EQUADIFF 12

Conference on Differential Equations and Their Applications

Brno, Czech Republic, July 20–24, 2009

organized by

Masaryk University
The Academy of Sciences of the Czech Republic
Brno University of Technology
The Union of Czech Mathematicians and Physicists

Scientific Committee

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is highly appreciated.

Special thanks to the Faculty of Informatics of the Masaryk University for its hospitality.

Dear Colleagues.

Following the tradition of the previous conferences EQUADIFF 1–11 held periodically in Prague, Bratislava, and Brno since 1962, the Conference on Differential Equations and Their Applications – EQUADIFF 12 – is held in Brno this year. EQUADIFF conferences represent the world's oldest series of comprehensive conferences on differential equations and their applications.

The topics of the meeting cover differential equations in a broader sense, including the numerical methods and applications. Its main goal is to stimulate cooperation among various branches in the theory of differential equations and related disciplines.

List of registered participants (as of July 3) consists of **253** persons from **39** countries.

The five-day scientific program runs from July 20 (Monday) till July 24, 2009 (Friday). It consists of invited lectures (plenary lectures and invited lectures in sections), contributed talks, and posters. The social program, including trips to various part of the Moravia, is organized too.

The following three main sections are organized

Ordinary differential equations,
Partial differential equations,
Numerical methods and applications, other topics.

Suggestions for invited speakers were given by the members of the Scientific Committee.

We hope that you will find scientific as well as social program interesting and fruitful.

Organizing Committee

Contents

Program

General Information

Conference site

The conference is held in the buildings of the Faculty of Informatics, Masaryk University, Botanická 68a, CZ-602 00 Brno, see Figures 1, 2, and 3 below.

Equadiff office

The Equadiff office is located

- in hotel Continental (Sunday, July 19, 16:00–21:00),
- in Josef Taufer Student Dormitory, (Sunday, 16:00–21:00),
- in room B011 in building B of the Faculty of Informatics (it is open from Monday, July 20, daily from 8:30 a.m.).

The conference staff can be recognized by the blue badges. If you have any questions, please feel free to ask any member of the conference staff.

Where to eat

For the participants who stay in hotel Continental and Josef Taufer Student Dormitory, breakfasts are served there.

Coffee, tea, mineral water, cakes and cookies will be served (free of charge) in the main lobby of the building D of the Faculty of Informatics during the morning and afternoon coffee breaks.

Concerning other meals, there is a great variety of restaurants close to the conference site, see Figure 5 below. We recommend the following restaurants, where daily menu at favorable prices is served: Restaurant *Fontána*, restaurant *Comodo*, pizzeria *Al Capone* (the nearest, all behind the Faculty of Informatics, Hrnčířská street), vegetarian restaurant *Aura* (the corner of Štefánikova street and Kabátníkova street), restaurant *Divá Bára* (Štefánikova street, close to Hrnčířská street), restaurant *Pohoda* (Štefánikova street, between Dřevařská street and Kotlářská street), Spanish restaurant *Espaňola* (the corner of Botanická street and Kotlářská street), restaurant *Plzeňský dvůr* (Šumavská street, close to Kounicova street) and restaurant *Zelená kočka* (the corner of Kounicova street and Klusáčkova street).

The participants can also have their snacks and lunches at the Faculty of Informatics canteen (ground floor of building A), open till 2:30 p.m.

A brief dictionary with the most frequent words concerning meals will be available in the Equadiff office.

E-mail and Internet Access

Computers with internet access are available in the first floor of building B of the Faculty of Informatics. Wifi access is available as well. For connection details ask in the conference office.

Tickets for public transport

Tickets for public transport are available in the conference office and in newspaper stalls . The price is 18 CZK for “10 minutes” (nontransferable) ticket, 30 CZK for “60 minutes” (transferable) ticket. Tickets can also be purchased

Map including hotel Continental and the conference site

It is approximately 20 min (slow) walking from hotel Continental to the conference place. You may alternatively take trolley-bus No. 32 going on the Kounicova street, and get off at the stop "Botanická" (the journey by trolley-bus takes 7 min).

FIGURE 1

Map including Josef Taufer Student Dormitory and the conference site

It is approximately 15 min (slow) walking from Josef Taufer Student Dormitory to the conference place (approximately 700 m).

FIGURE 2

Scheme of the Faculty of Informatics

Lecture rooms D1, D2, and D3 are in building D.

Lecture room A107 is on the 1st floor of building A nearby the main entrance.

Lecture rooms B003 and B007 are on the ground floor of building B.

Conference office is located in room B011, which is on the ground floor of building B.

The cafeteria is on the ground floor of building A.

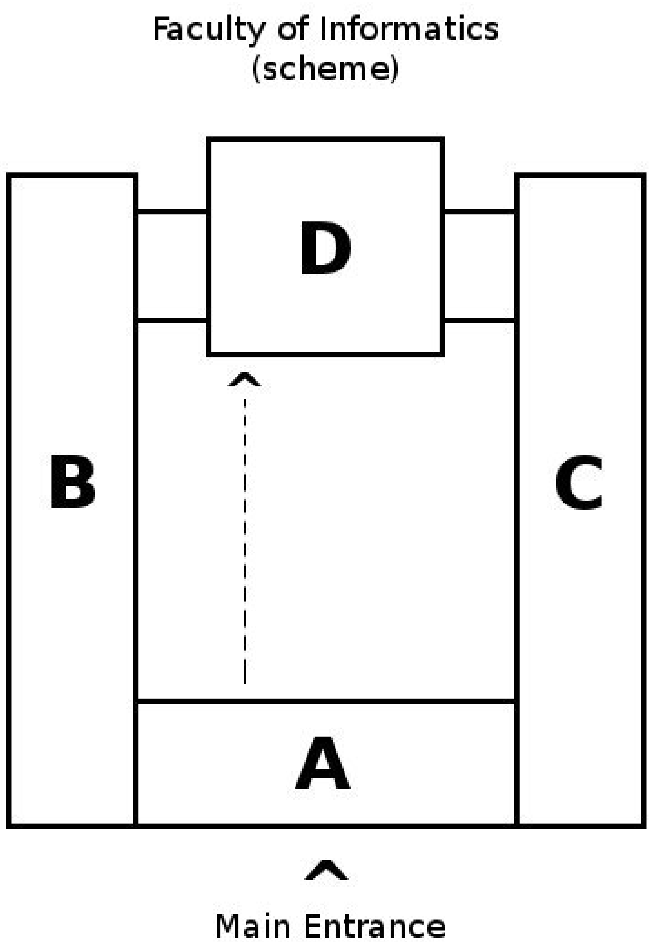

FIGURE 3

Map including hotel Continental, the place of Welcome Party, and the place of Farewell Party

FIGURE 4

Recommended Restaurants

1 – Restaurant Fontána
2 – Restaurant Comodo
3 – Pizzeria Al Capone
4 – (Vegetarian) restaurant Aura
5 – Restaurant Divá Bára
6 – Restaurant Pohoda
7 – Restaurant Española
8 – Restaurant Plzeňský dvůr
9 – Restaurant Zelená kočka

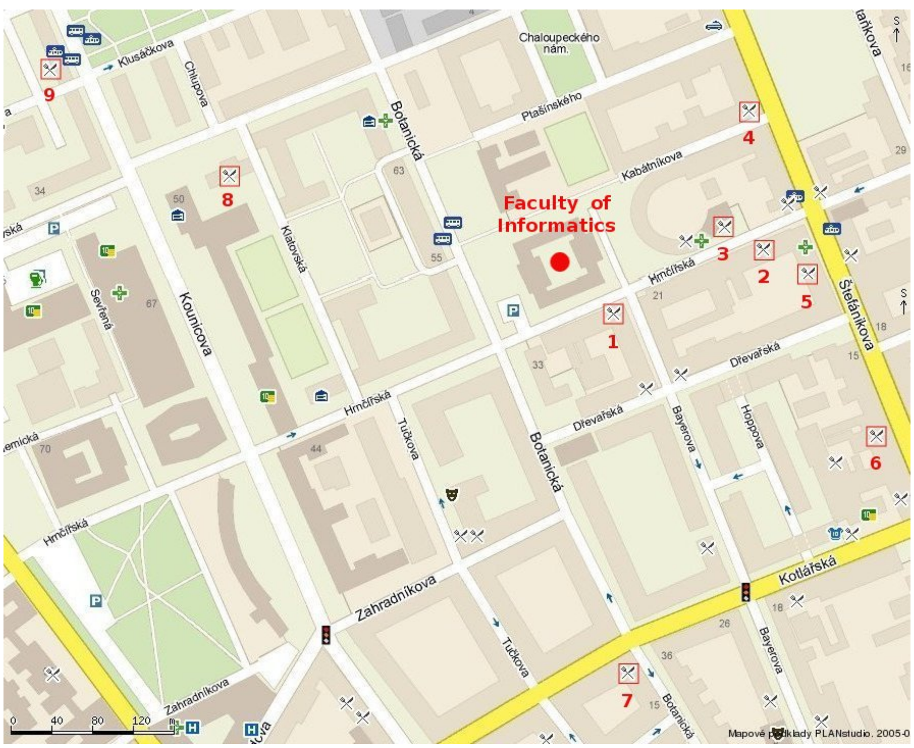

FIGURE 5

Social Program

During the conference week, three social events are planned: Welcome Party, trips to various parts of Moravia, and Farewell Party. The attendance in Welcome Party and trips is free of charge for all registered participants and accompanying persons. The price of Farewell Party is 30 EUR per person and includes a dinner with beer or nonalcoholic drinks.

The participants and their accompanying persons who want vegetarian meals for the dinner at Trips 1,2,3, and at Farewell Party, are kindly asked to announce their wish in the Equadiff office till Tuesday, July 21, 10:30 a.m.

Welcome Party
It will be held on Monday, July 20, at 19:30 in the representative area of Brno University of Technology Dvorana Centra VUT, Antoninska street (banquet, cimbalom folklore music) which is approximately 100 m from the hotel Continental, see FIGURE 4.

Program for Accompanying Persons
Sightseeing tour is planned on Tuesday, July 21. The departure will be at 9:30 a.m. from hotel Continental. The arrival is supposed at 12:00.

A visit of the Botanical Garden and the Faculty of Science is planned on Thursday, July 23. We will meet at Hotel Continental at 9:45 a.m., or at the main entrance of the Faculty of Science, Kotlářská 2, at 10:00 a.m.

Trips
Several kinds of trips are scheduled for Wednesday afternoon, July 22. The participants could register for a particular trip on the conference webpage. The price of trips is included in the conference fee.

Trip 1: Moravian Karst - Macocha Abyss, Punkva Caves and Černá Hora Brewery (visit, dinner, and beer tasting)

Trip 2: Pernštejn Castle and Černá Hora Brewery (visit, dinner, and beer tasting)

Trip 3: Czech-Moravian Highlands - Kinský Castle, Pilgrimage Church of St. John of Nepomuk on Green Hill (included on UNESCO's World Heritage List) and Šikland (western town; a dinner is included)

Trip 4: Lednice - chateau and park and the wine cellar (visit, buffet, and wine tasting).

Here is the detailed schedule of the trips:

Trip 1. Moravian Karst and Černá Hora Brewery

13:45 departure from the Faculty of Informatics (the conference site)

14:30 transfer to Punkva Caves (by the local road-train)

15:40 - a guided tour of the Punkva Caves including the water cruise on underground river Punkva (60 minutes)

16:40 transfer to the Upper Bridge of Macocha Abyss (by the cableway)

17:30 departure to Černá Hora

18:00 an excursion in the Černá Hora Brewery (45 minutes) or walking in the nearby chateau park

19:00 dinner and beer tasting

21:00 arrival to Brno

Trip 2. Pernštejn Castle and Černá Hora Brewery

13:15 departure from the Faculty of Informatics (the conference site)

14:30 a guided tour of the Pernštejn Castle at Nedvědice (60 minutes)

16:00 departure to Černá Hora

17:00 an excursion in the Černá Hora Brewery (45 minutes) or walking in the nearby chateau park

18:00 dinner and beer tasting

20:00 arrival to Brno

Trip 3. Kinský Castle, Church at Green Hill and Šikland

13:00 departure from the Faculty of Informatics (the conference site)

14:15 a guided tour of the Kinský Castle in Žd'ár nad Sázavou (50 minutes)

15:15 walking to the Green Hill (10 minutes)

15:30 a guided tour of the Pilgrimage Church of St. John of Nepomuk at Green Hill - National Cultural Monument registered in UNESCOs World Heritage List (30 minutes)

16:30 departure to Šikland

17:00 Šikland - visit of the western town including dinner in a local restaurant

20:00 arrival to Brno

Trip 4. Lednice Chateau and wine cellar in Valtice

13:30 departure from the Faculty of Informatics (the conference site)

15:00 a guided tour of the Lednice Chateau (45 minutes)

15:45 an individual program in the chateau park with a possible visit of local attractions

17:00 departure to the wine cellar in Valtice

17:30 visit of the historical wine cellar, wine tasting, and buffet

20:00 arrival to Brno

Farewell Party
It will be held on Friday, July 24, at 19:30 in Hotel Pegas, see Figure 4. The price is 30 EUR per person and includes a dinner. Beer and nonalcoholic drinks are also included in the price during the whole party.

Conference Proceedings

The Conference Proceedings will be published in autumn 2010 as regular issues of the journal Mathematica Bohemica edited by the guest editors J. Diblík, O. Došlý, P. Drábek, and M. Feistauer. All submitted papers will go through a regular peer review process.

The length of the contribution for plenary and invited speakers should not exceed 16 pages. The length of the contribution for other participants should not exceed 8 pages. The papers have to be prepared using the journal style (see Instructions for authors, `http://www.math.cas.cz/instr.html`) and submitted as a pdf file to the address `equadiff@math.muni.cz`.

The deadline for submission is **October 15, 2009.**

Scientific Program in Details

MONDAY – JULY 20

9:30–10:00 **Opening Ceremony (Room D1)**

PLENARY LECTURES

Room D1 Chairman: Neuman František

10:00–10:55 **Burton Theodore Allen** (USA)
Liapunov functionals and resolvents

11:00–11:30 *Break*

Chairman: Mawhin Jean

11:30–12:25 **Poláčik Peter** (USA)
Asymptotic behavior of positive solutions of parabolic equations: symmetry and beyond

12:30–14:00 *Lunch*

INVITED LECTURES

Room D1 Chairman: Fonda Alessandro

14:00–14:35 **Mawhin Jean** (Belgium)
Boundary value problems for differential equations involving curvature operators in Euclidian and Minkowskian spaces

Room D2 Chairman: Morita Yoshihisa

14:00–14:35 **Mizoguchi Noriko** (Japan)
Backward self-similar blowup solution to a semilinear heat equation

Room D3 Chairman: Rachůnková Irena

14:00–14:35 **Weinmüller Ewa B.** (Austria)
Recent advances in the numerical solution of singular BVPs

CONTRIBUTED TALKS

Room D1 Chairman: Fonda Alessandro

14:40–15:00 **Jaroš Jaroslav** (Slovakia)
Picone-type identity and half-linear differential equations of even order

15:05–15:25 **Yamaoka Naoto** (Japan)
Comparison theorems for oscillation of second-order nonlinear differential equations

15:30–15:50 **Usami Hiroyuki** (Japan)
Asymptotic forms of slowly decaying solutions of quasilinear ordinary differential equations with critical exponents

15:55–16:25 *Break*

Chairman: Usami Hiroyuki

16:25–16:45 **Domoshnitsky Alexander** (Israel)
Nonoscillation intervals for functional differential equations

16:50–17:10 **Bognár Gabriella** (Hungary)
On the boundary-layer equations for power-law fluids

17:15–17:35 **Karsai János** (Hungary)
On nonlinear damping in oscillatory systems

17:40–18:00 **Majumder Swarnali** (India)
Modifying some foliated dynamical systems to guide their trajectories to specified sub-manifolds

Room D2 Chairman: Morita Yoshihisa

14:40–15:00 **Burns Martin** (Scotland)
Steady state solutions of a bistable reaction diffusion equation with saturating flux

15:05–15:25 **Hsu Cheng-Hsiung** (Taiwan)
Inviscid and viscous stationary waves of gas flow through nozzles of varying area

15:30–15:50 **Franců Jan** (Czech Republic)
On special convergences in homogenization

15:55–16:25 *Break*

Chairman: Lawrence Bonita

16:25–16:45 **Franca Matteo** (Italy)
Radial solutions for p-Laplace equation with mixed non-linearities

16:50–17:10 **Nechvátal Luděk** (Czech Republic)
Homogenization with uncertain input parameters

17:15–17:35 **Setzer Katja** (Germany)
Definiteness of quadratic functionals and asymptotics of Riccati matrix differential equations

17:40–18:00 **Eisner Jan** (Czech Republic)
Smooth bifurcation branches of solutions for a Signorini problem

Room D3 Chairman: Rachůnková Irena

14:40–15:00 **Catrina Florin** (USA)
Compactness and radial solutions for nonlinear elliptic PDE’s

15:05–15:25 **Medková Dagmar** (Czech Republic)
Neumann problem for the Poisson equation on nonempty open subsets of the Euclidean space

15:30–15:50 **Rocca Elisabetta** (Italy)
A phase-field model for two-phase compressible fluids

15:55–16:25 *Break*

Chairman: Medková Dagmar

16:25–16:45 **Garcia–Huidobro Marta** (Chile)
On the uniqueness of the second bound state solution of a semilinear equation

16:50–17:10 **Filippakis Michael** (Greece)
Nodal and multiple constant sign solutions for equations with the p-Laplacian

17:15–17:35 **Viszus Eugen** (Slovakia)
Remarks on regularity for vector-valued minimizers of quasilinear functionals

17:40–18:00 **Filinovskiy Alexey** (Russia)
On the condensation of discrete spectrum under the transition to continuous

Room A107 Chairman: Stević Stevo

14:40–15:00 **Medved′ Milan** (Slovakia)
On a nonlinear version of the Henry integral inequality

15:05–15:25 **Pinelas Sandra** (Portugal)
Qualitative theory of divided difference first order systems

15:30–15:50 **Apreutesei Narcisa** (Romania)
Second order difference inclusions of monotone type

15:55–16:25 *Break*

Chairman: Matucci Serena

16:25–16:45 **Spadini Marco** (Italy)
Branches of forced oscillations for a class of constrained ordinary differential equations: A topological approach

16:50–17:10 **Stević Stevo** (Serbia)
Asymptotic methods in difference equations

17:15–17:35 **Fišnarová Simona** (Czech Republic)
Perturbation principle in discrete half-linear oscillation theory

17:40–18:00 **Rebenda Josef** (Czech Republic)
Asymptotic behaviour of a two-dimensional differential system with a nonconstant delay under the conditions of instability

Room B007 Chairman: Beneš Michal

14:40–15:00 **Segeth Karel** (Czech Republic)
Computational and analytical a posteriori error estimates

15:05–15:25 **Berres Stefan** (Chile)
A polydisperse suspension model as generic example of non-convex conservation law systems

15:30–15:50 **Fučík Radek** (Czech Republic)
Improvement to semi-analytical solution for two-phase porous-media flow in homogeneous and heterogeneous porous medium

15:55–16:25 *Break*

Chairman: Segeth Karel

16:25–16:45 **Kropielnicka Karolina** (Poland)
Implicit difference schemes and Newton method for evolution functional differential equations

16:50–17:10 **Mošová Vratislava** (Czech Republic)
RKPM and its modifications

17:15–17:35 **Yannakakis Nikos** (Greece)
Surjectivity of linear operators from a Banach space into itself

17:40–18:00 **Ezhak Svetlana** (Russia)
On estimates for the first eigenvalue of the Sturm–Liouville problem with an integral condition

Room B003 Chairman: Shmerling Efraim

14:40–15:00 **Estrella Angel G.** (Mexico)
On the zeros of a general characteristic equation with applications to absolute stability of delayed models

15:05–15:25 **Pereira Edgar** (Portugal)
A fixed point method to compute solvents of matrix polynomials

15:30–15:50 **Reitmann Volker** (Russia)
Realization theory methods for the stability investigation of nonlinear infinite-dimensional input-output systems

15:55–16:25 *Break*

Chairman: Pereira Edgar

16:25–16:45 **Sikorska–Nowak Aneta** (Poland)
Integro-differential equations of Volterra type on time scales

16:50–17:10 **Shmerling Efraim** (Israel)
Asymptotic stability conditions for stochastic Markovian systems of differential equations

17:15–17:35 **Goryuchkina Irina** (Russia)
Asymptotic forms and expansions of solutions to Painlevé equations

17:40–18:00 **Alzabut Jehad** (Saudi Arabia)
Perron's theorem for linear dynamic equations on time scales

TUESDAY – JULY 21

PLENARY LECTURES

Room D1 Chairman: Maslowski Bohdan

9:00–9:55 **Iserles Arieh** (United Kingdom)
Asymptotic numerics of highly oscillatory equations

10:00–10:30 *Break*

10:30–11:25 **Manásevich Raul** (Chile)
Some results for equations and systems with p-Laplace like operators

INVITED LECTURES

Room D1 Chairman: Bohner Martin

11:30–12:05 **Graef John** (USA)
Second order boundary value problems with sign-changing nonlinearities and nonhomogeneous boundary conditions

12:10–12:45 **Agarwal Ravi P.** (USA)
Complementary Lidstone interpolation and boundary value problems

12:45–14:00 *Lunch*

Room D2 Chairman: Krisztin Tibor

11:30–12:05 **Drábek Pavel** (Czech Republic)
A priori estimates for a class of quasi-linear elliptic equations

12:10–12:45 **Pituk Mihály** (Hungary)
Asymptotically autonomous functional differential equations

12:45–14:00 *Lunch*

Room D3 Chairman: Weinmüller Ewa

11:30–12:05 **Siafarikas Panayiotis** (Greece)
A "discretization" technique for the solution of ODE's

12:10–12:45 **Feistauer Miloslav** (Czech Republic)
On the numerical solution of compressible flow in time-dependent domains

12:45–14:00 *Lunch*

CONTRIBUTED TALKS

Room D1 Chairman: Garcia Isaac

14:00–14:20 **Khusainov Denys** (Ukraine)
The estimation of solutions of linear delayed scalar differential equations of neutral type

14:25–14:45 **Offin Daniel** (Canada)
Linearized stability and instability for symmetric periodic orbits in the N-body problem

14:50–15:10 **Lawrence Bonita** (USA)
The Marshall Differential Analyzer Project: A visual interpretation of dynamic equations

15:15–15:35 **Sanchez Luis A.** (Spain)
Cones of rank 2 and the Poincaré-Bendixson property for autonomous systems

15:40–16:10 *Break*

Chairman: Karsai János

16:10–16:30 **Braverman Elena** (Canada)
On stability and oscillation of equations with a distributed delay

16:35–16:55 **Röst Gergely** (Hungary)
Global dynamics for an epidemic model with infinite delay

17:00–17:20 **Matsunaga Hideaki** (Japan)
Stability switches in linear differential systems with diagonal delay

17:25–17:45 **Boichuk Aleksandr** (Slovakia)
Boundary-value problems for delay differential systems

17:50–18:10 **Garab Ábel** (Hungary)
The period function for a delay differential equation

Room D2 Chairman: Röst Gergely

14:00–14:20 **Ünal Mehmet** (Turkey)
Interval oscillation criteria for second order nonlinear delay dynamic equations

14:25–14:45 **Řehák Pavel** (Czech Republic)
A role of the coefficient of the differential term in oscillation theory of half-linear equations

14:50–15:10 **Kaymakçalan Billûr** (USA)
Oscillation criteria for some types of second order nonlinear dynamic equations

15:15–15:35 **Vítovec Jiří** (Czech Republic)
Theory of regular variation on time scales and its application to dynamic equations

15:40–16:10 *Break*

Chairman: Kaymakçalan Billûr

16:10–16:30 **Akin–Bohner Elvan** (USA)
Recessive solutions of nonoscillatory half-linear dynamic equations

16:35–16:55 **Oberste–Vorth Ralph** (USA)
The Fell topology on time scales and the convergence of solutions of dynamic equations

17:00–17:20 **Bodine Sigrun** (USA)
On second order nonoscillatory scalar linear differential equations

17:25–17:45 **Padial Juan Francisco** (Spain)
Estimate of the free-boundary for a non local elliptic-parabolic problem arising in nuclear fusion

17:50–18:10 **Abdeljawad Thabet** (Turkey)
Fractional calculus on time scales and integration by parts

Room D3 Chairman: Calamai Alessandro

14:00–14:20 **Răsvan Vladimir** (Romania)
Stability and sliding modes for a class of nonlinear time delay systems

14:25–14:45 **Federson Márcia** (Brazil)
Some contributions of Kurzweil integration to functional differential equations

14:50–15:10 **Matucci Serena** (Italy)
A boundary value problem on the half line for quasilinear equations

15:15–15:35 **Tomeček Jan** (Czech Republic)
On strictly increasing solutions of some singular boundary value problem on the half-line

15:40–16:10 *Break*

Chairman: Răsvan Vladimir

16:10–16:30 **Ruffing Andreas** (Germany)
To be announced

16:35–16:55 **Calamai Alessandro** (Italy)
Continuation results for forced oscillations of constrained motion problems with infinite delay

17:00–17:20 **García Isaac** (Spain)
Bifurcation of limit cycles from some monodromic limit sets in analytic planar vector fields

17:25–17:45 **Skiba Robert** (Poland)
A cohomological index of Fuller type for dynamical systems

17:50–18:10 **Burlica Monica–Dana** (Romania)
Viability on graphs for semilinear multi-valued reaction-diffusion systems

Room A107 Chairman: Ikeda Hideo

14:00–14:20 **Simon László** (Hungary)
On some singular systems of parabolic functional equations

14:25–14:45 **Nomikos Dimitris** (Greece)
Non-integrability of the Anisotropic Stormer Problem

14:50–15:10 **Murakawa Hideki** (Japan)
A relation between reaction-diffusion interaction and cross-diffusion

15:15–15:35 **Naito Yuki** (Japan)
Blowup rate for a parabolic-elliptic system in higher dimensional domains

15:40–16:10 *Break*

Chairman: Naito Yuki

16:10–16:30 **Malaguti Luisa** (Italy)
Continuous dependence in front propagation of convective reaction-diffusion equations

16:35–16:55 **Prykarpatsky Yarema** (Poland)
Symplectic method for the investigation Mel'nikov–Samoilenko adiabatic stability problem

17:00–17:20 **Ikeda Hideo** (Japan)
Dynamics of traveling front waves in bistable heterogeneous diffusive media

17:25–17:45 **Morita Yoshihisa** (Japan)
Traveling waves of a reaction-diffusion equation in the higher-dimensional space

17:50–18:10 **Kreml Ondřej** (Czech Republic)
Steady flow of a second grade fluid past an obstacle

Room B007 Chairman: Ćwiszewski Aleksander

14:00–14:20 **Dall'Acqua Anna** (Germany)
The Dirichlet boundary value problem for Willmore surfaces of revolution

14:25–14:45 **Harutyunyan Gohar** (Germany)
An application of the corner calculus

14:50–15:10 **Zafer Agacik** (Turkey)
On stability of delay dynamic systems

15:15–15:35 **Kajikiya Ryuji** (Japan)
Mountain pass theorem in ordered Banach spaces and its applications

15:40–16:10 *Break*

Chairman: Zafer Agacik

16:10–16:30 **Pilarczyk Dominika** (Poland)
Self-similar asymptotics of solutions to heat equation with inverse square potential

16:35–16:55 **Ćwiszewski Aleksander** (Poland)
Periodic solutions of nonautonomous damped hyperbolic equations at resonance

17:00–17:20 **Szafraniec Franciszek Hugon** (Poland)
Characterizing the creation operator via a differential equation

17:25–17:45 **Voitovich Tatiana** (Chile)
On the properties of the Proriol-Koornwinder-Dubiner hierarchical orthogonal bases for the DG FEM

17:50–18:10 **Tripathy Arun Kumar** (India)
To be announced

Room B003 Chairman: Kryszewski Wojciech

14:00–14:20 **Straškraba Ivan** (Czech Republic)
A selected survey of the mathematical theory of 1D flows

14:25–14:45 **Kania Maria** (Poland)
The perturbed viscous Cahn–Hilliard equation

14:50–15:10 **Roşu Daniela** (Romania)
Nonlinear multi-valued reaction-diffusion systems on graphs

15:15–15:35 **Omel'chenko Oleh** (Germany)
Spike solutions to singularly perturbed elliptic equation via the implicit function theorem

15:40–16:10 *Break*

Chairman: Straškraba Ivan

16:10–16:30 **Planas Gabriela** (Brazil)
Asymptotic behaviour of a phase-field model with three coupled equations without uniqueness

16:35–16:55 **Grosu Gabriela** (Romania)
Existence results for a class of reaction diffusion systems involving measures

17:00–17:20 **Seki Yukihiro** (Japan)
On exact dead-core rates for a semilinear heat equation with strong absorption

17:25–17:45 **Kryszewski Wojciech** (Poland)
Infinite-dimensional homology and multibump solutions

17:50–18:10 **Grobbelaar Marié** (South Africa)
Strong stability for a fluid-structure model

WEDNESDAY – JULY 22

PLENARY LECTURES

Room D1 Chairman: Poláčik Peter

9:00–9:55 **Maslowski Bohdan** (Czech Republic)
Linear and semilinear PDE's in infinite dimensions

10:00–10:30 *Break*

10:30–11:25 **Taliaferro Steven** (USA)
Blow-up behavior of solutions of semi-linear elliptic and parabolic inequalities

INVITED LECTURES

Room D1 Chairman: Korotov Sergey

11:30–12:05 **Teschl Gerald** (Austria)
Relative oscillation theory or how to compute Krein's spectral shift function by counting zeros of Wronski determinants

12:05–13:00 *Lunch*

13:00–20:00 *Trip*

Room D2 Chairman: Quittner Pavol

11:30–12:05 **Rachůnková Irena** (Czech Republic)
Singular second-order differential problems arising in hydrodynamics and membrane theory

12:05–13:00 *Lunch*

13:00–20:00 *Trip*

Room D3 Chairman: Siafarikas Panayiotis

11:30–12:05 **Růžička Michael** (Germany)
Theoretical and numerical analysis of generalized Newtonian fluids

12:05–13:00 *Lunch*

13:00–20:00 *Trip*

THURSDAY – JULY 23

PLENARY LECTURES

Room D1 Chairman: Taliaferro Steven

9:00–9:55 **Suzuki Takashi** (Japan)
Global in time solution to a class of tumor growth systems

10:00–10:30 *Break*

10:30–11:25 **Krejčí Pavel** (Czech Republic)
A bottle in a freezer

INVITED LECTURES

Room D1 Chairman: Manásevich Raul

11:30–12:05 **Fonda Alessandro** (Italy)
Lower and upper solutions to semilinear boundary value problems: An abstract approach

12:10–12:45 **Kratz Werner** (Germany)
Oscillation theory for discrete symplectic systems

12:45–14:00 *Lunch*

Room D2 Chairman: Graef John

11:30–12:05 **Quittner Pavol** (Slovakia)
Boundedness of solutions of superlinear elliptic boundary value problems

12:45–14:00 *Lunch*

Room D3 Chairman: Agarwal Ravi P.

11:30–12:05 **Bohner Martin** (USA)
Dynamic risk aversion and risk vulnerability

12:10–12:45 **Korotov Sergey** (Finland)
The generalized bisection algorithms with applications in finite element methods

12:45–14:00 *Lunch*

CONTRIBUTED TALKS

Room D1 Chairman: Jaroš Jaroslav

14:00–14:20 **Andres Jan** (Czech Republic)
Topological structure of solution sets to BVPs

14:25–14:45 **Benedetti Irene** (Italy)
Semilinear differential inclusions via week-topologies

14:50–15:10 **Taddei Valentina** (Italy)
Two-points b.v.p. for inclusions with weakly regular r.h.s.

