EASIAM 2016

The 11th East Asia Section of SIAM Conference

Book of Program

June 20-22, 2016

Macau, China

Organized by

Universidade de Macau
University of Macau

Society for Industrial
and Applied Mathematics

Macau
Mathematical Society

Contents

Executive Committee

President	Yongwimon Lenbury	Mahidol Univeristy
Vice President	Xiao-Qing Jin	University of Macau
• *Brunei*	Yeo Wee Ping	Universitii Brunei Darussalam
• *China*	Gang Bao	Zhejiang University
	Zhijian Yang	Wuhan University
• *Hong Kong, China*	Guangyue Han	University of Hong Kong
	Xiao-Ping Wang	Hong Kong University of Science & Technology
• *Indonesia*	Sri Redjeki Pudjaprasetya	Bandung Institute of Technology
	Yudi Suharyadi	Bandung Institute of Technology
• *Japan*	Takayasu Matsuo	University of Tokyo
	Takashi Sakajo	Kyoto University
• *Korea*	Eunok Jung	Konkuk University
	Myungju Kang	Seoul National University
• *Macau, China*	Seak-Weng Vong	University of Macau
• *Malaysia*	Mohd. Salmi Md. Noorani	Universiti Kebangsaan Malaysia (National University of Malaysia)
• *Philippines*	Roden David	Ateneo de Manila University
• *Singapore*	Weiqing Ren	National University of Singapore
	Hui Ji	National University of Singapore
• *Taiwan*	Ming-Chih Lai	National Chiao Tung University
	Weichung Wang	National Taiwan University
• *Thailand*	Somkid Amornsamankul	Mahidol Univeristy

Advisory Committee

• *China*	Zhong-Ci Shi	Institute of Computational Mathematics, Chinese Academy of Sciences (CAS)
	Tao Tang	South University of Science and Technology of China
• *Hong Kong, China*	Raymond Chan	The Chinese University of Hong Kong
• *Japan*	Hisashi Okamoto	Kyoto University
• *Korea*	Dongwoo Sheen	Seoul National University
• *Singapore*	Zuowei Shen	National University of Singapore
• *Taiwan*	I-Liang Chern	National Taiwan University

Local Committee

Chair

- Xiao-Qing Jin

Co-Chair

- Seak-Weng Vong

Members

- Che-Man Cheng
- Hai-Wei Sun
- Sik-Chung Tam
- Vai-Kuong Sin
- Guang-Hui Hu
- Siu-Long Lei

Secretary

- Iok-Kio Lam

Technical Support

- Hoi-Fong Mak

Student Volunteers

- Huan-Ying Bian
- Peng Chen
- Xu Chen
- Zheng-Jian Chen
- Lot-Kei Chou
- Si-Wen Deng
- Dao-Ying Fan
- Zhi-Wei Fang
- Ya-Guang Gu
- Yun-Chi Huang
- Yang Kuang
- Xue-Lei Lin
- Dong-Dong Liu
- Xin Lu
- Pin Lyu
- Yong Ma
- Xu-Cheng Meng
- Ye-Dan Shen
- Chen-Yang Shi
- Hui-Qin Wei
- Ze-Jia Xie

EASIAM 2016, 20-22 June 2016, Macau

Schedule

The room for plenary talks, invited talks, student paper prize session and executive committee meeting is E4-G078.

	Day 1	Day 2	Day 3
8:30 - 8:50	Registration		
8:50 - 9:00		Plenary Talk 2 **Hans G. Kaper**[1] Chair: Ming-Chih Lai	Invited Talk 5 **Chidchanok Lursinsap**[6] Chair: I-Liang Chern
9:00 - 9:10	Opening Speech		
9:10 - 9:30	Plenary Talk 1 **Gunther Uhlmann**[2] Chair: Yongwimon Lenbury		
9:30 - 9:40			Invited Talk 6 **Hai-Wei Sun**[8] Chair: I-Liang Chern
9:40 - 10:00		Invited Talk 2 **Jun Hu**[3] Chair: Ming-Chih Lai	
10:00 - 10:10	Invited Talk 1 **Takashi Sakajo**[7] Chair: Yongwimon Lenbury		
10:10 - 10:20			Coffee Break
10:20 - 10:30		Coffee Break	
10:30 - 10:40			Parallel Session 6 (4x5 talks)
10:40 - 11:10	Group Photo & Coffee Break	Parallel Session 3 (5x5 talks)	
11:10 - 11:50	Parallel Session 1 (4x5 talks)		
11:50 - 12:30			
12:30 - 13:50	Lunch	Lunch	Lunch
13:50 - 14:30	Parallel Session 2 (4x5 talks)	Invited Talk 3 **Wen-Wei Lin**[5] Chair: Hisashi Okamoto	
14:30 - 15:10		Invited Talk 4 **Ping Lin**[4] Chair: Hisashi Okamoto	
15:10 - 15:30	Coffee Break	Coffee Break	
15:30 - 16:30	Student Paper Prize Session: Kaibo Hu[9] Phusanisa Lomthong[10] Shun Sato[11] Zhi Zhao[12] Chair: Zhijian Yang	Parallel Session 4 (3x5 talks)	
16:30 - 16:40		Break (10 mins.)	
16:40 - 17:20		Parallel Session 5 (4x5 talks)	
17:20 - 18:00	Executive Committee Meeting		
18:00 - 18:10			
18:30 - 20:30		Banquet	

PLENARY: 50 MINS., INVITED: 40 MINS., CONTRIBUTED: 20 MINS., STUDENT PAPER PRIZE SPEAKER: 25 MINS.

Parallel Session 1

Monday, June 20, 2016

Room E4-G051 Chair: Yasumasa Nishiura		
11:10 - 11:30	Liqun Wang[106]	Traditional and Non-traditional FEM for Solving Interface Problems
11:30 - 11:50	Yasumasa Nishiura[76]	Frustrated Phases of Diblock Copolymers under Three-dimensional Confinement
11:50 - 12:10	Feng-Nan Hwang[45]	Nonlinear Preconditioning Techniques for PDE-Constrained Optimization Problem
12:10 - 12:30	Lane Chun Lanston Yeung[123]	An Uncertainty Quantification Framework for the Achievability of Backtesting Results of Trading Strategies
Room E4-G053 Chair: Guangyue Han		
11:10 - 11:30	Ming-Cheng Shiue[92]	Time-stepping Numerical Schemes for Three-dimensional Viscous Primitive Equation
11:30 - 11:50	Guangyue Han[40]	Limit Theorems in Hidden Markov Models
11:50 - 12:10	Hiroshi Fujiwara[35]	Numerical Computation of the 2D Radiative Transport Equation by Upwind Finite Volume Method
12:10 - 12:30	Tomoya Kemmochi[55]	Discrete Maximal Regularity and the Finite Element Method for Parabolic Problems
Room E4-G062 Chair: Xiaosheng Zhuang		
11:10 - 11:30	Ikha Magdalena[72]	Numerical Model for the Formation of Undular Bores Generated by Tsunami Fission
11:30 - 11:50	Yongwimon Lenbury[61]	Traveling Wave Solutions of a Model for Porcine Reproductive and Respiratory Syndrome
11:50 - 12:10	Xiaosheng Zhuang[129]	Canonical Quincunx Tight Framelets
12:10 - 12:30	Nurul Huda N.A[44]	Boussinesq Type Model for Flow Over a Bump
Room E4-G068 Chair: Hisashi Okamoto		
11:10 - 11:30	Bin Gao[36]	Column-wise BCD Method for Orthogonal Constrained Optimization Problems
11:30 - 11:50	Hisashi Okamoto[78]	Steady-states of the Generalized Constantin-Lax-Majda Equation
11:50 - 12:10	Go Felix[34]	Generalized Cat Bonds Pricing Analysis using Continuous-time Stochastic Process
12:10 - 12:30	Tao Chen[21]	An $\mathbf{A}$-ϕ Scheme for Type-II Superconductors

Room E4-1051 Chair: Myungjoo Kang		
11:10 - 11:30	Dharma Lesmono[62]	Optimal Ordering Policy for a Multi Item Probabilistic Inventory Model with All-units Discount
11:30 - 11:50	Myungjoo Kang[51]	TSOM Image Analysis using the Image Enhancement Methods and a Deep Learning Technique
11:50 - 12:10	Jutarat Kongson[58]	A Study on the Model of the Signal Transduction Process under a Delay
12:10 - 12:30	Sutrisno[97]	Modeling and Simulation of Hybrid Dynamic of Autonomous System with Several Restricted States Avoidance Scenario

Parallel Session 2

Monday, June 20, 2016

Room E4-G051 Chair: Sri Redjeki Pudjaprasetya		
13:50 - 14:10	Houying Zhu[128]	Discrepancy Bounds for Deterministic Acceptance-rejection Samplers
14:10 - 14:30	Sri Redjeki Pudjaprasetya[83]	Finite Volume Method for Traffic Flow with Exits-Entrances
14:30 - 14:50	Cheng Sheng Chien[25]	Efficient Continuation Methods for Spin-1 BEC in a Magnetic Field
14:50 - 15:10	Koya Sakakibara[88]	Analysis of the Invariant Scheme for MFS in Doubly-connected Regions
Room E4-G053 Chair: Somkid Amornsamankul		
13:50 - 14:10	Takahito Kashiwabara[52]	$W^{1,\infty}$-error Analysis of the Finite Element Method in a Smooth Domain
14:10 - 14:30	Somkid Amornsamankul[13]	Computational Analysis of Heavy Metals Removal from Waste Water
14:30 - 14:50	Takiko Sasaki[89]	Regularity and Singularity of the Blow-up Curve for a Nonlinear Wave Equation
14:50 - 15:10	Murong Xu[115]	A Study of the Neural Network of C. elegans: from Structure to Clustering
Room E4-G062 Chair: Roden Jason David		
13:50 - 14:10	Yusuke Morikura[74]	Performance Evaluation of Verified Computation for Linear System on Supercomputer
14:10 - 14:30	Roden Jason David[27]	Approximating Eigenvalues of Pseudo-Orthogonals by Means the Cayley-Transform
14:30 - 14:50	Darren Wall[102]	The Role of the Linear Instability in the Transition of Channel Flow
14:50 - 15:10	Xin Luo[71]	Development of Modal Interval Algorithm for Solving Continuous Minimax Problems
Room E4-G068 Chair: Yimin Wei		
13:50 - 14:10	Shyan Shiou Chen[20]	Delay-induced Behaviours in a Hindmarsh-Rose-type Model
14:10 - 14:30	Yimin Wei[109]	Generalized Tensor Eigenvalue Problems
14:30 - 14:50	Yuto Miyatake[73]	An Energy-preserving H^1-Galerkin Scheme for the Hunter-Saxton Equation
14:50 - 15:10	Jun Luo[69]	Density questions related to Cantor measures

Room E4-1051 Chair: Roger Hosking		
13:50 - 14:10	Yanmei Chen[22]	On Perturbation Bounds for Orthogonal Projections
14:10 - 14:30	Xiang Zhou[127]	Finding Transition States on Energy Landscape: from Dimer Method to Iterative Minimization Algorithm
14:30 - 14:50	Iryanto[46]	A Coupled Model for Wave Run-up Simulation
14:50 - 15:10	Tanaka Kazuaki[53]	Numerically Verifiable Condition for Positivity of Solution to Elliptic Equation

Parallel Session 3

Tuesday, June 21, 2016

Room E4-G051 Chair: Norikazu Saito		
10:40 - 11:00	Hanna Arini Parhuaip[81]	Computational Mathematics for Home Industries in Indonesia
11:00 - 11:20	Junkee Jeon[48]	Analytic Valuation of Russian Option with Finite Time Horizon
11:20 - 11:40	Lia Yuliawati[125]	A numerical approach for finding soliton solutions of the 1D Variational Boussinesq Model
11:40 - 12:00	Huadong Gao[37]	A Linearized Galerkin-mixed FEM for Ginzburg-Landau Equations
12:00 - 12:20	Masato Shinjo[91]	Solutions to Discrete Hungry Integrable Systems and Their Asymptotic Expansions
Room E4-G053 Chair: Shao-Liang Zhang		
10:40 - 11:00	Guanyu Zhou[126]	The Conservative Finite Volume Scheme on Voronoi Mesh for the Chemotaxis Model
11:00 - 11:20	Chien-Hong Cho[26]	On the Numerical Approximation for Blow-up Problems
11:20 - 11:40	Shuting Gu[39]	Convex Splitting Method for Saddle Point Search Problems
11:40 - 12:00	Xin Lu[68]	Approximate Inversion Method for Time Fractional Sub-diffusion Equations
12:00 - 12:20	Xiaoyu Wei[108]	Normal Mode Analysis for Micro-scale Flows in Special Domains and Applications
Room E4-G062 Chair: Yoshifumi Kimura		
10:40 - 11:00	Azizan Saaban[87]	Image Enlargement Using Harmonic and Bihamonic Said-ball Surface
11:00 - 11:20	Yoshifumi Kimura[57]	Reconnection of Vortex and Magnetic Flux Tubes
11:20 - 11:40	Swaroop Nandan Bora[16]	Sloshing of a Two-layer Fluid in a Cylinder in Presence of a Rigid Baffle
11:40 - 12:00	Jiejun Lu[67]	On Option Pricing under a Hidden Markovian Regime-switching Model
12:00 - 12:20	Novry Erwina[30]	Staggered Conservative Scheme for Simulation of Wave Run-up on a Sloping Beach

Room E4-G068 Chair: Suh-Yuh Yang		
10:40 - 11:00	Aulia Oktavia[79]	Staggered Grid Scheme for Simulation of Interfacial Wave
11:00 - 11:20	Suh-Yuh Yang[119]	IAS Scheme for Strongly Coupled Systems of Convection-diffusion Equations
11:20 - 11:40	Qingqing Yang[118]	Trading Strategy under Regime-Switching Jump-Diffusion Models in LOBs
11:40 - 12:00	Dong Wang[104]	An Efficient Threshold Dynamics Method for Wetting on Rough Surfaces
12:00 - 12:20	Kai Fung Kan[50]	Asian-style Index Futures Arbitrage: A Case of the Hong Kong Market
Room E4-G1051 Chair: Li-Ming Yeh		
10:40 - 11:00	Ippei Obayashi[77]	Inverse Problem from Persistence Diagrams to Point Clouds
11:00 - 11:20	Li-Ming Yeh[121]	A Hölder Estimate for Non-uniform Elliptic Equations in a Random Medium
11:20 - 11:40	Jilu Wang[105]	Unconditionally Optimal Error Estimates of Crank-Nicolson Galerkin FEMs for Nonlinear Parabolic System
11:40 - 12:00	Hyeon-uk Kim[56]	Hybrid of WENO and FOM for Robust Interface Tracking
12:00 - 12:20	Andreas A S Jacobs[47]	Numerical Modeling of Fluid Flow Around a Circular Cylinder

Parallel Session 4

Tuesday, June 21, 2016

Room E4-G051 Chair: Guojun Liao		
15:20 - 15:40	Yimin Sun[95]	On the Global Controllability of Planar Polynomial Systems
15:40 - 16:00	Guojun Liao[64]	A New Method for Higher Order Finite Element Meshes
16:00 - 16:20	Edi Cahyono[18]	Diffusion in a Temporaly Shrinkable Medium
Room E4-G053 Chair: Dongwoo Sheen		
15:20 - 15:40	Shih-Feng Shieh[90]	On the Dynamics of a Structure Preserving Flow of Symplectic Matrix Pairs
15:40 - 16:00	Hung-Yuan Fan[32]	An Iterative Method for Solving Linear Systems with Tensor Product Structures
16:00 - 16:20	Ade Candra Bayu[15]	Three-layer Staggered Non-hydrostatic Scheme for Free Surface Flow
Room E4-G062 Chair: Raymond Chan		
15:20 - 15:40	Ken'ichiro Tanaka[99]	Potential Theoretic Approach to Approximation in Weighted Hardy Spaces
15:40 - 16:00	Raymond Chan[19]	Point-spread Function Reconstruction in Ground-based Astronomy
16:00 - 16:20	Peter Chang-Yi Weng[111]	Statistical Condition Estimation of Large-scale Generalized Eigenvalue Problems
Room E4-G068 Chair: Yusaku Yamamoto		
15:20 - 15:40	Haidong Qu[84]	A Runge-Kutta Gegenbauer Spectral Method for Reaction-Diffusion Equation
15:40 - 16:00	Yusaku Yamamoto[117]	Solution of a Nonlinear Eigenvalue Problem using Signed Singular Values with Application to the Scaling Exponent Computation in 2 Dimensional Turbulent Flow
16:00 - 16:20	Ferry Jaya Permana[82]	Valuation of Basket Options under Variance Gamma Process

Room E4-1051 Chair: Ping Lin		
15:20 - 15:40	Yung-Ta Li[63]	Preconditioning almost Skew-symmetric Matrices with Applications
15:40 - 16:00	Emerson Escolar[31]	Persistence of Common Topological Features via Commutative Ladder Quivers
16:00 - 16:20	Jianyu Pan[80]	Shifted Power Method for computing H eigenvalue of Symmetric Tensor

