Young Women in Harmonic Analysis and PDE

Bonn, December 2 – 4, 2016

Location: Mathematisches Institut, Endenicher Allee 60, D-53115 Bonn
Organizers: Polona Durcik and Lisa Onkes

hausdorff center for mathematics

universitätbonn

Program

The plenary talks will be given by

Stefanie Petermichl (Université Paul Sabatier)
Gigliola Staffilani (Massachusetts Institute of Technology)

The plenary talks will take place in the Lipschitz room (L) (first floor, opposite of the main entrance).

The short talks will take place in the Lipschitz room (L) and in the seminar room SR 1.008 (S) (first floor).

The poster exhibition and the coffee breaks will take place in the Plücker and Hausdorff rooms (next to the Lipschitz room).

Friday, Dec 2

13.20 - 13.50 *Welcome and registration in the lobby in front of (L)*

14.00 - 14.50 (L) **Stefanie Petermichl**
Characterizations of multi-parameter BMO spaces through boundedness of commutators

15.00 - 16.00 (L) **Poster presentations** (max. 2 min per poster)

16.10 - 16.50 *Coffee break*

16.50 - 17.20 (L) **Xian Liao**
Regularity issue in Navier-Stokes equations
(S) **Teresa Luque**
The Bochner Riesz multiplier: a sparse approach

17.30 - 18.00 (L) **Laura Westermann**
Optimal Sobolev regularity for Laplace and Stokes operator on wegde type domains subject to Navier slip boundary conditions
(S) **Fernanda Clara de França Silva**
Sparse domination of sharp variational truncations

18.10 *Visit to the Christmas market*

Saturday, Dec 3

09.00 - 09.50 (L) **Stefanie Petermichl**
Characterizations of multi-parameter BMO spaces through boundedness of commutators

10.00 - 10.30 *Coffee break*

10.30 - 11.00 (L) **Chiara Gallarati**
Maximal regularity for non-autonomous parabolic equations

(S) **Cruz Prisuelos**
Weighted Hardy spaces associated with operators

11.10 - 11.40 (L) **Franziska Monika Borer**
Uniqueness of weak solutions for the normalised Ricci flow in two dimensions

(S) **Edyta Kania**
Hardy spaces for Bessel-Schrödinger operators

11.50 - 12.20 (L) **Judith Berendsen**
On a cross-diffusion model for multiple species with nonlocal interaction and size exclusion

(S) **Kristina Ana Škreb**
Bellman functions and L^p estimates for paraproducts

12.30 - 14.30 *Lunch break*

Saturday's schedule continues on the next page.

14.30 - 15.20 (L) **Gigliola Staffilani**
Randomization and nonlinear dispersive equations

15.30 - 16.00 *Coffee break*

16.00 - 16.30 (L) **Gabriele Bruell**
On a nonlocal shallow water wave equation

(S) **Cristina Benea**
On Rubio de Francia's theorem for arbitrary Fourier projections

16.40 - 17.10 (L) **Anna Geyer**
Spectral stability of periodic waves in the generalized reduced Ostrovsky equation

(S) **Jasmina Veta Buralieva**
Abelian results for the directional short-time Fourier transform

17.20 - 17.50 (L) **Ani Tumanyan**
On index stability of differential operators in anisotropic spaces

(S) **María Guadalupe Morales Macías**
An extension of some properties for the Fourier transform operator on $L^p(\mathbb{R})$ spaces

19.00 *Conference dinner at "Gasthaus Im Stiefel"*

Sunday, Dec 4

09.00 - 09.50 (L) **Gigliola Staffilani**
Randomization and nonlinear dispersive equations

10.00 - 10.30 *Coffee break*

10.30 - 11.00 (L) **Annegret Burtscher**
Hyperboloidal evolution for nonlinear wave equation
(S) **Analía Silva**
A mass transportation approach for Sobolev inequalities
in variable exponent spaces

11.10 - 11.40 (L) **Judith Campos Cordero**
Regularity and uniqueness of minimizers in the quasiconvex case
(S) **Dominique Maldague**
A restricted extremization problem for a weakened
Hausdorff-Young inequality

11.50 - 12.20 (L) **Taryn C. Flock**
A sharp k-plane Strichartz inequality for the Schrödinger equation

Posters

Julia Butz
Short time existence for curve diffusion flow for curves with boundary contact

Judith Campos Cordero
Regularity up to the boundary and sufficient conditions for strong local minimality

Ivana Crnjac
Variant of optimality criteria method for multiple state optimal design problems

Kamilia Dahmani
Sharp dimension-free weighted bounds for the Bakry-Riesz vector on a compact Riemannian manifold

Marco Fraccaroli
On distributions with full $GL_2(\mathbb{R})$ dilation symmetry

Janina Gärtner
Existence of solutions of the Lugiato-Lefever equation on $\mathbb{R}$

Jelena Jankov
Homogenisation of elastic plate equation

Len Meas
Dispersive estimates for the wave equation inside cylindrical convex domains: a model case

Lisa Onkes
Singularity formation for dispersive waves

Marija Prša
Heat conduction problem in a dilated pipe

João Pedro Ramos
On the equivalence of root uncertainty principles

Jelena Rupčić
On convergence of nonlinear analogues of trigonometric series

Mara Sandoval-Romero
Hodge decomposition on differential forms with Besov and Triebel-Lizorkin class

Laura Somorowsky
The spatial Ramsey model: modeling the nonlocal impact of direct neighbors

Ivana Vojnović
H-distributions with unbounded multipliers

Kathrin Welker
Efficient PDE constrained shape optimization

Abstracts

Plenary talks

Stefanie Petermichl (Université Paul Sabatier)

Characterizations of multi-parameter BMO spaces through boundedness of commutators

The characterisation of symbols that result in bounded Hankel or Toeplitz operators are classical and rather simple. When passing to real analysis and notably to multi-parameter real analysis, these questions become very quickly interesting and intensely complicated.

