50 Years of Seminar for Analysis and Foundation of Mathematics
led by Academician Bogoljub Stanković

International Conference
Topics in PDE, Microlocal and Time-frequency Analysis

September 3-8, 2012
Novi Sad, Serbia

PDEMTA2012

Book of Abstracts

Department of Mathematics and Informatics
University of Novi Sad
2012

Contents

Foreword

The Seminar for analysis and foundation of mathematics at the Novi Sad University was founded by Professor Bogoljub Stanković in 1962. More than hundred mathematicians of the Novi Sad University started their scientific work through this seminar. A large number of distinguished visitors participated at the seminar as well. From the very beginning a vast scope of mathematical topics was covered, starting from integral transforms and equations, theory of generalized functions, foundations of mathematics, general topology, qualitative analysis of differential equations, generalized asymptotics, numerical analysis of ODE, fixed point theory, etc.

At the present time the Seminar assembles enlarged mathematical interest of the researchers participating at the three research projects. Functional analysis topics, including Generalized functions as framework for singular ODE and PDE, Microlocal analysis and ΨDO, Integral transforms and asymptotics, Time-frequency analysis (research led by Academician Stevan Pilipović), Mathematical logic and general topology (research led by Professor Miloš Kurilić) and Differential equations with fractional derivatives and their applications (research led by Academician Teodor M. Atanacković).

The Department of Mathematics and Informatics, Department of Mechanics and the Center for Mathematical Research of Nonlinear Phenomena at Novi Sad University, and the Scientific and Organizing Committees are pleased to welcome you to the celebration of 50 years of Seminar for analysis and foundation of mathematics, successfully led by Academician Bogoljub Stanković.

The main programme consists of three conferences:

Topics in PDE, Microlocal and Time-frequency Analysis, September 3-8, 2012

Contemporary Problems of Mechanics and Applied Mathematics, September 3-6, 2012

Mathematical Logic and General Topology, September 5-8, 2012

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We acknowledge the financial support for this conference given by

the Serbian Academy of Sciences and Art

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the International Society for Analysis, its Applications and Computation - ISAAC

Schedules

Monday, September 3

9.30-10.10	Opening + Stevan Pilipović	*Classes of generalized functions with finite type regularities*
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11.25-12.05	Rudolf Gorenflo	*On subordination in time-fractional stochastic processes*
12.10-12.50	Alexander Seyranian	*Paradox of Nicolai and similar effects in non-conservative stability problems*
13.00-15.00		lunch break
15.00-15.40	Irina Melnikova	*Generalized solutions to differential-operator equations with white noise in spaces of distributions*
15.45-16.05	Dora Seleši	*Applications of chaos expansions to solving SPDEs*
16.10-16.30	Tijana Levajković	*Stochastic differential equations involving the Malliavin derivative operator*
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17.00-17.20	Andrzej Kaminski	*On ultradistributions and their convolution*
17.25-17.45	Paolo Giordano	*Generalized functions as a category of smooth set-theoretical maps*
17.50-18.10	Lukas Wurzer	*Stochastic partial differential equations with random set coefficients*
18.15-18.35	Georgi Boyadzhiev	*Comparison principle for non-cooperative elliptic systems and applications*

Tuesday, September 4

9.30-10.10	Man Wah Wong	*The heat kernel and Green function of the twisted bi-Laplacian*
10.15-10.55	Joachim Toft	*Multiplication properties in pseudo-differential calculus with small regularity assumptions on the symbols*
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11.25-12.05	Sandro Coriasco	*$L^p(\mathbb{R}^n)$-boundedness of anisotropic multipliers and of SG Fourier integral operators*
12.10-12.30	Patrik Wahlberg	*Schrödinger type propagators, pseudodifferential operators and modulation spaces*
12.35-11.55	Julio Delgado	*On the traceability and the asymptotic behavior of the eigenvalues of a class of integral operators*
13.00-15.00		lunch break
15.00-15.40	Ville Turunen	*Pseudo-differential operators and symmetries: old and new*
15.45-16.25	Diana T. Stoeva	*Invertible multipliers whose inverses can be written as multipliers*
16.35-17.00		coffee break
17.00-17.20	Krešimir Burazin	*Heat equation as a Friedrichs system*
17.25-17.45	Marko Vrdoljak	*Homogenisation theory for Friedrichs systems*
17.50-18.10	Luigi Riba	*Continuous inversion formulas for multi-dimensional Stockwell transforms*
18.15-18.35	Sanja Kostadinova	*The ridgelet transform of distributions*

