Workshop

Recent progress in evolution equations

10.08.-13.08.2015
Guangdong University of Finance, Guangzhou

Information, schedule, & abstracts

Organizers:

Zhou Jianmin (Guangzhou, China)

Liu Yan (Guangzhou, China)

Fumihiko Hirosawa (Yamaguchi, Japan)

Michael Reissig (Freiberg, Germany)

Contents

Time table **1**

Marcello D'Abbicco **5**

Abdelhamid Mohammed Djaouti **5**

Andrei Faminski **6**

Marina Ghisi **6**

Massimo Gobbino **7**

Tang Gusheng **7**

Congchong Guo **8**

Zhonghua He **8**

Fumihiko Hirosawa **8**

Christian P. Jäh **10**

Lavi Karp **10**

Yan Liu **11**

Makoto Nakamura **11**

Wanderley Nunes do Nascimento **12**

Kenji Nishihara **12**

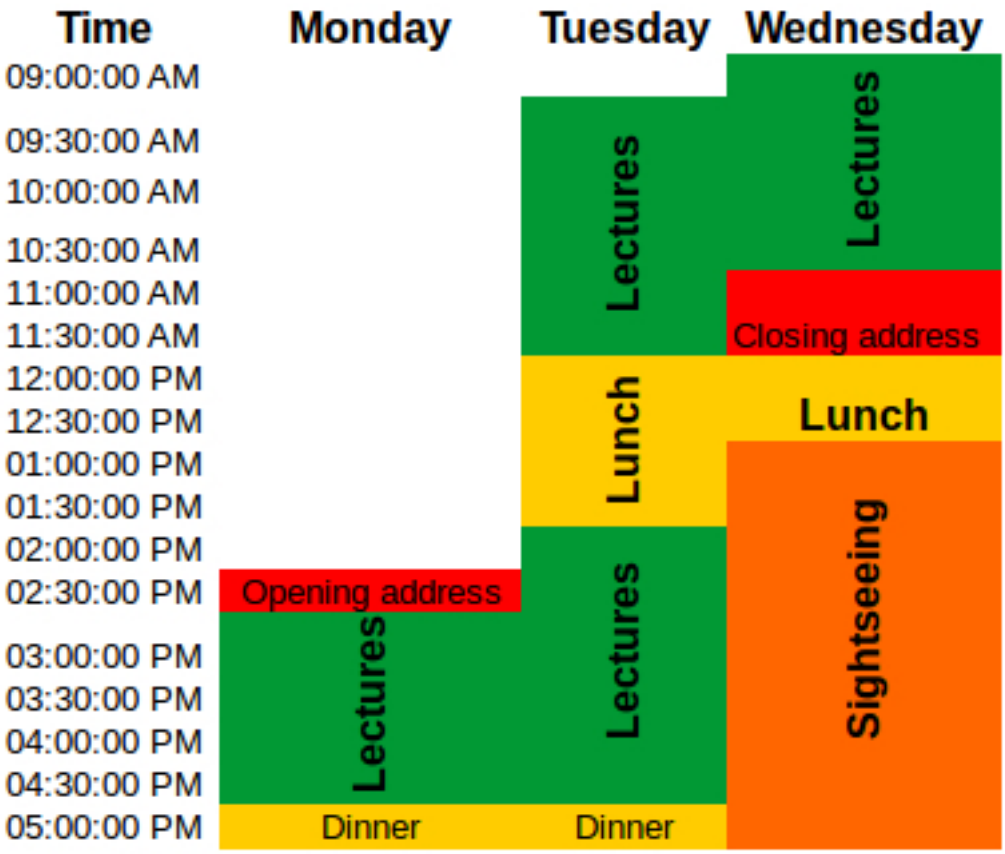
Duong Trieu Pham **13**

Maximilian Reich **13**

Michael Reissig **14**

Chen Wenhui **14**

Time table


Time
Monday
Tuesday
Wednesday
09:00:00 AM
09:30:00 AM
10:00:00 AM
10:30:00 AM
11:00:00 AM
11:30:00 AM
12:00:00 PM
12:30:00 PM
01:00:00 PM
01:30:00 PM
02:00:00 PM
02:30:00 PM
03:00:00 PM
03:30:00 PM
04:00:00 PM
04:30:00 PM
05:00:00 PM
Lectures
Lectures
Closing address
Lunch
Lunch
Opening address
Lectures
Lectures
Sightseeing
Dinner
Dinner

