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Scientific Program - Timetable

Time	Sunday 22	Monday 23	Tuesday 24	Wednesday 25	Thursday 26	Friday 27
9:00			Contributed sessions (15 in parallel)	Plenary Lecture Moritz Diehl	Contributed sessions (15 in parallel)	Contributed sessions (14 in parallel)
10:00		Registration		von Mises prize lecture		
11:00			Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:30			Plenary Lecture Thomas Böhlke	General Assembly	Plenary Lecture Ferdinando Auricchio	Contributed sessions (11 in parallel)
12:30			Lunch	Lunch	Lunch	
13:00		Opening				
13:30		Univ. Chorus Performance				Closing
14:00		Prandtl Lecture Keith Moffatt	Plenary Lecture Enrique Zuazua	Contributed sessions (15 in parallel)	Plenary Lecture Daniel Kressner	
15:00		Plenary Lecture Giovanni Galdi	Plenary Lecture Nikolaus Adams		Plenary Lecture Stanislaw Stupkiewicz	
16:00	Registration pre-opening	Coffee Break	Coffee Break Poster session	Coffee Break	Coffee Break Poster session	
16:30		Minisymposia & Young Reseachers' Minisymposia (10 in parallel)	Contributed sessions (14 in parallel)	Contributed sessions (15 in parallel)	Contributed sessions (15 in parallel)	
18:30			Public lecture Francesco D'Andria			
19:00		Opening reception at Castle of Charles V				
20:30				Conference dinner at Hotel Tiziano		
21:00						

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S23: Applied operator theory

The session welcomes talks in operator theory, including: differential operators, operator semigroups, spectral theory, operators in indefinite inner product spaces, function spaces and mathematical physics.

Squeezing of arbitrary order

Franciszek Hugon Szafraniec
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Let $A^{(k)}$ be an operator defined formally as $a_+^k + a_-^{(k)}$, where a_+ and a_- are the *creation* and *annihilation* operators of the quantum harmonic oscillator, resp.; $A^{(1)}$ generates the *displacement* operator while $A^{(2)}$ does the *squeeze* one. My intention is to discuss how essential selfadjointness of $A^{(k)}$ depends on $k = 1, 2, \ldots$, the problem which in quantum optics has been waiting for long time to be settled on rigorously.

The talk is based on [1].

References

[1] K. Górska, A. Horzela, F.H. Szafraniec, Squeezing of arbitrary order: the ups and downs, Proc. Royal Soc. Ser. A Math. Phys. Eng. Sci. 20140205. DOI 10.1098/rspa.2014.0205.

Lebesgue type decompositions and Radon-Nikodym derivates for unbounded linear operators and relations

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This is an overview of work in progress with Seppo Hassi (Vaasa) and Zoltán Sebestyén (Budapest) about Lebesgue decompositions. Recall the Lebesgue decomposition of a measure in an absolutely continuous part and a singular part. Ando [1] and Simon [7] have given similar decompositions for pairs of nonnegative operators and for forms, respectively. Following Ando and Simon there have been many contributions to this topic, including recent work by Sebestyén and coworkers.

It will be recalled how linear operators and relations in a Hilbert space allow a Lebesgue decomposition in a closable part and a singular part, see [3], where the original work of P.E.T. Jorgensen [5] and S. Ôta [6] concerning decompositions of linear operators was continued and extended. More general Lebesgue type decompositions will be discussed, including the uniqueness of such decompositions and the corresponding Radon-Nikodym derivatives. It will be shown how the Lebesgue type decompositions of relations gives rise to similar decompositions for pairs of bounded operators and pairs of (nonnegative) sesquilinear forms. A different treatment involving parallel sums and differences was given in [2] for the case of pairs of nonnegative forms. Finally some attention will be paid to an orthogonal operator decomposition which does not belong to the above types; see [4].

References

[1] T. Ando. Lebesgue-type decomposition of positive operators. Acta Sci. Math. (Szeged) 38 (1976), 253–260.

[2] S. Hassi, Z. Sebestyén, H.S.V. de Snoo. Lebesgue type decompositions for nonnegative forms. J. Functional Analysis 257 (2009), 3858–3894.