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10.15-10.55	Tommaso Ruggeri	*Extended Thermodynamics of Real Gases*
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11.25-12.05	Michael Ruzhansky	*Gevrey functions and ultradistributions on compact Lie groups and homogeneous spaces*
12.10-12.30	David Rottensteiner	*The Heisenberg group of the Heisenberg group: Its representation theory and applications to ΨDO's and coorbit space theory*
12.35-11.55	Donal Connolly	*Pseudo-differential operators on homogeneous spaces*

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15.00-15.40	Pavel Řehák	*Asymptotics of nonlinear differential systems*
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17.00-17.20	Vojislav Marić	*An asymptotic analysis of solutions to equations of Thomas-Fermi type*
17.25-18.05	Olga Hadžić	*50 years of Seminar for analysis and foundations of mathematics*

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11.25-12.05	Günther Hörmann	*A regularization approach to non-smooth symplectic structures*
12.10-12.30	Evelina Erlacher	*An implicit function theorem for generalized functions*
12.35-11.55	Clemens Sämann	*On the completeness of impulsive gravitational waves*
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15.00-15.40	Nenad Antonić	*Parabolic H-measures*
15.45-16.05	Irina Kmit	*Smoothing property for mixed and periodic first-order hyperbolic problems*
16.10-16.30	Marko Nedeljkov	*Singularities in (generalized) Chaplygin gas*
16.35-17.00		coffee break
17.00-17.20	Ivan Ivec	*Some generalisations of H-measures*
17.25-17.45	Marko Erceg	*Semiclassical distributions - an extension of semiclassical measures*
17.50-18.10	Darko Mitrović	*δ-type solution concept for systems of conservation laws*
18.15-18.35	Martin Lazar	*Velocity averaging — a general framework*
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Friday, September 7

9.30-10.10	Jasson Vindas	*Asymptotic distribution of Beurling's generalized prime numbers*
10.15-10.55	Hans Vernaeve	*Distributions having a value at a point in the sense of Robinson*
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11.25-12.05	Dimitris Scarpalezos	*Ideals of the ring of generalized constants with continuous parametrisation*
12.10-12.30	Hideo Deguchi	*The wave equation with a discontinuous coefficient depending on time only: generalized solutions and propagation of singularities*
12.35-11.55	Eduard Nigsch	*Towards a functional analytic foundation of Colombeau theory*
13.00-15.00		lunch break
15.00-15.40	Todor Gramchev	*Global normal forms and solvability in $\mathbb{R}^n$ for second order Shubin type operators*
15.45-16.05	Mohamed Taha Khalladi	*Differential properties of asymptotically almost periodic generalized functions*
16.10-16.30	Giorgia Tranquilli	*Global properties and normal forms of second order Shubin type operators*
16.35-17.00		coffee break
17.00-17.20	Nenad Teofanov	*Spectral asymptotic of a class of SG-type operators*
17.25-17.45	Bojan Prangoski	*Anti-Wick and Weyl quantization on ultradistribution spaces*

Saturday, September 8

10.00-18.00 Excursion

CONFERENCE SCHEDULE

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11.25-12.05	Gorenflo	Coriasco	Ruzhansky	Hörmann	Scarpalezos	
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15.00-15.40	Melnikova	Turunen	Rehak	Antonić	Gramchev	
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16.35-17.00	**Coffee break**					
17.00-17.20	Kaminski	Burazin	Marić	Ivec	Teofanov	
17.25-17.45	Giordano	Vrdoljak	Hadžić	Erceg	Prangoski	
17.50-18.10	Wurzer	Riba		Mitrović		
18.15-18.35	Boyadzhiev	Kostadinova		Lazar		
20.00				**Conference dinner**		

Abstracts of Talks

Nenad Antonić
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Thu 6 Sep: 15.00-15.40

Parabolic H-measures

Classical H-measures introduced by Tartar (1990) and independently by Gérard (1991) are not well suited for the study of parabolic equations. Recently, several parabolic variants have been proposed, together with a number of applications.

We introduce a new parabolic variant (and call it the parabolic H-measure), which is suitable for these known applications. Moreover, for this variant we prove the localisation and propagation principle, establishing a basis for more demanding applications of parabolic H-measures, similarly as it was the case with classical H-measures. In particular, the propagation principle enables us to write down a transport equation satisfied by the parabolic H-measure associated to a sequence of solutions of a Schrödinger type equation.

Some applications to specific equations will be presented, illustrating the possible use of this new tool. A comparison to similar results for classical H-measures will be made as well.

This is a joint work with Martin Lazar.

Georgi Boyadzhiev
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Mon 3 Sep: 18.15-18.35

Comparison principle for non-cooperative elliptic systems and applications

At this talk are given some results for the validity of comparison principle for non-cooperative systems of elliptic equations in a finite domain. Method of sub- and super-solutions is used to prove the existence of a classical solution of the system.

