

The Fourth Workshop on Recent Advances in Spectral Methods and Related Applications

November 2-4, 2013

School of Mathematical Sciences

Xiamen University

361005 Xiamen

China



Sponsored by:

Fujian Provincial Key Laboratory of

Mathematical Modeling and High Performance Scientific Computing

School of Mathematical Sciences, Xiamen University

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Background

This is the fourth workshop in the series on Spectral Methods and Their Applications, initially organized by Jie Shen (Purdue University & Xiamen University) and Chuanju Xu (Xiamen University).

There has been increasing growth in the analysis and applications of the spectral (element) methods. The main characteristic of spectral (element) methods is the use of high-order polynomials as basis functions, as compared to low-order piecewise polynomials in a finite element method. The main advantage of the spectral methods lies on the fact that the convergence of numerical solutions is exponential if the exact solution is smooth. While the classical spectral methods are limited to simple geometries, the development of the spectral element method allows to take advantages of the geometric flexibility of finite elements and the high accuracy of spectral methods. Undoubtedly the spectral (element) methods have become a major computational tool, especially when highly accurate solutions are needed.

The conference is sponsored by School of Mathematical Sciences, Xiamen University

Organizing Committee

- Zhijian Rong Xiamen University
- Jie Shen Purdue University, Xiamen University
- Chuanju Xu Xiamen University

Accommodation

All participants will be hosted at Wujing Xiamen Sanatorium, which is a sanatorium hotel, affiliated with the Chinese people's armed police forces. The hotel is in 10 minutes walking distance to the Haiyun campus of Xiamen University.

Travel

How to get to Wujing Xiamen Sanatorium (武警疗养院)

From airport by taxi:

The cost from the airport to the hotel is about 60 RMB (there may be an additional 20% charge after 23:00).

From train station by taxi:

The cost from the station is about 20 RMB.

Program

All talks will last 25 minutes including 5 minutes for discussion

	Nov. 1	Nov. 2	Nov. 3	Nov. 4
Time	Friday	Saturday	Sunday	Monday
8:30	Registration (13:00-21:00)	沈捷 杜魁 李会元	王立联 徐勤武 徐进	Tour (环岛游)
9:45		Tea Break	Tea Break	
10:05		张然 于海军 李娴娟	王中庆 赵廷刚 宋伦继	
12:00		Lunch	Lunch	
14:30		冯新龙 张俊 梁琴	赵山 周晓军 刘飞	
15:45		Tea Break	Tea Break	
16:05		毛志平 易利军 安静	庄清渠 孙涛 黄灿	
18:00		Dinner	Banquet	

Daily Program

Conference Venue: Shiyuan Building (实验楼) S105, Haiyun Campus of Xiamen University (厦门大学海韵园)

Friday, November 1, 2013		
13:00-21:00	Registration (Venue: Wujing Xiamen Sanatorium)	
Saturday, November 2, 2013		
A.M.		
8:00-12:00	Registration (Venue: S105)	
8:20-8:30	Opening Remarks	
Room S105	Session I: Chair 许传炬	
8:30-8:55	An efficient spectral method for scattering in unbounded rough surfaces	沈捷
8:55-9:20	Matrix decomposition algorithms for arbitrary order S^C tensor product finite element systems	杜魁
9:20-9:45	Sobolev-orthogonal polynomial approximations and the fully diagonalized spectral-Galerkin method on the unit ball	李会元
9:45-10:05	<i>Tea break</i>	
Room S105	Session II: Chair 王中庆	
10:05-10:30	Analysis of collocation solutions for nonstandard Volterra integral equations	张然
10:30-10:55	Spectral methods for the study of global stability of plane shear flow	于海军
10:55-11:20	Convergence analysis of Chebyshev spectral Galerkin methods for weakly singular Volterra integral equations	李娴娟
11:20-14:30	<i>Lunch break</i> 武警疗养院	
P.M.		
Room S105	Session III: Chair 张然	
14:30-14:55	Implicit-explicit Runge-Kutta methods for phase-field models	冯新龙
14:55-15:20	Finite difference/spectral approximations to a water wave model with a nonlocal viscous dispersive term	张俊
15:20-15:45	Pseudo-spectral method for self-consistent field equations of wormlike chain on a spherical surface	梁琴

