1/15 (Fri)

中興大學｜資科大樓

1/16 (Sat)

2021

第 29 屆

微分方程年會

大會手冊

國立中興大學
NATIONAL CHUNG HSING UNIVERSITY

主辦單位 § 國立中興大學應用數學系
協辦單位 § 台灣工業與應用數學會(TWSIAM)
贊助單位 § 科技部數學研究推動中心、國立中興大學
年會網址 § https://reurl.cc/000p0M

年會網址

第 29 屆微分方程年會

29th Annual Meeting on Differential Equations

會議時間：2021 年 1 月 15 日（五）至 2021 年 1 月 16 日（六）
會議地點：國立中興大學資訊科學大樓
主辦單位：國立中興大學應用數學系
協辦單位：台灣工業與應用數學會（TWSIAM）
贊助單位：科技部數學研究推動中心
國立中興大學

承辦單位籌備人員：吳菁菁教授、施因澤教授、陳焜燦教授、
陳鵬文教授、蔡亞倫教授、謝博文教授
（依姓氏筆劃順序排列）

行政事務：侯怜竹、梁佳瑜、陳柚滋、黃淑雯、董佳昕、蘇心怡
（依姓氏筆劃順序排列）

第 29 屆微分方程年會

29th Annual Meeting on Differential Equations

大會主講 Plenary Speaker：
郭忠勝 Jong-Shenq Guo（淡江大學數學學系）

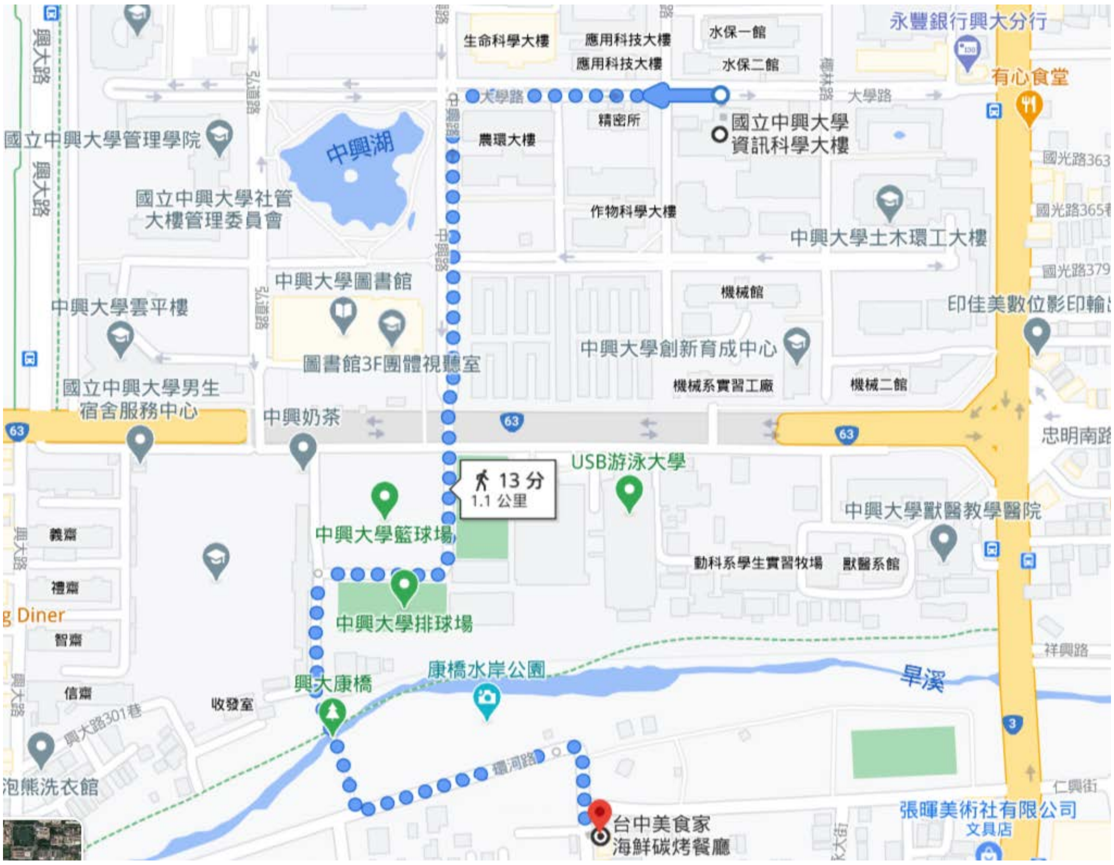
受邀講者 Invited Speakers：（依姓氏筆劃順序排列）

- 微分方程領域 (Differential Equations)
  王信華 Shin-Hwa Wang（國立清華大學數學系）
  王振男 Jenn-Nan Wang（國立臺灣大學數學系）