Krešimir Burazin **Tue 4 Sep: 17.00-17.20**
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Heat equation as a Friedrichs system

Symmetric positive systems (Friedrichs systems) of first-order linear partial differential equations were introduced by Kurt Otto Friedrichs (1958) in order to treat the equations that change their type, like the equations modelling transonic fluid flow. Such a system should be supplemented by an *admissible* boundary condition. Friedrichs showed that this class of problems encompasses a wide variety of classical and neoclassical initial and boundary value problems for various linear partial differential equations.
Inspired by recent advances in the general theory of Friedrichs' systems, we apply the newly developed results to the heat equation, by showing how the intrinsic theory of Ern, Guermond and Caplain (2007) can be used in order to get a well-posedness result for the Dirichlet initial-boundary value problem. We also demonstrate the application of the two-field theory with partial coercivity of Ern and Guermond (2008), originally developed for elliptic problems, and also discuss different possibilities for the construction of an appropriate boundary operator.
This is a joint work with Nenad Antonić and Marko Vrdoljak.

Donal Connolly **Wed 5 Sep: 12.35-12.55**
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Pseudo-differential operators on homogeneous spaces

In this talk, we discuss pseudo-differential operators on homogeneous spaces.
Consider a compact homogeneous space as a quotient space G/K, where G is a compact Lie group and $K \leq G$ is a closed subgroup. We study operators on G/K by lifting them to the transform group G. Using the Fourier series on G given by the unitary representations of G, we define global matrix-valued symbols of such lifted operators.
We then use these symbols to characterize Hörmander's classes $\Psi^m(G/K)$ of pseudo-differential operators. We will also discuss difficulties encountered in establishing a symbolic calculus.
The talk is based on joint work with Michael Ruzhansky (Imperial College London).

Sandro Coriasco **Tue 4 Sep: 11.25-12.05**
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$L^p(\mathbb{R}^n)$-boundedness of anisotropic multipliers and of SG Fourier integral operators

I will illustrate some recently obtained results about the continuity on $L^p(\mathbb{R}^n)$ of certain pseudodifferential and Fourier integral operators, defined through symbol classes satisfying global estimates on $\mathbb{R}^n$.
More precisely, I will first discuss necessary conditions for the $L^p(\mathbb{R}^n)$-continuity of multipliers $\sigma(D)$ associated with suitable, strictly positive, weight functions $\lambda, \psi = (\psi_1, \dots, \psi_n) \in \mathcal{C}(\mathbb{R}^n)$, λ

bounded. Namely, the derivatives of the symbol σ satisfy, for all $\alpha \in \mathbb{Z}_+^n$ and suitable constants $C_\alpha \geq 0$, the "anisotropic estimates"

$$|D^\alpha \sigma(\xi)| \leq \lambda(\xi) \cdot \psi(\xi)^{-\alpha}, \quad \xi \in \mathbb{R}^n,$$

where $\psi(\xi)^{-\alpha} = \prod_{j=1}^{n} \psi_j(\xi)^{-\alpha_j}$. This generalises a classical result by Beals, where no difference in the components of ψ was allowed.
Subsequently, I will present an extension of a result by Seeger, Sogge and Stein, to the Fourier integral operators defined on $\mathbb{R}^n$ by means of the so-called SG-symbols (a class of symbols independently introduced in the '70s by Cordes and Parenti). The lack of compactness in the supports gives additional complications, which imply the need of controlling the behaviour at infinity of the involved amplitude and phase functions. An interesting aspect of the results is that this reflects in a corresponding "loss of decay at infinity", completely analogous to the well-known "loss of smoothness". These results on Fourier integral operators globally defined on $\mathbb{R}^n$ have been obtained in a joint work with M. Ruzhansky.

Hideo Deguchi **Fri 7 Sep: 12.10-12.30**
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The wave equation with a discontinuous coefficient depending on time only: generalized solutions and propagation of singularities

We consider the Cauchy problem for the one-dimensional wave equation with a discontinuous coefficient depending on time in the framework of generalized functions introduced by Colombeau. We first show the existence and uniqueness of generalized solutions to the problem, and then investigate the phenomenon of propagation of singularities, arising from delta function initial data, for the case of a piecewise constant coefficient.
This talk is based on joint work with Günther Hörmann and Michael Oberguggenberger.

Julio Delgado **Tue 4 Sep: 12.35-12.55**
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On the traceability and the asymptotic behavior of the eigenvalues of a class of integral operators

In this talk we shall present some sufficient conditions for traceability and r-nuclearity of some integral operators. The belogness to the class of r-nuclear operators implies estimates of the asymptotic behavior of the eigenvalues. In particular we will consider the Fox-Li and related operators as well as pseudodifferential operators on the torus. The Fox-Li operator is a convolution operator with a highly oscillatory kernel which arises in laser engineering.