Parallel Session 5

Tuesday, June 21, 2016

Room E4-G051 Chair: Furong Lin		
16:40 - 17:00	Jengnan Tzeng[100]	Estimating the Leading Coefficient of Truncation Errors
17:00 - 17:20	Furong Lin[65]	An NCC Quadrature for Two-dimensional Volterra Integral Equations
17:20 - 17:40	Yuki Ueda[101]	An Error Estimate of the Successive Projection Methods by B-spline
Room E4-G053 Chair: Chidchanok Lursinsap		
16:40 - 17:00	Chun-Yueh Chiang[24]	On a Class of Nonlinear Matrix Equations $X \pm A^H f(X)^{-1} A = Q$
17:00 - 17:20	Yogi Erlangga[29]	Multilevel Krylov Solution of Symmetric Singular Systems
17:20 - 17:40	Yoshiki Sugitani[94]	A Remark on the Mathematical Formulation for the Immersed Boundary Method
17:40 - 18:00	Chao Wang[103]	Estimation of Regularized Parameter in Proximity Algorithms for Image Denoising
Room E4-G062 Chair: Hidenori Yasuda		
16:40 - 17:00	Chin-Tien Wu[112]	A Pipeline for 3D Image Processing Based on Landmark Matching
17:00 - 17:20	Hidenori Yasuda[120]	Low order finite difference scheme of Serre-Green-Naghdi equations
17:20 - 17:40	Li Luo[70]	A Highly Parallel Finite Element Method for 3D Two-phase Moving Contact Problems
17:40 - 18:00	Lusia K Budiasih[17]	Boussinesq-type Model for Wave Propagation Generating Undular Bore
Room E4-G068 Chair: Tsung-Ming Huang		
16:40 - 17:00	Piotr Skrzypacz[93]	On the Way How to Improve Local Projection Stabilization
17:00 - 17:20	Tsung-Ming Huang[42]	A Newton-type Method for Nonlinear EigenProblems in Photonic Crystal Modeling
17:20 - 17:40	Fenghui Yu[124]	Interacting Default Intensity with Hidden Markov Process

Room E4-1051 Chair: Wei Xu		
16:40 - 17:00	Yueh-Cheng Kuo[59]	The Asymptotic Analysis for Structure-Preserving Doubling Algorithms
17:00 - 17:20	Wei Xu[116]	Efficient Convergent Lattice Method for Asian Options Pricing with Superlinear Complexity
17:20 - 17:40	Rihuan Ke[54]	Numerical Ranges of Tensors

Parallel Session 6

Wednesday, June 22, 2016

Room E4-G051 Chair: Eunok Jung		
10:30 - 10:50	Dongming Wei[107]	Some Differential Equation Models for Nonlinear Materials Applications
10:50 - 11:10	Aymeric Grodet[38]	Adaptive Mesh Refinement Technique for the Classical Plateau Problem
11:10 - 11:30	Yiqun Sun[96]	An Implement of Minimum Action Method for Sharp Corner
11:30 - 11:50	Zejia Xie[114]	A Fast Algorithm for Solving Circulant Tensor Systems
Room E4-G053 Chair: Zhengjian Bai		
10:30 - 10:50	Chien-Chang Yen[122]	Self-gravitational Force Calculation of Infinitesimally Thin Gaseous Disks
10:50 - 11:10	Zhengjian Bai[14]	Semidefinite Inverse Eigenvalue Problems with Prescribed Entries and Eigendata
11:10 - 11:30	Daisuke Tagami[98]	A Generalized Particle Method for Convection-diffusion Equations
11:30 - 11:50	Wanhua He[41]	On Optimal Design Outsourcing Strategy
Room E4-G062 Chair: Wen-Wei Lin		
10:30 - 10:50	I-Liang Chern[23]	Ground State Patterns and Phase Transitions of Spin-1 Bose-Einstein Condensates
10:50 - 11:10	Dongjin Lee[60]	A Bisection Approach Combined with a Projection Method for Interior Eigenvalue Problems in Material Science
11:10 - 11:30	Grienggrai Rajchakit[86]	Improved Exponential Stability of Generalized Neural Networks with Interval Time-varing Delay

Room E4-G068 Chair: Ning Du		
10:30 - 10:50	Xuelei Lin[66]	A Fast Accurate Approximation Method with Multi-grid Solver for Two-dimensional Fractional Sub-diffusion Equation
10:50 - 11:10	Ning Du[28]	Fast Finite Element Method for Space-fractional Dispersion Equations
11:10 - 11:30	Yunchi Huang[43]	Fast Preconditioning Algorithm for Boundary Value Method for Space-fractional Diffusion Equations
Room E4-1051 Chair: Youwei Wen		
10:30 - 10:50	Xianping Wu[113]	Multi-period M-V Asset-liability Portfolio Selection with Correlated Returns
10:50 - 11:10	Youwei Wen[110]	A Semismooth Newton Method for Uniform Noise Removal with Linftynorm Constraint
11:10 - 11:30	Wei Qu[85]	On CSCS-based Iteration Method for Tempered Fractional Diffusion Equations
11:30 - 11:50	Zhiwei Fang[33]	Preconditioning Techniques in Chebyshev Spectral Collocation Method for Elliptic Equations

Abstract (Alphabetical Order)

---

[1] **Mathematics of Planet Earth**.

Hans G. Kaper. Georgetown University.

Abstract: Mathematics of Planet Earth (MPE) is an emerging area of research in the mathematical sciences. Its focus is on Earth's climate system, sustainability and natural resources, biodiversity and the impact of human activities, extreme events, and the management of risk. The stakes are high, decision makers have more questions than we can answer, and mathematical models and statistical arguments play a central role in assessment exercises. As mathematicians, we have a responsibility to apply our disciplinary expertise to the major challenges of our time. In this talk I will identify some problems of current interest in climate science and indicate how, as mathematicians, we can find inspiration for new applications.

[2] **Harry Potter's Cloak via Transformation Optics**.

Gunther Uhlamnn. University of Washington.

Abstract: Can we make objects invisible? This has been a subject of human fascination for millennia in Greek mythology, movies, science fiction, etc. including the legend of Perseus versus Medusa and the more recent Star Trek and Harry Potter. In this century there have been several scientific proposals to achieve invisibility. We will concentrate on "transformation optics" that has received the most attention in the scientific literature and survey recent developments on cloaking.

[3] **Mixed Finite Element Methods for Elasticity Problems**.

Jun Hu. Peking University.

Abstract: We developed a new framework to design and analyze the mixed FEM for elasticity problems by establishing the following three main results: A structure of the discrete stress space: on simplicial grids, the discrete stress space can be selected as the symmetric matrix-valued Lagrange element space, enriched by a symmetric matrix-valued polynomial H(div) bubble function space on each simplex; a corresponding choice applies to product grids. Two basic algebraic results: (1) on each simplex, the symmetric matrices of rank one produced by the tensor products of the unit tangent vectors of the $n(n+1)/2$ edges of the simplex, form a basis of the space of the symmetric

matrices; (2) on each simplex, the divergence space of the above H(div) bubble function space is equal to the orthogonal complement space of the rigid motion space with respect to the corresponding discrete displacement space (A similar result holds on a macroelement on product grids). These define a two-step stability analysis which is new and different from the classic one in literature. As a result, on both simplicial and product grids, we were able to define the first families of both symmetric and optimal mixed elements with polynomial shape functions in any space dimension. Furthermore, the discrete stress space has a simple basis which essentially consists of symmetric matrix-valued Lagrange element basis functions.

[4] **An Energy-law Preserving Finite Element Method for a Thermodynamically Consistent Phase-field Model**.

Ping Lin. University of Dundee.

Abstract: We develop a phase-field model for binary incompressible fluid with thermocapillary effects, which allows for different properties (densities, viscosities and heat conductivities) of each component while maintaining the thermodynamic consistency. A sharp-interface limit analysis is carried out to show that the interfacial conditions of the classical sharp-interface models can be recovered from our phase-field model. We also show how an energy law preserving continuous finite element scheme may be derived.

[5] **A Robust Numerical Alogrithm for Computing Maxwell's Transmission Eigenvalue Problems**.

Wen-Wei Lin. Chiao Tung University.

Abstract: We study a robust and efficient eigensolver for computing a few smallest positive eigenvalues of the three-dimensional Maxwell's transmission eigenvalue problem. The discretized governing equations by the N'ed'elec edge element result in a large-scale quadratic eigenvalue problem (QEP) for which the spectrum contains many zero eigenvalues and the coefficient matrices consist of patterns in the matrix form $XY^{-1}Z$, both of which prevent existing eigenvalue solvers from being efficient. To remedy these difficulties, we rewrite the QEP as a particular nonlinear eigenvalue problem and develop a secant-type iteration, together with an indefinite locally optimal block preconditioned conjugate gradient method (LOBPCG), to sequentially compute the desired positive eigenvalues. Furthermore, we propose a novel method to solve the linear systems in each iteration of LOBPCG. Intensive numerical experiments show that our proposed method is robust, although the desired real eigenvalues are surrounded by complex eigenvalues.

[6] **A Concern of Neural Learning for Big Data in Terms of Time and Space Complexities**.

Chidchanok Lursinsap. Chulalongkorn University.

Abstract: This talk will concern the view of big data analysis which generally occurs in various research areas including bioinformatics nowadays. How should we determine whether a given data set is big data in the sense of computer science? Two issues of time and space complexities in computer science will be discussed. A technique of neural clustering for pattern analysis of actual big data based on the concept of complexity preservation will be given.

[7] **Dissipative Vortex Collapse and Time's Arrow**.

Takashi Sakajo. Kyoto University.

Abstract: It is said that a family of singular incompressible Euler flows (dissipative weak solutions), whose existence was conjectured by Onsager and has been rigorously shown by Buckmaster-De Lelis-Szekelyhidi, could reproduce a Kolmogorov's statistical scaling law. However, it is unclear how these singular weak solutions dissipate a conserved quantity and how they look like physically. In order to clarify these questions, we are going to give a description of dissipative weak solutions in terms of vortex dynamics. It is suggested that the enstrophy dissipation of 2D incompressible flows in the zero viscous limit results in the emergence of the inertial range corresponding to the forward enstrophy cascade in the energy spectra of 2D turbulent flows. Since smooth solutions of the 2D incompressible Euler equations conserve the enstrophy, we need to consider non-smooth inviscid and incompressible flows that dissipate the enstrophy a dissiaptive weak solution to 2D Euler equation. To tackle this problem, we consider the 2D incompressible Euler-α equations for pointwise initial vortex distributions, called point vortex-α (PV) system. Considering three α-point vortices, we construct a singular incompressible and inviscid flow by taking the $\alpha \to 0$ limit of their evolution. We show rigorously that, under a certain condition on the vortex strengths, the limit solution becomes a self-similar finite-time triple vortex collapse followed by a self-similar triple vortex expansion to the infinity. We also find that, at the event of the collapse, a variational part of the enstrophy dissipates in the sense of distributions. Consequently, the triple vortex collapse is a mechanism that yields an anomalous enstrophy dissipation in conservative incompressible and inviscid flows. Furthermore, it is an interesting example generating a "time's arrow" in the Hamiltonian dynamical system. This is the joint work with my Ph.D student, Takeshi Gotoda.

[8] **Exponential Quadrature Rule for Fractional Diffusion Equations**.

Haiwei Sun. University of Macau.

Abstract: In this talk, we study the fractional diffusion equations. After spatial discretization to the fractional diffusion equation by the shifted Grunwald formula, it leads to a system of ordinary differential equations, where the resulting coefficient matrix possesses the Toeplitz-like structure. An exponential quadrature rule is employed to solve such a system of ordinary differential equations. The convergence by the proposed method is theoretically studied. In practical computation, the product of a Toeplitz-like matrix exponential and a vector is calculated by the shift-invert Arnoldi method. Meanwhile, the coefficient matrix satisfies a condition that guarantees the fast approximation by the shift-invert Arnoldi method. Numerical results are given to demonstrate the efficiency of the proposed method. This is a joint work with Lu Zhang and Hong-kui Pang.

[9] **Structure-preserving Finite Element Methods for Stationary MHD Models**.

Kaibo Hu. Peking University.

Abstract: Magnetohydrodynamics (MHD) is a complicated multi-physics model with many applications. The magnetic Gausss law (div B=0) is considered to be a crucial condition both in the physics and the simulations, but it is challenging to design stable and efficient numerical methods which preserve the divergence-free condition precisely. In this talk, we report a new class of finite element methods for the stationary MHD equations, which strongly preserve the magnetic Gausss law, normal continuity of the magnetic field and the energy law in the numerical discretization. Different from conventional H(curl) formulations of Maxwell and MHD equations, H(div) space is used to discretize the magnetic field. For the analysis of the new finite element scheme, a new regularity estimate of H(div) finite element functions is established. This is a joint work with Jinchao Xu.

[10] **Image Segmentation Using Fast Implementation of Level Set without Re-initialization**.

Phusanisa Lomthong. Mahidol University.

Abstract: The level set method is a kind of the numerical algorithms for segmentation objects in medical images. Unfortunately, the standard level set method, in which initialization is needed for every step (re-initialization process), make further computational time during searching boundary curve. It is necessary for medical technologist to obtain faster computing for image segmentation. So it is important issue to decrease the computational time for re-initialization process. On the other hand, there is another approach for fast computing technique using Message Passing Interface (MPI).

This paper present a fast level set method without re-initialization for the detection of medical CT images by developing computer program through MPI. This level set formulation is relied on three approaches including penalizing term, weighted length term and weighted area term. In this investigation, penalizing term is provided to avoid the time-consuming in re-initializing process. As a result, comparing with the standard program, the proposed method is effective for image segmentation in computational time reduction with the same accuracy.

[11] **A Lyapunov-type Theorem for Dissipative Numerical Integrators with Adaptive Time-stepping**.

Shun Sato. The University of Tokyo.

Abstract: The asymptotic behavior of continuous dissipative systems and dissipative numerical integrators with fixed time-stepping can be fully investigated by a Lyapunov-type theorem on continuous and discrete dynamical systems, respectively. However, once adaptive time-stepping is involved, such theories cease to work, and usually the dynamics should be investigated from the past, instead of the standard forward way, such as in terms of pullback attractors.

In this talk, we present a different approach—we stick to a forward definition of limit sets and show that still we can establish a Lyapunov-type theorem, which reveals the precise asymptotic behavior of adaptive time-stepping integrators in the presence of a discrete Lyapunov functional.

[12] **A Riemannian Newton Algorithm for Nonlinear Eigenvalue Problems**.

Zhi Zhao. Hangzhou Dianzi University.

Abstract: In this talk, we give the formulation of a Riemannian Newton algorithm for solving a class of nonlinear eigenvalue problems by minimizing a total energy function subject to the orthogonality constraint. Under some mild assumptions, we establish the global and quadratic convergence of the proposed method. Moreover, the positive definiteness condition of the Riemannian Hessian of the total energy function at a solution is derived. Some numerical tests are reported to illustrate the efficiency of the proposed method for solving large-scale problems.

[13] **Computational Analysis of Heavy Metals Removal from Waste Water**.

Somkid Amornsamankul. Mahidol University.

Abstract: Mathematical model for heavy metal removal from waste water adsorbed by microalgae (Chlorella sp.) in a trickling filter process have been investigated. The reactiondiffusion equation is applied to calculate the heavy metal concentration in biofilm form and bulk liquid, respectively. The pseudo-first order model and material balance are also combined into the model. This model is based on the assumption that the efficiency of adsorbents (microalgae), whether they are in flask or biofilm form, dead or alive, is the same. We used a finite difference scheme to solve the model equation. The result is satisfactory and in agreement with the experimental data. Furthermore, we consider the four parameters of the finite difference scheme and the mathematical model to carry out a sensitivity analysis of this procedure.

[14] **Semidefinite Inverse Eigenvalue Problems with Prescribed Entries and Eigendata**.

Zhengjian Bai. Xiamen University.

Abstract: In this paper, we study the semidefinite inverse eigenvalue problem of reconstructing a real n-by-n matrix C such that it is nearest to the original pre-estimated real n-by-n matrix C_o in the Frobenius norm and satisfies the measured partial eigendata, where the required matrix C should preserve the symmetry, positive semidefiniteness, and the prescribed entries of the pre-estimated matrix C_o. We propose the alternating direction method of multipliers for solving the semidefinite inverse eigenvalue problem. Numerical experiments are reported to illustrate the efficiency of the proposed method.

[15] **Three-Layer Staggered Non-Hydrostatic Scheme for Free Surface Flow**.

Ade Candra Bayu. Institut Teknologi Bandung.

S.R. Pudjaprasetya. Institut Teknologi Bandung.

I. Magdalena. Institut Teknologi Bandung.

Abstract: In this paper, a finite difference algorithm using three-layer approximation for the vertical flow region to solve the 2D Euler equations was considered. In this algorithm, the pressure was splitted into hydrostatic and hydrodynamic parts, and the predictor-corrector procedure was applied. In the predictor step, the momentum hydrostatic models was formulated. In the corrector step, the hydrodynamic pressure was accommodated after solving the Laplace equation using the Successive Over Relaxation (SOR) iteration method. The resulting algorithm was first tested to simulate a standing wave over an intermediate constant depth. Dispersion relation of the scheme was derived and it was shown to approximate the analytical dispersion relation. The second test was a solitary wave simulation. Our computed solitary wave propagated with constant velocity, undisturbed in shape, in a good agreement with the analytical solitary wave. Finally, the scheme was used to simulate the appearance of undular bore. The result shows a good agreement with result from the finite volume scheme for the

Boussinesq-type model by Soares-Frazão and Guinot (2008).

Keywords: non-hydrostatic pressure, Euler equations, solitary wave, undular bore.

[16] **Sloshing of a two-layer fluid in a cylinder in presence of a rigid baffle**.

Swaroop Nandan Bora. Indian Institute of Technology Guwahati.

