Sino-German Workshop on

Analysis on Partial Differential Equations and Applications

College of Mathematics and Statistics

Chongqing University

March 26-30, 2012

Sino-German Workshop on

Analysis on Partial Differential Equations and Applications

Chongqing University, March 26-30, 2012

A workshop on "Analysis on Partial Differential Equations and Applications", supported by the NSF of China and the DFG of Germany via the Research Project in Partial Differential Equations, is scheduled to be held at Chongqing University, People's Republic of China, during March 26-30, 2012.

Organizing Committee:

Hua Chen (Wuhan) Song Jiang (IAPCM) Chunlai Mu (Chongqing)
B.-W. Schulze (Potsdam) Ingo Witt (Göttingen)

Featured Topics:

Asymptotic Theory of Differential Equations
Reaction-Diffusion Equations and Applications
Partial Differential Equations and Application in Physics and Geometry
Nonlinear Equations and Systems

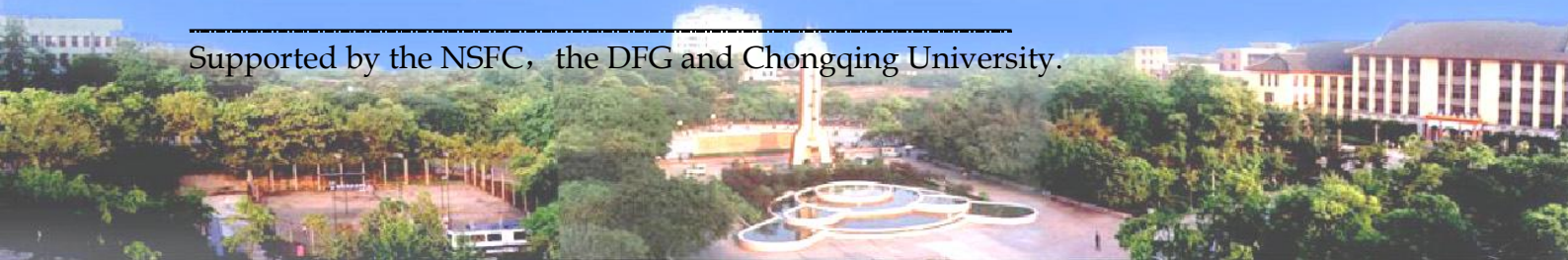
List of Invited Speakers :

Franka Baaske (Freiberg)
Wolfram Bauer (Greifswald)
Swanhild Bernstein (Freiberg)
Daomin Cao (AMSS)
Hua Chen (Wuhan)
Li Chen (Tsinghua)
Michael Dreher (Konstanz)
Juergen Eichhorn (Greifswald)
Daoyuan Fang (Zhejiang)
Christian Jaeh (Freiberg)
Song Jiang (IAPCM)
Chunhua Jin (SCNU)
Jun Li (Nanjing)
Xiaochun Liu (Wuhan)
Zhaoli Liu (Capital Normal)
Oliver Matte (Clausthal)
Chunlai Mu (Chongqing)
Bui Tang Bao Ngoc (Freiberg)
Michael Pokojovy (Konstanz)
Yuming Qin (Donghua)
Changzheng Qu (Ningbo)
Reinhard Racke (Konstanz)
Michael Reissig (Freiberg)
B.-W. Schulze (Potsdam)
Heinz Siedentop (München)
Edgardo Stockmeyer (Freiberg)
Chunlei Tang (Southwest Univ.)
Chunpeng Wang (Jilin)
Y.G. Wang(Shanghai Jiaotong)
Yawei Wei (Nankai)
Ingo Witt (Göttingen)
Huicheng Yin (Nanjing)
Jingxue Yin (SCNU)

Webpage: http://maths.whu.edu.cn/kxyj/xshy/201203/t20120308_5874.htm

Contact Information: Dr. Xiaochun Liu （E-mail: xcliu@whu.edu.cn）

Supported by the NSFC，the DFG and Chongqing University.