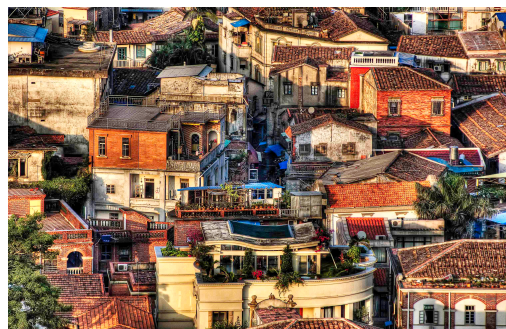
15:45-16:05	<i>Tea break</i>	
Room S105	Session IV: Chair 冯新龙	
16:05-16:30	Legendre Spectral Methods for two dimensional fractional differential equations	毛志平
16:30-16:55	An h-p version Petrov-Galerkin FEM for nonlinear Volterra integro-differential equations	易利军
16:55-17:20	各向异性介质逆电磁波传输问题有效的谱元方法及其应用	安静
18:00	宴请: 牡丹万鹏宾馆 (17:50 在海韵园门口乘车前往)	
Sunday, November 3, 2013		
A.M.		
Room S105	Session V: Chair 沈捷	
8:30-8:55	Defeating ill-conditioning of collocation methods: polynomials and PSWFs	王立联
8:55-9:20	Multi-domain spectral collocation method for fractional differential equations	徐勤武
9:20-9:45	Investigation on using different high-order bases for some applications	徐进
9:45-10:05	<i>Tea break</i>	
Room S105	Session VI: Chair 容志建	
10:05-10:30	A multistep Legendre-Gauss spectral collocation method for nonlinear Volterra integral equations with delays	王中庆
10:30-10:55	Legendre-collocation method for nonlinear Volterra-type integro-differential equations of the second kinds	赵廷刚
10:55-11:20	Interior penalty discontinuous Galerkin methods with implicit time-integration techniques for nonlinear parabolic equations	宋伦继
11:20-14:30	<i>Lunch break</i> 武警疗养院	
P.M.		
Room S105	Session VII: Chair 王立联	
14:30-14:55	Time domain interface methods for electromagnetic wave propagation in dispersive media	赵山
14:55-15:20	一类耦合分数阶微分方程组的理论分析及数值方法	周晓军
15:20-15:45	Efficient spectral method for variable coefficients and nonlinear differential equations with applications	刘飞
15:45-16:05	<i>Tea break</i>	

Room S105	Session VIII: Chair 李会元	
16:05-16:30	一类具有非线性边界条件四阶方程的数值求解: 紧差分逼近与谱逼近	庄清渠
16:30-16:55	Some spectral approximations in one dimension and their applications	孙涛
16:55-17:20	Spectral methods for spectrum computation of non-oscillatory and highly oscillatory kernels with weak singularity	黄灿
18:00	晚餐 武警疗养院	
Monday, November 4, 2013		
9:00-11:00	参观, 8:30 在酒店门口集合	
12:00	午餐, 武警疗养院	
18:00	晚餐, 武警疗养院	

Tour Information

Gulangyu (鼓浪屿)

As a place of residence for Westerners during Xiamen's colonial past, Gulangyu is famous for its architecture and for hosting China's only piano museum, giving it the nickname of "Piano Island" or "The Town of Pianos" or "The Island of Music". There are over 200 pianos on this island. The Chinese name also has musical roots, as Gu lang means drum waves so-called because of the sound generated by the ocean waves hitting the reefs. Yu means "islet". In addition, there is a museum dedicated to Koxinga, Haidi Shijie Marine World, a subtropical garden containing plants introduced by overseas Chinese, as well as Xiamen Museum, formerly the Eight Diagrams Tower. There's also an Organ museum, bird sanctuary, plant nursery, and a tram that takes to the peak. On the west beach of the island you can rent pedal boats and jet skis. There's a garden of 12 grottos to represent each of the animals on the zodiac. Built into the hillside, its a maze of caves and tunnels to find all twelve (and the exit). There are many boutique hotels to stay in as well. The island of Gulangyu is a pedestrian only destination, where the only vehicles on the islands are several fire trucks and electric tourist buggies. The narrow streets on the island, together with the architecture of various styles around the world, give the island a unique appearance.