Abstract: The presence of free surface of a liquid in a partially filled container forces the liquid to perform motion with an oscillating free surface subject to some external disturbances. This phenomenon is known as sloshing. Liquid sloshing is a key factor in vehicle movement problems. It is necessary to perform the movement in such a way that the liquid does not splash out of the container. Sloshing is encountered in a wide range of engineering applications. Two immiscible, incompressible and inviscid fluids are assumed to perform irrotational motion in a vertical circular cylinder partially filled with fluid. The radius of the cylinder is taken as R_1. The fluids are separated by an interface and have a free surface in the upper fluid. We evaluate natural sloshing frequencies of a two-layer fluid of different layer-wise densities $\rho_1 < \rho_2$ with an interface and a surface in a vertical circular cylinder in presence of a rigid annular baffle placed at the free surface. Linear water wave theory is utilized to describe the fluid motion inside the container. Due to the presence of two immiscible fluids, and the presence of a rigid baffle inside the fluid domain, solution to the boundary-value problem (BVP) cannot be obtained directly. In order to find an analytical solution to the BVP, a semi-analytical approach is used for which the liquid domain is divided into four sub-domains to obtain the solutions. Boundary value problem is set up for each sub-domain. We employ superposition principle to find the mode shape of the liquid domain. In every sub-domain, there are rigid boundaries as well as non-rigid boundaries. Non-rigid boundaries are the liquid interfaces of two successive sub-domains. On the basis of the velocity potential formulation of the fluid motion inside the container, an infinite system of homogeneous linear equation is obtained. We study the effects of the parameters such as fluid heights, baffle-width and density ratio on the natural sloshing frequencies. It can be seen that each parameter has significant effect in controlling sloshing. The main observation is the selection of the location where the baffle is to be placed. The results are supported by relevant graphs.

[17] **Boussinesq-Type Model for Wave Propagation Generating Undular Bore**.

Lusia K Budiasih. Institut Teknologi Bandung.

Abstract: A Boussinesq-type model is derived for the case of various depth using pertubation method. The model is an extension of Boussinesq type model for a constant depth derived by Mei (1982). In this paper, we solve the equations numerically using a

finite difference method. For constant water depth, we do test case of a solitary wave propagation. Solitary wave is reproduced and it travels undisturb in shape. It shows that our numerical scheme results a balance of nonlinearity and dispersive effects. Then, the development of an undular bore is presented and gives a good agreement with the results of Soares-Frazao and Guinot (2008) and I. Magdalena (2015). Moreover, we implement our scheme to simulate dam-break flows over a sloping wet bed.

[18] **Diffusion in a Temporaly Shrinkable Medium**.

Edi Cahyono. Universitas Halu Oleo.

Abstract: Some media often show shrinkage when the mass inside diffuse, such as drying wood. Shrinkage is responsible for developing cracks on clay, wood and concrete during the drying process. We discuss a mathematical model of temporaly shrinkable medium based on macro scale modeling. We apply a finite difference method to solve the model. We also show for a limiting case of non-shrinkable medium. In this limiting case the model is just a diffusion equation and the numerical method is a standard finite difference method.

[19] **Point-spread function reconstruction in ground-based astronomy**.

Raymond Chan. The Chinese University of Hong Kong.

Abstract: Because of atmospheric turbulence, images of objects in outer space acquired via ground-based telescopes are usually blurry. One way to estimate the blurring kernel or point spread function (PSF) is to make use of the aberration of wavefronts received at the telescope, i.e., the phase. However only the low-resolution wavefront gradients can be collected by wavefront sensors. In this talk, I will introduce the necessary background first and then discuss how to use regularization methods to reconstruct high-resolution phase gradients and then use them to recover the phase and the PSF in high accuracy.

[20] **Delay-induced behaviours in a Hindmarsh-Rose-Type model**.

Shyan Shiou Chen. National Taiwan Normal University.

Abstract: In this talk, we investigate a Hindmarsh-Rose-type model with the structure of recurrent neural feedback. The number of equilibria and their stability for the model with zero delay are reviewed first. We derive conditions for the existence of a Hopf bifurcation in the model and derive equations for the direction and stability of the bifurcation with delay as the bifurcation parameter. The ranges of parameter values for the existence of a Hopf bifurcation and the system responses with various levels of delay are obtained. When a Hopf bifurcation due to delay occurs, canard-like mixed-mode oscillations (MMOs) are produced at the parameter value for which either the

fold bifurcation of cycles or homoclinic bifurcation occurs in the system without delay. This behavior can be found in a planar system with delay but not in a planar system without delay. Therefore, the results of this study will be helpful for determining suitable parameters to represent MMOs with a simple system with delay.

[21] **An A-ϕ scheme for type-II superconductors**.

Tao Chen. Communication University of China.

Abstract: A fully discrete **A**-ϕ finite element scheme for a nonlinear electromagnetic model of type-II superconductors is proposed and analysed. The non-linearity is due to a field-dependent conductivity with the regularized power-law form in the domain. The challenges of this model are the error estimation for the nonlinear terms under the time derivative. Applying the backward Euler method in time discretization, we show the well-posedness of the approximate problem based on the theory of monotone operators. We obtain the fully discrete system by linear nodal finite element and discuss its solvability. The obtained error estimate theorem is optimal in time and sub-optimal in space. Finally, some numerical experiments are demonstrated to verify the theoretical result.

[22] **On Perturbation Bounds for Orthogonal Projections**.

Yanmei Chen. South China Normal University.

Abstract: Let A be an $m \times n$ matrix. In this report, we present some perturbation bounds for the orthogonal projections, which improve some existing results for the orthogonal projections.

[23] **Ground State Patterns and Phase Transitions of of Spin-1 Bose-Einstein Condensates**.

I-Liang Chern. National Taiwan University.

Abstract: The ultra-cold dilute boson gases have apparent macroscopic quantum ground state, called Bose-Einstein condensates (BECs). In this talk, I will report our numerical and analytical results on such ground state patterns and their phase transitions of spin-1 BECs confined in a harmonic or box potential under the influence of a homogeneous magnetic field, based on a mean field model–a generalized Gross-Pitaevskii equation.

References

[1] Jen-Hao Chen, I-Liang Chern and Weichung Wang, *A Complete Study of the Ground State Phase Diagrams of Spin*-1 *Bose-Einstein Condensates in a Magnetic Field via Continuation Methods,* Journal of Scientific Computing, 2014.

[2] Liren Lin and I-Liang Chern, *A kinetic energy reduction technique and characterizations of the ground states of spin-1 Bose-Einstein condensates,* Discrete and Continuous Dynamical Systems, Ser. B (2014).

[3] Liren Lin and I-Liang Chern, *Bifurcation between 2-component and 3-component ground states of spin-1 Bose-Einstein condensates in uniform magnetic fields,* ArXiv:1302.0279, 2013.

[4] Tien-Tsan Hsieh and I-Liang Chern, *Ground state patterns of spin-1 Bose-Einstern condensates, Thomas-Fermi approximation and* Γ*-convergence theory,* ArXiv: 1509.05182. pp. 1-46 (2015).

[5] Jen-Hao Chen and I-Liang Chern, *Patterns and phase diagrams of excited states of spin-1 Bose-Einstein states in magnetic fields,* preprint (2016).

.

[24] **On a class of nonlinear matrix equations** $X \pm A^H f(X)^{-1} A = Q$.

Chun-Yueh Chiang. National Formosa University.

Abstract: Nonlinear matrix equations are encountered in many applications of control and engineering problems. In this talk, we establish a complete study for a class of nonlinear matrix equations. With the aid of Sherman Morrison Woodbury formula, we have shown that any equation in this class has the maximal positive definite solution under a certain condition. Furthermore, A thorough study of properties about this class of matrix equations is provided. An acceleration of iterative method with R-superlinear convergence with order $r > 1$ is then designed to solve the maximal positive definite solution efficiently.

[25] **Efficient continuation methods for spin-1 BEC in a magnetic field**.

Cheng Sheng Chien. Chien Hsin University of Science and Technology.

Abstract: We study efficient spectral collocation and pseudo-arclength continuation methods for computing the ground state and first excited solutions of spin-1 Bose-Einstein condensates (BEC) in a magnetic field. First we consider the physical system without the affect of magnetic field. By exploiting the physical properties of both ferromagnetic and antiferromagnetic cases, we describe different continuation algorithms for both cases. When the magnetic field is imposed on the physical system, we develop a two-level continuation algorithm for the ferromagnetic case and continue to trace the solution curve for various values of magnetic field. Extensive numerical results for both spin-1 BEC in a magnetic field, and in optical lattices are reported.

[26] **On the numerical approximation for blow-up problems**.

Chien-Hong Cho. National Chung Cheng University.

Abstract: In this talk, we consider numerical approximation for blow-up problems. We first introduce a numerical method for computing blow-up solutions and show how blow-ups for solutions of certain model equations are reproduced numerically by our method. Our recent results will be reported.

[27] **Approximating Eigenvalues of Pseudo-Orthogonals by Means the Cayley-Transform**.

Roden Jason David. Ateneo de Manila University.

Abstract: We introduce a method to approximate some of the eigenvalues of large pseudo-orthogonal matrices near a given target in the complex plane by using the Cayley transform. We present numerical evidence that the method is superior to the shift-and-invert method.

[28] **Fast finite element method for space-fractional dispersion equations**.

Ning Du. Shandong University.

Abstract: We develop a fast and accurate finite element method for nonlinear space-fractional dispersion equations in two space dimensions, which are expressed in terms of fractional directional derivatives in all the directions that are integrated with respect to a probability measure on the unit circle. The fast method significantly reduces the computational work of solving the discrete linear algebraic systems from $O(N^3)$ by a direct solver to $O(N \log N)$ per iteration and a memory requirement from $O(N^2)$ to $O(N)$. The developed preconditioned fast Krylov subspace iterative solver significantly reduces the number of iterations in a Krylov subspace iterative method and may improve the convergence behavior of the solver. Numerical results show the utility of the method.

[29] **Multilevel Krylov solution of symmetric singular systems**.

Yogi Erlangga. Nazarbayev University.

Abstract: We consider a two-level version of the multilevel Krylov method (MK) *[Erlangga and Nabben, SIAM J. Sci. Comput. 30 (2008), pp. 1572–1595]* for solving linear systems of equations $Ax = b$, with symmetric positive semidefinite matrix of coefficients $A \in \mathbb{R}^{n\times n}$. At an abstract level, the MK method can be viewed as solving the system $AQ_N\tilde{x} = b$ with a Krylov method, where

$$Q_N = I - Z(Z^TAZ)^{-1}Z^TA + \lambda_n Z(Z^TAZ)^{-1}Z^T,$$

and Z an $n \times r$ full-rank matrix, $r < n$. A few possible types of solutions that can be extracted from the associated Krylov subspace include the least-squares and the Drazin-inverse solution. The first can, e.g., be constructed by GMRES and the latter by DGMRES. Our main result is that, under the nonsingularity assumption of the $Z^T AZ$ that can be practically met, (1) GMRES converges to a solution, and this solution is the least-squares solution if Z corresponds to eigenvectors of A; and (2) that DGMRES converges to the Drazin-inverse solution, and this solution is different from the solution obtained by GMRES. Similar results also hold for the left-preconditioned implementation of MK, which in this case $P_N = Q_N^T$. Numerical results based on diffusion problems with Neumann conditions are presented to show the convergence, which is independent of the gridsize.

[30] **Staggered Conservative Scheme for Simulation of Wave Run-up On a Sloping Beach**.

Novry Erwina. Bandung Institute of Technology.

Abstract: Prediction of wave run-up is instrumental in coastal mitigation planning. Recently, several numerical schemes have been developed for the purpose, for various type of beaches. In this article, run-up of nonlinear waves on a sloping beach is studied numerically. Staggered momentum conservation scheme is implemented to solve the shallow water equations. Wet-dry procedure is applied to incorporate the moving boundary. The scheme is used to simulate wave propagation on a sloping beach, and to produce the corresponding run-up and run-down. The analytical solution, as derived by Carrier and Greenspan, is used to validate the scheme. Furthermore, the maximum run-up height is calculated numerically and shows a good agreement with analytical solution. Another validation is conducted using solitary waves, which gives a good agreement with Synolakis experimental data. We conclude that the proposed simple numerical scheme, is able to simulate wave run-up reasonably well.

[31] **Persistence of Common Topological Features via Commutative Ladder Quivers**.

Emerson Escolar. Tohoku University.

Abstract: Recently, the use of persistent homology in topological data analysis has greatly increased in popularity. It can be used to study robust topological features, and the presence, scale, and robustness of these features can be compactly summarized in a persistence diagram. We provide a rough overview of its main ideas. We then review a recent result extending these ideas using the representation theory of quivers with nontrivial relations. In particular, we studied persistence modules over commutative

ladder quivers of finite representation type. Using Auslander-Reiten theory, we provided a generalization of persistence diagrams in our setting. This extension is motivated by applications, and in particular we show that it can be used to detect topological structures that are simultaneously robust and common.

[32] **An Iterative Method for Solving Linear Systems with Tensor Product Structures**.

Hung-Yuan Fan. National Taiwan Normal University.

Abstract: We consider the numerical solution of a c-stable linear equation in the tensor product space $\mathbb{R}^{n_1\times\cdots\times n_d}$, arising from a discretized elliptic partial differential equation in $\mathbb{R}^d$. Utilizing the stability, we produce an equivalent d-stable generalized Stein-like equation which can be solved iteratively. For large-scale problems defined by sparse and structured matrices, the methods can be modified for further efficiency, producing algorithms of $O(\sum_i n_i)+O(n_s)$ computational complexity, under appropriate assumptions (with n_s being the flop count for solving a linear system associated with $A_i - \gamma I_{n_i}$). Numerical examples will be presented.

[33] **Preconditioning Techniques in Chebyshev Spectral Collocation Method for Elliptic Equations**.

Zhiwei Fang. University of Macau.

Abstract: The elliptic equation is discretized by the spectral collocation method on the Chebyshev-Gauss-Lobatto grid. The resulting coefficient matrix is dense and ill-conditioned. A finite difference preconditioner is suggested to solve the associated system. For purpose of speeding up the calculation of the preconditioned system, a modified preconditioner based on the approximate inverse technique is constructed. The resulting two-dimensional system is efficiently implemented with $\mathcal{O}(\ell N_x N_y \log N_x)$ computational cost, where ℓ is a moderate number. Numerical examples are given to demonstrate the efficiency of the proposed preconditioner.

[34] **GENERALIZED CAT BONDS PRICING ANALYSIS USING CONTINUOUS-TIME STOCHASTIC PROCESS**.

Go Felix. Technology Institute of Bandung.

Abstract: Tackling catastrophe risks for traditional insurance approach, insurance industries have introduced various methods of securitization during past decades. One such renowned insurance-linked-securities issued and gained their successful acknowledgement are the so-called Catastrophe Bonds. Their involvement in insurance portfolio has enticed both parties; insurers and investors. Focusing on continuous-time

framework, this paper elaborates optimal payoff structures which take account the problematic basis risk and moral hazard of Catastrophe Bonds, contributing lucrative outcomes simultaneously to three parties; investors, insurers, and insured. By incorporating Martingale Equivalent Measure, quantities such as generalized contingent payoff of catastrophe bonds, interest rate dynamics, and other dynamics are carefully brought to risk-neutral world as simpler expressions would be obtained through this measure. Eventually, Monte Carlo used as numerical analysis purposes results in specified Catastrophe Bonds payoff structure in which optimal insurance premium for insured, risk reserve process for insurer, and yield rate for investors are determined.

[35] **Numerical Computation of the 2D Radiative Transport Equation by Upwind Finite Volume Method**.

Hiroshi Fujiwara. Kyoto University.

Abstract: The radiative transport equation (RTE) is a mathematical model of near-infrared light propagation in human tissue, and its analysis is required for developing new medical imaging techniques. RTE is an integro-differential equation and it contains differentiation with respect to position. In this talk we adopt an upwind finite difference and show error estimates and numerical examples.

[36] **Column-wise BCD Method for Orthogonal Constrained Optimization Problems**.

Bin Gao. Academy of Mathematics and Systems Science.

Abstract: We propose a column-wise block coordinate descent approach for solving a class of orthogonal constrained optimization problems. This approach combines a Gauss-Sedeil type of iteration with a multiplier symmetrization step to guarantee the stationarity satisfied at any cluttering point. We prove the global convergence of the proposed approach. Preliminary experiments illustrate that the new algorithm performs well and is of great potential.

[37] **A linearized Galerkin-mixed FEM for Ginzburg–Landau equations**.

Huadong Gao. Huazhong University of Science and Technology.

Abstract: We present an efficient and accurate numerical methods for approximations of the time-dependent Ginzburg–Landau equations (TDGL) under the Lorentz gauge. The new method is based on a fully linearized backward Euler scheme in temporal direction, and a mixed finite element method in spatial direction which introduces the magnetic induction $\boldsymbol{\sigma} = \mathbf{curl}\,\mathbf{A}$ as a new variable. The proposed linearized Galerkin-mixed finite element method offers many advantages over conventional Lagrange type

Galerkin FEMs. It enjoys four important advantages: (1) the scheme is semiimplicit and at each time step one only need to solve a linear system; (2) the coefficient matrices for the FEM system remain unchanged at all time steps, which reduce computational costs greatly; (3) it solves for the magnetic induction $\boldsymbol{\sigma} = \mathbf{curl}\,\mathbf{A}$ directly,and thus numerical differentiation can be avoided; (4) as the conventional Lagrange FEM suffers from singularities at domain corners for computing $\boldsymbol{\sigma} = \mathbf{curl}\,\mathbf{A}$, our method successfully overcomes this numerical singularities. Extensive numerical experiments in both two and three dimensional spaces are presented to confirm the above properties of our numerical methods for the TDGL equations. Excellent accuracy and stability of the proposed method are shown through numerical examples. We also use the proposed method to investigate the vortex motion in superconductors.

[38] **Adaptive mesh refinement technique for the classical Plateau problem**.

Aymeric Grodet. Ehime University.