We discuss the simplicity and beauty of the classical base cases as well as the cornerstones into the world of real analysis 'away' from operator theory. In this situation one studies 'commutators' the simplest one of which takes the form

$$Hb - bH$$

where H is the Hilbert transform and b stands for multiplication by a (bmo) function. Multi-parameter study of related objects was initiated by Sarah Ferguson and Cora Sadosky in the late 90s.

The real variable one-parameter theory we discuss includes parts of a classical article by Coifman Rochberg Weiss while the multi-parameter questions include a deep line by Ferguson, Lacey, Pipher, Wick, myself and others.
Emphasis is given to a recent result by Ou, Strouse and myself that solves an endpoint question begun by Ferguson/Sadosky. Although the proofs are 'hard analysis' exploiting several recent developments, one recognises the core that lies in elegant arguments stemming from operator theory.

Gigliola Staffilani (Massachuessets Institute of Technology)

Randomization and nonlinear dispersive equations

I will start by recalling the notion of well-posedness for an initial value problem, I will introduce the Strichartz estimates and indicates some of the proofs one encounters in the deterministic approach. Then I will move to describing the Gaussian measure and the Gibbs measure associated to certain dispersive equations in Hamiltonian form. I will illustrate some of the work of Bourgain in this area and I will show how randomizing the initial data of a Cauchy problem improves well-posedness results. I will conclude with a recent work of myself with Magda Czubak, Dana Mendelson and Andrea Nahmod in which we treat the well-posedness of a geometric wave equation with randomized supercritical data.

The references to some abstracts are available at
http://www.math.uni-bonn.de/veranstaltung/ywhapde2016/talksposters.htmpl.

Short talks

Cristina Benea (Université de Nantes, LMJL)

On Rubio de Francia's Theorem for arbitrary Fourier projections

In [2], Rubio de Francia proved that disjointness in frequency is enough for establishing a one-dimensional orthogonality principle. That is,

$$\Big| \Big(\sum_k \Big| \int_{\mathbb{R}} \hat{f}(\xi) \mathbf{1}_{[a_k,b_k]}(\xi) e^{2\pi i x\xi} d\xi \Big|^{\nu} \Big)^{1/\nu} \Big\|_p \leq C \|f\|_p, \tag{1}$$

whenever the intervals $[a_k, b_k]$ are mutually disjoint, $\nu > 2$ and $p > \nu'$ or $\nu = 2$ and $p \geq 2$. Moreover, the constant C does not depend on the choice of intervals.

In the bilinear setting, a similar, one-parameter question can be formulated: given an arbitrary collection Ω of mutually disjoint squares, prove that

$$\Big\| \Big(\sum_{\omega \in \Omega} \Big| \int_{\mathbb{R}^2} \hat{f}(\xi) \hat{g}(\eta) \Phi_\omega(\xi,\eta) e^{2\pi i x(\xi+\eta)} d\xi d\eta \Big|^{r} \Big)^{1/r} \Big\|_s \leq C \|f\|_p \|g\|_q, \tag{2}$$

whenever $\frac{1}{p} + \frac{1}{q} = \frac{1}{s}$ and p, q, s are in the "local r'" range. While r needs to be ≥ 2, just like in the linear case, we were able to prove the above result only for $r > 2$. This is joint work with F. Bernicot.

Judith Berendsen (University of Münster)

On a cross-diffusion model for multiple species with nonlocal interaction and size exclusion

In this talk we study a PDE model for two diffusing species interacting by local size exclusion and global attraction. This leads to a nonlinear degenerate cross-diffusion system, for which we provide a global existence result as well as a uniqueness proof in the case of equal diffusivities. The analysis is motivated by the formulation of this system as a formal gradient flow for an appropriate energy functional consisting of entropic terms as well as quadratic nonlocal terms. Key ingredients are entropy dissipation methods as well as the recently developed boundedness-by-entropy principle. Moreover, we investigate phase separation effects inherent in the cross-diffusion model by an analytical and numerical study of minimizers of the energy functional and their asymptotics to a previously studied case as the diffusivity tends to zero.

Franziska Monika Borer (ETH Zurich)

Uniqueness of Weak Solutions for the Normalised Ricci Flow in Two Dimensions

We show uniqueness of classical solutions of the normalised, two-dimensional Hamilton-Ricci flow on closed, smooth Riemannian surfaces for H^2 initial data among solutions satisfying (essentially) only a uniform bound for the Liouville energy and a natural space-time L^2-bound for the time derivative of the solution. The result is surprising when compared with results for the harmonic map heat flow, where nonuniqueness through reverse bubbling may occur.

Gabriele Bruell (Norwegian Institute of Science and Technology)

On a nonlocal shallow water wave equation

The Korteweg-de Vries equation is a famous and well studied model equation in shallow water. The balance between nonlinear and linear (dispersive) terms allows for solitary traveling wave solutions. While the Korteweg-de Vries equation is a valid approximation for long waves in shallow water, it fails to sustain this property for relatively short waves. In addition it can not explain phenomena like wave breaking nor does it admit traveling wave solutions which form cusps. In 1967 G. Whitham introduced a nonlocal alternative to the Korteweg-de Vries equation by keeping the nonlinear part, but replacing the linear term by a nonlocal operator involving the exact dispersion relation of the linearized Euler equations. It turns out that the resulting equation is a better approximation for relatively short waves in shallow water. Moreover, it explains the phenomena of solitary waves as well as wave breaking and traveling periodic waves with cusps.