Nanjing Tulou (南靖土楼)

Fujian Tulou is a type of Chinese rural dwellings of the Hakka and Minnan people in the mountainous areas in southeastern Fujian, China. They were mostly built between the 12th and the 20th centuries. A tulou is usually a large, enclosed and fortified earth building, most commonly rectangular or circular in configuration, with very thick load-bearing rammed earth walls between three and five stories high and housing up

to 80 families. Smaller interior buildings are often enclosed by these huge peripheral walls which can contain halls, storehouses, wells and living areas, the whole structure resembling a small fortified city. The fortified outer structures are formed by compacting earth, mixed with stone, bamboo, wood and other readily available materials, to form walls up to 6 feet (1.8 m) thick. Branches, strips of wood and bamboo chips are often laid in the wall as additional reinforcement. The result is a well-lit, well-ventilated, windproof and earthquake-proof building that is warm in winter and cool in summer. Tulous usually have only one main gate, guarded by 4–5-inch-thick (100–130 mm) wooden doors reinforced with an outer shell of iron plate. The top level of these earth buildings has gun holes for defensive purposes.

A total of 46 Fujian Tulou sites, including Chuxi tulou cluster, Tianluokeng tulou cluster, Hekeng tulou cluster, Gaobei tulou cluster, Dadi tulou cluster, Hongkeng tulou cluster, Yangxian lou, Huiyuan lou, Zhengfu lou and Hegui lou, have been inscribed in 2008 by UNESCO as World Heritage Site, as "exceptional examples of a building tradition and function exemplifying a particular type of communal living and defensive organization in a harmonious relationship with their environment".



Xiamen

Xiamen is a major city on the southeast (Taiwan Strait) coast of the People's Republic of China. It is administered as a sub-provincial city of Fujian province with an area of 1575.16 km² and population of 3.61 million. Its built up area is now bigger than the old urban island area and covers now all six districts of Xiamen (Huli, Siming, Jimei, Tong'an, Haicang and recently Xiang'an), for a total of 3,531,147 inhabitants. It borders Quanzhou to the north and Zhangzhou making with this city a unique built up area of more than 5 million people. The Jinmen (Kinmen) Islands administered by the Republic of China (Taiwan) are less than 10 kilometers (6.2 mi) away.

Xiamen and the surrounding southern Fujian countryside are the ancestral home to large communities of overseas Chinese in Southeast Asia and Taiwan. The city was a treaty port in the 19th century and one of the four original Special Economic Zones opened to foreign investment and trade when China began economic reforms in the early 1980s. It is endowed with educational and cultural institutions supported by the overseas Chinese diaspora. In 2006, Xiamen was ranked as China's second "most suitable city for living" as well as China's "most romantic leisure city" in 2011.

Xiamen and its surrounding countryside is known for its scenery and tree-lined beaches. Gulangyu, also known as Piano Island, is a popular weekend getaway with views of the city and features many Victorian-era style European edifices. Xiamen's Botanical Garden is a nature lover's paradise. The Buddhist Nanputuo Temple, dating back to the Tang Dynasty, is a national treasure. Xiamen is also famous for its history as a frontline in the Chinese Civil War with Taiwan over Jinmen (also known as Jinmen or Quemoy) 50 years ago. One attraction for tourists is to view Kinmen, a group of islands a few kilometers away and under Taiwanese control, from Xiamen island.

Xiamen University. Beautiful campus with old traditional buildings and a tranquil lake outside the foreign language department. Nowadays the University is open for anyone, some registration may be needed on peak holidays. To avoid long registration procedure, you may enter the university from three smaller gates which are across the Baicheng beach.

Water Garden Expo Park. Water Garden Expo Park has a planning area of about 6.76 square kilometers (land area of 3.03 square kilometers), which consists of five exhibition park islands, four ecological landscapes islands and two peninsulas, including the main pavilion, Chinese Education Park, Marine Culture Island, Spa Island and other functional areas and related facilities.

Xiamen University

Xiamen University colloquially known as Xia Da, located in Xiamen, Fujian province, is the first university in China founded by overseas Chinese. Before 1949, it was originally known as the University of Amoy. The school motto is "Pursue Excellence, Strive for Perfection". The university is one of many comprehensive universities directly administered by the Chinese Ministry of Education. In 1995 it was included in the list of the 211 Project for the state key construction; in 2000 it became one of China's higher-level universities designated for the state key construction of the 985 Project.