15:15–15:35 **Došlá Zuzana** (Czech Republic)
Limit properties for ordinary differential equations with bounded Φ-Laplacian operator

15:40–16:10 *Break*

Chairman: Andres Jan

16:10–16:30 **Vas Gabriella** (Hungary)
Large slowly oscillating periodic solutions for an equation with delayed positive feedback

16:35–16:55 **Bartha Ferenc** (Hungary)
Morse decomposition for a state-dependent delayed differential equation

17:00–17:20 **Cernea Aurelian** (Romania)
Existence results for Fredholm-type integral inclusion

17:25–17:45 **Domachowski Stanislaw** (Poland)
An application of a global bifurcation theorem and selectors theorems to the existence results for non-convex differential inclusions

Room D2 Chairman: Simon Peter

14:00–14:20 **Infante Gennaro** (Italy)
A third order BVP subject to nonlinear boundary conditions

14:25–14:45 **Luca–Tudorache Rodica** (Romania)
On a class of m-point boundary value problems

14:50–15:10 **Tvrdý Milan** (Czech Republic)
A generalized anti-maximum principle for the periodic one dimensional p-Laplacian with sign changing potential

15:15–15:35 **Tanaka Satoshi** (Japan)
On the uniqueness of positive solutions for two-point boundary value problems of Emden–Fowler differential equations

15:40–16:10 *Break*

Chairman: Tvrdý Milan

16:10–16:30 **Sett Jayasri** (India)
On the boundary conditions satisfied by a given solution of a linear third-order homogeneous ordinary differential equation

16:35–16:55 **Simon Peter** (Hungary)
Exact multiplicity of positive solutions for a class of singular semilinear equations

17:00–17:20 **Zima Mirosława** (Poland)
Positive solutions of non-local boundary value problems

17:25–17:45 **Dzhalladova Irada** (Ukraine)
Stability of linear differential equations with random coefficients and random transformation of solutions

Room D3 Chairman: Tadie Tadie

14:00–14:20 **Shioji Naoki** (Japan)
Existence of multiple sign-changing solutions for a singularly perturbed Neumann problem

14:25–14:45 **Kuo Tsang-Hai** (Taiwan)
Existence results to some quasilinear elliptic problems

14:50–15:10 **Smyrlis George** (Greece)
Multiple solutions for nonlinear Neumann problems with the p-Laplacian and a nonsmooth crossing potential

15:15–15:35 **Tello Jose Ignacio** (Spain)
An inverse problem in Lubrication Theory

15:40–16:10 *Break*

Chairman: Tello Jose Ignacio

16:10–16:30 **Ainouz Abdelhamid** (Algeria)
Homogenized double porosity models for poroelastic media with interfacial flow barrier

16:35–16:55 **Jiménez–Casas Ángela** (Spain)
Asymptotic behaviour of attractors of problems with terms concentrated in the boundary

17:00–17:20 **Matsuzawa Hiroshi** (Japan)
Dynamics of a transition layer for a scalar bistable reaction-diffusion equation with spatially heterogeneous environments

17:25–17:45 **Tadie Tadie** (Denmark)
Comparison results for some nonlinear elliptic equations

Room A107 Chairman: Toader Rodica

14:00–14:20 **Sushch Volodymyr** (Poland)
Instanton-anti-instanton solutions of discrete Yang–Mills equations

14:25–14:45 **Schmeidel Ewa** (Poland)
Existence of asymptotically periodic solutions of system of Volterra difference equations

14:50–15:10 **Stinner Christian** (Germany)
Very slow convergence rates for a supercritical semilinear parabolic equation

15:15–15:35 **Dénes Attila** (Hungary)
Eventual stability properties in a non-autonomous model of population dynamics

15:40–16:10 *Break*

Chairman: Schmeidel Ewa

16:10–16:30 **Kundrát Petr** (Czech Republic)
Asymptotic properties of differential equation with several proportional delays and power coefficients

16:35–16:55 **Serrano Hélia** (Spain)
Γ-convergence of complementary energies

17:00–17:20 **Tomoeda Kenji** (Japan)
Repeated support splitting and merging phenomena in some nonlinear diffusion equation

17:25–17:45 **Bondar Lina** (Russia)
Boundary value problems for quasielliptic systems in R^n_+

Room B007 Chairman: Krbec Miroslav

14:00–14:20 **Beneš Michal** (Czech Republic)
Numerical solution of non-local anisotropic Allen–Cahn equation

14:25–14:45 **Dittmar Bodo** (Germany)
Local and global maxima for the expectation of the lifetime of a Brownian motion

14:50–15:10 **Opluštil Zdeněk** (Czech Republic)
Some oscillatory properties of the second-order differential equation with an argument deviation

15:15–15:35 **Egami Chikahiro** (Japan)
A sufficient condition for the existence of Hopf bifurcation for an immune response model

15:40–16:10 *Break*

Chairman: Dittmar Bodo

16:10–16:30 **Nakaki Tatsuyuki** (Japan)
Numerical computations to porous medium flow with convection

16:35–16:55 **Krbec Miroslav** (Czech Republic)
On dimension-free Sobolev imbeddings

17:00–17:20 **Horváth László** (Hungary)
Nonlinear integral inequalities and integral equations with kernels defined by concave functions

17:25–17:45 **Dutkiewicz Aldona** (Poland)
On the existence of L^p-solutions of the functional-integral equation in Banach spaces

Room B003 Chairman: Wilczyński Paweł

14:00–14:20 **Hasil Petr** (Czech Republic)
Critical higher order Sturm–Liouville difference operators

14:25–14:45 **Shatirko Ondrey** (Ukraine)
The estimation of absolute stability of discrete systems with delay

14:50–15:10 **Slavík Antonín** (Czech Republic)
Periodic averaging of dynamic equations on time scales

15:15–15:35 **Maza Susana** (Spain)
A new approach to center conditions for simple analytic monodromic singularities

15:40–16:10 *Break*

Chairman: Šremr Jiří

16:10–16:30 **Toader Rodica** (Italy)
Periodic orbits of radially symmetric systems with a singularity

16:35–16:55 **Zemánek Petr** (Czech Republic)
Friedrichs extension of operators defined by discrete symplectic systems

17:00–17:20 **Wilczyński Paweł** (Poland)
Chaos in planar polynomial nonautonomous ODEs

17:25–17:45 **Svoboda Zdeněk** (Czech Republic)
Asymptotic properties of one p-type retarded differential equation

POSTER SESSION

Building D Chairman: Šimon Hilscher Roman

17:50–18:15 **Poster Session**

Campos Beatriz (Spain)
Chiralt Cristina (Spain)
Cichoń Mieczysław (Poland)
Hakl Robert (Czech Republic)
Hsu Tsing-San (Taiwan)
Jánský Jiří (Czech Republic)
Kharkov Vitaliy (Ukraine)
Kisela Tomáš (Czech Republic)
Kuzmych Olena (Ukraine)
Lomtatidze Aleksander (Czech Republic)
Mácha Václav (Czech Republic)
Mařík Robert (Czech Republic)
Řezníčková Jana (Czech Republic)
Růžičková Miroslava (Czech Republic)
Šmarda Zdeněk (Czech Republic)
Was Konrad (Poland)

FRIDAY – JULY 24

PLENARY LECTURES

Room D1 Chairman: Došlý Ondřej

9:00–9:55 **Šimon Hilscher Roman** (Czech Republic)
Eigenvalue, oscillation, and variational results for time scale symplectic systems

10:00–10:30 *Break*

INVITED LECTURES

Room D1 Chairman: Došlý Ondřej

10:30–11:05 **Krisztin Tibor** (Hungary)
Differential equations with delayed monotone feedback

Room D3 Chairman: Schwabik Štefan

10:30–11:05 **Rontó András** (Czech Republic)
On slowly growing solutions of linear functional differential equations

CONTRIBUTED TALKS

Room D1 Chairman: Mukhigulashvili Sulkhan

11:10–11:30 **Bartušek Miroslav** (Czech Republic)
Noncontinuable solutions of differential equations with delays

11:35–11:55 **Giorgadze Givi** (Georgia)
On oscillatory properties of solutions of linear differential systems with deviating arguments

12:00–12:20 **Koplatadze Roman** (Georgia)
On a boundary value problem for the integro-differential equations

12:25–14:00 *Lunch*

Chairman: Hakl Robert

14:00–14:20 **Bravyi Eugene** (Russia)
On the solvability sets for boundary value problems for functional differential equations

14:25–14:45 **Astashova Irina** (Russia)
On the asymptotic behavior at the infinity of solutions to quasilinear differential equations

14:50–15:10 **Derhab Mohammed** (Algeria)
Existence of solutions for quasilinear elliptic systems with Hölder continuous nonlinearities and nonlocal boundary conditions

15:15–15:30 *Break*

15:30–16:00 *Closing*

Room D2 Chairman: Boichuk Aleksandr

11:10–11:30 **Obaya García Rafael** (Spain)
Monotone methods for neutral functional differential equations

11:35–11:55 **Karulina Elena** (Russia)
On some estimates for the minimal eigenvalue of the Sturm–Liouville problem with third-type boundary conditions

12:00–12:20 **Telnova Maria** (Russia)
Some estimates of the first eigen-value of a Sturm–Liouville problem with a weight integral condition

12:25–14:00 *Lunch*

Chairman: Diblík Josef

14:00–14:20 **Slezák Bernát** (Hungary)
On the Lipschitz-continuous parameter-dependence of the solutions of abstract functional differential equations with state-dependent delay

14:25–14:45 **Dwiggins David** (USA)
To be announced

14:50–15:10 **Biswas Anjan** (USA)
To be announced

15:15–15:30 *Break*

15:30–16:00 *Closing*

Room D3 Chairman: Čermák Jan

11:10–11:30 **Diblík Josef** (Czech Republic)
Representation of solutions of linear discrete systems with constant coefficients, a single delay and with impulses

11:35–11:55 **Rocha Eugénio** (Portugal)
Four solutions for an elliptic equation with critical exponent and singular term

12:00–12:20 **Flad Heinz–Jürgen** (Germany)
Hartree-Fock equation for Coulomb systems: asymptotic regularity, approximation and Galerkin discretization

12:25–14:00 *Lunch*

Chairman: Lomtatidze Aleksander

14:00–14:20 **Besenyei Adam** (Hungary)
On a system consisting of three different types of differential equations

14:25–14:45	**Pokorný Milan** (Czech Republic) On regularity criteria for the incompressible Navier–Stokes equations containing velocity gradient
14:50–15:10	**Mukhigulashvili Sulkhan** (Czech Republic) The periodic problem for the systems of higher order linear differential equation with deviations
15:15–15:30	*Break*
15:30–16:00	*Closing*
Room A107	Chairman: Řehák Pavel
11:10–11:30	**Kon Ryusuke** (Austria) Dynamics of interacting structured populations
11:35–11:55	**Ruggerini Stefano** (Italy) Asymptotic speed of propagation for a class of degenerate reaction-diffusion-convection equations
12:00–12:20	**Yang Tzi–Sheng** (Taiwan) Global optimizations by intermittent diffusion
12:25–14:00	*Lunch*
	Chairman: Franců Jan
14:00–14:20	**Lazu Alina Ilinca** (Romania) On the regularity of the state constrained minimal time function
14:25–14:45	**Amar Makhlouf** (Algeria) 3-dimentional Hopf bifurcation via averaging theory of second order
14:50–15:10	**Faouzi Haddouchi** (Algeria) Inversion of singular systems with delays
15:15–15:30	*Break*
15:30–16:00	*Closing*
Room B007	Chairman: Vodák Rostislav
11:10–11:30	**Chrastinová Veronika** (Czech Republic) Parallelism between differential and difference equations
11:35–11:55	**Dalík Josef** (Czech Republic) Approximations of directional derivatives by averaging
12:00–12:20	**Vala Jiří** (Czech Republic) Multiscale modelling of thermomechanical behaviour of early-age silicate composites
12:25–14:00	*Lunch*

Chairman: Mařík Robert

14:00–14:20 **Vodák Rostislav** (Czech Republic)
Dynamics of heat conducting fluids inside of heat conducting domains

14:25–14:45 **Rajaee Leila** (Iran)
Heated microwave ceramic by the microwave laser

14:50–15:10 **Ghaemi Mohammad Bagher** (Iran)
The existence of weak solutions for some classes of nonlinear P(x)-boundary value problems

15:15–15:30 *Break*

15:30–16:00 *Closing*

Room B003 Chairman: Medved' Milan

11:10–11:30 **Veselý Michal** (Czech Republic)
Almost periodic homogeneous linear difference systems without almost periodic solutions

11:35–11:55 **Pavlačková Martina** (Czech Republic)
Bound sets approach to Floquet problems for vector second-order differential inclusions

12:00–12:20 **Pekárková Eva** (Czech Republic)
Estimations of noncontinuable solutions

12:25–14:00 *Lunch*

Chairman: Bartušek Miroslav

14:00–14:20 **Franková Dana** (Czech Republic)
Regulated functions of multiple variables

14:25–14:45 **Baštinec Jaromír** (Czech Republic)
Oscillation of solutions of a linear second order discrete delayed equation

14:50–15:10 **Šremr Jiří** (Czech Republic)
On the Cauchy problem for hyperbolic functional-differential equations

15:15–15:30 *Break*

15:30–16:00 *Closing*

MONDAY, JULY 20

PLENARY AND INVITED LECTURES

	Room D1	**Room D2**	**Room D3**
9:30–10:00	*Opening Ceremony*		
Chairman	*Neuman*		
10:00–10:55	Burton		
11:00–11:30	*Break*		
Chairman	*Mawhin*		
11:30–12:25	Poláčik		
12:30–14:00	*Lunch*		
Chairman	*Fonda*	*Morita*	*Rachůnková*
14:00–14:35	Mawhin	Mizoguchi	Weinmüller

MONDAY, JULY 20

CONTRIBUTED TALKS

	Room D1	**Room D2**	**Room D3**	**Room A107**	**Room B007**	**Room B003**
Chairman	*Fonda*	*Morita*	*Rachůnková*	*Stević*	*Beneš*	*Shmerling*
14:40–15:00	Jaroš	Burns	Catrina	Medved′	Segeth	Estrella
15:05–15:25	Yamaoka	Hsu C. H.	Medková	Pinelas	Berres	Pereira
15:30–15:50	Usami	Franců	Rocca	Apreutesei	Fučík	Reitmann
15:55–16:25	*Break*					
Chairman	*Usami*	*Lawrence*	*Medková*	*Matucci*	*Segeth*	*Pereira*
16:25–16:45	Domoshnitsky	Franca	Garcia–Huidobro	Spadini	Kropielnicka	Sikorska–Nowak
16:50–17:10	Bognár	Nechvátal	Filippakis	Stević	Mošová	Shmerling
17:15–17:35	Karsai	Setzer	Viszus	Fišnarová	Yannakakis	Goryuchkina
17:40–18:00	Majumder	Eisner	Filinovskiy	Rebenda	Ezhak	Alzabut

TUESDAY, JULY 21

PLENARY AND INVITED LECTURES

	Room D1	**Room D2**	**Room D3**
Chairman	*Maslowski*		
9:00–9:55	Iserles		
10:00–10:30	*Break*		
10:30–11:25	Manásevich		
Chairman	*Bohner*	*Krisztin*	*Weinmüller*
11:30–12:05	Graef	Drábek	Siafarikas
12:10–12:45	Agarwal	Pituk	Feistauer
12:45–14:00	*Lunch*		

TUESDAY, JULY 21

CONTRIBUTED TALKS

	Room D1	**Room D2**	**Room D3**	**Room A107**	**Room B007**	**Room B003**
Chairman	*Garcia*	*Röst*	*Calamai*	*Ikeda*	*Ćwiszewski*	*Kryszewski*
14:00–14:20	Khusainov	Ünal	Răsvan	Simon L.	Dall'Acqua	Straškraba
14:25–14:45	Offin	Řehák	Federson	Nomikos	Harutyunyan	Kania
14:50–15:10	Lawrence	Kaymakçalan	Matucci	Murakawa	Zafer	Roşu
15:15–15:35	Sanchez	Vítovec	Tomeček	Naito	Kajikiya	Omel'chenko
15:40–16:10	*Break*					
Chairman	*Karsai*	*Kaymakçalan*	*Răsvan*	*Naito*	*Zafer*	*Straškraba*
16:10–16:30	Braverman	Akın–Bohner	Ruffing	Malaguti	Pilarczyk	Planas
16:35–16:55	Röst	Oberste–Vorth	Calamai	Prykarpatsky	Ćwiszewski	Grosu
17:00–17:20	Matsunaga	Bodine	Garcia	Ikeda	Szafraniec	Seki
17:25–17:45	Boichuk	Padial	Skiba	Morita	Voitovich	Kryszewski
17:50–18:10	Garab	Abdeljawad	Burlica	Kreml	Tripathy	Grobbelaar

WEDNESDAY, JULY 22

PLENARY AND INVITED LECTURES

	Room D1	**Room D2**	**Room D3**
Chairman	*Poláčik*		
9:00–9:55	Maslowski		
10:00–10:30	*Break*		
10:30–11:25	Taliaferro		
Chairman	*Korotov*	*Quittner*	*Siafarikas*
11:30–12:05	Teschl	Rachůnková	Růžička
12:05–13:00	*Lunch*		
13:00–20:00	*Trip*		

THURSDAY, JULY 23

PLENARY AND INVITED LECTURES

	Room D1	**Room D2**	**Room D3**
Chairman	*Taliaferro*		
9:00–9:55	Suzuki		
10:00–10:30	*Break*		
10:30–11:25	Krejčí		
Chairman	*Manásevich*	*Graef*	*Agarwal*
11:30–12:05	Fonda	Quittner	Bohner
12:10–12:45	Kratz		Korotov
12:45–14:00	*Lunch*		

THURSDAY, JULY 23

CONTRIBUTED TALKS

	Room D1	**Room D2**	**Room D3**	**Room A107**	**Room B007**	**Room B003**
Chairman	*Jaroš*	*Simon P.*	*Tadie*	*Toader*	*Krbec*	*Wilczyński*
14:00–14:20	Andres	Infante	Shioji	Sushch	Beneš	Hasil
14:25–14:45	Benedetti	Luca–Tudorache	Kuo	Schmeidel	Dittmar	Shatirko
14:50–15:10	Taddei	Tvrdý	Smyrlis	Stinner	Opluštil	Slavík
15:15–15:35	Došlá	Tanaka	Tello	Dénes	Egami	Maza
15:40–16:10	*Break*					
Chairman	*Andres*	*Tvrdý*	*Tello*	*Schmeidel*	*Dittmar*	*Šremr*
16:10–16:30	Vas	Sett	Ainouz	Kundrát	Nakaki	Toader
16:35–16:55	Bartha	Simon P.	Jiménez–Casas	Serrano	Krbec	Zemánek
17:00–17:20	Cernea	Zima	Matsuzawa	Tomoeda	Horváth	Wilczyński
17:25–17:45	Domachowski	Dzhalladova	Tadie	Bondar	Dutkiewicz	Svoboda
17:50–18:15	*Poster session*					

FRIDAY, JULY 24

PLENARY AND INVITED LECTURES

	Room D1	**Room D2**	**Room D3**
Chairman	*Došlý*		
9:00–9:55	Šimon Hilscher		
10:00–10:30	*Break*		
Chairman	*Došlý*		*Schwabik*
10:30–11:05	Krisztin		Rontó

FRIDAY, JULY 24
CONTRIBUTED TALKS

	Room D1	**Room D2**	**Room D3**	**Room A107**	**Room B007**	**Room B003**
Chairman	*Mukhigulashvili*	*Boichuk*	*Čermák*	*Řehák*	*Vodák*	*Medveď*
11:10–11:30	Bartušek	Obaya	Diblík	Kon	Chrastinová	Veselý
11:35–11:55	Giorgadze	Karulina	Rocha	Ruggerini	Dalík	Pavlačková
12:00–12:20	Koplatadze	Telnova	Flad	Yang	Vala	Pekárková
12:25–14:00	*Lunch*					
Chairman	*Hakl*	*Diblík*	*Lomtatidze*	*Franců*	*Mařík*	*Bartušek*
14:00–14:20	Bravyi	Slezák	Besenyei	Lazu	Vodák	Franková
14:25–14:45	Astashova	Dwiggins	Pokorný	Amar	Rajaee	Baštinec
14:50–15:10	Derhab	Biswas	Mukhigulashvili	Faouzi	Ghaemi	Šremr
15:15–15:30	*Break*					
15:30–16:00	*Closing*					

Abstracts

Plenary and Invited Lectures

COMPLEMENTARY LIDSTONE INTERPOLATION AND BOUNDARY VALUE PROBLEMS

Ravi P. Agarwal, *Melbourne, USA*

2000 MSC:

We shall introduce and construct explicitly the complementary Lidstone interpolating polynomial $P_{2m}(t)$ of degree $2m$, which involves interpolating data at the odd order derivatives. For $P_{2m}(t)$ we shall provide explicit representation of the error function, best possible error inequalities, best possible criterion for the convergence of complementary Lidstone series, and a quadrature formula with best possible error bound. Then, these results will be used to establish existence and uniqueness criteria, and the convergence of Picard's, approximate Picard's, quasilinearization, and approximate quasilinearization iterative methods for the complementary Lidstone boundary value problems which consist of an $(2m + 1)$th order differential equation and the complementary Lidstone boundary conditions.

DYNAMIC RISK AVERSION AND RISK VULNERABILITY

Martin Bohner, *Rolla, Missouri, USA*

2000 MSC: 39A10, 91B02, 91B16, 91B30

This talk discusses utility functions for money, where allowable money values are from an arbitrary nonempty closed subset of the real numbers. Thus the classical case, where this subset is the set of all real numbers, is included in the study. The discrete case, where this subset is the set of all integer numbers, is also included. In a sense this discrete case (which has not been addressed in the literature thus far) is more suitable for real-world applications than the continuous case. The concepts of risk aversion and risk premium are defined, an analogue of Pratt's fundamental theorem is proved, and temperance, prudence, and risk vulnerability is examined. Applications, e.g., the standard portfolio problem, are discussed. For illustration purposes, numerous examples with different choices of the underlying money set are presented. This topic unifies two areas of mathematics (dynamic equations on time scales, see [1]) and economics (the economics of risk and time, see [2]).

[1] M. Bohner and A. Peterson. *Dynamic Equations on Time Scales: An Introduction with Applications*. Birkhäuser, Boston, 2001.

[2] C. Gollier. *The Economics of Risk and Time*. The MIT Press, Cambridge, Massachusetts, 2001.

LIAPUNOV FUNCTIONALS AND RESOLVENTS

T. A. Burton, *Port Angeles, WA and Memphis, TN, USA*

2000 MSC: 45D05, 34K15, 34D20

This work is joint with Prof. David Dwiggins. Many real-world problems are modelled using $\int_0^t C(t,s)g(x(s))ds$ where C is convex. We take $B(t,s) = C(t,s)+ D(t,s)$ where D is an integrable error term and discuss an integral equation of the form $x(t) = a(t) - \int_0^t B(t,s)[x(s) + G(s,x(s))]ds$ where G is another error term satisfying $|G(t,x)| \leq \phi(t)|x|$ and $\phi \in L^1[0,\infty)$. The equation is separated into $y(t) = a(t) - \int_0^t B(t,s)y(s)ds$ and $x(t) = y(t) - \int_0^t R(t,s)G(s,x(s))ds$ where R is the resolvent and solves $R(t,s) = B(t,s) - \int_s^t B(t,u)R(u,s)du$. We construct a Liapunov functional for the resolvent equation and deduce that $\sup_{0\leq s\leq t<\infty} \int_s^t R^2(u,s)du < \infty$. Next, we study the differential equations of the resolvent with respect to both t and s, concluding that $R(t,s) \to 0$ as $t \to \infty$ and that R_s is bounded. This is key to showing that for fixed s then $R(t,s)$ converges to $B(t,s)$ both in $L^2[0,\infty)$ and pointwise. While the results are of non-convolution type, viewing this in the convolution case reveals it is a striking relation. The properties of R are used to study the nonlinear problem.

[1] T. A. Burton, Liapunov Functionals for Integral Equations. Trafford, Victoria, B. C., 2008 (www.trafford.com/08-1365)

A PRIORI ESTIMATES FOR A CLASS OF QUASI-LINEAR ELLIPTIC EQUATIONS

Pavel Drábek, *Plzeň, Czech Republic*

2000 MSC:

This is a joint work with Prof. Daniel Daners. In this paper we prove a priori estimates for a class of quasi-linear elliptic equations. To make the proofs clear and transparent we concentrate on the p-Laplacian. We focus on Lp- estimates for weak solutions of the problem with all standard boundary conditions on non-smooth domains. As an application we prove existence, continuity and compactness of the resolvent operator. We finally prove estimates for solutions to equations with nonlinear source and show that under suitable growth conditions, all solutions are globally bounded.

ON THE NUMERICAL SOLUTION OF COMPRESSIBLE FLOW IN TIME-DEPENDENT DOMAINS

Miloslav Feistauer, *Prague, Czech Republic*

2000 MSC: 65M60, 76M10

The paper will be concerned with the simulation of inviscid and viscous compressible flow in time dependent domains. The motion of the boundary of the domain occupied by the fluid is taken into account with the aid of the ALE (Arbitrary Lagrangian-Eulerian) formulation of the Euler and Navier-Stokes equations describing compressible flow. They are discretized in space by the discontinuous Galerkin finite element method using piecewise polynomial discontinuous approximations. The time discretization is based on a semi-implicit linearized scheme, which leads to the solution of a linear algebraic system on each time level. Moreover, we use a special treatment of boundary conditions, shock capturing and isoparametric elements at curved boundaries, allowing the solution of flow with a wide range of Mach numbers. As a result we get an efficient and robust numerical process. The applicability of the developed method will be demonstrated by some computational results obtained for flow in a channel with a moving wall and past an oscillating airfoil.

These results were obtained in cooperation with Václav Kučera and Jaroslava Prokopová from Charles University in Prague, Faculty of Mathematics and Physics, and Jaromír Horáček from Institute of Thermomechanics of Academy of Sciences of the Czech Republic.

LOWER AND UPPER SOLUTIONS TO SEMILINEAR BOUNDARY VALUE PROBLEMS: AN ABSTRACT APPROACH

Alessandro Fonda, *Trieste, Italy*

2000 MSC: 35K20, 35J25

This is a joint work with R. Toader. We provide an abstract setting for the theory of lower and upper solutions to some semilinear boundary value problems. In doing so, we need to introduce an abstract formulation of the Strong Maximum Principle. We thus obtain a general version of some existence results, both in the case where the lower and upper solutions are well-ordered, and in the case where they are not so. Applications are given, e.g., to boundary value problems associated to parabolic equations, as well as to elliptic equations.

SECOND ORDER BOUNDARY VALUE PROBLEMS WITH SIGN-CHANGING NONLINEARITIES AND NONHOMOGENEOUS BOUNDARY CONDITIONS

John R. Graef, *Chattanooga, Tennessee USA*

2000 MSC: 34B15

This is a joint work with Professors Lingju Kong (Chattanooga, TN), Qingkai Kong (DeKalb, IL), and Bo Yang (Kennesaw, GA). The authors consider the boundary value problem with a two–parameter nonhomogeneous multi–point boundary condition

$$u'' + g(t)f(t,u) = 0, \quad t \in (0,1),$$

$$u(0) = \alpha u(\xi) + \lambda,\ u(1) = \beta u(\eta) + \mu.$$

Criteria are established for the existence of nontrivial solutions. The nonlinear term $f(t,x)$ can take negative values and may be unbounded from below. Conditions are determined by the relationship between the behavior of the quotient $f(t,x)/x$ for x near 0 and $\pm\infty$, and the smallest positive characteristic value of an associated linear integral operator. The analysis mainly relies on topological degree theory. The results are illustrated with examples.

ASYMPTOTIC NUMERICS OF HIGHLY OSCILLATORY EQUATIONS

Arieh Iserles, *Cambridge, United Kingdom*

2000 MSC: 65L05

In this talk I introduce a novel methodology, based on combination of asymptotic and numerical techniques, for the computation of ordinary differential equations with rapidly oscillating forcing terms. I focus on a family of nonlinear second-order equations which generalise the familiar van der Pol oscillator and appear in numerous applications, in particular in electronic engineering. It will be demonstrated that their solution can be expanded asymptotically employing modulated Fourier expansions. The calculation of expansion terms requires solely manipulation of non-oscillatory quantities, therefore is easily affordable and the computational cost is uniform in frequency.

The methodology of this talk can be extended to other families of ordinary and partial differential equations and DAEs with extrinsic high oscillation. Time allowing, I'll discuss these extensions.

THE GENERALIZED BISECTION ALGORITHMS WITH APPLICATIONS IN FINITE ELEMENT METHODS

Sergey Korotov, *Helsinki, Finland*

2000 MSC: 65N50, 65M50

In this talk we present several popular and several new variants of bisection algorithms, mostly in the context of the finite element methods (for mesh generation and mesh refinement purposes). Various properties of generated adaptive meshes will be proved and discussed. The talk will be given in the form suitable for a general mathematical audience.

OSCILLATION THEORY FOR DISCRETE SYMPLECTIC SYSTEMS

Werner Kratz, *Ulm, Germany*

2000 MSC: 39A12, 15A18

This is joint work with Ondřej Došlý (see [1]). We consider symplectic difference systems involving a spectral parameter together with Dirichlet boundary conditions. As the main result I present a discrete version of the so-called oscillation theorem which relates the number of finite eigenvalues less than a given number to the number of focal points of the principal solution of the symplectic system. This includes a discussion of the used concepts, namely the *multiplicity of focal points* for discrete symplectic systems and *finite eigenvalues* for discrete symplectic eigenvalue problems from the theory of matrix pencils. Moreover, the main tool for the proof, namely the so-called *index theorem* (see [2]), will be discussed.

[1] O. Došlý and W. Kratz, *Oscillation theorems for symplectic difference systems*, J. Difference Equ. Appl. **13** (2007), 585–605.

[2] W. Kratz, *An index theorem for monotone matrix-valued functions*, SIAM J. Matrix Anal. Appl. **16** (1995), 113–122.

A BOTTLE IN A FREEZER

Pavel Krejčí, *Prague, Czech Republic*

2000 MSC: 80A22

This is a joint work with Elisabetta Rocca and Jürgen Sprekels. We propose a model for water freezing in a bounded deformable 3D container. Since ice has larger specific volume than water, the pressure increase may damage the container. The physical state is characterized by the local volume U, absolute temperature $\theta > 0$, and liquid contents $\chi \in [0, 1]$, and the process is governed by three evolution equations: energy balance, quasistatic momentum balance, and phase dynamics equation. We discuss some properties of solutions to the resulting system of one PDE, one differential inclusion, and one integro-differential equation in each of the three cases: rigid, elastic, or elastoplastic container. In a gravity field and under constant outer temperature, e.g., all solution trajectories converge to an equilibrium with single ice layer above and water layer below.

[1] P. Krejčí, E. Rocca, J. Sprekels, *A bottle in a freezer.* arXiv:0904.4380, 2009.

[2] P. Krejčí, E. Rocca, J. Sprekels, *Phase separation in a gravity field.* arXiv:0905.2131, 2009.

DIFFERENTIAL EQUATIONS WITH DELAYED MONOTONE FEEDBACK

Tibor Krisztin, *Szeged, Hungary*

2000 MSC: 34K13, 34K19, 37L25

Consider the equation

$$\dot{x}(t) = -\mu x(t) + f(x(t-1)) \tag{1}$$

where $\mu \geq 0$ and f is a smooth real function with $f(0) = 0$. If f is monotone and a mild dissipativity condition holds then the global attractor of the semiflow generated by (1) exists, and there is a very detailed information about the structure of it.

The closure of the unstable set of an unstable equilibrium point is always a subset of the global attractor, and it can be described more or less completely: it contains equilibria, periodic orbits and smooth connecting sets between equilibria and periodic orbits. For certain nonlinearities f, it is expected that the global attractor coincides with the above unstable set of zero or with the union of unstable sets of the unstable equilibria. As an example, Wright's equation — the particular case of (1) when $\mu = 0$ and $f(x) = -\alpha(e^x - 1)$, $\alpha > 0$ — will be discussed.

SOME RESULTS FOR EQUATIONS AND SYSTEMS WITH p-LAPLACE LIKE OPERATORS

Raul Manásevich, *Santiago, Chile*

2000 MSC:

In this talk we will consider some results for existence of positive solutions to boundary value problems of the form

$$(\phi(u'))' + f(t, u) = 0,$$

with nonlinear boundary conditions.

We will also consider existence of periodic solutions to systems of the form

$$(\phi_p(u'))' + \frac{d}{dt}(\nabla F(u)) + \nabla G(u) = e(t).$$

In this case we will give some results concerning the asymptotic behavior of all solutions to such systems, as well as sufficient conditions for uniform ultimate boundedness of solutions.

Work done in collaboration with M. García-Huidobro and J. R. Ward.

LINEAR AND SEMILINEAR PDE'S IN INFINITE DIMENSIONS

Bohdan Maslowski, *Prague, Czech Republic*

2000 MSC: 60H15

Parabolic and elliptic-like equations in infinite dimensional state spaces, which are the main subject of the talk, appear in a natural way in stochastic analysis, when transition semigroups or control problems are studied for stochastic PDEs (or other infinite-dimensional stochastic systems). Although these objects are deterministic, stochastic equations provide both motivation and tools for their analysis. Some of these methods may be interesting even in finite dimensions, when more standard methods are available.

We will briefly introduce the concept of cylindical Brownian motion in a separable Hilbert space as well as the notion of the space-time white noise. Some examples of simple stochastic PDEs driven by space-dependent noise, white in time, will be presented. Also, some finite and infinite time horizon control problems for stochastic PDEs will be mentioned. Then a backward Kolmogorov equation for the transition semigroup for the solutions of SPDE's will be derived, which is a linear parabolic equation in a Hilbert (or Banach) space, and an appropriate concept of solution will be suggested. Analogously, some semilinear Hamilton-Jacobi-Bellman equations will be introduced for the related control problems, which are semilinear parabolic or elliptic equations in the Hilbert space. Basic results on existence, uniqueness and regularity of solutions to these equations will be given.

BOUNDARY VALUE PROBLEMS FOR DIFFERENTIAL EQUATIONS INVOLVING CURVATURE OPERATORS IN EUCLIDIAN AND MINKOWSKIAN SPACES

Jean Mawhin, *Louvain-la-Neuve, Belgium*

2000 MSC: 34B15

The lecture will survey some recent results for ordinary differential equations or systems of the form

$$\left(\frac{u'}{\sqrt{1 \pm u'^2}}\right)' = f(x, u, u'), \tag{1}$$

on a compact interval, and for radial solutions of partial differential equations of the form

$$\nabla \cdot \left(\frac{\nabla u}{\sqrt{1 \pm \|\nabla u\|^2}}\right) = f(x, u, du/dv) \tag{2}$$

on a ball or a torus, submitted to non-homogeneous Dirichlet or Neumann boundary conditions.

[1] C. Bereanu and J. Mawhin, *Boundary value problems for some nonlinear systems with singular ϕ-laplacian*, J. Fixed Point Theory Appl. **4** (2008), 57-75

[2] C. Bereanu, P. Jebelean and J. Mawhin, *Radial solutions for some nonlinear problems involving mean curvature operators in Euclidian and Minkowski spaces*, Proc. Amer. Math. Soc. **137** (2009), 161-169

[3] C. Bereanu and J. Mawhin, *Non-homogeneous boundary value problems for some nonlinear equations with singular ϕ-laplacian*, J. Math. Anal. Appl. **352** (2009), 218-233

[4] C. Bereanu, P. Jebelean and J. Mawhin, *Radial solutions for Neumann problems involving mean curvature operators in Euclidian and Minkowski spaces*, Proc. ICMC Summer Meeting on Differential Equations (Sao Carlos 2009), to appear

BACKWARD SELF-SIMILAR BLOWUP SOLUTION TO A SEMILINEAR HEAT EQUATION

Noriko Mizoguchi, *Tokyo, Japan*

2000 MSC: 35B33

We are concerned with a Cauchy problem for a semilinear heat equation

$$\begin{cases} u_t = \Delta u + |u|^{p-1}u & \text{in } \mathbb{R}^N \times (0,T), \\ u(x,0) = u_0(x) \in L^\infty(\mathbb{R}^N) & \text{in } \mathbb{R}^N \end{cases}$$

with $p > 1$ and $T > 0$. Backward self-similar blowup solutions play an important role in the study of asymptotic behavior of all blowup solutions. In this talk, we consider the structure of all backward self-similar blowup solutions which depends on p.

ASYMPTOTICALLY AUTONOMOUS FUNCTIONAL DIFFERENTIAL EQUATIONS

Mihály Pituk, *Veszprém, Hungary*

2000 MSC: 34K25

In this talk, we will summarize some of our earlier results on asymptotically autonomous functional differential equations [1], [2] and we will present some new results on the asymptotic behavior of the nonnegative solutions.

[1] M. Pituk, *A Perron type theorem for functional differential equations* J. Math. Anal. Appl. **316** (2006), 24–41.

[2] M. Pituk, *Asymptotic behavior and oscillation of functional differential equations* J. Math. Anal. Appl. **322** (2006), 1140–1158.

ASYMPTOTIC BEHAVIOR OF POSITIVE SOLUTIONS OF PARABOLIC EQUATIONS: SYMMETRY AND BEYOND

Peter Poláčik, *Minneapolis, USA*

2000 MSC: 35B40, 35K15

Results to be discussed are related to the spatial symmetry of solutions. First we review existing theorems on the asymptotic symmetry of positive solutions of parabolic equations on bounded and unbounded domains, mentioning also some recent developments. Then we show how such symmetry results can effectively be used in studies of threshold solutions of parabolic equations on the whole space and in other applications.

BOUNDEDNESS OF SOLUTIONS OF SUPERLINEAR ELLIPTIC BOUNDARY VALUE PROBLEMS

Pavol Quittner, *Bratislava, Slovakia*

2000 MSC: 35J55, 35J65, 35B33, 35B65

We study the impact of boundary conditions on the boundedness of very weak solutions of superlinear elliptic boundary value problems.

After presenting recent results on scalar problems, we will consider the model elliptic system $-\Delta u = f(x, v)$, $-\Delta v + v = g(x, u)$ in a bounded smooth domain Ω. Here f, g are nonnegative Carathéodory functions satisfying the growth conditions $f \leq C(1+|v|^p)$, $g \leq C(1+|u|^q)$, and we complement the system with one of the following three boundary conditions on $\partial\Omega$: $u = v = 0$ (Dirichlet), $\partial_\nu u = \partial_\nu v = 0$ (Neumann) and $u = \partial_\nu v = 0$ (Dirichlet-Neumann). In all three cases we find optimal conditions on p, q guaranteeing that all nonnegative solutions belong to $L^\infty(\Omega)$ (and satisfy suitable a priori estimates).

We also consider related problems in non-smooth domains and problems with nonlinear boundary conditions.

SINGULAR SECOND-ORDER DIFFERENTIAL PROBLEMS ARISING IN HYDRODYNAMICS AND MEMBRANE THEORY

Irena Rachůnková, *Olomouc, Czech Republic*

2000 MSC: 34B16, 34B40, 34C37

We investigate differential equations which can have singularities at time and/or space variable. Equations are subject to boundary conditions on compact interval or on the half-line. In particular, we consider the equation

$$(p(t)u')' = p(t)f(u), \tag{1}$$

where the assumption $p(0) = 0$ yields a singularity at $t = 0$. We provide conditions guaranteeing that (1) has a homoclinic solution u, that is u fulfils $u'(0) = 0, \quad \lim_{t\to\infty} u(t) = L > 0$ and, after a proper extension, also $\lim_{t\to-\infty} u(t) = L$. Such problem arises in hydrodynamics. Other problems of the membrane theory, see [1], are also discussed.

[1] I. Rachůnková, S. Staněk, M. Tvrdý, Solvability of nonlinear singular problems for ordinary differential equations. Hindawi, New York, 2009.

ON SLOWLY GROWING SOLUTIONS OF LINEAR FUNCTIONAL DIFFERENTIAL EQUATIONS

András Rontó, *Brno, Czech Republic*

2000 MSC: 34K06, 34K12

For the system of linear functional differential equations

$$x_i'(t) = \sum_{k=1}^{n} (l_{ik}x_k)(t) + q_i(t), \qquad t \in [a, b), \quad i = 1, 2, \ldots, n,$$

where $-\infty < a < b < \infty$, the functions q_i, $i = 1, 2, \ldots, n$, are locally integrable, and $l_{ik} : C([a, b), \mathbb{R}) \to L_{1;\,\mathrm{loc}}([a, b), \mathbb{R})$, $i, k = 1, 2, \ldots, n$, are linear mappings, we obtain conditions sufficient for the existence of a solution which, in a sense, has limited growth as t approaches the point b. The question on the uniqueness of such a solution is discussed.