The Program of

Sino-German Workshop on Partial Differential Equations and Applications

Chongqing University, March 26-30, 2012

Date / Time	Monday, Mar. 26	Tuesday, Mar. 27	Wednesday, Mar. 28	Thursday, Mar. 29	Friday, Mar. 30
8:30-9:15	**Chairman: L. Qin (秦岚)** 9:00-9:20 Opening	**Chairman: Ingo Witt** J. X. Yin (尹景学)	**Chairman: S. Jiang** J. Eichhorn	**Chairman: J. Eichhorn** Y. G. Wang (王亚光)	
9:20-10:05	9:20-9:40 Conference Photo 9:40-9:50: Tea Break **(Chairman: H. Chen)**	Michael Dreher	Z. L. Liu (刘兆理)	Reinhard Racke	
10:10-10:30 (Tea Break)	9:50-10:35 B.-W. Schulze	**Chairman: D.M. Cao**	**Chairman:** Heinz Siedentop	**Chairman:** Z. L. Liu	
10:30-11:15	10:40-11:25 D. M. Cao (曹道民)	D. Y. Fang (方道元)	H. C. Yin (尹会成)	C. Z. Qu (屈长征)	
11:20-12:05	11:30-12:15 C. L. Mu (穆春来)	Wolfram Bauer	Swanhild Bernstein	Michael Pokojovy	
12:10 -14:00 (Lunch)	**Chairmain: C.J. He** **（何传江）**	**Chairman:** B.-W. Schulze	**Chairman:** J. X. Yin	**Chairman: Y.G. Wang**	City Tour
14:30 -15:15	14:00-14:45 Heinz Siedentop	Michael Reissig	X. C. Liu (刘晓春)	Oliver Matte	
15:20-16:05	14:50-15:35 Y. M. Qin (秦玉明)	Y. W. Wei (魏雅薇)	Edgardo Stockmeyer	Christian Jaeh	
16:10-16:30 (Tea Break)	**15:40-16:00(Tea Break)** **Chairman:** Reinhard Racke	**Chairman:** H. C. Yin	**Chairman:** Michael Reissig	**Chairman: C. L. Mu**	
16:30-17:15	16:00-16:45 L. Chen (陈丽)	J. Li (李军)	Bui, Tang Bao Ngoc	C. L. Tang (唐春雷)	
17:20-18:05	16:50-17:35 C. H. Jin (金春花)	C. P. Wang (王春朋)	Franka Baaske	Ingo Witt	
18:30(supper)	Banquet 18:30				

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The Schedule

Monday, March 26, 2012

Chairman	***Lan Qin***
9:00-9:20	***Opening***
9:20-9:40	***Conference photo***
9:40-9:50	***Tea break***
Chairman	***Hua Chen***
9:50-10:35	***Bert-Wolfgang Schulze*** ***The Variable branching asymptotics on manifolds with edges***
10:40 -11:25	***Daomin Cao*** ***Existence of multiple solutions for a free boundary problem of an elliptic equation***
11:30-12:15	***Chunlai Mu*** ***Well-posedness and blow-up phenomena for a higher order shallow water equation***
12:20 -14:00	**Lunch**
Chairman	***Chuanjiang He***
14:00-14:45	***Heinz Siedentop*** ***The spectrum of Graphene Quantum Dots***
14:50-15:35	***Yuming Qin*** ***Global existence and asymptotic behavior of solutions to the 1D compressible radiative fluids***
15:40-16:00	***Tea Break***
Chairman	***Reinhard Racke***
16:00-16:45	***Li Chen*** ***Towards nonlinear Hartree dynamics with factorized initial data***
16:50-17:35	***Chunhua Jin*** ***Traveling wavefronts for a time delayed non-Newtonian filtration equation***
18:30	***Banquet***

Tuesday, March 27, 2012

Chairman	***Ingo Witt***
8:30-9:15	***Jingxue Yin*** ***Some dynamical properties in evolutionary p-Laplacian***
9:20-10:05	***Michael Dreher*** ***Large data solutions to the viscous quantum hydrodynamic model with barrier potential***
10:10-10:30	***Tea break***
Chairman	***Daomin Cao***
10:30 -11:15	***Daoyuan Fang*** ***Existence results for Oldroyd-B fluids in exterior domains***
11:20 -12:05	***Wolfram Bauer*** ***On the spectral analysis of sub-Laplacians on spheres***
12:05 -14:00	**Lunch**
Chairman	***Bert-Wolfgang Schulze***
14:30-15:15	***Michael Reissig*** ***Global existence for semi-linear damped wave equation***
15:20-16:05	***Yawei Wei*** ***The Mellin-Edge quantisation for corner operators***
16:10 - 16:30	***Tea Break***
Chairman	***Huicheng Yin***
16:30 - 17:15	***Jun Li*** ***On three-dimensional supersonic conic shock wave***
17:20 -18:05	***Chunpeng Wang*** ***Smooth transonic flows in De Laval nozzles***
18:30	***Supper***