  王琪仁 Chi-Jen Wang（國立中正大學數學系）
  吳宗芳 Tsung-Fang Wu（國立高雄大學應用數學系）
  吳恭儉 Kung-Chien Wu（國立成功大學數學系）
  洪盟凱 Meng-Kai Hong（國立中央大學數學系）
  夏俊雄 Chun-Hsiung Hsia（國立臺灣大學數學系）
  張覺心 Chueh-Hsin Chang（東海大學應用數學系）
  陳國璋 Kuo-Chang Chen（國立清華大學數學系）
  黃信元 Hsin-Yuan Huang（國立交通大學應用數學系）

- 計算數學領域 (Computational Mathematics)
  朱家杰 Chung-Lin Tseng（國立清華大學數學系）
  李雪甄 Hsueh-Chen Lee（文藻外語大學通識教育中心）
  郭岳承 Yueh-Cheng Kuo（國立高雄大學應用數學系）
  陳明志 Ming-Jyh Chern（國立臺灣科技大學機械工程系）
  曾仲麟 Chung-Lin Tseng（國立清華大學數學系）
  黃杰森 Chieh-Sen Huang（國立中山大學應用數學系）
  黃楓南 Feng-Nan Hwang（國立中央大學數學系）
  鄭博文 Bor-Wen Jeng（國立臺中教育大學數學教育學系）
  薛名成 Ming-Cheng Shiue（國立交通大學應用數學系）

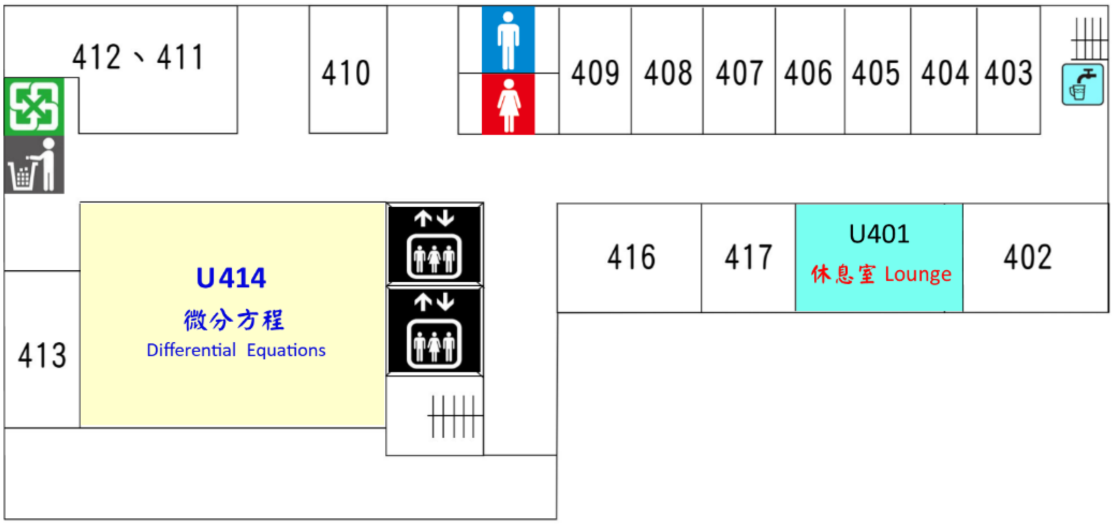

興大路
學府路
校門
停車費繳費機
行政大樓
中興湖
圖書館
資訊科學大樓
國立中興大學
National Chung Hsing University
校園平面配置示意圖
忠明南路地下道入口
運動場
體育館
國光路
南門路
N