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[5] P.E.T. Jorgensen. Unbounded operators, perturbations and commutativity problems. J. Functional Analysis 39 (1980), 281–307.

[6] S. Ôta. On a singular part of an unbounded operator. Zeitschrift für Analysis und ihre Anwendungen 7 (1987), 15–18.

[7] B. Simon. A canonical decomposition for quadratic forms with applications to monotone convergence theorems. J. Functional Analysis 28 (1978), 377–385.

Remarks on the convergence of pseudospectra

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We establish the convergence of pseudospectra for closed operators acting in different Hilbert spaces and converging in the generalised norm resolvent sense. As an assumption, we exclude the case that the limiting operator has constant resolvent norm on an open set. We extend the class of operators for which it is known that the latter cannot happen by showing that if the resolvent norm is constant on an open set, then this constant is the global minimum. We present examples exhibiting various resolvent norm behaviours and illustrating the applicability of our results.

References

[1] S. Bögli, P. Siegl. Remarks on the convergence of pseudospectra. Integral Equation Operator Theory 80 (2014), 303–321.

Recent results on functional calculus for Tadmor-Ritt operators

Felix L. Schwenninger, Hans Zwart
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An operator T on a Banach space X is called *Tadmor-Ritt* if its spectrum is contained in the closed unit disc of the complex plane and its resolvent satisfies

$$\|(zI - T)^{-1}\| \leq \frac{C(T)}{|z-1|}, \quad \text{for } |z| > 1,$$

for some positive constant $C(T)$. Such operators appear in studying stability of numerical schemes. The question whether T is power-bounded, i.e. $\sup_{n\in\mathbb{N}} \|T^n\| < \infty$, was answered positively by Lyubich [1] and independently by Nagy, Zemanek [2] in 1999. This result can be seen as a consequence of a more general result about boundedness of a functional calculus for T. We will give an introduction to such a calculus and discuss recent results concerning its bound. This generalizes work by Vitse [3].

References

[1] Yu. Lyubich. Spectral localization, power boundedness and invariant subspaces under Ritt's type condition. Studia Math. 134 vol. 2 (1999), 153–167.

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[3] P. Vitse. A band limited and Besov class functional calculus for Tadmor-Ritt operators. Arch. Math. (Basel) 485 vol. 4 (2005), 374–385.

A functional analytic look upon Remling's oracle theorem

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Universität Bremen

Remling's oracle theorem [1] is a corner stone in the study of the absolutely continuous spectrum of one-dimensional Jacobi operators and Schrödinger operators. Roughly speaking, it says that one-dimensional operators with absolutely continuous spectrum always are 'somewhat periodic'.

The proof given by Remling relies on limit properties of the asymptotic value distribution of the Titchmarch-Weyl m-function belonging to the operator. We indicate a different approach based on the Poisson transform on the half plane, and we explain how the method can be applied to general Sturm-Liouville operators.

References

[1] Christian Remling. The absolutely continuous spectrum of Jacobi matrices. Ann. of Math. 174 (2011), 125–171.

On Abstract grad-div Systems

Rainer Picard, Stefan Seidler, Sascha Trostorff and Marcus Waurick
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In the framework of a particular class of dynamical systems based on the investigation of typical systems of partial differential equations, skew-selfadjointness of the spatial operator A involved plays an important role as a key reference case for modeling physical phenomena, see e.g. [4]. Typically, skew-selfadjointness hinges on the particular form of A as