Marko Erceg **Thu 6 Sep: 17.25-17.45**
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Semiclassical distributions - an extension of semiclassical measures

Semiclassical measures (also known under the name of Wigner measures) are mathematical objects used in the study of high-frequency limits in continuum and quantum mechanics. In contrast to the H-measures, they are tailored to deal with problems which have a characteristic length (e.g. thickness of a plate). However, in same cases the information about oscillations is lost, which prompted Luc Tartar to introduce a different approach. Starting from H-measures he constructed a measure corresponding to the semiclassical one, which has better behaviour in the situations where semiclassical measures did not give good information.
Our goal is to extend this construction and introduce an extension of semiclassical measures, the semiclassical distributions, starting from H-distributions recently introduced by Antonić and Mitrović.
This is a joint work with Nenad Antonić.

Evelina Erlacher **Thu 6 Sep: 12.10-12.30**
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An implicit function theorem for generalized functions

We show an implicit function theorem in the special Colombeau algebra based on a generalized inverse function theorem [1]. Furthermore, we give conditions for the injectivity of a generalized function.
Joint work with Clemens Hanel.
References
[1] E. Erlacher. *Inversion of Colombeau generalized functions.* Proceedings of the Edinburgh Mathematical Society. to appear.

Paolo Giordano **Mon 3 Sep: 17.25-17.45**
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(Work in collaboration with Michael Kunzinger)

Generalized functions as a category of smooth set-theoretical maps

We present a new approach to generalized functions, so-called generalized smooth functions (GSF), as set-theoretical maps defined on, and taking values in, a suitable non-archimedean ring of scalars. Our choice for the ring of scalars is Colombeau's ring of generalized numbers (CGN). Based on the theory of algebras of generalized functions, we prove that GSF form a category which unifies and extends Schwartz distributions and Colombeau generalized functions. The calculus of these generalized functions is less general than that introduced by J. Aragona, R. Fernandez and S.O.

Juriaans, but it is more closely related to classical analysis, with point values, composition, non linear operations, the usual rules for differentiation and integration and the generalization of some classical theorems like the intermediate value theorem, the mean value theorems and the extreme value theorem. The basic idea is to set the minimal logical conditions to have maps of CGN generated by nets (u_ε) of ordinary smooth functions, with $u_\varepsilon \in \mathcal{C}^\infty(\Omega_\varepsilon, \mathbb{R}^t)$ and $\Omega_\varepsilon \subseteq \mathbb{R}^s$ open. That is, so that the equality $f(x) = [u_\varepsilon(x_\varepsilon)]$ is well defined. The use of ε-dependent domains is necessary to have closure with respect to composition and carries us to the notion of strongly internal sets, which seems to have better logical properties with respect to the internal sets of M. Oberguggenberger and H. Vernaeve.

The differential calculus of this type of functions can be developed in an intrinsic way using the Fermat-Reyes theorem, which states existence and uniqueness of a generalized smooth incremental ratio r satisfying $f(x + h) = f(x) + h \cdot r(x, h)$. We finally present two threads of ideas to extend this theory to an infinite-dimensional calculus framed in a quasi-topos and including diffeological spaces, in particular finite and infinite-dimensional manifolds and their function spaces. In the first one, we have general closure with respect to composition but a weaker sheaf property, in the second one we have only sufficient conditions so that the composition is still a GSF, but a full sheaf property.

Todor Gramchev **Fri 7 Sep: 15.00-15.40**
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Global normal forms and solvability in $\mathbb{R}^n$ for second order Shubin type operators

Let P be a second order differential operator in $\mathbb{R}^n$ of Shubin type. We propose reductions to simpler normal forms and discuss the global regularity and the global solvability of P in scales of Banach subspaces of Gelfand–Shilov classes when P is not globally elliptic.

Günther Hörmann **Thu 6 Sep: 11.25-12.05**
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A regularization approach to non-smooth symplectic structures

In recent years a substantial theory of pseudodifferential and Fourier integral operators with generalized functions as symbols or phase functions has been developed. To further exploit the underlying geometric concepts and methods, one is led to extend symplectic geometry to a non-smooth setting in the spirit of a regularization approach. Another important motivation for the study of non-smooth symplectic forms and generalized symplectomorphisms arises from geodesic sprays and flows corresponding to non-smooth semi-Riemannian metrics. We carefully discuss first steps in the extension of essential basic theories such as symplectic linear algebra for modules over rings of generalized numbers and manifolds equipped with non-smooth symplectic forms.