THEORETICAL AND NUMERICAL ANALYSIS OF GENERALIZED NEWTONIAN FLUIDS

Michael Růžička, *Freiburg, Germany*

2000 MSC: 76A05, 35K65, 35J70, 65M15

In the last 15 years we have seems a significant progress in the mathematical theory of generalized Newtonian fluids. We present some recent results in the existence and regularity theory of solutions and in the error analysis for approximate solutions. The talk is based on joined work with L.C. Berselli and L. Diening.

A "DISCRETIZATION" TECHNIQUE FOR THE SOLUTION OF ODE'S

Panayiotis D. Siafarikas, *Patras, Greece*

2000 MSC: 34A12, 34A25, 34A34, 34B15, 34M10, 34M99, 65J15, 65L05, 65L10, 76M25, 76M40

A functional-analytic technique was developed in the past for the establishment of unique solutions of ODEs in $H_2(\mathbb{D})$ and $H_1(\mathbb{D})$ and of difference equations in ℓ_2 and ℓ_1. This technique is based on two isomorphisms between the involved spaces. The two isomorphisms are combined in order to find discrete equivalent counterparts of ODEs, so as to obtain eventually the solution of the ODEs under consideration. As an application, the initial value problem for the Duffing equation (in $\mathbb{R}$) and the boundary value problem for the Blasius equation (in $\mathbb{C}$) are studied. The results are compared with numerical ones obtained using the 4^{th} order Runge-Kutta method. The advantages of the present method are that, it is accurate, the only errors involved are the round-off errors, it does not depend on the grid used and the obtained solution is proved to be unique.

EIGENVALUE, OSCILLATION, AND VARIATIONAL RESULTS FOR TIME SCALE SYMPLECTIC SYSTEMS

Roman Šimon Hilscher, *Brno, Czech Republic*

2000 MSC: 34C10, 34B05, 39A12

In this talk we focus on the theory of time scale symplectic systems, which are linear dynamic systems possessing the traditional Hamiltonian properties. In particular, these systems unify the classical linear Hamiltonian systems known in the continuous time setting and the discrete symplectic systems known in the discrete time setting. We present results for general time scale symplectic systems regarding their variational background in optimal control problems on time scales, eigenvalue properties (such as those known for self-adjoint systems), and oscillation properties (such as the Riccati equations). The main objectives of this talk are

- to emphasize the interplay between the continuous and discrete time theories,
- to show how one theory inspires the other one (both directions),
- to demonstrate how the general time scale theory explains the differences between them,
- to provide new results even for the special cases of continuous and discrete time stemming from the general theory of time scale symplectic systems.

Most of these results were obtained jointly with Vera Zeidan from the Michigan State University and with Werner Kratz form the University of Ulm.

[1] R. Hilscher, V. Zeidan, *Time scale symplectic systems without normality*, J. Differential Equations **230** (2006), no. 1, 140–173.

[2] R. Hilscher, V. Zeidan, *Applications of time scale symplectic systems without normality*, J. Math. Anal. Appl. **340** (2008), no. 1, 451–465.

[3] R. Hilscher, V. Zeidan, *Riccati equations for abnormal time scale quadratic functionals*, J. Differential Equations **244** (2008), no. 6, 1410–1447.

[4] R. Hilscher, V. Zeidan, *Weak maximum principle and accessory problem for control problems on time scales*, Nonlinear Anal. **70** (2009), no. 9, 3209–3226.

[5] W. Kratz, R. Šimon Hilscher, V. Zeidan, *Eigenvalue and oscillation theorems for time scale symplectic systems*, submitted (June 2009).

[6] R. Šimon Hilscher, V. Zeidan, *Symplectic structure of Jacobi systems on time scales*, in preparation (July 2009).

GLOBAL IN TIME SOLUTION TO A CLASS OF TUMOR GROWTH SYSTEMS

Takashi Suzuki, *Osaka, Japan*

2000 MSC: 35K50

This talk is focused on a class of parabolic-ODE systems modeling tumor growth, typically describing the stage of angiogenesis. We discuss on its mathematical modeling with hybrid simulation, the main and related results, outline of the proof, and derivation of a nonlocal equation associated with the multi-scaled modeling.

BLOW-UP BEHAVIOR OF SOLUTIONS OF SEMI-LINEAR ELLIPTIC AND PARABOLIC INEQUALITIES

Steven Taliaferro, *College Station, Texas, USA*

2000 MSC: 35B40

We discuss how the blow-up behavior at an isolated singularity of solutions of semi-linear elliptic inequalities depends on a exponent in the inequalities. We also discuss similar results for initial blow-up of solutions of semi-linear parabolic inequalities. In particular, we show that for certain exponents there exists an apriori bound on the rate of blow-up and for other exponents the solutions can blow-up arbitrarily fast.

RELATIVE OSCILLATION THEORY OR HOW TO COMPUTE KREIN'S SPECTRAL SHIFT FUNCTION BY COUNTING ZEROS OF WRONSKI DETERMINANTS

Gerald Teschl, *Wien, Austria*

2000 MSC:

We develop an analog of classical oscillation theory for Sturm- Liouville operators which, rather than measuring the spectrum of one single operator, measures the difference between the spectra of two different operators.

This is done by replacing zeros of solutions of one operator by zeros of Wronskians of solutions of two different operators. In particular, we show that a Sturm-type comparison theorem still holds in this situation and we show how this can be used to investigate the finiteness of eigenvalues in essential spectral gaps. Furthermore, the connection with Krein's spectral shift function is established.

RECENT ADVANCES IN THE NUMERICAL SOLUTION OF SINGULAR BVPS

Ewa B. Weinmüller, *Wien, Austria*

2000 MSC:

We consider boundary value problems for systems in ordinary differential equations which exhibit singular points in the interval of integration. These problems typically have the form

$$z'(t) = \frac{1}{t^\alpha} f(t, z(t)), \quad t \in (0,1], \quad g(z(0), z(1)) = 0,$$

where α is non-negative. Such systems may also occur in a second order formulation

$$z''(t) = \frac{1}{t^\alpha} f_1(t, z'(t)) + \frac{1}{t^{\alpha+1}} f_2(t, z(t)) + f_3(t, z(t), z'(t)), \quad t \in (0,1],$$
$$g(z(0), z'(0), z(1), z'(1)) = 0,$$

or as regular boundary value problems posed on infinite intervals,

$$z'(t) = f(t, z(t)), \quad t \in [0, \infty), \quad g(z(0), \lim_{t\to\infty} z(t)) = 0,$$

We first briefly discuss the analytical properties of such problems, especially the existence and uniqueness of bounded solutions. We also point out typical difficulties arising in the investigation of stability and convergence of standard discretization methods applied to approximate their solutions.
A `Matlab` code `bvpsuite` (a new version of `sbvp1.0`) for the numerical treatment of the above problem class is presented. This solver is based on polynomial collocation, equipped with an a-posteriori estimates of the global error of the approximation z_h to the solution z, and features an adaptive mesh selection procedure. Moreover, in the present version of the code a pathfollowing strategy based on pseudo-arclength parametrization applied for the computation of solution branches with turning points of parameter-dependent equations,

$$z'(t) = \frac{1}{t^\alpha} f(t, z(t), \lambda), \quad t \in (0,1], \quad g(z(0), z(1)) = 0,$$

where λ is a parameter, has been implemented. We show that the pathfollowing procedure is well-defined, and a numerical solution is possible with a stable, high-order discretization method.

Finally, we demonstrate the reliability and efficiency of our code by solving a few problems relevant in applications. These comprise the computation of density profile equation in hydrodynamics, self-similar blow-up solution profiles of nonlinear parabolic PDEs describing temperature profiles in a fusion reactor plasma, complex Ginzburg-Landau equation with applications in nonlinear optics, and reaction-diffusion systems, and problems from the shell buckling.

Abstracts

Contributed Talks

FRACTIONAL CALCULUS ON TIME SCALES AND INTEGRATION BY PARTS

Thabet Abdeljawad, *Ankara, Turkey*

2000 MSC: 34C10

This is a joint work with Prof Dumitru Baleanu. Right (backward) fractional differences are defined. Their semigroup properties are studied and used together with those for the left (forward) fractional differences introduced in [1] and studied in [2], to obtain an integration by parts formula. An open problem for more general time scales is proposed as well.

[1] K. S. Miller, B. Ross, *Fractional difference calculus*Proceedings of the International Symposium on Univalent Functions, Fractional Calculus and Their Applications, Nihon University, Koriyama, Japan, (1989), 139–152.

[2] F. M. Atıcı, P.W. Eloe, *A Transform method in discrete fractional calculus*, Int. J. Diff. Eq. **2** (2007), 165–176.

HOMOGENIZED DOUBLE POROSITY MODELS FOR POROELASTIC MEDIA WITH INTERFACIAL FLOW BARRIER

Abdelhamid Ainouz, *Algiers, Algeria*

2000 MSC: 35B27, 35B40, 76Q05

The work is concerned with the homogenization of a micro-model based on Biot's system ([3]) for two periodic component porous solids with exchange flow barrier formulation ([1]). The derived macro-model is a generalization of the concept of Aifantis double porosity models (see for e.g. [2]).

[1] H. I. Ene and D. Polievski, *Model of diffusion in partially fissured media,* Z. angew. Math. Phys. **53** (2002), 1052–1059.

[2] Markov, V. Levine, A. Mousatov and E. Kazatchenko, *Elastic properties of double-porosity rocks using the differential effective medium model,* Geophysical Prospecting, **53** (2005), 733–754.

[3] R. E. Showalter and B. Momken, *Single-phase Flow in Composite Poro-Elastic Media,* Math. Methods Appl. Sci, **25** (2002), 115–139.

RECESSIVE SOLUTIONS OF NONOSCILLATORY HALF-LINEAR DYNAMIC EQUATIONS

Elvan Akin-Bohner, *Rolla, Missouri, USA*

2000 MSC: 39A10

We will consider recessive solutions of nonoscillatory half-linear dynamic equations. Recessive solutions are characterized using limit and integral properties. This is joint work with Professor Došlá.

3-DIMENTIONAL HOPF BIFURCATION VIA AVERAGING THEORY OF SECOND ORDER

Makhlouf Amar, *Annaba, Algeria*

2000 MSC: 37G15, 37D45

This is a joint work with Prof. Jaume Llibre and Prof. Badi Sabrina. We study the Hopf Bifurcation occuring in polynomial quadratic vector fields in $\mathbb{R}^3$ via the Averaging method of second order, we obtained that at most three limit cycles can bifurcated from a singular point having eigenvalues of the form $\pm bi$, 0 by applying the second order averaging method. We give an example of a quadratic polynomial differential system for which exactly three limit cycles bifurcate from a such singular point.

TOPOLOGICAL STRUCTURE OF SOLUTION SETS TO BVPS

Jan Andres, *Olomouc, Czech Republic*

2000 MSC: 34A60, 34B15, 47H10

Cauchy (initial-value) problems for ordinary differential equations and inclusions are well-known to possess the R_δ-structure of solution sets. On the other hand, for boundary value problems, the much more recent results about the topological structure of solution sets are rather rare. Our main aim will be therefore to present some of these results in terms of retracts and to point out the difficulties related especially to asymptotic BVPs.

SECOND ORDER DIFFERENCE INCLUSIONS OF MONOTONE TYPE

Narcisa Apreutesei, *Iasi, Romania*

2000 MSC: 39A12, 39A11, 34G25, 47H05

We present some existence, uniqueness and asymptotic behavior results for the solution to a class of second-order difference inclusions. Different boundary conditions are associated. These equations are the discrete version of some second order evolution equations of monotone type in Hilbert spaces. In the subdifferential case, the equivalence to a minimization problem was established. One uses the theory of the maximal monotone operators in Hilbert spaces.

[1] N. Apreutesei, Nonlinear second order evolution equations of monotone type and applications, Pushpa Publishing House, Allahabad, India, 2007.

[2] G. Apreutesei, N. Apreutesei, *Continuous dependence on data for bilocal difference equations* J. Difference Equ. Appl. **15** (2009), no. 5, 511–527.

ON THE ASYMPTOTIC BEHAVIOR AT THE INFINITY OF SOLUTIONS TO QUASILINEAR DIFFERENTIAL EQUATIONS

Irina Astashova, *Moscow, Russia*

2000 MSC: 34C10

For the differential equation

$$y^{(n)}(x) + \sum_{j=0}^{n-1} a_j(x)\, y^{(j)}(x) + p(x)\, y(x)|y(x)|^{k-1} = 0\,, \tag{1}$$

with $n \geq 1$, $k > 1$, and continuous functions $p(x)$ and $a_j(x), j = 0, ..., n-1$, qualitative properties to solutions at the infinity such that the uniform estimates, oscillation, existence of solution tending to a polynomial, etc., are obtained. In [1], [2], [3] some of these properties have been proved for (1) with $a_j(x) = 0, j = 0, ..., n-1$.

For several differential equations of the type (1) asymptotic behavior of all inextensible solutions is described.

[1] F. V. Atkinson *On second order nonlinear oscillations.* Pacif. J. Math. **5** (1955), No. 1, 643-647.

[2] I. T. Kiguradze *On the oscillation to solution of the equation* $d^m/dt^m + a(t)|u|^n \mathrm{sign} u = 0$. Mat. sbornik, **65** (1964), No. 2, 172-187. (Russian)

[3] I. M. Sobol *On Asymptotical Behavior of Solutions to Linear Differential Equations*// Doklady Akad. Nauk SSSR, **LXI** (1948), No. 2, 219-222. (Russian)

MORSE DECOMPOSITION FOR A STATE-DEPENDENT DELAYED DIFFERENTIAL EQUATION

Ferenc Ágoston Bartha, *Szeged, Hungary*

2000 MSC: 34K25

We consider the delayed differential equation: $\dot{x}(t) = f(x(t), x(t-r))$. Let r be dependent on a segment of the solution before time t. This is called state-dependent delay.

Our goal is to prove the existence of the global attractor and its Morse decomposition based on counting the sign changes. For constant delay this was first done by J. Mallet-Paret. Also for the special case the necessary tools were introduced by Mallet-Paret, Nussbaum, Krisztin and Arino.

We deal with two specific delays, one is defined by the threshold condition $\int_{t-r}^{t} a(x(s))ds = 1$, the other is implicitly given by $R(x(t), x(t-r)) = r$. First we discuss the right choice for the phase space then prove the existence of the attractor and its decomposition. Finally we show the existence of periodic orbits in all Morse sets with sufficiently small index. The result is formally new for the case $r = r(x(t))$ as well. This is a joint work with Dr. Tibor Krisztin.

NONCONTINUABLE SOLUTIONS OF DIFFERENTIAL EQUATIONS WITH DELAYS

Miroslav Bartušek, *Brno, Czech republic*

2000 MSC: 34K10, 34C11

In the lecture sufficient conditions for the existence (nonexistence) of non-continuable solutions (i.e. solutions which are defined on a finite maximal interval only) for the n-th order nonlinear differential equation with delays are presented.

OSCILLATION OF SOLUTIONS OF A LINEAR SECOND ORDER DISCRETE DELAYED EQUATION

Jaromír Baštinec, *Brno, Czech Republic*

2000 MSC: 34C10

This is a joint work with Prof. Josef Diblík.

A linear second order discrete delayed scalar linear equation of the second order

$$\Delta x(n) = -p(n)x(n-1) \tag{1}$$

with a positive coefficient p is considered for $n \to \infty$. This equation is known to have a positive solution if p fulfils an inequality. The goal of the paper is to show that in the case of an opposite inequality for p all solutions of the equation considered are oscillating for $n \to \infty$.

Acknowledgement: This investigation was supported by the Councils of Czech Government MSM 0021630529, MSM 00216 30503 and MSM 00216 30519.

[1] J. Baštinec, J. Diblík, *Remark on positive solutions of discrete equation* $\Delta u(k+n) = -p(k)u(k)$, Nonlinear Anal., **63** (2005), e2145–e2151.

SEMILINEAR DIFFERENTIAL INCLUSIONS VIA WEEK-TOPOLOGIES

Irene Benedetti, *Firenze, Italy*

2000 MSC: 34A60

This is a joint work with L.Malaguti and V.Taddei. We consider the multivalued initial value problem:

$$\begin{cases} x' \in A(t,x)x + F(t,x) \ \text{ for a.a. } \ t \in [a,b], \\ x(a) = x_0 \end{cases}$$

in a separable, reflexive Banach space E, where $A(t,x)$ is a linear and bounded operator for any $t \in [a,b]$, $x \in E$ and F is a nonlinear weakly upper semicontinuous multimap. We allow both A and F to have a superlinear growth in x. We prove the existence of local and global solutions in the Sobolev space $W^{1,p}([a,b],E)$ with $1 < p < \infty$. We avoid any use of measure of non-compactness as it is usually required (see [2]). When introducing a suitable Lyapunov-like function, we are able to investigate the topological structure of the solution set. Our main tool is a continuation principle in Frechét spaces (see [1]).

[1] J. Andres and L. Górniewicz, *Topological Fixed Point Principles for Boundary Value Problems*, Kluwer, Dordrecht, (2003);

[2] M. I. Kamenskii, V. V. Obukhovskii and P. Zecca, *Condensing Multivalued Maps and Semilinear Differential Inclusions in Banach Space*, W. deGruyter, Berlin, (2001).

NUMERICAL SOLUTION OF NON-LOCAL ANISOTROPIC ALLEN-CAHN EQUATION

Michal Beneš, *Prague, Czech Republic*

2000 MSC: 80A22, 82C26, 35A40

This is the joint work with Shigetoshi Yazaki and Masato Kimura. The contribution presents the results of ongoing research related to numerical methods used for solution of the Allen-Cahn equation with a non-local term. This equation originally mentioned in [1] is related to the mean-curvature flow with the constraint of constant volume enclosed by the evolving curve. We study this motion approximately by the mentioned PDE, we generalize the problem by including anisotropy (see [2]). Correspondingly, several computational studies are presented.

[1] J. Rubinstein and P. Sternberg, *Nonlocal reaction-diffusion equations and nucleation*, IMA Journal of Applied Mathematics 1992 **48(3)**:249–264

[2] M. Beneš, *Diffuse-interface treatment of the anisotropic mean-curvature flow*, Applications of Mathematics 2003, **48(6)**, 437–453

A POLYDISPERSE SUSPENSION MODEL AS GENERIC EXAMPLE OF NON-CONVEX CONSERVATION LAW SYSTEMS

Stefan Berres, *Temuco, Chile*

2000 MSC: 35L65, 76T20, 65M06.

A multiphase flow of dispersed solid particles in a fluid, with the solid phases having equal densities but different particle sizes, is described by the system

$$\partial_t \Phi + \partial_x \mathbf{f}(\Phi) = 0, \quad \mathbf{f}(\Phi) = \Big(f_1(\Phi), \dots, f_N(\Phi)\Big)^{\mathrm{T}}, \tag{1}$$

$$f_i(\Phi) = \phi_i v_i(\Phi) = \phi_i\Big(u_i - (u_1\phi_1 + \dots + u_N\phi_N)\Big), \quad i = 1, \dots, N. \tag{2}$$

The relative velocity $u_i = u_i(\Phi) = u_{\infty i} V_i(\phi)$ is modeled as the product of a constant $u_{\infty i}$ times an individual hindrance settling term $V_i(\phi)$, with $\partial_\phi V_i(\phi) < 0$ for $\phi \in [0,1]$. This contribution gives an overview of the modelling, analysis and simulation of system (1)–(2).

[1] S. Berres, R. Bürger, On Riemann problems and front tracking for a model of sedimentation of polydisperse suspensions, ZAMM Z. Angew. Math. Mech. 87 (2007) 665–691.

ON A SYSTEM CONSISTING OF THREE DIFFERENT TYPES OF DIFFERENTIAL EQUATIONS

Adam Besenyei, *Budapest, Hungary*

2000 MSC: 35K60, 35J60

We study a nonlinear system consisting of three different types of differential equations: a first order ordinary, a parabolic and an elliptic one. This system is a generalization of a model describing fluid flow in porous media. Existence of weak solutions is shown by the Schauder fixed point theorem, further, the long-time behaviour of solutions is investigated by the theory of monotone operators.

ON SECOND ORDER NONOSCILLATORY SCALAR LINEAR DIFFERENTIAL EQUATIONS

Sigrun Bodine, *Tacoma, USA*

2000 MSC: 34E10

We are interested in the asymptotic behavior of solutions of

$$[r(t)x']' + f(t)x = 0, \qquad t \geq t_0, \tag{1}$$

as a perturbation of

$$[r(t)y']' + g(t)y = 0, \qquad t \geq t_0, \tag{2}$$

which is assumed to be nonoscillatory at infinity (here $r(t) > 0$).

This problem has drawn significant attention in the past and was studied, for example, by Hartman and Wintner, Trench, Šimša, and Chen. The goal has been to identify conditions on the difference $f - g$ as well as the solutions of (2) so that solutions of (1) will behave asymptotically as those of (2) and to find estimates of the error terms. Methods used include fixed point and Riccati techniques for scalar equations.

Here we offer a new approach to this problem. Working in a matrix setting, we use preliminary and so-called conditioning transformations to bring the system in the form $\vec{z}' = [\Lambda(t) + R(t)]\vec{z}$, where Λ is a diagonal matrix and R is an absolutely integrable perturbation. This allows us to apply Levinson's Fundamental Theorem to find the asymptotic behavior of solutions of (1) and, in addition, to estimate the error involved.

This method allows us to derive the main results mentioned above in a more unified setting. Moreover, it allows us to weaken the hypotheses in some instances. This is a joint work with Professor Donald A. Lutz from San Diego State University.

ON THE BOUNDARY-LAYER EQUATIONS FOR POWER-LAW FLUIDS

Gabriella Bognár, *Miskolc, Hungary*

2000 MSC: 34B15

The main subject is the model

$$\left(\left|f''\right|^{n-1} f''\right)' + \frac{1}{n+1} f f'' = 0, \tag{1}$$

$$f(0) = 0, \quad f'(0) = 0, \tag{2}$$

$$f'(\infty) = \lim_{\eta\to\infty} f'(\eta) = 1. \tag{3}$$

arising in the study of a 2D laminar boundary-layer with power-law viscosity, $f = f(\eta)$ is the non-dimensional stream function and $n > 0$.

Our aim is to show the existence of power series solutions for the momentum boundary layer equation, thus extending the classical Blasius result [1] for the case $n \neq 1$. The behavior and the determination of the skin friction $f''(0)$, which is an important part of the analysis in boundary-layer problems, are examined.

[1] H. Blasius, Grenzschichten in Flussigkeiten mit kleiner Reibung, *Z. Math. Phys.* 56 (1908) 1–37.

BOUNDARY-VALUE PROBLEMS FOR DELAY DIFFERENTIAL SYSTEMS

Alexander Boichuk, *Žilina, Slovak Republic*

2000 MSC: 34K10

This is a joint work with Prof J. Diblík, D. Khusainov, M. Růžičková. Conditions of the existence of solutions of linear Fredholm's boundary-value problems for systems of ordinary differential equations with constant coefficients and a single delay are derived. Utilizing a delayed matrix exponential [1] and a method of pseudo-inverse matrices [2] led to an explicit and *analytical* form of a criterion for the existence of solutions in a relevant space and to the construction of a family of linearly independent solutions of such problems in a general case. This work was supported by the grant 1/0771/08 of the Grant Agency of Slovak Republic (VEGA) and by the project APVV-0700-07 of Slovak Research and Development Agency.

[1] Khusainov, D.Ya., Shuklin, G.V. *Relative controllability in systems with pure delay.* (English. Russian original) Int. Appl. Mech. **41**, No. 2 (2005), 210–221 ; translation from Prikl. Mekh. **41** No. 2 (2005), 118–130.

[2] Boichuk, A.A., Samoilenko, A.M., Generalized Inverse Operators and Fredholm Boundary Value Problems. VSP, Utrecht-Boston, 2004.

BOUNDARY VALUE PROBLEMS FOR QUASIELLIPTIC SYSTEMS IN R^n_+

Lina Bondar, *Novosibirsk, Russia*

2000 MSC: 35H30, 35G15

In this paper we continue the study [1] of the boundary value problems

$$\mathcal{L}(D_x)U = F(x), \quad x \in R^n_+, \quad \mathcal{B}(D_x)U|_{x_n=0} = 0$$

for quasielliptic systems in the half-space. We consider the class of matrix quasielliptic operators $\mathcal{L}(D_x)$ which was introduced by Volevich [2]. The symbol of the matrix differential operator $\mathcal{L}(D_x)$ is assumed to be homogeneous with respect to a vector $\alpha = (\alpha_1, \dots, \alpha_n)$, where $1/\alpha_i$ are natural. In particular, this class of operators includes homogeneous elliptic operators. We suppose that the boundary value problems under consideration satisfy the Lopatinskii condition. In the present paper we give theorems on solvability of the boundary value problems in the Sobolev spaces $W^l_p(R^n_+)$, $l = (1/\alpha_1, \dots, 1/\alpha_n)$, $1 < p < \infty$.

[1] G. V. Demidenko, *On solvability of boundary value problems for quasi-elliptic systems in R^n_+*. J. Anal. Appl. **4** (2006), 1–11.

[2] L. R. Volevich, *Local properties of solutions to quasielliptic systems.* Mat. Sb. **59** (1962), 3–52 (in Russian).

ON STABILITY AND OSCILLATION OF EQUATIONS WITH A DISTRIBUTED DELAY

Elena Braverman, *Calgary, Canada*

2000 MSC:

We present some new stability results for linear equations with variable coefficients and delays, as well as for equations with a distributed delay. We also discuss oscillation and nonoscillation of such equations. The results are applied to obtain local stability and oscillation results for some equations of mathematical biology with a distributed delay. This is a joint work with L. Berezansky (Ben Gurion University, Israel).

ON THE SOLVABILITY SETS FOR BOUNDARY VALUE PROBLEMS FOR FUNCTIONAL DIFFERENTIAL EQUATIONS

Eugene Bravyi, *Perm', Russia*

2000 MSC: 34K10

Consider the boundary value problem for a functional differential equation

$$\begin{aligned} &x^{(n)}(t) = (T^+x)(t) - (T^-x)(t) + f(t), \quad t \in [a,b], \\ &\ell x = c, \end{aligned} \tag{1}$$

where $T^+, T^- : \mathbf{C} \to \mathbf{L}$ are positive linear operators; $\ell : \mathbf{A}C^{n-1} \to \mathbf{R}^n$ is a linear bounded vector-functional, $f \in \mathbf{L}$, $c \in \mathbf{R}^n$.

Let the solvability set for problem (1) be the set of all points $(\mathcal{T}^+, \mathcal{T}^-) \in \mathbf{R}_2^+$ such that (1) has a unique solution for all f and c for every operators T^+, T^- with $\| T^\pm \|_{\mathbf{C}\to\mathbf{L}} = \mathcal{T}^\pm$. A method of finding solvability sets are proposed. Some new properties of these sets in different cases are obtained.

We continue the investigations started in [1], [2], and others by R. Hakl, S. Mukhigulashvili, A. Lomtatidze, B. Půža, J. Šremr.

[1] A. Lomtatidze, S. Mukhigulashvili, Some two-point boundary value problems for second-order functional-differential equations. Folia, Facult. Scient. Natur. Univ. Masarykianae Brunensis. Mathematica 8. Brno, 2000.

[2] R. Hakl, A. Lomtatidze, J. Šremr, Some boundary value problems for first order scalar functional differential equations. Folia, Facult. Scient. Natur. Univ. Masarykianae Brunensis. Mathematica 10. Brno, 2002.

VIABILITY ON GRAPHS FOR SEMILINEAR MULTI-VALUED REACTION-DIFFUSION SYSTEMS

Monica-Dana Burlica, *Iasi, Romania*

2000 MSC: 35K57,34G25

In this paper, by using tangency conditions expressed in terms of tangent sets, we establish a necessary and a necessary and sufficient condition for mild viability referring to a class of reaction-diffusion systems on graphs.

The author's participation at this conference was supported by the PN-II,IDEI cod ID 397.

STEADY STATE SOLUTIONS OF A BISTABLE REACTION DIFFUSION EQUATION WITH SATURATING FLUX

Martin Burns, *Glasgow, Scotland*

2000 MSC: 35B32, 35D05, 35J65, 35K57

This is a joint work with Dr. Michael Grinfeld (The University of Strathclyde). We consider the prescribed curvature equation (1) with a bistable nonlinearity, which has been advocated by P. Rosenau [1] as a model of reaction and diffusion with saturating flux,

$$u_t = \left(\frac{u_x}{\sqrt{1+u_x^2}} \right)_x + \lambda f(u), \;\; x \in (0,L), \quad t > 0, \tag{1}$$

where $f(u) = u - u^3$ and $\lambda > 0$ is a parameter, $u_x(0,t) = u_x(L,t) = 0$ and $u(x,0) = u_0(x)$ for some appropriate class of initial conditions (for example $u_0(x) \in \mathrm{BV}((0,L))$. We are primarily interested in the bifurcation of steady state solutions using λ as a bifurcation parameter, and show (using time maps) that, unlike the situation in the semilinear Allen-Cahn equation, the bifurcation diagrams of (classical) steady state solutions depend on the size of the spatial domain L.

Furthermore, we study non-classical (discontinuous) steady state solutions and investigate the intimate connection between discontinuity and stability.

[1] P. Rosenau, Free-Energy Functionals at the High-Gradient Limit. Phys. Rev. A, **41** (1990), 2227–2230.

CONTINUATION RESULTS FOR FORCED OSCILLATIONS OF CONSTRAINED MOTION PROBLEMS WITH INFINITE DELAY

Alessandro Calamai, *Ancona, Italy*

2000 MSC: 34K13

We study the retarded functional motion equation

$$x''_\pi(t) = \lambda\,(F(t, x_t) - \varepsilon x'(t))\,, \tag{1}$$

on a smooth boundaryless manifold $X \subseteq \mathbb{R}^s$, where $\lambda \geq 0$ is a real parameter, $x''_\pi(t)$ stands for the tangential part of the acceleration $x''(t) \in \mathbb{R}^s$ at the point $x(t) \in X$, the map $F : \mathbb{R} \times C((-\infty, 0], X) \to \mathbb{R}^s$ is T-periodic in the first variable and such that $F(t, \varphi) \in T_{\varphi(0)}X$ for all (t, φ), and $\varepsilon \geq 0$ is the frictional coefficient.

Using a topological approach based on the fixed point index theory, in [1] we obtain a global continuation result for T-periodic solutions of equation (1). As an application, we prove the existence of forced oscillations of retarded functional motion equations defined on compact manifold with nonzero Euler-Poincaré characteristic. This existence result is obtained under the assumption $\varepsilon \neq 0$, and we conjecture that it is still true in the frictionless case. This is a joint work with P. Benevieri, M. Furi and M.P. Pera (Università di Firenze).

[1] P. Benevieri, A. Calamai, M. Furi and M.P. Pera, *A continuation result for forced oscillations of constrained motion problems with infinite delay*, preprint 2009, `http://arxiv.org/abs/0903.1248`

COMPACTNESS AND RADIAL SOLUTIONS FOR NONLINEAR ELLIPTIC PDE'S

Florin Catrina, *New York, USA*

2000 MSC: 35J25

In this talk we discuss the existence of radial solutions for semilinear elliptic partial differential equations with power type nonlinearities. We show the nonexistence of radial solutions by an energy balance argument applied to the ODE's obtained by symmetry reduction. The nonexistence of solutions is a reflection of the loss of compactness in embeddings between various function spaces. This work helps explain in part the role played by critical exponents in nonlinear elliptic PDE's.

EXISTENCE RESULTS FOR FREDHOLM-TYPE INTEGRAL INCLUSIONS

Aurelian Cernea, *Bucharest, Romania*

2000 MSC: 34A60

The study of existence of solutions for several boundary value problems associated to differential inclusions of the form $\mathcal{D}x \in F(t,x)$, where $\mathcal{D}$ is a differential operator and $F(.,.) : I \times X \to \mathcal{P}(X)$ is a set-valued map reduces often to the existence of solutions for integral inclusions of the form

$$x(t) = \lambda(t) + \int_0^1 G(t,s)u(s)ds, \quad u(t) \in F(t, x(t)), \quad a.e.\ (I), \tag{1}$$

where $I = [0, T]$, $\lambda(.) : I \to X$, $F(.,.) : I \times X \to \mathcal{P}(X)$, $G(.,.) : I \times I \to \mathbb{R}$, are given mappings and X is a separable Banach space.

We provide several existence results for problem (1), when the set-valued map $F(.,.)$ has convex or nonconvex values. Our results are essentially based on a nonlinear alternative of Leray-Schauder type, Bressan-Colombo selection theorem for lower semicontinuous set-valued maps with decomposable values and Covitz-Nadler set-valued contraction principle.

PARALLELISM BETWEEN DIFFERENTIAL AND DIFFERENCE EQUATIONS

Veronika Chrastinová, *Brno, Czech Republic*

2000 MSC: 34A34, 39A05

We discuss the higher–order ordinary differential equations and the analogous higher–order difference equations and compare the corresponding fundamental concepts. Important dissimilarities appear only for the moving frame method.

[1] P. E. Hydon, Symmetries and first integrals of ordinary difference equations. Proc. R. Soc. Lond., Ser. A, Math. Phys. Eng. Sci. 456, No. 2004, 2835-2855 (2000).

[2] P. J. Olver, Applications of Lie groups to Differential Equations. Springer, Berlin (1986).

[3] P. J. Olver, Equivalence, Invariants and Symmetry. Cambridge Univ. Press, New York (1995).

[4] V. Tryhuk, V. Chrastinová, Equivalence of difference equations and the web theory. To appear.

PERIODIC SOLUTIONS OF NONAUTONOMOUS DAMPED HYPERBOLIC EQUATIONS AT RESONANCE

Aleksander Ćwiszewski, *Toruń, Poland*

2000 MSC: 35L70, 35B10, 37J45

We study the periodic problem

$$\begin{cases} \ddot{u} + \beta\dot{u} + Au + \varepsilon F(t,u) = 0, \ t \in [0,T] \\ u(0) = u(T), \dot{u}(0) = \dot{u}(T) \end{cases} \tag{1}$$

where $A : D(A) \to X$ is a self-adjoint operator on a Hilbert space X with compact resolvent and such that there is $\omega > 0$ such that $A + \omega$ is positive, $\beta, \varepsilon > 0$ and $F : \mathbf{R} \times X^{1/2} \to X$, where $X^{1/2}$ is the fractional space of A, is compact and T-periodic in the first variable. It is proved that if $Ker\, A \neq \{0\}$, then, for sufficiently small $\varepsilon > 0$, the local fixed point index of the translation along trajectories operator for (1) (acting on $X^{1/2} \times X$) is equal up to a sign to the Brouwer degree of the time average of F restricted to the space $Ker\, A$. The proof is based on an averaging idea and the Krasnosel'skii type formula relating the fixed point index of the translation along tajectories operator with the topological degree of the right hand side ([2]). As an application we obtain an averaged Landesman-Lazer type criteria for the existence of T-periodic solution for a class of hyperbolic equations including

$$\begin{cases} u_{tt} + \beta u_t = \Delta u + \lambda_k u + f(t,x,u) & x \in \Omega, \ t \in [0,T] \\ u(x,t) = 0 \ \ (\text{or } \nabla u(x,t) \cdot \nu(x) = 0) & x \in \partial\Omega, \ t \in [0,T], \end{cases}$$

where λ_k is one of the eigenvalues of the Laplacian operator on a bounded open $\Omega \subset \mathbf{R}^N$ with smooth boundary with either Dirichlet or Neumann boundary conditions, respectively and $f : \mathbf{R} \times \overline{\Omega} \times \mathbf{R} \to \mathbf{R}$ is a bounded, T-periodic in t, locally Lipschitz function. These results correspond to [1] and [4].

[1] H. Brezis, L. Nirenberg, *Characterizations of the ranges of some nonlinear operators and applications to boundary value problems*, Ann. Scuola Norm. Sup. Pisa, 4, 5 (1978), 225-326.

[2] A. Ćwiszewski, P. Kokocki, *Krasnosel'skii type formula and translation along trajectories method for evolution equations*, Dis. Cont. Dyn. Sys. 22 (2008), 605-628.

[3] A. Ćwiszewski, *Periodic solutions of damped hyperbolic equations at resonance*, submitted.