校園位置圖


國立中興大學
資訊科學大樓
中興湖
大學路
13 分
1.1 公里
興大康橋
康橋水岸公園
台中美食家
海鮮碳烤餐廳

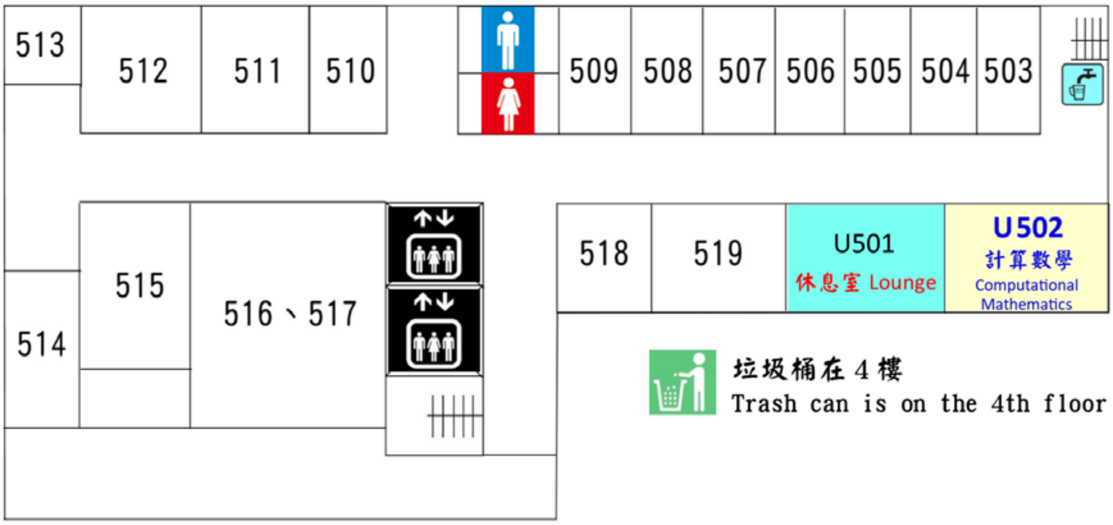
晚宴路線圖

會場平面圖



資訊科學大樓四樓平面圖

Information Science Building Level 4



資訊科學大樓五樓平面圖

Information Science Building Level 5

Day 1

<table>
<tr><td colspan="4">Jan 15 (Fri.)</td></tr>
<tr><td>8:50-9:20</td><td colspan="3">Registration</td></tr>
<tr><td>9:20-9:30</td><td colspan="3">Opening</td></tr>
<tr><td>9:30-10:20</td><td colspan="3">Jong-Shenq Guo (Zhiping Hall)
Chair: Yin-Tzer Shih
Traveling wave solutions for some three-species predator-prey systems</td></tr>
<tr><td>10:20-10:50</td><td colspan="3">Group photo, Tea break</td></tr>
<tr><td colspan="2">Differential Equations (U414)
Chair: Chiun-Chuan Chen</td><td colspan="2">Computational Mathematics (U502)
Chair: Suh-Yuh Yang</td></tr>
<tr><td rowspan="3">10:50-11:35</td><td rowspan="3">Meng-Kai Hong
Global classical solutions near vacuum to the compressible Euler equations for variable nozzle flow</td><td>10:50-11:20</td><td>Chieh-Sen Huang
A self-adaptive nonlinear theta method using discontinuity aware quadrature for solving hyperbolic conservation laws</td></tr>
<tr><td>11:20-11:50</td><td>Ming-Jyh Chern
Direct-forcing immersed boundary modeling for dynamic stall in turbulent flow</td></tr>
<tr><td>11:50-12:20</td><td>Yueh-Cheng Kuo
The generalized orthogonal flows</td></tr>
<tr><td>11:35-12:20</td><td>Kung-Chien Wu
Space-time behavior of the solution to the Boltzmann equation with soft potentials</td><td></td><td></td></tr>
<tr><td>12:20-13:50</td><td colspan="3">Lunch</td></tr>
<tr><td colspan="2">Differential Equations (U414)
Chair: Ya-Lun Tsai</td><td colspan="2">Computational Mathematics (U502)
Chair: Po-Wen Hsieh</td></tr>
<tr><td rowspan="3">13:50-14:35</td><td rowspan="3">Kuo-Chang Chen
Some recent advances on the Kepler problem</td><td>13:50-14:20</td><td>Feng-Nan Hwang
A dynamic contrast-enhanced MRI-based data-driven computational technique for early detection of chronic liver diseases</td></tr>
<tr><td>14:20-14:50</td><td>Hsueh-Chen Lee
Non-Newtonian flows of power-law fluid cross a square cylinder placed symmetrically in a plane channel</td></tr>
<tr><td>14:50-15:20</td><td>Bor-Wen Jeng
Multi-parameter continuation methods for boson-fermion mixtures</td></tr>
<tr><td>14:35-15:20</td><td>Hsin-Yuan Huang
Recent progress on the Liouville systems</td><td></td><td></td></tr>
<tr><td>15:20-15:50</td><td colspan="3">Tea break</td></tr>
<tr><td colspan="2">Differential Equations (U414)
Chair: Chang-Hong Wu</td><td colspan="2">Computational Mathematics (U502)
Chair: Po-Wen Hsieh</td></tr>
<tr><td rowspan="3">15:50-16:35</td><td rowspan="3">Shin-Hwa Wang
Structures and evolution of bifurcation diagrams for a one-dimensional diffusive generalized logistic problem with constant yield harvesting</td><td>15:50-16:20</td><td>Ming-Cheng Shiue
Iterated pressure-correction projection methods for the 2d Navier-Stokes equations based on the scalar auxiliary variable approach</td></tr>
<tr><td>16:20-16:50</td><td>Jay Chu
Numerical methods for partial differential equations on surface</td></tr>
<tr><td>16:50-17:20</td><td>Chung-Lin Tseng
A novel solver for fractional diffusion equations</td></tr>
<tr><td>16:35-17:20</td><td>Chueh-Hsin Chang
Front-back-pulse solutions in the three-species competition-diffusion systems</td><td></td><td></td></tr>
<tr><td>18:00-</td><td colspan="3">Banquet</td></tr>
</table>

