Web: http://www.zsliu.net and http://gr.xjtu.edu.cn/web/zishun/home

报告人 Luo Xiaoyu (University of Glasgow)

报告题目

On the chordae structure and dynamic behaviour of the mitral valve

报告摘要

Mitral valve (MV) dysfunction, including mitral valve stenosis, prolapse, and regurgitation, is one of the most common valvular heart diseases and hence has attracted significant research interest. Computational modelling of human MV function can improve our understanding of MV biomechanics, which is important for improving surgical procedures and medical therapies. However, because of the challenges of modelling the highly complex MV structure, its deformation, and its interaction with the left ventricle, only limited progress in multi-physics modelling of the MV has been made to date.

We develop a mitral valve (MV) model that includes physiologically detailed descriptions of the leaflets and the chordae tendineae. Three different chordae models – complex, "pseudo-fibre", and simplified chordae – are compared to determine how different chordae representations affect the dynamics of the mitral valve. To quantify the highly complex system behaviour resulting from the fluid-structure interaction (FSI), an energy budget analysis of the coupled MV FSI model is performed.

Our MV model is based on physiologically-detailed MV geometry from multi-slice CT scans of a normal mitral valve at middle diastole, from a 61-year-old male patient, which incorporates detailed leaflet thickness and chordal information. Both leaflets and chordae are modelled as fibre-reinforced hyperelastic materials. We use an immersed boundary-finite element (IB/FE) method for our dynamic MV modelling. The simulation has been carefully verified against the commercial software ABAQUS under static loading conditions. Energy budget is conducted with introduction of different energy terms appearing in the system: change of the kinetic energy, kinetic energy flux, rate of work done by the applied pressure, the rate of energy dissipation and the rate of change of elastic strain energy in the immersed structure.

Our results show that the complex and pseudo-fibre chordae models yield good MV closure during systole, but that the simplified chordae model leads to poorer leaflet coaptation and an unrealistic bulge in anterior leaflet belly. Energy budget analysis shows that the MV models with complex and pseudo-fibre chordae have similar energy distribution patterns, but the MV model with the simplified chordae consumes more energy, especially during valve closing and opening. Interesting flow patterns and vortex formulation are seen in all three cases.

In general, we show that the complex chordae and pseudo-fibre chordae have similar

impact on the overall MV function, but that the simplified chordae representation is less accurate. Because a pseudo-fibre chordal structure is much easier to construct and less computationally intensive, it may be a good candidate for modelling MV dynamics or interaction between the MV and the heart in patient-specific applications.

报告人简介

Academic history

2008-Present: Professor, School of Mathematics & Statistics, University of Glasgow
2006-2008: Reader, Department of Mathematics, University of Glasgow
2005-2006: Senior Lecturer, Department of Mathematics, University of Glasgow
2000-2004: Lecturer/SL, Department of Mechanical Engineering, University of Sheffield
1997-2000: Lecturer, Department of Engineering, Queen Mary & Westfield College
1996-1997: Research Fellow, Department of Fuel and Energy, University of Leeds
1992-1996: Research Fellow, Department of Applied Mathematical Studies, University of Leeds
1985-1992: Lecturer, Department of Engineering Mechanics, Xi'an Jiaotong University

Professional Memberships

Executive director of the EPSRC Centre SofTMech
Director of the Centre for Mathematics Applied to the Life Sciences (CMALS), 2014-2016
Founder of the GlasgowHeart Consortium
Member of European Mechanics Society
Member of London mathematical society

Editorships

Associate editor for the Journal of Royal Society Open Science, 2016-
Executive Editor of International Journal of Applied Mechanics, 2009-
Associated Editor of International Journal for Numerical Methods in Biomedical Engineering, 2008-
Associated Editor of International Journal of Computer Mathematics - Section B, 2008-

Fellowships

The Leverhulme Research Fellowship, 2015-2016
Fellow of the Royal Society of Edinburgh, 2014-
Fellow of the Institute of Mechanical Engineers (IMechE), 2004-

报告人 马幸双 (重庆大学)