Monday, August 10th

Time	Speaker/activity	
14:45	Zhou Jianming	Opening address
15:00	Nakamura, Makoto	Page 11
15:30	Karp, Lavi	Page 10
16:00	Faminski, Andrei	Page 6
16:30	Liu, Yan	Page 11
17:00	Dinner	

Table 1: Time table of Monday, August 10th

Tuesday, August 11th

Time	Speaker/activity	
09:30	Jäh, Christian	Page 10
10:00	Reich, Maximilian	Page 13
10:30	Gobbino, Massimo	Page 7
11:00	Ghisi, Marina	Page 6
11:30	Hirosawa, Fumihiko	Page 8
12:00	Lunch	
14:00	He, Zhonghua	Page 8
14:30	Guo, Congchong	Page 8
15:00	Pham, Duong Trieu	Page 13
15:30	D'Abbicco, Marcello	Page 5
16:00	Tang, Gusheng	Page 7
16:30	Chen, Wenhui	Page 14
17:00	Dinner	

Table 2: Time table of Tuesday, August 11th

Wednesday, August 12th

Time	Speaker/activity	
09:00	Nishihara, Kenji	Page 12
09:30	Nunes do Nascimento, Wanderley	Page 12
10:00	Reissig, Michael	Page 14
10:30	Reissig, Michael	Closing address
12:00	Lunch	
13:00	Sight–seeing	

Table 3: Time table of Wednesday, August 12th

Thursday, August 13th

Day of departure.

Abstracts

A partially effective damping for semilinear waves

Marcello D'Abbicco
Departamento de Computação e Matemática
Universidade de São Paulo (USP)
dabbicco@dm.uniba.it

The speaker is supported by São Paulo Research Foundation (FAPESP), grants 2013/15140-2 and 2014/02713-7.

In this talk, we prove that the critical exponent for small data solutions to

$$u_{tt} - \Delta u + \frac{2}{1+t}\, u_t = |u|^p, \qquad t \geq 0,\ x \in \mathbb{R}^n,$$

is given by $\max\{p_0(n+2), 1+2/n\}$, where $p_0(k)$ is the Strauss exponent for the semilinear wave with no damping in space dimension k, and $1+2/n$ is Fujita exponent for the semilinear heat equation.

The talk is based on joint results obtained with S. Lucente (Bari) and M. Reissig (Freiberg).

Semi-Linear Systems of Weakly Coupled Classical Waves

Abdelhamid Mohammed Djaouti
Department of Mathematics, Hanoi University of Education
djaouti_abdelhamid@yahoo.fr

Let us consider the following model of semi-linear systems of weakly coupled classical waves

$$\begin{cases} u_{tt} - \Delta u + b_1(t)u_t = |v|^p, (t,x) \in [0,\infty), x \in \mathbb{R}^n \\ v_{tt} - \Delta v + b_2(t)v_t = |u|^q \\ (u, u_t, v, v_t)(0,x) = (u_0, u_1, v_0, v_1)(x), x \in \mathbb{R}^n \end{cases}$$

for $n \leq 4$ and $p, q > 1$. Our aim is to investigate the global existence of $\mathcal{C}([0,\infty), H^1) \cap \mathcal{C}^1([0,\infty), L^2)$ solutions for small initial data. In particular, we suppose an effective dissipation (i.e. $b_1(t), b_2(t)$ are positive, monotone and $|b_1'(t)| = o(b_1^2(t)), |b_2'(t)| = o(b_2^2(t))$ as $t \mapsto \infty$) for both damping terms of the system.