Wednesday, March 28, 2012

Chairman	***Song Jiang***
8:30-9:15	***Juergen Eichhorn*** ***Chains of Sobolev spaces for cusp-like ends of open manifolds***
9:20-10:05	***Zhaoli Liu*** ***Equations with linearly bounded nonlinearities***
10:10 - 10:30	***Tea break***
Chairman	***Heinz Siedentop***
10:30 - 11:15	***Huicheng Yin*** ***On the blowup of classical solutions to some class of nonlinear wave equations***
11:20 - 12:05	***Swanhild Bernstein*** ***Lax pairs and the inverse scattering transform***
12:10 - 14:00	**Lunch**
Chairman	***Jingxue Yin***
14:30 - 15:15	***Xiaochun Liu*** ***On a semilinear equation involving critical cone Sobolev exponent and sign-changing weight function***
15:20-16:05	***Edgardo Stockmeyer*** ***Real analyticity of pseudorelativistic Hartree-Fock orbitals***
16:10 - 16:30	***Tea Break***
Chairman	***Michael Reissig***
16:30 - 17:15	***Bui Tang Bao Ngoc*** ***A damped waves with time-dependent speed and dissipation term***
17:20 - 18:05	***Franka Baaske*** ***Scattering theory for the Dirac operator***
18:30	***Supper***

Thursday, March 29, 2012

Chairman	***Juergen Eichhorn***
8:30 - 9:15	***Yaguang Wang*** ***Stability of contact discontinuities in 3-D compressible steady flow***
9:20 - 10:05	***Reinhard Racke*** ***Compressible Euler equations with Second Sound: discontinuous solutions***
10:10 - 10:30	***Tea break***
Chairman	***Zhaoli Liu***
10:30 - 11:15	***Changzheng Qu*** ***Wave-breaking and peakons for a modified Camassa-Holm equation***
11:20 - 12:05	***Michael Pokojovy*** ***On Neumann boundary controllability for heat conducting Reissner-Mindlin plates***
12:10 - 14:00	**Lunch**
Chairman	***Yaguang Wang***
14:30 - 15:15	***Oliver Matte*** ***On enhanced binding due to the quantized radiation field***
15:20 - 16:05	***Christian Jaeh*** ***Qualitative properties of elliptic and backward-parabolic operators with low regular coefficients***
16:20 - 16:30	***Tea Break***
Chairman	***Chunlai Mu***
16:30 - 17:15	***Chunlei Tang*** ***Existence and multiplicity of positive solutions of semilinear elliptic equations in unbounded domains***
17:20 - 18:05	***Ingo Witt*** ***Fundamental solutions of Klein-Gordon and other strictly hyperbolic operators***
18:30	***Supper***

Friday, March 30，2012

Local tour

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Abstract

Scattering theory for the Dirac operator

Franka Baaske

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We consider the scattering of time-harmonic acoustic waves by an inhomogeneous medium contained in a domain with compact support. Based on the Schröinger scattering we use a factorisation of the operator $\Delta + k^2 = -(D+k)(D-k)$, where D is the Dirac operator and k^2 a fixed positive energy. The problem can be formulated as follows:

$$\begin{cases} (D + kn(x))u(x) = 0, & n \in C^1(\mathbb{R}^n) \\ u = u^i + u^s & \\ \left(k - \frac{x}{|x|^2} + ik\frac{x}{|x|}\right) u^s = o(|x|^{-\frac{n-1}{2}}), & |x| \to \infty \end{cases} \tag{1}$$

where the last equation describes the radiation condition, which is significant for the existence of a solution in unbounded domains. Under these assumptions the problem (1) is equivalent to the Lippmann-Schwinger integral equation

$$u(x) \;=\; u^i(x) - k \int_{\mathbb{R}^n} E_k(x,y)u(y)m(y)\mathrm{d}y,$$

with $m = 1 - n$, m compactly supported and E_k is the fundamental solution of $D + k$.

A damped waves with time-dependent speed and dissipation term

Bui, Tang Bao Ngoc

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In my talk we will consider the strictly hyperbolic Cauchy problem with a time-dependent speed and a time-dependent dissipation term of the form

$$u_{tt} - a^2(t)\Delta u + b(t)u_t = 0,\ u(0,x) = u_1(x),\ u_t(0,x) = u_2(x). \tag{2}$$

In our project we will try complete a description of the behavior of solutions. That is, we have to distinguish not only between *non-effective*, *effective* dissipation but also between *scattering result* and *overdamping effect*.