In this talk we introduce the so-called Whitham equation and focus on its solitary wave solutions. In particular, we show that any solitary wave solution is symmetric with exactly one crest from which the surface decreases exponentially. Moreover, the structure of the Whitham equation allows to conclude that conversely any unique symmetric solution constitutes a traveling wave. In fact, the latter result holds true for a large class of partial differential equations sharing a certain structure.

Jasmina Veta Buralieva (University Goce Delcev, Stip)

Abelian results for the directional short-time Fourier transform

(joint work with K. Hadzi-Velkova Saneva anda S. Atanasova)

We study the directional short-time Fourier transform (DSTFT) of Lizorkin distributions. DSTFT on the space $L^1(\mathbb{R}^n)$ was introduced and investigated by Giv in [4]. Saneva and Atanasova extended this transform on the space of tempered distributions [5]. Here, we analyze the continuity of the DSTFT on the closed subspace of $\mathcal{S}(\mathbb{R}^n)$, i.e. on the space $\mathcal{S}_0(\mathbb{R}^n)$ of highly time-frequency localized functions over $\mathbb{R}^n$. We also prove the countinuity of the directional synthesis operator on the space $\mathcal{S}(\mathbb{Y}^{2n})$. Using the obtained continuity results, we will define the DSTFT on space $\mathcal{S}_0'(\mathbb{R}^n)$ of Lizorkin distributions, and prove an Abelian type result for this transform.

Annegret Burtscher (University of Bonn)

Hyperboloidal evolution for nonlinear wave equations

In the recent past the study of the initial value problem for nonlinear wave equations on hyperboloidal slices has gained much popularity and lead to several interesting results. We will briefly discuss the advantages of this approach and then apply the hyperboloidal technique to obtain results about the dynamics of global solutions for the cubic wave equation (joint work with Roland Donninger).

Judith Campos Cordero (University of Augsburg)

Regularity up to the boundary and sufficient conditions for strong local minimality

In the context of integral functionals defined over a Sobolev class of the type $W_g^{1,p}(\Omega, \mathbb{R}^N)$, with $N \geq 1$, the quasiconvexity of the integrand is known to be equivalent to the lower semicontinuity of the functional. In this context, L.C. Evans showed in 1986 that the minimizers are regular outside a subset of their domain of measure zero. On the other hand, E. Spadaro recently provided examples showing that no uniqueness of minimizers can be expected even under strong quasiconvexity assumptions. In this talk we present some results stating that, under the same natural assumptions on the integrand, if the boundary conditions are suitably small, it is possible to obtain full regularity (up to the boundary) for the minimizers and, furthermore, they are unique. This is joint work with Jan Kristensen.

Fernanda Clara de França Silva (Universität Tübingen)

Sparse domination of sharp variational truncations

We provide a versatile formulation of Lacey's recent sparse pointwise domination technique with a local weak type estimate on a nontangential maximal function as the only hypothesis. We verify this hypothesis for sharp variational truncations of singular integrals in the case when unweighted L^2 estimates are available.

Taryn C. Flock (University of Birmingham)

A sharp k-plane Strichartz inequality for the Schrödinger equation

We explore a natural interplay between the solution to the time-dependent free Schrödinger equation on $\mathbb{R}^d$ and the (spatial) k-plane transform for $1 \leq k \leq d-1$. A first result is that

$$\|X(|u|^2)\|_{L^3_{t,\ell}} \leq C\|f\|^2_{L^2(\mathbb{R}^2)},$$

where $u(x,t)$ is the solution to the linear time-dependent Schrödinger equation on $\mathbb{R}^2$ with initial datum f, and X is the X-ray transform on $\mathbb{R}^2$. In particular, we identify the best constant C and show that a datum f is an extremiser if and only if it is an isotropic cen-

tered gaussian. We also establish bounds of this type in higher dimensions d, where the X-ray transform is replaced by the k-plane transform for any $1 \leq k \leq d-1$. In the process we obtain sharp $L^2(\mu)$ bounds on Fourier extension operators associated with certain high-dimensional spheres, involving measures μ supported on natural "co-k-planarity" sets.

Chiara Gallarati (Delft University of Technology)

Maximal regularity for non-autonomous parabolic equations

Maximal regularity is a useful tool to obtain a priori estimates which give global existence results. In this talk I will explain a new approach to maximal L^p-regularity for parabolic PDEs with time dependent generator $A(t)$. The novelty is that I merely assume a measurable dependence on time. I will first show that there is an abstract operator theoretic condition on $A(t)$ which is sufficient to obtain maximal L^p-regularity. As an application I will obtain an optimal $L^p(L^q)$ regularity result in the case each $A(t)$ is a 2m-th order elliptic differential operator on $\mathbb{R}^d$ in non-divergence form, for every $p, q \in (1, \infty)$. This is a joint work with Mark Veraar (TU Delft).