We use Matsumura type estimates for a family of parameter-dependent Cauchy problems along the lines of (Chin. Ann. Math. 34B(3) (2013),

345–380) to estimate the decay of the solutions under some conditions on p, q depending on the classical Fujita exponent $p_{Fuj}(n)$ or $q_{Fuj}(n)$.

We show further that for $p \neq q$, $\min(p,q) < p_{Fuj}(n) < \max(p,q)$ one obtains a loss of decay of the solutions compared to the case $p = q$, $p > p_{Fuj}(n)$ and the scalar case.

Internal regularity of solutions to quasilinear dispersive evolution equations

Andrei Faminski
Department of Mathematics, Peoples Friendship University Moscow
afaminskii@sci.pfu.edu.ru

Consider certain quasilinear dispersive evolution equations such as the Korteweg-de Vries, Kawahara and Zakharov-Kuznetsov equations. For weak solutions to the initial value problem and certain initial-boundary value problems the gain of internal regularity depending on the decay rate of initial data at infinity is considered. Existence of both Sobolev and continuous derivatives of any prescribed order is established. For continuous derivatives estimates in Hölder norms are obtained. Some of the results are applied to study large-time decay of solutions.

Kirchhoff equations with strong damping

Marina Ghisi
University of Pisa, Pisa, Italy
ghisi@dm.unipi.it

We consider Kirchhoff equations with strong damping, namely with a friction term which depends on a power of the "elastic" operator. When the exponent in the friction term is greater than 1/2, the dissipation prevails, and we obtain global existence in the energy space assuming only degenerate hyperbolicity and continuity of the nonlinear term. When the exponent is less than 1/2, the situation is more delicate, as in the non dissipative case,

and we have to consider a phase space depending on the continuity modulus of the nonlinear term and on the exponent in the damping.

Linear hyperbolic equations with strong damping

Massimo Gobbino
University of Pisa, Pisa, Italy
massimo.gobbino@unipi.it

We consider abstract second order linear equations with strong damping, namely friction terms that depend on a power of the "elastic" operator.

In the case with constant coefficients, we investigate the phase spaces in which the initial value problem gives rise to a semigroup, and the further regularity of solutions. When the "elastic" operator is multiplied by a time-dependent coefficient, we investigate how higher regularity of initial data compensates lower regularity of the coefficient.

The problem exhibits a variety of different regimes, with completely different behaviors, depending on the exponent in the friction term.

(This talk is based on joint works with Marina Ghisi (Pisa) and Alain Haraux (Paris 6)).

Spatial behavior of a coupled system of wave-plate type

Tang Gusheng
Department of Mathematics, Hunan University of Science and Technology
gshtang@126.com

In this talk the spatial behavior of a coupled system of wave-plate type is studied. We get the alternative results of Phragmén-Lindelöf type in terms of an area measure of the amplitude in question based on a first order differential inequality. We also get the spatial decay estimates based on a second order differential inequality.

Well–posedness and space-time regularity of the solutions to the Liquid Crystal equations in critical space

Guo, Chongchong
Guangdong University of Finance

I will briefly introduce the Liquid Crystal equations first. The talk presents the local well–posedness and the space-time regularity for the incompressible nematic liquid crystal flow in the critical Lebesgue space with rough initial data. More precisely, we obtain two results which supply the research to the Liquid Cristal equations.

Generalized Integration operators between Bloch-type spaces and $F^s_{p,q}$ spaces

He, Zhonghua
Guangdong University of Finance

This talk is about

- criteria for boundedness and compactness of a generalized integration operator between Bloch-type spaces and $F^s_{p,q}$ spaces,
- differences of two generalized integration operators from $F^s_{p,q}$ spaces to Bloch-type spaces.