Ivan Ivec **Thu 6 Sep: 17.00-17.20**
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Some generalisations of H-measures

H-measures were defined independently by Luc Tartar and Patrick Gérard, as objects measuring the lack of strong convergence in weakly converging sequences in $\mathrm{L}^2(\mathbf{R}^d;\mathbf{R}^r)$. They are Radon measures defined on $\mathbf{R}^d \times S^{d-1}$, their existence relying on the First commutation lemma (as it was baptised by Tartar). They have already found a number of applications to hyperbolic and elliptic partial differential equations.
Recently, Nenad Antonić and Martin Lazar introduced parabolic H-measures for applications to parabolic problems, showing their feasibility to the main types of applications, as they were known for the classical H-measures.
Our goal is to provide a systematic approach to this and other possible extensions, with an ultimate goal of tailoring the variants appropriate for applications in various classes of partial differential equations. We also provide some general variants of the first commutation lemma.
This is a joint work with Nenad Antonić.

Mohammed Taha Khalladi **Fri 7 Sep: 15.45-16.05**
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Differential properties of asymptotically almost periodic generalized functions

The aim of this talk is to present an algebra of asymptotically almost periodic generalized functions containing the classical Fréchet asymptotically almost periodic functions as well as asymptotically almost periodic Schwartz distributions, then to study some differential properties of these asymptotically almost periodic generalized functions.

References

[1] Cioranescu I., Asymptotically almost periodic distributions, Appl. Analysis, 34, 251-259, 1990
[2] Colombeau J.F., Elementary introduction to new generalized functions. North-Holland, 1985
[3] Fréchet M., Les fonctions asymptotiquement presque périodiques, Revue Sci., 79,341-354, 1941
[4] Stankovič B., Asymptotic almost periodic distributions, application to partial differential equations, Proc. Steklov Inst. Math. Issue 3, 367-375, 1994

Irina Kmit **Thu 6 Sep: 15.45-16.05**
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Smoothing property for mixed and periodic first-order hyperbolic problems

We discuss regularity properties of solutions to initial-boundary and periodic problems for first-order one-dimensional hyperbolic PDEs. For large classes of boundary operators, in particular, those appearing in traveling wave models of laser and population dynamics and chemical kinetics, we show that smoothness of solutions increases with time. This property plays an important role in local investigations of nonlinear hyperbolic PDEs (bifurcations and periodic synchronizations).

Sanja Kostadinova **Tue 4 Sep: 18.15-18.35**
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(Work in collaboration with Stevan Pilipović, Katerina Saneva and Jasson Vindas)

The ridgelet transform of distributions

In this paper we prove that the ridgelet transform $\mathcal{R} : \mathcal{S}_0(\mathbb{R}^n) \to \mathcal{S}(\mathbb{Y}^{n+1})$ and its adjoint $\mathcal{R}^* : \mathcal{S}(\mathbb{Y}^{n+1}) \to \mathcal{S}_0(\mathbb{R}^n)$ are continuous. We extend the definition of ridgelet transform to the space od tempered distributions. Also, we provide some Abelian and Tauberian type results relating the quasyasymtotic behaviour of tempered distributions with the asymtotic behaviour of their ridgelet transform.

Michael Kunzinger **Thu 6 Sep: 10.15-10.55**
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(Work in collaboration with Shantanu Dave)

Abstract regularity theory

We present a unified approach to measuring regularity in various settings. The underlying concept is that of a singularity structure, a triple (A, X, Y) consisting of a filtered algebra A and graded Fréchet A-modules X and Y. In this minimal setting we measure the regularity of polynomially tame (linear or nonlinear) mappings maps $\phi : X \to Y$ and give abstract definitions of wavefront sets, distributions, and propagation of singularities. Classical examples that can be described algebraically in this approach are singular support and wavefront sets of Schwartz distributions, as well as microlocal ellipticity.

Martin Lazar **Thu 6 Sep: 18.15-18.35**
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Velocity averaging — a general framework

We establish the strong $\mathrm{L}^2_{\mathrm{loc}}(\mathbf{R}^d)$ precompactness of the sequence of averaged quantities $\int_{\mathbb{R}^m} u_n(\mathbf{x}, \mathbf{p})$ $\rho(\mathbf{p})d\mathbf{p}$, where $\rho \in \mathrm{L}^2_{\mathrm{c}}(\mathbb{R}^m)$ and $u_n \in \mathrm{L}^2(\mathbb{R}^m; \mathrm{L}^s(\mathbf{R}^d))$, $s \geq 2$, are weak solutions to differential operator equations with variable coefficients. In particular, this includes differential operators of hyperbolic, parabolic or ultraparabolic type, but also fractional differential operators. If $s > 2$ then the coefficients can be discontinuous with respect to the space variable $\mathbf{x} \in \mathbb{R}^d$. The main tool in this work is an extension of H-measures, for which a representation theorem is proved. An application is given to ultraparabolic equations with discontinuous coefficients.
This is a joint work with Darko Mitrović.