Day 2

Jan 16 (Sat.)	
9:00-9:10	Registration
Differential Equations (U414) Chair: Jann-Long Chern	
9:10-9:55	Jenn-Nan Wang *Non-radiating sources for the elastic waves in anisotropic inhomogeneous media*
9:55-10:40	Chi-Jen Wang *Bifurcation diagram of a MEMS problem*
10:40-11:00	Tea break
Differential Equations (U414) Chair: Chun-Kong Law	
11:00-11:45	Tsung-Fang Wu *On non-local nonlinear elliptic boundary value problems involving an eigenvalue problem*
11:45-12:30	Chun-Hsiung Hsia *On the mathematical analysis of Synchronization theory*
12:30-13:30	Lunch
13:30-16:20	Free Discussions

目錄 Table of Contents

Traveling wave solutions for some three-species predator-prey systems

Jong-Shenq Guo

Department of Mathematics, Tamkang University
E-mail: **jsguo@mail.tku.edu.tw**

Abstract

In this talk, we shall present some recent developments on the application of Schauder's fixed point theorem to the existence of traveling waves for some three-species predator-prey systems. The existence of traveling waves of predator-prey systems is closely related to the invasion phenomenon of some alien species to the habitat of aboriginal species. Two different three-species predator-prey models with different invaded and invading states shall be presented. In this talk, we shall focus on the methodology of deriving the convergence of stable tail of wave profiles.

Global classical solutions near vacuum to the compressible Euler equations for variable nozzle flow

John M. Hong

Department of Mathematics, National Central University
E-mail: **jhong@math.ncu.edu.tw**

Abstract

In this talk, we study the global classical solutions of the nozzle flow near vacuum in terms of the Riemann invariants for compressible Euler equations. We present the solutions for two kinds of variable nozzles. One is the C^2 expanding nozzle corresponding to the initial value problem of the nozzle flow. The other case is the piecewise C^2 nozzles, which is related to an initial-boundary value problem. These results are established by the application of Lax-Li method. We first establish the local existence and then develop the uniform a priori estimate to the first-order derivatives of the Riemann invariants. The former is from the local existence theorem in ODE. The latter is to study the solutions of the Riccati equations induced from Riemann invariants. These results imply the global C^1 solutions of the nozzle flow near vacuum. Theoretic results are also supported by numerical simulations. This is a joint work with Jay Chu(NTHU), Hsin-Yi Lee (NCU) and Ying-Chieh Lin (NUK).

Space-time behavior of the solution to the Boltzmann equation with soft potentials

Kung-Chien Wu

National Cheng Kung University
E-mail: **kcwu@mail.ncku.edu.tw**

Abstract

In this talk, we will discuss the quantitative space-time behavior of the full Boltzmann equation with soft potentials in the close to equilibrium setting, under some velocity decay assumption, but without any Sobolev regularity assumption on the initial data.