On the spectral analysis of sub-Laplacians on spheres

Wolfram Bauer

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We start by a explaining the complete classification of trivializable sub-Riemannian structures on odd dimensional spheres $\mathbb{S}^{2N-1}$ that are induced by a Clifford module structure on $\mathbb{R}^{2N}$. Only finitely many cases appear and the defining distributions are spanned by the restriction of linear vector fields $\{X_1, \cdots, X_m\}$ to the sphere. The sub-Laplace operator corresponding to such a distribution is given by $\Delta_{\text{sub}} = -\sum_{j=1}^{m} X_j^2$ where $m < 2N-1$. As is well known Δ_{sub} is hypo-elliptic due to a classical theorem by L. H mander. In an on-going project we aim to find explicit expressions for the heat kernel of Δ_{sub}. In this talk we derive certain sub-series of eigenvalues together with the corresponding eigenfunctions. In the case of a trivializable sub-Riemannian structure on $\mathbb{S}^7$ and $\mathbb{S}^{15}$ of rank four and eight, respectively, we show that some of the eigenfunctions are induced by the Jacobi polynomials. In the cases of a co-rank one distribution on $\mathbb{S}^3$ and $\mathbb{S}^7$ the spectra of the sub-Laplace operators are completely known and we can analyze the corresponding spectral zeta function which gives the small time asymptotic of the heat trace. This is joint work with K. Furutani (Tokyo) and C. Iwasaki (Hyogo).

References

[1] W. Bauer, K. Furutani, Spectral analysis and geometry of a sub-Riemannian structure on $\mathbb{S}^3$ and $\mathbb{S}^7$, *J. Geom. Phy.*, **58** (2008), 1693-1738.

[2] W. Bauer, K. Furutani, C. Iwasaki, Trivializable subriemannian structures on spheres, preprint 2011.

[3] W. Bauer, K. Furutani, C. Iwasaki, Spectral zeta function of the sub-Laplacian on two step nilmanifolds, *J. Math. Pures. Appl.* **97** (2012), 242-261.

[4] W. Bauer, K. Furutani, C. Iwasaki, Spectral analysis and geometry of a sub-Laplacian and related Grushin type operators, in: "Partial Differential Equations and Spectral Theory", Operator Theory: Advances and Applications **211** (2011), 183-287.

Lax pairs and the Inverse Scattering Transform

Swanhild Bernstein

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Lax pairs are a well-established tool for the study of instationary nonlinear PDE's. If there is a pair of linear operators acting on a certain Hilbert space $\mathcal{H}$, we say that they form a a Lax pair for an instationary nonlinear (or linear) PDE is that PDE arises as a compatibility condition of these two given operators. A generalization of the Lax pair method is the AKNS method of **A**blowitz, **K**aup, **N**ewel and **S**egur. As long as the operators involved are linear the two methods are equivalent, but the AKNS method is not restricted to an eigenvalue dependence. Therefore, we will use the AKNS method to obtain a nonlinear system linked to a nonlinear multidimensional system of PDE's.
We construct Lax pairs using the AKNS method for a generalized KdV equation based on the Dirac operator, i.e. a first order operator which factorizes the Laplacian.

Existence of multiple solutions for a free boundary problem of an elliptic equation

Daomin Cao

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Towards Nonlinear Hartree Dynamics with factorized initial data

Li Chen

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The mean field dynamics of N weekly interacting Boson system can be described by the nonlinear Hartree equation. I will present our recent results on the optimal 1/N rate

of convergence of many-body Schrodinger dynamics to the one-body nonlinear Hartree dynamics with factorized initial data. Typically in the case of two-body interaction potential V in L^{2+}, which includes the most physical relevant Colomb potential case. The key estimates are from an estimate of the Coherent states by JiOon Lee and the using of Schartz type estimates for nonlinear Hartree equation. This is a joint work with JiOon Lee and Benjamin Schlein.

Large data solutions to the viscous quantum hydrodynamic model with barrier potential

Michael Dreher

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We discuss a nonlinear elliptic boundary value problem as it appears in the modelling of the resonant tunnel diode. This system is of Douglis-Nirenberg type, due to terms describing quantum mechanical interaction. By means of a special transformation and a variational formulation, we prove the existence of solutions for any choice of the (possibly large) given data.