$$A = \begin{pmatrix} 0 & -G^* \\ G & 0 \end{pmatrix},$$

where $G : D(G) \subseteq H_0 \to H_1$ is a closed densely defined linear operator between the Hilbert spaces H_0, H_1. A typical case is where $G = \operatorname{grad} = \begin{pmatrix} \partial_1 \\ \partial_2 \\ \partial_3 \end{pmatrix}$ realized as the operator of weak differentiation from $L^2(\Omega)$ to $L^2(\Omega)^3$, where Ω is a non-empty open set in 3-dimensional Euclidean space. In this case $-G^*$ is the weak divergence operator with containment in $D(G^*)$ generating a generalization of vector fields being "tangential" even though a normal may not exist. The particular class of operators A under consideration is an abstraction of this situation, hence the term "abstract grad-div systems", where the role of the partial derivatives ∂_k, $k = 1, 2, 3$, is replaced by general Hilbert space operators. It is demonstrated by three examples how this concept can be utilized in approaching evolutionary problems. As an application we consider first the so-called Guyer-Krumhansl model of thermodynamics, [2]. We conclude with a discussion of (dynamic) surface dissipation boundary conditions in acoustics, [1, 5], and an impedance type boundary condition in electrodynamics (Leontovich boundary condition), [3], under this new perspective.

References

[1] Angelo Favini, Gisèle Ruiz Goldstein, Jerome A. Goldstein, and Silvia Romanelli. The heat equation with generalized Wentzell boundary condition. J. Evol. Equ. 2 (2002), 1–19.

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Eigenfunction expansions associated with the one-dimensional Schrödinger operator

Daphne J. Gilbert
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We consider the one-dimensional Schrödinger operator H on $L_2(-\infty,\infty)$ associated with

$$Lu := -u'' + q(r)u = \lambda u, \quad -\infty < r < \infty,$$

where $q(r) : \mathbb{R} \to \mathbb{R}$ is locally integrable, $\lambda \in \mathbb{R}$ is the spectral parameter, and the differential expression L is in Weyl's limit point case at both infinite endpoints. In this case the unique selfadjoint operator H is defined by

$$Hf = Lf, \quad f \in D(H),$$

where $f \in D(H)$ when $f, Lf \in L_2(\mathbb{R})$, and f, f' are locally absolutely continuous on $\mathbb{R}$. We refer to H as the Schrödinger operator on the line.

Starting from the well known Weyl-Kodaira formulation [1], an alternative form of the expansion is derived in such a way that the principal features contributing to it, namely a scalar spectral density function, the multiplicity properties of the spectrum and the generalised eigenfunctions, are explicitly exhibited in the expansion [2], [3]. Moreover, the spectral types of the generalised eigenfunctions, which may be absolutely continuous, singular continuous or pure point, can be determined from the asymptotic behaviour of the generalised eigenfunctions at both endpoints using the theory of subordinacy [4]. The main steps of the proof will be briefly outlined and the results illustrated by one or more simple examples.

References

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[3] D.J. Gilbert. Eigenfunction expansions associated with the one dimensional Schrödinger operator. Oper. Theory: Adv. Appl. 227 (2013), 89–105.

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Collocation-quadrature methods and fast summation for Cauchy singular integral equations with fixed singularities

P. Junghanns, Robert Kaiser, D. Potts,
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This contribution deals with the notched half plane problem of two-dimensional elasticity theory, which considers a straight crack perpendicular to and ending at the boundary of the elastic half plane. The problem can be modeled by a hypersingular integral equation, the solution of which is the crack opening displacement. For the numerical solution of this equation we propose a collocation-quadrature method, which looks for an approximation of the derivative of the crack opening displacement. This derivative is the solution of a Cauchy singular integral equation with additional fixed singularities,

$$\frac{1}{\pi}\int_{-1}^{1}\left[\frac{1}{y-x}-\frac{1}{2+y+x}+\frac{6(1+x)}{(2+y+x)^2}-\frac{4(1+x)^2}{(2+y+x)^3}\right]u(y)\,dy=f(x)\,,\quad -1<x<1\,.$$

A first numerical approach to this equation, which uses collocation methods, was described in [1]. This paper pays mainly attention to the computational aspects by using special structural properties of the matrices of the respective discretized equations. Basing on a recent result [2] on the stability of collocation methods applied to such integral equations we give, using C* algebra techniques, necessary and sufficient conditions for the stability of collocation-quadrature methods. These methods have the advantage that the respective system of equations has, in contrast to [1], a very simple structure and allows the application of fast summation methods which results in a fast algorithm with $\mathcal{O}(n\log n)$ complexity.