Abstract of Talks

各向异性介质逆电磁波传输问题的谱元方法及其应用

安静

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各向异性介质逆电磁波传输问题在逆传输理论中扮演着重要的角色。这是由于材料的性质不能够由远场数据唯一确定，即使多频数据能够获得。最近，一种新的质量方法出现了，这种方法是利用传输特征值去估计非均匀介质的折射率，然而该方法需要一些较强的先验假设。我们将考虑用数值方法去估计物质材料的性质，但是该方法需要有一个有效而且强劲的数值方法去计算传输特征值。因此，我们提出了一种有效的谱元方法来计算传输特征值，然后与最优化方法相结合，从而能够对非均匀介质的折射率进行估计。

Matrix decomposition algorithms for arbitrary order S^k tensor product finite element systems

杜魁

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Matrix decomposition algorithms (MDAs) are fast direct methods for the solution of systems of linear algebraic equations which arise in the approximation of Poisson's equation on the unit square using various techniques such as finite difference, spline collocation and spectral methods. The attraction of MDAs is that they employ fast Fourier transforms and require $O(N^2 \log N)$ operations on an $N \times N$ uniform partition of the unit square. In this talk, MDAs are formulated for use in the solution of various Poisson problems on the unit square when the finite element Galerkin method with spaces of S^k piecewise polynomials of arbitrary degree k are employed. Results of numerical experiments exhibit the expected optimal global convergence rates and superconvergence phenomena. Some extensions are also discussed.

Implicit-explicit Runge-Kutta methods for phase-field models

冯新龙

新疆大学

(fxlmath@gmail.com)

In this talk, we are concerned with numerical solutions for the phase-field models by the implicit-explicit Runge-Kutta schemes and Fourier spectral method. The scheme is based on

energy convex splitting technique and predictor-corrector technique. We numerically demonstrate that the scheme converges for large time steps. The scheme allows for spectral accuracy in space and fast simulation of the dynamics in high dimensions while preserving the discrete form of the energy law. This work is joint with Prof. Tao Tang and Dr. Jiang Yang at Hong Kong Baptist University.

Spectral methods for spectrum computation of non-oscillatory and highly oscillatory kernels with weak singularity

黄灿

密西根州立大学

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We compute the spectra of integral compact operators with weak singularity. Jacobi-collocation methods are applied for problems without oscillation. A convergence rate is obtained for general non-oscillatory operators. Furthermore, if the bilinear form associated with the kernel is positive definite, the convergence rate is doubled. A spectral Galerkin method with modified Fourier expansion is developed to compute the spectra of highly oscillatory kernel. Numerical results demonstrates the effectiveness and accuracy of our algorithms and theorems.

Sobolev-orthogonal polynomial approximations and the fully diagonalized spectral-Galerkin method on the unit ball

李会元

中科院软件研究所

(huiyuan@iscas.ac.cn)

The spectral approximation using polynomials on the unit ball is first explored in this talk. Mutually orthogonal polynomials in an arbitrary high order Sobolev space is first proposed and analyzed; a nearly best approximation for functions in W_p^σ space is then established. Focuses are then set on the structure and optimal error estimates of the nearly best approximation. On the basis of polynomial approximations, a direct and fully-diagonalized spectral-Galerkin method for second and fourth order elliptic equations are developed; Illustrative numerical results, which are in agreement with the theoretical estimates, are also demonstrated.

Convergence analysis of Chebyshev spectral Galerkin methods for weakly singular Volterra integral equations

李娟娟
福州大学

In this paper, we propose the Chebyshev spectral and pseudo-spectral Chebyshev-Galerkin method for the second kind Volterra integral equations with weakly singular kernel $(x-s)^{-\mu}$, $0 < \mu < 1$. The convergence analysis in both L^∞ and $L^2_{\{\omega^{-\frac{1}{2}}, -\frac{1}{2}\}}$ norm is given provided that the solution is sufficiently smooth. Numerical experiments validate the theoretical prediction.