Chains of Sobolev spaces for cusp-like ends of open manifolds

Jürgen Eichhorn

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If $(E, h, \nabla) \to (M^n, g)$ is Riemannian vector bundle over an open manifold, A is a differential operator acting on the sections of E, then the study of the equation $Au = f$ is performed in Sobolev spaces $\Omega^{p,r}(E, D)$ based on powers $D, D^2, ...$ of a differential operator D with injective symbol. D must not be the connection ∇ and should be in a certain sense adapted to A. It could be e.g. the Laplace operator, a generalized Dirac operator or a classical Dirac operator. If one would make another choice D', then there would arise the natural question $\Omega^{p,r}(E, D) = \Omega^{p,r}(E, D')$ in the sense of equivalence of Sobolev spaces? In preceding papers and his monographs, the author proved $\Omega^{p,r}(E, D) = \Omega^{p,r}(E, D')$ if i)$D' - D$ is of zero'th order, ii) $D' - D \in \Omega^{p,r-1}(EndE, D)$ and iii) the curvatures of E, M

are bounded up to order $k \geq r$ and the injectivity radius $r_{inj}(M)$is greater than 0. The key to prove this is the module structure theorem for Sobolev spaces on open manifolds which assures under which conditions the (tensor) product of Sobolev sections is again a Sobolev section. The latter follows from the following.

Theorem. Let $(E \to M)$be a Riemannian vector bundle with bounded curvature up to order k and $r_{inj}(M) > 0$, $k\backslash 1$. a)Assume $k \geq r, r - n/p \geq s - n/q, r \geq s, q \geq p$. Then $\Omega^{p,r}(E) \subset \Omega^{q,s}(E)$ continuously. b) If $r - n/p \geq s$, then $\Omega^{p,r}(E) \subset C^s(E)$ continuously.

If the injectivity radius tends to zero at infinity (as e.g. in the case $vol(M) < \infty$) then we see now chance to save the Theorem above.

But we were able in this case to save the **Theorem** for appropriate weighted Sobolev spaces.

Existence Results for Oldroyd-B Fluids in Exterior Domains

Daoyuan Fang

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We investigate the 3D Oldroyd-B fluids in exterior domains. We obtain the local existence and uniqueness of the strong solution. Moreover, for arbitrary retardation parameter, we prove that the solution is global provided the initial data is small in some sense.

This is the joint work with Matthias Hieber and Ruizhao Zi.

Qualitative Properties of Elliptic and Backward-Parabolic Operators with Low Regular Coefficients

Christian Jaeh

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We consider the Cauchy problem for the operators

$$\mathcal{E} = D_t^2 + \sum_{k,l=1}^{n} a_{kl}(t) D_{x_k} D_{x_l} + \beta(t,x) D_t + \sum_{m=1}^{n} b_m(t,x) D_{x_m} + c(t,x)$$

and

$$\mathcal{P} = D_t + i \sum_{k,l=1}^{n} a_{kl}(t) D_{x_k} D_{x_l} + \sum_{m=1}^{n} b_m(t,x) D_{x_m} + c(t,x),$$

where we suppose

$$\exists a_0, A_0 > 0 : \quad a_0 |\xi|^2 \leq \sum_{k,l=1}^{n} a_{kl}(t) \xi_i \xi_j \leq A_0 |\xi|^2, \forall \xi \in \mathbb{R}^n_\xi$$

and β, b_m and $c \in L^\infty([0,T] \times \mathbb{R}^n_x)$. We present uniqueness and stability results for the solutions to those operators under different conditions on the principal part coefficients. We consider global regularity assumptions ($a_{kl} \in C^{\mathcal{M}}[0,T]$), local regularity assumptions ($a_{kl} \in C^1(0,T]$ with $\sum_{k,l=1}^{n} |F(t) \frac{d}{dt} a_{kl}(t) \frac{\xi_k \xi_l}{|\xi|^2}|) \leq C$) and the mixing of the two. In the latter case the space $C^{\mathcal{M}}$ will be defined by a modulus of continuity $\mathcal{M}$ not satisfying the Osgood condition $\int_0^1 \frac{ds}{\mathcal{M}(s)} = +\infty$. We present sufficient results as well as counterexamples of Pliš-type showing, that our results are sharp.

This is a joint work with Michael Reissig and Daniele Del Santo.

Traveling Wavefronts for a time delayed Non-Newtonian Filtration Equation

Chunhua Jin

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This is a joint work with Prof. Jingxue Yin. We discuss the traveling waves for a degenerate parabolic equation with time delay. We first establish the necessary and sufficient conditions to the existence of monotone nonincreasing and nondecreasing traveling wave solutions, which correspond to a unique wave speed $c^*(\tau)$ respectively. It will be shown that the traveling wave may be a finite, semi-finite, or infinite traveling wave under different exponent. Furthermore, we give an accurate estimation on the convergent rate for the semi-finite or infinite traveling waves.