References

[1] M. R. Capobianco, G. Criscuolo and P. Junghanns. On the numerical solution of a hypersingular integral equation with fixed singularities. Oper. Theory Adv. Appl. (2008), 95–116

[2] P. Junghanns, R. Kaiser and G.Mastroianni. Collocation for singular integral equations with fixed singularities of particular Mellin type. Electr. Trans. Numer. Analysis (2014)

Exponential stability of a second order integro-differential equation with delay

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Motivated by a recent article [1], we study a wave equation of the form

$$u''(t) - \Delta u(t) - \int_{-\infty}^{t} k(t-s)\Delta u(s)\ \mathrm{d}s + \kappa u'(t-h) = f(t) \quad (t \in \mathbb{R})$$

on a domain $\Omega \subseteq \mathbb{R}^n$ with homogeneous Dirichlet boundary conditions. Here, k is a suitable operator-valued kernel, $h > 0, \kappa \in \mathbb{R}$ and f is a given source term. We provide a way to rewrite this equation as an abstract first-order evolutionary problem and we discuss sufficient conditions on the coefficients involved, which yield the exponential stability of the second order problem.

References

[1] F. Alabau-Boussouira, S. Nicaise, C. Pignotti. Exponential stability of the wave equation with memory and time delay. Technical report. arXiv:1404.4456.

The div M grad Without Ellipticity

Amru Hussein[1], Vadim Kostrykin[1], David Krejčiřik[2],
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The talk discusses some recent results [1] on div$M$ grad-operator on a bounded domain for sign-indefinite coefficient matrices M. A simplest example of such kind is $\mathcal{L} = -\frac{d}{dx}\mathrm{sign}(x)\frac{d}{dx}$ on a bounded interval. We prove several new representation theorems for indefinite quadratic forms, generalizing results of [2], [3], [4], [5]. Using these theorems, for a wide class of coefficient matrices we prove the existence of a unique self-adjoint operator $\mathcal{L}$ associated with the form $\langle \mathrm{grad} u, M\, \mathrm{grad} u \rangle$. We discuss several examples when the operator $\mathcal{L}$ turns out to have a nontrivial essential spectrum.

References

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Rational matrix solutions of a Bezout type equation on the half plane

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A state space description is given of all stable rational matrix solutions of a general rational Bezout type equation on the right half plane. To be precise, let G be a stable and proper rational $m \times p$ matrix function. We shall be interested in stable rational $p \times m$ matrix-valued solutions X of the Bezout type equation

$$G(s)X(s) = I_m, \quad \Re s \geq 0. \tag{1}$$

Throughout we shall assume that G admits a state space realization of the form

$$G(s) = C(sI_n - A)^{-1}B + D, \tag{2}$$

with A a stable matrix.

A state space formula for a particular solution X satisfying a certain H^2 minimality condition is presented, as well as a state space formula for the inner function describing the null space of the multiplication operator corresponding to the Bezout equation, and a parameterization of all solutions using the particular solution and this inner function. A state space version of the related Tolokonnikov lemma is also presented.

The talk will present the main results of [1]. The analogues for the unit disc case can be found in [2, 3].

References

[1] A.E. Frazho, M.A. Kaashoek, A.C.M. Ran. Rational matrix solutions of a Bezout type equation on the half plane. Oper. Theory Adv. Appl. 237 (2013), 145–160.

[2] A.E. Frazho, M.A. Kaashoek, A.C.M. Ran. Right invertible multiplication operators and stable rational matrix solutions to an associate Bezout equation, I. the least squares solution. Integral Equations Operator Theory 70 (2011), 395–418.