Abstract: Let $D = \{(u,v) \in R^2 \,|\, u^2 + v^2 < 1\}$ be the unit disk with boundary $\partial D = S^1$ the unit circle. Let $\Gamma \subset R^d$ be an arbitrary Jordan curve. We would like to compute a minimal surface $\varphi : \overline{D} \to R^d$ with $\varphi(\partial D) = \Gamma$. For such a minimal surface, it exists the following variational principle: $H^1(D; R^d)$ being the ordinary Sobolev space, let

$$X_\Gamma = \left\{\psi \in C(\overline{D}; R^d) \cap H^1(D; R^d) \,\middle|\, \psi(\partial D) = \Gamma, \psi|_{\partial D} : \text{monotone}\right\}$$

where monotone means that if ∂D is traversed in a given direction, Γ is also traversed in the corresponding direction, although we allow arcs of ∂D to map onto single points of Γ. To such a map φ, we denote its Dirichlet integral by

$$D(\varphi) = \int_D |\nabla\varphi|^2 \,\mathrm{d}x = \int\int_D \sum_{k=1}^{d} \left[\left(\frac{\partial\varphi_k}{\partial u}\right)^2 + \left(\frac{\partial\varphi_k}{v}\right)^2\right] \mathrm{d}u\mathrm{d}v.$$

Then, $\varphi \in X_\Gamma$ is a minimal surface if and only if it is a stationary point of $D(\varphi)$. The problem of finding such points is called the classical Plateau problem. The mapping φ is actually obtained by minimizing its Dirichlet integral. We need a normalization condition to determine a minimal surface (locally) uniquely. Several exist. For example, one can specify the images of three points on ∂D to define the same orientation on ∂D and Γ. Let $\{\Delta_h\}$ be a family of triangulations of the unit disk. If one apply a finite element approximation of minimal surfaces on the unit disk, with piecewise linear functions on each triangle, some inaccuracies can occur, in particular at singularities of Γ. We propose to overcome this difficulty by introducing a posteriori error estimation and an adaptive mesh refinement. This allows us to refine the mesh only in the local area corresponding to the problematic one on Ω. In this talk, we explain how to perform

the finite element approximation and present several numerical examples to highlight what problems can occur and how to solve them.

[39] **Convex splitting method for saddle point search problems**.

Shuting Gu. City University of Hong Kong.

Abstract: To evolve the steepest descent dynamics of energy functional, the convex splitting method has been very successful in maintaining unconditional energy stability. This method is of particularly use to search local minimas of energy landscape since large time step size is allowed. In this work, we generalize this method to the challenging problem of searching transition states, i.e., index-1 saddle points. By using the iterative minimization formulation, the saddle point problem is transformed to a series of minimization subproblems. We present how to construct the convex splitting scheme in the use of steepest decent dynamics for these new minimization subproblems. We demonstrate that this strategy of convex splitting not only benefits the subproblems, but also improves the efficiency of the overall performance of the algorithm. Numerical results confirm the advantage of the convex splitting scheme compared to traditional methods.

[40] **Limit Theorems in Hidden Markov Models**.

Guangyue Han. The University of Hong Kong.

Abstract: In this talk, under mild assumptions, we derive a law of large numbers, a central limit theorem with an error estimate, an almost sure invariance principle and a variant of the Chernoff bound in finite-state hidden Markov models. These limit theorems are of interest in certain areas of information theory and statistics. Particularly, we apply the limit theorems to derive the rate of convergence of the maximum likelihood estimator in finite-state hidden Markov models..

[41] **On Optimal Design Outsourcing Strategy**.

Wanhua He. The University of Hong Kong.

Abstract: To improve product sales, a manufacturer would hire a designer, a team or a company to provide service in product packaging or advertisement before the production takes place. In this paper, we investigate the issue of designing outsourcing and production planning for a manufacturer facing asymmetric design cost information and uncertain market demand information. A contract including the design level and the payment to the designer is introduced such that the designer may have incentive to report the exact cost to the manufacturer. Furthermore, a model with the goal of maximizing the manufacturer's net-profit is proposed, in which both of the demand

of the product and the payment to the designer are influenced by the design level. Analytic solutions of the optimal strategies including the optimal design level and the optimal payment to the designer are obtained. Both the optimal retail price and the optimal production quantity are obtained for the manufacturer's production decisions.

[42] **A Newton-Type Method for Nonlinear EigenProblems in Photonic Crystal Modeling**.

Tsung-Ming Huang. National Taiwan Normal University.

Abstract: The numerical simulation of the band structure of three-dimensional dispersive metallic photonic crystals with face-centered cubic lattices leads to large-scale nonlinear eigenvalue problems, which are very challenging due to a high dimensional subspace associated with the eigenvalue zero and the fact that the desired eigenvalues (with smallest real part) cluster and close to the zero eigenvalues. For the solution of the nonlinear eigenvalue problem, a Newton-type iterative method is proposed and the nullspace-free method is applied to exclude the zero eigenvalues from the associated generalized eigenvalue problem. To find the successive eigenvalue/eigenvector pairs, we propose a new non-equivalence deflation method to transform converged eigenvalues to infinity, while all other eigenvalues remain unchanged. The deflated problem is then solved by the same Newton-type method, which is used as a hybrid method that combines with the Jacobi-Davidson and the nonlinear Arnoldi methods to compute the clustering eigenvalues. Numerical results illustrate that the proposed method is robust even for the case of computing many clustering eigenvalues in very large problems.

[43] **Fast preconditioning algorithm for boundary value method for space-fractional diffusion equations**.

Yunchi Huang. University of Macau.

Abstract: For solving space-fractional diffusion equations, boundary value method with spatial fourth-order discretization of Hao et al. [A fourth-order approximation of fractional derivatives with its applications, J. Comput. Phys. 281 (2015), pp. 787-805] is adopted to produce a numerical solution with high-order accuracy in both spatial and time direction. GMRES method is employed for solving the discretized linear system with the Crank-Nicolson preconditioner. Based on a circulant-and-skew-circulant representation of Toeplitz matrix inversion, the preconditioner can be applied efficiently, and the convergence rate of the preconditioned GMRES method is proven to be fast. Numerical example is given to support the theoretical analysis.

[44] **Boussinesq Type Model For Flow Over A Bump**.

Nurul Huda N.A. Institut Teknologi Bandung.

I. Magdalena. Institut Teknologi Bandung.

Abstract: Flow over a bump occurs when the water flow with specific velocity in a wide channel approaches a bump, so that the flow will be deform. In this research, we study the deformation of the flow over a bump. The equation that we used here is one dimensional Boussinesq equations. We solve the equation numerically using finite difference methods with predictor-corrector step. We investigate this phenomena using Boussinesq model without and with dispersive term. Boussinesq model without dispersive term is known as Saint Venant model. To validate our numerical model, first we compare the numerical result using Saint Venant method with analytical result. Moreover, our numerical result confirms the analytical solution. Second, we examine our numerical scheme of Boussinesq model with dispersive term by doing dam break test. Using dispersive Boussinesq model, we observe the appearance of undulation in dam break test as we expect for indicating dispersive phenomena. Further, we implement our numerical model to simulate various evolution flow over a bump.
Keywords: Boussinesq equations, finite difference methods, dispersive, dambreak.

[45] **Nonlinear Preconditioning Techniques for PDE-Constrained Optimization Problem**.

Feng-Nan Hwang. National Central University.

Abstract: The full-space Lagrange-Newton algorithm is one of the numerical algorithms for solving problems arising from optimization problems constrained by nonlinear partial differential equations. Newton-type methods enjoy fast convergence when the nonlinearity in the system is well-balanced, however, for some problems, such as the control of incompressible flows, even linear convergence is difficult to achieve and a long stagnation period often appears in the iteration history. In this work, we introduce a nonlinearly preconditioned inexact Newton algorithm for the boundary control of incompressible flows. The system has nine field variables, and each field variable plays a different role in the nonlinearity of the system. The nonlinear preconditioner approximately removes some of the field variables, and as a result, the nonlinearity is balanced and inexact Newton converges much faster when compared to the unpreconditioned inexact Newton method or its two-grid version. Some numerical results are presented to demonstrate the robustness and efficiency of the algorithm.

[46] **A Coupled Model for Wave Run-Up Simulation**.

Iryanto. Politeknik Negeri Indramayu.

S.R. Pudjaprasetya. Institut Teknologi Bandung.

Abstract: Simplified model like shallow water equations (SWE) are commonly adopted model for describing a wide range of free surface flow problems, like flows in rivers, lakes, estuaries or coastal areas. Numerical methods for SWE are abundant in literature. They are mostly mesh based methods. However, this macroscopic approach is unable to represent accurately the complexity of the flow near the coast, when waves are breaking. This fact raised the idea of coupling the mesh based SWE model with the mesh-free particle method solving the Navier-Stokes equations (NSE). In the previous paper, a way to couple the staggered scheme SWE and the smoothed particle hydrodynamics NSE was proposed and discussed. In this article, this coupled model was used for simulating wave run up. Simulation of the solitary wave run up on a sloping beach has shown a good agreement with the experimental data of Synolakis. Simulations of wave overtopping of a seawall were also performed.

Keywords: coupled model, smoothed particle hydrodynamics, staggered conservative scheme, solitary wave run up, wave overtopping of seawall.

[47] **Numerical Modelling of Fluid Flow Around a Circular Cylinder**.

Andreas A S Jacobs. Bandung Institute of Technology.

Abstract: In this presentation, numerical simulations of incompressible flow around stationary circular cylinders have been performed using Finite difference method in uniform cartesian grid. The circular cylinder geometry will be approached with polygon. This presentation will be divided into 2 cases, inviscid flow and viscous flow. In the first case, inviscid incompressible flow will be simulated using two different approaches. The two-dimensional Laplace equation is solved by using analytical and numerical approach. In the viscous incompressible flow case, viscous incompressible flow will be simulated with two different methods. In the first class of methods, the flow is described in terms of primary variables including the velocity and the pressure. The structure of the velocity and pressure field in a steady flow, is computed by solving the Navier-Stokes equation and the continuity equation, subject to appropriate boundary conditions. In the second class of methods, the flow is computed on the basis of the vorticity transport equation. The various streamline, velocity, pressure will be obtained based on Reynold Numbers and other assumption.

[48] **Analytic valuation of Russian option with finite time horizon.**

Junkee Jeon. Seoul National University.

Abstract: In this talk, we first describe a general solution for the inhomogeneous Black-Scholes partial differential equation with mixed boundary conditions using Mellin transform techniques. Since Russian options with a finite time horizon are usually for-

mulated into the inhomogeneous free-boundary Black-Scholes partial differential equation with a mixed boundary condition, we apply our method to Russian options and derive an integral equation satisfied by Russian options with a finite time horizon. Furthermore, we present some numerical solutions and plots of the integral equation using recursive integration methods and demonstrate the computational accuracy and efficiency of our method compared to other competing approaches.

[49] **A fast FV scheme for a FDE discretized on a locally refined composite mesh**.

Jinhong Jia. Fudan University.

Abstract: In this talk we present a preconditioned fast Krylov subspace iterative method for the efficient and faithful solution of finite volume schemes defined on a locally refined composite mesh for fractional diffusion equations to resolve boundary layers of the solutions. Numerical results will be presented to show the utility of the method.

[50] **Asian-style index futures arbitrage: a case of the Hong Kong market**.

Kai Fung Kan. The Chinese University of Hong Kong.

Abstract: We examines the arbitrage opportunity of Hang Seng Index Futures (HSI Futures) on the expiration day. HSI Futures is cash-settled by an Asian settlement procedure at maturity. We introduce an integer program to detect mispricing and construct delta-neutral portfolio. Empirical results show that there is a positive relationship between magnitude of mispricing and time to maturity. Furthermore, the size of underpricing and overpricing are not significantly different. We also propose a practical trading strategy to exploit the mispricing opportunity and analyze its profitability.

[51] **TSOM image analysis using the image enhancement methods and a deep learning technque**.

Myungjoo Kang. Seoul National University.

Abstract: Since 1990, many mathematicians studied the image processing based on partial differential equations and variational methods. Using TV(total variation) and some optimization techniques, there were a lot of improvement in image processing areas. Also recently, using a deep learning method, many exciting results for image processing come out. In this talk, I will explain the some results for TSOM(Through-focus Scanning Optical Microscopy) image analysis using the traditional image enhancement methods and a deep learning method.

[52] $W^{1,\infty}$**-error analysis of the finite element method in a smooth domain**.

Takahito Kashiwabara. The University of Tokyo.

Abstract: This study focuses on $W^{1,\infty}$- (as well as L^∞-) error estimate for the finite element method in a smooth domain $\Omega \subset \mathbb{R}^N$ ($N \geq 2$). As a model problem, we consider the Poisson equation. Since $\partial\Omega$ is curved, one needs to approximate Ω by some polyhedral domain, which introduces errors caused from the domain perturbation. L^∞-error estimate taking into account such a situation is known if the homogeneous Dirichlet boundary condition is considered and Ω is convex (Schatz and Wahlbin, Math. Comp., 1982). In this study, we extend their result to a general (i.e. non-convex) domain subject to a non-homogeneous Neuman boundary condition.

[53] **Numerically verifiable condition for positivity of solution to elliptic equation**.

Tanaka Kazuaki. Waseda University.

Kouta Sekine. Waseda University.

Shin'ichi Oishi. Waseda University.

Abstract: We are concerned with a verified numerical computation of solutions to the following elliptic problem:

$$\begin{cases} -Lu = f(u) & \text{in } \Omega, \qquad (1a) \\ u > 0 & \text{in } \Omega \qquad (1b) \end{cases}$$

with appropriate boundary conditions. Here, Ω is a bounded domain in $\mathbb{R}^n$ ($n = 1, 2, 3, \cdots$), f is a given nonlinear operator from an appropriate solution space to $L^2(\Omega)$, and L is a uniformly elliptic self-adjoint operator. We propose an extended result of [1,Theorem 2], which provides a sufficient condition for the positiveness of a solution u to (1a). To verify the solution to (1a)(1b), we first obtain a numerical inclusion of a solution to (1a) (without (1b)) using verified numerical computation tectonics. After that, we confirm its positivity using our theorem with computer assistance. Numerical examples for some concrete equations will be presented.

Keywords: elliptic equation, verifying positivity, verified numerical computation

References

[1] K. Tanaka, K. Sekine, M. Mizuguchi, and S. Oishi, *Numerical verification of positiveness for solutions to semilinear elliptic problems*, JSIAM Letters 7, 73–76 (2015).

.

[54] **Numerical ranges of tensors**.

Rihuan Ke. The Chinese University of Hong Kong.

Abstract: In this talk, I would like introduce a generalization of matrix numerical ranges to tensor case based on tensor norms. We show that the basic properties of matrix numerical ranges such as compactness and convexity are valid for tensor numerical ranges. Making use of convexity property, an algorithm is proposed for approximating tensor numerical ranges in which tensor eigenvalues are contained. Also we consider tensor numerical ranges based on inner products, however, they may not be convex in general.

[55] **Discrete maximal regularity and the finite element method for parabolic problems**.

Tomoya Kemmochi. The University of Tokyo.

Norikazu Saito. The University of Tokyo.

Abstract: Maximal regularity is a fundamental concept in the theory of partial differential equations, which is described as follows: the operator A on a Banach space X has maximal L^p-regularity if the Cauchy problem

$$u' = Au + f, \quad u(0) = 0$$

has a unique solution u that satisfies

$$\|u'\|_{L^p(0,\infty;X)} + \|Au\|_{L^p(0,\infty;X)} \leq C\|f\|_{L^p(0,\infty;X)}$$

uniformly for $f \in L^p(0,\infty;X)$. This property has been widely applied to numerous nonlinear PDEs, such as quasilinear parabolic problems and the Navier-Stokes equations. Therefore, it is natural to ask whether the discrete analogue in space or time of maximal regularity is established. In our study, we obtain the maximal regularity property for the discrete Laplace operator, discretized by P1-finite element method with mass-lumping, and its full-discrete version. Then, our main result is their application to error estimates for the finite element approximation of linear and semilinear heat equations. Our method of error analysis is based on the contraction mapping principle and the fractional powers of the discrete Laplacian. This new technique allows us to obtain optimal order error estimates in $L^p(0,T;L^q(\Omega))$ norm, for $p, q \in (1,\infty)$, and other various norms. In this talk, we consider the following semilinear heat equation in a bounded polygonal domain Ω:

$$\partial_t u = \Delta u + f(u), \quad u(0) = u_0,$$

where f is the nonlinear term with $f(0) = 0$, and u_0 is chosen from the appropriate interpolation space. We assume that f is locally Lipschitz continuous. We will present

the outline of the proof of optimal order error estimate in $L^p(0,T;L^q(\Omega))$ norm, for fully discretized problem:

$$\frac{u_h^{n+1}-u_h^n}{\tau} = \Delta_h u_h^{n+1} + Q_h f(u_h^n), \quad u_h^0 = P_h u_0.$$

Here, Δ_h is the discrete Laplacian as mentioned above, τ is the time increment, P_h is the L^2-projection operator, and Q_h is another "projection" operator. Some interesting auxiliary results including discrete Gagliardo-Nirenberg and Sobolev inequalities are also presented.

[56] **Hybrid of WENO and FOM for Robust Interface Tracking**.

Hyeon uk Kim. Seoul National University.

Abstract: Face offsetting method(FOM), introduced by Xiangmin Jiao et al, has won great success in the field of interface propagation. Big advantages for FOM is that the method uses only Lagrangian surface mesh, without making use of Eulerian mesh. Therefore, the method spends much less time and suffers much smaller volume loss than the methods based on Eulerian mesh, such as a well-known level set method. But, FOM still has some restrictions. First of all, as it uses only neighboring face normals to determine offsetting directions, the order of FOM is restricted to low order even in smooth regions. Second, as it uses some specific parameters to determine the local shape at each node which is used to find the correct propagating direction, the method is greatly influenced by those parameters. For surfaces with complex geometry, it is hard to adjust parameters fit to the situation. To overcome such limitations, we observe that the process of determining offsetting direction quite similar to that of determining numerical fluxes at the interface of elements. In this talk, we present new framework for high order propagation based on this similarity. Different from standard FOM, our new method approximate normal vector at each node by using wider stencils of faces to get high order accuracy. Among many interpolation schemes, we used the WENO(Weighted Essentially Non-Oscillatory) scheme, which is a widely-used interpolation scheme and it is known to work well even under the presence of shocks. By using the WENO scheme, we can efficiently find the normal direction which is robust with sharp shape, such as ridge or corner. We will numerically show that the area loss of proposed method is much smaller than that of FOM. Also, we will show that our method is less vulnerable to specific parameters than FOM, and we can find local geometry at each node more stably. We present simple results for 1D surface first, and then we will show that our method can be extended to 2D surface naturally.