On three-dimensional supersonic conic shock wave

Jun Li

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This is a joint work with Prof. Witt Ingo and Prof. Yin, Huicheng.

In this talk, I will introduce recent progress on three-dimensional supersonic conic shock wave. We establish the global existence and stability of a three-dimensional supersonic conic shock wave for a perturbed steady supersonic flow past an infinitely long circular con with a sharp angle. The flow is described by a 3-D steady potential equation, which is multi-dimensional, quasi-linear, and hyperbolic with respect to the supersonic direction. Mathematically, the problem is reformulated as global well-posedness of a second order quasi-linear wave equation with physical initial-boundary value conditions, which does not satisfy so-called "null" conditions. Making use of the geometric properties of the pointed shock surface together with the Rankine-Hugoniot conditions on the conic shock surface and the boundary condition on the surface of the cone, we obtain a global uniform weighted energy estimate for the nonlinear problem by finding an appropriate multiplier and establishing a new Hardy-type inequality on the shock surface. Based on this, we prove that a multi-dimensional conic shock attached at the vertex of the cone exists globally when the Mach number of the incoming supersonic flow is sufficiently large.

On a semilinear equation involving critical cone Sobolev exponent and sign-changing weight function

Xiaochun Liu

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This is joint work with H. N. Fan.

In this paper, we give some results on the decomposition of the Nehari manifold via the combination of concave and convex nonlinearities. Furthermore, we use these results to get multiple positive solutions of a class of semilinear elliptic equations involving critical cone Sobolev exponent and sign-changing weight function on manifolds with conical singularities.

Equations with linearly bounded nonlinearities

Zhaoli Liu

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In this talk we will discuss existence of one or multiple nontrivial solutions to elliptic equations, elliptic systems, and Hamiltonian systems, in the case where these equations and systems have linearly bounded nonlinearities. New results obtained jointly with Jiabao Su and Zhi-Qiang Wang will be presented. In these results the nonlinearities are allowed to intersect infinitely many times the spectra of the linear operators from the equations and systems.

On enhanced binding due to the quantized radiation field

Oliver Matte

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We consider a quantum mechanical non-relativistic or relativistic matter particle in three dimensions moving in the field of some attractive potential. There exist certain potentials which are not strong enough to produce an eigenvalue of the corresponding (pseudo-)differential operator below its continuous spectrum, but give rise to a lowering of the minimal energy when the interaction with the quantized radiation field is taken into account. This effect is called enhanced binding due to the quantized radiation field. A related effect is the increase of the binding energy due to the radiation field. In this talk we explain how the occurrence of these effects can be proven mathematically. In the case of a relativistic matter particle our main results are new. In the non-relativistic case we are able to improve on earlier results by providing complete proofs that avoid a smallness assumption on the coupling parameter of the radiation field.

The talk is based on joint work with Martin Könenberg (Vienna).

Well-posedness and blow-up phenomena for a higher order shallow water equation

Chunlai Mu

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In this talk, we study the Cauchy problem for a higher order shallow water equation. The local well-posedness of solutions for the Cauchy problem in Sobolev space is obtained. Under some assumptions, the existence and uniqueness of the global solutions to the equation are shown, and conditions that lead to the development of singularities in finite time for the solutions are also acquired. Finally, the weak solution for the equation is considered.

On Neumann boundary controllability for heat conducting Reissner-Mindlin plates

Michael Pokojovy

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We consider a Reissner-Mindlin plate with hyperbolic heat conduction due to Green & Naghdi of Type II modeled by a conservative system of second order PDEs. Under certain conditions on the geometry of the domain as well as physical parameters, we prove the exact solvability for the Neumann boundary control problem: given null Dirichlet boundary conditions on one part of the boundary, there exist Neumann L^2-boundary controls on the other part of the boundary steering the system between from an "arbitrary" initial into an "arbitrary" final state.

The proof is based on a general control theory in reflexive Banach spaces consisting in showing the admissibility of the control operator as well as an observability inequality for the dual operator. Time permitting, a generalization for the case of a Reissner-Mindlin plate with hyperbolic heat conduction due to Cattaneo will be presented.

