2009 International Workshop on Differential Equations and Their Applications

2009/12/18 ~ 2009/12/21 at NCTS and NCKU

Final Program

	Friday(12/18)	Saturday(12/19)	Sunday(12/20)	Monday(12/21)
0840~0855		Open Ceremony: Da Hsuan Feng (Vice President) 馮達旋		
		Chair: Hwaichiuan Wang 王懷權	Chair: Tai-ping Liu 劉太平	Chair: Kuo-Ming Lee 李國明
0900~0940		1 Tai-ping Liu 劉太平	10 Yoshio Sone 曾根良夫	19 Gen Nakamura 中村玄
0940~1020		2 Hitoshi Imai 今井仁司	11 San-Yih Lin 林三益	20 Ciann-Dong Yang 楊憲東
1020~1040		Break	Break	Break
		Chair: Hitoshi Imai 今井仁司	Chair: Tei-Chen Chen 陳鐵城	Chair: G. Nakamura 中村玄
1040~1120		3 Kazumi Tanuma 田沼一實	12 Takayuki Kitamura 北村隆行	21 Chien-Hong Cho 卓建宏
1120~1200		4 Chung Kwong Law 羅春光	13 Se Eun NOH 盧世垠	22 Yuusuke Iso 磯祐介
		Lunch	Lunch	Lunch
		Chair: Y. Iso 磯祐介	Chair: Yung-Fu Fang 方永富	
1330~1410	Registration	5 Jong-Sheng Guo 郭忠勝	14 Tohru Ozawa 小澤徹	
1410~1450		6 Yung-Sze Choi 蔡英士	15 I-kun Chen 陳逸昆	
1450~1510		Break	Break	
		Chair: Jyh-hao Lee 李志豪	Chair: T. Ozawa 小澤徹	
1510~1550		7 Chieh-Sen Huang 黃杰森	16 Kenji Nakanishi 中西賢次	
1550~1630		8 Yasushi Hataya 幡谷泰史	17 Jin-Cheng Jiang 江金城	
1630~1640		Break	Break	
		Chair: Wen-Ching Lien 連文璟	Chair: Kazumi Tanuma 田沼一實	
1640~1720		9 Yu-lin Lin 林玉琳	18 Yun-Che Wang 王雲哲	
1800~	Buffet	Banquet		

1. Yuusuke Iso-

   Title: Finite Difference Approach for the Kowalevskian

   Abstract: We deal with numerical treatment of the Cauchy problem for the Kowalevskian with multipre-precision arithmetic. The problem considered in the class of analytic functions has, as is well known, the unique solution, but it may be ill-posed in the frame of Sobolev spaces; we obtain the solution in the mathematical sense, but we have not been able to construct, in general, its numerical one on computer. The multipre-precision arithmetic, which can extinguish influence of the rounding errors in computing process, enables us to construct reliable numerical solutions now, and many numerical examples have been shown. In this talk, theoretical background of the approach is presented. We discuss on the problem by a Banach scale, and we give finite difference approximation of the Banach Scale. Some numerical results on interval output are also shown.

2. Gen Nakamura-

   Title: Analytic Extension and Reconstruction of Obstacles from Few Measurements for Elliptic Second Order Operators

   Abstract: For the inverse scattering problems, the uniqueness and reconstruction of unknown scatterers from few measurements are the fundamental problems. In this talk we will show that if the scatterer has non-analytic boundary and the medium properties are analytic near the boundary, then we can provide a reconstruction scheme of the unknwon scatterer. The proof is based on the analytic extension of solutions of elliptice second order operators with analytic coefficients and convergence argument for the one wave no-response test.