A class of non-analytic functions for the global solvability of Kirchhoff equation

Fumihiko Hirosawa
Yamaguchi University, Japan
hirosawa@yamaguchi-u.ac.jp

We consider the global solvability for the Cauchy problem of Kirchhoff equation with an extended class of Manfrin's class. Manfrin's class is a subclass of Sobolev space, but we shall extend this class as a subclass of ultradifferentiable class; thus we succeed to set the widest class which ensures the global solvability of Kirchhoff equation with large data.

Backward uniqueness for parabolic equations with low–regular coefficients

Christian P. Jäh
Institute of Applied Analysis, TU Bergakademie Freiberg, Germany
christian.jaeh@math.tu-freiberg.de, christian@jaeh.cc

We consider the Cauchy problem for backward-parabolic operators

$$\begin{cases} \mathcal{P}u = \partial_t u + \sum\limits_{i,j=1}^{n} \partial_{x_i}(a_{ij}(t,x)\partial_{x_j}u) + \sum\limits_{k=1}^{n} b_k(t,x)\partial_k u + c(t,x)u \\ u(0,x) = u_0(x), \end{cases}$$

and look for sufficient and (almost) necessary conditions on the regularity of the principal part–coefficients to ensure uniqueness of solutions $u \in H^1([0,T], L^2(\mathbb{R}^n_x)) \cap C^0([0,T], H^2(\mathbb{R}^n_x))$with

$$\sum_{i,j=1}^{n} \partial_{x_i}(a_{ij}(t,x)\partial_{x_j}u) \in L^2([0,T], L^2(\mathbb{R}^n_x))$$

of the above Cauchy problem with $u_0 \in L^2(\mathbb{R}^n_x)$.

We will prove uniqueness under the following regularity–condition:

$$a_{ij} \in C^{\mu}([0,T], L^{\infty}(\mathbb{R}^n_x)) \cap L^{\infty}([0,T], C^{\omega}(\mathbb{R}^n_x)),$$

where μ is an arbitrary modulus of continuity satisfying the Osgood condition $\int_0^1 \frac{ds}{\mu(s)} = +\infty$ and ω is the modulus of continuity $\omega(s) = \sqrt{\mu(s^2)}$.

Semi-linear equations on asymptotically flat Riemannian manifolds

Lavi Karp
Department of Mathematics, ORT Braude College, Israel
karp@braude.ac.il

The construction of solutions of the Einstein constraint equations requites the studying of semi-linear equations with coefficients in Sobolev spaces and on Riemannian manifolds. We are aiming to solve these equations under minimal regularity assumptions. I shall discuss an homotopy argument to solve these equations and possible extensions to larger classes of equations.

Structural stability for a thermal convection model with temperature-dependent solubility

Liu Yan
Department of Applied Mathematics, Guangdong University of Finance, Guangzhou
ly801221@163.com

We study the structural stability for a thermal convection model with temperature-dependent solubility. We prove both the convergence and continuous dependence results for the Boussinesq coefficient.

On the existence time of the solutions of the scaling critical semilinear Schrödinger equations

Makoto Nakamura
Department of Mathematical sciences, Yamagata University
nakamura@sci.kj.yamagata-u.ac.jp

The Cauchy problem of semilinear Schrödinger equations is considered in the Sobolev spaces. The semilinear terms are power type and scaling critical. In this case, the existence time depends on the profile of the initial data. One method is proposed to measure the time by the frequency decomposition.

Semi-linear wave equation with time-dependent scale-invariant mass and dissipation

Wanderley Nunes do Nascimento
Institute of Applied Analysis, TU Bergakademie Freiberg, Germany &
Federal University of Sao Carlos, Sao Carlos, Brasil
wnunesmg@yahoo.com.br

The aim of this talk is to prove global existence (in time), for $n \leq 4$, of small energy data solutions for the following semi-linear Cauchy problem:

$$u_{tt} - \Delta u + \frac{\mu_1}{(1+t)} u_t + \frac{\mu_2^2}{(1+t)^2} u = |u|^p, \;\; u(0,x) = u_0(x), \;\; u_t(0,x) = u_1(x),$$

with $(t,x) \in [0,\infty) \times \mathbb{R}^n$, $p > 1$ and $\mu_1 > 0, \mu_2$ real constants. We will obtain estimates for the solution and its derivatives with the same decay rate of the linear problem.