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On the trace class property of the resolvent regularization of a Dirac-type operator on $\mathbb{R}^3$

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In [1], C. Callias discusses the perturbed Dirac operator $L = \sum_{j=1}^{n} \gamma_j \partial_j + \Phi$, where $n \in \mathbb{N}$ odd, γ_j are the elements of the Euclidean Dirac algebra realized as $2^{\hat{n}} \times 2^{\hat{n}}$-matrices with $n = 2\hat{n} + 1$ and Φ is a multiplication operator of multiplying with a bounded C^∞-function with values in the selfadjoint $m \times m$-matrices. Assuming suitable decay conditions on the derivatives of Φ, it can be shown that L is a Fredholm operator as an operator on $L^2(\mathbb{R}^n)^{2^{\hat{n}}m}$. In [1] the index, ind$L$, of L is obtained with the help of the resolvent regularization

$$\operatorname{ind} L = \lim_{z \to 0+} z \operatorname{tr} \operatorname{tr}_{\text{int}} \left((L^*L + z)^{-1} - (LL^* + z)^{-1} \right),$$

provided $\operatorname{tr}_{\text{int}} \left((L^*L + z)^{-1} - (LL^* + z)^{-1} \right)$ is a trace class operator in $L^2(\mathbb{R}^n)$, where $\operatorname{tr}_{\text{int}}$ denotes the operator mapping any bounded linear operator considered as a block operator matrix on $L^2(\mathbb{R}^n)^{2^{\hat{n}}m}$ to the sum of the diagonal entries. In the talk, for $n = 3$, $m = 2$, we give an example for a potential Φ satisfying the decay and differentiability conditions assumed in [1], where the trace class property of $\operatorname{tr}_{\text{int}} \left((L^*L + z)^{-1} - (LL^* + z)^{-1} \right)$ is violated.

References

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On the spectrum of non-selfadjoint operators over dynamical systems

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We consider equivariant continuous families of discrete one-dimensional operators over arbitrary dynamical systems. We introduce the concept of a pseudo-ergodic element of a dynamical system. We then show that all operators associated to pseudo-ergodic elements have the same spectrum and that this spectrum agrees with their essential spectrum. As a consequence we obtain that the spectrum is constant and agrees with the essential spectrum for all elements in the dynamical system if minimality holds.

This is joint work with Siegfried Beckus (FSU Jena, Germany), Daniel Lenz (FSU Jena, Germany) and Marko Lindner (TU Hamburg-Harburg, Germany).

Uniform mean ergodicity of C_0–semigroups in a class of Fréchet spaces

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Let $(T(t))_{t\geq 0}$ be a strongly continuous C_0–semigroup of bounded linear operators on a Banach space X such that $\lim_{t\to\infty} \|T(t)/t\| = 0$. Characterizations of when $(T(t))_{t\geq 0}$ is uniformly mean ergodic, i.e., of when its Cesàro means $r^{-1}\int_0^r T(s)\,ds$ converge in operator norm as $r \to \infty$, are known. For istance, this is so if and only if the infinitesimal generator A has closed range in X if and only if $\lim_{\lambda\downarrow 0^+} \lambda R(\lambda, A)$ exists in the operator norm topology ($R(\lambda, A)$ is the resolvent operator of A at λ). These characterizations, and others, are shown to remain valid in the class of quojection Fréchet spaces, which includes all Banach spaces, countable products of Banach spaces, and many more. An example is presented which shows that the extension fails to hold for all Fréchet spaces.

On deformations of classical Jacobi matrices

Michał Wojtylak
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Let

$$A = \begin{pmatrix} a_0 & b_0 & & \\ b_0 & a_1 & b_1 & \\ & b_1 & a_2 & \ddots \\ & & \ddots & \ddots \end{pmatrix}, \quad a_i \in \mathbb{R},\ b_i > 0.$$

be a classical Jacobi matrix. We will try to reveal the spectrum of the product HA, where $H = \mathrm{diag}(-1, 1, 1, ...)$. We will start with a short motivation, lying in the fields of signal analysis (extracting information from a highly noisy signal) and numerical analysis. The main problem will be to locate the (unique) nonpositive eigenvalue of HA, that is the unique eigenvalue with the eigenvector x satisfying $\langle Hx, x \rangle \leq 0$. This eigenvalue can be approximated by the eigenvalue of nonpositive type of the finite truncation of the matrix HA, the properties of this approximation will be studied in detail.

Joint work with M. Derevyagin, L. Perotti, D. Vrinceanu.

References

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