3. Kenji Nakanishi-

   Title: Scattering threshold for the focusing nonlinear Klein-Gordon equation

   Abstract: This is joint work with Slim Ibrahim and Nader Masmoudi. We show scattering versus blow-up dichotomy below the ground state energy for the focusing nonlinear Klein-Gordon equation, in the spirit of Kenig-Merle for the critical wave equation. The main difficulty in our setting is the lack of scaling invariance both in the linear and nonlinear terms. The interesting feature is that the mass for the ground energy as the threshold may be reduced in some cases. More precisely, the mass becomes zero for the H^1 critical power in three or higher dimensions, whereas it is shifted to a positive smaller value for some exponential type nonlinearities in two dimensions, where the reduced mass is characterized by the best constant in a sharp Trudinger-Moser inequality.

4. Tohru Ozawa-

   Title: Global Cauchy problem for quadratic NLKG

   Abstract: This talk is based on my recent joint work with Jun Kato. We consider the Cauchy problem for semilinear Klein-Gordon equations with nonlinearity vanishing quadratically at the origin in space dimensions $n \geq 2$. We prove the existence and asymptotic completeness of wave operators in a small ball at the origin in the Sobolev space with sufficiently large order.

5. Kazumi Tanuma-

   Title:

   Abstract:

6. Yung-Sze Choi-
   Title:
   Abstract:
7. Takayuki Kitamura-
   Title: Multi-physics property of nano-components
   Abstract: I have investigated the strength of low-dimensional nano-components such as films and islands formed on substrates in terms of the nanometer-scale mechanics by novel experimental research and ab initio computational simulations. In the latter, the recent focus is put on the understanding the interaction between mechanical property and other physical ones (electrical conductance and ferroelectric and magnetic characteristics), namely multi-physics property. In the workshop, I will present the structure of PbTiO3 nano-component and its ferroelectric behavior including the influence of deformation. Figure shows an example of our analyses on the domain boundary under tension. You can find the domain switching where the bonds at the domain boundary are swapped by the applied shear strain. The detail of change in the ferroelectric behavior by the switching will be discussed.
8. Hitoshi Imai-
   Title: Numerical continuation for the Laplace equation with higher order regularization
   Abstract: Cauchy problems for the two-dimensional Laplace equation are considered. In the case where the solution is part of a global function
   direct numerical computation by IPNS is successful. On the other hand, in the case where the solution is part of a function which has singularity direct numerical computation sometimes fails. In this situation we consider the application of several kinds of regularization. Numerical results show that the second order regularization works well.
9. Yasushi Hataya-
   Title: Incompatibility of initial and final data in a free boundary problem
   Abstract: In a free boundary problem of viscous incompressible fluid, some "incompatibility" of the initial data η_0 and the final data η_{∞} occurs. If the initial data is not orthogonal to the space spaned by eigen vectors, the trace of fluid velocity does not belong to $L^1_{t,x}$, which leads our incompatibility $\int_{\Omega_0}\eta_0dx \not=\int_{\Omega_{\infty}}\eta_{\infty}dx$.
10. Tai-Ping Liu-
   Title: Some Open Problems for Nonlienar PDE
   Abstract: We will raise some open problems for the shock wave theory and kinetic theory. Of particular importance for the shock wave theory is the muliti-dimensional waves and the resulting problems in nonlinear mixed-types PDE. We will mention two types of problems for the kinetic theory. One is for the relation with the gas dynamics and the other is the phenomena distinctly kinetic in nature.
11. Jin-Cheng Jiang-
   Title: Bilinear Strichartz estimates for Schr\"{o}dinger operators in 2 dimensional compact manifolds
   Abstract: In this talk, we will talk about the bilinear Strichartz estimates for Schr\"{o}dinger operators in 2 dimensional compact manifolds with boundary. Using these estimates, we can

infer the local well-posedness of cubic nonlinear Schr\"{o}dinger equation in H^s for every $s>\frac{2}{3}$ on such manifolds by standard nonlinear analysis. Hence we will present the ideas of building such estimates in compact manifolds with boundary. The case for manifolds without boundary can be obtained by a simplified proof.