Some recent advances on the Kepler problem

Kuo-Chang Chen

Department of Mathematics, National Tsing Hua University
E-mail: **kchen@math.nthu.edu.tw**

Abstract

The Newtonian 2-body problem is also known as the Kepler problem in honor of Johannes Kepler (1571-1630) for his discovery of three laws of planetary motion, based on which Newton deduced in 1687 the celebrated law of universal gravitation. It is commonly considered a well-understood problem, as solving it with given initial data and proving Kepler's three laws require nothing more than tools from elementary calculus. In this talk I will briefly describe its history, outline recent discoveries from variational perspectives, and show some progresses regarding singularities.

Recent progress on the Liouville systems

Hsin-Yuan Huang

Department of Applied Mathematics, National Chiao Tung University
E-mail: **hyhuang@math.nctu.edu.tw**

Abstract

The Liouville systems have several applications to the various areas of biology, geometry and physics. For example, the abelian Chern-Simons system with n-Higgs fields can be regarded as a perturbation of the Liouville system. Also, the nonlocal Liouville system corresponds to the stationary or self-similar Patlak-Keller-Segel system. In this talk, I will review some recent results on this system, and its connection to the Patlak-Keller-Segel system. I will especially focus on the bubbling phenomenon of the solutions.

Structures and evolution of bifurcation diagrams for a one-dimensional diffusive generalized logistic problem with constant yield harvesting

Shin-Hwa Wang

Department of Mathematics, National Tsing Hua University
E-mail: **shwang@math.nthu.edu.tw**

Abstract

We study the one-dimensional diffusive generalized logistic problem with constant yield harvesting:

$$\begin{cases} u''(x) + \lambda g(u) - \mu = 0, & -1 < x < 1, \\ u(-1) = u(1) = 0, \end{cases}$$

where $\lambda, \mu > 0$. We assume that nonlinearity g satisfies $g(0) = g(1) = 0$, $g(u) > 0$ on $(0, 1)$, and g either is concave on $(0, 1)$ or (is concave-convex on $(0, 1)$ and satisfies a certain condition). We prove that, for any fixed $\mu > 0$, on the $(\lambda, \|u\|_\infty)$-plane, the bifurcation diagram consists of a $\subset$-shaped curve and then we study the structures and evolution of bifurcation diagrams for varying $\mu > 0$. We also prove that, for any fixed $\lambda > \frac{\pi^2}{4g'(0)}$, on the $(\mu, \|u\|_\infty)$-plane, the bifurcation diagram consists of a reversed $\subset$-shaped curve and then we study the structures and evolution of bifurcation diagrams for varying $\lambda > \frac{\pi^2}{4g'(0)}$. It is a joint work with Kuo-Chih Hung and Yiu-Nam Suen.

2000 *Mathematical subject classification*: 34B18, 74G35

Front-back-pulse solutions in the three-species competition-diffusion systems

Chueh-Hsin Chang

Department of Applied Mathematics, Tunghai University
E-mail: **changjuexin@thu.edu.tw**

Abstract

Coexistence about competing species is a central problem in biological problems. It has been found that the front-back-pulse (FBP) solutions can be used as building block to construct coexistence patterns in three-species environments numerically. In this talk we will survey some results of the FBP solutions in the three-species competition-diffusion systems. For example, exact solutions, existence, asymptotic stability and the weak interaction between FBP solutions (the distances between them are sufficiently large) under different assumptions of the parameters. This talk includes the joint work with Chiun-Chuan Chen, Shin-Ichiro Ei, Li-Chang Hung, Masayasu Mimura and Toshiyuki Ogawa.

29th Annual Meeting of Differential Equations
Department of Applied Mathematics, National Chung Hsing University
Jan. 15-16, 2021

Non-radiating sources for the elastic waves in anisotropic inhomogeneous media

Jenn-Nan Wang

Department of Mathematics, National Taiwan University
E-mail: **jnwang@math.ntu.edu.tw**

Abstract

In this talk, I would like to discuss the characterization of non-radiating volume and surface (faulting) sources for the elastic waves in anisotropic inhomogeneous media. Each type of the source can be decomposed into a radiating part and a non-radiating part. The radiating part can be uniquely determined by an explicit formula containing the near-field measurements. On the other hand, the non-radiating part does not induce scattered waves at a certain frequency. In other words, such non-radiating sources can not be detected by measuring the field at one single frequency in a region outside of the domain where the source is located. This is a recent joint work with Pu-Zhao Kow.