Critical exponents for the Cauchy problem to weakly coupled system of wave equations with space or time dependent damping

Kenji Nishihara
Waseda University, Japan
kenji@waseda.jp

Consider the Cauchy problem for a weakly coupled system of wave equations with effective space or time dependent dissipation. In this talk we concentrate the case of time dependent dissipation and prove the blow-up result in the subcritical exponents. Even for time-dependent dissipation note that the critical exponents are the same as those in the case of constant coefficient dissipation.
This talk is based on the joint work with Yuta Wakasugi.

A deterministic approach to study the diffusion properties generated by non-stochastic Laplacian

Pham Trieu Duong
Department of Mathematics, Hanoi University of Education
duongptmath@hnue.edu.vn

One question appearing in the study of the Cauchy problem for the equation:

$$u_{tt} + (-\Delta)^{\sigma} u + u_t = 0 \tag{0.1}$$

is to relate the solution $u(t,x)$ to the corresponding problem for equation $(-\Delta)^{\sigma} v + v_t = 0$. The classical semi-group approach seeks the connection of these equations in a very narrow stochastic setting and therefore it cannot cover all possible powers of Laplacian $(-\Delta)^{\sigma}$ that may occur. In this talk we show that the Gagliardo–Nirenberg inequality itself can substitute the Markovian notions of processes and therefore it serves a crucial tool in order to investigate the diffusion in (0.1) and the solvability for corresponding nonlinear problems.

A Non-analytic Superposition Result on Gevrey-modulation Spaces

Maximilian Reich
Institute of Applied Analysis, TU Bergakademie Freiberg
maximilian.reich@math.tu-freiberg.de

We define classical modulation spaces by an approach in terms of the frequency-uniform decomposition. Motivated by classical results for Gevrey spaces a discussion on the weights of modulation spaces leads to the definition of Gevrey-modulation spaces, where we leave the Sobolev frame and proceed to the Gevrey frame. We prove that Gevrey-modulation spaces are algebras under pointwise multiplication. Moreover, we establish a non-analytic superposition result which gives rise to discuss the possibility to apply Gevrey-modulation spaces to non-linear partial differential equations. Similar results are shown for modulation spaces with ultra-differential weights weaker than Gevrey type weights.

Theory of damped wave models with integrable and decaying in time speed of propagation

Michael Reissig
Institute of Applied Analysis, TU Bergakademie Freiberg
reissig@math.tu-freiberg.de

In this talk we report on the Cauchy problem for damped wave equations with a time-dependent propagation speed and dissipation. The model of interest is

$$u_{tt} - a(t)^2\Delta u + b(t)u_t = 0, \;\; u(0,x) = u_0(x), \;\; u_t(0,x) = u_1(x).$$

We assume $a \in L^1(\mathbb{R}^+)$. Then we propose a classification of dissipation terms in non-effective and effective. In each case we derive estimates for kinetic and elastic type energies by developing a suitable WKB analysis. Moreover, we show optimality of results by the aid of scale-invariant models. Finally, we explain by an example that in some estimates a loss of regularity appears.

Structural stability for a Brinkman-Forchheimer type model with temperature-dependent solubility

Chen Wenhui
Department of Applied Mathematics, Guangdong University of Finance
chenwenhui2007@vip.qq.com

We study the structural stability for a Brinkman-Forchheimer Equations with temperature-dependent solubility. We prove both the convergence and continuous dependence results for the Forchheimer coefficient λ. We also demonstrate how to get the same results for the Forchheimer equations.