[4] A. Schiaffino, K. Schmitt, *Periodic Solutions of a Class of Nonlinear Evolution Equations*, Ann. Mat. Pura Appl. **137** (1984), 265–272.

APPROXIMATIONS OF DIRECTIONAL DERIVATIVES BY AVERAGING

Josef Dalík, *Brno, Czech Republic*

2000 MSC: 65D25

There are described effective algorithms for the local approximations of the directional derivatives $\partial u/\partial\vec{v}(a)$ of smooth functions u in the directions of the unit vectors $\vec{v}$ in vertices a of given triangulations $\mathcal{T}_h$ in the forms

$$f_1\partial\left(\Pi_h(u)|_{T_1}\right)/\partial\vec{v}+\cdots+f_n\partial\left(\Pi_h(u)|_{T_n}\right)/\partial\vec{v}. \tag{1}$$

Here $\Pi_h(u)$ is the interpolant of the function u in the vertices of $\mathcal{T}_h$ linear on the triangles from $\mathcal{T}_h$, $\vec{v}$ is an arbitrary unit vector and $T_1,\ldots,T_n$ are the triangles from $\mathcal{T}_h$ with vertex a. The accuracies of these algorithms are compared numerically. For a unit vector $\vec{v}$ and a vertex a, the set $\mathcal{F}_a(\vec{v})$ of vectors f such that the linear combination (1) is equal to $\partial u/\partial\vec{v}(a)$ for all polynomials u in two variables of total degree less than or equal to two is described explicitly and certain consequences of this description are formulated.

THE DIRICHLET BOUNDARY VALUE PROBLEM FOR WILLMORE SURFACES OF REVOLUTION

Anna Dall'Acqua, *Magdeburg, Germany*

2000 MSC: 49Q10, 53C42, 35J65, 34L30

The Willmore functional is the integral of the square of the mean curvature over the unknown surface. We consider the minimisation problem among all surfaces which obey suitable boundary conditions. The Willmore equation as the corresponding Euler-Lagrange equation may be considered as frame invariant counterpart of the clamped plate equation. This equation is of interest not only in mechanics and membrane physics but also in differential geometry.

We consider the Willmore boundary value problem for surfaces of revolution with arbitrary symmetric Dirichlet boundary condition. Using direct methods of the calculus of variations, we prove existence and regularity of minimising solutions.

The lecture is based on joint work with K. Deckelnick (Magdeburg), S. Fröhlich (Free University of Berlin) and H.-Ch. Grunau (Magdeburg).

EVENTUAL STABILITY PROPERTIES IN A NON-AUTONOMOUS MODEL OF POPULATION DYNAMICS

Attila Dénes, *Szeged, Hungary*

2000 MSC: 34D20

This is a joint work with L. Hatvani and L. L. Stachó. We investigate a population dynamical model describing the change of the amount of two fish species – a carnivore and a herbivore – living in Tanganyika Lake. The system of differential equations – after a series of simplifications – has the form

$$\begin{aligned} \dot{L} &= C - LG \\ \dot{G} &= (L - \lambda(t))G, \end{aligned} \tag{1}$$

where $\lambda : [0, \infty) \to (0, \infty)$ is a given continuous function and $\lim_{t\to\infty} \lambda(t) = \lambda_1 > 0$ exists. This equation does not have an equilibrium, but its limit equation $\dot{L} = C - LG$, $\dot{G} = (L - \lambda_1)G$ has the equilibrium $\left(\lambda_1, \frac{C}{\lambda_1}\right)$. We showed that $\left(\lambda_1, \frac{C}{\lambda_1}\right)$ is a globally eventually uniform-asymptotically stable point of the non-autonomous system (1). In the proof we use linearization, the method of limit equations and Lyapunov's direct method.

EXISTENCE OF SOLUTIONS FOR QUASILINEAR ELLIPTIC SYSTEMS WITH HÖLDER CONTINUOUS NONLINEARITIES AND NONLOCAL BOUNDARY CONDITIONS

Mohammed Derhab, *Tlemcen, Algeria*

2000 MSC: 34B10, 34B15

The purpose of this work is to study the existence of solutions of the following quasilinear elliptic system with nonlocal boundary conditions:

$$\begin{cases} -\left(\varphi_1\left(u'\right)\right)' = f\left(x,u,v\right),\ x \in (0,1)\,, \\ -\left(\varphi_2\left(v'\right)\right)' = g\left(x,u,v\right),\ x \in (0,1)\,, \\ u\left(0\right) - a_0 u'\left(0\right) = g_0\left(u\right),\ u\left(1\right) + a_1 u'\left(1\right) = g_1\left(u\right), \\ v\left(0\right) - a_2 v'\left(0\right) = g_2\left(v\right),\ v\left(1\right) + a_3 v'\left(1\right) = g_3\left(v\right), \end{cases} \tag{1}$$

where $\varphi_i : \mathbb{R} \to \mathbb{R}$ are continuous, strictly increasing and $\varphi_i(\mathbb{R}) = \mathbb{R}$ for $i = 1, 2$, $a_i \in \mathbb{R}_+$, for all $i = 0, ..., 3$, $f : [0,1] \times \mathbb{R}^2 \to \mathbb{R}$ and $g : [0,1] \times \mathbb{R}^2 \to \mathbb{R}$ are Hölder continuous functions and g_i are a continuous functions for all $i = 0, .., 3$.

Existence of solutions of (1) is discussed by using upper and lower solutions and monotone iterative techniques. We also give some examples to illustrate our results.

REPRESENTATION OF SOLUTIONS OF LINEAR DISCRETE SYSTEMS WITH CONSTANT COEFFICIENTS, A SINGLE DELAY AND WITH IMPULSES

Josef Diblík, *Brno, Czech Republic*

2000 MSC: 39A10

This is a joint work with B. Morávková. Consider initial Cauchy problem

$$\Delta x(k) = Bx(k-m), \quad k \in \mathbb{Z}_0^{\infty}, \tag{1}$$

$$x(k) = \varphi(k), \quad k \in \mathbb{Z}_{-m}^{0} \tag{2}$$

where $\mathbb{Z}_s^q := \{s, s+1, \dots, q\}$, $k \in \mathbb{Z}_0^{\infty}$, $m \geq 1$ is a fixed integer, B is a constant $n \times n$ matrix, $x\colon Z_{-m}^{\infty} \to \mathbb{R}^n$ and $\Delta x(k) = x(k+1) - x(k)$. We add impulses $J_i \in \mathbb{R}^n$ in points $k = i(m+1)+1$, where $i \geq 0$, $i = [(k-1)/m]$, i.e.,

$$x(i(m+1)+1) = x(i(m+1)+1-0) + J_i \tag{3}$$

and investigate representation of solutions of problems (1), (2) and (1)–(3).

LOCAL AND GLOBAL MAXIMA FOR THE EXPECTATION OF THE LIFETIME OF A BROWNIAN MOTION

Bodo Dittmar, *Halle (Saale), Germany*

2000 MSC: 60J65

Let $G_B(x,y)$ be the Green's function of a domain B and
$\Gamma_B(x,y) = \int_B G_B(x,z)G_B(z,y)dz$ the iterated Green's function, which is one of the Green's functions of the biharmonic equation. The expectation of the lifetime of a Brownian motion in B, starting in x, conditioned to converge to and to be stopped at y and to be killed on exiting B is known to be equal

$$E_x^y = \frac{\Gamma_B(x,y)}{G_B(x,y)}. \tag{1}$$

It is of interest to know where the expectation for the lifetime E_x^y attained maxima. The talk deals with the case of the disk in the plane and the ball in the space. Basing on [1] it is proven in the case of the disk using only elementary conformal mapping that E_x^y cannot obtain its maximum at interior points the same is proven for the case of the ball if at least one point is on the boundary.

[1] B. Dittmar, *Local and global maxima for the expectation of the lifetime of a Brownian motion on the disk.* J. Analyse **104** (2008), 59 - 68.

AN APPLICATION OF A GLOBAL BIFURCATION THEOREM AND SELECTORS THEOREMS TO THE EXISTENCE RESULTS FOR NON-CONVEX DIFFERENTIAL INCLUSIONS.

Stanisław Domachowski, *Gdańsk, Poland*

2000 MSC: 47H04, 34A60

Applying a global bifurcation theorem for convex- valued completely continuous mappings and selectors theorems we prove existence theorems for the first order differential inclusions

$$x'(t) \in F(t, x(t)) \quad \text{for a.e. } t \in (a, b), \tag{1}$$

where x satisfies the Nicolleti boundary conditions, and $F : [a, b] \times \mathbb{R} \to cl(\mathbb{R})$ is a multivalued mapping which is not necessarily convex- valued.

[1] S.Domachowski, J.Gulgowski, *A global bifurcation theorem for convex-valued differential inclusions.* Zeitschrift für Analysis und ihre Anwendungen Vol. **23** (2004), No. 2, 275-292.

WRONSKIAN, NONOSCILLATION AND MAXIMUM PRINCIPLES FOR n-TH ORDER FUNCTIONAL DIFFERENTIAL EQUATIONS

Alexander Domoshnitsky, *Ariel, Israel*

2000 MSC:

We study the maximum principle for n-th order linear functional differential equations. A definition of the homogeneous delay equation is proposed in such a form that their fundamental system is finite dimensional and the general solution can be represented in the integral forms. Properties of the Wronskian of the fundamental system are studied. Nonoscillation intervals are estimated. Results about positivity and regular behavior of the Green's functions of the interpolation boundary value problems are obtained on the basis of non–vanishing Wronskian and nonoscillation. Analogs of Sturm separation theorem are obtained on the basis of results about non-vanishing Wronskian. Assertions about growth of Wronskian are presented and on this basis results about existence of unbounded solutions to second order delay differential equations are obtained.

LIMIT PROPERTIES FOR ORDINARY DIFFERENTIAL EQUATIONS WITH BOUNDED Φ-LAPLACIAN OPERATOR

Zuzana Došlá, *Brno, Czech Republic*

2000 MSC: 34C10

This is a joint research with Mariella Cecchi and Mauro Marini, University of Florence.

We study asymptotic problems for equation with bounded Φ-Laplacian

$$\Big(a(t)\Phi(x')\Big)' + b(t)F(x) = 0, \tag{1}$$

where Φ is an increasing homeomorphismus, $\Phi : \mathbb{R} \to (-\sigma, \sigma)$ such that $\Phi(u)u > 0$ for $u \neq 0$ and $0 < \sigma < \infty$. The prototype of (1) is the equation which arises in the study of the radially symmetric solutions of partial differential equation with the curvature operator

$$\operatorname{div}\left(g(|x|)\frac{\nabla u}{\sqrt{1+|\nabla u|^2}}\right) + B(|x|)F(u) = 0, \tag{2}$$

where $g : \mathbb{R}^+ \to \mathbb{R}^+$ is a weight function. Discrepancies between the classical Φ-Laplacian and the curvature operator will be illustrated.

ON THE EXISTENCE OF L^p-SOLUTIONS OF THE FUNCTIONAL-INTEGRAL EQUATION IN BANACH SPACES

Aldona Dutkiewicz, *Poznań, Poland*

2000 MSC: 45N05

We consider the functional - integral equation of Volterra type

$$x(t) = \phi(t, \int_{D(t)} K(t,s)g(s,x(s))ds) \tag{1}$$

with the kernel $K(t,s) = A(t,s)/|t-s|^r$, $0 < r < n$, where
$D(t) = \{s :\ 0 \le s_i \le t_i,\ i = 1,\dots,m\}$ for $t = (t_1,\dots,t_m) \in D$. Assuming that

$$\alpha(g(s,X)) \le H(s)\alpha(X), \tag{2}$$

where α is the measure of noncompactness, we prove the existence of a solution $x \in L^p(D,E)$ of (1). For $r < 1$, we replace (2) by a weaker condition $\alpha(g(s,X)) \le \omega(\alpha(X))$, where ω is continuous nondecreasing function $R_+ \mapsto R_+$ such that $\omega(0) = 0$, $\omega(t) > 0$ for $t > 0$ and $\int_0^\delta [s/\omega(s)]^{1/1-r}(1/s)ds = \infty \quad (\delta > 0)$.

[1] W. Mydlarczyk, *The existence of nontrivial solutions of Volterra equations*, Math. Scand. **68** (1991), 83-88.

[2] S. Szufla, *On the Hammerstein integral equation with weakly singular kernel*, Funkc. Ekvac. **34** (2) (1991), 279–285.

[3] S. Szufla, *On the Volterra integral equation with weakly singular kernel*, Mathem. Bohem. **131** (3) (2006), 225–231.

STABILITY OF LINEAR DIFFERENTIAL EQUATIONS WITH RANDOM COEFFICIENTS AND RANDOM TRANSFORMATION OF SOLUTIONS

Irada A. Dzhalladova, *Kiev, Ukraine*

2000 MSC: 34C10

We study the linear differential equations

$$\frac{dX}{dt} = A\left(t, \xi\left(t\right)\right) X\left(t\right) \tag{1}$$

with semi-markov coefficients. Together with (1) we consider systems

$$\frac{dX_k\left(t\right)}{dt} = A_k\left(t\right) X_k\left(t\right), \quad k = 1, 2, \ldots, n. \tag{2}$$

Every system (2) has a solution $X_k\left(t\right) = N_k\left(t\right) X_k\left(0\right)$ where N_k is the fundamental matrix. We assume that for moments $t = t_j$, $j = 1, 2, \ldots$ solutions of the system (1) are subjected to random transformations. We prove results about stability of zero solutions of system (1) using quadratic Lyapunov's functions.

A SUFFICIENT CONDITION FOR THE EXISTENCE OF HOPF BIFURCATION FOR AN IMMUNE RESPONSE MODEL

Chikahiro Egami, *Numazu, Japan*

2000 MSC: 34C23; 92D30

Nowak and Bangham [1] built up a CTL-response model for persistent viruses such as HIV-1 and HTLV-1. The Nowak-Bangham model can have three equilibria according to the basic reproduction number, and generates a Hopf bifurcation through two bifurcations of equilibria.

In this talk, we show a sufficient condition for the interior equilibrium to have a unique bifurcation point at which a simple Hopf bifurcation occurs. For this proof, new computational techniques are developed in order to apply the method established by Liu [2]. Moreover, to demonstrate the result obtained theoretically, some bifurcation diagrams are presented with numerical examples.

[1] M. A. Nowak, C. R. M. Bangham, *Population Dynamics of Immune Responses to Persistent Viruses.* Science **272** (1996), 74–79.

[2] W. M. Liu, *Criterion of Hopf bifurcations without using eigenvalues.* J. Math. Anal. Appl. **182** (1) (1994), 250–256.

SMOOTH BIFURCATION BRANCHES OF SOLUTIONS FOR A SIGNORINI PROBLEM

Jan Eisner, *České Budějovice, Czech Republic*

2000 MSC: 35J85, 35B32, 47J07

This is a joint work with Milan Kučera from Prague and Lutz Recke from Berlin. We study the Signorini boundary value problem

$$\Delta u + \lambda u + g(\lambda, u) = 0 \quad \text{in } \Omega, \tag{1}$$

$$u = 0 \text{ on } \Gamma_D, \quad \frac{\partial u}{\partial \nu} = 0 \text{ on } \Gamma_N, \tag{2}$$

$$u \le 0, \quad \frac{\partial u}{\partial \nu} \le 0, \quad u\frac{\partial u}{\partial \nu} = 0 \quad \text{on } \Gamma_U \tag{3}$$

where λ is a real parameter, g is a C^1-smooth function and $\Gamma_D \cup \Gamma_N \cup \Gamma_U = \partial\Omega$. We will show under which conditions there is a smooth bifurcation branch of nontrivial solutions arising from trivial solutions. Moreover, solutions on that branch have interval as a touching set. The result is based on a certain local equivalence of the unilateral boundary value problem to a smooth abstract equation in a Hilbert space and on an application of the Implicit Function Theorem to that equation.

ON THE ZEROS OF A GENERAL CHARACTERISTIC EQUATION WITH APPLICATIONS TO ABSOLUTE STABILITY OF DELAYED MODELS

Angel Estrella, *Merida, Mexico*

2000 MSC: 34D05

In this work we consider a general characteristic equation which includes the case of several delayed models. In the first part, we give conditions, in terms of the coefficients, for the equation to have only complex roots with negative real part and consider the particular case when the roots of the polynomial part of this equation are known. In the second part, we apply this conditions to delayed models of testosterone dynamics and of interaction of species obtaining conditions for absolute stability (local stability for any delay) on these models.

ON ESTIMATES FOR THE FIRST EIGENVALUE OF THE STURM-LIOUVILLE PROBLEM WITH AN INTEGRAL CONDITION

Svetlana Ezhak, *Moscow, Russia*

2000 MSC: 34L15

Consider the Sturm-Liouville problem:

$$y''(x) - Q(x)y(x) + \lambda y(x) = 0, \quad y(0) = y(1) = 0,$$

where $Q(x)$ is a nonnegative bounded function on $[0, 1]$ satisfying the condition $\int_0^1 Q^\alpha(x)dx = 1, \quad \alpha \neq 0$. By A_α denote the set of all such functions. We estimate the first eigenvalue λ_1 of this problem for different values of α.

Denote $R[Q, y] = \frac{\int_0^1 y'^2(x)dx + \int_0^1 Q(x)y^2(x)dx}{\int_0^1 y^2(x)dx}$. Then, according to the variation principle, $\lambda_1 = \inf_{y(x)\in H_0^1(0,1)} R[Q, y]$. Denote $m_\alpha = \inf_{Q(x)\in A_\alpha} \lambda_1, \quad M_\alpha = \sup_{Q(x)\in A_\alpha} \lambda_1$.

Theorem. *If $\alpha > 1$, then $m_\alpha = \pi^2$, $M_\alpha < \infty$, and there exist functions $u(x) \in H_0^1(0, 1)$ and $Q(x) \in A_\alpha$ such that $\inf_{y(x)\in H_0^1(0,1)} R[Q, y] = R[Q, u] = M_\alpha$.*

If $\alpha = 1$, then $m_1 = \pi^2$, $M_1 = \frac{\pi^2}{2} + 1 + \frac{\pi}{2}\sqrt{\pi^2 + 4}$, and there exist functions $u(x) \in H_0^1(0, 1)$ and $Q(x) \in A_\alpha$ such that $\inf_{y(x)\in H_0^1(0,1)} R[Q, y] = R[Q, u] = M_1$.

If $0 < \alpha < 1$, then $m_\alpha = \pi^2$, $M_\alpha = \infty$.

If $\alpha < 0$, then $m_\alpha > \pi^2$, $M_\alpha = \infty$, and there exist functions $u(x) \in H_0^1(0, 1)$ and $Q(x) \in A_\alpha$ such that $\inf_{y(x)\in H_0^1(0,1)} R[Q, y] = R[Q, u] = m_\alpha$.

INVERSION OF SINGULAR SYSTEMS WITH DELAYS

Haddouchi Faouzi, *Oran, Algeria*

2000 MSC: 93C25

In this note we consider the invertibility problem for singular systems with delays and whose state is described by

$$E\dot{x}(t) = A_0x(t) + A_1x(t - h) + Bu(t), \ y(t) = Cx(t). \tag{1}$$

Where $x(0) = 0$, $x(t) \equiv 0$, $\forall t \in [-h, 0[$, $(h > 0)$, $\dot{x}(t), x(t) \in H$; $u(t) \in U$; $y(t) \in Y$. E, A_0, A_1, B and C are linear (unbounded) operators on Hilbert spaces, with E not necessarily invertible. Our aim is to extend this notion in the infinite dimensional case for singular systems with delays. By splitting the system (1), it is shown that invertibility of the global system (1) is then equivalent to the invertibility of a subsystem without delays.

[1] E. M. Bonilla and M. Malabre, Solvability and one side invertibility for implicit descriptions, 29 th, IEEE, Conf on Decision and Control, Hawai, Dec 5-7, 1990.

[2] L. M. Silverman, Inversion of multivariable linear systems, IEEE. Trans. Auto. Contr. AC-14, no. 3, June, 1969.

SOME CONTRIBUTIONS OF KURZWEIL INTEGRATION TO FUNCTIONAL DIFFERENTIAL EQUATIONS

Márcia Federson, *São Paulo, Brazil*

2000 MSC: 34K20, 26A39

We present new results for retarded functional differential equations (RFDEs) concerning the stability of solutions ([1], [2]). These results were obtained by means of the relation between RFDEs and a certain class of generalized ODEs ([3]). The concept of non-absolute integral introduced by J. Kurzweil is the heart of generalized ODEs and it allows one to deal with highly oscillating functions.

[1] M. Federson; Š. Schwabik, *A new approach to impulsive retarded differential equations: stability results*, Functionals Differential Equations, to appear.

[2] M. Federson; Š. Schwabik, *Stability for retarded differential equations*, Ukrainian Mathematical Journal **60** (2008), 107–126.

[3] M. Federson; Š. Schwabik, *Generalized ODEs approach to impulsive retarded differential equations*, Differential and Integral Equations **19**(11) (2006), 1201–1234.

ON THE CONDENSATION OF DISCRETE SPECTRUM UNDER THE TRANSITION TO CONTINUOUS

Alexey Filinovskiy, *Moscow, Russian Federation*

2000 MSC: 35P15

Let L be a self-adjoint operator generated by the differential expression $lu = -r^s\,\Delta u$, $r = |x|$, $s \geq 0$, in Hilbert space $L_{2,s}(\Omega)$ with the norm $\|u\|^2_{L_{2,s}(\Omega)} = \int_\Omega r^{-s}|u|^2\,dx$ where $\Omega \subset R^n \cap \{|x| > 1\}$, $n \geq 2$. Let Σ_η be the set $\{x : x \in R^n, |x| = 1, \eta x \in \Omega\}$, $\eta > 1$. We will consider the unbounded domains Ω such that $\Sigma_{\eta_1} \subset \Sigma_{\eta_2}$ for $\eta_1 < \eta_2$. Denote by $\hat{\lambda}(\eta)$ the eigenvalue with the least possible modulus of the Laplace–Beltrami operator in Σ_η with zero Dirichlet data on $\partial\Sigma_\eta$. Let $\Lambda = \lim\limits_{\eta\to+\infty} |\hat{\lambda}(\eta)|$ and $m = (n-2)^2/4 + \Lambda$.

Theorem. *If $s = 2$, then $\sigma(L) = [m, +\infty)$; if $s > 2$, then $\sigma(L) \subset (m, +\infty)$ and discrete. For all $\lambda \in [m, +\infty)$ there exists the constant $C(\lambda) > 0$ and number $s_0 > 2$, such that for all $s \in (2, s_0]$ we have $\sigma(L) \cap (\lambda - \delta(s), \lambda + \delta(s)) \neq \emptyset$, where $\delta(s) = \left|\hat{\lambda}\,(\ln\ln(1/(s-2)))\right| - \Lambda + C \ln\ln\ln(1/(s-2))/\ln\ln(1/(s-2))$.*

[1] R.T. Lewis, *Singular elliptic operators of second order with purely discrete spectra.* Trans. Amer. Math. Soc. **271** (1982), 653–666.

[2] D.M. Eidus, *The perturbed Laplace operator in a weighted L^2-space.* Journal of Funct. Anal. **100** (1991), 400–410.

NODAL AND MULTIPLE CONSTANT SIGN SOLUTIONS FOR EQUATIONS WITH THE p-LAPLACIAN

Michael E. Filippakis, *Athens, Greece*

2000 MSC:

This is a joint work with Prof. Ravi P. Agarwal, Prof. Donal O'Regan, and Prof. Nikolaos S. Papageorgiou. We consider nonlinear elliptic equations driven by the p-Laplacian with a nonsmooth potential (hemivariational inequalities). We obtain the existence of multiple nontrivial solutions and we determine their sign (one positive, one negative and the third nodal). Our approach uses nonsmooth critical point theory coupled with the method of upper-lower solutions.

PERTURBATION PRINCIPLE IN THE DISCRETE HALF-LINEAR OSCILLATION THEORY

Simona Fišnarová, *Brno, Czech Republic*

2000 MSC: 39A10

This is a joint work with Prof. Ondřej Došlý. We investigate oscillatory properties of the second order half-linear difference equation

$$\Delta(r_k \Phi(\Delta x_k)) + c_k \Phi(x_{k+1}) = 0, \quad \Phi(x) := |x|^{p-2}x, \; p > 1, \tag{1}$$

where this equation is viewed as a perturbation of another (nonoscillatory) equation of the same form. We also study summation characterization of the recessive solution of (1). The crucial role in our investigation is played by estimates for a certain nonlinear function which appears in the so-called modified Riccati equation. The results are applied to perturbed Euler-type equation.

REGULATED FUNCTIONS OF MULTIPLE VARIABLES

Dana Franková, *Buštěhrad, Czech Republic*

2000 MSC:

Regulated functions are a useful tool to describe certain kinds of processes with discontinuities. There will be presented a definition and basic properties of regulated functions defined on topological spaces. Sometimes, we do not deal with really a discontinous process, but there is a sudden change. It is suggested for the finite case how to transform a regulated function into a continuous function, so that the areas of "sudden change" can be observed by methods of continuous functions.

HARTREE-FOCK EQUATION FOR COULOMB SYSTEMS: ASYMPTOTIC REGULARITY, APPROXIMATION AND GALERKIN DISCRETIZATION

Heinz-Jürgen Flad, *Berlin, Germany*

2000 MSC: 35Q55, 35B40, 41A50

The nonlinear Hartree-Fock equation for Coulomb systems is a fundamental model in quantum chemistry for the calculation of the electronic structure of atoms and molecules. We have studied in Ref. [1] the asymptotic regularity of solutions of the Hartree-Fock equation near atomic nuclei. In order to deal with singular Coulomb potentials, integro-differential operators are discussed within the calculus of pseudo-differential operators on conical manifolds. Using a fixed-point approach, it can be shown that the solutions of the Hartree-Fock equation have Taylor asymptotics near the nuclei.

The observed asymptotic regularity can be used to characterize best N-term approximation spaces for solutions of Hartree-Fock equations with respect to (an)isotropic wavelet tensor product bases. It was shown in Ref. [2] that despite the presence of conical singularities, optimal approximation rates can be achieved in the adaptive setting of best N-term approximation theory.

[1] H.-J. Flad, R. Schneider and B.-W. Schulze, *Asymptotic regularity of solutions of Hartree-Fock equations with Coulomb potential*, Math. Methods Appl. Sci. **31** (2008), 2172–2201.

[2] H.-J. Flad, W. Hackbusch, and R. Schneider, *Best N-term approximation in electronic structure calculation. I. One-electron reduced density matrix*, ESAIM: M2AN **40** (2006), 49–61.

RADIAL SOLUTIONS FOR p-LAPLACE EQUATION WITH MIXED NON-LINEARITIES

Matteo Franca, *Ancona, Italy*

2000 MSC: 35M10-35B33-37D10

We discuss the existence and the asymptotic behavior of positive radial solutions for the following equation:

$$\Delta_p u(\mathbf{x}) + f(u, |\mathbf{x}|) = 0, \tag{1}$$

where $\Delta_p u = div(|Du|^{p-2} Du)$, $\mathbf{x} \in \mathbb{R}^n$, $n > p > 1$, and we assume that $f \geq 0$ is subcritical for u large and $|\mathbf{x}|$ small and supercritical for u small and $|\mathbf{x}|$ large, with respect to the Sobolev critical exponent.

We give sufficient conditions for the existence of ground states with fast decay. As a corollary we also prove the existence of ground states with slow decay and of singular ground states with fast and slow decay.

For the proofs we use a Fowler transformation that enables us to use dynamical arguments. This approach allows to unify the study of different types of nonlinearities and to complete the results already appeared in literature with the analysis of singular solutions.

ON SPECIAL CONVERGENCES IN HOMOGENIZATION

Jan Franců, *Brno, Czech Republic*

2000 MSC: 35B27

Homogenization is a mathematical method developed for modelling media with periodic structure. In mathematic setting it studies behavior and the limit of solutions to the sequence of differential equations e.g. $-\nabla(a_n \cdot \nabla u_n) = f$ with periodic coefficients $a_n(x)$ when its period $\varepsilon_n \to 0$. The key point of the homogenization theory is passing to the limit in the product of two weakly converging sequences $\{a_n\}$ and $\{\nabla u_n\}$. The problem is solved by a special convergence called two-scale convergence introduced by G. Nguetseng and Allaire, which works in the case of periodic coefficients. Since real media are not strictly periodic, several generalizations were proposed both deterministic and stochastic. The contribution deals with a modification of the two-scale convergence and with recent Σ-convergence designed by G. Nguetseng for non-periodic coefficients.

IMPROVEMENT TO SEMI-ANALYTICAL SOLUTION FOR TWO-PHASE POROUS-MEDIA FLOW IN HOMOGENEOUS AND HETEROGENEOUS POROUS MEDIUM

Radek Fučík, *Prague, Czech Republic*

2000 MSC: 76S05, 65R20, 83C15

This is a joint work with J. Mikyška, M. Beneš, and T. H. Illangasekare.

We present a closed-form solution for the one-dimensional two-phase flow through a homogeneous porous medium that is applicable to water flow in the vadose zone and flow of non aqueous phase fluids in the saturated zone. The solution is a significant improvement to the method originally presented by McWhorter and Sunada. The aim is to provide a detailed analysis of how the solution to the governing partial differential equation of two-phase flow can be obtained from a functional integral equation given by the analytical treatment of the problem and present an improved algorithm for the implementation of this solution. The integral functional equation is obtained by imposing a set of assumptions on the boundary conditions. The proposed method can be used to obtain solutions to incorporate a wide range of saturation values at the entry point. Moreover, the semi-analytical solution can be obtained for a particular heterogeneous porous medium problem. The semi-analytical solutions will be useful in the verification of vadose zone flow and multi-phase flow codes designed to simulate more complex two-phase flow problems in porous media where capillary effects have to be included.

[1] Fučík R., Mikyška J., Illangasekare T.H. and Beneš M. *Semi-Analytical Solution for Two-Phase Flow in Porous Media with a Discontinuity,* Vadose Zone Journal 7:1001–1007 (2008)

[2] Fučík R., Mikyška J., Illangasekare T.H. and Beneš M. *Improvement to Semi-Analytical Solution for Validation of Numerical Models of Two-Phase Porous-Media Flow,* Vadose Zone Journal 6:93–104 (2007)

LIMIT CYCLES OF PLANAR POLYNOMIAL DYNAMICAL SYSTEMS

Valery Gaiko, *Minsk, Belarus*

2000 MSC: 34C05, 34C07, 34C23, 37G05, 37G10, 37G15

We establish the global qualitative analysis of planar polynomial dynamical systems and suggest a new geometric approach to solving Hilbert's Sixteenth Problem on the maximum number and relative position of their limit cycles in two special cases of such systems. First, using geometric properties of four field rotation parameters of a new canonical system, we present the proof of our earlier conjecture that the maximum number of limit cycles in a quadratic system is equal to four and their only possible distribution is (3 : 1). Then, by means of the same geometric approach, we solve the Problem for Liénard's polynomial system (in this special case, it is considered as Smale's Thirteenth Problem). Besides, generalizing the obtained results, we present the solution of Hilbert's Sixteenth Problem on the maximum number of limit cycles surrounding a singular point for an arbitrary polynomial system and, applying the Wintner–Perko termination principle for multiple limit cycles, we develop an alternative approach to solving the Problem. By means of this approach we complete also the global qualitative analysis of a generalized Liénard cubic system, a neural network cubic system, a Liénard-type piecewise linear system and a quartic dynamical system which models the population dynamics in ecological systems.

THE PERIOD FUNCTION FOR A DELAY DIFFERENTIAL EQUATION

Ábel Garab, *Szeged, Hungary*

2000 MSC: 34K13

We consider the delayed differential equation:

$$\dot{x}(t) = -\mu x(t) + f(x(t-\tau)), \tag{1}$$

where $\mu > 0$, τ is a positive parameter and f is a strictly monotone, nonlinear C^1 function satisfying $f(0) = 0$ and some convexity properties. Krisztin and Walther [1] showed that for prescribed oscillation frequencies (characterized by the values of a discrete Lyapunov functional) there exists $\tau^* > 0$ such that for every $\tau \geq \tau^*$ there is a unique periodic solution of (1).

We consider the period function of such periodic solutions. First we show that it is a monotone increasing Lipschitz continuous funtion of τ with Lipschitz constant 2. Finally we show that this result can be used to give necessary and sufficient conditions for a certain system of delayed differential equations to have unique periodic solutions with prescribed oscillation frequencies. This is a joint work with Dr. Tibor Krisztin.

[1] T. Krisztin and H.-O. Walther, *Unique periodic orbits for delayed positive feedback and the global attractor* J. Dynam. Differential Equations **13** (2001), 1–57.

BIFURCATION OF LIMIT CYCLES FROM SOME MONODROMIC LIMIT SETS IN ANALYTIC PLANAR VECTOR FIELDS

Isaac A. García, *Lleida, Spain*

2000 MSC: 34C05, 37G15, 37G10, 37G20

This is a joint work with Prof. Héctor Giacomini and Prof. Maite Grau.

This work is concerned with planar real analytic differential systems with a smooth and non–flat inverse integrating factor V defined in a neighborhood of some monodromic limit set Ω of an analytic planar vector field. Since $\Omega \subset V^{-1}(0)$, via the vanishing multiplicity m of V at Ω, we study the cyclicity of Ω. Roughly speaking, m is the number of times that V vanishes on Ω. More precisely, when Ω is a limit cycle γ_0, we show that the multiplicity of γ_0 coincides with m. We also study the homoclinic loop bifurcation in the case that Ω is a homoclinic loop Γ whose critical point is a hyperbolic saddle s_0 and whose Poincaré return map is not the identity. A local analysis of V near s_0 allows us to determine the cyclicity of Γ in terms of m. Our result also applies in the particular case in which the saddle s_0 is linearizable, that is, the case in which a bound for the cyclicity of Γ cannot be determined through an algebraic method. Finally, we also study the maximum number of limit cycles that can bifurcate from a focus singular point p_0 (either non-degenerate or degenerate without characteristic directions or nilpotent) under an analytic perturbation. In this case, m determines the cyclicity of p_0 in the non-degenerate case and a lower bound of it otherwise.

[1] I.A. García, H. Giacomini and M. Grau, *The inverse integrating factor and the Poincaré map*, Trans. Amer. Math. Soc., to appear. `arXiv:0710.3238v1 [math.DS]`

[2] I.A. García, H. Giacomini and M. Grau, *Generalized Hopf bifurcation for planar vector fields via the inverse integrating factor*. `arXiv:0902.0681v1 [math.DS]`

ON THE UNIQUENESS OF THE SECOND BOUND STATE SOLUTION OF A SEMILINEAR EQUATION

Marta García-Huidobro, *Santiago, Chile*

2000 MSC: 35J60, 34B40, 35B05

This is a joint work with Prof. C. Cortázar and Prof. C. Yarur. We establish the uniqueness of the second radial bound state solution of

$$\Delta u + f(u) = 0, \quad x \in \mathbb{R}^n. \tag{1}$$

That is, we will prove that the problem

$$\begin{gathered} u''(r) + \frac{n-1}{r}u'(r) + f(u) = 0, \quad r > 0, \quad n > 2, \\ u'(0) = 0, \quad \lim_{r\to\infty} u(r) = 0, \end{gathered} \tag{2}$$

has at most one solution $u \in C^2[0, \infty)$ such that

$$\begin{gathered} \text{there exists } R > 0 \text{ such that } u(r) > 0 \quad r \in (0, R), \quad u(R) = 0, \\ u(r) < 0, \ \text{ for } r > R. \end{gathered} \tag{3}$$

Any nonconstant solution to (2) is called a bound state solution. Bound state solutions such that $u(r) > 0$ for all $r > 0$, are referred to as a first bound state solution, or a ground state solution. We assume that the nonlinearity $f \in C(-\infty, \infty)$ is an odd function satisfying some convexity and growth conditions of superlinear type, and either has one zero at $b > 0$, is non positive and not identically 0 in $(0, b)$, and is differentiable and positive $[b, \infty)$, or is positive and differentiable in $[0, \infty)$.

THE EXISTENCE OF WEAK SOLUTIONS FOR SOME CLASSES OF NONLINEAR $p(x)$-BOUNDARY VALUE PROBLEMS

Mohammad Bagher Ghaemi, *Tehran, Iran*

2000 MSC: 35J60, 35B30, 35B40

This is a joint work with Somaieh Saeidinezhad. This talk deals with the $p(\cdot)$-Laplacian boundary value problems on a smooth bounded domain in $\mathbb{R}^n$ and $p(\cdot)$ is a continuous function defined on the domain Ω and $p(\cdot) > 1$. We investigate a class of PDE in variable exponent theory of generalized Lebesgue-Sobolev spaces. Our approach relies on the variational methods.