Tijana Levajković **Mon 3 Sep: 16.10-16.30**
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Stochastic differential equations involving the Malliavin derivative operator

This talk is devoted to a class of stochastic differential equations involving the Malliavin differential operator. In particular, we consider a stochastic eigenvalue problem, an homogeneous and a nonhomogeneous first order linear equation involving the Malliavin derivative operator with stochastic coefficients. Equations are solved by use of the chaos expansion method and it is proved that solutions converge in an appropriate weighted space of generalized stochastic distributions.

Jelena Manojlović **Wed 5 Sep: 16.10-16.30**
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Asymptotic analysis of positive solutions of fourth order nonlinear differential equations in the framework of regular variation

The set of positive solutions of the sublinear fourth-order differential equations of Emden-Fowler type

$$x^{(4)} = q(t)|x|^{\gamma-1}x, \qquad 0 < \gamma < 1, \tag{A}$$

and

$$(|x''|^{\alpha-1}x'')'' + q(t)|x|^{\beta-1}x = 0, \qquad 0 < \gamma < 1, \tag{B}$$

is studied in the framework of regular variation in the sense of Karamata. The purpose of this lecture is to fully describe the overall structure of regularly varying solutions of these two equations on the basis of the behavior and the regularity index of the regularly varying coefficient $q(t)$. Moreover, an application of the theory of regular variation gives the possibility of determining the precise asymptotic forms of such solutions of (A) and (B).

Jean-André Marti **Thu 6 Sep: 9.30-10.10**
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Generalized functions on the closure of an open set

In many problems (as differential Cauchy ones with $f \in [0, +\infty[$ as initial data), we have to define some spaces or algebras on the closure of an open set Ω of $\mathbb{R}^n$. In another cases the asymptotic analysis of a family of functions (as $e^{-\frac{x}{\varepsilon}}$) depending on a parameter (as ε) need the study in an algebra defined on the closure of an open set (as $[0, +\infty[$).
The starting point of our constructions is the algebra of smooth functions, and we come back to the technics of continuous extension of such functions and their derivatives on the boundary of a

closed subset of $\mathbb{R}^n$. Following the definitions of H. Biagioni [3] and J. Aragona [2], we give some precisions on the association process for the elements in the Colombeau algebra $\mathcal{G}\left(\overline{\Omega}\right)$.
The space $\mathcal{O}_M\left(\mathbb{R}^n\right)$ of slowly increasing functions, endowed by the family of semi-norms $\left(p_{\varphi,\alpha}\right)_{(\varphi,\alpha)\in\mathcal{S}(\mathbb{R}^n)\times\mathbb{N}^n}$ becomes a topological algebra. This algebra is used by A.Delcroix [4] to define the generalized algebra $\mathcal{G}_{\mathcal{O}_M}\left(\mathbb{R}^n\right)$ which is very useful to prove the uniqueness of some linear characteristic Cauchy problem studied in [1]. But in nonlinear cases, we cannot obtain the result without replacing $\mathbb{R}^n$ by a smaller closed set. When Ω is a convex open set in $\mathbb{R}^n$, we prove that $\mathcal{O}_M\left(\overline{\Omega}\right)$, with the topology deducted from that of $\mathcal{O}_M\left(\mathbb{R}^n\right)$ by replacing $\mathcal{S}\left(\mathbb{R}^n\right)$ by $\mathcal{S}\left(\overline{\Omega}\right)$, becomes also a locally convex algebra. Involving the framework of $(\mathcal{C},\mathcal{E},\mathcal{P})$-algebra ([5]) with $\mathcal{E}=\mathcal{O}_M(\overline{\Omega})$, $\mathcal{P}=(p_{\varphi,\alpha})$ and $\mathcal{C}$ generated by $(\varepsilon)_\varepsilon$ we define the generalized algebra $\mathcal{G}_{\mathcal{O}_M}\left(\overline{\Omega}\right)$ as the quotient algebra $\mathcal{M}_{\mathcal{O}_M}\left(\overline{\Omega}\right)/\mathcal{N}_{\mathcal{O}_M}\left(\overline{\Omega}\right)$. When Ω is unbounded, it is given an alternative representation of $\mathcal{N}_{\mathcal{O}_M}\left(\overline{\Omega}\right)$ conjectured by H. Vernaeve leading to a point-value characterization ([6]) of elements in $\mathcal{G}_{\mathcal{O}_M}\left(\overline{\Omega}\right)$.
Now, we think have the toolbox to obtain the uniqueness for nonlinear characteristic Cauchy problem involved above.
The author thanks E. Allaud, A. Delcroix, M. Hasler and H. Vernaeve for their contributions to this synthesis.