Pseudo-spectral method for self-consistent field equations of wormlike chain on a spherical surface

梁琴
湘潭大学数学与计算科学学院
(liangqin1997@gmail.com)

A new class of basis functions is presented and a pseudo-spectral method is developed to solve the self-consistent field equations of wormlike chain on a spherical surface. While the spherical harmonic functions will introduce a pole effect for this spherical problem, our new basis functions can handle the pole effectively. As is shown in our numerical experiments, this pseudo-spectral method has good performance in both stability and accuracy.

Efficient spectral method for variable coefficients and nonlinear differential equations with applications

刘飞
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A simple and efficient spectral method for solving the second and third order elliptic equations with variable coefficients and nonlinear differential equations is presented. It is different from spectral-collocation method which leads to dense, ill-conditioned matrices. The spectral method in this paper solves for the coefficients of the solution in a Chebyshev series, leads to discrete systems with special structured matrices which can be factorized by using the FACTORIZE package. Ample numerical results indicate that the proposed method is extremely accurate and efficient, as well as several interesting applications are presented, including Allen-Cahn and Cahn-Hilliard equations.

Legendre Spectral Methods for two dimensional fractional differential equations

毛志平

厦门大学

(maozhiping2005@sina.com)

In this presentation, we consider Legendre spectral methods to solve two dimensional fractional differential equations with variable coefficients. First, for separable coefficients problem, matrix diagonalization methods are used. Both partial diagonalization method and full diagonalization method are considered. Second, for non-separable coefficients problems, we develop a preconditional iterative method. A rigorous error estimate is given for constant coefficients equations. Some numerical results are presented.

An efficient spectral method for scattering in unbounded rough surfaces

沈捷

Purdue University and Xiamen University

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I shall present an efficient and stable spectral algorithm for solving the unbounded rough surface scattering problem, which is referred to as a non-local perturbation of an infinite plane surface such that the whole surface lies within a finite distance of the original plane. The method uses a transformed field expansion to reduce the boundary value problem with a complex scattering surface into a successive sequence of transmission problems of the Helmholtz equation with a plane surface. We then construct a special algorithm using Hermit functions to fully decouple the problem into a sequence of one-dimensional two-point boundary value problems with piecewise constant wavenumbers, which can be solved efficiently by a spectral-element method. I shall present ample numerical results to show that the new spectral method is efficient, accurate, and well suited to solve the scattering problem by unbounded rough surfaces.

Interior penalty discontinuous Galerkin methods with implicit time-integration techniques for nonlinear parabolic equations

宋伦继

兰州大学数学与统计学院

(lodgeslg@hotmail.com)

We prove existence and numerical stability of numerical solutions of three fully discrete interior

penalty discontinuous Galerkin methods for solving nonlinear parabolic equations. Under some appropriate regularity conditions, we give the $l_2(H_1)$ and $l_\infty(L_2)$ error estimates of the fully discrete symmetric interior penalty discontinuous Galerkin–scheme with the implicit θ -schemes in time, which include backward Euler and Crank–Nicolson finite difference approximations. Our estimates are optimal with respect to the mesh size h . The theoretical results are confirmed by some numerical experiments.

Some spectral approximations in one dimension and their applications

孙涛

上海金融学院

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We introduce some orthogonal and quasi-orthogonal approximations in one dimension, and establish a series of results on these approximations, which play important roles in numerical solutions of higher-order differential equations. In particular, they serve as powerful tools in spectral element method. As examples of applications, we propose a Petrov-Galerkin spectral element method for fourth-order problem, with precise error analysis. Efficient algorithm is implemented in detail. Numerical results demonstrate its high accuracy, and confirm theoretical analysis well.

A multistep Legendre-Gauss spectral collocation method for nonlinear Volterra integral equations with delays

王中庆

上海师范大学

(zqwang@shnu.edu.cn)

In this talk, we introduce a multistep Legendre-Gauss spectral collocation method for the nonlinear Volterra integral equations with delays. This method is easy to implement and possesses the high order accuracy. We also derive the convergence of the hp-version of the multistep collocation method under L^2 -norm. Numerical experiments confirm the theoretical expectations.