[57] **Reconnection of vortex and magnetic flux tubes**.

Yoshifumi Kimura. Nagoya University.

Abstract: As an initial stage of vortex reconnection, approach of nearly anti-parallel vortices has often been observed experimentally and studied numerically. In this paper, we first consider the annihilation process of anti-parallel Burgers vortices. We can demonstrate that during the annihilation process the total vorticity decays exponentially on a time-scale proportional to the inverse of the rate of strain, even as the kinematic viscosity tends to 0. These analytic results are compared with the numerical simulations of two strained vortices with the vortex-vortex nonlinear interaction by Buntine and Pullin. Then we proceed to the case of skewed vortices. Due to the straining action of velocity, Two Burgers-type vortices originally placed symmetrically in a skewed configuration get closer to a single line being parallel each other while the crossing parts tend to annihilate. Using an analytic solution, we can monitor this process graphically. Helicity is calculated also analytically during this process, which decays to zero exponentially as reconnection occurs. Finally this result is applied to reconnection of magnetic flux tubes by including the effect of the Lorentz force.

[58] **A study on the model of the signal transduction process under a delay**.

Jutarat Kongson. Burapha University.

Abstract: The study on the signal transduction pathway is attractive topic for many researchers because it is the important process for communication of cells. Here, we consider a model of the signal transduction process which involve the dynamic interaction between an inhibitor protein and the ligand-receptor complexes in second messenger synthesis. A delay of the conversion from the signal amplification of the ligand-receptor complexes is taken into account. The persistence and stability of the model system are established.

[59] **The asymptotic analysis for Structure-Preserving doubling algorithms**.

Yueh-Cheng Kuo. National University of Kaohsiung.

Abstract: Taking advantage of the special structure and properties of the Hamiltonian matrix, we apply a symplectically similar transformation to reduce $\mathscr{H}$ to a Hamiltonian Jordan canonical form $\mathfrak{J}$. The asymptotic analysis of the structure-preserving flows and RDEs is studied by using $e^{\mathfrak{J}t}$. The convergence of the SDA as well as its rate can thus result from the study of the structure-preserving flows. A complete asymptotic dynamics of the SDA is investigated, including the linear and quadratic convergence studied.

[60] **A bisection approach combined with a projection method for interior eigenvalue problems in materials science**.

Dongjin Lee. Nagoya University.

Takeo Hoshi. Tottori University.

Yuto Miyatake. Nagoya University.

Tomohiro Sogabe. Nagoya University.

Abstract: A numerical approach based on the bisection and a projection method is proposed for computing only a few selected interior eigenvalues of a symmetric-definite generalized eigenvalue problem in electronic structure calculations. The bisection has been mainly applied to computing all or some selected eigenvalues of a real symmetric tridiagonal matrix, because the spectrum can be estimated easily and the inertia can be computed efficiently. However, applying the bisection to the generalized eigenvalue problem is not straightforward, because simple and practical estimation of the spectrum is difficult to be achieved. In addition, computation of the inertia is highly costly, because the matrices of the problem are not assumed to be tridiagonal. To deal with the two issues, a projection method is utilized to estimate the spectrum and reduce computational cost for the inertia computation. Numerical results of the matrix size up to hundreds of thousands are presented.

[61] **Traveling Wave Solutions of A Model for Porcine Reproductive and Respiratory Syndrome**.

Yongwimon Lenbury. Mahidol University & Centre of Excellence in Mathematics, Thailand.

Abstract: There are many epidemic diseases in the swine population such as swine fever disease, foot and mouth disease and Aujesky's disease. One of the most important diseases is porcine reproductive and respiratory syndrome (PRRSV) which was first reported in the United States in 1987. The important consequences of the disease are severe reproductive failure in sows, respiratory symptoms, increased pre-weaning mortality in suckling pigs, and a mild flu-like symptom in grower-finisher pigs. Recently, there has been reports that infectiousness of pigs infected by the PRRSV is time-dependent. We therefore construct a structured model for the spread of PRRSV that incorporates both the time and spatial dimensions as well as the decline of infectiousness with time. We derive analytical solutions to the model system by using the travelling wave coordinate, based on the extended tanh method, in order to gain insights into the spatial spread of the infection as time progresses.

[62] **Optimal Ordering Policy for a Multi Item Probabilistic Inventory Model with All-units Discount**.

Dharma Lesmono. Universitas Katolik Parahyangan.

Abstract: A mathematical model for a multi item probabilistic inventory problem with all-unit discount is the main focus of this paper. In developing the model, our objective is to determine the optimal ordering policy to minimize the total cost. We will also compare the total cost, which consists of the purchasing cost, ordering cost, handling and shortage costs for individual and joint replenishment policy. In the individual order policy, our model will determine the optimal order quantity and reorder point for each item while in the joint replenishment, the optimal ordering time will become the decision variable. Demand for these items are assumed to follow Gamma distribution with certain parameters and all shortages are back-ordered. Supplier gives all-units discount for items ordered above certain amount. This policy will lower the purchase cost and probably the shortage cost but on the other hand handling cost becomes higher. When joint replenishment policy is applied, the ordering cost is lower compared to the ordering cost for the individual ordering policy. Our numerical experiments shows, for three items with one price break for all-unit discount, individual replenishment policy gives lower total cost than the joint replenishment policy. However, in general many factors such as demand parameters, holding cost and the joint ordering cost that will determine which policy is preferable.

Keywords: multi item, joint replenishment policy, individual replenishment policy, all-units discount.

[63] **Preconditioning almost skew-symmetric matrices with applications**.

Yung-Ta Li. Fu Jen Catholic University.

Abstract: In this talk, we define an almost skew-symmetric matrix via applying pseudospectral methods for solving boundary value problems of differential equations. Here the boundary values are imposed asymptotically by the penalty method. We then provide a sufficient and necessary condition for the nonsingularity of the almost skew-symmetric matrix. We also propose a preconditioner to reduce the condition number of the matrix. Finally we present numerical examples to show that the preconditioner is viable.

[64] **A New Method for Higher Order Finite Element Meshes**.

Guojun Liao. University of Texas at Arlington.

Abstract: In this talk, we present a new moving grid method for higher order meshes and illustrate the method by generation of a cubic-curved triangular mesh outside an ellipse. In this example, an initial linear grid outside the ellipse is deformed to generate the cubic-curved triangular grid. Two equally spaced points are selected on each side of the triangles. The selected points on the straight elliptic boundary are to

be moved to their closest points on the curved ellipse, respectively. The velocity vector is calculated by solving a Div-Curl system under the Dirichlet condition. Solving the Div-Curl Equations We denote the domain covered by the initial mesh by D(0) and denote the domain outside the ellipse by D(1). We deform the initial grid on D(0) by a suitable velocity vector V from t=0 to t = 1, and denote the deforming domain by D(t). In order to define such a velocity vector field VV, we first find a vector field U by solving a divergence and curl system (Div-Curl) on the deforming domain at each time t = k/n, where n is the number of time steps for solving the Ode from t = 0 to t = 1, k = 1, 2,,n. Solving the ODE (A2) After determination of U, we define the velocity vector field V by V = f(t) U and solve an ordinary differential equation for the transformation T(x, y, z, t) with the initial condition T(x, y, z, 0) = (x, y, z). Indeed, we get the new location of any point (x, y, z) of D(0).

[65] **An NCC quadrature for two-dimensional Volterra integral equations**.

Furong Lin. Shantou University.

Abstract: Nyström-Clenslaw-Curtis (NCC) quadrature is a highly accurate discretization method for integral equation with semi-smooth kernel function, which is proposed in [Math. Comp., 72 (2003), pp. 729–756]. In this talk, we consider applying the NCC quadrature to two-dimensional Volterra integral equations of the second kind

$$f(x,y) - \int_a^x \int_a^y k(x,y,t,s) f(t,s) ds dt = g(x,y), \qquad (x,y) \in [a,b] \times [a,b],$$

where the kernel function $k(x,y,t,s)$ and the true solution $f(t,s)$ are smooth in $[a,b]^4$ and $[a,b]^2$ respectively. We also consider composite NCC quadrature for the integral equations and present error analysis. Numerical results, including comparison with the well-known spectrum method, are presented to illustrate the efficiency and the accuracy of the NCC method.

[66] **A Fast Accurate Approximation Method with Multigrid Solver for Two-Dimensional Fractional Sub-Diffusion Equation**.

Xuelei Lin. University of Macau.

Xin Lu. University of Macau.

Micheal K. Ng. Hong Kong Baptist University.

Haiwei Sun. University of Macau.

Abstract: A fast accurate approximation method with multigrid solver is proposed to solve a two-dimensional fractional sub-diffusion equation. By using the finite difference discretization of fractional time derivative, a block lower triangular Toeplitz matrix is obtained where each main diagonal block contains a two-dimensional matrix for the Laplacian operator. Our idea is to make use of block ϵ-circulant approximation via fast Fourier transforms so that the resulting task is to solve a block diagonal system where each diagonal block matrix is the sum of a complex scalar times identity matrix and a Laplacian matrix. We show that the accuracy of the approximation scheme is of $O(\epsilon)$. Because of the special diagonal block structure, we employ the multigrid method to solve the resulting linear system, and establish the convergence of the multgrid method. Numerical examples are presented to illustrate the accuracy of the proposed approximation scheme and the efficiency of the proposed solver.

[67] **On option pricing under a hidden Markovian regime-switching model**.

Jiejun Lu. The University of Hong Kong.

Abstract: We discuss an option pricing problem in a hidden Markovian regime-switching model with stochastic interest rate and volatility. Regime switches are attributed to structural changes in hidden economic environment and are described by a continuous-time, finite-state, unobservable Markov chain. The model is then applied to valuation of a standard European option. By means of the separation principle, filtering and option valuation problems are separated. Robust filters for the hidden states of the economy and their robust filtered estimates of unknown parameters based on the expectation maximization (EM) algorithm are provided. Then an explicit expression of a conditional characteristic function relevant to option pricing is presented and the valuation of option is discussed using the inverse Fourier transformation approach. Using the limiting behavior of the conditional characteristic function, an efficient implementation of the transform inversion integral is considered. Numerical experiments are given to illustrate the flexibility of filtering algorithms and the significance of regime-switching in option pricing.

[68] **Approximate Inversion Method for Time Fractional Sub-Diffusion Equations**.

Xin Lu. Univerisity of Macau.

Abstract: The finite difference method applied to the time-fractional sub-diffusion equation usually leads to a large-scale linear system with a block lower triangular Toeplitz (BLTT) coefficient matrix. The approximate inversion method is employed to fast solve this linear system. A sufficient condition is proved to guarantee the high accuracy of the approximate inversion method for solving the BLTT systems. The proposed sufficient condition is easy to verify in practice and has a wide range of application. The application of this sufficient condition to several existing finite difference schemes are

investigated. Numerical experiments are presented to verify the validity of theoretical results.

[69] **Density Questions Related to Cantor Measures**.

Jun Luo. Sun Yat-sen University.

Yu Huang. Sun Yat-sen University.

Abstract: We consider the product μ of a symmetric Cantor measure defined on [0,1] with itself. The aim is to obtain fundamental properties about the asymptotic of the lower density $\underline{\Theta}(\mu, O)$ at the origin $O \in \mathbb{R}^2$, which is of some interest from a computational point of view. Part of our motivations are from the study of fractal geometry, and the reciprocal of $\underline{\Theta}(\mu, O)$ is connected to the packing measure of certain fractal sets.

[70] **A highly parallel finite element method for 3D two-phase moving contact problems**.

Li Luo. Hong Kong University of Science and Technology.

Abstract: Moving contact line problem plays an important role in fluid-fluid interface motion on solid surfaces. The problem can be described by a phase-field model consisting of the coupled Cahn-Hilliard and Navier-Stokes equations with the generalized Navier boundary condition (GNBC). Accurate simulation of the interface and contact line motion requires very fine meshes, and the computation in 3D is even more challenging. Thus, the use of high performance computers and scalable parallel algorithms are indispensable. In this paper, we generalize the GNBC to surfaces with complex geometry and introduce a finite element method on unstructured 3D meshes with a semi-implicit time integration scheme. A highly parallel solution strategy using different solvers for different components of the discretization is presented. We show the validity of our solver through extensive numerical experiments, including bumpy channel flows, droplet spreading on rough surfaces, and a moving fiber through liquid interface. Results show that the two-phase flow solver is efficient and scalable for 3D problems with complex geometry and on a supercomputer with a large number of processors.

[71] **Development of Modal Interval Algorithm for Solving Continuous Minimax Problems**.

Xin Luo. The University of Alabama.

Abstract: While there are a large variety of effective methods developed for solving more traditional minimization problems, much less success has been reported in solving

the minimax problem. Continuous minimax problems can be applied to engineering, finance and other fields. Miguel . Sainz in 2008 proposed a modal interval algorithm based on his semantic extensions to solve continuous minimax problems. We introduced a new definition of semantic extensions and developed an improved algorithm using modal intervals to solve unconstrained continuous minimax problems. A new interval method is introduced by taking advantage of both the original minimax problem and its dual problem(called maxmini problem). The new algorithm is implemented in the framework of uniform partition of the search domain. Various improvement techniques including more bisecting choices, sampling methods and deletion conditions are applied to make the new method more powerful. Preliminary numerical test results provide promising evidence of its effectiveness.

[72] **Numerical Model for The Formation of Undular Bores Generated by Tsunami Fission**.

Ikha Magdalena. Institut Teknologi Bandung.

Abstract: Undular bores are mostly created in many estuaries, such as in the Qiantang River, Araguari River, Seine River, and Daly river. However, during the 2004 Indian Ocean Tsunami, some videos recorded the tsunami approaching the coastline as a series of short period breaking fronts or strong undular bore as state in Ioualalen et al. (2007). These short-period waves or undular bores may be the result of fission processes of a steep tsunami front propagating across a wide shelf of shallow depth. These water surface undulations cannot be predicted by a hydrostatic model, because they are dispersive in nature. In this paper, undular bores generated by tsunamis waves fission is examined considering non-hydrostatic pressure and dispersive effects. The depth integrated Euler equations are chosen as the governing equations. The equations are solved numerically using finite volume method on a staggered grid with predictor-corrector step. In the predictor step, we solve the equations without non-hydrostatic terms, the scheme is based on the momentum conservative scheme for the shallow water equations developed by Stelling and Duinmeijer (2013). Then, we use those values as the predictor in the corrections step by including non-hydrostatic terms. Several benchmark problems are tested to illustrate the accuracy of our non-hydrostatic scheme. Numerical results are presented and compared with analytical and experimental data to show the ability of our non-hydrostatic numerical model for the application to undular bores generated by tsunami fission.

[73] **An Energy-preserving H^1-Galerkin scheme for the Hunter–Saxton equation**.

Yuto Miyatake. Nagoya University.

Abstract: In this talk, we propose an energy-preserving Galerkin scheme for the Hunter–Saxton equation. This partial differential equation is a model for the propagation of weakly nonlinear orientation waves in a nematic liquid crystal, and has rich mathematical structures: it is integrable; it is bi-Hamiltonian; etc. It should also be noted that this equation admits non-smooth solutions. Motivated by these facts, our main aim is to derive an H^1-Galerkin scheme which exactly inherits the energy-preservation property. However, this task is not straightforward mainly because the equation has a non-local operator. In this talk, we show how we can avoid this problem, derive an intended scheme, and present some numerical experiments.

[74] **Performance Evaluation of Verified Computation for Linear System on Supercomputer**.

Yusuke Morikura. Waseda Univirsity.

Daichi Mukunoki. RIKEN Advanced Institute for Computational Science.

Takeshi Fukaya. Hokkaido University.

Naoya Yamanaka. Meisei University.

Abstract: This talk is concerned with the computational performance of a numerical algorithm with verification for linear systems

$$Ax = b,\ A \in \mathbb{R}^{n\times n},\ b \in \mathbb{R}^n.$$

The purpose of this research is to investigate the computational efficiency of verified computation for linear systems on recent supercomputers.There is a number of numerical algorithms to verify an approximate solution obtained by a numerical algorithm [1, 2].The cost of the computation with verification is theoretically 6x that without verification.However, it is not too obvious that how much the execution time of the computation with verification on parallel computers,because of it is affected by many factors.We illustrate that the execution time of the computation with verification was less than 2x that without verification on 1024 nodes of the K computer.

References

[1] S. Oishi, S. M. Rump, *Fast Verification of Solutions of Matrix Equations,* Numer. Math., vol. 90, no. 4, pp. 755–773, February 2002.

[2] Y. Morikura, K. Ozaki, S. Oishi, *Verification methods for linear systems using ufp estimation with rounding-to-nearest,* Nonlinear Theory and its Applications, IEICE, vol. 4, no. 1, pp. 12–22, January 2013.

.

[75] **Error analysis of an inverse problem of a stochastic differential equation arising from an empirical modelling and its application**.

Naoto Nakano. JST PRESTO / Hokkaido University.

Abstract: We consider a method of empirical modelling for a dimensionality-reduced system of a nonlinear dynamical system based on the framework of the stochastic differential equation (SDE). Following the mathematical theorem corresponding to some inverse problem of the probability theory, we derive the empirically evaluating formulae for the drift and the diffusion coefficients of the SDE, and we obtain error analysis results for the resultant coefficients. Moreover, we compare the ensemble variance of solutions generated by the SDE to that of the trajectories of the projected orbit of the time-series. The results have a good agreement in the distribution of values of the ensemble variance and show the predictive ability of the SDE modelling.