Global Existence and Asymptotic Behavior of Solutions to the $1D$ Compressible Radiative Fluids

Yuming Qin

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In this talk, we shall show the global existence and asymptotic behavior of solutions to the 1D compressible radiative fluids.

Wave-breaking and peakons for a modified Camassa–Holm equation

Changzheng Qu

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In this talk, we shall discuss the formation of singularities and the existence of peaked traveling-wave solutions for a modified Camassa-Holm equation with cubic nonlinearity. The equation is known to be integrable and comes from a non-stretching curve flow in Euclidean geometry, its scale limit is the short-pulse equation. It admits a single peaked soliton and multi-peakon solutions, of a different character than those of the Camassa-Holm equation. Stability of peakons will be also studied. Singularities of the solutions can occur only in the form of wave-breaking, and a new wave-breaking mechanism for solutions with certain initial profiles is described in detail.

Compressible Euler equations with Second Sound: discontinuous solutions

Reinhard Racke

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We consider the compressible Euler equations in three space dimensions where heat conduction is modeled by Cattaneo's law instead of Fourier's law. For the arising purely hyperbolic system, the asymptotics of discontinuous solutions to the linearized Cauchy problem is investigated. We give a description of the behavior as time tends to infinity and, in particular, as the relaxation parameter tends to zero. The latter corresponds to the singular limit and a formal convergence to the classical (i.e. Fourier law for the heat flux - temperature relation) Euler system. We recover a phenomenon observed for hyperbolic thermoelasticity, namely the dependence of the asymptotics on the mean curvature of the initial surface of discontinuity, but, in addition, we prove a more complex behavior in general.

Global existence for semi-linear damped wave equation

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We study the Cauchy problem for the semi-linear wave equation with time-dependent damping

$$u_{tt} - \triangle u + b(t)u_t = f(u), \qquad u(0,x) = u_0(x), \quad u_t(0,x) = u_1(x) \tag{3}$$

in space dimension $n \geq 1$. We assume that the time-dependent damping term $b(t) > 0$ is *effective*, in particular $tb(t) \to \infty$ as $t \to \infty$. This assumption allows us to derive linear Matsumura type estimates for the solution. We prove the global existence of small energy data solutions for $|f(u)| \approx |u|^p$ in the supercritical case $p > 1 + 2/n$ (and $p \leq n/(n-2)$ for $n \geq 3$).
The exponent $1+2/n$ was first proved to be critical for the parabolic equation $u_t - \triangle u = u^p$ by Fujita. In particular, the solution corresponding to suitable data blows up in infinite

time if $p \leq 1+2/n$. Later Todorova and Yordanov [TY], and Ikehata and his collaborators [IMN, IO, IT] proved that this exponent is critical also for the classical damped wave equation, that is, equation (3) with $b \equiv 1$.
By assuming small data in $(L^1 \cap H^1) \times (L^1 \cap L^2)$ we derive global existence for any $p > 1 + 2/n$ for $n = 1, 2$ (and for $p \geq 2$ if $n = 3, 4$), whereas by assuming small data in some weighted energy space $H^1(\rho) \times L^2(\rho)$ we can prove the global existence for any $p > 1+2/n$ in any space dimension $n \geq 1$. Moreover, the solution to (3) has the same decay rate as the solution to the linear problem.
Our assumptions on the *damping term* are the following:

- $b(t) > 0$ for any $t \geq 0$, $b(t)$ is monotone, and $tb(t) \to \infty$ as $t \to \infty$,
- $((1+t)^2 b(t))^{-1} \in L^1([0,\infty))$ and $1/b \notin L^1([0,\infty))$
- $b \in \mathcal{C}^3$ and $|b^{(k)}(t)| \leq Cb(t)(1+t)^{-k}$, for any $k = 1, 2, 3$,
- there exists $m \in [0, 1)$ such that $tb'(t) \leq mb(t)$.

These are joint considerations with Marcello D'Abbicco and Sandra Lucente from University of Bari (see [DALR]).

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The Variable Branching Asymptotics on Manifolds with Edges

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The talk is based on joint work with L. Tepoyan, Yerevan State University. We establish the shape of regularity of solutions to elliptic equations on a manifold with edge. The degenerate behaviour of operators causes asymptotics in the distance variable to the edge. The asymptotic data with complex exponents and logarithmic terms as well as the coefficients in the singular functions are determined by so-called conormal symbols that are associated with the operators. Those are families of meromorphic functions in the complex plane of the Mellin covariable, depending on the variable on the edge. Poles and multiplicities are variable. This causes a very subtle behaviour of asymptotics, and one of the tasks is to characterise the functional analytic nature of the singular functions. Our talk gives an outline on recent results in this field. An essential feature are weighted edge Sobolev spaces and the description of asymptotics in terms of vector and operator-valued analytic functionals in the complex plane.