Defeating ill-conditioning of collocation methods: polynomials and PSWFs

王立联

Nanyang Technological University, Singapore

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In this talk, we shall discuss how to construct well-conditioned collocation schemes from the perspective of Birkhoff interpolation for e.g., Legendre and Chebyshev polynomials. However, for the prolate spheroidal wave functions (PSWFs)---a non-polynomial basis, a different routine should be adopted. We shall also demonstrate that the PSWF-based method enjoys significant advantages over the polynomial counterpart in some applications, e.g., eigen-problems and Helmholtz equations with high wavenumbers.

Investigation on using different high-order bases for some applications

徐进

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Many physical simulations need highly efficient numerical methods, which depend on many factors, such as expansion bases, mesh, algorithms and parallel models. This paper will investigate the effects of using different expansion bases in some physical simulations. Their performance will be compared in detail, which includes accuracy, speed, and parallel efficiency. Based on these, we will investigate the reason for the difference. This will help us to improve the bases for simulations in some particular regime. The advantages and disadvantages of using different bases will be studied. Some simulation results will be presented using the suitable solvers.

Multi-domain spectral collocation method for fractional differential equations

徐勤武

中南大学

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In this talk, we discuss the multi-domain spectral collocation method for both space and time fractional differential equations. First, we propose two different methods for approximating fractional differential operator of Caputo type. The accuracy of the proposed methods are analyzed and the differences between them are discussed. For the time fractional differential equation, we apply Fourier transform to both sides of the equation and convert it to a system of ordinary differential equations. Then we analyze the flexibility and stability of the new scheme and provide its stability region. For the space fractional differential equations, we introduce stable multi-domain spectral penalty methods for solving fractional advection and diffusion equations. The equations are discretized in each sub-domain separately and the global schemes are obtained by weakly imposed boundary and interface conditions through a penalty term. Numerical

examples are given for both time and space fractional differential equations to highlight the flexibility and high accuracy of the proposed schemes.

An h-p version Petrov-Galerkin FEM for nonlinear Volterra integro-differential equations

易利军

上海师范大学

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In this talk, we shall present an h-p version Petrov-Galerkin finite element method for nonlinear Volterra integro-differential equations. We derive a priori error bounds in the L^2 - and H^1 -norm that are explicit in the time steps, the approximation orders, and the regularity of the exact solution. Numerical experiments are provided to illustrate the theoretical results.

Spectral methods for the study of global stability of plane shear flow

于海军

中国科学院

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Osborne Reynolds studied the instability of pipe flow in his seminal 1883 paper. Since then, the interests in the instability of fluid dynamics rose up. The linear stability analysis was first introduced by W. M. Orr and A. Sommerfeld (1907, 1908). Later, a lot of theoretical and numerical works were carried out for the linear stability analysis. This has been one of the most important problems in fluid dynamics for more than one century. However, linear stability analysis is not sufficient for the nonlinear Navier-Stokes equation. In this talk, we introduce two methods to study the global stability of solutions of plane shear flow. The first one is the Minimum Action Method (MAM), it is a deterministic method minimizing the action on the transition path. The second method is a stochastic method, which study the global stability by solving the stochastic Navier-Stokes equation for a very very long time. Both approaches require huge computations, therefore spectral methods are used to reduce the degree of freedom and overall computational cost.

Finite difference/spectral approximations to a water wave model with a nonlocal viscous dispersive term

张俊

贵州财经大学

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The numerical simulation of a water wave model with a nonlocal viscous dispersive term is considered in this article. We construct two linearized finite difference/spectral schemes for numerically solving the considered water model. A particular attention is paid to the treatment of the nonlocal dispersive term and the nonlinear convection term. The proposed methods employ a known $(2-\alpha)$ -order schema for the α -order fractional derivative and a mixed linearization for the nonlinear term. A detailed analysis shows that the proposed schemes are unconditionally stable. Some error estimates are provided to predict that the method using the linearized Euler plus $(2-\alpha)$ order schema in time and the spectral approximation in space is convergent with order of $O(\Delta t + N^{1-m})$, where Δt , N and m are respectively the time step size, polynomial degree, and regularity in the space variable of the exact solution. Moreover, we prove that the second order backward differentiation plus $(2-\alpha)$ -order schema converges with order $3=2$ in time. A series of numerical examples is presented to confirm the theoretical prediction. Finally the proposed methods are used to investigate the asymptotical decay rate of the solutions of the water wave equation, as well as the impact of different terms on this decay rate.