Anna Geyer (University of Vienna)

Spectral stability of periodic waves in the generalized reduced Ostrovsky equation

In this talk I will discuss the stability of periodic travelling wave solutions of the generalized reduced Ostrovsky equation with respect to co-periodic perturbations. Compared to recent literature, the approach presented here relies on a simple argument that proves spectral stability of all smooth periodic travelling waves for arbitrary amplitudes, independent of the nonlinearity power. The argument is based on energy convexity and monotonicity of the energy to period map.

Edyta Kania (University of Wrocław)

Hardy spaces for Bessel-Schrödinger operators

Let $K_t = exp(-\mathbf{L}t)$ be the semigroup generated by a Bessel-Schrödinger operator on $L^2((0,\infty), x^\alpha dx)$ given by

$$\mathbf{L}f(x) = -f''(x) - \frac{\alpha}{x} f'(x) + V(x)f(x),$$

where $V \in L^1_{loc}((0,\infty), x^\alpha dx)$ is a non-negative potential and $\alpha > 0$. We say that $f \in L^1((0,\infty), x^\alpha dx)$ belongs to Hardy space $\mathcal{H}^1(\mathbf{L})$ if

$$\| \sup_{t>0} |K_t f| \|_{L^1((0,\infty), x^\alpha dx)} < \infty.$$

Under certain assumptions on V and K_t we characterize the space $\mathcal{H}^1(\mathbf{L})$ by atomic decom-

position of local type. Moreover, we provide an application of this result for any potential $0 \leq V \in L^1_{loc}((0,\infty), x^\alpha dx)$ and for $\alpha \in (0,1)$.

The talk is based on joint work with Marcin Preisner (University of Wrocław).

Xian Liao (University of Bonn)

Regularity issue in Navier-Stokes equations

I will first review some basic properties of Navier-Stokes equations (such as scaling invariant property and energy inequalities), so as to introduce the notations of strong solutions and weak solutions. Then we turn to have a look at the density dependent case, where we show in particular the propagation of the regularity of the density patch problem.

Teresa Luque (Departamento de Análisis Matemático, Universidad Complutense de Madrid)

The Bochner Riesz multiplier: a sparse approach

We establish a control for the Bochner Riesz multipliers by sparse bilinear forms. Since for such operators the pointwise domination by sparse operators is not possible because of their range of boundedness, we use this other control. To obtain this result we combine the recent ideas developed by Lacey and extended by Bernicot-Frey-Petermichl. This is a joint work with Cristina Benea and Frédéric Bernicot.

Dominique Maldague (UC Berkeley)

A restricted extremization problem for a weakened Hausdorff-Young inequality

Among subsets of Euclidean space with prescribed measure, for which functions and sets is the L^q norm of the Fourier transform of bounded multiples of the indicator function maximized? Various partial results concerning this question are established, including the existence of maximizers and the identification of maximizers as ellipsoids times Fourier characters for certain exponents.

María Guadalupe Morales Macías (Universidad Nacional Autónoma de México, Facultad de Estudios Superiores Cuautitlán.)

An extension of some properties for the Fourier Transform operator on $L^p(\mathbb{R})$ spaces

In this work the Fourier Transform is studied using the Henstock-Kurzweil integral on $\mathbb{R}$. We obtain that the classical Fourier Transform $\mathcal{F}_p : L^p(\mathbb{R}) \to L^q(\mathbb{R})$, $1/p + 1/q = 1$ and $1 < p \leq 2$, is represented by the integral on a subspace of $L^p(\mathbb{R})$, which strictly contains $L^1(\mathbb{R}) \cap L^p(\mathbb{R})$. Moreover, for any function f in that subspace, $\mathcal{F}_p(f)$ obeys a generalized Riemann-Lebesgue Lemma.

Cruz Prisuelos (ICMAT)

Weighted Hardy spaces associated with operators

In this talk we consider weighted Hardy spaces defined using conical square functions, non-tangential maximal functions, and the Riesz transform associated with an elliptic operator in divergence form L. In the case of conical square functions and non-tangential maximal functions, for $0 < p \leq 1$, we give a molecular characterization of them, and for $p \in \mathcal{W}_w(p_-(L), p_+(L))$, we show that they are isomorphic to the $L^p(w)$ spaces. Besides in the case of the Riesz transform we show that the corresponding weighted Hardy space is isomorphic to the weighted Hardy space defined by a particular conical square function.

Analía Silva (Imasl - Universidad Nacional de San Luis)

A mass transportation approach for Sobolev inequalities in variable exponent spaces

The existence of a transport between two probability measures and that this transport is the gradient of a convex function can be used to prove geometric and functional inequalities. For example, in 2004, Cordero-Erasquin, Nazaret and Villani give a proof of the Sobolev critical inequalities as application of mass transportation techniques. The objective of this talk is to show how extend these ideas in the context of variable exponent spaces. Joint work Juan Pablo Borthagaray (UBA- IMAS) and Julián Fernández Bonder (UBA-IMAS).

Kristina Ana Škreb (University of Zagreb)

Bellman functions and L^p estimates for paraproducts

We regard dyadic paraproducts as trilinear forms. Even though they are well-known to satisfy L^p estimates in the whole Banach range of exponents, one might want to give a direct proof or study the behavior of the constants. We find an explicit formula for one possible Bellman function associated with the L^p boundedness of dyadic paraproducts in the spirit of the Bellman function by Nazarov, Treil, and Volberg. Then we apply the same Bellman function in various other settings, to give self-contained alternative proofs of the estimates for several classical operators. These include the martingale paraproducts of Bañuelos and Bennett and the paraproducts with respect to the heat flows. This is a joint work with Vjekoslav Kovač (University of Zagreb).