ON OSCILLATORY PROPERTIES OF SOLUTIONS OF LINEAR DIFFERENTIAL SYSTEMS WITH DEVIATING ARGUMENTS

Givi Giorgadze, *Tbilisi, Georgia*

2000 MSC: 34K11

We study oscillatory properties of solutions of the third–dimensional linear differential system

$$x_i'(t) = p_i(t)\, x_{i+1}(\tau_i(t)) \quad (i = 1, 2),$$
$$x_3'(t) = -p_3(t)\, x_1(\tau_3(t)),$$

where

$$p_i \in L_{\mathrm{loc}}(R_+, R_+), \quad \tau_i \in C(R_+; R_+),$$
$$\lim_{t\to+\infty} \tau_i(t) = +\infty \quad (i = 1, 2, \dots), \quad \tau_1'(t) \geq 0.$$

Optimal sufficient conditions are established for oscillation of solutions of this system.

ASYMPTOTIC FORMS AND EXPANSIONS OF SOLUTIONS TO PAINLEVÉ EQUATIONS

Irina Goryuchkina, *Moscow, Russia*

2000 MSC: 34M55

We consider Painlevé equations [1] which are nonlinear ordinary differential equations of the second order and their solutions determine new special functions (Painlevé transcendents). For these equations we seek their formal solutions, which are represented in asymptotic expansions near any point $x = x_0$ (including zero and infinity) of form

$$y = c_r(x - x_0)^r + \sum_s c_s(x - x_0)^s,\ s \in \mathbf{K}, \tag{1}$$

of four types: power ([2],§3), power-logarithmic ([2], §3), complicated [3] and exotic [4]. Besides we can calculate exponential asymptotic forms ([2], §5) and exponentially small additions ([2], §7) to the expansions (1). To the sixth Painlevé equation we found all expansions (1) of four types near its three singular and non-singular points for all values of its four complex parameters. Expansions of other types are absent. To the formal solutions of the first four Painlevé equations exist also elliptic and exponential asymptotic forms and exponentially small additions to the expansions (1).

[1] Rozov N.H., *Painlevé equation*, Math. Encycl., Kluwer Acad. Publ., 1995, vol. 8.

[2] Bruno A.D., Mathematical Surveys,**59** (2004), no. 3, pp. 429–480.

[3] Bruno A.D., Doklady Mathematics,**73** (2006), no. 1, pp. 117–120.

[4] Bruno A.D., Doklady Mathematics,**76** (2007), no. 2, pp. 714–718.

STRONG STABILITY FOR A FLUID-STRUCTURE MODEL

Marié Grobbelaar, *Johannesburg, South Africa*

2000 MSC: 74F10

We consider the question of stabilization of a fluid-structure model which describes the interaction between a 3-D incompressible fluid and a 2-D plate, the interface, which coincides with a flat flexible part of the surface of the vessel containing the fluid. The mathematical model comprises the Stokes equations and the equations for the longitudinal deflections of the plate with inclusion of the shear stress which the fluid exerts on the plate. The coupled nature of the problem is also manifested in no-slip conditions at the interface. We show that the energy associated with the model exhibits strong asymptotic stability when the interface is equipped with a locally supported dissipative mechanism. Our main tool is an abstract resolvent criterion due to Y. Tomilov.

[1] Y. Tomilov, *A resolvent approach to stability of operator semigroups* J. Operator Theory **46** (2001), 63-98.

EXISTENCE RESULTS FOR A CLASS OF REACTION DIFFUSION SYSTEMS INVOLVING MEASURES

Gabriela Grosu, *Iaşi, Romania*

2000 MSC: 47J35, 35K37, 35K45

In this paper we prove some existence results for L^∞-solutions to a reaction diffusion system

$$\begin{cases} du = (Au + F(u,v))\,dt + df \\ dv = (Bv + G(u,v))\,dt + dg \\ u(0) = u_0 \\ v(0) = v_0, \end{cases}$$

where A generates a C_0-semigroup of contractions in a real Banach space X, B generates a C_0-semigroup of contractions in a real Banach space Y, $F : X \times Y \to X$, $G : X \times Y \to Y$, $f \in BV([0,+\infty[\,;X)$, $g \in BV([0,+\infty[\,;Y)$, $u_0 \in X$ and $v_0 \in Y$. The proofs are essentially based on an interplay between compactness and Lipschitz type arguments.

AN APPLICATION OF THE CORNER CALCULUS

Gohar Harutyunyan, *Oldenburg, Germany*

2000 MSC: 35J40, 35B40

Asymptotic structure at the singular points is one of the main problems of singular analysis.

Our aim is to characterise asymptotics of solutions to elliptic operators in the corner calculus. As an application we consider operators with singular potenzials $\Delta + V$ for Laplacian Δ and singular part V and establish asymptotics of the eigenfunctions close to the singularities of V.

[1] H.-J. Flad, G. Harutyunyan, R. Schneider and B.-W. Schulze, *Application of the corner calculus to the helium atom* (in preparation).

[2] G. Harutyunyan, B.-W. Schulze, Elliptic Mixed, Transmission and Singular Crack Problems. EMS Tracts in Mathematics Vol. 4, European Math.Soc. Publ. House Zrich, 2008.

[3] B.-W. Schulze, *Operators with Symbol Hierarchies and Iterated Asymptotics*. Publ. RIMS, Kyoto Univ. Vol. 38, No. 4, 2002.

CRITICAL HIGHER ORDER STURM-LIOUVILLE DIFFERENCE OPERATORS

Petr Hasil, *Brno, Czech Republic*

2000 MSC: 39A10, 47B36, 47B25

This is a joint work with Prof. Ondřej Došlý. We study the criticality of $2n$-order Sturm-Liouville difference operators

$$L(y)_k := \sum_{\nu=0}^{n} (-\Delta)^\nu \left(r_k^{[\nu]} \Delta^\nu y_{k-\nu} \right), \quad k \in \mathbb{Z}.$$

Using a Sturmian-type separation theorem for recessive solutions of Hamiltonian systems (see [1]) we show, that arbitrarily small (in a certain sense) negative perturbation of nonnegative critical operator leads to an operator which is no longer nonnegative. This research is motivated by [2], where the concept of critical operators is introduced for operators of second order.

[1] M. Bohner, O. Došlý, W. Kratz, *A Sturmian Theorem for Recessive Solutions of Linear Hamiltonian Difference Systems.* Appl. Math. Lett. **12** (1999), 101–106.

[2] F. Gesztesy, Z. Zhao, *Critical and Subcritical Jacobi Operators Defined as Friedrichs Extensions.* J. Differential Equations **103** (1993), 68–93.

NONLINEAR INTEGRAL INEQUALITIES AND INTEGRAL EQUATIONS WITH KERNELS DEFINED BY CONCAVE FUNCTIONS

László Horváth, *Veszprém, Hungary*

2000 MSC: 45G10

In this talk we study some special nonlinear integral inequalities and the corresponding integral equations in measure spaces. They are significant generalizations of Bihari type integral inequalities and Volterra and Fredholm type integral equations. The kernels of the integral operators are determined by concave functions. Explicit upper bounds are given for the solutions of the integral inequalities. The integral equations are investigated with regard to the existence of a minimal and a maximal solution, extension of the solutions, and the generation of the solutions by successive approximations.

INVISCID AND VISCOUS STATIONARY WAVES OF GAS FLOW THROUGH NOZZLES OF VARYING AREA

Cheng-Hsiung Hsu, *Chung-Li, Taiwan*

2000 MSC:76H05, 76N17, 35B35, 34E20

This is a joint work with Prof. John M. Hong and Prof. Weishi Liu.

In this work we consider the inviscid and viscous stationary waves of gas flow through nozzles of varying area. Treating the viscosity coefficient as a singular parameter, the steady state problem can be viewed as a singularly perturbed system. For a contracting-expanding or expanding-contracting nozzle, a complete classification of inviscid steady states and the existence of viscous profiles are established by using the geometric singular perturbation theory.

DYNAMICS OF TRAVELING FRONT WAVES IN BISTABLE HETEROGENEOUS DIFFUSIVE MEDIA

Hideo Ikeda, *Toyama, Japan*

2000 MSC: 35K57, 34C37, 35B32

We consider two component reaction-diffusion systems with a specific bistable and odd symmetric nonlinearity, which have the bifurcation structure of pitchfork type of traveling front solutions with opposite velocities. Under this situation, we introduce a special heterogeneity, for example Heaviside-like abrupt change at the origin in the space, into diffusion coefficients. Numerically, the responses of traveling fronts via the heterogeneity can be classified into four types depending on the height of the jump: passage, stoppage and two types of reflection. The aim of this talk is to show the mathematical mechanism producing the four types of responses by reducing the PDE dynamics to a finite-dimensional ODE system.

[1] S.-I. Ei, H. Ikeda and T. Kawana, *Dynamics of front solutions in a specific reaction-diffusion system in one dimension* Japan J. Indust. Appl. Math. **25** (2008), 117–147.

A THIRD ORDER BVP SUBJECT TO NONLINEAR BOUNDARY CONDITIONS

Gennaro Infante, *Università della Calabria, Italy*

2000 MSC: 34B18, 34B10

This is a joint work with Professor Paolamaria Pietramala. Utilizing the theory of fixed point index for compact maps, we establish new results on the existence of positive solutions for some third order boundary value problem. The boundary conditions that we study are of nonlocal type, involve Stieltjes integrals and are allowed to be nonlinear.

PICONE-TYPE IDENTITY AND HALF-LINEAR DIFFERENTIAL EQUATIONS OF EVEN ORDER

Jaroslav Jaroš, *Bratislava, Slovak Republic*

2000 MSC: 34C10

A generalization of the well-known Picone's formula to the case of even order half-linear differential operators is given and some new comparison results concerning the associated differential equations are established with the help of this formula.

ASYMPTOTIC BEHAVIOUR OF ATTRACTORS OF PROBLEMS WITH TERMS CONCENTRATED IN THE BOUNDARY

Ángela Jiménez-Casas, *Madrid, Spain*

2000 MSC: 35K55

This is a joint work with Prof Aníbal Rodríguez-Bernal.

We analyze the asymptotic behavior of the attractors of a parabolic problem 1 when some reaction and potential terms are concentrated in a neighborhood of a portion Γ of the boundary and this neighborhood shrinks to Γ as a parameter ϵ goes to zero.

$$(P_\epsilon) \equiv \begin{cases} u_t^\epsilon + A_\epsilon u^\epsilon + \mu u^\epsilon = F_\epsilon(x, u^\epsilon) & \text{in } (0,T)\times\Omega \\ \frac{\partial u^\epsilon}{\partial n} = 0 & \text{on } \Gamma \\ u^\epsilon(0) = u_0 \in H^1(\Omega) & \end{cases} \tag{1}$$

where $A_\epsilon u^\epsilon = -\Delta u^\epsilon + \frac{1}{\epsilon}\mathcal{X}_{\omega_\epsilon} V_\epsilon u_\epsilon$, and $F_\epsilon(x, u^\epsilon) = f_\epsilon(x, u^\epsilon) + \frac{1}{\epsilon}\mathcal{X}_{\omega_\epsilon} g_\epsilon(x, u^\epsilon)$.

We denote by $\mathcal{X}_{\omega_\epsilon}$ the characteristic function of the set ω_ϵ, thus the potential functions and the effective reaction are "concentrated" in ω_ϵ. Note that we assume that both f_ϵ and g_ϵ are defined on $\overline{\Omega} \times R$.

We are interested in the behavior, for small ϵ, of the attractor of this parabolic problem.

We prove that this family of attractors is upper continuous at $\epsilon = 0$.

[1] J.M. Arrieta, Spectral Behavior and Uppersemicontinuity of Attractors, International Conference on Differential Equations (EQUADIFF'99) Berlin. World Scientific.pp 615-621 (2000).

[2] J.M. Arrieta, A. Jiménez-Casas, A. Rodríguez-Bernal, *Nonhomogeneous flux condition as limit of concentrated reactions* , Revista Iberoamericana de Matematicas **24,n 1**, 183-211, (2008).

[3] J.M.Arrieta, A. Rodríguez–Bernal, J. Rossi, *The best Sobolev trace constant as limit of the usual Sobolev constant for small strips near the boundary*. Proceeding of the Royal Society of Edinburgh.Section A. Mathematics, **138A**, 223-237 (2006).

[4] J.K. Hale, Asymptotic Behavior of Dissipative System, (1998).

[5] D. Henry, Geometry Theory of Semilinear Parabolic Equations, Springer-Verlag, (1981).

[6] A. Jiménez-Casas, A. Rodríguez-Bernal *Asymptotic behaviour of a parabolic problem with terms concentrating on the boundary*, to appear Nonlinear Analysis Series A: Theory, Methods and Applications.

MOUNTAIN PASS THEOREM IN ORDERED BANACH SPACES AND ITS APPLICATIONS

Ryuji Kajikiya, *Saga, Japan*

2000 MSC: 35J20

We establish a mountain pass theorem in ordered Banach spaces and apply it to semilinear elliptic equations. The usual mountain pass theorem gives a non-trivial solution but our theorem presents a non-trivial non-negative solution. We apply our mountain pass theorem to the equation,

$$\begin{cases} -\Delta u = a(x)u^p + \lambda g(x,u) \quad \text{in } \Omega, \\ u = 0 \quad \text{on } \partial\Omega, \end{cases} \tag{1}$$

where Ω is a bounded domain in $\mathbb{R}^N$ with smooth boundary $\partial\Omega$, $a(x)$ and $g(x,u)$ may change their signs. Then we prove the existence of a positive solution when $\lambda > 0$ is small enough.

THE PERTURBED VISCOUS CAHN-HILLIARD EQUATION

Maria Kania, *Katowice, Poland*

2000 MSC: 35B41, 35L35

We show that the semigroup generated by the initial-boundary value problem for the perturbed viscous Cahn-Hilliard equation

$$\epsilon u^\epsilon_{tt} + u^\epsilon_t + \Delta\left(\Delta u^\epsilon + f(u^\epsilon) - \delta u^\epsilon_t\right) = 0, \quad x \in \Omega, \quad t > 0, \tag{1}$$

$$u^\epsilon(0,x) = u_0(x), \quad u^\epsilon_t(0,x) = v_0(x) \qquad \text{for} \qquad x \in \Omega, \tag{2}$$

$$u^\epsilon(t,x) = 0, \quad \Delta u^\epsilon(t,x) = 0 \qquad \text{for} \qquad x \in \partial\Omega \tag{3}$$

with $\epsilon > 0$ as a parameter admits a global attractor $\mathcal{A}_\epsilon$ in the phase space $X^{\frac{1}{2}} = (H^2(\Omega) \cap H^1_0(\Omega)) \times L^2(\Omega)$, $\Omega \subset \mathbb{R}^n, n \leq 3$. Moreover, we show that the family $\{\mathcal{A}_\epsilon\}_{\epsilon\in[0,1]}$ is upper semicontinuous at 0, which means that the Hausdorff semidistance

$$d_{X^{\frac{1}{2}}}(\mathcal{A}_\epsilon, \mathcal{A}_0) \equiv \sup_{\psi\in\mathcal{A}_\epsilon} \inf_{\phi\in\mathcal{A}_0} \|\psi - \phi\|_{X^{\frac{1}{2}}},$$

tends to 0 as $\epsilon \to 0^+$.

[1] S. Zheng and A. Milani, *Global attractors for singular perturbations of the Cahn-Hilliard equations.* J. Differential Equations **209** (2005), 101–139.

ON NONLINEAR DAMPING IN OSCILLATORY SYSTEMS

János Karsai, *Szeged, Hungary*

2000 MSC: 34D05, 34D20, 34C15

This is a joint work with Prof John Graef. We consider the system

$$x'' + a(t)|x'|^\beta \operatorname{sign}(x') + f(x) = 0 \quad (t \geq 0,\ a(t) \geq 0), \tag{1}$$

where $\beta > 0, xf(x) > 0,\ x \neq 0$ as a prototype of more general nonlinear systems. It is well known that the nonlinearity of $f(x)$ plays an essential role in the asymptotic behavior of equation (1). It is also obviuos for the damping term. The case $\beta = 1$ and $\beta > 1$ has been widely investigated, but the results for $\beta > 1$ are not really based on the power β. The case of sublinear damping $0 < \beta < 1$ is hardly investigated as yet, although its behavior is essentially different from the linear and superlinear cases.

In this talk, we give new attractivity and oscillation results for equation (1), $a(t) \geq a_0 > 0$. Our conditions essentially involve the power β in such a way that our results reduce directly to known conditions in the case $\beta = 1$. We also formulate results for equations with more general nonlinearities, and open problems for future research will be indicated. The results and problems will be illustrated by interactive demonstrations with *Mathematica*.

ON SOME ESTIMATES FOR THE MINIMAL EIGENVALUE OF THE STURM-LIOUVILLE PROBLEM WITH THIRD-TYPE BOUNDARY CONDITIONS

Elena Karulina, *Moscow, Russia*

2000 MSC: 34L15

Consider the Sturm-Liouville problem:

$$y''(x) - q(x)y(x) + \lambda y(x) = 0, \quad \begin{cases} y'(0) - k^2 y(0) = 0, \\ y'(1) + k^2 y(1) = 0, \end{cases}$$

where $q(x)$ is a non-negative bounded summable function on $[0,1]$ such that $\int_0^1 q^\gamma(x)dx = 1$, $\gamma \neq 0$. By A_γ denote the set of all such functions. We estimate the first eigenvalue $\lambda_1(q)$ of this problem for different values of γ and k. For $M_\gamma = \sup_{q \in A_\gamma} \lambda_1(q)$ some estimates were obtained. In particular, we have

Theorem 1. *1. If $\gamma \in (-\infty, 0) \cup (0,1)$, then $M_\gamma = +\infty$;*
2. If $\gamma \geq 1$ and $k = 0$, then $M_\gamma = 1$.
3. If $\gamma = 1$ and $k \neq 0$, then $M_1 = \xi_*$, where ξ_* is the solution to the equation $\arctan \frac{k^2}{\sqrt{\xi}} = \frac{\xi - 1}{2\sqrt{\xi}}$.

Remark. The problem for the equation $y'' + \lambda q(x)y = 0$, $q(x) \in A_\gamma$, and conditions $y(0) = y(1) = 0$ was considered in [1].

[1] Egorov Yu.V., Kondratiev V.A., On Spectral theory of elliptic operators. Operator theory: Advances and Applications. Birkhouser. 1996. V. 89. P. 1–325.

OSCILLATION CRITERIA FOR SOME TYPES OF SECOND ORDER NONLINEAR DYNAMIC EQUATIONS

Billûr Kaymakçalan, *Statesboro-GA, U.S.A.*

2000 MSC: 34K11, 34C10, 39A11

We investigate the oscillatory behavior of second order nonlinear dynamic equations of the form

$$(a(x^{\Delta})^{\alpha})^{\Delta}(t) + q(t)x^{\beta}(t) \ = \ 0, \tag{1}$$

their forced and forced-perturbed extensions, as well as similar behavior of equations of the type

$$(a(t)(x^{\Delta}(t))^{\alpha})^{\Delta} + f(t, x^{\sigma}(t)) \ = \ 0, \tag{2}$$

on an arbitrary time scale $\mathbb{T}$, where α and β are ratios of positive odd integers, a and q are real-valued, positive, rd-continuous functions on $\mathbb{T}$ and $f : [t_0, \infty) \times \mathbb{R} \to \mathbb{R}$ is continuous, $\operatorname{sgn} f(t,x) = \operatorname{sgn} x$, with $f(t,x)$ being non-decreasing in x for each fixed $t \geq t_0$.

THE ESTIMATION OF SOLUTIONS OF LINEAR DELAYED SCALAR DIFFERENTIAL EQUATIONS OF NEUTRAL TYPE

Denys Khusainov, *Kiev, Ukraine*

2000 MSC: 34C10

This is a joint work with Prof J. Diblík, J. Baštinec, O. Kuzmich, and A. Ryvolová. Using Lyapunov-Krasovskii functionals stability of an equation

$$\frac{d}{dt}\left[x(t) - dx(t-\tau)\right] = -ax(t) + bx(t-\tau) \tag{1}$$

is studied, where $t \geq 0$, $\tau > 0$ and a, b, d are real constants.
Theorem: Let g_1, g_2 and β be positive constants and let the matrix

$$S := \begin{pmatrix} 2a - g_1 - a^2 g_2 & -b(1 - ag_2) & -d(1 - ag_2) \\ -b(1 - ag_2) & e^{-\beta\tau} g_1 - b^2 g_2 & -bdg_2 \\ -d(1 - ag_2) & -bdg_2 & \left(e^{-\beta\tau} - d^2\right) g_2 \end{pmatrix},$$

be positive definite. Then the zero solution of (1) is exponentially stable in C^1.
Acknowledgement: This research was supported by the project No.M/34-2008 (27.03.2008) of Ukrainian Ministry Education and by the Councils of Czech Government MSM 0021630529, MSM 00216 30503, and MSM 00216 30519.

DYNAMICS OF INTERACTING STRUCTURED POPULATIONS

Ryusuke Kon, *Vienna, Austria*

2000 MSC: 92D25

There are many studies on mathematical models for interacting populations, such as Lotka-Volterra equations [1]. Similarly, there are many studies on mathematical models for structured populations, such as Leslie matrix models and LPA models. However, there are not many studies on mathematical models for interacting structured populations. In this talk, we focus on populations with a certain age-structure, and consider their species interaction. In particular, we consider a simple competition model for two species with the age-structure, and using an approximation by Lotka-Volterra equations we classify the qualitative dynamics into 12 equivalence classes.

[1] Hofbauer, J., Sigmund, K.: *Evolutionary games and population dynamics*. Cambridge University Press, Cambridge, 1998

ON A BOUNDARY VALUE PROBLEM FOR THE INTEGRO-DIFFERENTIAL EQUATIONS

Roman Koplatadze, *Tbilisi, Georgia*

2000 MSC: 34K10, 34K11

Consider the boundary value problem

$$x'(t) = p(t) \int_0^{\sigma(t)} q(s)\, x(\tau(s))\, ds, \tag{1}$$

$$x(t) = \varphi(t) \quad \text{for} \quad t \in [\tau_0, 0), \quad \liminf_{t\to+\infty} |x(t)| < +\infty, \tag{2}$$

where $p \in C(R_+; (0, +\infty))$, $q \in L_{\text{loc}}(R_+; R_+)$, $0 \le \sigma(t) \le t$, $\tau(t) < t$ for $t \in R_+$, $\lim\limits_{t\to+\infty} \sigma(t) = \lim\limits_{t\to+\infty} \tau(t) = +\infty$, $\tau_0 = \inf\{\tau(t) : t \in R_+\}$, $\varphi \in C([\tau_0, 0))$ and $\sup\{|\varphi(t)| : t \in [\tau_0, 0)\} < +\infty$.

The sufficient conditions for problem (1), (2) to have a solutions, a unique solution and a unique oscillation solution are obtained.

ON DIMENSION-FREE SOBOLEV IMBEDDINGS

Miroslav Krbec, *Prague, Czech Republic*

2000 MSC: 46E35

Target spaces for standard imbedding inequalities depend on the dimension of the underlying Euclidean space in such a manner that the Sobolev exponent tends to the original integrability exponent as the dimension grows. Hence there is a natural question about existence of some residual improvement of integrability properties independent of the dimension. This talk will concern such imbeddings into logarithmic Lebesgue and weighted Lebesgue spaces. We will discuss their relations to the Gross logarithmic inequality and its generalizations, and the problem of reducing the information on derivatives without loss of the imbedding scheme. The talk is based on a joint paper with H.-J. Schmeisser.

STEADY FLOW OF A SECOND GRADE FLUID PAST AN OBSTACLE

Ondřej Kreml, *Prague, Czech Republic*

2000 MSC: 35Q35

This is a joint work with Pawel Konieczny. We study the steady flow of a second grade fluid past an obstacle in 3D. Arising equations can be split into a transport equation and an Oseen equation for the velocity. We use the theory of fundamental solutions to the Oseen equation in weighted Lebesgue spaces together with results of Herbert Koch [1] to prove the existence of a wake region behind the obstacle, i.e. a region where the solution decays slower to the prescribed velocity at infinity.

[1] H. Koch, *Partial differential equations and singular integrals* Dispersive nonlinear problems in mathematical physics, Quad. Mat. **15** (2004), 59–122.

IMPLICIT DIFFERENCE SCHEMES AND NEWTON METHOD FOR EVOLUTION FUNCTIONAL DIFFERENTIAL EQUATIONS

Karolina Kropielnicka, *Gdańsk, Poland*

2000 MSC: 65M12, 35R10

We present a general result for the investigation of the stability of implicit difference schemes generated by first order partial differential functional equations

$$\partial_t z(t,x) = f(t,x,z_{(t,x)},\partial_x z(t,x)) \tag{1}$$

and by parabolic problems

$$\partial_t z(t,x) = F(t,x,z_{(t,x)},\partial_x z(t,x),\partial_{xx} z(t,x)) \tag{2}$$

To give a theorem on error estimates of approximate solutions for implicit functional difference equations corresponding to equations (1) and (2) it is sufficient to consider the following scheme of the Volterra type

$$\delta_0 z^{(r,m)} = G_h[z_{[r,m]}, z_{<r+1,m>})]^{(r,m)} \tag{3}$$

We show that the Newton method is a basic tool for numerical solution of nonlinear algebraic systems generated by nonlinear functional differential equations. Theoretical results are illustrated by numerical examples.

INFINITE–DIMENSIONAL HOMOLOGY AND MULTIBUMP SOLUTIONS

Wojciech Kryszewski, *Toruń, Poland*

2000 MSC: 58E05, 35Q55, 55N05, 58E30

We shall discuss a construction of an infinite-dimensional homology theory suitable for so-called strongly indefinite problems. Then we turn our attention to the Schrödinger equation

$$-\Delta u + V(x)u = f(x,u), \quad u \in H^1(\mathbb{R}^N),$$

where V and f are periodic in $x_1,\dots,x_N$ and 0 is in a gap of the spectrum of $-\Delta + V$ in $L^2(\mathbb{R}^N)$. Under appropriate assumptions on f it has been proved in that this equation has a ground state solution u_0. We show that this solution, if isolated, must necessarily have a nontrivial critical group (in the sense of Morse theory) with respect to the mentioned above homology. This gives rise to the existence of so-called multibump solutions which are obtained by gluing together translates of u_0 in a suitable way. The idea of using variational methods in order to find such solutions goes back to the work of Séré, Coti Zelati and Rabinowitz.

This is a joint work with Andrzej Szulkin.

ASYMPTOTIC PROPERTIES OF DIFFERENTIAL EQUATION WITH SEVERAL PROPORTIONAL DELAYS AND POWER COEFFICIENTS

Petr Kundrát, *Brno, Czech republic*

2000 MSC: 34K25

The aim of the contribution si to introduce an asymptotic estimate of solutions of differential equation with several proportional delays and power coefficients

$$\dot{y}(t) = at^{\alpha} y(t) + \sum_{j=1}^{m} b_j t^{\beta_j} y(\lambda_j t), \qquad t > 0, \tag{1}$$

where $a, b_j, \alpha, \beta_j, \lambda_j$ are reals such that $a, b_j \neq 0, 0 < \lambda_j < 1, j = 1, \dots, m$. Presented and discussed results are particularly inspired by [1].

[1] J. Čermák, *On the differential equation with power coefficients and proportional delays,* Tatra Mt. Math. Publ. **38** (2007), 57–69.

EXISTENCE RESULTS TO SOME QUASILINEAR ELLIPTIC PROBLEMS

Tsang-Hai Kuo, *Taoyuan, Taiwan*

2000 MSC: 35D05, 35J25, 46E35

It is shown that the quasilinear elliptic equation $-\sum_{i,j=1}^{N} D_i(a_{ij}(x,u)D_j u) + f(x,u,\nabla u) = 0$ on a bounded domain Ω in $\mathbb{R}^N$ has a solution $u \in H_0^1(\Omega)$ if a_{ij} are bounded and $f(x,r,\xi) = o(|r| + |\xi|)$. Assume in addition that a_{ij} and $\partial\Omega$ are smooth then there exists a solution $u \in W^{2,p}(\Omega) \cap W_0^{1,p}(\Omega)$, $1 \leq p < \infty$ to the elliptic equation $-\sum_{i,j=1}^{N} a_{ij}(x,u)D_{ij}u + f(x,u,\nabla u) = 0$ provided the oscillations of $a_{ij}(x,r)$ with respect to r are sufficiently small. The existence of $W^{2,p}(\Omega) \cap W_0^{1,p}(\Omega)$ solutions to the equation $-\sum_{i,j=1}^{N} a_{ij}(x,u)D_{ij}u + c(x,u)u + f(x,u,\nabla u) = 0$, where $\beta \geq c(x,r) \geq \alpha > 0$, remains valid if f has a sub-quadratic growth in ξ.

THE MARSHALL DIFFERENTIAL ANALYZER PROJECT: A VISUAL INTERPRETATION OF DYNAMIC EQUATIONS

Bonita Lawrence, *Huntington, WV, USA*

2010 MSC: 3404

This is joint work with Clayton Brooks and Richard Merritt.

Beginning in the late 1920's, a variety of nonlinear differential equations were solved by mathematicians and scientists using electro-mechanical devices known as differential analyzers. The first such machine was built by Vannevar Bush at M.I.T. These fascinating machines performed mechanical integration using components known as "integrators" which were physically connected together to describe the problem under consideration. The Marshall Differential Analyzer Team, a team of undergraduate and graduate students, has recently completed construction of a small two integrator machine and a larger four integrator machine. Modeled after the first machine built at the University of Manchester by Arthur Porter under the direction of Douglas Hartree, the devices are constructed of Meccano-like components. Now that the construction phase is over, the focus of the Project is twofold: to train local mathematics and science educators to teach their charges to analyze functions from the perspective of their derivatives and the relationship between their derivatives and to study nonlinear problems of interest to researchers in the broad field of dynamic equations. A brief history of the project will be presented as well as a discussion of how differential equations are modeled and solved using the device. The big finale will be a demonstration of the small two integrator machine (we call her Lizzie).

ON THE REGULARITY OF THE STATE CONSTRAINED MINIMAL TIME FUNCTION

Alina Lazu, *Iaşi, Romania*

2000 MSC: 49N60

In this paper, we provide sufficient conditions for the state constrained minimal time function to be proto-Lipschitz around the target.

ON A CLASS OF *m*-POINT BOUNDARY VALUE PROBLEMS

Rodica Luca-Tudorache, *Iasi, Romania*

2000 MSC: 34B10, 34B18

We investigate the existence and nonexistence of positive solutions of the nonlinear second-order differential system

$$(S) \qquad \begin{cases} u''(t) + b(t)f(v(t)) = 0 \\ v''(t) + c(t)g(u(t)) = 0, \quad t \in (0,T), \end{cases}$$

with m-point boundary conditions

$$(BC) \qquad \begin{cases} \beta u(0) - \gamma u'(0) = 0, \quad u(T) = \sum_{i=1}^{m-2} a_i u(\xi_i) + b_0, \\ \beta v(0) - \gamma v'(0) = 0, \quad v(T) = \sum_{i=1}^{m-2} a_i v(\xi_i) + b_0, \quad m \geq 3. \end{cases}$$

The arguments for existence of solutions are based upon the Schauder fixed point theorem and some auxiliary results.

MODIFYING SOME FOLIATED DYNAMICAL SYSTEMS TO GUIDE THEIR TRAJECTORIES TO SPECIFIED SUB-MANIFOLDS

Swarnali Majumder, *Bangalore, India*

2000 MSC: 34D35, 34A55

This is a joint work with Prof. Prabhakar G. Vaidya.

We show that dynamical systems in inverse problems are often foliated if the embedding dimension is greater than the dimension of the manifold on which the system resides. Under this condition we end up reaching different leaves of the foliation if we start from different initial conditions. In some of the cases we have found a method by which we can asymptotically guide the system to a specific leaf even if we start from an initial condition which corresponds to some other leaf. For systems like the harmonic oscillator and Duffing's oscillator we find an alternative set of equations such that no matter what initial conditions we choose, the system would asymptotically reach the same desired sub-manifold.

CONTINUOUS DEPENDENCE IN FRONT PROPAGATION OF CONVECTIVE REACTION-DIFFUSION EQUATIONS

Luisa Malaguti, *Reggio Emilia, Italy*

2000 MSC: 35K57, 92D25, 34B40, 34B16

This talk is based on a joint work with C. Marcelli and S. Matucci [2]. Continuous dependence of the threshold wave speed and of the traveling wave profiles for reaction-diffusion-convection equations

$$u_t + h(u)u_x = \Big(d(u)u_x\Big)_x + f(u), \qquad x \in \mathbb{R} \text{ and } t \geq 0$$

is discussed, with respect to all the terms included in the equation. Under the sole conditions ensuring the existence of traveling wave solutions, the lower semi-continuity of the threshold speed is showed and sufficient conditions are established guaranteeing its continuity. The convergence of the wave profiles and of their derivatives is also discussed. The results make use of a recent theory about traveling wave solutions developed in [1] for reaction-diffusion-convection equations of a degenerate type.

[1] L. Malaguti - C. Marcelli, *Finite speed of propagation in monostable degenerate reaction-diffusion-convection equations*. Adv. Nonlinear Stud. **5** (2005), 223-252.

[2] L. Malaguti - C. Marcelli - S. Matucci, *Continuous dependence in front propagation of convective reaction-diffusion equations*, submitted, (2009).

STABILITY SWITCHES IN LINEAR DIFFERENTIAL SYSTEMS WITH DIAGONAL DELAY

Hideaki Matsunaga, *Sakai, Japan*

2000 MSC: 34K20

Some recent results on the asymptotic stability of linear differential systems with diagonal delay are presented. Under suitable conditions, the zero solution switches finite times from stability to instability to stability as a given parameter increases monotonously.

[1] H. Matsunaga, *Stability switches in a system of linear differential equations with diagonal delay.* Appl. Math. Comput. **212** (2009), 145–152.

[2] Xiang-Ping Yan and Wan-Tong Li, *Hopf bifurcation and global periodic solutions in a delayed predator-prey system.* Appl. Math. Comput. **177** (2006), 427–445.

DYNAMICS OF A TRANSITION LAYER FOR A SCALAR BISTABLE REACTION-DIFFUSION EQUATION WITH SPATIALLY HETEROGENEOUS ENVIRONMENTS

Hiroshi Matsuzawa, *Numazu, Japan*

2000 MSC: 35K57, 35B25

This is a joint work with Prof. Shin-Ichiro Ei(Kyushu Univ., Japan). In this talk, we study a dynamics of a transition layer of a solution to a bistable reaction diffusion equation with spatial heterogeneity in one space dimension. In particular, we consider the case when the spatial heterogeneity degenerates on an interval I and study the dynamics of the transition layer on I. In this case the dynamics of the transition layer on I becomes so-called *very slow dynamics*. In order to analyze such a dynamics, we construct an attractive local invariant manifold giving the dynamics of transition layer by the method due to [1].

[1] S.-I. Ei, *The motion of weakly interacting pulses in reaction-diffusion systems*, J. Dynam. Differential Equations **14** (2002), no. 1, 85–137.

[2] S.-I. Ei and H. Matsuzawa, *The motion of a transition layer for a bistable reaction diffusion equation with heterogeneous environment*, submitted.

A BOUNDARY VALUE PROBLEM ON THE HALF LINE FOR QUASILINEAR EQUATIONS

Serena Matucci, *Florence, Italy*

2000 MSC: 34B40

This is a joint work with Prof. M. Marini (University of Florence) and Prof. Z. Došlá (Masaryk University of Brno). The existence of globally positive solutions on $(0, \infty)$ for the BVP

$$\begin{cases} (a(t)|x'|^{\alpha} \operatorname{sgn} x')' = b(t)|x|^{\beta} \operatorname{sgn} x \\ x(0) = 0, \quad \lim_{t\to\infty} x(t) = 0, \end{cases} \tag{1}$$

is considered. It is known that (1) has no positive solutions if b is of one sign. Here necessary and sufficient conditions for the solvability of this problem are obtained when b has no constant sign on $(0, \infty)$. Our approach combines phase space analysis, properties of principal solutions in the half-linear case [2], and some results from [1], [3].