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Mon 3 Sep: 15.00-15.40

Generalized solutions to differential-operator equations with white noise in spaces of distributions

The Cauchy problem for the equation $X'(t)=AX(t)+B\mathbb{W}(t),\ t\geq 0$, with singular white noise $\mathbb{W}$ and operator A generating different regularized semigroups in a Hilbert space H is investigated in spaces of abstract distributions. In dependence on properties of A solutions generalized in time, random variables and variables of the space H as well as in cumulative variables are constructed. The techniques of abstract distribution spaces and abstract stochastic distribution spaces are applied.

Žarko Mijajlović **Wed 5 Sep: 15.45-16.05**
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Regularly varying solutions of Friedmann equations

In this paper we discuss the asymptotic solutions of Friedmann equations

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}\rho - \frac{kc^2}{a^2} \quad \text{(Friedmann equation)} \tag{1}$$

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}\left(\rho + \frac{3p}{c^2}\right) \quad \text{(acceleration equation)} \tag{2}$$

that describe the evolution of the expansion scale factor $a(t)$ of the universe. Here, $p = p(t)$ is the energy pressure in the universe, $\rho = \rho(t)$ is the density of matter in the universe, k is the space curvature, G is the gravitational constant and c is the speed of light. The variable t represents the cosmic time.
We found a necessary and sufficient condition for solutions that satisfy the generalized power law expressed as $a(t) = t^\alpha L(t)$, where $L(t)$ is a regularly varying function in the sense of J. Karamata, see [3]. Our analysis is strongly based on the theory of regularly varying solutions of the linear second order differential equation developed by V. Marić, see [4]. For this reason we introduced a new parameter $\mu(t) = q(t)(H(t)t)^2$ where $q(t)$ is the deceleration parameter and $H(t)$ is the Hubble parameter. We prove that the Friedmann equations (1) and (2) have an asymptotical solution $a(t)$ that satisfy the generalized power law if and only if the integral limit (first considered by V. Marić and M. Tomić)

$$\Gamma = \lim_{x\to\infty} x\int_x^\infty \frac{\mu(t)}{t^2}dt. \tag{3}$$

exists and $\Gamma < 1/4$. We proved that the values of the constant Γ completely determines the asymptotical behavior of all cosmological parameters $a(t)$, $H(t)$, $q(t)$, $p(t)$ and $\rho(t)$. It appears that our approach covers all results on cosmological parameters for the Standard model of the universe, as presented for example in [1] or in [2].
The crucial role in this analysis has the linear functional related to (3):

$$\mathbf{M}(u) = \lim_{x\to\infty} x\int_x^\infty \frac{u(t)}{t^2}dt,$$

$\mathbf{M}$ is defined on the class of real functions that satisfy (3) for some Γ. We proved that $u \in \ker \mathbf{M}$ if and only if there are real functions ε and η such that

$$u(t) = t\dot{\varepsilon}(t) + \eta, \quad \varepsilon(t),\, \eta(t) \to 0 \ \text{ as } \ t \to 0.$$

This representation of $u \in \ker \mathbf{M}$ yields the asymptotical representations of the mentioned cosmological parameters, even assuming that the Einstein's cosmological constant Λ is non-zero. Detailed proofs and physical interpretations of these results can be found in [5].

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Darko Mitrović **Thu 6 Sep: 17.50-18.10**
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δ-type solution concept for systems of conservation laws

Existence and admissibility of δ-shock solutions is discussed for the non-convex strictly hyperbolic system of equations

$$\partial_t u + \partial_x\big(\frac{u^2+v^2}{2}\big) = 0$$
$$\partial_t v + \partial_x(v(u-1)) = 0.$$

This fully nonlinear system (i.e. nonlinear with respect to both unknowns) is considered in [1] where it is noticed that it does not admit the classical Lax-admissible solution for certain Riemann problems. By introducing complex-valued corrections in the framework of the weak asymptotic method, we show that a compressive δ-shock solution resolves such Riemann problems. By letting the approximation parameter tend to zero, the corrections become real-valued and the solutions can be seen to fit into the framework of weak singular solutions defined in [2]. Moreover, in this context, we can show that every 2×2 system of conservation laws admits δ-shock solutions.
Joint work with: Henrik Kalisch (*University of Bergen*).

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Marko Nedeljkov **Thu 6 Sep: 16.10-16.30**
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Singularities in (generalized) Chaplygin gas

Some reacent models of so called dark energy in the Universe include the old model of Chaplygin gas or its generalizations

$$\begin{aligned} \rho_t + q_x &= 0 \\ q_t + (q^2/\rho + \rho^{-\alpha})_x &= 0. \end{aligned}$$

For Chaplygin gas $\alpha = -1$. In both cases unbounded solutions resembling delta function are found. The purpose of this talk is to describe situations where entropic solutions of such a type can occur and how they look like.