Ani Tumanyan (Russian-Armenian (Slavonic) University)

On Index Stability of Differential Operators in Anisotropic Spaces

We study the Fredholm property and index stability of differential linear operators, acting in anisotropic Sobolev spaces in $\mathbb{R}^n$. Conditions are established under which lower order terms of differential operator do not affect the index of the operator. The Fredholm prop-

erty is studied in anisotropic Sobolev spaces with different weights. We establish sufficient conditions for preservation of the Fredholm property in weighted spaces (see [1]). These results are used in the investigation of the special classes of semielliptical operators. For a semielliptical operator a sufficient condition for the invariance of the index on the scale of anisotropic spaces is obtained in [2]. The influence of numerous applications makes actual the investigation of the index theory of semielliptical operators.

Laura Westermann (University of Düsseldorf)

Optimal Sobolev Regularity for Laplace and Stokes Operator on Wegde Type Domains subject to Navier Slip Boundary Conditions

The aim of this talk is to show for $1 < p < \infty$ the $W^{2,p}$-Sobolev regularity for Laplace and Stokes operator in the L^p-space on two-dimensional wedge type domains subject to Navier slip boundary conditions. Introducing polar coordinates and applying the Euler transformation, we transform the elliptic problem of the Laplace operator from wedge type domains to a layer domain. The resulting operator on a layer is described by the sum of two linear closed operators. The proof of the $W^{2,p}$-Sobolev regularity requires a subtle spectral analysis of these two operators. This then allows for applying elements of H^∞-calculus and a consequence of the Kalton-Weis theorem to prove invertibility of the full operator on the layer domain. Thanks to this result and after back transformation to wedge type domains, we are able to prove the well-posedness of the Stokes equations. The topic of the talk is content of [1], [2].

Posters

Julia Butz (University of Regensburg)

Short Time Existence for Curve Diffusion Flow for Curves with Boundary Contact

In non-linear PDEs it is always desirable to be able to find strong solutions even if the initial regularity is low, as this gives insights in smoothing properties of the system and helps to provide good blow-up criteria.

In this contribution, we obtain local well-posedness for flexible initial data in $H_2^{4(\mu-\frac{1}{2})}(I)$, $\mu \in (\frac{7}{8}, 1]$ in the case of evolving curves driven by curve diffusion flow. This is done for curves which intersect an external boundary at a fixed angle $\alpha \in (0, \pi)$.

In order to reduce the geometric evolution equation to a quasilinear fourth order PDE on an interval, we use curvilinear coordinates. To establish local well-posedness for this equation and to deal with the rough initial data, we have to work in a setting of temporally weighted L_p-spaces. More precisely, we use a linearization procedure and employ a result on maximal L_p-regularity with temporal weights [1].

Once we know that the flow starts, a further step is to deduce a blow up rate by adapting the techniques of [2], [3].

Judith Campos Cordero (University of Augsburg)

Regularity up to the boundary and sufficient conditions for strong local minimality

The question of finding suitable conditions to guarantee that a given map minimizes a functional is a fundamental problem in the Calculus of Variations. It was first solved by Weierstrass in the scalar case and, after developments from Hestenes [5], Taheri [9], Zhang [10], Kristensen & Taheri [8], etc., Grabovsky & Mengesha [7] finally solved the problem for the vectorial case. Their result is framed under the natural quasiconvexity assumptions. It establishes that C^1-extremals at which the second variation is strictly positive are, in fact, strong local minimizers. This settled affirmatively a conjecture by Ball [1], according to which a set of sufficient conditions should be based on the notion of quasiconvexity.

In this work we present a new proof of the seminal result by Grabovsky & Mengesha. Furthermore, we introduce a full regularity result (up to the boundary), which aims at relaxing the a priori regularity assumption on the extremal. This is in deep connection with further recent results regarding partial boundary regularity for strong local minimizers [3].

Ivana Crnjac (University of Osijek)

Variant of optimality criteria method for multiple state optimal design problems

In the multiple state optimal design problems, one is trying to find the best arrangement of given materials, such that the obtained body has some optimal properties regarding different regimes.The performance of the mixture is measured by an objective function which

is an integral functional. We consider mixtures of two isotropic materials in context of stationary diffusion equation. It is well known that these problems do not admit classical solution, therefore we use relaxation by homogenization method. We rewrite optimality conditions for relaxed problem in order to apply optimality criteria method to multiple state problems in three dimensions. This problem was considered by Vrdoljak (2010), but optimality criteria method didn't give converging sequence of designs for some energy minimization problems. We present another variant of optimality criteria method that can be applied to those problems as well. This is joint work with Krešimir Burazin and Marko Vrdoljak.

Kamilia Dahmani (Université Paul Sabatier)

Sharp dimension-free weighted bounds for the Bakry-Riesz vector on a compact Riemannian manifold

We present a sharp estimate of the Riesz transform in the weighted case on a compact Riemannian manifold with positive Bakry-Emery curvature, using a Bellman function proof.