[1] M. Cecchi, Z. Došlá, M. Marini, I. Vrkoč, *Integral conditions for nonoscillation of second order nonlinear differential equations*, Nonlinear Anal. **64** (2006), 1278–1289.

[2] A. Elbert, T. Kusano, *Principal solutions of non-oscillatory half-linear differential equations*, Adv. Math. Sci. Appl. **8** (1998), 745–759.

[3] M. Gaudenzi, P. Habets, F. Zanolin, *An example of a superlinear problem with multiple positive solutions*, Atti Sem. Mat. Fis. Univ. Modena **51** (2003), 259–272.

A NEW APPROACH TO CENTER CONDITIONS FOR SIMPLE ANALYTIC MONODROMIC SINGULARITIES

Susanna Maza, *Lleida, Spain*

2000 MSC: 34C25, 37C27, 34D20

This is a joint work with Prof. Isaac A. García.

In this work we present an alternative algorithm for computing Poincaré–Liapunov constants of simple monodromic singularities of planar analytic vector fields based on the concept of inverse integrating factor, see for instance [1, 2]. Simple monodromic singular points are those for which after performing the first (generalized) polar blow–up, there appear no singular points. In other words, the associated Poincaré return map is analytic. An improvement of the method determines a priori the minimum number of Poincaré–Liapunov constants which must cancel to ensure that the monodromic singularity is in fact a center when the explicit Laurent series of an inverse integrating factor is known in (generalized) polar coordinates.

[1] I.A. García, H. Giacomini and M. Grau, *The inverse integrating factor and the Poincaré map*, Trans. Amer. Math. Soc., to appear. `arXiv:0710.3238v1 [math.DS]`

[2] I.A. García, H. Giacomini and M. Grau, *Generalized Hopf bifurcation for planar vector fields via the inverse integrating factor*. `arXiv:0902.0681v1 [math.DS]`

NEUMANN PROBLEM FOR THE POISSON EQUATION ON NONEMPTY OPEN SUBSETS OF THE EUCLIDEAN SPACE

Dagmar Medková, *Prague, Czech Republic*

2000 MSC: 35J05

The Neumann problem for the Poisson equation is studied on nonempty open subsets Ω of R^m, $m > 2$. The right-hand side is a distribution f supported on $\overline{\Omega}$. A necessary condition for the solvability of the Neumann problem with the boundary condition f is $f \in \mathcal{E}(\overline{\Omega}) = \{g \in L^1_{loc}(R^m), \nabla g \in L^2(R^m), g = 0$ on $R^m \setminus \overline{\Omega}\}$. Moreover, a solution has a form $S\varphi + c$, where $S\varphi$ is the Newton potential corresponding to $\varphi \in \mathcal{E}(\overline{\Omega})$ and c is a constant. The solution is looked for in this form and the original problem reduces to the integral equation $T\varphi = f$. If the Neumann problem is solvable then the solution of the corresponding integral equation $T\varphi = f$ is given by the Neumann series $\varphi = \sum_{j=0}^{\infty}(I - T)^j f$, where I is the identity operator. Necessary and sufficient conditions for the solvability of the Neumann problem is given for NTA domains with compact boundary. Remark that NTA domains might have fractal boundary.

ON A NONLINEAR VERSION OF THE HENRY INTEGRAL INEQUALITY

Milan Medveď, *Bratislava, Slovakia*

2000 MSC: 34D05, 34G20, 26D15, 47J35

We present some results on the upper bound of continuous solutions to the integral inequality

$$\begin{aligned} u(t)^k \le a + \sum_{i=1}^{N} \int_0^t (t-s)^{\beta_i - 1} \lambda_i(s)\omega_i(u(s))ds + \sum_{j=N+1}^{M} \int_0^t \lambda_j(s)\omega_j(u(s))ds \\ + \sum_{l=M+1}^{n} \int_0^t (t-s)^{\beta_l - 1} s^{\gamma_l - 1} \lambda_l(s)\omega_l(u(s))ds, \qquad t \in \langle 0, T \rangle, \end{aligned} \tag{1}$$

(a generalization of the Henry inequality (see [1, Lemma 7.1.1] and [1, Lemma 7.12]), where $a > 0, k > 0, 0 < T < \infty, 0 < \beta_i < 1$, are constants, $\lambda_i(t)$ are continuous, nonnegative functions on $\langle 0, T)$, $\omega_i(u), i = 1, 2, \dots, n$ are continuous, positive, functions on $\langle 0, \infty)$, satisfying some additional conditions and $0 < \gamma_l < 1, l = M+1, M+2, \dots, n$ are constants.

[1] D. Henry, Geometric Theory of Semilinear Parabolic Equations. Springer-Verlag, Berlin, Heidelberg,New York 1981.

TRAVELING WAVES OF A REACTION-DIFFUSION EQUATION IN THE HIGHER-DIMENSIONAL SPACE

Yoshihisa Morita, *Otsu, Japan*

2000 MSC: 35K57

We are dealing with the following reaction-diffusion equation:

$$u_t = \Delta u + u_{yy} + f(u) \qquad (x, y) \in \mathbb{R}^n \times \mathbb{R}, \tag{1}$$

where Δ is the Laplacian in $\mathbb{R}^n$. Assume that the equation has two stable constant solutions $u = 0, 1$ and an unstable one $u = a$ $(0 < a < 1)$. Under the condition $\int_0^1 f(u)du > 0$ the equation allows planar traveling waves connecting two stable constant solutions and an unstable standing wave solution $v(x) > 0$. Then we prove that there are a family of traveling waves $u = U(x, \eta)$, $\eta = y - ct$ connecting $u = 1$ (or $u = 0$) at $\eta = -\infty$ to $u = v(x)$ at $\eta = \infty$. Those speeds belong to a half infinite interval. We prove the result by constructing an appropriate subsolution and a supersolution. This lecture is based on a joint work with Prof. Hirokazu Ninomiya [1].

[1] Y. Morita and H. Ninomiya, *Monostable-type traveling waves of bistable reaction-diffusion equations in the multi-dimensional space.* Bull. Inst. Math. Acad. Sin. (N.S.) **3** (2008), 567-584.

RKPM AND ITS MODIFICATIONS

Vratislava Mošová, *Olomouc, Czech republic*

2000 MSC: 65N05

Meshless methods became an effective tool for solving problems from engineering practice in last years. They have been successfully applied to problems in solid and fluid mechanics. One of their advantage is that they do not require any explicit mesh in computation. It is the reason why they are proper tool to solution of large deformations, crack propagations and so on.

Reproducing Kernel Particle method (RKPM) is one of meshless methods. In this contribution, we deal with some modifications of the RKPM. The construction of considered methods is given together with simple examples of their applications to solving simple boundary value problems.

THE PERIODIC PROBLEM FOR THE SYSTEMS OF HIGHER ORDER LINEAR DIFFERENTIAL EQUATION WITH DEVIATIONS

Sulkhan Mukhigulashvili, *Brno, Czech Republic*

2000 MSC: 34K06, 34K13

Consider a linear system

$$\begin{aligned} v_i^{(m_i)}(t) &= p_i(t)v_{i+1}(\tau_{i+1}(t)) + h_i(t) \qquad (i = 1, \dots, n-1), \\ v_n^{(m_n)}(t) &= p_n(t)v_1(\tau_1(t)) + h_n(t), \end{aligned} \tag{1}$$

on the interval $[0, \omega]$, together with periodic boundary conditions

$$v_i^{(j)}(0) = v_i^{(j)}(\omega) \qquad j = 0, \dots, m_i - 1, \quad i = 1, \dots, n, \tag{2}$$

where $p_i \in L^\infty([0, \omega])$, $h_i \in L([0, \omega])$, and the functions $\tau_i : [0, \omega] \to [0, \omega]$ $(i = 1, \dots n)$ are measurable.

Efficient conditions sufficient for the solvability of the problem (1) (2) are established – there are obtained pointwise conditions of solvability of the problem. The results are concretized for the differential equations and two–dimensional systems of such equations.

A RELATION BETWEEN REACTION-DIFFUSION INTERACTION AND CROSS-DIFFUSION

Hideki Murakawa, *Toyama, Japan*

2000 MSC: 35K55, 35K57

Iida and Ninomiya [1] proposed a semilinear reaction-diffusion system with a small parameter and showed that the limit equation takes the form of a weakly coupled cross-diffusion system provided that solutions of both the reaction-diffusion and the cross-diffusion systems are sufficiently smooth. In this talk, the results are extended to a more general cross-diffusion problem involving strongly coupled systems. It is shown that a solution of the problem can be approximated by that of a semilinear reaction-diffusion system without any assumptions on the solutions. This indicates that the mechanism of cross-diffusion might be captured by reaction-diffusion interaction.

[1] M. Iida and H. Ninomiya, *A reaction-diffusion approximation to a cross-diffusion system*, in Recent Advances on Elliptic and Parabolic Issues (eds. M. Chipot and H. Ninomiya), World Scientific, (2006), 145–164.

BLOWUP RATE FOR A PARABOLIC-ELLIPTIC SYSTEM IN HIGHER DIMENSIONAL DOMAINS

Yuki Naito, *Ehime, Japan*

2000 MSC: 35K55

This is a joint work with Prof. Takasi Senba. Let $\Omega = \{x \in \mathbf{R}^N : |x| < L\}$ with $N \geq 3$. We consider the blowup behavior of radially symmetric solutions to the system

$$u_t = \nabla \cdot (\nabla u - u \nabla v), \quad 0 = \Delta v + u$$

in $\Omega \times (0, T)$ with zero flux of u through $\partial\Omega$ and $v = 0$ on $\partial\Omega$. We will investigate the blowup rate of solutions by employing the intersection comparison argument with a particular self-similar solution, and then identify a class of initial data for which the blowup behavior is of self-similar type.

NUMERICAL COMPUTATIONS TO POROUS MEDIUM FLOW WITH CONVECTION

Tatsuyuki Nakaki, *Higashi-Hiroshima, Japan*

2000 MSC: 65M06, 76S05

In this talk, we propose a numerical scheme to a problem of flow through porous medium described by

$$u_t = (u^m)_{xx} - a(u^n)_x, \tag{1}$$

where $m > n > 1$ and a are constants. Our motivation comes from the development of numerical scheme to oil reservoir problems, and we can regard (1) as such a toy problem. Some numerical computations to (1) as well as the oil reservoir problems shall be demonstrated. This research was partially supported by Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (S) No.16104001, (B) No.18340030 and Exploratory Research No.21654018.

HOMOGENIZATION WITH UNCERTAIN INPUT PARAMETERS

Luděk Nechvátal, *Brno, Czech Republic*

2000 MSC: 35B27, 35B30

This is a joint work with Prof. Jan Franců. The contribution deals with modelling of strongly heterogeneous materials via the homogenization method (for introduction see e.g. [1]). Contrary to the usual assumptions of fixed periodic structures and material properties, we consider uncertainties in the equation's coefficients in some sense. These are solved by means of the worst scenario method introduced by I. Hlaváček et al., see [2]. The procedure is demonstrated on a nonlinear elliptic equation of monotone type.

[1] D. Cioranescu, P. Donato, An Introduction to Homogenization. Oxford University Press, 1999.

[2] I. Hlaváček, J. Chleboun, I. Babuška, Uncertain input data problems and the worst scenario method. Applied Mathematics and Mechanics, North Holland, 2004.

NON-INTEGRABILITY OF THE ANISOTROPIC STORMER PROBLEM

Dimitris Nomikos, *Patras, Greece*

2000 MSC: 30B40, 33E05, 34M35

The Anisotropic Stormer Problem with zero angular momentum (ASP_0) admits the Hamiltonian function

$$H = \frac{1}{2}p_r^2 + \frac{1}{2}p_z^2 + \frac{r^2}{2\left(r^2 + \nu^2 z^2\right)^3},$$

where $\nu^2 > 0$ is a constant. The ASP_0 was introduced in [1] and in [2] it was proved that it is non-integrable, in the Liouville sense, for $\nu^2 \neq 5/12,\ 2/3$. In this lecture we will present how the Morales-Ramis theory [3] and its generalization [4] can be applied to prove that the ASP_0 is non-integrable for $\nu^2 = 5/12,\ 2/3$. The latter result on ASP_0 was obtained through collaboration with Professor V. Papageorgiou [5].

[1] M.A. Almeida, I.C. Moreira, F.C. Santos, *On the Ziglin-Yoshida analysis for some classes of homogeneous Hamiltonian systems*,, Rev. Bras. Fis., 28, 4, 470-480, 1998.

[2] M.A. Almeida, T.J. Stuchi, *Non-integrability of the anisotropic Stormer problem with angular momentum*, Physica D, 189, 3-4, 219-233, 2004.

[3] J.J. Morales-Ruiz, Birkhauser-Verlag, *Differential Galois theory and non-integrability of Hamiltonian systems*, Basel-Boston-Berlin, 1999.

[4] J.J. Morales-Ruiz, J.P. Ramis, C. Simó, *Integrability of Hamiltonian systems and differential Galois groups of higher variational equations*, Ann. Sci. École. Norm. Sup., 4, 40, 6, 845-884, 2007.

[5] D.G. Nomikos, V.G. Papageorgiou, *Non-integrability of the Anisotropic Stormer Problem and the Isosceles Three-Body Problem*, Physica D, 238, 3, 273-289, 2009.

MONOTONE METHODS FOR NEUTRAL FUNCTIONAL DIFFERENTIAL EQUATIONS

Rafael Obaya, *Valladolid, Spain*

2000 MSC: 37B55

We study the monotone skew-product semiflow generated by a family of neutral functional differential equations with infinite delay and stable D- operator. The stability properties of D allow us to introduce a new order and to take the neutral family to a new family of differential equations with infinite delay. We establish the 1-covering property of the omega limit sets under appropriate dynamical conditions. We show the applicability of the results in some examples intensively studied in the literature.

[1] Jiang, J., Zhao, X. *Convergence in monotone ans uniformly stable skew-product semiflows with applications.* Reine Angew. Math., **589** (2005), 21–55.

[2] Novo, S., Obaya, R. Sanz, A. *Stability and extensibility results for abstract skew-product semiflows.* J. Differential Equations, **235** (2007), 623–646.

[3] Muñoz, V. Novo, S., Obaya, R.*Neutral functional differential equations with applications to compartmental systems*. SIAM J. Math Anal, **40**. (2008), 1003–1028.

[4] Novo, S., Obaya, R. Villarragut, V. M. *Exponential ordering for nonautonomous neutral functional differential equations.* SIAM J. Math Anal. To appear.

THE FELL TOPOLOGY ON TIME SCALES AND THE CONVERGENCE OF SOLUTIONS OF DYNAMIC EQUATIONS

Ralph Oberste-Vorth, *Huntington, WV, USA*

2010 MSC: 34N05

This is a joint work with Bonita A. Lawrence.

Time scales and dynamic equations have been studied extensively over the last two decades (see [1]). We discuss the use of the Fell topology on the set of time scales and related function spaces (see [2] and [3]). This gives us a framework for a convergence theorem for the solutions of dynamic equations as the functions defining the equations, their initial data, and their time scales converge (to appear in [4]).

[1] M. Bohner and A. Peterson, Dynamic Equations on Time Scales: An Introduction with Applications. Birkhäuser, Boston, 2001.

[2] R. Oberste-Vorth, *The Fell topology on the space of time scales for dynamic equations.* Adv. Dyn. Syst. Appl. **3** (2008), 177–184.

[3] R. Oberste-Vorth, *The Fell topology for dynamic equations on time scales.* Nonlinear Dyn. Syst. Theory **9** (2009), to appear.

[4] B. Lawrence and R. Oberste-Vorth, *Convergence of solutions of dynamic equations on time scales.* (in preparation)

LINEARIZED STABILITY AND INSTABILITY FOR SYMMETRIC PERIODIC ORBITS IN THE *N*-BODY PROBLEM

Daniel Offin, *Kingston, Canada*

2000 MSC: 34C10

Variational methods for periodic orbits in the N-body problem have opened a vast realm of new mathematical discoveries. However, the traditional stability analysis for these solutions requires detailed information about the Lyapunov multipliers for these orbits. We develop an alternative method based on Lagrangian singularities and the Maslov index. This technique has the added advantage of being well suited to the variational method. Let G be a group acting linearly on $\mathcal{X} \subset \mathbb{R}^n$ where G is a subgroup of the Euclidean group and H defines a G-reversible equivariant Hamiltonian flow on $T^*\mathcal{X}$ where $T^*\mathcal{X}$ has been reduced symplectically by a subgroup of G acting freely on $\mathcal{X}$. We consider the question of linear stability of a periodic solution $z(t)$ with spatio-temporal symmetries obtained via a minimizing variational method. We suppose that $z(t)$ lies in a constant energy level and that the symmetry group of the periodic solution is finite and does not contain time-reversing symmetries. Our main theorem states that $z(t)$ is unstable if the second variation at the minimizer has positive directions and the Lagrange plane W associated with the boundary conditions of the minimizing problem has no focal points on its interval. The proof is done by showing that the Lagrange plane distribution of W is without focal points for all time and using it to construct transversal stable and unstable subspaces. Our result is valid in the context of periodic solutions of the N-body problem such as the spatial isosceles three body problem.

SPIKE SOLUTIONS TO SINGULARLY PERTURBED ELLIPTIC EQUATION VIA THE IMPLICIT FUNCTION THEOREM

Oleh Omel'chenko, *Berlin, Germany*

2000 MSC: 35B25, 35C20, 35J65

This is a joint work with PD Dr. Lutz Recke. Recently, we have proposed a new method based on the Modified Implicit Function Theorem for justification of formal approximations in singularly perturbed problems and successfully applied it to study a series of one-dimensional nonlinear BVP's [1, 2].

Here, with the help of our method we construct and justify asymptotics of spike solution to the Neumann problem for elliptic equation

$$\varepsilon^2 \left[\partial_i(a^{ij}(x)\partial_j u) + b^i(x)\partial_i u\right] = f(x, u(x), \varepsilon), \quad x \in \Omega \subset \mathbb{R}^n,$$

where ε is a small parameter, and Ω is a bounded domain.

[1] L. Recke and O.E. Omel'chenko, *Boundary Layer Solutions to Problems with Infinite-Dimensional Singular and Regular Perturbations* J. Diff. Eq. **245** (2008), 3806–3822.

[2] O. Omel'chenko and L. Recke, *Boundary Layer Solutions to Singularly Perturbed Problems via the Implicit Function Theorem* Asymptot. Anal. **62** (2009), 207–225.

SOME OSCILLATORY PROPERTIES OF THE SECOND-ORDER DIFFERENTIAL EQUATION WITH AN ARGUMENT DEVIATION

Zdeněk Opluštil, *Brno, Czech Republic*

2000 MSC: 34K11

Some oscillatory properties of the second-order equation

$$u''(t) = -p(t)u\Big(\tau(t)\Big)$$

will be discussed, where $p\colon [0,+\infty) \to \mathbb{R}$ and $\tau\colon [0,+\infty) \to [0,+\infty)$ are, respectively, locally integrable and locally measurable functions.

BOUND SETS APPROACH TO FLOQUET PROBLEMS FOR VECTOR SECOND-ORDER DIFFERENTIAL INCLUSIONS

Martina Pavlačková, *Olomouc, Czech Republic*

2000 MSC: 34A60, 34B15, 47H04

The talk is based on a joint work with Jan Andres (Palacký University) and Luisa Malaguti (University of Modena and Reggio Emilia).

The Floquet boundary value problems associated to second-order differential inclusions are considered. The existence and the localization result, obtained by means of Scorza-Dragoni type technique, will be presented. A bound sets approach allows us to check the behaviour of trajectories on the boundary of a suitable parametric set of candidate solutions. An illustrating example will be supplied.

ESTIMATIONS OF NONCONTINUABLE SOLUTIONS

Eva Pekárková, *Brno, Czech Republic*

2000 MSC: 34C10

We study asymptotic properties of solutions for a system of second order differential equations with p-Laplacian. The main purpose is to investigate lower estimates of singular solutions of equation

$$(A(t)\Phi_p(y'))' + B(t)g(y') + R(t)f(y) = e(t). \tag{1}$$

We use the version of [1, Theorem 1.2] and [2, Theorem 1.2]. Furthermore, we obtain important results for scalar case of (1).

[1] M. Bartušek, M. Medveď, *Existence of global solutions for systems of second-order functional-dierential equations with p-Laplacian*, EJDE, **40** (2008), 1–8.

[2] M. Medveď, E. Pekárková, *Existence of global solutions of systems of second order differential equations with p-Laplacian*, EJDE, **136** (2007), 1–9.

ESTIMATE OF THE FREE-BOUNDARY FOR A NON LOCAL ELLIPTIC-PARABOLIC PROBLEM ARISING IN NUCLEAR FUSION

Juan Francisco Padial, *Madrid, Spain*

2000 MSC: 34K65

We consider the following nonlinear elliptic–parabolic problem

$$(P)\begin{cases} \beta_t\left(u\left(t\right)\right)-\Delta u\left(t\right)=aG(u(t))+H\left(u\left(t\right),b_{*u(t)}\right)+J(u\left(t\right)(x)) \text{ in } (0,T)\times\Omega, \\ u\left(t\right)-\gamma\in H_0^1(\Omega), \text{ on } (t,x)\in(0,T)\times\partial\Omega, \beta\left(u\left(0,x\right)\right)=\beta\left(u_0\left(x\right)\right), \quad \text{in } \Omega, \end{cases}$$

where Ω is a regular open connected set of R^2, $T>0$, $\gamma<0$ (unknown constant), $\beta\left(\sigma\right)=\sigma_- := \min(0,\sigma)$, $\sigma\in R$, $a\in L^\infty(\Omega)$, and the functions

$$\begin{aligned} G(x,u(t),b_{*u(t)}) &= \left[F_v^2-F_1\left(x,u\left(t\right),b_{*u(t)}\right)+F_2\left(x,u\left(t\right)\right)\right]_+^{\frac{1}{2}} \\ F_1\left(x,u\left(t\right),b_{*u(t)}\right) &= 2\int_{|u(t)>0|}^{|u(t)>u(t)_+(x)|}[p\left(u\left(t\right)_*\right)]'(r)\,b_{*u(t)}\left(r\right)dr, \\ F_2\left(x,u\left(t\right)\right) &= 2\int_{|u(t)>0|}^{|u(t)>u(t)_+(x)|} j_s'(u\left(t\right)_{+*}\left(r\right),u\left(t\right)_{+*}\left(0\right))(u\left(t\right)'_{+*}(r))^2dr, \\ H\left(u\left(t\right),b_{*u(t)}\right) &= p'\left(u\left(t\right)(x)\right)\left[b\left(x\right)-b_{*u(t)}\left(|u\left(t\right)>u\left(t\right)(x)\,|\right)\right], \\ J\left(u\left(t\right)(x)\right) &= j_s'(u\left(t\right)_+\left(x\right),u\left(t\right)_{+*}\left(0\right))u\left(t\right)'_{+*}\left(|u\left(t\right)>u\left(t\right)(x)\,|\right). \end{aligned}$$

With $F_v>0$, $p\in W^{1,\infty}_{loc}(R)$, $\lambda>0$, $b\in L^\infty(\Omega)$, $b>0$ a.e. in Ω and $u(t)_*$ and $b_{*u(t)}$ are the monotone and relative rearrangements respectively. Finally $u_0\in H^1(\Omega)$ with $\beta\left(u_0\right)\in L^\infty\left(\Omega\right)$. Problem (P) arises in the study of the transient regime of the magnetic confinement of a fusion plasma in a Stellarator device (for the equilibrium regime see [2], and for transient regime see [3]). We point out that for a similar elliptic–parabolic model, but without the nonlocal terms J, Lerena proved in [1] some estimates on the plasma region. Based in this work, the aim of this lecture is to show some estimates on the location and size of the plasma region $\Omega_p : \{x\in\Omega : u\left(t,x\right)\geq 0\}$ for a given solution of (P).

[1] M. B. Lerena, *On the existence of the free–boundary for problems arising in plasma physics*, Nonlinear Analysis **55** (2003), 419–439.

[2] J. I. Díaz, J. F. Padial and J. M. Rakotoson, *Mathematical treatment of the magnetic confinement in a current-carrying Stellarator*, Nonlinear Analysis, Theory, Methods and Applications **34** (1998), 857–887.

[3] J. I. Díaz, B. Lerena, J. F. Padial and J. M. Rakotoson, *An elliptic–parabolic equation with a nonlocal term for the transient regime of a plasma in a Stellarator*, J. Differential Equations **198** (2004), 321–35.

A FIXED POINT METHOD TO COMPUTE SOLVENTS OF MATRIX POLYNOMIALS

Edgar Pereira, *IT-Covilha, Portugal*

2000 MSC: 34M99, 65F30, 15A24

This is a joint work with Fernando Marcos of IPG-Guarda, Portugal. Matrix polynomials play an important role in the theory of matrix differential equations. We develop here a fixed point method to compute solutions, under certain conditions, for monic matrix polynomials equations. Some examples illustrate the presentation.

SELF–SIMILAR ASYMPTOTICS OF SOLUTIONS TO HEAT EQUATION WITH INVERSE SQUARE POTENTIAL

Dominika Pilarczyk, *Wroclaw, Poland*

2000 MSC: 35K05, 35K15, 35B05, 35B40

We study properties of solutions to the initial value problem

$$\begin{aligned} &u_t = \Delta u + \frac{\lambda}{|x|^2}u, \quad x \in \mathbb{R}^n, \quad t > 0 \\ &u(x,0) = u_0(x), \end{aligned}$$

where $\lambda \in \mathbb{R}$ is a given parameter. We show, using the estimates of the fundamental solution, that the large time behavior of solutions to this problem is described by the explicit self-similar solutions.

QUALITATIVE THEORY OF DIVIDED DIFFERENCE FIRST ORDER SYSTEMS

Sandra Pinelas, *Ponta Delgada, Portugal*

2000 MSC:

This is a joint work with Prof. Agarwal. In this paper we shall develop several comparison results for a very general class of difference systems. From these results almost all known Gronwall type inequalities in one independent variable can be deduced as simple exercises. We shall show that our results can be employed directly to study various qualitative properties of solutions such as boundedness and continuous dependence on the initial data. We shall further investigate the asymptotic behavior and the stability over the manifolds of solutions of such systems.

ASYMPTOTIC BEHAVIOUR OF A PHASE-FIELD MODEL WITH THREE COUPLED EQUATIONS WITHOUT UNIQUENESS

Gabriela Planas, *Campinas, Brazil*

2000 MSC: 35B41, 35K55, 35K65, 80A22

This is a joint work with Pedro Marín-Rubio and José Real (Sevilla, Spain).

We prove the existence of weak solutions for a phase-field model with three coupled equations with unknown uniqueness, and state several dynamical systems depending on the regularity of the initial data. Then, the existence of families of global attractors (level-set depending) for the corresponding multi-valued semiflows is established, applying an energy method. Finally, using the regularizing effect of the problem, we prove that these attractors are in fact the same.

[1] P. Marn-Rubio, G. Planas, J. Real, *Asymptotic behaviour of a phase-field model with three coupled equations without uniqueness.* to appear J. of Differential Equations.

ON REGULARITY CRITERIA FOR THE INCOMPRESSIBLE NAVIER–STOKES EQUATIONS CONTAINING VELOCITY GRADIENT

Milan Pokorný, *Praha, Czech Republic*

2000 MSC: 35Q35

Part of the results is a joint work with Patrick Penel from the University of Toulon. We consider the Cauchy problem for the incompressible Navier–Stokes equations. Recently, many new conditions on the integrability of certain components of the velocity gradient appeared which ensure the global-in-time smoothness of the solution. We try to review the known results in this field and prove some new criteria which should be understood as intermediate results between some known results.

SYMPLECTIC METHOD FOR THE INVESTIGATION OF MEL'NIKOV-SAMOILENKO ADIABATIC STABILITY PROBLEM

Yarema Prykarpatsky, *Cracow, Poland*

2000 MSC: 37J40, 70H08, 70H11

We propose a new approach to the solution of the Mel'nikov-Samoilenko adiabatic stability of an oscillator-perturbed invariant manifold problem. The method is based on the special structure of the so-called "virtual" canonical transformations of the phase space in terms of the Hamilton-Jacobi variables. By means of these transformations the initial adiabatically perturbed oscillator-type Hamiltonian system is reduced to a Hamiltonian system in the canonical Bogoliubov form, to which the standard procedure of the KAM theory which is based on the accelerated convergence, can be applied.

HEATED MICROWAVE CERAMIC BY THE MICROWAVE LASER

Leila Rajaee, *Qom, Iran*

2000 MSC: 34C10

It is proposed to heat the microwave ceramic by the maser beam in two dimensions. The microwave ceramic which has a complex permittivity can absorb energy easily and heat quickly. It is shown that the maser beam with Gaussian profile can heat ceramic sample better than the plan electromagnetic wave. Moreover, the effect of the important factors such as the permittivity of ceramic, the incident wave intensity and the spot size of the Gaussian wave on the heat transfer within the sample are investigated. Also, the microwave ceramics AL_2O_3 and ZnO are subjected on the Gaussian wave and the rate of heat transfer in these samples will be compared with each other.

[1] Yu. V. Bykov, K. I. Rybakov and V. E. Semenov, High-temperature microwave processing of materials, *J. Phys. D: Appl. Phys.* **34**, R55-R75 (2001).

[2] P. Varga a, P. Torok, The Gaussian wave solution of Maxwell's equations and the validity of scalar wave approximation, *Optics Communications.* **152**, 108–118 (1998).

STABILITY AND SLIDING MODES FOR A CLASS OF NONLINEAR TIME DELAY SYSTEMS

Vladimir Răsvan, *Craiova, Romania*

2000 MSC: 34K20, 34K05, 34K35, 93D10

It is considered the following class of time delay systems

$$\dot{x} = Ax(t) + \sum_{1}^{r} bq_i^* x(t - \tau_i) - b\phi(c^* x(t)), \tag{1}$$

where $\phi : \mathbb{R} \mapsto \mathbb{R}$ may have discontinuities, in particular at the origin. The solution is defined using the "redefined nonlinearity" concept due to gelig, Leonov and Yakubovich [1] i.e. by considering the system

$$\begin{aligned} \dot{x} &= Ax(t) + \sum_{1}^{r} bq_i^* x(t - \tau_i) - b\mu(t), \\ \sigma &= c^* x \quad , \quad -\xi \in \phi(\sigma). \end{aligned} \tag{2}$$

For such systems sliding modes are discussed and a frequency domain inequality for global asymptotic stability is given.

[1] A.Kh. Gelig, G.A. Leonov, V.A. Yakubovich, Stability of nonlinear systems with non-unique equilibrium state (in Russian). Nauka, Moscow, 1978 (English version by World Scientific, Singapore, 2004).

ASYMPTOTIC BEHAVIOUR OF A TWO-DIMENSIONAL DIFFERENTIAL SYSTEM WITH A NONCONSTANT DELAY UNDER THE CONDITIONS OF INSTABILITY

Josef Rebenda, *Brno, Czech Republic*

2000 MSC: 34K15

This is a joint work with Prof. Josef Kalas, Brno, Czech Republic. We present several results dealing with the asymptotic behaviour of a real two-dimensional system $x'(t) = \mathsf{A}(t)x(t) + \mathsf{B}(t)x(\theta(t)) + h(t, x(t), x(\theta(t)))$ with a bounded nonconstant delay $t - \theta(t) \geq 0$ satisfying $\lim_{t\to\infty} \theta(t) = \infty$ under the assumption of instability. Here A, B and h are supposed to be matrix functions and a vector function, respectively. The conditions for the instable properties of solutions together with the conditions for the existence of bounded solutions are given. The methods are based on the transformation of the considered real system to one equation with complex-valued coefficients. Asymptotic properties are studied by means of a Lyapunov-Krasovskii functional and the suitable Ważewski topological principle. The results generalize some previous ones, where the asymptotic properties for two-dimensional systems with a constant delay were studied.

A ROLE OF THE COEFFICIENT OF THE DIFFERENTIAL TERM IN OSCILLATION THEORY OF HALF-LINEAR EQUATIONS

Pavel Řehák, *Brno, Czech Republic*

2000 MSC: 34C10; 39A11; 39A12; 39A13

We will discuss an important role of the coefficient r in oscillation theory of the half-linear dynamic equation $\left(r(t)\Phi(y^\Delta)\right)^\Delta + p(t)\Phi(y^\sigma) = 0$, where $\Phi(u) = |u|^{\alpha-1} \operatorname{sgn} u$ with $\alpha > 1$. Due to the lack of suitable transformations (which may require linearity or a time scale being equal to reals), the study of the equation with $r \not\equiv 1$ is important, and, moreover, different types of the asymptotic behavior of r have to be distinguished since one type cannot be in general transferred to the other one. On two types of results, comparison theorems and (non)oscillation criteria, we will demonstrate how they are affected by the behavior of the coefficient r in a combination with the behavior of the graininess. In particular, we will reveal discrepancies between the corresponding continuous and discrete statements. Some observations are new also in the classical differential and difference equation cases.

REALIZATION THEORY METHODS FOR THE STABILITY INVESTIGATION OF NONLINEAR INFINITE-DIMENSIONAL INPUT-OUTPUT SYSTEMS

Volker Reitmann, *St. Petersburg, Russia*

2000 MSC: 34G20, 44A05

Realization theory for linear input-output operators and frequency-domain methods for the solvability of Riccati operator equations are used for the stability and instability investigation of a class of nonlinear Volterra integral equations in some Hilbert space. The key idea is to consider, similar to the Volterra equation, a time-invariant control system generated by an abstract ODE in some weighted Sobolev space, which has the same stability properties as the Volterra equation.

FOUR SOLUTIONS FOR AN ELLIPTIC EQUATION WITH CRITICAL EXPONENT AND SINGULAR TERM

Eugénio Rocha, *Aveiro, Portugal*

2000 MSC: 35J20, 35J70

This is a joint work with Prof Jianqing Chen. We show, under some conditions, that the Dirichlet problem

$$-\Delta u - \frac{\lambda}{|x|^2} u = |u|^{2^*-2} u + \mu |x|^{\alpha-2} u + f(x) \text{ a.e. on } \Omega \backslash \{0\} \quad \text{with } u \in H_0^1(\Omega),$$

has four nontrivial solutions where at least one of solutions is sign changing. We assume that $0 \in \Omega \subset \mathbb{R}^N (N \geq 3)$ is a bounded domain with smooth boundary, $2^* := 2N/(N-2)$ is the critical Sobolev exponent, $0 \leq \lambda < \Lambda := ((N-2)/2)^2$ and $f \in L^\infty(\Omega)$. These results extend some previous works on the literature, as [1, 2, 3].

[1] N. Hirano and N. Shioji, A multiplicity result including a sign changing solution for an inhomogeneous Neumann problem with critical exponent, *Proc. Roy. Soc. Edinburgh* **137A**(2007) 333–347.

[2] D. Kang and Y. Deng, Multiple solutions for inhomogeneous elliptic problems involving critical Sobolev-Hardy exponents, *J. Math. Anal. Appl.* **60**(2005) 729–753.

[3] G. Tarantello, Multiplicity results for an inhomogeneous Neumann problem with critical exponent, *Manuscripta Math.* **81**(1993) 51–78.

A PHASE-FIELD MODEL FOR TWO-PHASE COMPRESSIBLE FLUIDS

Elisabetta Rocca, *University of Milan, Italy*

2000 MSC: 35Q30, 76T99, 80A22

This is a joint work with Eduard Feireisl, Hana Petzeltová (Institute of Mathematics of the Academy of Sciences of the Czech Republic) and Giulio Schimperna (University of Pavia, Italy).

A fluid-mechanical theory for two-phase mixtures of fluids faces a well known mathematical difficulty: the movement of the interfaces is naturally amenable to a Lagrangian description, while the bulk fluid flow is usually considered in the Eulerian framework. The phase field methods overcome this problem by postulating the existence of a "diffuse" interface spread over a possibly narrow region covering the "real" sharp interface boundary. A phase variable χ is introduced to demarcate the two species and to indicate the location of the interface. A mixing energy is defined in terms of χ and its spatial gradient the time evolution of which is described by means of a convection-diffusion equation.