[76] **Frustrated phases of diblock copolymers under three-dimensional confinement**.

Yasumasa Nishiura. Tohoku University.

Abstract: We study a set of coupled Cahn-Hilliard equations as a means to find morphologies of diblock copolymers in three-dimensional spherical confinement. This approach allows to find a variety of energy minimizers including rings, tennis balls, Janus balls and multipods among several others. Phase diagrams of confined morphologies are presented. We modify the size of the interface between microphases to control the number of holes in multipod morphologies. Comparison to experimental observation by transmission electron microtomography of multipods in polystyrene-polyisoprene diblock copolymers is also presented.

[77] **Inverse problem from persistence diagrams to point clouds**.

Ippei Obayashi. Tohoku University.

Abstract: Using the idea of Topological Data Analysis (TDA), we can analyze data from the viewpoint of topology and geometry. Persistent homology is a main tool of TDA, and persistence diagrams are used to visualize the information of persistent homology. Persistence diagrams have quantitative geometric information of the data. Normally, persistence diagrams are computed from point clouds (finite points in an euclidean space) and we examine the diagrams to clarify the geometric features of the data. We consider the problem of computing the point cloud data whose diagram is the given diagram. We call this problem “Inverse problem” from a persistence diagram to a point cloud. Since a persistence diagram has only the reduced geometric information of a point cloud, the inverse problem has no unique solution. To solve the problem of

uniqueness, we formalize the inverse problem as an optimization problem. In the optimization problem, we require two inputs, "the initial point cloud" and "the target persistence diagram", and we try to compute the point cloud whose diagram fits the target persistence diagram closest to the initial point cloud. I will show you numerical methods to solve the optimization problem. The mathematical key is the differentiability of the map from point clouds to persistence diagrams. The new methods will be useful to analyze the time series of a point cloud and to design the atomic configurations of materials from the viewpoint of persistence diagrams. The result is shown in the paper [1]. [1] M. Gameiro, Y. Hiraoka, and I. Obayashi. Continuation of point clouds via persistence diagrams. Physica D, in press. `http://dx.doi.org/10.1016/j.physd.2015.11.011`.

[78] **Steady-states of the generalized Constantin–Lax–Majda equation**.

Hisashi Okamoto. Kyoto University.

Abstract: Steady-states of the generalized Constantin–Lax–Majda equation with viscosity and external force are computed by the spectral method. This equation is regarded as a model for two-dimensional turbulent motion for incompressible viscous fluid. At high Reynolds number, we found a steady-state which exhibits power laws in two intervals of wave numbers, one in higher and the other in lower waves numbers. Interpretation of this solution via the cascade theory of 2D turbulence will be presented.

[79] **Staggered Grid Scheme for Simulation of Interfacial Wave**.

Aulia Oktavia. Institut Teknologi Bandung.

S.R Pudjaprasetya. Institut Teknologi Bandung.

Abstract: Internal waves are waves in the interior of the ocean. Due to differences of water temperature, salinity, and pressure, water column in the ocean is stratified in layers of fluid with different densities. The heavier fluid lays below the lighter fluid. In this paper, the water column is considered as two layers of fluid with constant density. Interfacial wave are waves that appear at the interface of this two layers of fluid. Here, the two layer shallow water equations (SWE) is considered, and the conditionally stable staggered grid scheme is implemented to simulate barotropic and baroclinic modes. The period of these external and internal modes conform the analytical periods. To validate the staggered scheme of the nonlinear SWE, several numerical simulations of interfacial dam break problem was conducted. Finally, the scheme is used to simulate a long interfacial waves propagate over a topography with shelf, simulating shoaling phenomena.

Keywords: interfacial wave, two layer shallow water equations, staggered scheme.

[80] **Shifted Power Method for computing H-eigenvalue of Symmetric Tensor**.

Jianyu Pan. East China Normal University.

Abstract: We propose a shifted symmetric higher order power method for computing the H-eigenvalues of a real symmetric even-order tensor. The local convergence of the method is given. In addition, by utilizing the fixed point analysis, we can characterize exactly which H-eigenvalue can be found and which cannot be found by the method. Numerical examples are presented to illustrate the performance of the method.

[81] **Computational Mathematics for Home Industries in Indonesia**.

Hanna Arini Parhusip. Satya Wacana Christian University.

M.R.S. Shanti.

Abstract: Computational mathematics in the sense of innovation on curves and surfaces are presented here where the obtained designed are used to be innovation of home industries in Indonesia. The mathematical technique relies on generalization of circle and ball equations i.e. for a generalization of circle equation and generalization of ball equation. The generalization is based on varying the exponent in the equations of circle and ball. For some values of p, families of curves and surfaces are found defined by the real part of (x,y) and (x,y,z) respectively. Other parametric curves are also studied here, i.e. 2 dimensional hypocycloid curves into hypocycloid surfaces for various values of parameters. The derivatives of the equations are also considered to be the new curves and surfaces. The curves and surfaces are then constructed into objects by printing the curves into some media (such as bags and glass) and creating the surfaces into ornaments. All are obtained by presenting the equations into spherical coordinates. There are about 12 home industries around the Salatiga city involving on these innovation.

2010 Mathematics Subject Classification: *65D17,78A55,00A06*

Keywords: *Hypocycloid, complex mapping, spherical coordinates, ornaments, surface area.*

.

[82] **Valuation of Basket Options under Variance Gamma Process**.

Ferry Jaya Permana. Universitas Katolik Parahyangan.

Dharma Lesmono. Universitas Katolik Parahyangan.

Erwinna Chendra. Universitas Katolik Parahyangan.

Abstract: Investment using a portfolio of several assets are preferable by companies and investors to reduce the risk. A basket option, that is an option whose portfolio as the underlying asset, is becoming a good choice to protect their portfolio. We will model the value of the basket option by assuming the log return of each asset follows the Variance Gamma process. Such a model is more realistic than model assuming the log return of each asset follows the Geometric Brownian motion. Performance of the model will be investigated by comparing the obtained prices to the prices obtained by the Monte carlo simulation.

Keywords: Valuation, basket option, Variance Gamma Process.

[83] **Finite Volume Method for Traffic Flow with Exits-Entrances**.

Sri Redjeki Pudjaprasetya. Institut Teknologi Bandung.

Abstract: We consider a macroscopic study of traffic dynamics, in which traffic flow on a roadway is considered as a continuum governed by the kinematic LWR model with basic variables: flow rate, traffic density, and travel speed. Traffic density in a road containing exits and entrances from a junction is calculated here by applying the upwinded finite volume numerical method. We first test the validity and convergence rate of the procedure using known exact solutions of the LWR model; both shock wave and expansion fan cases are tested. We then use the procedure to simulate the flow of traffic along a road with exits and entries under both light and heavy density conditions. To avoid over capacity in the simulations with exits-entrances, and to preserve the positivity of traffic density, we need to employ a procedure, which is called a stop-go procedure. The resulting numerical traffic density is shown to confirm the analytical solution. With a good numerical algorithm at hand, we simulate various traffic dynamics in a roadway with exits-entrances.

[84] **A Runge-Kutta Gegenbauer Spectral Method for Reaction-Diffusion Equation**.

Haidong Qu. Shantou University.

Abstract: In this paper, a new Runge-Kutta Gegenbauer spectral method is introduced to solve the two-dimensional Riesz space fractional nonlinear reaction-diffusion equation. The temporal component is calculated by the Runge-Kutta method. The convergence for the derived method is analysised, which shows that the present method is convergent of order 4 in time. By adjusting the parameter of the Gegenbauer polynomial the boundary singularity is removed. This approach is used to solve the fractional FitzHugh-Nagumo model and the fractional Gray-Scott model. Numerical results are provided to verify effectiveness of the method.

[85] **On CSCS-based Iteration Method for Tempered Fractional Diffusion Equations**.

Wei Qu. Shaoguan University.

Abstract: Circulant and skew-circulant splitting iteration method is employed for solving linear systems from finite difference discretisation of tempered fractional diffusion equations. The method is shown to be convergent unconditionally and the convergence rate is fast in numerical tests. In each iteration, a circulant system and a skew-circulant system are required to be solved which cost only $O(N \log N)$ operations by fast Fourier transform, where N is the number of interior mesh points in space. Moreover, the induced preconditioner possesses circulant-times-skew-circulant structure so that it can be inverted in $O(N \log N)$ operation. In all of our numerical experiments, the preconditioner performs very well with a very simple choice of the method parameter.

[86] **Improved exponential stability of generalized neural networks with interval time-varing delay**.

Grienggrai Rajchakit. Maejo university.

Abstract: This paper scrutinizes the problem of exponential stability for a class of generalized neural networks (GNNs) with interval time-varying delays. The exponential stability criteria is proposed by establishing a suitable Lyapunov-Krasovskii functional and applying new analysis theory. The integral terms in the time derivative of the Lyapunov-Krasovskii functional are handled by the improved reciprocally convex combination approach (RCC) and a new weighted integral inequality (WII). A set of novel sufficient conditions is obtained to guarantee the exponential stability of generalized neural networks with interval time-varying delays. The obtained criterion shows the advantages over the existing ones. To verify the advantages and benefits of employing the proposed method is illustrated by numerical examples.

[87] **Image Enlargement Using Harmonic and Bihamonic Said-Ball Surface**.

Azizan Saaban. Universiti Utara Malaysia.

Abstract: This paper will discuss the use of harmonic and biharmonic cubic Said-Ball surfaces in image enlargement area. Resizing an image through up sampling or down sampling is generally common for making smaller image fit a bigger screen in full screen mode or reducing a higher resolution image to a smaller resolution. However due to some limitation, this paper will focus on image enlargement based on scaling factor of two. We use Harmonic and bihamonic cubic Said-Ball subject to a given two and four boundary curves condition respectively. We implement and evaluate the performance of the proposed method using well-known gray-scale test images.

[88] **Analysis of the invariant scheme for MFS in doubly-connected regions**.

Koya Sakakibara. The University of Tokyo.

Abstract: Let Ω be a nondegenerate doubly-connected region in the complex plane. That is, assume that there exist two disjoint connected components K_1 and K_2 such that $\hat{\mathbb{C}} \setminus \Omega = K_1 \sqcup K_2$, K_1 is unbounded, and neither K_1 nor K_2 is reduced to a single point. Then, we consider the following potential problem:

$$-\Delta u = 0 \text{ in } \Omega,$$
$$u = f_\mu \text{ on } \Gamma^\mu \ (\mu = 1, 2)$$

where $\Gamma^\mu = \partial K_\mu$ and f_μ is a given function defined on Γ^μ for each $\mu = 1, 2$. The aim of this talk is to develop a theory of the invariant scheme for MFS (I-MFS) for the potential problem in doubly-connected regions. I-MFS offers an approximate solution for the target problem, as given by the following procedure. (I) Take N points $\{y_{\nu k}\}_{k=1}^{N}$ in $\mathring{K}_\nu$ for each $\nu = 1, 2$. (II) Construct an approximate solution $u^{(N)}$ as follows:

$$u^{(N)}(x) = Q_0 + \sum_{\nu=1}^{2} \sum_{k=1}^{N} Q_{\nu k} E(x - y_{\nu k}),$$

where $E(x) = -(2\pi)^{-1} \log |x|$ is the fundamental solution of the operator $-\triangle$. (III) Determine the coefficients $\{Q_{\nu k}\}_{\nu=1,2}^{k=1,2,\ldots,N}$ using the collocation method. That is, take N points $\{x_{\mu j}\}_{j=1}^{N}$ on Γ^μ for each $\mu = 1, 2$, and impose the following boundary conditions:

$$u^{(N)}(x_{\mu j}) = f_\mu(x_{\mu j}) \quad (\mu = 1, 2;\ j = 1, 2, \ldots, N)$$

with the constraint

$$\sum_{\nu=1}^{2} \sum_{k=1}^{N} Q_{\nu k} = 0.$$

The above is one algorithm for I-MFS. We arrange $\{y_{\nu k}\}_{\nu=1,2}^{k=1,2,\ldots,N}$ and $\{x_{\mu j}\}_{\mu=1,2}^{j=1,2,\ldots,N}$ by using a peripheral conformal mapping, which is a conformal mapping in a neighborhood of the boundary of a region. Then we have

$$\|u - u^{(N)}\|_{H^s} = O(N^P \delta^{-N/2}),$$

where $\delta \geq 1$ and it becomes greater than 1 when the boundary data is analytic, and P is a real number and takes negative value when $\delta = 1$. Moreover, we will show the results of some numerical experiments, in order to exemplify the sharpness of our error estimate.

[89] **Regularity and singularity of the blow-up curve for a nonlinear wave equation**.

Takiko Sasaki. Waseda University.

Abstract: This talk considers the problem in pure mathematics (theory of nonlinear partial differential equations). However, a part of the strategy is taken from numerical analysis. We consider a blow-up curve for the one dimensional wave equation $\partial_t^2 u - \partial_x^2 u = |\partial_t u|^p$ with $p > 1$. The purpose of this talk is to show that the blow-up curve is a C^1 curve if the initial values are large and smooth enough. To prove the result, we convert the equation into a first order system, and then apply a modification of the method of Caffarelli and Friedman (1986). Moreover, we present some numerical investigations of the blow-up curves. From the numerical results, we were able to confirm that the blow-up curves are smooth if the initial values are large and smooth enough. Moreover, we can predict that the blow-up curves have singular points if the initial values are not large enough even they are smooth enough.

[90] **On the dynamics of a structure preserving flow of symplectic matrix pairs**.

Shih-Feng Shieh. National Taiwan Normal University.

Abstract: We construct a nonlinear differential equation of matrix pairs $(\mathcal{M}(t), \mathcal{L}(t))$ that is invariant (the **Structure-Preserving Property**) in the class of symplectic matrix pairs. Its solution also preserves invariant subspaces on the whole orbit (the **Eigenvector-Preserving Property**). Such a flow is called a *structure-preserving flow* and is governed by a Riccati differential equation (RDE). In addition, Radon's lemma leads to the explicit form of the solution. Therefore, blow-ups for the structure-preserving flows may happen at a finite t whenever $Q(t)$ is singular. To continue, we then utilize the Grassmann manifolds to extend the domain of the structure-preserving flow to the whole $\mathbb{R}$ subtracting some isolated points. On the other hand, the Structure-Preserving Doubling Algorithm (SDA) is an efficient numerical method for solving algebraic Riccati equations and nonlinear matrix equations. In conjunction with the structure-preserving flow, we consider the following two special classes of symplectic pairs: $\mathbb{S}_1 = \mathbb{S}_{I_{2n}, I_{2n}}$ and $\mathbb{S}_2 = \mathbb{S}_{-I_{2n}, \mathcal{J}}$ and the corresponding algorithms SDA-1 and SDA2. It is shown that at $t = 2^{k-1}, k \in \mathbb{Z}$ this flow passes through the iterates generated by SDA-1 and SDA-2, respectively. Therefore, the SDA and its corresponding structure-preserving flow have identical asymptotic behaviors, including the stability, instability, periodicity, and quasi-periodicity of the dynamics.

[91] **Solutions to discrete hungry integrable systems and their asymptotic expansions**.

Masato Shinjo. Kyoto University.

Abstract: Two types of the discrete-time hungry Lotka-Volterra systems are originally derived from a skillful discretization, which differs from, for example, simple Euler dis-

cretization, of the hungry Lotka-Volterra systems describing predator-prey interactions in mathematical biology. An inverse ultra-discretization of a numbered box-ball system also leads to a discrete-time hungry integrable system named the discrete-time hungry Toda equation. There also exists another type of the discrete-time hungry Toda equation. Of course, the discrete-time hungry Toda equations and Lotka-Volterra systems can be regarded as extensions of the famous discrete-time Toda equation and Lotka-Volterra system, respectively. The iterative discrete-time evolutions in the discrete-time hungry integrable systems are already shown to generate sequences of similarity transformations of totally nonnegative (TN) matrices whose minors are all positive. As discrete-time goes to infinity, the Hessenberg matrices converge to triangle matrices whose diagonal entries are just the eigenvalues. Numerical algorithms for TN matrices have been thus designed based on the discrete-time hungry integrable systems. It is worth noting that these algorithms potentially compute eigenvalues of even the Hessenberg matrices not having TN properties. In this talk, we derive the determinant solution to the discrete-time hungry integrable systems from investigating a certain infinite sequence, and then clarify that the algorithms based on the discrete-time hungry integrable systems can be applied to eigenvalue problems of the Hessenberg matrices regardless of TN properties. Moreover, we show the convergence of the extended algorithms through giving asymptotic expansions of variables in the discrete-time hungry integrable systems as discrete-time variable goes to infinity.

[92] **Time-Stepping numerical schemes for three-dimensional viscous primitive equation**.

Ming-Cheng Shiue. National Chiao Tung University.

Abstract: In this talk, three-dimensional viscous primitive equations are considered. Primitive equations are also called hydrostatic Navier-Stokes equations which are the governing equations of the motion of flows in geophysical fluid dynamics. The global in time strong solution for these models has been established by Cao and Titi and Kobelkov independently. In this talk, several time-stepping numerical schemes have been studied. We are interested in the study and discussion of the long-time stability of these numerical schemes, which is important for the study of the climate. In this talk, we will begin with giving an introduction to the primitive equations, and then present the semi-discretized schemes and analyze and discuss these numerical schemes. This talk is based on the joint work with Chun-Hsuing Hsia.

[93] **On the way how to improve Local Projection Stabilization**.

Piotr Skrzypacz. Nazarbayev University.