报告题目

猪心脏二尖瓣腱索的生物力学性能及本构方程研究

报告摘要

二尖瓣是复杂的心脏阀门，组成包括瓣膜环，前叶，后叶，前后叶间过渡区域，乳头肌和连接叶片的腱索。腱索力学性能对于二尖瓣功能的正常发挥起着关键作用：腱索辅助维持心动过程中叶片的开合，从而实现周身供血并防止血液回流，而病变或老化的腱索如果发生断裂则会造成二尖瓣功能不全，从而导致心脏疾病。本研究通过对猪心脏腱索进行离体力学拉伸实验及组织学观察，分析其宏观生物力学特性与微观结构的关系，构建基于二尖瓣腱索材料各向异性的非线性组织力学模型，为后续利用有限元进行动态模拟提供理论基础,并以期对心脏瓣膜疾病临床研究及人工瓣膜的设计起到指导作用。

报告人简介

2006年毕业于西安交通大学工程力学专业，获工学学士学位。2009年毕业于西安交通大学固体力学专业，获工学硕士学位，师从王铁军教授。2009年赴英国格拉斯哥大学（University of Glasgow, United Kingdom）数学与统计学院生物数学专业攻读博士，师从苏格兰皇家院士Luo Xiaoyu教授，从事人类二尖瓣及心脏的流固耦合数值模拟研究工作。2011年赴美国纽约大学库郎数学科学研究所（New York University, Courant Institute of Mathematical Sciences）访问学习，师从浸入边界法的创始人、美国科学院院士Charles Peskin教授与 IBAMR开源软件的编译者Boyce Griffith教授。2014年博士毕业后到重庆大学生物工程学院工作至今。现主要从事个体化二尖瓣、心脏、血管及心脏植入物的流固耦合数值模拟、骨关节系统软组织力学失稳损伤及修复的机制以及人工假体的建模与设计研究。主持国家青年自然科学基金1项（基于临床医疗图像的各向异性人类个体化二尖瓣的流固耦合研究），参与国家自然科学基金重点项目、面上项目、重点研发等多项基金项目。

报告人 齐楠 (山东大学)

报告题目

Multiscale single cell mechanical model based on fluid-structure interaction

报告摘要

The eukaryotic cell, as a basic building block of life, has a highly complex substructures, e.g. nucleus, cytoplasm, cytoskeleton (different types of filaments), organelles and membrane. Cell mechanical model studies basic cellular mechanical properties via mathematical modelling. It not only substantially enhances our understanding of micro-scale cell mechanism, but also provides clues for solving many macro-scale problems, which is of a great importance and value for the development of new medical technology.

Atomic force microscopy (AFM) has been established as a popular tool to measure the mechanical stiffness of different cells. However, most of the measured data are interpreted using the classical Hertzian law, which applies for linear elasticity only and ignores the substrate effect. In this talk, we first present a modified though linear Hertzian expression incorporating the stiffness of the substrate material. In the aspect of nonlinearity characterizing the overall mechanical response of a whole cell, a homogenization method is discussed to upscale a single cell by overall quantities based on volume averaging over each composite material domain. The traction continuity at the interface has been shown to be equivalent to the minimisation of the admissible strain-energy function with respect to the discontinuity in the deformation gradient along the interface. Lastly, we propose to build a single cell fluid-structure interaction (FSI) system. The solid part (actin cortex) are defined via a fibrous soft tissue nonlinear hyperelastic constitutive law. This law is multiscale as the single filament contribution is upscaled to a network structure based on a microsphere model. To solve the FSI, we make use of the Arbitrary Lagrangian-Eulerian method and the frontal solver. The method of three-dimensional rotating spines is used to update the adaptive mesh deformation. This multiscale and multiphysical computational system will be compared with an AFM experiment in the lab where a round cell is indented with a spherical AFM tip from the top.

报告人简介

山东大学海洋研究院助理研究员。在西北工业大学理学院数学系取得理学学士和硕士学位，2016年在英国University of Glasgow获得生物力学博士学位，而后在英国SofTMech数学研究中心做research associate。主要研究细胞力学、心血管力学、流固耦合模拟及有限元计算方法等。曾获国家优秀自费留学生奖学金、Jim

Gatheral Fellowship、Jack prize提名、陕西省优秀毕业生。

报告人 Ren Weiqing (National University of Singapore)

报告题目

Modelling rare events in complex systems

报告摘要

The dynamics of complex systems is often driven by rare but important events. Well-known examples include nucleation events during phase transition, conformational changes of bio-molecules, dislocation dynamics in crystalline solides, etc. The long time scale associated with these rare events is a consequence of the disparity between the effective thermal energy and typical energy barrier of the systems. The dynamics proceeds by long waiting periods around metastable states followed by sudden jumps from one state to another. In this talk, I will discuss numerical methods, particularly the string method, for modelling such rare events. Applications, including conformational changes of bio-molecules, switching of micro-magnetics, the wetting transition on patterned solid surfaces, etc, will also be presented.