Typically, different variants of Cahn-Hilliard, Allen-Cahn or other types of dynamics are used (see Anderson et al. [1]). In this paper, we consider a variant of a model for a two phase flow undergoing phase changes proposed by Blesgen [2]. The resulting problem consists of a *Navier-Stokes system* governing the evolution of the fluid density $\varrho = \varrho(t, x)$ and the velocity field $\mathbf{u} = \mathbf{u}(t, x)$, coupled with a modified *Allen-Cahn equation* describing the changes of the phase variable $\chi = \chi(t, x)$.

Our main goal is to develop a rigorous *existence theory* for the corresponding problem based on the concept of weak solution for the compressible Navier-Stokes system introduced by Lions [3]. In particular, the theory can handle any initial data of finite energy and the solutions exist globally in time. Unfortunately, we are not able to exclude the possibility that solutions might develop a vacuum state in a finite time, which is one of the major technical difficulties to be overcome.

[1] D. M. Anderson, G. B. McFadden, and A. A. Wheeler, *Diffuse-interface methods in fluid mechanics*. In Annual review of fluid mechanics, **30** of Annu. Rev. Fluid Mech., pages 139–165. Annual Reviews, Palo Alto, CA, 1998.

[2] T. Blesgen, *A generalization of the Navier-Stokes equations to two-phase flow*. J. Phys. D Appl. Phys., **32** (1999), 1119–1123.

[3] P.-L. Lions. Mathematical topics in fluid dynamics, Vol.2, Compressible models. Oxford Science Publication, Oxford, 1998.

GLOBAL DYNAMICS FOR AN EPIDEMIC MODEL WITH INFINITE DELAY

Gergely Röst, *Szeged, Hungary*

2000 MSC: 34K60, 92D30

An SEIR model with distributed infinite delay is derived when the infectivity depends on the age of infection. The basic reproduction number $\mathcal{R}_0$, which is a threshold quantity for the stability of equilibria, is calculated. If $\mathcal{R}_0 < 1$, then the disease-free equilibrium is globally asymptotically stable and this is the only equilibrium. On the contrary, if $\mathcal{R}_0 > 1$, then an endemic equilibrium appears which is locally asymptotically stable. Applying a permanence theorem for infinite dimensional systems, we obtain that the disease is always present when $\mathcal{R}_0 > 1$. Recently, C. McCluskey constructed a Lyapunov functional that integrates over all past states and showed the global attractivity of the endemic equilibrium in our system. Finally, we demonstrate how the model can be applied to AIDS/HIV epidemics.

[1] G. Röst, J. Wu, *SEIR epidemiological model with varying infectivity and infinite delay* Math. Biosci. Eng. **5**(2) (2008), 389-402.

[2] C. McCluskey, *Global stability for an SEIR epidemiological model with varying infectivity and infinite delay*, submitted

[3] G. Röst, *SEI model for HIV epidemics with varying transmission and death rates* submitted

NONLINEAR MULTI-VALUED REACTION-DIFFUSION SYSTEMS ON GRAPHS

Daniela Roşu, *Iassy, Romania*

2000 MSC: 35K57, 34G25

By using the concept of A-quasi-tangent set, we establish a necessary and sufficient condition in order that the graph of a multi-function $K : I \rightsquigarrow \overline{D(A)} \times \overline{D(B)}$ is C^0-viable for nonlinear reaction-diffusion systems governed by multi-valued perturbations of m-dissipative operators A and B.

The author's participation at Equadiff 12 was supported by the PN-II-ID-PCE-2007, Grant ID-397.

ASYMPTOTIC SPEED OF PROPAGATION FOR A CLASS OF DEGENERATE REACTION-DIFFUSION-CONVECTION EQUATIONS

Stefano Ruggerini, *Modena, Italy*

2000 MSC: 35K57, 35B40, 35K65, 35K15, 35B35

This is a joint work with Prof Luisa Malaguti. We study the equation

$$u_t + h(u)u_x = (u^m)_{xx} + f(u), \qquad x \in \mathbb{R},\ t > 0, \quad m > 1, \tag{1}$$

with f of Fisher-type, h continuous and both f and h satisfying some technical assumptions. By means of comparison type techniques, we show that $u \equiv 1$ is an attractor for the solutions of the Cauchy problem associated to (1) with continuous, bounded, non-negative initial condition $u_0(x) = u(x,0) \not\equiv 0$; moreover, when u_0 is also compactly supported and satisfies $0 \leq u_0 \leq 1$, we prove the convergence in speed to the travelling-wave solution of (1) with minimal speed.

CONES OF RANK 2 AND THE POINCARÉ-BENDIXSON PROPERTY FOR AUTONOMOUS SYSTEMS

Luis A. Sanchez, *Cartagena, Spain*

2000 MSC: 34C12

Cones of rank 2 are homogenous subsets of $\mathbb{R}^N$ that consist of 2-dimensional linear subspaces. They can be seen as generalizations of convex cones, and in fact in [1] they are used to establish some extensions of the classical Perron-Frobenius theorem.

In this talk we describe the results of [2] about how to employ cones of rank 2 to obtain Poincaré-Bendixson properties for flows. The idea is that a convenient notion of monotone flow with respect to these cones allows to project conveniently some omega limit sets into certain two-dimensional linear subspaces. This line of thought was already developed for instance en the setting of the theory of 3-dimensional competitive systems (see [3]). In fact our result can be seen as an extension of this theory to arbitrary finite dimensions.

[1] M. A. Krasnoselskij, J. A. Lifshits, A. V. Sobolev, *Positive Linear Systems*, Heldermann Verlag, Berlin, 1989.

[2] L. A. Sanchez, *Cones of rank* 2 *and the Poincaré-Bendixson property for a new class of monotone systems*, Journal of Differential Equations 216 (2009), 1170-1190.

[3] H. L. Smith, *Monotone Dynamical Systems*, American Mathematical Society, Providence, 1995.

EXISTENCE OF ASYMPTOTICALLY PERIODIC SOLUTIONS OF SYSTEM OF VOLTERRA DIFFERENCE EQUATIONS

Ewa Schmeidel, *Poznań, Poland*

2000 MSC: 39A11, 39A10

We are concerned with asymptotically periodic solutions of the following Volterra system of difference equations

$$x_s(n+1) = a_s(n) + b_s(n)x_s(n) + \sum_{i=0}^{n} K_{s1}(n,i)x_1(i) + \sum_{i=0}^{n} K_{s2}(n,i)x_2(i), \tag{1}$$

where $a_s, b_s, x_s \colon \mathbf{N} \to \mathbf{R}$, $K_{sp} \colon \mathbf{N} \times \mathbf{N} \to \mathbf{R}$, $s = 1, 2$. The presented results generalize and improve some results derived in [1] for scalar Volterra equation.

[1] J. Diblík, M. Růžičková, E. Schmeidel, *Asymptotically periodic solutions of Volterra difference equations,* Ruffing, A. (ed.) et al., Communications of the Laufen colloquium on science, Laufen, Austria, April 1–5, 2007. Aachen: Shaker. Berichte aus der Mathematik **5** (2007) 1–12.

[2] J. Diblík, M. Růžičková, E. Schmeidel, *Existence of asymptotically periodic solutions of system of Volterra difference equations,* Journal of Difference Equations and Applications (to appear).

COMPUTATIONAL AND ANALYTICAL A POSTERIORI ERROR ESTIMATES

Karel Segeth, *Liberec, Czech Republic*

2000 MSC: 65N15, 65N30

A review of a posteriori error estimation procedures for some differential problems is presented with special regards to the needs of *hp*-finite element methods. A priori, a posteriori, and computational estimates are compared on particular examples: a linear second order elliptic problem in R^2 and a problem for the stationary convection-diffusion-reaction equation in R^n. Undoubtedly, estimates free of unknown constants are preferable.

ON EXACT DEAD-CORE RATES FOR A SEMILINEAR HEAT EQUATION WITH STRONG ABSORPTION

Yukihiro Seki, *Tokyo, Japan*

2000 MSC: 35B40

We study a semilinear heat equation with strong absorption $u_t = \Delta u - u^p$ with $0 < p < 1$. It is known that a solution develops dead-core in finite time for a wide class of initial data. Dead-core rates are known to be faster than the self-similar rate, i.e., the one given by the corresponding ODE [1]. Improving the method of Guo-Wu [2], we construct some special solutions with exact dead-core rates which are faster than the self-similar rate. They are constructed at first formally by means of matched asymptotic expansion technique and then rigorously by means of a topological fixed-point argument with mapping degree.

[1] J.-S. Guo and Ph. Souplet, *Fast rate of formation of dead-core for the heat equation with strong absorption and applications to fast blow-up*, Math. Ann. **331** (2005), 651–667.

[2] J.-S. Guo and C.-C. Wu, *Finite time dead-core rate for the heat equation with a strong absorption*, Tohoku Math. J. **60** (2008), 37–70.

Γ-CONVERGENCE OF COMPLEMENTARY ENERGIES

Hélia Serrano, *Ciudad Real, Spain*

2000 MSC: 35A15, 49J45

Γ-convergence is a variational convergence on sequences of functionals defined in some Lebesgue space (see [1]). Given a sequence of energies, an interesting problem is to describe explicitly its limit energy density. Here we are interested whether the limit energy density of a sequence of complementary energies may be described using the limit energy density of initial energies. Namely, we study the Γ-convergence of a sequence of quadratic functionals for which Γ-convergence is stable under the conjugate operator. However, this statement may not be generalized. Div-Young measures (see [2]) turn out to be a useful tool to characterize explicitly the limit energy density of complementary energies.

[1] G. Dal Maso, An introduction to Γ-convergence. Birkhäuser, 1993.

[2] P. Pedregal, Parametrized measures and variational principles. Birkhäuser, 1997.

ON THE BOUNDARY CONDITIONS SATISFIED BY A GIVEN SOLUTION OF A LINEAR THIRD–ORDER HOMOGENEOUS ORDINARY DIFFERENTIAL EQUATION

Jayasri Sett, *Calcutta, India*

2000 MSC: 34B

We consider the third–order linear homogeneous ordinary differential equation (ODE)

$$L[y] = a_0(t)y^{(3)}(t) + a_1(t)y^{(2)}(t) + a_2(t)y^{(1)}(t) + a_3(t)y(t) = 0, \qquad t \in [a,b], \tag{1}$$

where a_0, a_1, a_2, a_3 are complex–valued continuous functions in $[a,b]$ and $a_0(t) \neq 0$ for any $t \in [a,b]$. A real linear homogeneous boundary condition (BC) associated with the ODE is of the form

$$U_\alpha[y] = \alpha_1 y(a) + \alpha_2 y^{(1)}(a) + \alpha_3 y^{(2)}(a) + \alpha_4 y(b) + \alpha_5 y^{(1)}(b) + \alpha_6 y^{(2)}(b) = 0, \tag{2}$$

where the α_i's are real numbers.

In this paper we determine the number of BCs satisfied by each solution of the ODE (1). Also, if μ be a given solution of (1) and $B(\mu)$ denotes the set of vectors $\alpha = (\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6)$ in R^6 that satisfy (2), we determine the dimension of the set of BCs of type (2) that will be satisfied by μ.

This is a joint work with Prof. Chandan Das.

[1] J. Das, *On the solution spaces of linear second–order homogeneous ordinary differential equations and associated boundary conditions*, Journal of Mathematical Analysis and Applications 200 (1996), 42–52.

DEFINITENESS OF QUADRATIC FUNCTIONALS AND ASYMPTOTICS OF RICCATI MATRIX DIFFERENTIAL EQUATIONS

Katja Setzer, *Ulm, Germany*

2000 MSC: 49N10, 34C10

In my talk I will present the results of my diploma thesis (see [3]). The main reference for this work is the paper [1].
As a main result I obtain several statements which all turn out to be equivalent under some technical conditions. To be more precise, the following assertions are equivalent: Strong Observability - positivity of the functional - asymptotics of the Riccati matrix differential equation - Ehrling's condition from functional analysis.
This result may be used to derive a generalization of the "optimal linear regulator". In this way we are able to show that results for time-invariant linear systems (see [2]) extend to time-dependent systems.

[1] W. Kratz, D. Liebscher and R. Schätzle, *On the definiteness of quadratic functionals,* Annali di Matematica pura ed applicata (4) Vol. 176, (1999), 133-143.

[2] W. Kratz, *On the optimal linear regulator,* Internat. Journal Control, 60, No.5, (1994), 1005-1013.

[3] K. Setzer, *Definitheit quadratischer Funktionale und Asymptotik Riccatischer Matrixdifferentialgleichungen,* diploma thesis, Universität Ulm, 2008.

THE ESTIMATION OF ABSOLUTE STABILITY OF DISCRETE SYSTEMS WITH DELAY

Andrew Shatyrko, *Kiev, Ukraine*

2000 MSC: 34C10

In the talk problems on absolute stability of nonlinear control systems described by difference equations with delay will be considered. The investigation is performed using the second method of Lyapunov. If we study differential equations with delay, then we use functional of Lyapunov-Krasovskii in the form of quadratic forms of an integral. Similarly, if difference equations with delay are considered, we use functionals in the form of a sum of quadratics forms. Let us consider a system of nonlinear difference equations with one delay

$$x(k+1) = Ax(k) + Bx(k-m) + f(\sigma(k)), x(k) \in R^n, k = 0, 1, 2, \dots .$$

For investigations we use a functional of Lyapunov-Krasovskii type:

$$V[x(k)] = x^T(k) Hx(k) + \sum_{j=0}^{m} x^T(k-j) Gx(k-j) + \beta \int_0^{\sigma(k)} f(\xi) d\xi$$

where $\beta > 0$, $\sigma(k) = c^T x(k)$. Results on absolute stability and estimation of convergence of solutions are derived.

EXISTENCE OF MULTIPLE SIGN-CHANGING SOLUTIONS FOR A SINGULARLY PERTURBED NEUMANN PROBLEM

Naoki Shioji, *Yokohama, Japan*

2000 MSC: 35J20

We study the existence of multiple sign-changing solutions of the problem

$$\begin{cases} -d^2\Delta u + u = f(u) & \text{in } \Omega, \\ \dfrac{\partial u}{\partial \nu} = 0 & \text{on } \partial\Omega. \end{cases}$$

where $d > 0$ is small enough, Ω is a domain in $\mathbf{R}^N$ $(N \geq 2)$ whose boundary is compact and smooth and $f \in C(\mathbf{R}, \mathbf{R})$ is a function satisfying a subcritical growth condition. We give lower estimates of the number of the sign-changing solutions by the category of a set related to the configuration space $\{(x, y) : \partial\Omega \times \partial\Omega : x \neq y\}$ of the boundary $\partial\Omega$.

ASYMPTOTIC STABILITY CONDITIONS FOR STOCHASTIC MARKOVIAN SYSTEMS OF DIFFERENTIAL EQUATIONS

Efraim Shmerling, *Ariel, Israel*

2000 MSC: 34F05, 47B80, 60H25, 93E03

The examination of the asymptotic stability of Markovian systems of differential equations via analysis of systems of coupled Lyapunov matrix equations has attached much attention recently. We consider the more complicated stochastic jump parameter systems of differential equations given by

$$dX(t) = A(\xi(t))X(t)dt + H(\xi(t))X(t)dw(t) \ ,$$

where $\xi(t)$ is a finite-valued Markov process and $w(t)$ is a standard Wiener process. We derived the system of coupled Lyapunov matrix equations adapted for stochastic jump parameter systems and proved that the asymptotic stability of solutions of such systems is equivalent to the existence of a unique positive solution of the obtained system of coupled Lyapunov matrix equations. The well-known Lyapunov matrix equations for Markovian jump systems that do not incorporate white noise as a Wiener term and systems of Lyapunov matrix equations for stochastic systems of differential equations without Markovian switching can be viewed as special cases of the system of coupled Lyapunov matrix equations derived in the paper.

INTEGRO-DIFFERENTIAL EQUATIONS OF VOLTERRA TYPE ON TIME SCALES

Aneta Sikorska-Nowak, *Poznań, Poland*

2000 MSC: 34D09, 34D99

We present the existence theorems for solutions and Caratheodory's type solutions of the integro-differential equation of Volterra type on infinite time scales. We consider the problem:

$$x^{\Delta}(t) = f(t, x(t), \int_0^t k(t, s, x(s))\Delta s), \quad t \in J = [0, \infty) \cap T \tag{1}$$
$$x(0) = x_0,$$

where T denotes a time scale, J denotes a time scale interval and integral is taken in the sense of Δ-integral. We assume that functions f and k, with values in a Banach space, are continuous or satisfy Carathéodory's conditions and some conditions expressed in terms of measures of noncompactness. The Mönch fixed point theorem and the Ambrosetti type lemma is used to prove the main result. Dynamic equations in Banach spaces constitute quite a new research area. The presented results are new not only for Banach valued functions, but also for real valued functions.

ON SOME SINGULAR SYSTEMS OF PARABOLIC FUNCTIONAL EQUATIONS

László Simon, *Budapest, Hungary*

2000 MSC: 35R10, 35K65

We shall consider initial-boundary value problems for a system consisting of a quasilinear parabolic functional equation and an ordinary differential equation with functional terms. The parabolic equation may contain the gradient with respect to the space variable of the unknown function in the ODE. It will be formulated global existence theorem on weak solutions and some properties of them, by using the theory of monotone type operators. The problem was motivated by models describing reaction-mineralogy-porosity changes in porous media and polimer diffusion.

EXACT MULTIPLICITY OF POSITIVE SOLUTIONS FOR A CLASS OF SINGULAR SEMILINEAR EQUATIONS

Peter Simon, *Budapest, Hungary*

2000 MSC: 34B18

The exact multiplicity of positive solutions of the singular semilinear equation $\Delta u + \lambda f(u) = 0$ with Dirichlet boundary condition is studied. The nonlinearity f tends to infinity at zero, it is the linear combination of the functions $u^{-\alpha}$ and u^p with $\alpha, p > 0$. The number λ is a positive parameter. The goal is to determine all possible bifurcation diagrams that can occur for different values of α and p. These kinds of equations have been widely studied on general domains, here we focus on the exact number of radial solutions on balls that can be investigated by the shooting method.

It is shown how the so-called time-map can be introduced by the shooting method, and its properties determining the exact number of the positive solutions of the boundary value problem are studied. The exact multiplicity of positive solutions is given in the one-dimensional case.

A COHOMOLOGICAL INDEX OF FULLER TYPE FOR DYNAMICAL SYSTEMS

Robert Skiba, *Toruń, Poland*

2000 MSC: 34C25, 37C25, 37C27

The subject of my talk is a joint work with W. Kryszewski. It will be devoted to the Fuller index for periodic orbits of flows generated by differential equations. First, we recall the classical construction of the Fuller index (see [2, 1]). Next, we present a new approach to the construction of the Fuller index. Our approach will be based on cohomological techniques (see [3, 4, 5]). Finally, some applications to differential equations will be provided.

[1] S. N. Chow, J. Mallet-Paret, The Fuller index and global Hopf bifurcation, J. Differential Equations **29** (1978), no. 1, 66–85.

[2] F. B. Fuller, An index of fixed point type for periodic orbits, Amer. J. Math. **89** (1967) 133–148.

[3] W. Kryszewski, R. Skiba, A cohomological index of Fuller type for multivalued dynamical systems (to appear).

[4] R. Srzednicki, Periodic orbits indices, Fund. Math. **135** (1990), no. 3, 147–173.

[5] R. Srzednicki, The Fixed Point Homomorphism of Parametrized Mappings of ANR's and the Modified Fuller Index, Ruhr-Universitat Bochum (1990), Preprint.

PERIODIC AVERAGING OF DYNAMIC EQUATIONS ON TIME SCALES

Antonín Slavík, *Praha, Czech Republic*

2000 MSC: 34C29, 39A12

We present a generalization of the classical theorem on periodic averaging of differential equations. The generalized version is applicable to dynamic equations on time scales, namely to initial-value problems of the form

$$x^{\Delta}(t) = \varepsilon f(t, x(t)) + \varepsilon^2 g(t, x(t), \varepsilon), \quad x(t_0) = x_0, \tag{1}$$

where f is a T-periodic function and $\varepsilon > 0$ is a small parameter. An approximate solution of this initial-value problem can be obtained by solving the averaged equation

$$y^{\Delta}(t) = \varepsilon f^0(y(t)), \quad y(t_0) = x_0, \tag{2}$$

where $f^0(y) = \frac{1}{T}\int_{t_0}^{t_0+T} f(t, y)\,\Delta t$.

ON THE LIPSCHITZ-CONTINUOUS PARAMETER-DEPENDENCE OF THE SOLUTIONS OF ABSTRACT FUNCTIONAL DIFFERENTIAL EQUATIONS WITH STATE-DEPENDENT DELAY

Bernát Slezák, *Veszprém, Hungary*

2000 MSC: 34K05, 34A12

The Lipschitz-continuouty of the resolvent function of retarded functional differential equations with unbounded state-dependent delay is established, with respect to the supremum norme topology, generalizing some known results and obtaining stronger consequences under weaker assumptions.

CHARACTERIZING THE CREATION OPERATOR VIA A DIFFERENTIAL EQUATION

Franciszek Hugon Szafraniec, *Kraków, Poland*

2000 MSC: 47B37, 34C10

A differential equation in a separable Hilbert space is proposed so as to characterize the creation operator of the quantum harmonic, hence the other members of the family. This is a follow-up of [1].

[1] F.H.Szafraniec, Charlier polynomials and translational invariance in the quantum harmonic oscillator, Math. Nachtr., 241(2002), 163-169.

MULTIPLE SOLUTIONS FOR NONLINEAR NEUMANN PROBLEMS WITH THE p-LAPLACIAN AND A NONSMOOTH CROSSING POTENTIAL

George Smyrlis, *Athens, Greece*

2000 MSC: 35J25, 35J70

This is a joint work with Prof. N.S.Papageorgiou and D.Kravvaritis.

Let $\Omega \subseteq \mathbb{R}^N$ $(N \geq 1)$ be a bounded domain with a C^2-boundary $\partial\Omega$. In this paper we study the following nonlinear Neumann problem with a nonsmooth potential (hemivariational inequality):

$$\left\{ \begin{array}{l} -\Delta_p u(z) \in \partial F(z, u(z)), \quad \text{a.e. in } \Omega, \quad 1 < p < \infty, \\ \dfrac{\partial u}{\partial n} = 0, \quad \text{on } \partial\Omega, \end{array} \right\} \tag{1}$$

where $\Delta_p u = \operatorname{div}(\, \|Du\|^{p-2} Du)$ ($p-$ *Laplacian*).

Also $F : \Omega \times \mathbb{R} \to \mathbb{R}$ is a measurable potential function and for almost all $z \in \Omega$, $x \to F(z, x)$ is locally Lipschitz with Clarke's subdifferential $\partial F(z, x)$. Moreover, $n(\cdot)$ denotes the unit outward normal on $\partial\Omega$ and $\dfrac{\partial x}{\partial n} = (Dx, n)_{\mathbb{R}^N}$ is the normal derivative on $\partial\Omega$.

Our goal in this paper is to prove a multiplicity theorem for problem (1), when the "generalized slopes" $\left\{ \dfrac{u}{|x|^{p-2}x} : u \in \partial F(z, x) \right\}$ become negative for x near $+\infty$ and positive for x near $-\infty$. Therefore, as $x \in \mathbb{R}$ moves from $-\infty$ to $+\infty$, the "generalized slopes" *cross* at least λ_0 (the principal eigenvalue of $-\Delta_p$ under Neumann boundary conditions).

This problem was investigated recently by Aizicovici - Papageorgiou -Staicu [1] and Barletta-Papageorgiou [2] and their method of proof (which was based on degree theory) required that $p \geq 2$. Here we remove this restriction and our method of proof is variational based on the nonsmooth critical point theory.

[1] S. Aizicovici - N.S. Papageorgiou - V.Staicu: *The spectrum and an index formula for the Neumann p- Laplacian and multiple solutions for problems with a crossing nonlinearity*, Discrete Cont. Dynam. Systems (to appear).

[2] G. Barletta - N.S. Papageorgiou: *A multiplicity theorem for the Neumann p-Laplacian with an assymetric nonsmooth potential*, J.Global Optim. **39**(2007), 365-392.

BRANCHES OF FORCED OSCILLATIONS FOR A CLASS OF CONSTRAINED ORDINARY DIFFERENTIAL EQUATIONS: A TOPOLOGICAL APPROACH

Marco Spadini, *Firenze, Italy*

2000 MSC: 34C25, 34C40

We provide a "reduction" formula for the degree (or rotation or characteristic) of a tangent vector field on particular smooth submanifolds of $\mathbb{R}^n$. This formula is then applied to the study of the set of forced oscillations of periodically perturbed second order autonomous systems in $\mathbb{R}^n$ subject to a class of constraints.

ON THE CAUCHY PROBLEM FOR HYPERBOLIC FUNCTIONAL-DIFFERENTIAL EQUATIONS

Jiří Šremr, *Brno, Czech Republic*

2000 MSC: 35L15, 35L10

We will discuss the question on the existence, uniqueness, and continuous dependence on parameters of the Carathéodory solutions to the Cauchy problem for linear partial functional-differential equations of hyperbolic type

$$\frac{\partial^2 u(t,x)}{\partial t\,\partial x} = \ell(u)(t,x) + q(t,x),$$

where $\ell\colon L([a,b]\times[c,d];\mathbb{R}) \to C([a,b]\times[c,d];\mathbb{R})$ is a linear bounded operator and $q \in L([a,b]\times[c,d];\mathbb{R})$.

We will also show that the results obtained are new even in the case of equations without argument deviations, because we do not suppose absolute continuity of the function the Cauchy problem is prescribed on, which is rather usual assumption in the existing literature (see, e. g., [1, 2]).

[1] K. Deimling, *Absolutely continuous solutions of Cauchy problem for* $u_{xy} = f(x, y, u, u_x, u_y)$. Ann. Mat. Pura Appl. **89** (1971), 381–391.

[2] W. Walter, Differential and integral inequalities. Springer-Verlag, Berlin, Heidelberg, New York, 1970.

ASYMPTOTIC METHODS IN DIFFERENCE EQUATIONS

Stevo Stević, *Belgrade, Serbia*

2000 MSC: 39A11

We describe some asymptotic methods developed by L. Berg and the speaker ([1]-[4]), which can be used in showing that a nonlinear difference equation has monotonous or nontrivial solutions. As an example we show that, for each $k \in \mathbb{N} \setminus \{1\}$, there is a positive solution converging to zero of the following difference equation

$$y_n = y_{n-k}/(1 + y_{n-1} \cdots y_{n-k+1}), \quad n \in \mathbb{N}_0.$$

[1] L. Berg, Inclusion theorems for non-linear difference equations with applications, *J. Differ. Equations Appl.* **10** (4) (2004), 399-408.

[2] L. Berg and S. Stević, On the asymptotics of the difference equation $y_n(1 + y_{n-1} \cdots y_{n-k+1}) = y_{n-k}$, (2009) (to appear).

[3] S. Stević, Asymptotics of some classes of higher order difference equations, *Discrete Dyn. Nat. Soc.* Vol. 2007, Article ID 56813, (2007), 20 pages.

[4] S. Stević, Nontrivial solutions of a higher-order rational difference equation, *Mat. Zametki* **84** (5) (2008), 772-780.

VERY SLOW CONVERGENCE RATES FOR A SUPERCRITICAL SEMILINEAR PARABOLIC EQUATION

Christian Stinner, *Essen, Germany*

2000 MSC: 35K15, 35B40, 35K57

We study the asymptotic behavior of nonnegative solutions to the Cauchy problem for the semilinear parabolic equation $u_t = \Delta u + u^p$ with a supercritical nonlinearity. We prove that the convergence to zero or to steady states can take place with very slow rates which are arbitrarily slow in some sense and are slower than any algebraic rate. In particular, any rate resulting from iterated logarithms occurs if the initial data are chosen properly. The results are obtained by comparison with suitably constructed sub- and supersolutions.

A SELECTED SURVEY OF THE MATHEMATICAL THEORY OF 1D FLOWS

Ivan Straškraba, *Prague, Czech Republic*

2000 MSC: 35B40, 76N10

The global behavior of compressible fluid in a tube is investigated under physically realistic assumptions. Different initial and boundary conditions are discussed. General conditions are established, under which the fluid stabilizes to an equilibrium state. Motivation for this study is that apriori recognition of stabilization of the fluid is important in many situations in industrial applications. This contribution may serve as a partial survey of some results in this respect.

INSTANTON-ANTI-INSTANTON SOLUTIONS OF DISCRETE YANG-MILLS EQUATIONS

Volodymyr Sushch, *Koszalin, Poland*

2000 MSC: 39A12

We study an intrinsically defined discrete model of the $SU(2)$ Yang-Mills equations on a combinatorial analog of $\mathbb{R}^4$. It is known that a gauge potential can be defined as a certain $su(2)$-valued 1-form A (the connection 1-form). Then the gauge field F (the curvature 2-form) is given by $F = dA + A \wedge A$. We consider the self-dual and anti-self-dual equations

$$F = *F, \qquad F = - * F, \tag{1}$$

where $*$ is the Hodge star operator. Equations (1) are nonlinear matrix first order partial differential equations. In 4-dimensional Yang-Mills theory self-dual (instanton) and anti-self-dual (anti-instanton) solutions of (1) are the absolute minima of the Yang-Mills action.

In this talk based on the paper [1] we describe a discrete analog of (1) which preserves the geometric structure of these equations. By analogy with the continual theory we construct instanton and anti-instanton solutions of corresponding difference self-dual and anti-self-dual equations.

[1] V. Sushch, *A gauge-invariant discrete analog of the Yang-Mills equations on a double complex*. Cubo A Math. Journal **8** (2006), no. 3, 61–78.

ASYMPTOTIC PROPERTIES OF ONE P-TYPE RETARDED DIFFERENTIAL EQUATION

Zdeněk Svoboda, *Brno, Czech Republic*

2000 MSC: 34C25

The first Lyapunov method which is applied for linear equations with perturbation is very useful tool for study asymptotic properties of ordinary differential equations. The asymptotic behavior of solution of equation with righthand side in the form of power series i.e.

$$\dot{y}(t) = -a(t)y(t) + \sum_{|\mathbf{i}|=2}^{\infty} c_{\mathbf{i}}(t)\Big(\mathbf{y}(\boldsymbol{\xi}(t))\Big)^{\mathbf{i}}, \tag{1}$$

where $a(t) > 0$, $c_{\mathbf{i}}(t)$ are continuous functions and $\mathbf{i} = (i_1, \ldots, i_n)$ is a multiindex, $\mathbf{y}(\boldsymbol{\xi}(t))^{\mathbf{i}} = \prod_{j=1}^{n} \Big(y(\xi_j(t))\Big)^{i_j}$ and functions $\xi_j(t)$ satisfy $t_0 \leq \xi_j(t) \leq t$ for all $t \in [t_0, \infty)$ are obtained by asymptotic expansion of this solution. The existence of the solution is proved by Wazewski's topological method for p-type retarded differential equation.

TWO-POINTS BVP FOR INCLUSIONS WITH WEAKLY REGULAR R.H.S.

Valentina Taddei, *Modena, Italy*

2000 MSC: 34A60

This is a joint work with I.Benedetti and L.Malaguti.

We give existence results for the two-points b.v.p. associated to semi-linear evolution inclusions in a reflexive separable Banach space E

$$\begin{cases} x' \in A(t,x)x + F(t,x), & \text{for a.a. } t \in [a,b], \\ Mx(a) + Nx(b) = 0, \end{cases} \tag{1}$$

where M, N are linear bounded operators from E into itself. We assume the regularities on A and F with respect to the weak topology and we investigate (1) in the Sobolev space $W^{1,p}([a,b],E)$, with $1 < p < \infty$. We avoid the use of any measure of non-compactness, like usually required in Banach spaces (see, e.g., [2]). When A and F are integrably bounded, we apply a fixed point theorem, when A and F have a sublinear growth in x, we apply a continuation principle in Fréchet spaces (see [1]), assuming the existence of a Lyapunov function in order to prove the usual pushing condition. Some examples complete the discussion.

[1] Andres, Górniewicz, Topological Fixed Point Principles for Boundary Value Problems. Kluwer, Dordrecht, (2003).

[2] Kamenskii, Obukhovskii, Zecca, Condensing Multivalued Maps and Semilinear Differential Inclusions in Banach Space. W. deGruyter, Berlin, (2001).

COMPARISON RESULTS FOR SOME NONLINEAR ELLIPTIC EQUATIONS

Tadie Tadie, *Copenhagen, Denmark*

2000 MSC: 35J60, 35J70

By means of some Picone-type identities , some comparison results are established for the problems like

$$\left.\begin{aligned} Lu &:= \textstyle\sum_{i,j=1}^{n} \dfrac{\partial}{\partial x_i}\Big\{a(x,u)\dfrac{\partial}{\partial x_j}\Big\}u + f(x,u) + c(x)u \\ &:= \nabla.\Big\{a(x,u)\nabla u\Big\} + f(x,u) + c(x)u \quad \text{in } G\ ; \\ &(i) \qquad u|_{\partial G} = 0 \qquad \text{or} \quad (ii) \qquad \nabla u|_{\partial G} = 0 \end{aligned}\right\} \tag{1}$$

where G is a regular and bounded domain in $\mathbb{R}^n$; $n \geq 3$;
$\sum_{i,j=1}^{n} a(x,s)\xi_i\xi_j > 0 \quad \forall\ \xi \in \mathbb{R}^n \setminus \{0\}\ ,\ (x,s) \in (\overline{G} \times \mathbb{R})$;
the functions $a \in C^1(\overline{G} \times \mathbb{R}\ ;\ \mathbb{R}^+)$, $f \in C(\overline{G} \times \mathbb{R}\ ;\ \mathbb{R})$
with $tf(x,t) > 0 \quad \forall x \in G\ ,\ t \in \mathbb{R}$ and $c \in C(\overline{G}\ ;\ \mathbb{R})$.
Here (classical) solutions of (1) will mean functions
$u \in C^1(\overline{G}) \bigcap C^2(G)$ with $a(x,u)\nabla u \in C^1(\overline{G}\ ;\ \mathbb{R})$
which satisfy weakly either (1),(i) or (1),(ii) . The most interesting result here is that uniqueness theorem for (1) is obtained under the condition that

$$\forall t > 0 \quad , \quad meas.\Big\{x \in G \mid c(x) + \frac{f(x,t)}{t} \leq 0\Big\} = 0\ .$$

ON THE UNIQUENESS OF POSITIVE SOLUTIONS FOR TWO-POINT BOUNDARY VALUE PROBLEMS OF EMDEN-FOWLER DIFFERENTIAL EQUATIONS

Satoshi Tanaka, *Okayama, Japan*

2000 MSC: 34B15, 35J60

The following two-point boundary value problem

$$u'' + a(x)u^p = 0, \quad x_0 < x < x_1, \qquad u(x_0) = u(x_1) = 0 \tag{1}$$

is considered, where $p > 1$, $a \in C^1[0,1]$, $a(x) > 0$ for $x_0 \leq x \leq x_1$. It is well-known that problem (1) has at least one positive solution. Several sufficient conditions have been obtained for uniqueness of positive solutions of (1). On the other hand, a non-uniqueness example was given by Moore and Nehari in 1959. Although problem (1) is basic and classical, it is not clearly known yet what the essential for uniqueness is. In this talk, some new uniqueness results for (1) are presented. Moreover the results obtained here are applied to the study of radially symmetric solutions of elliptic equations.

AN INVERSE PROBLEM IN LUBRICATION THEORY

J. Ignacio Tello, *Madrid, Spain*

2000 MSC: 35J20, 47H11, 49J10

Lubricated contacts are widely used in mechanical systems to connect solid bodies that are in relative motion. A lubricant fluid is introduced in the narrow space between the bodies with the purpose of avoiding direct solid-to-solid contact. This contact is said to be in the hydrodynamic regime, and the forces transmitted between the bodies result from the shear and pressure forces developed in the lubricant film.

We consider a lubricated system called journal bearing consisting of two cylinders in relative motion. An incompressible fluid, the lubricant, is introduced in the narrow space between the cylinders. An exterior force F is applied on the inner cylinder (shaft) which turns with a known velocity ω. The wedge between the two cylinders is assumed to satisfy the thin-film hypothesis, so that the pressure (assumed time-independent) does not depend on the normal coordinate to the bodies and obeys the Reynolds equation.

We present results of existence of solutions under suitable assumptions.