Abstract: Composite finite elements and novel postprocessing based on the local L_2 projection are proposed in order to improve the standard one-level Local Projection Stabilization (LPS) on quadrilateral meshes, cf. [1,2,3]. Theoretical results are justified by several tests for convection-dominated problems in two dimensions. Numerical results show that the discrete solution is oscillation-free and of optimal accuracy in the regions away from the boundary layer whereas the spurious oscillations are significantly reduced near the boundary layers when the postprocessing is applied.

References

[1] Matthies Gunar, Skrzypacz Piotr, and Tobiska Lutz, *A unified convergence analysis for local projection stabilisations applied to the Oseen problem.* M2AN Math. Model. Numer. Anal., 41(4):713-742, 2007.

[2] Matthies Gunar, Skrzypacz Piotr, and Tobiska Lutz, *Stabilization of local projection type applied to convection-diffusion problems with mixed boundary conditions.* Electron. Trans. Numer. Anal. 32 (2008), 90105.

[3] Schieweck Friedhelm and Skrzypacz Piotr, *A local projection stabilization method with shock capturing and diagonal mass matrix for solving non-stationary transport dominated problems.* Comput. Methods Appl. Math. 12 (2012), no. 2, 221240.

.

[94] **A remark on the mathematical formulation for the immersed boundary method**.

Yoshiki Sugitani. The University of Tokyo.

Abstract: The immersed boundary method was first introduced by Peskin and has evolved into a generally useful method for problems of fluid-structure interaction. Its mathematical formulation is characterized by the Dirac delta function supported on an immersed fiber or surface to capture the interaction between a dynamically evolving elastic membrane and the incompressible fluid in which it is immersed. As a result, we come to consider the Navier-Stokes equations under the outer force

$$f(x,t) = \int F(\theta,t)\delta(x - X(\theta,t))\ d\theta$$

where F stands for the elastic force density and X denotes the configuration of the elastic materials at time t and the Lagrangian coordinate θ defined on the immersed boundary. For numerical computations, f is approximated to a smooth function f^ε with a regularization of the Dirac delta δ_ε. As $\varepsilon \to 0$, however, f^ε never converges to f in the dual space of usual Sobolev space H_0^1. In order to tackle this problem,

I introduce another formulation to express the immersed boundary effect with the characteristic function χ instead of the Dirac delta by $f = g(\nabla\chi \cdot n)$ where g stands for the elastic force and n is the unit outer normal vector to the immersed boundary. Then, we can easily show the existence of a approximated function f^{ε} satisfying that $f^{\varepsilon} \to f$ in H^{-1} as $\varepsilon \to 0$. In this talk, I will show some mathematical and numerical results such as the error estimates for a model Stokes problem.

[95] **On the Global Controllability of Planar Polynomial Systems**.

Yimin Sun. Sun Yat-Sen University.

Abstract: In this report, we will introduce some recent results on the global controllability of nonlinear systems. A class of planar affine polynomial systems will be considered. We assume that the control curves of the systems can be described by a polynomial function. A constructive criterion algorithm for the global controllability is obtained.This algorithm is imposed on the coefficients of polynomials only and the analysis is based on some fundamental results in real algebraic geometry, including Sturm theorem and real roots isolation and classification. By this algorithm, we can determine in finite steps arithmetic operations whether or not a planar polynomial system is globally controllable.

[96] **An Implement of Minimum Action Method for Sharp Corner**.

Yiqun Sun. City University of Hong Kong.

Abstract: Minimum action method has been efficient in finding minimum action path in both gradient and non-gradient systems. However, notice that sometime the minimum action path may not be smooth at the critical points, this will cause problem in accuracy of numerical solution. We made some implementation on geometric minimum action method ,using Weighted Essentially non-oscillatory (WENO) method and moving mesh strategy, to get high order accurate solution.

Keywords: Minimum Action Method, transition path, WENO, moving mesh strategy.

[97] **Modeling and Simulation of Hybrid Dynamic of Autonomous System with Several Restricted States Avoidance Scenario**.

Sutrisno. Diponegoro University.

Abstract: In this paper, we formulate and simulate a hybrid dynamic in the piecewise affine model of an autonomous system that has discrete linear time invariant dynamic to avoid several restricted areas simultaneously. This avoidance scenario will be formulated, by labeling the normal area mode and the restricted area mode, as

a piecewise-affine model governed by these two modes. We use model predictive control method to generate the optimal input and optimal trajectory from some initial state/position to the given target/final state/position so that this autonomous system avoids the given several restricted areas with minimal effort and reaches the target state. From the simulation results, for two dimensional state, the given autonomous system reaches the target position and avoids the given restricted areas with optimal trajectory.

[98] **A Generalized Particle Method for Convection-Diffusion Equations**.

Daisuke Tagami. Kyushu University.

Abstract: A generalized particle method is considered for convection-diffusion equations. In Imoto–Tagami (JSIAM Letters, to apear), the generalized particle method has been introduced as a class of particle methods, which can describes Smoothed Particle Hydrodynamics (SPH), Moving Particle Semi-implicit (MPS), and others, and the truncation error estimate has been established. Moreover, in Imoto–Tagami (Proc. of the Fourth Conference on Particle-Based Methods (PARTICLES2015), Barcelona, Sep. 2015), error estimates of the generalized particle method for the Poisson equation and the heat equation have been introduced. Our goal is to construct of mathematical frameworks of particle methods, and this paper is regarded as the next step toward our goal. At this step, the particle motions is considered, which play a key role in practical computational fluid dynamics with particle methods. In general, the particle motions cause particle distributions unevenness and numerical schemes instability. To overcome this difficulties, the Lagrange–Galerkin characteristic starategy (see, for example, Pironneau (Numer. Math., vol.38 (1982), pp.309–332), and Notsu–Tabata (ESAIM: M2AN, to appear)), is introduced into numerical schemes. The Lagrange–Galerkin characteristic starategy does not require particle redistributions in our numerical scheme and solves numerical instabilities of the scheme. Some mathematical and numerical investigations are shown to confirm the effectiveness of our strategy.

[99] **Potential theoretic approach to approximation in weighted Hardy spaces**.

Ken'ichiro Tanaka. Musashino University.

Tomoaki Okayama. Hiroshima City University.

Masaaki Sugihara. Aoyama Gakuin Univerisity.

Abstract: We propose a method for designing accurate interpolation formulas on the real axis for the purpose of function approximation and numerical integration in weighted Hardy spaces. We consider the Hardy space of functions that are analytic in a strip region around the real axis, being characterized by a weight function w that

determines the decay rate of its elements in the neighborhood of infinity. Such a space is considered as a set of analytic functions that are transformed by variable transformations that yield a certain decay rate at infinity. So far, interpolation by sinc functions is a representative way for approximating the functions in the space. However, it is not guaranteed that the sinc formulas are optimal. In this research, we adopt a potential theoretic approach to obtain almost optimal formulas in weighted Hardy spaces in the case of general weight functions w. We formulate the problem of designing an optimal formula in each space as an optimization problem written in terms of a Green potential with an external field. By solving the optimization problem numerically, we obtain an almost optimal formula that outperforms the sinc formulas. Furthermore, we apply the approach to obtain accurate formulas for numerical integration. This is a joint work with Dr. Tomoaki Okayama (Hiroshima City University) and Prof. Masaaki Sugihara (Aoyama Gakuin Univerisity).

[100] **Estimating the leading coefficient of trunction errors**.

Jengnan Tzeng. National Chengchi University.

Abstract: Estimating errors in numerical analysis is an important task. We try to balance the rounding error and truncation error to make the best numerical result. Most of the time, we can use the Taylor expression to analyze the order of truncation error and it is usually expressed by the big O notation, say, $E(h) = O(h^k) = Ch^k$. Since the leading coefficient C often contains the factor $f^{(k)}(\xi)$ for some higher order k and some unknown ξ, the leading coefficient C is not estimated easily. We will propose a regression method to estimate the leading coefficient C. This accurate estimation will make the error control easier.

[101] **An error estimate of the successive projection methods by B-spline**.

Yuki Ueda. The University of Tokyo.

Abstract: We present a stability and error analysis of the successive projection technique with B-spline functions. The successive projection technique (SPT) with B-spline was introduced by K.Takizawa and T.E.Tezduyar in 2013. Successive projection methods allow us to construct a projection by several small projections, and this construction has an advantage of avoiding a large computation. SPT with B-spline propose to convert a function into the representation by B-spline, that is a piecewise polynomial with some smoothness on the breakpoints. The degrees of freedom of B-spline functions is small, therefore we can deal with the data efficiently. SPT with B-spline can be applied to the approximate solution of the space-time finite element methods. In the space-time finite element formulations, the discretization in time based on discontinuous Galerkin methods, and governing equations are solved on the space-time slab, which is the slice of space-time domain between two time steps. The basis functions are discontinuous between different slabs, and the discontinuity produce the gradual computation of the system. We obtain the approximate solution that is discontinuous, and then we apply the SPT with B-spline to it. Actually, the SPT with B-spline uses only a part of approximate solution in each small projection, therefore SPT computation can be executed in parallel with the space-time finite element computation. We present the stability property of SPT with B-spline, and the error estimate can be introduced by the stability. Moreover, we show numerical examples of application to the simple space-time finite element methods.

[102] **The role of the linear instability in the transition of channel flow**.

Darren Wall. Nippon Bunri University.

Abstract: The explanation of the transition of shear flows from laminar to turbulent regimes remains one of the central problems of fluid dynamics. Unlike other canonical flows, such as pipe or plane Couette flows, channel (Poiseuille) flow becomes unstable to infinitesimal disturbances at a finite value of the Reynolds number, R. While it is known that this linear instability is bypassed in practical situations, the role of the nonlinear secondary flows that bifurcate from the linear neutral stability points, and the higher-order flows that in turn bifurcate from these flows, remains an open question. As a first step towards understanding this problem the previous study of this problem by Ehrenstein & Koch (JFM, 1991) is reconsidered. These authors identified two tertiary flows, which they labelled '$M^{(n,2m)}$' and '$M^{(n,m)}$', with the conclusion that the former of these could exist down to values of R at which transition is first observed in channel flows, with friction factor values that correspond to experimental values. However, the present study reveals that the $M^{(n,2m)}$ does not exist as a separate solution of the governing Navier-Stokes equations, rather it is another instance of a $M^{(n,m)}$ flow. Furthermore, the corresponding $M^{(n,m)}$ flow cannot exist below values of R that are more than double the value at which transition is first observed, and has friction factors that are an order of magnitude smaller than the experimentally observed values. This study will also consider the connections between secondary, tertiary and quarternary flows derived from the linear instability with flows that have been recently been discovered (Wall& Nagata JFM 2016, Gibson & Brand JFM 2014, Nagata & Deguchi JFM 2013) independently of this instability.

[103] **Estimation of regularized parameter in proximity algorithms for image denoising**.

Chao Wang. The Chinese University of Hong Kong.

Abstract: We consider image denoising by using proximity algorihthms [C.A. Micchelli, L. Shen and Y. Xu, Inverse Prob. 27(2011) 045009 (30pp)], which have a regularized parameter. A new way to choose a suitable regularization parameter based on the normalized cumulative periodogram (NCP) is presented by using the two-dimensional discrete cosine transform. Numerical results show that these methods are efficient and competitive.

[104] **An efficient threshold dynamics method for wetting on rough surfaces**.

Dong Wang. Hong Kong University of Science and Technology.

Abstract: The threshold dynamics method developed by Merriman, Bence and Osher(MBO) is an efficient method for simulating the motion by mean curvature flow when the interface is away from the solid boundary. Direct generalization of the MBO type method to the wetting problems with interface intersecting the solid boundary is not easy because solving heat equation on general domain with wetting boundary condition is not as efficient as that for the original MBO method. The dynamics of the contact point also follows a different dynamic law compared to interface dynamics away from the boundary. In this paper, we develop an efficient volume preserving threshold dynamics method for wetting on rough surfaces, which is based on minimization of the weighted surface area functional over a extended domain that includes the solid phase. The method is simple, stable with the complexity $O(NlogN)$ per time step and it is not sensitive to the inhomogeneity or roughness of the solid boundary.

[105] **Unconditionally optimal error estimates of Crank-Nicolson Galerkin FEMs for nonlinear parabolic system**.

Jilu Wang. Renmin University of China.

Abstract: In this talk, we present unconditionally optimal error estimates of linearized Crank- Nicolson Galerkin FEMs for the following nonlinear parabolic system

$$c(x,u)u_t - \nabla \cdot (a(x,u)\nabla u) = f(x,u)$$

while all previous works required certain time-step conditions. To overcome the difficulty caused by the nonlinear capacity term, theoretical analyses are given in two different cases, i.e., $\tau \leq h$ or $\tau \geq h$. Here, τ denotes the time step and h is the mesh size. If $\tau \leq h$, we prove optimal L^2 and H^1 error estimates by mathematical induction, inverse inequality and other techniques. However, there are few methods to deal with the nonlinearity of the capacity coefficient if $\tau \geq h$ and numerical solutions cannot be bounded by inverse inequality directly. In such case, we introduce a time-discrete system and the error is split into two parts. With rigorous analyses of the time-discrete

system and corresponding projection operator, we prove that the L^2 error bound of the fully discrete numerical scheme to the time-discrete system is dependent on both h^2 and τh. By using some new approaches, the uniform boundedness of numerical solutions can be obtained. Then, optimal error estimates follow immediately. Numerical examples are given and confirm our theoretical results.

[106] **Traditional and non-traditional FEM for solving interface problems**.

Liqun Wang. China University of Petroleum-Beijing.

Abstract: Interface problems occur frequently when two or more materials meet. The difficulty of solving interface problems is how to capture complex interface geometry and jump conditions effectively while the PDE is not valid across the interface. I am going to discuss the non-traditional finite element method for solving the elliptic, parabolic and elasticity interface problems, even on multiple domains. Also, I am going to show some of my recent results for solving the two dimensional nonlinear interface problems using traditional finite element method.

[107] **Some Differential Equation Models for Nonlinear Materials Applications**.

Dongming Wei. Nazarbayev University.

Abstract: Several nonlinear DEs arising in modeling of structures made of nonlinear materials are presented in the context of continuum mechanics. Analytic solutions of some spring-mass equations associated with the PDEs are presented in terms of generalized trigonometric functions. Analysis and numerical solutions of some of the initial and boundary value problems are also presented, including nonlinear eigenvalue problems and that of some nonlinear wave equations. Open problems and challenges for modeling of structural nonlinear materials without a well-defined yield are discussed.The materials include graphene, polyimide, Titanium alloy, and bio-material such as corneal, scleral and lamina cribrosa with applications in MEMS as well as in conventional engineering industries.

[108] **Normal Mode Analysis for Micro-scale Flows in Special Domains and Applications**.

Xiaoyu Wei. Hong Kong University of Science and Technology.

Abstract: In this work, we consider micro-scale flows modeled by the Stokes equation, subject to Navier slip boundary conditions, within a periodic channel. Eigenfunctions of the system are explicitly calculated. Compared to known results for non-slip case, the eigenvalues of the system are shifted due to the slip boundary. Several applications of the results are discussed, including stability analysis for numerical schemes and determining hydrodynamic boundary conditions from equilibrium fluctuations.

[109] **GENERALIZED TENSOR EIGENVALUE PROBLEMS**.

Yimin Wei. Fudan University.

Abstract: This talk is devoted to generalized tensor eigenvalue problems. We focus on the properties and perturbations of the spectra of regular tensor pairs. Employing different techniques, we extend several classical results from matrices or matrix pairs to tensor pairs, such as the Gershgorin circle theorem, the CollatzWielandt formula, the BauerFike theorem, the RayleighRitz theorem, backward error analysis, the componentwise distance of a nonsingular tensor to singularity, etc. Some of these results preserve their original forms, while others change when being extended.

[110] **A Semismooth Newton Method for Uniform Noise Removal with Linfty-norm Constraint**.

Youwei Wen. Kunming University of Science and Technology.

Abstract: The problem of uniform noise removal is considered in this paper. In maximum a posteriori approach, the problem can be formulated as an L_∞-norm constrained minimization problem. There are two key issues in solving the minimization problem: the first one is to estimate the noise level and the second one is to develop an efficient numerical scheme to cope with the numerical difficulty due to the non-differentiability of the L_∞-norm. In this paper, a two-stage approach is proposed to handle the problem of uniform noise removal. The first stage is to estimate the noise level by the method of moments. The second stage is to solve the L_∞-norm constrained minimization problem for given noise level. We derive the optimality conditions for the minimization problem and then apply semi-smooth Newton method to compute the solution of the optimality system. Numerical results show the proposed method is efficient and outperforms the state-of-the-art method.

[111] **Statistical Condition Estimation of Large-Scale Generalized Eigenvalue Problems**.

Peter Chang-Yi Weng. Institute of Statistical Science, Academia Sinica.

Abstract: We consider the evaluation of the sensitivity or condition number of (generalized) eigenvalue problems for a large and sparse real matrix (or matrix pair) in $\mathbb{R}^{n\times n}$, through some (coupled) Sylvester equation using Newton's method. The technique of the statistical condition estimation has been adapted to the sensitivity of symmetric matrices as well as general matrices with special structures under some assumptions on various types of perturbations.

[112] **A pipeline for 3D image processing based on landmark matching**.

Chin-Tien Wu. National Chiao Tung University.

Abstract: Due to the advance of 3D sensing technology, processing 3D sensing data and generating realistic 3D images become more and more important espe- cially in the applications such as VR (virtual reality) and AR (augmented reality), etc. Some of the major challenges on 3D image processing includes (i) efficiently manage huge amount of data generated by scanner, (ii) merg- ing 3D point data from various sensors and (iii) calibrating color maps for different color sensors. Recently, Gu and Yau propose to compress the data using mean curvature H and conformal factor λ. In this work, we follow Gu and Yaus idea and further apply it to 3D surface morphing and retargeting where matching landmark points on parametric domains, interpolating (H, λ) for generating remaining frames, and reconstructing 3D geometry and texture are essential. To dealt with point data merging and color calibration, we employee the ICP (iterative closest point) type of rigid registration and calibrate the color variations in the LAB color space. In this talk, we shall briefly review the theory of conformal global parametriza- tion, the quaternion registration methods and optimization methods for color calibration. We shall also introduce the geodesic spline landmark matching using discrete Green function built by HCT finite element. Some of our numerical results will also be shown.