报告人简介

Education

Ph.D. September, 2002, Courant Institute, New York University

B.S. June, 1994, Department of Mathematics, Nanjing University, China

Academic Appointments

Professor of Mathematics (2017–present), Associate Professor (2011-2016), National University of Singapore

2011–present, Senior Scientist (joint appointment), Institute of High Performance Computing, A*STAR, Singapore;

2005-2011, Assistant Professor of Mathematics, Courant Institute, New York University

2007-2011, Director of the Master Program in Scientific Computing, Courant Institute

2003-2005, Instructor, Department of Mathematics, Princeton University

2002-2003, Member, School of Mathematics, Institute for Advanced Study, Princeton

Awards

Feng Kang Prize of Scientific Computing (冯康科学计算奖), 2015

Alfred P. Sloan Research Fellowship, 2007

Webpage

http://www.math.nus.edu.sg/ matrw

报告人 沈晓芹 (西安理工大学)

报告题目

Mathematical modelling for human heart valves

报告摘要

Heart valves, which control the direction of blood flow during each cardiac cycle, are key physiological structure of heart and play an important role in the cardiovascular circulation system. In this talk, for the first time we characterize the heart valves as an elastic static model and then, take the time variable into account and set up a class of elastodynamic model for heart valves which is characterized by a hyperbolic partial differential equation based on existing imaging data of the cardiovascular system. We semi-discretize the space variable by a suitable finite element method and full-discretize the time variable by an appropriate finite difference method to complete the computation and adjust the model. Finally, a novel elastodynamic model and its corresponding numerical algorithm of human heart valves are eventually established based on the theories and methods of elasticity, which provides a significant support for heart valve treatment, replacement and other clinical applications.

报告人简介

西安理工大学教授，陕西省特支计划青年拔尖人才，陕西高校杰出青年人才，陕西省青年科技新星，瑞士洛桑联邦理工学院（EPFL）访问学者。主要研究方向：弹性壳体数学模型、数值计算及其在生物医学领域的应用。目前已在国际国内重要学术期刊发表学术论文20余篇。主持国家自然科学基金面上项目、青年项目、天元专项共3项，主持省部级、厅局级其他项目6项。

报告人 王岗 (西安交通大学第二附属医院)

报告题目

临床信息化与数据挖掘

报告摘要

临床信息化建设是临床医疗工作质量监控和改进的基础。本报告将系统回顾国内外临床信息化现状、缺陷及展望，在此基础上分析数据挖掘在临床信息化建设及临床应用中的前景。

报告人简介

英国伦敦国王大学心血管医学博士，西安交通大学第二附属医院急诊科、急诊ICU副主任，主治医师，研究员，急诊医学及心血管内科学博士生导师。一直致力于重症医学的临床、教学和科研工作。承担国家自然基金2项、其它省部级等各类基金6项，近年以第一或通讯作者发表SCI论文23篇，影响因子近100分。2014年获陕西省青年科技新星，2015年入选西安交通大学“青年拔尖人才支持计划”，2016年获第十一届陕西青年科技奖，2017年获中华医学会第三届重症医学青年研究奖及第十四届长城青年医师奖一等奖，2018年获陕西高等学校科学技术奖一等奖并入选陕西省“高层次人才特殊支持计划”青年拔尖人才。参编人民卫生出版社等各类规划教材6部。现任中华医学会急诊医学分会信息化建设学组副组长，中国医师协会急诊分会中西医结合急重症专业委员会副主任委员，中国医疗保健国际交流促进会胸痛分会青委会副主任委员，《中国循证医学杂志》青年编委。

报告人 Wang Qi (University of South Carolina，北京计算科学研究中心)

报告题目

Numerical approximations to thermodynamically consistent nonequilibrium models

报告摘要

Thermodynamically consistent models are the ones that are derived following the conservation laws and thermodynamical laws, especially, the second law of thermodynamics. These models are desired in materials modeling and engineering at the macroscopic level. Given the constraints in the conservation properties and the thermodynamical laws, these models possess some nice mathematical properties that can be fully exploited to produce numrical approximations that obey the analogous properties and laws. In this talk, I will present some new methods to develop numerical algorithms to solve the models to preserve the properties at the discrete level. Applications in materials and life science will be discussed as well.