Marco Fraccaroli (University of Bonn)

On distributions with full $GL_2(\mathbb{R})$ dilation symmetry

The tempered distribution in $\mathbb{R}^4$

$$\Lambda(\varphi) := \text{p.v.} \int_{\mathbb{R}^4} \frac{1}{\det(x\ y)} \varphi(x,y)\ dxdy,$$

arises in a recent paper by Gressman, He, Kovač, Street, Thiele, Yung, where $x, y \in \mathbb{R}^2$ and the principal value is taken as $\det(x\ y)$ goes to 0. It satisfies the following invariance property:

For a matrix $A \in GL_2(\mathbb{R})$ define the transform

$$D^1_A \varphi(x,y) := \frac{1}{\det A} \varphi(A^{-1}x, A^{-1}y)$$

for every $\varphi \in \mathcal{S}(\mathbb{R}^4)$. Then for every A and φ as above

$$\Lambda(D^1_A \varphi) = \Lambda(\varphi).$$

Motivated by this we want to classify all the tempered distributions in $\mathbb{R}^4$ satisfying the D^α_A-invariance property for matrices with positive determinant (where α identify the exponent of $(\det A^{-1})$ in the definition of $D^\alpha_A \varphi$) and distinguish them according to their behaviour against a matrix with determinant -1, namely one of the two possible invariances of the form

$$\Lambda(\varphi(x_1, -x_2, y_1, -y_2)) = \pm\Lambda(\varphi(x,y)).$$

Janina Gärtner (Karlsruhe Institute of Technology)

Existence of solutions of the Lugiato-Lefever equation on $\mathbb{R}$

The stationary Lugiato-Lefever equation is given by

$$-du'' + (\zeta - \mathrm{i})u - |u|^2 u + \mathrm{i}f \;=\; 0$$

for $d \in \mathbb{R}$, $\zeta, f > 0$. Here, we are interested in solutions in $\{u = u^\star + \widetilde{u} : u^\star = const., \widetilde{u} \in H^2(\mathbb{R}), u'(0) = 0\}$. It is well known that for $d > 0$, $\zeta > 0$ the solutions of the nonlinear Schrödinger equation

$$\begin{cases} u \in H^1(\mathbb{R}), u \neq 0, \\ -du'' + \zeta u - |u|^2 u \;=\; 0 \end{cases}$$

are given by $u(x) = \mathrm{e}^{\mathrm{i}\alpha}\varphi(x)$, $\alpha \in \mathbb{R}$, where $\varphi(x) = \sqrt{2\zeta}\frac{1}{\cosh\sqrt{\frac{\zeta}{d}}x}$. Using a theorem of Crandall-Rabinowitz, we can show that bifurcation with respect to the parameter f only arises for $\alpha \in \left\{\frac{\pi}{2}, \frac{3\pi}{2}\right\}$.
Afterwards, we are interested in solutions u_ε of

$$-du'' + (\widetilde{\zeta} - \varepsilon\mathrm{i})u - |u|^2 u + \mathrm{i}\widetilde{f} \;=\; 0$$

for small $\varepsilon > 0$. Then $a(x) := \frac{1}{\sqrt{\varepsilon}} \cdot u_\varepsilon\left(\frac{1}{\sqrt{\varepsilon}}x\right)$ solves the stationary Lugiato-Lefever equation for $\zeta = \frac{\widetilde{\zeta}}{\varepsilon}$ and $f = \frac{\widetilde{f}}{\varepsilon^{\frac{3}{2}}}$. Using a reformulation of this equation, Sturm's oscillation and comparison theorem, Agmon's principle and a suitable version of the implicit function theorem, we can find a quantitative neighborhood where the reformulated equation is uniquely solvable.

Jelena Jankov (J. J. Strossmayer University of Osijek)

Homogenisation of elastic plate equation

We consider a homogeneous Dirichlet boundary value problem for
$\mathrm{divdiv}(M\nabla\nabla u) = f$ which describes an elastic symmetric plate clamped at the boundary. We are interested in homogenisation of this equation. The physical idea of homogenisation is to average heterogeneous media in order to derive effective properties. Homogenisation theory is well developed for a second order elliptic equation where a key role plays H-convergence, which was introduced by Murat and Tartar (1978).

We improve homogenisation theory for elastic plate equation which is a fourth order elliptic equation and prove properties of H-convergence, such as locality, irrelevance of the boundary conditions, ... We also derive corrector results whose purpose is to "transforme" a weak convergence into a strong one.

This is joint work with Krešimir Burazin and Marko Vrdoljak.

Len Meas (Université Nice Sophia Antipolis)

Dispersive Estimates For The Wave Equation Inside Cylindrical Convex Domains: A Model Case

In this work we will establish local in time dispersive estimates for solutions of the model case Dirichlet wave equation inside cylindrical convex domain $\Omega \subset \mathbb{R}^3$ with a smooth boundary $\partial\Omega \neq \emptyset$. Our result is concerned with the case where the curvature radius ≥ 0 depends on the incident angle and vanishes in some directions and the case of boundary with an infinite order contact points.

Lisa Onkes (University of Bonn)

Singularity Formation for Dispersive Waves

We consider the (focusing) nonlinear Schrdinger equation

$$\text{(NLS)} \qquad \begin{cases} iu_t = -\Delta u - |u|^{p-1}u, \quad (t,x) \in \mathbb{R} \times \mathbb{R}^N \\ u(0,x) = u_0(x) \in H^1(\mathbb{R}^N, \mathbb{C}) \end{cases},$$

which depending on the exponent is either *subcritical*, *critical* or *supercritical*. In the subcritical case all solutions are globally defined (J. Ginibre and G. Velo), while solutions in the critical case assumed initial data mass comparable to the soliton mass and negative Galilean energy present singularities with almost self-similar blow-up speed (F. Merle and P. Raphaël).
In the supercritical case physical experiments (V. Zakharov, E. Kuznetsov and S. Musher) suggest the existence of self-similar blow-up solutions. However this has only been proven in the slightly supercritical case (F. Merle, P. Raphaël, and J. Szeftel), by viewing this as a pertubation of the critical case. Our goal is to adopt an approach used by R. Donninger and B. Schörkhuber for the supercritical wave equation and obtain a proof for the existence of self-similar blow-up solutions of the mass supercritical Schrödinger equation, which does not depend on the closeness to the critical case. Thus (under numerically verifiable assumptions) providing a self-similar blow-up result for the whole supercritical range.