12. I-Kun Chen -
    Title: Spherical Averaged Endpoint Strichartz Estimates for the Two-dimensional Schrodinger Equations with Inverse Square Potential
    Abstract: I investigate two-dimensional Schrodinger equation with repulsive inverse square potential, V(x)=a^2/|x|^2. I prove a version of homogeneous endpoint Strichartz estimate. I defined a norm that takes L2 average on angular variable first and then supremum norm on radial variable and then L2 norm on time variable. The L2 norm of the initial data contrals the solution in the norm defined above.
13. Yu-Lin Lin -
    Title: Large-time rescaling behaviors to the Hele-Shaw problem driven by injection
    Abstract: This talk addresses a large-time rescaling behavior of Hele-Shaw cells for large data initial domains. The Polubarinova-Galin equation is the reformulation of zero surface tension Hele-Shaw flows with injection at the origin in two dimensions by considering the moving domain $\Omega(t)=f(B_{1}(0),t)$ for some Riemann mapping $f(\xi,t)$. We give a sharp large-time rescaling behavior of global strong polynomial solutions to this equation and the corresponding moving boundary in terms of the invariant complex moments. Furthermore, by proving a perturbation theorem of polynomial solutions, we also show that a small perturbation of the initial function of a global strong polynomial solution also gives rise to global strong solution and a large-time rescaling behavior of the moving domain is shown as well. More applications of this perturbation theorem are given as well.
14. Yoshio Sone-
    Title: Ghost effect of infinitesimal curvature and bifurcation of the plane Couette flow
    Abstract: The fluid-dynamic-type system with the ghost effect of infinitesimal curvature, derived by the asymptotic analysis of the Boltzmann system for small Knudsen numbers, is first described, and how the ghost effect of infinitesimal curvature enters the system is explained. Then, the bifurcation of the plane Couette flow of a gas in the continuum limit is shown on the basis of the fluid-dynamic-type system.
15. San-Yih Lin-
    Title: Progress in the Development and Application of Lattice Boltzmann Method
    Abstract: As an alternative computational fluid dynamics approach, lattice Boltzmann method (LBM) receives more and more attention in recent years.LBM is a particle-based approach, which does not involve the solution of partial differential equations and their resultant algebraic equations. Currently, LBM has been widely applied to simulate various fluid flow problems. This talk will report the progress in the development and

application of LBM by our group.
In the development of the LBM, we developed a direct-forcing pressure-based LBM to study the fluid-particle interaction problems. The direct-forcing scheme is also served as a wall-boundary condition. This scheme is simpler than the bounce-back boundary condition. About the force evaluation, by applying the Gauss theorem, the formulas for computing the force and the torque acting on the particle from the flows are derived from the volume integrals over the particle volume instead from the surface integrals over the particle surface. This talk will address the application to the sedimentations of many particles in an enclosure.

16. Cheng-Chien Liu-
Title: Solving the radiative transfer equation for remote sensing of ocean color
Abstract: The light propagating upwards from beneath the surface contains information about the material dissolved and suspended in the water. Based on this principle, the technology of remote sensing has provided an avenue, by which the synoptic observation of ocean color can be made from space. Retrieving information from these radiative signals of water color plays a key role in the success of spaceborne ocean color missions. In principle, this is an inverse problem of hydrologic optics governed by the radiative transfer equation (RTE): given radiometric measurements from space, determine the concentration and characteristics of water constituents. The RTE, however, is an integral-differential equation that is currently solved by numerical approaches. There are certainly some limitations of numerical approaches. In this paper, we will present the related works in (1) validating biogeochemical models, (2) simulating the underwater light field, and (3) retrieving water constituents from remote sensing of ocean color. Some discussions and our research strategy for the future works would be given, and hopefully, more collaboration with mathematicians could be initiated after this workshop.