Bifurcation diagram of a MEMS problem

Chi-Jen Wang

Department of Mathematics, National Chung Cheng University
E-mail: **cjwang@ccu.edu.tw**

Abstract

In this talk, we will introduce a way to determine the number of stationary solutions to a MEMS problem with fringing field. The critical value is determined by an implicit relation between two controlling parameters in this problem. We will show that this critical value exists.

On non-local nonlinear elliptic boundary value problems involving an eigenvalue problem

Tsung-Fang Wu

Department of Applied Mathematics, National University of Kaohsiung
E-mail: **tfwu@nuk.edu.tw**

Abstract

In this talk, we will consider the existence and multiplicity of solutions for a class of non-local elliptic boundary value problems with superlinear source functions are investigated in this paper. Using variational methods, we examine the changes arise in the solution behaviors as a result of the non-local effect. Comparisons are made of the results here with those of the elliptic boundary value problem in the absence of the non-local term under the same prescribed conditions to highlight this effect of non-locality on the solution behaviors. Our results here demonstrate that the complexity of the solution structures is significantly increased in the presence of the non-local effect with the possibility ranging from no permissible positive solution to three positive solutions and, contrary to those obtained in the absence of the non-local term, the solution profiles also vary depending on the superlinearity of the source functions. This work joint with Ching-yu Chen, Yueh-cheng Kuo and Kuan-Hsiang Wang.

On the mathematical analysis of Synchronization theory

Chun-Hsiung Hsia

Department of Mathematics, National Taiwan University
E-mail: **willhsia@math.ntu.edu.tw**

Abstract

Synchronization is a pervasive phenomena which has been observed in biological, chemical, physical and social systems. The first reported observation of synchronization dates back to the 17th century; a Dutch scientist, Christiaan Huygens has discovered in 1665 that two pendulum clocks hanging on the wall have always ended up swinging in exactly the opposite direction from each other. Since then, various synchronization phenomena have been reported. These include circadian rhythms, chirping crickets, flashing fireflies, croaking frogs, electrical generators, Josephson junction arrays, intestinal muscles and menstrual cycles. In this talk, we shall introduce the recent development of the mathematical theory of synchronization.

A self-adaptive nonlinear theta method using discontinuity aware quadrature for solving hyperbolic conservation laws

Chieh-Sen Huang

Department of Applied Mathematics, National Sun Yat-sen University
E-mail: **huangcs@math.nsysu.edu.tw**

Abstract

We present a *discontinuity aware quadrature* (DAQ) rule, and use it to develop implicit *self-adaptive theta* (SATh) schemes for the approximation of scalar hyperbolic conservation laws. Our SATh schemes require the solution of a system of two equations, one controlling the cell averages of the solution at the time levels, and the other controlling the space-time averages of the solution. These quantities are used within the DAQ rule to approximate the time integral of the hyperbolic flux function accurately, even when the solution may be discontinuous somewhere over the time interval. The result is a finite volume scheme using the theta time stepping method, with theta defined implicitly (or self-adaptively). We prove that DAQ is accurate to second order when there is a discontinuity in the solution and third order when it is smooth. We prove that the scheme is unconditionally stable (provided that theta is set to be at least 1/2), satisfies the maximum principle and is total variation diminishing under appropriate monotonicity and boundary conditions. Compared to solutions of finite volume schemes using Crank-Nicolson and backward Euler time stepping, solutions of our scheme often approach the accuracy of the former but without oscillation, and they are numerically less diffuse than the later.

Direct-forcing immersed boundary modeling for dynamic stall in turbulent flow

Ming-Jyh Chern

Department of Mechanical Engineering, National Taiwan University of Science and Technology
E-mail: **mjchern@ntust.edu.tw**

Abstract

Dynamic stall is a common physical phenomenon in a helicopter or a rotating fluid machinery. It can be considered as a uniform flow past a pitching airfoil. Dynamic stall occurs when its pitching angle exceeds a critical value. This study aims to establish a numerical model to simulate dynamic stall and the way to control dynamics stall. It is a typical fluid-structure interaction problem, so the direct-forcing immersed boundary method [1] is proposed to simulate the pitching airfoil in fluid flow. Turbulence is simulated by the Large Eddy Simulation (LES). Smagorinsky-Lilly sub-grid model is used to predict small eddy motion. The proposed numerical model was implemented by a hybrid parallel computing program and executed in Taiwania, the supercomputer at National Center for High-Performance Computing.