Analysis of collocation solutions for nonstandard Volterra integral equations

张然

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Abstract

In this work, we study the existence, uniqueness and regularity properties of solutions for the nonstandard Volterra integral equation $u(t)=g(t)+\int_0^t K(t,s,u(t),u(s))ds, t \in [0,1]$. We then present a collocation method to solve this equation, and analyze the convergence and super-convergence of piecewise polynomial collocation approximations. We also illustrate the theoretical results by extensive numerical experiments.

Time domain interface methods for electromagnetic wave propagation in dispersive media

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Dispersive media are ubiquitous in nature, such as in biological tissues, rocks, soils, ice, snow, and plasma. In such media, the dielectric permittivity is a function of frequency so that a broadband electromagnetic wave will propagate and attenuate in a frequency dependent manner. The interaction of such a wave with a dispersive interface, which separates a dispersive medium and a non-dispersive medium, is a very complex electromagnetic process. In particular, the electromagnetic field discontinuity across the dispersive interface is known to be frequency-dependent or time-varying in time domain simulations. Based on the auxiliary differential equation approach, we will examine a dispersive interface problem with the Debye dispersion model. A novel mathematical formulation will be established to describe the regularity changes in electromagnetic fields at the dispersive interface. The resulting time-dependent jump conditions will then be numerically enforced via the matched interface and boundary (MIB) scheme. High order convergences are achieved in treating complex and dispersive interfaces. This is a joint work with my PhD student Duc Nguyen.

Legendre-collocation method for nonlinear Volterra-type integro-differential equations of the second kinds

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In this paper, we propose an efficient numerical method for Volterra-type nonlinear integro-differential equations, based on Legendre-Gauss-Radau interpolation, which is easy to be implemented and possesses the spectral accuracy. We also develop a multi-step version of this approach. Numerical results coincide well with the theoretical analysis and demonstrate the effectiveness of these approaches.

一类耦合分数阶微分方程组的理论分析及数值方法

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运用单调迭代技巧并结合上下解方法, 得到了耦合分数阶微分系统:

$$D^\alpha u_i(t) = f_i(u_1, u_2, u_3, u_4), u_i(0) = u_i^0, i = 1, 2, 3, 4$$

解的存在性和唯一性，同时，还给出解对初值的连续依赖性。此外，我们给出了一个例子：分数阶捕食模型，研究该模型的可解性，给出了数值结果。当 α 趋于1时，数值模拟结果表明与整数阶捕食模型是一致的。最后，研究了非线性耦合分数阶微分方程组

$$D^\alpha u_i(t) = f_i(u_1, u_2), u_i(0) = u_i^0, i = 1, 2。$$

的高阶数值算法，构造了一个高阶格式，并给出了该格式的稳定性分析和收敛性分析。我们证明了：当 $0 < \alpha \leq 1$ 时，格式的收敛阶为 $3 + \alpha$ ；当 $\alpha > 1$ 时，收敛阶是4。最后，一系列的数值算例验证了理论分析结果。

一类具有非线性边界条件四阶方程的数值求解： 紧差分逼近与谱逼近

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针对一类具有非线性边界条件的四阶方程，首先提出紧差分格式进行逼近，对差分格式进行了误差分析。分别利用Newton迭代算法和差商迭代方式来处理非线性边界条件。数值结果表明逼近格式是可行的，且逼近精度为 $O(h^4)$ 。然后考虑该方程的谱逼近，数值结果表明逼近格式具有谱收敛性质。

Map

Direction from the hotel to the campus

从厦门武警疗养院到报告厅(厦门大学海韵校区实验楼 S105)步行大约 10 分钟，11 月 2 日早上 7:50 在宾馆大厅集合，将有专人引导到报告厅。



参会代表名单（按照单位拼音顺序）

序号	姓名	单位
1	赵山	University of Alabama
2	蒋凯	北京大学
3	叶时炜	北京大学
4	张晶	北京计算科学研究中心
5	艾丽萍	长江大学
6	赵璇	东南大学
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8	张俊	贵州财经大学
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17	张然	吉林大学
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34	徐进	中国科学院软件研究所
35	徐勤武	中南大学
36	江颖	中山大学
37	巫斌	中山大学
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40	哈里曼达力汗	厦门大学
41	刘晓玲	厦门大学
42	刘红霞	厦门大学
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