[113] **Multi-period M-V Asset-Liability Portfolio Selection with correlated returns**.

Xianping Wu. South China Normal University.

Abstract: In this talk, we tackle the multi-period mean-variance portfolio of asset-liability management where the returns of risky assets themselves and liability are statistically correlated among different time periods. We adopt a formulation with a general form of correlation but not assuming a particular stochastic process to model the correlation which better matches the real markets. For the random variables whose distribution are unknown, we use approximated ones to calculate their expectations of functions. Analytical optimal strategies and efficient frontiers are derived accurately and the numerical examples are presented to shed light on the results established in this work.

[114] **A Fast Algorithm for Solving Circulant Tensor Systems**.

Ze-Jia Xie. University of Macau.

Abstract: A new definition for circulant tensors is given, which is a generalization of the one for circulant matrices. Furthermore, we define the generalized circulant tensors which can be diagonalized by the Fourier matrix F and/or F^*. We also consider

solving the circulant tensor systems by a fast algorithm based on the fast Fourier transform. Such algorithm is similar to that for circulant linear systems and it can also be performed in $O(n \log n)$.

[115] **A study of the neural network of C. elegans: from structure to clustering**.

Murong Xu. West Virginia University.

Abstract: The neural network of the nematode Caenorhabditis elegans is one of the best studied organisms in biology. A neuron can be thought of as a unit that accepts a number of inputs, either excitatory or inhibiting, combines them, and generates an output result that is sent to one or more further neurons. In other words, the neural network can thus be represented as a set of vertices, the neurons, connected by two types of directed edges, one for excitatory inputs and one for inhibiting inputs. Despite recent interest in studying the structure of the neural network of C. elegans, discovering more precise properties in network terms are still important. Using the most current C. elegans wiring diagram (280 nonpharyngeal neurons (CANL/R were excluded since they have no obvious synapses), covering 6393 chemical synapses, 890 electrical junctions, and 1410 neuromuscular junctions), we propose a new method of detecting clusters for directed networks (QCM). We calculate statistical and topological properties of the network, such as laplacian centrality, a wavelet view of small-world properties and its robustness. Finally, we analyze the functional segregation and "rich clubs" from clustering and attacking the network and thus, reveal the functional mechanism of C. elegans neural network.

[116] **Efficient Convergent Lattice Method for Asian Options Pricing with Superlinear Complexity**.

Wei Xu. Tongji Univeristy.

Abstract: Asian options have payoffs that depend strongly on the historical information of the underlying asset price. Although approximated closed form formulas are available with various assumptions, most them do not guarantee the convergence. Thus, binomial tree and PDE methods are two popular numerical solutions for pricing. However, either the PDE method or binomial tree method has the complexity of $O(N^2)$ at least, where N is the number of time steps. In this paper, we propose a first convergent lattice method with the complexity of $O(N^{1.5})$ based on the willow tree method. The corresponding convergence rate and error bounds are also analyzed. It shows that our proposed method can provide the same accuracy as the PDE and binomial tree methods, but requires much less computational time. When a quick pricing is required,

our method can give the price with precision in a penny less than half second. Finally, numerical results support our claims.

[117] **Solution of a nonlinear eigenvalue problem using signed singular values with application to the scaling exponent computation in 2-dimensional turbulent flow**.

Yusaku Yamamoto. The University of Electro-Communications.

Abstract: We propose a robust numerical algorithm for solving the nonlinear eigenvalue problem $A(\lambda)\mathbf{x} = \mathbf{0}$. Our algorithm is based on the idea of finding the value of λ for which $A(\lambda)$ is singular by computing the smallest eigenvalue or singular value of $A(\lambda)$ viewed as a constant matrix. To further enhance computational efficiency, we introduce and use the concept of signed singular value. Our method is applicable when $A(\lambda)$ is large and nonsymmetric and has strong nonlinearity. Numerical experiments on a nonlinear eigenvalue problem arising in the computation of scaling exponent in 2-dimensional turbulent flow show robustness and effectiveness of our method.

[118] **Trading Strategy under Regime-Switching Jump-Diffusion Models in LOBs**.

Qingqing Yang. The University of Hong Kong.

Abstract: We discuss an optimal trading strategy of an investor who has a certain quantity shares to sell within a given time horizon in a Markov-modulated jump-diffusion model. We illustrate how the trading strategy is altered due to the possibility of potential regime shifts, which depend on the degree of information leakage at the beginning of the trading day. In particular, we consider three different cases: one without regime shifts, one with exactly one regime shift and one with no more than one regime shift. The impacts of information leakage on investors behavior are highlighted. We also extend our model to consider the impact of information delay on the trading strategy.

[119] **IAS scheme for strongly coupled systems of convection-diffusion equations**.

Suh-Yuh Yang. National Central University.

Abstract: This paper is devoted to developing the Il'in-Allen-Southwell (IAS) parameter-uniform difference scheme for solving strongly coupled systems of singularly perturbed equations of convection-diffusion type, whose solutions may display strong boundary and/or interior layer behavior, where the strong coupling means that solution components in the system are coupled together mainly through their first derivatives in the convection terms. By decomposing the coefficient matrix of convection term into the Jordan canonical form, we first construct the IAS scheme for 1-D systems and then

extend the scheme to 2-D systems by employing an alternating direction technique. The robustness of the developed IAS scheme is illustrated through a series of numerical examples. The numerical evidence indicates that when the perturbation parameter is small, the developed IAS scheme is first order convergent in the discrete maximum norm uniformly in the perturbation parameter on uniform meshes.

[120] **Low order finite difference scheme of Serre-Green-Naghdi equations**.

Hidenori Yasuda. Josai University.

Abstract: Serre-Green-Naghdi(S-GN) equations, a second order shallow water (SW) equations with dispersion, is used to study breaking waves on the beach.

$$h_t + (hu)_x = 0$$

$$u_t + gh_x + uu_x = \frac{1}{3h}\frac{\partial}{\partial x}\left[h^3\left(u_{xt} + uu_{xx} - (u_x)^2\right)\right]$$

We propose a low order finite difference scheme to reduce computational cost and that reflects the some physical property of S-GN eq.

S-GN eq. consists of two parts, SW eq. and dispersion. In coastal engineering, numerical methods of operator splitting and high order scheme are developed. For operator splitting, Strang splitting is usually used, however, that is not robust to treat boundary condition. And complicated Riemann solver for SW eq. and fourth order Runge-Kutta method for the dispersion term are usually adopted. However, S-GN eq. is not an equation representing the first principle, which is derived ignoring high order terms when averaging horizontal velocity. From the view point of computation cost, low order scheme is favorable for the problems that require parameter runs in the case of coating process simulations. For fluid dynamics, invariance under Galilei transformation and similarity transformation is important. At first, the difference of invariance between SW eq. and S-GN eq. is investigated using infinitesimal operators of transformations. Then, in order that the modified equation of numerical scheme allows the same invariance, a scheme which consists of invariant finite difference scheme for SW eq. and Heun method for dispersion is proposed. The calculation of dispersion term requires inversion of linear equation. Modification to circumvent inversion is also proposed. And, the scheme is applied to the broken dam problem to investigate similarity of the scheme.

[121] **A Hölder estimate for non-uniform elliptic equations in a random medium**.

Li-Ming Yeh. National Chiao Tung University.

Abstract: Uniform regularity for second order elliptic equations in a highly heterogeneous random medium is concerned. The medium is separated by a random ensemble of simply closed interfaces into a connected sub-region with high conductivity and a disconnected subset with low conductivity. The elliptic equations, whose diffusion coefficients depend on the conductivity, have fast diffusion in the connected sub-region and slow diffusion in the disconnected subset. Without a stationary-ergodic assumption, a uniform Hölder estimate in $\omega, \epsilon, \lambda$ for the elliptic solutions is derived, where ω is a realization of the random ensemble, $\epsilon \in (0, 1]$ is the length scale of the interfaces, and $\lambda^2 \in (0, 1]$ is the conductivity ratio of the disconnected subset to the connected sub-region. Results show that if external sources are small enough in the disconnected subset, the uniform Hölder estimate in $\omega, \epsilon, \lambda$ holds in the whole domain. If not, it holds only in the connected sub-region. Meanwhile, the elliptic solutions change rapidly in the disconnected subset.

[122] **Self-Gravitational Force Calculation of Infinitesimally Thin Gaseous Disks**.

Chien-Chang Yen. Fu Jen Catholic University.

Abstract: Investigating the evolution of disk galaxies and the dynamics of protostellar disks can involve the use of both a hydrodynamical and a Poisson solver. These systems are usually approximated as infinitesimally thin disks using two-dimensional Cartesian or polar coordinates. We will present a direct algorithm for calculating self-gravitational forces with second order accuracy without artificial boundary conditions. With the help of convolution representation and fast Fourier transform, the numerical computational complexity is nearly linear.

[123] **An uncertainty quantification framework for the achievability of backtesting results of trading strategies**.

Lane Chun Lanston Yeung. The Chinese University of Hong Kong.

Abstract: Backtesting has always been an indispensable component in analyzing the profitability of trading strategies in empirical finance literature. When measuring return, while the majority of literature implicitly assumes that a trade can be implemented at the same closing price as the one generating the trading signal, others find empirical evidence suggesting that this assumption presents a significant challenge to the robustness of their results. Hence, several alternative return measurements have been proposed, including the incorporation of a one-day delay to mitigate this execution latency. The mixture of opinions regarding this issue triggers us to quantify the achievability of backtesting results in the presence of this implementation uncertainty. In particular, we propose a framework for implementing and backtesting trading strategies. A new concept called return at risk (RaR) is introduced to quantify such achievability, and we illustrate the proposed framework on a representative class of

trading strategies. Results show that a significant number of technical trading strategies in our sample with positive returns are found to be not achievable in the presence of implementation uncertainity.

[124] **Interacting Default Intensity with Hidden Markov Process**.

Fenghui Yu. The University of Hong Kong.

Abstract: Modelling credit risk has long been a critical issue in credit risk management. It has important applications in pricing and hedging credit derivatives, as well as managing credit portfolios. Here we proposed a reduced-form intensity-based credit risk model with a hidden state process under the condition that general expressions of default intensities are unknown. That is to say, no matter what forms of the default intensities are, this general model can always be applied to. In this model, we assume the default intensities are driven by common external factors as well as the defaults of the other names in the portfolio without specific expressions. The common factors can be represented as an underlying process which is unobservable, but all the default processes are observable. The hidden state process is then adopted with another observable process which reveals the delayed and noisy information of the underlying process. With the information observed, we introduced how to extract the underlying state by a recursive method. After gaining this, we further derived closed-form formulas for calculating the default distributions. Moreover, an extended total hazard construction method is also proposed to obtain the joint distribution of multiple default times. In the numerical experiments, we pay attention to some classical and important applications of this model like pricing the credit default swaps of regular and basket type to demonstrate our proposed methods.

[125] **A numerical approach for finding soliton solutions of the 1D Variational Boussinesq Model**.

Lia Yuliawati. Bandung Institute of Technology.

Abstract: In this paper, we discuss the soliton solution for the Variational Boussinesq Model (VBM) in one dimension. We assume that the soliton is a solution that optimizes the momentum at the level set Hamiltonian energy. Based on Klopman [2005] and Adytia et al [2012], we used their Hamiltonian of VBM with the assumption the weakly-nonlinear of Hamiltonian. Numerically, we will use the steepest descent method to find the extreme point, and finite element implementation for solving the dynamic of the method. Based on the method and the hypothesis, a solitary wave solution is obtained.

[126] **The conservative finite volume scheme on Voronoi mesh for the chemotaxis model**.

Guanyu Zhou. The University of Tokyo.

Abstract: We consider the finite volume scheme on Voronoi mesh for the Keller-Segel system modelling chemotaxis. The conservation laws of mass and positivity are verified for the numer- ical solution. The discrete Lyapunov functionals are investigated. To study the error analysis, we introduce a mass-lumping operator on Voronoi mesh, and a projection operator from the finite volume-element method. Then, using the discrete semigroup theories of a discrete elliptic operator, we deduce the optimal error estimate. The theoretical results are confirmed by numerical experiments.

[127] **Finding transition states on energy landscape: from dimer method to iterative minimization algorithm**.

Xiang Zhou. City University of Hong Kong.

Abstract: We summarize the development of numerical methods to calculate the transition states (saddle points) on energy landscape. This talk is to review the dimer method and eigenvector-following method, to build mathematical modelling for transition state problem, to provide systematic and rigorous theory for numerical analysis and to give insight of new algorithmic developments. The main result is Gentlest Ascent Dynamics (Nonlinearity 2010) and Iterative Minimisation Formulation (SINUM 2015). The tremendous improvements, extensions and applications will also be addressed. This is joint work with Weiguo Gao, Jing Leng, Shuting Gu. It is supported by Research Grants Council of the Hong Kong (11304314, 109113 and 11304715).

[128] **Discrepancy bounds for deterministic acceptance-rejection samplers**.

Houying Zhu. City University of Hong Kong.

Abstract: The Monte Carlo method is one of the widely used numerical methods for simulating probability distributions. Its convergence rate is independent of the dimension but slow. Quasi-Monte Carlo methods, which can be seen as a deterministic version of Monte Carlo methods, have been developed to improve the convergence rate to achieve greater accuracy, which partially depends on generating samples with small discrepancy. In this talk we focus on constructing low-discrepancy point sets with respect to non-uniform target measures using the acceptance-rejection sampler. The central contribution is the establishment of discrepancy bounds for samples generated this way. Together with a Koksma-Hlawka type inequality, we obtain an improvement of the numerical integration error for non-uniform measures. This is a joint work with Josef Dick (UNSW, Australia).

[129] **Canonical Quincunx Tight Framelets**.

Xiaosheng Zhuang. City University of Hong Kong.

Abstract: In this talk, we shall focus on the construction a family of quincunx tight framelets having the following desirable properties: 1) The high-pass filters have high order of vanishing moments. 2) The low-pass filter and all the high-pass filters possess symmetry. 3) The number of high-pass filters should be relatively small for computational efficiency. 4) The high-pass filters should have shortest possible support, more precisely, the supports of all high-pass filters should not be larger than the support of the low-pass filter. 5) The tight framelet filter bank has the canonical property. We shall construct a family of symmetric canonical quincunx tight framelets that has the minimum number of generators (associated with double canonical quincunx tight framelet filter banks) and has increasing orders of vanishing moments. Family of multiple canonical quincunx tight framelets with symmetry and increasing order of vanishing moments can be also constructed using tensor product of one-dimensional filters. This is a joint work with Bin Han (Univ. of Alberta), Qingtang Jiang (UMSL), and Zuowei Shen (NUS).

Index (Alphabetical Order)

Plenary Speaker

Invited Speaker

Student Paper Prize Session

Contributed Paper Session

Yunchi Huang [43]
Nurul Huda N.A [44]
Feng-Nan Hwang [45]
Iryanto [46]
Andreas A S Jacobs [47]
Junkee Jeon [48]
Jinhong Jia [49]
Kai Fung Kan [50]
Myungjoo Kang [51]
Takahito Kashiwabara [52]
Tanaka Kazuaki [53]
Rihuan Ke [54]
Tomoya Kemmochi [55]
Hyeon-uk Kim [56]
Yoshifumi Kimura [57]
Jutarat Kongson [58]
Yueh-Cheng Kuo [59]
Dongjin Lee [60]
Yongwimon Lenbury [61]
Dharma Lesmono [62]
Yung-Ta Li [63]
Guojun Liao [64]
Furong Lin [65]
Xuelei Lin [66]
Jiejun Lu [67]
Xin Lu [68]
Jun Luo [69]
Li Luo [70]
Xin Luo [71]
Ikha Magdalena [72]
Yuto Miyatake [73]
Yusuke Morikura [74]
Naoto Nakano [75]
Yasumasa Nishiura [76]
Ippei Obayashi [77]
Hisashi Okamoto [78]
Aulia Oktavia [79]
Jianyu Pan [80]
Hanna Arini Parhusip [81]
Ferry Jaya Permana [82]
Sri Redjeki Pudjaprasetya [83]
Haidong Qu [84]
Wei Qu [85]
Grienggrai Rajchakit [86]
Azizan Saaban [87]
Koya Sakakibara [88]
Takiko Sasaki [89]
Shih-Feng Shieh [90]
Masato Shinjo [91]
Ming-Cheng Shiue [92]
Piotr Skrzypacz [93]
Yoshiki Sugitani [94]
Yimin Sun [95]
Yiqun Sun [96]
Sutrisno [97]
Daisuke Tagami [98]
Ken'ichiro Tanaka [99]
Jengnan Tzeng [100]
Yuki Ueda [101]
Darren Wall [102]
Chao Wang [103]
Dong Wang [104]
Jilu Wang [105]
Liqun Wang [106]
Dongming Wei [107]
Xiaoyu Wei [108]
Yimin Wei [109]
Youwei Wen [110]
Peter Chang-Yi Weng [111]
Chin-Tien Wu [112]
Xianping Wu [113]
Ze-Jia Xie [114]
Murong Xu [115]
Wei Xu [116]
Yusaku Yamamoto [117]
Qingqing Yang [118]
Suh-Yuh Yang [119]
Hidenori Yasuda [120]
Li-Ming Yeh [121]
Chien-Chang Yen [122]
Lane Chun Lanston Yeung [123]
Fenghui Yu [124]
Lia Yuliawati [125]
Guanyu Zhou [126]
Xiang Zhou [127]
Houying Zhu [128]
Xiaosheng Zhuang [129]