The spectrum of Graphene Quantum Dots

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We will review the basic mathematical description of graphene quantum dots, discuss the mathematical structure of the multi-particle picture and present some recent results on the critical coupling constant of graphene with impurities and the number of bound states localized in a dot.

Real analyticity of pseudorelativistic Hartree-Fock orbitals

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In this talk I will explain the proof that the Hartree–Fock orbitals of pseudorelativistic atoms, that is, atoms where the kinetic energy of the electrons is given by the pseudorelativistic operator $\sqrt{-\Delta + 1} - 1$, are real analytic away from the nuclear positions.

Existence and Multiplicity of Positive Solutions of Semilinear Elliptic Equations in Unbounded Domains

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We investigate the existence and the multiplicity of positive solutions for the semilinear elliptic equation $-\Delta u + u = Q(x)|u|^{p-2}u$ in exterior domain which is very close to R^N. The potential $Q(x)$ tends to positive constant at infinity and may change sign. This is a joint work with my student Kai Hu which has been published on J. Differential Equations 251(3) (2011) 609-629.

Smooth Transonic Flows in De Laval Nozzles

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This talk concerns with smooth transonic flows of Meyer type in de Laval nozzles, which are governed by an equation of mixed type with degeneracy and singularity at sonic state. By precise analysis on sonic curves, it is shown that for a C^2 transonic flow of Meyer type, the set of the exceptional points is a closed segment (may be empty or only

one point); furthermore, the flow with nonexceptional points is unstable for a C^1 small perturbation on the wall. The unstability motives us to seek a smooth transonic flow of Meyer type whose sonic points are exceptional. For such a flow, its sonic curve must be located at the throat of the nozzle and the potential on its sonic curve equals identically to a constant. It is proved that there exists uniquely such a smooth transonic flow near the throat of the nozzle if the wall of the nozzle is sufficiently flat. Furthermore, the flow is smooth in the sense that the acceleration is Lipschitz continuous.

Stability of Contact Discontinuities in 3-D Compressible Steady Flow

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In this talk, we study the stability of contact discontinuities in three-dimensional compressible steady Euler equations for supersonic flow. By developing the Kreiss, Majda and Osher's arguments, we obtain the necessary and sufficient weakly stable condition of contact discontinuities. The energy estimate of solutions to the linearized problem has a loss of regularity. This is a joint work with Fang YU.

The Mellin-Edge Quantisation for Corner Operators

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This is a joint work with B.-W. Schulze. We establish a quantisation of corner-degenerate symbols, here called Mellin-edge quantisation, on a manifold M with second order singularities. The typical ingredients come from the most singular stratum of M which is a second order edge where the infinite transversal cone has a base B that is itself a manifold with smooth edge. The resulting operator-valued amplitude functions on the second order edge are formulated purely in terms of Mellin symbols taking values in the edge algebra over B. In this respect our result is formally analogous to a quantisation rule for the simpler case of edge-degenerate symbols that corresponds to the singularity order 1. However, from the singularity order 2 on there appear new difficulties for the first time, partly caused by the edge singularities of the cone over B that tend to infinity.

Fundamental solutions of Klein-Gordon and other strictly hyperbolic operators

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This talk aims at gaining a better understanding of the analytic properties of fundamental solutions of strictly hyperbolic operators, like the advanced (or retarded) fundamental solution of the Klein-Gordon operator. We shall approach the subject through the notion of a paired Lagrangian distribution. Operators whose kernels are paired Lagrangian distributions are a generalization of the class of Fourier integral operators. Among others, we shall introduce this (former) concept and also discuss composition within this class.

On the blowup of classical solutions to some class of nonlinear wave equations

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In this talk, we mainly focus on the blowup problem in nonlinear wave equations with general small initial data. These equations come from the pressure-gradient model in fluid dynamics and liquid crystal model in material science. These works are joint ones with Prof.Ingo Witt, Ding Bingbing or Dr.Li Jun respectively.

Some Dynamical Properties in Evolutionary p-Laplacian

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We are concerned with the evolutionary p-Laplacian by using some concepts of dynamical systems. The structures of ω-limit sets for some rescaled solutions and the chaotic dynamical systems for the evolutionary p-Laplacian will be discussed.

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