17. Chien-Hong Cho-
Title: On the finite difference approximation for hyperbolic blow-up problems
Abstract: We first consider the CLM equation as an example showing the difficulties in reproducing blow-up numerically. Then we consider the semilinear wave equation $u_{tt}=u_{xx}+u^2$ and its finite difference analogue whose time mesh is adaptively-defined. We show not only that our numerical solution blows up in finite time but also that the numerical blow-up time converges to the real blow-up time under certain assumptions. However, it is difficult to show the stability of the numerical solution if the time mesh varies every step. Our recent results on this issue and several numerical examples will be reported.

18. Yun-Che Wang-
Title: Ellipticity and stability of the Navier equation in composite materials
Abstract: Composite materials containing negative-stiffness inclusions have been experimentally demonstrated to exhibit extreme high effective stiffness and viscoelastic damping. The long-term stability of the extreme properties require further mathematical analysis on the corresponding Navier equation with judiciously chosen parameters. Its ellipticity ensures uniqueness, but not pointwise stability. It has been shown that the composite materials may be stable under traction boundary conditions. Specific quantitative requirements on the elastic

moduli of the constituent materials have been derived to show that negative-stiffness phases can exist in composites, while overall stability is achieved in the low frequency limit. Dynamic stability of the plane-strain elastic composite consisting of a circular cylinder of non-positive-definite material firmly bonded to a positive-definite concentric coating has been performed. Effects of interfacial stresses at the matrix-inclusion boundary are discussed. The roles of viscoelasticity and non-classical elasticity are examined in relation to the extreme phenomena.

19. Ciann-Dong Yang-

Title: Connecting Hamilton-Jacobi Equation to Schrödinger Equation: A Route from Classical World to Quantum World

Abstract: The Hamilton-Jacobi (H-J) equation is the governing PDE in classical physics advocated by Einstein, while the Schrödinger equation is the governing PDE in quantum physics advocated by Bohr. Up to now, the debate between Einstein and Bohr is still an open question. It is a common thinking that the two governing PDE belong to different domains and seem to be independent. In this talk, I wish to point out that the H-J equation and the Schrödinger equation can be made equivalent in complex space. The remarkable implication behind this equivalence is that the deterministic world described by the H-J equation and the probabilistic world described by the Schrödinger equation now can be connected by a route via complex space.

This talk introduces the development and the progress of such a route called complex-valued mechanics within which every physical quantity is represented by a complex variable having real and imaginary parts. Although the imaginary part cannot be directly measured in the real world, its influences on the nature can be definitely detected via the measurement of its interaction with the real part. The interaction between real and imaginary parts gives rise to the quantum phenomena we have observed in the physical world.

The random feature of quantum mechanics originates from the influence of the unmeasurable imaginary parts as we view a quantum event from the real space. However, if we could view the same event from the complex space, the randomness would disappear because a causal relation between the evolution of a quantum event and its initial conditions can be defined uniquely in the complex space. Therefore, regarding the debate between Einstein and Bohr, I wish to say that both of them are right. If we describe quantum events in complex space, then everything is deterministic as expected by Einstein. Actually, since only the real part of quantum events can be measured, randomness and uncertainty caused by the unmeasurable imaginary parts emerge naturally in our physical world, as expected by Bohr.

20. Jong-Sheng Guo-

Title: Traveling wave fronts for a 2-component LDS arising in competition models

Abstract: We study traveling wave front solutions for a two-component system on a one dimensional lattice. This system arises in the study of the competition between two species with diffusion (or migration), if we divide the habitat into discrete regions or niches. We consider the case when the nonlinear source terms are of Lotka-Volterra type. For the monostable case, we first show that there is a minimal wave speed such that a traveling wave front exists if and only if its speed is above this minimal wave speed. Next, we characterize the

minimal wave speed using the parameters in the
system. Then we show that any wave profile is strictly monotone. Moreover, under some conditions, we show that the wave profile is unique (up to
translations) for a given wave speed. Finally, for the numerical aspect, we derive the convergence of discretized minimal wave speeds as the mesh size tends to zero.