Marija Prša (Faculty of Graphic Arts, Department of Mathematics, University of Zagreb, Croatia)

Heat conduction problem in a dilated pipe

We study the heat conduction through a pipe filled with incompressible viscous fluid. The goal of this work is to take into account the effects of the pipe's dilatation due to the heating. In view of that, we assume that the longitudinal dilatation of the pipe is described by a linear heat expansion law. We prove the existence and uniqueness theorems for the corresponding boundary-value problem. The main difficulty comes from the fact that the flow domain changes depending on the solution of the heat equation leading to a non-standard

coupled governing problem. This is a joint work with Eduard Marušić-Paloka and Igor Pažanin from University of Zagreb.

João Pedro Gonçalves Ramos (University of Bonn)

On the equivalence of root uncertainty principles

Let $\widehat{f}(\xi) = \int_{\mathbb{R}} f(x)e^{2\pi i x\xi}dx$ be the Fourier transform on the real line, and, for every L^1, real and even function on the real line, with $f(0), \widehat{f}(0) \leq 0$, consider the number

$$A(f) := \inf\{r \geq 0; f(x) \geq 0, \forall x \geq r\}.$$

Inspired by recent bounds on $\mathcal{A} := \inf_{f \text{ as above}} A(f)A(\widehat{f})$ and the classical uncertainty principles in harmonic analysis, we prove the equivalence (in)equalities

$$\mathcal{A} = \mathcal{A}_{\mathcal{S}} = \mathcal{A}_{bl} \geq \mathcal{A}_d > 0,476\mathcal{A},$$

where $\mathcal{A}_{\mathcal{S}}$ and $\mathcal{A}_{bl}$ stand for, respectively, the infimum of $A(f)A(\widehat{f})$ taken over the intersection of the function space above with Schwartz functions and functions with compact support, and the last term $\mathcal{A}_d$ is the analogous *discrete* infimum. That is, if $f : \mathbb{T} \to \mathbb{R}$ is also even and integrable, with $\widehat{f} \in \ell^1(\mathbb{Z})$ and $f(0), \widehat{f}(0) \leq 0$, then

$$Z(f) = \inf\{1/2 \geq r \geq 0; f(x) \geq 0, \forall x \geq r\}$$
$$Z(\widehat{f}) = \inf\{n \geq 0; \widehat{f}(k) \geq 0, \forall k \geq n\}.$$

Jelena Rupčić (University of Zagreb)

On convergence of nonlinear analogues of trigonometric series

We study nonlinear analogues of trigonometric series which can be considered as products of matrices in the group SU(1,1). Nonlinear analogues of lacunary trigonometric series are presented and different types of convergence are discussed. Precisely, we introduce a new metric and then study convergence with respect to that metric. In addition, convergence a.e. is studied and so far obtained results are explained.
This is a joint work with Vjekoslav Kovač from the University of Zagreb.

Mara Sandoval-Romero (Universidad Nacional Autónoma de México)

Hodge Decomposition on Differential forms with Besov and Triebel-Lizorkin class

This joint work is about a generalization of the results of the Hodge decomposition and regularity of differential forms that are solutions of an elliptic (in terms of Lopatinskii-Shapiro) partial differential equation with boundary conditions in a compact Riemannian manifolds with boundary. We study the problem on differential forms in a more general

class of functions: the Triebel-Lizorkin spaces.

Laura Somorowsky (Trier University)

The Spatial Ramsey Model: Modeling the Nonlocal Impact of Direct Neighbors

The Ramsey model is one of the most popular neoclassical growth models in economics. First introduced by F.P. Ramsey in [3], it has been analyzed and varied a lot. The outstanding idea in this model is the lifetime utility optimization approach of the consuming sector. Combining this with the assumption of a gain maximization effort in the producing sector, leads to an equilibrium problem. The primary time-depending model has been extended by a spatial component in the last few years, meaning that capital accumulation is a process not only in time but in space as well which then yields an optimal control problem with PDE constraints of parabolic type.
In a new approach, we consider a Ramsey economy where the value of capital is influenced by the surrounding area. We adapt the spatial Ramsey model introduced by Brito in [1] including a nonlocal diffusion term in integral form. This leads to an optimal control problem with a PIDE constraint and volume constraints as defined by Du et al in [2]. The numerical examples show that our nonlocal model is able to preserve heterogeneity in the initial capital distribution, which is a huge advantage compared to Brito's model, at least if myopic consumers are considered.

Ivana Vojnović (Department of Mathematics and Informatics, Faculty of Sciences, Novi Sad)

H-distributions with unbounded multipliers

H-measures were introduced independently by Tartar, [4] and Gérard, [3]. They are used to determine weather a weakly convergent sequence in $L^2(\mathbb{R}^d)$ converges strongly. Antonić and Mitrović in [2] introduced H-distributions, extension of H-measures to an $L^p - L^q$ setting for $1 < p < \infty$ and $q = p/p - 1$. In [1], H-distributions are constructed for sequences in dual Sobolev spaces, $W^{-k,p} - W^{k,q}$. Test functions for H-measures and H-distributions are bounded Fourier multipliers.