报告人简介

Appointments

College of Arts and Sciences Distinguished Professor, University of South Carolina, 2013-present

Professor, Department of Mathematics, University of South Carolina, 2008-present

Thruster Leader, Theory, Modeling and Simulation, Nano-Center at USC, 2008-present

Director of Applied and Computational Mathematics Program, Florida State University, 2004-2007

Professor, Department of Mathematics, Florida State University, 2003-2009

Associate Professor, Department of Mathematics, Florida State University, 2001-2003

Associate Professor, Department of Mathematical Sciences, Indiana University-Purdue University Indianapolis, 1997-2001

Assistant Professor, Department of Mathematical Sciences, IUPUI, 1991-1997

Synergistic Activities

Developed an applied and computational math (ACM) Ph. D. program at the University of South Carolina, a MS degree program at IUPUI, and renovated the ACM program at the Florida State University.

Organized various workshops and mini-symposia on soft matter and complex fluids at national and international meetings.

Referee for many professional journals (e.g., J. Rheology, J. Non-Newtonian Fluid

Mechanics, Rheological Acta, Macromolecules, J. Chem. Phys, PRE, Liquid Crystals, Siam Appl. Math, J. Phys. A, Liquid Crystals and Molecular Crystals, J. Appl. Mech., Comm. Math Sci., Comm. Comp. Phys., etc.), NSF, AFOSR, NIH, National Academy of Science, State of Mississippi EPSCOR Program, Petroleum Fund, etc.
Editorial board: DCDS-series B, 2005-present; Mathematical Methods in the Applied Sciences, 2009- present. Nanoscale Systems: Mathematical Modelling, Theory and Applications, 2012-present. Molecular Based Mathematical Biology, 2012-present.
Thrust leader for the thrust on in-silico modeling of biofabrication in the SC NSF EPSCOR RII project on biofabrication of tissues and organs.

报告人 Xu Jiake (University Of Western Australia)

报告题目

EGFL protein expression and function as novel angiogenic factors

报告摘要

Angiogenesis plays an important role in physiological bone growth and remodeling, as well as in pathological bone disorders such as delayed fracture repair, osteonecrosis, and tumor metastasis to bone. Angiogenic factors, produced by cells from a basic multicellular unit (BMU) within the bone remodeling compartment (BRC) regulate local endothelial cells and pericytes. The expression of angiogenic factors by osteoclasts, osteoblasts and osteocytes in the BMU and in the cartilage-bone interface is evident. These include vascular endothelial growth factor (VEGF), basic fibroblast growth factor (bFGF), BMP7, and epidermal growth factor (EGF)-like family members. In addition, the expression of EGFLs has been recently identified in the bone local environment, giving important clues to their roles in angiogenesis and bone homeostasis. EGFL7, is a secreted factor produced by osteoclasts and osteoblasts and promotes angiogenesis. EGFL6 is expressed by osteoblasts and regulate angiogenesis via a paracrine mode of action. Using EGFL6 KO mouse model, and neutralizing antibody approach, we found that EGFL6 plays an important role in bone fracture healing. In addition, we identified that Nephronectin (NPNT), a homologue of EGFL6, is expressed in osteoblasts, and exert a paracrine effect on endothelial cells. Intriguingly, the expression of NPNT is reduced in the bone of ovariectomised mice and in osteoporosis patients. Exogenous addition of mouse recombinant NPNT on SVEC (a simian virus 40-transformed mouse microvascular endothelial cell line) stimulates endothelial cell migration and tube-like structure formation in vitro. Furthermore, NPNT promotes angiogenesis in an ex vivo fetal mouse metatarsal angiogenesis assay. We show that NPNT stimulates the phosphorylation of extracellular signal-regulated kinase 1/2 (ERK1/2) and p38 mitogen-activated kinase (MAPK) in SVEC cells. Inhibition of ERK1/2 impaired NPNT-induced endothelial cell migration, tube-like structure formation and angiogenesis. Understanding the role of angiogenic factors in the bone microenvironment may help to develop novel therapeutic targets and diagnostic biomarkers for bone and joint diseases, such as osteoporosis, osteonecrosis, osteoarthritis, and delayed fracture healing.

报告人简介

Dr. Jiake Xu is currently Winthrop Professor, and Head of Molecular Laboratory and Head of the Division of Regenerative Biology at the University of Western Australia (UWA). (http://www.web.uwa.edu.au/people/jiake.xu). He is also a founding

Fellow, Faculty of Science, the Royal College of Pathologists of Australia. He also serves as the Vice President of the Australia Chinese Association for Biomedical Sciences Inc. (ACABS).