The proposed numerical model is validated by the comparison of drag and lift with Ohtake et al.'s experiment [2] for flow past a stationary airfoil at Re $= 10^5$. Evolution of leading edge vortex (LEV) with respect to the pitching angle is visulaized. The variation of lift with respect to the angle of attack (AOA) in dynamic stall is captured by the numerical model.

References

[1] M. J. Chern, Y. H. Kuan, G. Nugroho, G. T. Lu and T. L. Horng. 2014 Direct-forcing immersed boundary modeling of vortex-induced vibration of a circular cylinder, *Journal of Wind Engineering & Industrial Aerodynamics*, **134**, 109-121.

[2] T. Ohtake, Y. Nakae and T. Motohashi. 2007 Nonlinearity of the aerodynamic characteristics of NACA0012 aerofoil at low Reynolds numbers. *Journal of the Japan Society for Aeronautical and Space Sciences*, **55**, 439-445.

29th Annual Meeting of Differential Equations
Department of Applied Mathematics, National Chung Hsing University
Jan. 15-16, 2021

The generalized orthogonal flows

Yueh-Cheng Kuo

Department of Mathematics, National University of Kaohsiung
E-mail: **yckuo@nuk.edu.tw**

Abstract

In the field of scientific computation, the orthogonal iteration plays an important role in computing the invariant subspace corresponding to the largest k eigenvalues. In this paper, we construct a flow that connects the sequence of matrices generated by the orthogonal iteration. Such a flow is called an orthogonal flow. In addition, we also show that the orthogonal iteration forms a time-one mapping of the orthogonal flow. By using a suitable change of variables, the orthogonal flow can be transformed into a Riccati differential equation (RDE). Conversely, a RDE also can be transformed to a flow which can be represented by the orthogonal flow multiplied by an orthogonal matrix.

A dynamic contrast-enhanced MRI-based data-driven computational technique for early detection of chronic liver diseases

Feng-Nan Hwang

Department of Mathematics, National Central University
E-mail: **hwangf@math.ncu.edu.tw**

Abstract

Liver diseases are always on the list of the top ten causes of death in Asian countries. Generally speaking, liver disease progression can be classified into three stages: liver fibrosis, liver cirrhosis, and liver cancer. One of the research focus for clinical practice is to develop some noninvasive technique used for determining the status of the liver disease. Early diagnosis of the liver's fibrosis with some proper treatments can decrease the hepatocellular carcinoma chance. In this work, we propose a data-driven computational technique in conjunction with the dynamic contrast-enhanced MRI (DCI-MRI) for the early detection of chronic liver diseases. The proposed technique's kernel is a Darcy solver weakly coupled with an unsteady convection-diffusion solver used to simulate the blood flows through the liver, assumedly as a kind of porous medium, and the relative signal enhancement scanned by MRI varied in time. Our approach consists of two phases: the online and online stages. We correlate the porosity in the mathematical model to the degree of liver fibrosis during the online phase, determined by the liver biopsy result using the clinical data. During the online stage, to help the doctors' diagnosis, we perform the numerical simulation by using the patient-specific data to determine the liver's fibrosis stage. Our method achieves a 93% success rate for diagnosing moderate liver fibrosis status from the mild one correctly.

Non-Newtonian flows of power-law fluid cross a square cylinder placed symmetrically in a plane channel

Hsueh-Chen Lee

General Education Center, Wenzao Ursuline University of Languages
E-mail: **87013@mail.wzu.edu.tw**

Abstract

The aim of this work is to present a numerical study of non- Newtonian flows of power-law fluid across an unconfined square cylin- der at two inclination angles, placed symmetrically in a two-dimensional channel. This work develops a least-squares finite element method which offers a direct approximation of the extra stress tensor com- ponents, a symmetric positive definite system, and the openness of choosing finite element spaces. We prove that the least-squares ap- proximation converges to linearized solutions of the non-Newtonian model at the optimal rate. We demonstrated that numerical results agree with the theoretical estimates and present the effects of physical parameters on the physical attributes of the power-law model, such as drag coefficients, stream function, vorticity, and wake length. These results agree with others published in the literature.