21. Chung Kwong Law-
    Title: Some inverse eigenvalue problems on graphs
    Abstract: Recently there is a lot of interest in eigenvalue problems on graphs. Motivations come from stability analysis of stationary interfaces, limiting study of thin domains and even carbon nano-structures. We shall study some inverse eigenvalue problems on graphs.
22. Se Eun NOH-
    Title: GLOBAL WEAK SOLUTION TO THE BOLTZMANN-ENSKOG EQUATION
    Abstract: We present the regularity theory of renormalized solutions to the Boltzmann-Enskog model with a truncation kernel and Lp-stability estimate. We use the multi-dimensional Bony type functional to control the time-phase space integral of the collision operator with a truncation. Then following Cercignani's argument [14, 15], we show that the renormalized solutions to the Boltzmann-Enskog model are weak solutions in classical distribution sense and generalized Gronwall inequality is used for L^p-stability.
23. Chieh-Sen Huang-
    Title: A Locally Conservative Streamline Method for a Model Two-Phase Flow Problem in a One-Dimensional Porous Medium
    Abstract: Motivated by possible generalizations to more complex multiphase multicomponent systems in higher dimensions, we develop a numerical approximation for a system of two conservation laws in one space dimension modeling two-phase flow in a porous medium. The method is based on tracing streamlines, so it is stable independent of any CFL constraint. The main difficulty is that it is not possible to trace individual streamlines independently. We approximate streamline tracing using local mass conservation principles and self-consistency. The two-phase flow problem is governed by a system of equations representing mass conservation of each phase, so there are two local mass conservation principles. Our numerical method respects both of these conservation principles over the computational mesh (i.e., locally), and so is a fully conservative streamline method. We present numerical results that demonstrate the ability of the method to handle problems with shocks and rarefactions, and to do so with very coarse spatial grids and time steps larger than the CFL limit.
24. Kuo-Ming Lee-
    Title: A Simple Hybrid Method In Inverse Scattering Problem
    Abstract: Consider the scattering from a sound soft obstacle which can be modelled by the exterior Dirichlet problem for the Helmholtz equation.
    The task of the direct problem is to find a solution u^s is in $C^2(R^2 \setminus \bar D) \cap C(R^2 \setminus D)$ to the Helmholtz equation
    $\Delta u^s + k^2 u^s = 0;$ in $R^2 \setminus \bar D$ (1)
    which satisfies the Dirichlet boundary conditions
    $u^s = -u^i$ on $\Gamma := \partial D$ (2)

and the Sommerfeld radiation condition

$$\lim_{r\to\infty} \sqrt{r} \left(\frac{\partial u^s}{\partial \nu} - iku^s \right) = 0, \quad r := |x| \qquad (3)$$

uniformly for all directions $\hat{x} := x/|x|$ given an incident plane wave $u^i(x; d) := e^{ik\langle x,d\rangle}$ with a wave number $k > 0$ and a unit vector d giving the direction of propagation. This kind of problem is solved sucessfully using boundary integral equation method, see [1] for example.

In this talk we present a simple method for solving time-harmonic acoustic inverse scattering problem for a sound-soft obstacle in R^2. Based on the integral equation methods, the solving of the inverse scattering problem leads to a Fredholm integral equation of the first kind

$$F(\Gamma) = u_\infty \qquad (4)$$

where Γ is the boundary of the unknown scatterer. Instead of applying regularized Newton's method directly to this integral equation (see [2], [3]), we decompose the inverse problem into a linear well-posed problem and a nonlinear problem:

$$B_\Gamma (\varphi) = -2u^i \qquad (5)$$

$$F_\varphi (\Gamma) = u_\infty$$

which will be solved iteratively. The major advantage of this method over that in [2], [3] is that the update of the iteration is obtained directly from the solving of the system 5 instead of solving another related direct problem. From the practical point of view, the resultant system can be solved more efficiently than the method used in [4], [5] since the system (5) is treated as uncoupled. Several numerical examples will be given at the end of the presentation to illustrate our method.