He completed his PhD studies at UWA in 1994, and carried out his postdoctoral research at Stanford University from 1994 to 1998. His current research activities are focused on regenerative biology, angiogenic factors and regulation. He has published over 180 SCI papers; including Nature Medicine, Endocrine Reviews, Nature Comm. PNAS, Mol. Cell. Biol., J Biol. Chem., Arthritis Rheum. Stem Cells, and Biomaterials.

报告人 应文俊 (上海交通大学)

报告题目

Solution of the bidomain equations with a composite backward differentiation formula

报告摘要

For numerically solving the bidomain equations, a semi-implicit or an operator splitting method is usually preferred than a fully implicit time integration method even though it is known that both semi-implicit and operator splitting methods are not L-stable methods for stiff problems, including the bidomain equations. As many (if not most) researchers in the community have an impression that a fully implicit method is too complicated for someone to implement and too expensive for the computer to run. In this talk, we will present a fully implicit time integration method for the bidomain equations in multiple space dimensions. We will show by numerical simulation results that the bidomain equations may be solved very efficiently with the implicit method. The method is a composite backward differentiation formula (CBDF), L-stable for stiff problem. It was first proposed for implicitly modeling cardiac dynamics (the monodomain equation) along a cable in [Wenjun Ying, Donald Rose and Craig Henriquez, Efficient fully implicit time integration method for modeling cardiac dynamics, IEEE Trans. Biomed. Engrg, Vol 55 (12), pp. 2701-11, 2009]. The nonlinear equations resulting from the fully implicit discretization of the bidomain equations are solved with the Newton method. In multiple space dimensions, the linearized discrete equations are no longer tridiagonal and can not be solved with the Thomas algorithm. In our work, by a special arrangment of the equations, the discrete system has a very nice formulation. It is symmetric and non-negative definite and can be solved with a multilevel and multigrid iterative method. Some other techniques that we use to accelerate the Newton and multilevel/multigrid iterations will be reported in the talk.

报告人简介

清华大学应用数学学士，计算数学硕士，美国杜克大学计算数学博士，生物医学工程系博士后，曾任美国密歇根理工大学助理教授，现为上海交通大学数学科学学院及自然科学研究院教授，是中组部首批“青年千人计划”入选者之一。其研究主要包括求解非线性双曲守恒律方程和奇异扰动反应扩散方程的时间空间自适应网格加密算法，求解刚性系统的L-稳定时间积分方法，求解椭圆型偏微分方程的边界积分方法，以及一类基于位势理论的求解复杂区域上椭圆型、抛物型偏微分方程的笛卡尔直角网格法，研究涉及的领域包括计算空气动力学、计算生物物理学、计算电生理学和计算流体力学等。相关研究得到美国国家科学基金(NSF)和中

国国家自然科学基金等多个基金项目支持。

报告人 朱光宇 (西安交通大学)

报告题目

新型膨聚四氟乙烯(ePTFE)双叶主动脉瓣的数值仿真及体外实验研究

报告摘要

针对需要进行主动脉瓣膜置换的儿科先天性心脏病患者，临床上多需手术医师在术前自行制备瓣膜。而瓣膜的制备不仅要求医师具有丰富的相关经验，同时传统的生物瓣膜制备需要使用具有较强毒性的戊二醛进行处理，手术室条件下进行相关操作极易造成戊二醛残留，进而导致相关术后并发症的发生。针对上述问题，本研究提出了一种新型膨聚四氟乙烯(expanded polytetrafluoroethylene, ePTFE)双叶主瓣，并针对该瓣膜在主动脉条件下的动态特性及血流动力学特性开展了数值仿真及体外实验研究。本研究提出的新型ePTFE双叶主动脉瓣在有限元仿真及体外实验中展现了较为优良的动态特性和血流动力学特性，为需要进行主动脉瓣膜置换的儿科病人的治疗提供了一种可靠的选择。

报告人简介

西安交通大学能动学院讲师，2016年9月至2017年9月新加坡南洋理工大学访问，期间在新加坡 KK Women's and Children's Hospital心脏外科做助理研究员。主要研究方向是主动脉、肺动脉、瓣膜的设计、数值仿真及体外测试，TAVI、冠状动脉支架等心血管疾病介入治疗过程中的血流动力学数值仿真及体外实验研究。在BioMedical Engineering Online、Shock and Vibration等期刊发表学术论文10余篇，授权国家发明专利2项。