Multi-parameter continuation methods for boson-fermion mixtures

Bor-Wen Jeng

Department of Mathematics Education, National Taichung University of Education
E-mail: **bwjeng@mail.ntcu.edu.tw**

Abstract

In this talk, we will introduce the coupled Gross-Pitaevskii equations (CGPEs) for modeling the boson-fermion mixtures (BFM). We will discuss the existence of nontrivial solution curves of the CGPEs in some neighborhoods of bifurcation points. Based on the existence theory three multi-parameter continuation algorithms combined with the spectral collocation method are proposed for computing the ground state of BFM. We compare the efficiency of the proposed algorithms with the preconditioned imaginary time evolution method. Some numerical results will be presented.

Iterated pressure-correction projection methods for the 2d Navier-Stokes equations based on the scalar auxiliary variable approach

Ming-Cheng Shiue

Department of Applied Mathematics, National Chiao Tung University
E-mail: **mshiue@math.nctu.edu.tw**

Abstract

In this talk, the first-order iterated pressure-correction projection methods based on the scalar auxiliary variable approach is proposed and studied for the 2d Navier-Stokes equations and Boussinesq equations.

In the literature, enormous amounts of work have contributed to the study of numerical schemes for computing the Navier-Stokes equations. In general, two of the main numerical difficulties for solving Navier-Stokes equations are the incompressible condition and the nonlinear term. One of the approaches to deal with the incompressible condition is the so-called projection. The typical projection method only needs to solve the Poisson type of equations depending on the nonlinear term's treatment, which is efficient. However, the pressure-correction projection methods suffer from the splitting error, leading to spurious numerical boundary layers and the limitation of accuracy in time. In the literature, an iterated pressure-correction projection method has been proposed to overcome the difficulty.

As for the nonlinear term treatment, it is better to treat the nonlinear term explicitly so that one only requires to solve the corresponding linear system with constant coefficients at each time step. However, such treatment often results in a restricted time step due to the stable issue. Recently, the scalar auxiliary variable approach has been constructed to have an unconditional energy stable numerical scheme.

In this work, a new iterated pressure-correction projection method based on the scalar auxiliary variable's simple choice is proposed. We find that this new scheme can enjoy two properties, including reducing the splitting errors and having unconditional energy stability. The proofs of the energy stability and error convergence are provided and analyzed. Finally, numerical examples are provided to illustrate the theoretical work. This is joint work with Tony Chang.

Numerical methods for partial differential equations on surface

Jay Chu

Department of Mathematics, National Tsing Hua University
E-mail: **ccchu@math.nthu.edu.tw**

Abstract

Partial differential equations (PDEs) on surfaces have wild applications in many areas. Solving these PDEs numerically can be complicated and computationally expensive. This work targets applications that use implicit or non-parametric representations of closed surfaces or curves and require numerical solution for minimization problems defined on the surfaces.

We showed that the energy function defined on surfaces can be extended to the energy function defined on the nearby tubular neighborhood that gives the same energy when input the constant-along-normal extension. Furthermore, the extended energy function gives the same minimizer as which the original energy function gives in the sense of restriction on the surface. This new approach connects the original energy function to an extended energy function and provides a good framework to solve PEDs numerically on Cartesian grids. We continue the results in previous work to develop a framework to solve more challenging problems defined on surfaces, such as nonlinear and non-convex energy problems, Hamilton-Jacobi-Bellman equations. Currently, an investigation of applying this methodology to the mean curvature flow problem has been done and some preliminary results will be discussed in this talk.

A novel solver for fractional diffusion equations

Chung-Lin Tseng

Department of Mathematics, National Tsing Hau University
E-mail: **tseng0920@gapp.nthu.edu.tw**

Abstract

In recent years, there are many applications of the fractional derivative and fractional Laplacian in different areas. The fractional order differential operators can be seen as an essential tool for developing more sophisticated mathematical models that can accurately describe complex anomalous systems. Since the fractional order differential operators are nonlocal, the corresponding linear system involves a dense, structured Toeplitz matrix. Many research activities are devoted to developing robust and efficient solvers for such linear systems. In this talk, we will introduce some common used definition and discretization of fractional derivative, then propose a numerical method for the fractional diffusion equations based on a new preconditioner that can be used to develop direct and iterative solvers for fractional diffusion equations with total $O(N \log N)$ operations per time step. Numerical results confirms that the new approach is a competitive alternative to existing methods.