Using theory of pseudo-differential operators we construct H-distributions for sequences in dual Bessel potential spaces, $H_q^k - H_p^{-k}, k \in \mathbb{R}$, $1 < p < \infty$. In this case we consider classes of unbounded test functions. Also, a necessary and sufficient condition is given so that the weak convergence of sequence in H_p^{-k} implies the strong one. Results are applied on a weakly convergent sequence of solutions to a family of partial differential equations.

This is a joint work with Jelena Aleksić and Stevan Pilipović.

Kathrin Welker (Trier University)

Efficient PDE Constrained Shape Optimization

Shape optimization problems arise frequently in technological processes which are modelled by partial differential equations (PDEs). In many practical circumstances, the shape under investigation is parametrized by finitely many parameters, which, on the one hand, allows the application of standard optimization approaches, but on the other hand, limits the space of reachable shapes unnecessarily. Shape calculus presents a way to circumvent this dilemma. However, so far it is mainly applied in the form of gradient descent methods, which can be shown to converge. The major difference between shape optimization and the standard PDE constrained optimization framework is the lack of a linear space structure on shape spaces. If one cannot use a linear space structure, then the next best structure is a Riemannian manifold structure.

We consider optimization problems which are constrained by PDEs and embed these problems in the framework of optimization on Riemannian manifolds to provide efficient techniques for PDE constrained shape optimization problems on shape spaces. The Riemannian geometrical point of view on unconstrained shape optimization in [1] is extended to a Lagrange-Newton, as well as to a quasi-Newton technique in shape spaces for PDE constrained shape optimization problems. These techniques are based on the so-called Hadamard-form of shape derivatives, i.e., in the form of integrals over the surface of the shape under investigation. It is often a very tedious, not to say painful, process to derive such surface expressions. Along the way, there appear volume formulations in the form of integrals over the whole domain as an intermediate step. Domain integral formulations of shape derivatives are coupled with optimization strategies on shape spaces. Efficient shape algorithms reducing analytical effort and programming work are presented and a novel shape space is proposed in this context.

Participants

Natalia Accomazzo (University of the Basque Country)
Alex Amenta (Delft University of Technology)
Adolfo Arroyo-Rabasa (University of Bonn)
Cristina Benea (Université de Nantes, LMJL)
Judith Berendsen (University of Münster)
Frédéric Bernicot (CNRS - Université de Nantes)
Franziska Borer (ETH Zürich)
Gianmarco Brocchi (University of Bonn)
Gabriele Bruell (Norwegian Institute of Science and Technology)
Jasmina Veta Buralieva (University Goce Delcev, Stip)
Annegret Burtscher (University of Bonn)
Julia Butz (Universität Regensburg)
Judith Campos Cordero (University of Augsburg)
Dimitrije Cicmilović (University of Bonn)
Ivana Crnjac (University of Osijek)
Kamilia Dahmani (Université Paul Sabatier)
Fernanda Clara de França Silva (Universität Tübingen)
Marjorie Drake (University of Texas at Austin)
Polona Durcik (University of Bonn)
Taryn Flock (University of Birmingham)
Marco Fraccaroli (University of Bonn)
Chiara Gallarati (TU Delft)
Janina Gärtner (Karlsruhe Institute of Technology)
Manuela Gehrig (ETH Zürich)
Anna Geyer (University of Vienna)
Zihui He (University of Bonn)
Jelena Jankov (University of Osijek)
Edyta Kania (University of Wrocław)
Xian Liao (University of Bonn)
Teresa Luque (Universidad Complutense de Madrid)
Dominique Maldague (UC Berkeley)
Len Meas (University Nice Sophia Antipolis)
Julia Menzel (Universität Regensburg)
Mara Guadalupe Morales Macas (Universidad Nacional Autónoma de México)
Diogo Oliveira e Silva (University of Bonn)
Lisa Onkes (University of Bonn)
Anne Pein (TU Berlin)
Stefanie Petermichl (Université Paul Sabatier)
Cruz Prisuelos (ICMAT)
Marija Prša (University of Zagreb)
João Pedro Ramos (University of Bonn)
Ziping Rao (University of Bonn)

Johanna Richter (Universität Stuttgart)
Joris Roos (University of Bonn)
Jelena Rupčić (University of Zagreb)
Olli Saari (Aalto University)
David Sabonis (TU Munich)
Mara Sandoval-Romero (Universidad Nacional Autónoma de México)
Louisa Seelbach Benkner (Universität Siegen)
Analia Silva (Imasl - Universidad Nacional de San Luis)
Laura Somorowsky (Trier University)
Gigliola Staffilani (Massachusetts Institute of Technology)
Mario Stipčić (University of Zagreb)
Kristina Ana Škreb (University of Zagreb)
Gudrun Thäter (Karlsruhe Institute of Technology)
Ani Tumanyan (Russian-Armenian (Slavonic) University)
Ivana Vojnović (University of Novi Sad)
Kathrin Welker (Trier University)
Laura Westermann (Universität Düsseldorf)
Pavel Zorin-Kranich (University of Bonn)

It is good to keep in mind ...

Conference dinner: It will take place in the restaurant "Gasthaus Im Stiefel", Bonngasse 30, 53111 Bonn.

Suggestion for lunch: Clemens-August Strasse (highlighted in orange on the map below, in walking distance of the Mathematical institute) offers many options for lunch.

Christmas market: It is in the city center of Bonn.