SOME ESTIMATES OF THE FIRST EIGEN–VALUE OF A STURM–LIOUVILLE PROBLEM WITH A WEIGHT INTEGRAL CONDITION

Maria Telnova, *Moscow, Russia*

2000 MSC: 34L15

Let $\lambda_1(Q)$ be the first eigen–value of the Sturm–Liouville problem

$$y'' - Q(x)y + \lambda y = 0, \quad y(0) = y(1) = 0, \quad 0 \leqslant x \leqslant 1.$$

We give some estimates for $m_{\alpha,\beta,\gamma} = \inf\limits_{Q \in T_{\alpha,\beta,\gamma}} \lambda_1(Q)$ and $M_{\alpha,\beta,\gamma} = \sup\limits_{Q \in T_{\alpha,\beta,\gamma}} \lambda_1(Q)$, where $T_{\alpha,\beta,\gamma}$ is the set of real–valued measurable on $[0,1]$ functions with non–negative values such that $\int_0^1 x^\alpha (1-x)^\beta Q^\gamma(x)dx = 1$ $(\alpha, \beta, \gamma \in \mathbb{R}, \gamma \neq 0)$.

Theorem 1. *If $\gamma > 0$ then $m_{\alpha,\beta,\gamma} = \pi^2$ and $m_{\alpha,\beta,\gamma} < +\infty$ for $\gamma < 0$.*

Theorem 2. *If $\gamma < 1$ $(\gamma \neq 0)$ then $M_{\alpha,\beta,\gamma} = +\infty$ and $M_{\alpha,\beta,\gamma} < +\infty$ for $\gamma \geqslant 1$.*

[1] Y. V. Egorov, V. A. Kondrat'ev, *On some estimates of the first eigen–value of a Sturm–Liouville problem,* Uspehi Matematicheskih Nauk, **51** (1996), No. 3, 73–144.

[2] K. Z. Kuralbaeva, *On estimate of the first eigen–value of a Sturm–Liouville operator,* Differentsialnye uravneniya, **32** (1996), No. 6, 852–853.

PERIODIC ORBITS OF RADIALLY SYMMETRIC SYSTEMS WITH A SINGULARITY

Rodica Toader, *Udine, Italy*

2000 MSC: 34C25

This is a joint work with A. Fonda. We study radially symmetric systems with a singularity. The attractive case has been treated in [2]. In this talk we will consider the repulsive case. In the presence of a radially symmetric periodic forcing, we show the existence of three distinct families of subharmonic solutions: one oscillates radially, cf. [1], one rotates around the origin with small angular momentum, and one rotates with both large angular momentum and large amplitude. The results have been obtained in [3] by the use of topological degree theory.

[1] A. Fonda, R. Manasevich, F. Zanolin, *Subharmonic solutions for some second order differential equations with singularities*, SIAM J. Math. Anal. **24** (1993), 1292–1311.

[2] A. Fonda, R. Toader, *Periodic orbits of radially symmetric Keplerian-like systems: a topological degree approach*, J. Differential Equations **244** (2008), 3235–3264.

[3] A. Fonda, R. Toader, *Periodic orbits of radially symmetric systems with a singularity: the repulsive case*, preprint, 2009.

ON STRICTLY INCREASING SOLUTIONS OF SOME SINGULAR BOUNDARY VALUE PROBLEM ON THE HALF–LINE

Jan Tomeček, *Olomouc, Czech Republic*

2000 MSC: 34B16, 34B40

This is a joint work with Prof. Irena Rachůnková. We are looking for a strictly increasing solution (having one zero) of singular boundary value problem on the half–line

$$(p(t)u'(t))' = p(t)f(u(t)), \quad t \in (0,\infty), \tag{1}$$

$$u'(0) = 0, \quad u(\infty) = L$$

which arises in Cahn–Hilliard theory studying the behaviour of nonhomogenous fluids. Such solution has great physical importance. To obtain its existence we use the shooting method. We investigate IVPs (1), $u(0) = B$, $u'(0) = 0$ according to parameter B. From the uniqueness of solution of IVP and continuous dependence on B, we obtain the existence result.

REPEATED SUPPORT SPLITTING AND MERGING PHENOMENA IN SOME NONLINEAR DIFFUSION EQUATION

Kenji Tomoeda, *Osaka, Japan*

2000 MSC: 35K55, 35K65, 65M06

We are concerned with *numerically repeated support splitting phenomena* appearing in the following nonlinear diffusion equation with strong absorption:

$$v_t = (v^m)_{xx} - cv^p, \qquad x \in \boldsymbol{R}^1, \quad t > 0, \tag{1}$$

$$v(0,x) = v^0(x), \qquad x \in \boldsymbol{R}^1, \tag{2}$$

where $m > 1$, $0 < p < 1$, c is a positive constant, v denotes the temperature, and $v^0(x) \in C^0(\boldsymbol{R}^1)(\geq 0)$ has compact support. From numerical computation it is difficult to justify whether *such phenomena* are true or not, because the space mesh and the time step are sufficiently small but not zero ([1]).

In this talk we justify such phenomena in the specific case $m+p = 2$ by using the properties of the particular solution.

[1] T.Nakaki and K.Tomoeda, A finite difference scheme for some nonlinear diffusion equations in absorbing medium: support splitting phenomena, *SIAM J. Numer. Anal.*, **40**(2002), 945–964.

A GENERALIZED ANTI-MAXIMUM PRINCIPLE FOR THE PERIODIC ONE DIMENSIONAL p-LAPLACIAN WITH SIGN CHANGING POTENTIAL

Milan Tvrdý, *Prague, Czech Republic*

2000 MSC: 34B18

The contribution is based on the joint work with Alberto Cabada and José Ángel Cid. It deals with qualitative properties of the quasilinear periodic problem

$$(\phi_p(u'))' + \mu(t)\,\phi_p(u) = h(t), \quad u(0) = u(T), \quad u'(0) = u'(T), \tag{P}$$

where $0 < T < \infty$, $1 < p < \infty$, ϕ_p stands for the p-Laplacian, $\phi_p(y) = |y|^{p-2}\,y$ for $y \in R$, $\mu \in L_\alpha[0,T]$ for some α, $1 \leq \alpha \leq \infty$, and $h \in L_1[0,T]$. Problem (P) is said to fulfil an *anti-maximum principle* if, for each $h \in L_1[0,T]$ such that $h \geq 0$ a.e. on $[0,T]$, any solution of (P) is nonnegative on $[0,T]$.

We give new conditions ensuring that problem (P) fulfils the anti-maximum principle. Our main goal is to include the case that μ can change its sign on the interval $[0,T]$. If $\alpha = \infty$ and $\mu \geq 0$ a.e. on $[0,T]$ our condition reduces the condition

$$\|\mu\|_\infty \leq \lambda_1^D,$$

where λ_1^D stands for the first eigenvalue of the related Dirichlet problem.

INTERVAL OSCILLATION CRITERIA FOR SECOND-ORDER NONLINEAR DELAY DYNAMIC EQUATIONS

Mehmet Ünal, *İstanbul, Turkey*

2000 MSC: 34A30, 34C10

This is a joint work with Professor Ağacık Zafer. Interval oscillation criteria are established for the second order nonlinear delay dynamic equations on time scales by utilizing Riccati technique. No restriction is imposed on the potentials and forcing term to be nonnegative

ASYMPTOTIC FORMS OF SLOWLY DECAYING SOLUTIONS OF QUASILINEAR ORDINARY DIFFERENTIAL EQUATIONS WITH CRITICAL EXPONENTS

Hiroyuki Usami, *Higashi-Hiroshima, Japan*

2000 MSC: 34C41

Let us consider the quasilinear ODE

$$(t^{\beta}|u'|^{\alpha-1}u')' + t^{\sigma}(1+o(1))u^{\lambda} = 0 \quad \text{near} \quad +\infty, \tag{1}$$

where α, β, λ, and σ are constants satisfying $\lambda > \alpha > 0, \beta > \alpha$, and $\sigma \in \mathbf{R}$. It is important to analyze the asymptotic behavior of positive solutions u satisfying

$$\lim_{t\to\infty} u(t) = 0 \quad \text{and} \quad \lim_{t\to\infty} t^{(\beta-\alpha)/\alpha}u(t) = 0. \tag{2}$$

Such positive solutions u are referred as slowly decaying solutions. When $(\beta-\alpha)-1 < \sigma < \frac{\lambda}{\alpha}(\beta-\alpha)-1$, we have shown that, under some additional conditions, every slowly decaying solutions u satisfies $u(t) \sim Ct^{-\gamma}$ for some positive constants $C = C(\alpha, \beta, \lambda, \sigma)$ and $\gamma = \gamma(\alpha, \beta, \lambda, \sigma)$, $0 < \gamma < (\beta-\alpha)/\alpha$.

In today's talk we consider (1) with the critical exponent $\sigma = \beta - \alpha - 1$

$$(t^{\beta}|u'|^{\alpha-1}u')' + t^{\beta-\alpha-1}(1+\varepsilon(t))u^{\lambda} = 0, \quad \text{near} \quad +\infty, \tag{3}$$

where $\varepsilon(t) = o(1)$. We show that every slowly decaying solution u of (3) has the asymptotic form $u(t) \sim A(\log t)^{-\rho}$ for some positive constants $A = A(\alpha, \beta, \lambda)$ and $\rho = \rho(\alpha, \lambda)$ under some additional conditions.

Our results can be applied to describe asymptotic forms of positive radial solutions of quasilinear elliptic equations

$$\operatorname{div}(|Du|^{m-2}Du) + |x|^{-m}(1+\varepsilon(|x|))u^{\lambda} = 0 \quad \text{near} \quad \infty. \tag{4}$$

MULTISCALE MODELLING OF THERMOMECHANICAL BEHAVIOUR OF EARLY-AGE SILICATE COMPOSITES

Jiří Vala, *Brno, Czech Republic*

2000 MSC: 74E30, 74F05, 74Q15

Strains and stresses in silicate composites, namely in massive concrete structures, in addition to those caused by exterior mechanical loads, are results of rather complicated non-deterministic physical and chemical processes in fresh material mixtures. Their computational prediction at the macro-scale level requires the non-trivial physical analysis based on the thermodynamic principles, making use of micro-structural information from both theoretical and experimental research. Unlike the phenomenological approach of [1] and the mechanistic one of [2], this paper, generalizing [3] and [4], demonstrates the derivation of a nonlinear system of macroscopic partial differential equations of evolution with certain effective material characteristics, based on the mass, momentum and energy balance for mixtures, and suggests the algorithm for its numerical analysis.

[1] Z. P. Bažant, *Prediction of concrete creep and shrinkage: past, present and future*, Nuclear Engineering and Design **203** (2001) 27–38.

[2] D. Gawin, F. Pesavento and B. A. Schrefler, *Hygro-thermo-chemo-mechanical modelling of concrete at early ages and beyond*, International Journal for Numerical Methods in Engineering **67** (2006) 297–363.

[3] Ch. Pichler, R. Lackner and H. A. Mang, *A multiscale micromechanics model for the autogenous-shrinkage deformation of early-age cement-based materials*, Engineering Fracture Mechanics **74** (2007), 34–58.

[4] L. Sanavia, B. A. Schrefler and P. Steinmann, *A formulation for an unsaturated porous medium undergoing large inelastic strains*, Computational Mechanics **28** (2002), 137–151.

ALMOST PERIODIC HOMOGENEOUS LINEAR DIFFERENCE SYSTEMS WITHOUT ALMOST PERIODIC SOLUTIONS

Michal Veselý, *Brno, Czech Republic*

2000 MSC: 20H20, 39A10, 42A75, 51F25

Almost periodic homogeneous linear difference systems over $\mathbb{Z}$ are considered. It is supposed that the coefficient matrices belong to a group. The aim is to find such groups that the systems having no nontrivial almost periodic solution form a dense subset of the set of all considered systems. A closer examination of the used methods reveals that the problem can be treated in such a generality that the entries of coefficient matrices are allowed to belong to any complete metric field. The concepts of transformable and strongly transformable groups of matrices are introduced and these concepts enable us to derive efficient conditions for determining what matrix groups have the required property.

LARGE SLOWLY OSCILLATING PERIODIC SOLUTIONS FOR AN EQUATION WITH DELAYED POSITIVE FEEDBACK

Gabriella Vas, *Szeged, Hungary*

2000 MSC: 34K13

We consider the scalar equation

$$\dot{x}(t) = -x(t) + f(x(t-1)), \tag{1}$$

where feedback function f is smooth and strictly increasing. In case Eq. (1) admits 3 equilibria (of which two are stable and one is unstable), then at certain technical conditions periodic solutions appear in a small neighbourhood of the unstable equilibrium and the global attractor forms a so called spindle. The conjecture was that whenever there exist three stable and two unstable equilibrium points, then the gobal attractor is simply two spindles joined together. We disprove this conjecture by constructing a feedback function f with the properties given above so that Eq. (1) has exactly two slowly oscillating periodic solutions with large amplitude. Heteroclynic connections are also described.

Joint work with Tibor Krisztin.

[1] T. Krisztin, H.-O. Walter and J. Wu, Shape, Smoothness and Invariant Stratification of an Attracting Set for Delayed Monotone Positive Feedback, Amer. Math. Soc., Providence, RI, 1999.

REMARKS ON REGULARITY FOR VECTOR-VALUED MINIMIZERS OF QUASILINEAR FUNCTIONALS

Eugen Viszus, *Bratislava, Slovak republic*

2000 MSC: 35J60

This is a joint work with Prof. Josef Daněček, FAST VUT Brno. We discuss the interior $C^{0,\gamma}$-everywhere regularity for minimizers of functionals

$$\mathcal{A}(u;\Omega) = \int_{\Omega} A_{ij}^{\alpha\beta}(x,u) D_\alpha u^i D_\beta u^j \, dx, \tag{1}$$

where *VMO* dependence on the variable x and continuous dependence on the variable u are supposed.

[1] J. Daněček, E. Viszus, *$C^{0,\gamma}$-regularity for vector-valued minimizers of quasilinear functionals.* NoDEA, **16** (2009), 189–211.

THEORY OF REGULAR VARIATION ON TIME SCALES AND ITS APPLICATION TO DYNAMIC EQUATIONS

Jiří Vítovec, *Brno, Czech Republic*

2000 MSC: 26A12, 26A99, 34C11, 39A11, 39A12

This is a joint work with P. Řehák. We discuss a regular variation on time scales, which extends well studied classic theory of continuous and discrete cases. As an application, we consider the second order half-linear dynamic equation

$$(\Phi(y^{\Delta}))^{\Delta} - p(t)\Phi(y^{\sigma}) = 0 \tag{1}$$

on time scales and give necessary and sufficient conditions under which certain solutions of this equation are regularly varying. The talk is finished by a few interesting open problems of this themes.

[1] P. Řehák, J. Vítovec, *Regularly varying decreasing solutions of half-linear dynamic equations*. To appear in Proceedings of ICDEA 2007, Lisbon

[2] P. Řehák, J. Vítovec, *Regular variation on measure chains*. To appear in Nonlinear Analysis TMA 2009

DYNAMICS OF HEAT CONDUCTING FLUIDS INSIDE OF HEAT CONDUCTING DOMAINS

Rostislav Vodák, *Olomouc, Czech Republic*

2000 MSC: 76N10, 35Q30, 35A05

The main subject is to prove the existence of a solution to the model that describes behaviour of compressible heat conducting fluids inside of heat conducting domains. Boundary conditions involving a radiation term are assumed. As compared with previous papers, the used scheme of the proof requires lower regularity of the boundary of the domain in the case of applications to barotropic compressible fluids.

ON THE PROPERTIES OF THE PRORIOL-KOORNWINDER-DUBINER HIERARCHICAL ORTHOGONAL BASES FOR THE DG FEM

Tatiana Voitovich, *Temuco, Chile*

2000 MSC: 35L05, 41A10, 65D15

This is a joint work with Prof. Dr. Raimund Bürger, and Prof. Dr. Mauricio Sepúlveda. In this contribution we consider some properties of the hierarchical orthogonal bases employed by hp-adaptive DG methods in two and three space dimensions. Namely, we provide analytical expressions for the elements of the mass matrices and L^2 condition numbers for the hierarchical orthogonal basis of Proriol-Koornwinder-Dubiner on a equlateral simplex. For example, in two space dimensions, $\kappa_2 = (2p + 1)(p + 1)$. The expressions for the condition number of the mass matrix have a methodological interest as they allows to have a solid argument about how well conditioned is the Proriol-Koornwinder-Dubiner basis, in comparison to the polynomial basis, the condition number of which grows as $\kappa_2 \propto 10^p$. Obtained formulas provide a basis for efficient implementation of the RK-DG and LDG methods. Numerical experiments are presented that confirm our calculations.

CHAOS IN PLANAR POLYNOMIAL NONAUTONOMOUS ODES

Paweł Wilczyński, *Cracow, Poland*

2000 MSC: 34C28 (37B55)

We investigate the planar equation

$$z' = P(z, \bar{z}, t). \tag{1}$$

in complex number notation, where P denotes polynomial in variables z and $\bar{z}$. Some methods of detecting chaotic behaviour were presented in e.g. [1, 3]. In contrast, some subclass of (1) is not chaotic (e.g. [2]).

In the talk we discuss possible mechanisms for geneterating chaos in (1).

[1] L. Pieniażek, *On detecting of chaotic dynamics via isolating chains* Topol. Methods Nonlinear Anal. **22** (2003), 115–138.

[2] P. Wilczyński, *Planar nonautonomous polynomial equations: the Riccati equation* J. Differential Equations **244** (2008), 1304–1328.

[3] K. Wójcik, P. Zgliczyński, *Isolating segments, fixed point index, and symbolic dynamics. III. Applications* J. Differential Equations **183** (2002), 262–278.

COMPARISON THEOREMS FOR OSCILLATION OF SECOND-ORDER NONLINEAR DIFFERENTIAL EQUATIONS

Naoto Yamaoka, *Sakai, Japan*

2000 MSC: 34C10

In this talk, we present new comparison theorems for the oscillation of solutions of second-order nonlinear differential equations. Combining the comparison theorems and oscillation criteria for the generalized Euler differential equation, we can also derive new oscillation criteria for the nonlinear equations. Proof is given by means of phase plane analysis of systems.

GLOBAL OPTIMIZATIONS BY INTERMITTENT DIFFUSION

Tzi-Sheng Yang, *Taichung, Taiwan*

2000 MSC: 65C20

This is a joint work with Shui-Nee Chow and Haomin Zhou. We propose an novel intermittent diffusion(ID) method to find global minimizers of a given function $g : \mathbb{R}^n - \mathbb{R}$. The main idea is to add intermittent, instead of continuously diminishing, random perturbations to the gradient flow generated by g, so that the trajectories can quickly escape from one minimizer and approach other minimizers. We prove that for any given finite set of minimizers of g, the trajectories of the ID method will visit an arbitrary small neighborhood of each minimizer with positive probability. Numerical simulations show that the proposed method achieves significant improvements in terms of the frequencies, and the fastest time of reaching the global minimizers over some existing global optimization algorithms.

[1] F. Aluffi-Pentini, V. Parisi and F. Zirilli, Global optimization and stochastic differential equations, *J. Optmiz. Theory App.*, 47 (1), 1-16, 1985.

[2] T.-S. Chiang, C.-R. Hwang and S.-J. Sheu, Diffusion for global optimization in $\mathbb{R}^n$, *SIAM J. Control and Optim.*, 25 (3), 737-753, 1986.

[3] S. Geman and C.-R. Huang, Diffusion for global optimization, *SIAM J. Control and Optim.*, 24 (5), 1031-1043, 1986.

SURJECTIVITY OF LINEAR OPERATORS FROM A BANACH SPACE INTO ITSELF

Nikos Yannakakis, *Athens, Greece*

2000 MSC: 47A05, 47B44, 47A50, 35J15

This is a joint work with D. Drivaliaris.

We show that linear operators from a Banach space into itself which satisfy some relaxed strong accretivity conditions are invertible. Moreover, we characterize a particular class of such operators in the Hilbert space case. By doing so we manage to answer a problem posed by B. Ricceri, concerning a linear second order partial differential operator.

FRIEDRICHS EXTENSION OF OPERATORS DEFINED BY DISCRETE SYMPLECTIC SYSTEMS

Petr Zemánek, *Brno, Czech Republic*

2000 MSC: 47B36, 39A70, 15A63, 39A12, 34L05

We consider a discrete linear operator $\mathcal{L}(z)_k$ associated with a discrete symplectic system, i.e, with the system

$$z_{k+1} = \mathcal{S}_k z_k, \tag{$\mathcal{S}$}$$

where the matrix $\mathcal{S}_k$ satisfies $\mathcal{S}_k^T \mathcal{J} \mathcal{S}_k = \mathcal{J}$ for all $k \in [0, \infty) \cap \mathbb{Z}$ with $\mathcal{J} := \left(\begin{smallmatrix} 0 & I \\ -I & 0 \end{smallmatrix}\right)$. We characterize the Friedrichs extension of the minimal oprator defined by $\mathcal{L}(z)_k$ in terms of the recessive system of solutions of system ($\mathcal{S}$). This generalizes a similar results recently obtained by Došlý and Hasil in [1] for linear operators defined by infinite banded matrices corresponding to even-order Sturm–Liouville difference equations. In the last part of the talk we show a generalization of this result to the time scales setting, i.e., for a linear operator associated with a time scale symplectic dynamic system. This generalization is motivated by the discrete result and yields a new result even in the special case of the continuous time, i.e, for operators associated with linear Hamiltonian differential systems. This paper is based on a joint work with Roman Šimon Hilscher.

[1] O. Došlý, P. Hasil, Friedrichs extension of operators defined by symmetric banded matrices, *Linear Algebra Appl.* **430** (2009), no. 8–9, 1966–1975.

[2] R. Š. Hilscher, P. Zemánek, Friedrichs extension of operators defined by discrete symplectic systems, submitted (May 2009).

ON STABILITY OF DELAY DYNAMIC SYSTEMS

Agacik Zafer, *Ankara, Turkey*

2000 MSC:

Consider the linear system of delay dynamic equation

$$x^{\Delta}(t) = A(t)x(t) + B(t)x(g(t)),$$

where A, B, g are *rd*-continuous.

It is shown that the zero solution is stable if $h(t) - t$ is bounded ($h = g^{-1}$) and if the system satisfies the Perron condition, i.e., if every solution of

$$x^{\Delta}(t) = A(t)x(t) + B(t)x(g(t)) + f(t)$$

with zero initial condition is bounded for any given *rd*-continuous bounded function f.

The stability becomes uniform when $h(t) - t$ is bounded uniformly. The asymptotic stability and uniform asymptotic stability of the zero solution are also obtained under some reasonable conditions.

POSITIVE SOLUTIONS OF NON-LOCAL BOUNDARY VALUE PROBLEMS

Mirosława Zima, *Rzeszów, Poland*

2000 MSC: 34B18

We discuss the existence of positive solutions for the following boundary value problem

$$-u'' + \omega^2 u = h(t,u), \quad u'(0) = 0, \; u(1) = \beta[u],$$

where $\omega > 0$ and $\beta[u]$ is a linear functional on $C[0,1]$, that is, Riemann-Stieltjes integral

$$\beta[u] = \int_0^1 u(s)\, dB(s),$$

with B a function of bounded variation. We make use of the existence theorems obtained by Webb and Infante [1]. In particular, we establish existence of positive solutions for non-perturbed boundary value problems at resonance by considering equivalent non-resonant perturbed problems with the same boundary conditions. The talk is based on the joint paper [2].

[1] J. R. L. Webb, G. Infante, Positive solutions of nonlocal boundary value problems involving integral conditions, Nonlinear Differential Equations and Applications NoDEA 15 (2008), 45–67.

[2] J. R. L. Webb, M. Zima, Multiple positive solutions of resonant and non-resonant nonlocal boundary value problems, Nonlinear Anal. 71 (2009), 1369-1378.

Abstracts

Posters

NON EQUIVALENCE OF NMS FLOWS ON S^3

Beatriz Campos, *Castellón, Spain*

2000 MSC: 37D15

This is a joint work with Prof P. Vindel. We built the flows of Non singular Morse-Smale systems on the 3-sphere from its round handle decomposition [1], [3]. We show flows corresponding to the same link of periodic orbits [4] that are non equivalent. So, the link of periodic orbits is not in 1-1 correspondence with this type of flows and we search for other topological invariants such as the associated dual graph [2].

[1] D. Asimov. *Round handles and non-singular Morse-Smale flows.* Annals of Mathematics. **102** (1975), 41–54.

[2] B. Campos, P. Vindel. *Graphs of NMS flows on S^3 with knotted saddle orbits and no heteroclinic trajectories.* Acta Math. Sinica, vol 23. **12** (2007), 2213–2224.

[3] J. W. Morgan. *Non-singular Morse-Smale flows on 3-dimensional manifolds.* Topology. **18** (1978), 41–53.

[4] M. Wada, *Closed orbits of non-singular Morse-Smale flows on S^3* J. Math. Soc. Japan. **41** (1989), 405–413.

BIFURCATIONS IN THE TWO IMAGINARY CENTERS PROBLEM

Cristina Chiralt, *Castellón, Spain*

2000 MSC: 37G99

This is a joint work with Profs B. Campos and P. Vindel. In this work, we obtain the orbital structure of the set of the periodic orbits in the phase space of the two imaginary centers problem [1], [2]. By using appropiate coordinates one can separate the hamiltonian of the problem and solve the equations [3], [4]. We combine the corresponding spaces in order to build the complete phase space and we study the topology of the phase space for different values of the energy.

[1] L.A. Pars, Analytical Dynamics. Heinemann, London, 1968.

[2] U.V. Beletsky, Essays on the motion of celestial bodies. Birkhäuser-Verlag, 2001.

[3] B. Campos, J. Martnez Alfaro y P. Vindel, *Periodic Orbit Structure of The Two Fixed Centres Problem.* Celestial Mechanics and Dynam. Astron. **82** (2002), 203–223.

[4] A. Cordero, J. Martnez Alfaro y P. Vindel, *Topology of the Two Fixed Centres Problem.* Proc. of the Third International Workshop on Positional Astronomy and Celestial Mechanics. Ed. A. Lpez et al. (1996)

MULTIVALUED INTEGRATION IN THE THEORY OF DIFFERENTIAL INCLUSIONS

Mieczysław Cichoń, *Poznań, Poland*

2000 MSC: 34A60, 28B20

In this note, we recall some notions of multivalued integrals and their relations with differential inclusions (cf. [1]). Thus new theorems about existence of solutions (in some generalized sense) for differential inclusions in Banach spaces are proved (by using some properties of nonabsolute integrals). The integrals of Pettis, Henstock-Kurzweil and Henstock-Kurzweil-Pettis are of our special interest. The last two were even constructed as a solution to some problems which arise in the theory of differential equation. We show the role of such a kind of integrals in the theory of differential inclusions (see [2], for instance).

Some recent results about existence of solutions for a general (nonlocal) Cauchy problem for differential inclusions in Banach spaces are presented.

[1] K. Cichoń, M. Cichoń, *Some applications of nonabsolute integrals in the theory of differential inclusions in Banach spaces*, to appear.

[2] B. Satco, *Second order three boundary value problem in Banach spaces via Henstock and Henstock-Kurzweil-Pettis integral*, J. Math. Anal. Appl. **332** (2007), 919–933.

ON PERIODIC SOLUTIONS OF SECOND–ORDER DIFFERENTIAL EQUATIONS WITH ATTRACTIVE–REPULSIVE SINGULARITIES

Robert Hakl, *Brno, Czech Republic*

2000 MSC: 34B18, 34C25

Sufficient conditions for the existence of a solution to the problem

$$u''(t) = \frac{g(t)}{u^{\mu}(t)} - \frac{h(t)}{u^{\lambda}(t)} + f(t) \qquad \text{for a. e. } t \in [0, \omega], \tag{1}$$
$$u(0) = u(\omega), \qquad u'(0) = u'(\omega)$$

are established, where $g, h \in L\big(\mathbb{R}/\omega\mathbb{Z}; \mathbb{R}_+\big)$, $f \in L\big(\mathbb{R}/\omega\mathbb{Z}; \mathbb{R}\big)$, and $\lambda, \mu > 0$. The equation (1) is interesting due to a mixed type of singularity on the right–hand side. Since the functions g and h are possibly zero on some sets of positive measure, the singularity may combine attractive and repulsive effects.

This is a joint work with Pedro J. Torres.

MULTIPLE POSITIVE SOLUTIONS FOR A CRITICAL ELLIPTIC SYSTEM WITH CONCAVE-CONVEX NONLINEARITIES AND SIGN-CHANGING WEIGHTS

Tsing-San Hsu, *Taipei, Taiwan*

2000 MSC: 35J50, 35J60

Let $\Omega \ni 0$ be an open bounded domain in $\mathbb{R}^N (N \geq 3)$ and $2^* = \frac{2N}{N-2}$. We consider the following elliptic system of two equations in $H_0^1(\Omega) \times H_0^1(\Omega)$:

$$\begin{cases} -\Delta u = \lambda f(x)|u|^{q-2}u + \dfrac{2\alpha}{\alpha+\beta} h(x)|u|^{\alpha-2}u|v|^{\beta}, \\ -\Delta v = \mu g(x)|v|^{q-2}v + \dfrac{2\beta}{\alpha+\beta} h(x)|u|^{\alpha}|v|^{\beta-2}v, \end{cases} \tag{$P_{\lambda f,\mu g,h}$}$$

where λ, $\mu > 0$, $1 \leq q < 2$, $\alpha, \beta > 1$ satisfy $\alpha + \beta = 2^*$ and f, g, h are continuous functions on $\overline{\Omega}$ which are somewhere positive but which may change sign on Ω.

In this poster, we motivated by [1] we extend the results of Hsu-Lin [1] with constant weights to sign-changing weights. We shall establish the existence and multiplicity results of positive solutions to $(P_{\lambda f,\mu g,h})$ by variational methods.

[1] T.S. Hsu and Huei-Li Lin, Multiple positive solutions for a critical elliptic system with concave-convex nonlinearities, Proc. Roy. Soc. Edin. Ser. A, in press.

ON QUALITATIVE PROPERTIES OF SOME VECTOR LINEAR DIFFERENCE EQUATIONS

Jiří Jánský, *Brno, Czech Republic*

2000 MSC: 39A11

This contribution deals with the stability and asymptotic properties of the vector linear delay difference equation

$$y(n+1) = A(n)y(n) + B(n)y(\lfloor \lambda n \rfloor), \quad 0 < \lambda < 1, \quad n = 0, 1, \dots, \tag{1}$$

where $A(n)$ and $B(n)$ are variable matrices. Assuming that the system

$$y(n+1) = A(n)y(n)$$

is uniformly asymptotically stable we derive the asymptotic estimate of all solutions of (1). Furthermore, we focus on the equation (1) with constant matrices A, B and using some results of the spectral theory of nonnegative matrices we improve the estimate obtained in the non-stationary case.

LINEAR NABLA H-FRACTIONAL DIFFERENCE EQUATIONS: BASIC NOTIONS AND METHODS OF SOLVING

Tomas Kisela, *Brno, Czech Republic*

2000 MSC: 39A12, 34A25, 26A33

We introduce the notion of the nabla h-fractional difference and sum which is a discrete version of fractional derivative and integral. Difference equations involving the differences of this kind are reffered to as nabla h-fractional difference equations. The aim of this presentation is to propose the discrete form of the Mittag-Leffler function and show that this special function plays a key role in the solving linear nabla h-fractional equations. Moreover, we discuss possible generalizations on other discrete settings.

[1] F. M. Atici, P. W. Eloe, *Initial Value Problems in Discrete Fractional Calculus.* Proc. of the Am Math Soc. **137** (2008), 981–989.

[2] F. M. Atici, P. W. Eloe, *A Transform Method in Discrete Fractional Calculus.* IJDE **2** (2007), 165–176.

[3] M. Bohner, A. Peterson, *Laplace Transform and Z-transform: Unification and Extension.* Meth and App of Analysis. **9** (2002), 151–158.

FREDHOLM THEOREMS FOR THE SECOND-ORDER SINGULAR DIRICHLET PROBLEM

A. Lomtatidze, V. Zahoransky, *Brno, Czech Republic*

2000 MSC: 34B05

Consider the singular Dirichlet problem

$$u'' = p(t)u + q(t); \qquad u(a) = 0, \quad u(b) = 0,$$

where $p, q\colon]a, b[\to \mathbb{R}$ are locally Lebesgue integrable functions.

It is proved that if

$$\int_a^b (t-a)(b-t)[p(t)]_- \mathrm{d}t < +\infty,$$

then the Fredholm theorem remains true.

REGULARITY OF SOLUTION TO GENERALIZED STOKES PROBLEM

Václav Mácha, *Praha, Czech Republic*

2000 MSC: 35B65

Presented work deals with the regularity of solution to generalized Stokes problem, which has following form:

$$\begin{aligned} -\mathrm{div} A\mathcal{D}u + B\nabla p &= f \\ \mathrm{div} u &= g \end{aligned} \tag{1}$$

with zero Dirichlet boundary condition. The study of this problem is motivated by the research concerning partial regularity of weak solution of equations describing the flow of non-Newtonian fluids. More about such models can be read in work written by Málek, Bulíček, Franta and Rajagopal ([1], [2]).

[1] M. Franta, J. Malek, K. R. Rajagopal, *On steady flows of fluids with pressure- and shear-dependent viscosities*, Proc. R. Soc. A (2005) **461**, 651-670

[2] M. Bulicek, J. Malek, K. R. Rajagopal, *Navier's Slip and Evolutionary Navier-Stokes-like Systems*, Indiana Univ. Math. J., Vol. 56, No. 1 (2007)

OSCILLATION OF PDE WITH p-LAPLACIAN

Robert Mařík, *Brno, Czech Republic*

2000 MSC: 35B05, 34C10

In this contribution we present oscillation criteria for partial differential equation with p-Laplacian in the form

$$\mathrm{div}\left(\|\nabla u\|^{p-2}\,\nabla u\right) + c(x)|u|^{p-2}u = 0, \qquad p > 2 \tag{1}$$

and some it generalizations. Usual oscillation criteria for this equation detect oscillation from the mean value of the function $c(x)$ over spheres. In this contribution we suggest a refined approach to oscillation theory, which can be used even if the mean value of the function $c(x)$ is small.

ON AN OSCILLATION CONSTANT IN THE HALF-LINEAR OSCILLATION THEORY

Jana Řezníčková, *Zlín, Czech Republic*

2000 MSC: 34C10

This is a joint work with Prof. Ondřej Došlý.

In this contribution we investigate the half-linear second order differential equation

$$(r(t)\Phi(x'))' + c(t)\Phi(x) = 0, \quad \Phi(x) := |x|^{p-2}x,\ p > 1, \tag{1}$$

where r, c are continuous functions, $r(t) > 0$.

We discuss the oscillation constant appearing in the oscillation theory. It will be proved that using the Riccati technique we can obtain better results than using the variational principle.

CONVERGENCE OF THE SOLUTIONS OF A DELAYED DIFFERENTIAL EQUATION

Miroslava Růžičková, *Žilina, Slovakia*

2000 MSC: 34K25

The asymptotic behaviors of solutions of a linear homogeneous differential equation with delayed terms

$$\dot{y}(t) = \sum_{i=1}^{n} \beta_i(t)[y(t-\delta_i) - y(t-\tau_i)] \tag{1}$$

as $t \to \infty$ are under our investigation. The main results concern the asymptotic convergence of all solutions of equation (1). The proof of the main results is based on the comparison of solutions of (1) with solutions of an auxiliary inequality which formally copies (1). Therefore, at first, we will introduce auxiliary inequality and their relation to (1), next we prove that (1) has a strictly increasing solution and then we extend this convergence statement to all the solutions of (1). Finally, independently on the critical case, we give a general roundabout convergence criterion.

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CAUCHY SINGULAR PROBLEM FOR IMPLICIT FREDHOLM INTEGRO-DIFFERENTIAL EQUATIONS

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A singular initial value problem for implicit Fredholm integro-differential equations

$$y'(t) = \mathcal{F}\left(t, y(t), \int_{0^+}^{1} K(t,s,y(s),y'(s))ds, \mu\right), \quad y^{(i)}(0^+,\mu) = 0,\ i = 0,1 \tag{1}$$

depending on a parameter μ is considered. The existence, uniqueness and continuous dependence of solutions with respect to variables (t,μ) are the subject of the paper.

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