Eduard A. Nigsch **Fri 7 Sep: 12.35-12.55**
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Towards a functional analytic foundation of Colombeau theory

The power of the theory of Schwartz distributions comes for the most part from a rock-solid foundation on functional analysis. Its generalization to theories of nonlinear generalized functions in the sense of Colombeau, however, often consists of ad-hoc constructions leaving behind this background. We will discuss approaches to basing the construction of Colombeau algebras on concepts more closely related to distribution theory, with the aim to elucidate their structure and eventually give a formulation in a less technical, more functional language.

Michael Oberguggenberger **Mon 3 Sep: 10.15-10.55**
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Detection of singularities in hyperbolic PDEs via asymptotic properties of generalized solutions

The talk addresses propagation of singularities in linear hyperbolic systems with non-smooth coefficients. The existence of distributional solutions requires a minimal degree of regularity of the coefficients. In case of more singular coefficients, e.g., discontinuous coefficients, solutions may still be constructed in algebras of generalized functions, like the Colombeau algebras.
These generalized functions are represented by families of smooth functions depending on a parameter ε. Classical notions for locating the singularities, such as the wave front set, have a generalization and refinement in the setting of Colombeau algebras in terms of asymptotic estimates with respect to ε.
The talk addresses recently established possibilities of tracing the singularities issuing from the initial data across singularities of the coefficients. Methods of proof involve the generalized wave front set, commutators of vector fields, and Fourier integral operators.
The talk is based on joint work with Hideo Deguchi, Claudia Garetto and Günther Hörmann.

Stevan Pilipović **Mon 3 Sep: 9.30-10.10**
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Classes of generalized functions with finite type regularities

We analyze regularity properties of elements of generalized function algebras parallel to the corresponding theory within distribution spaces. In this sense we considered subspaces or subalgebras which correspond to Sobolev, Zygmund and Hölder spaces. Moreover, we investigate regularity propetoes of Schwartz distributons within the Besov spaces of functions and distributions. In this case, instead of growth order of the form "$O(\varepsilon^a)$", we consider weighted integrals from zero to one with respect to the measure $d\varepsilon/\varepsilon$..
This talk is based on a joint work of Pilipović, Scarpalezos and Vindas, as well as of Pilipović and Vindas.

Bojan Prangoski **Fri 7 Sep: 17.25-17.45**
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Anti-Wick and Weyl quantization on ultradistribution spaces

New classes of symbols is introduced and the pseudodifferencial calculus within ultradistribution spaces which correspond to a sequence (M_p), is realized. By the use of the short time Fourier transform in ultradistribution spaces, the relation of the Weyl symbols and Anti-Wick symbols is obtained through the convolution with $e^{a|x|^2}$. For this purpose, the Laplace transform is studied and used.

Partially, results are obtained jointly by S. Pilipović.

Pavel Řehák **Wed 5 Sep: 15.00-15.40**
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Asymptotics of nonlinear differential systems

In this talk, we will consider the nonlinear differential system

$$\left.\begin{aligned}(p(t)\Phi_\alpha(x'))' &= \varphi(t)\Phi_\lambda(y),\\ (q(t)\Phi_\beta(y'))' &= \psi(t)\Phi_\mu(x),\end{aligned}\right\} \tag{S}$$

where $\Phi_\xi(u) = |u|^\xi \operatorname{sgn} u$, $\alpha, \beta, \lambda, \mu$ are positive constants, and p, q, φ, ψ are positive continuous functions on $[a, \infty)$. The subhomogeneity condition (at ∞), i.e., $\alpha\beta > \lambda\mu$, is assumed. We will investigate, in particular, strongly decreasing solutions of (S), i.e. the solutions of whose both components are eventually positive decreasing and along with their quasiderivatives tend to zero (as the independent variable tends to infinity). With the help of the theory of regular variation we will derive exact asymptotic formula for these solutions. We do not pose in general any condition on divergence or convergence of the integrals $\int_a^\infty p^{-\frac{1}{\alpha}}(s)\,ds$, $\int_a^\infty q^{-\frac{1}{\beta}}(s)\,ds$, and we do not explicitly distinguish among particular cases. In fact, all possible cases (including the mixed ones) are covered by our results.

System (S) can be understood as of generalized Emden-Fowler type, and includes important classes of fourth order equations. Further, the results for (S) can serve to obtain nontrivial information about the behavior of positive radial solutions to certain systems of quasilinear partial differential equations.

Some of other relevant topics will also be discussed. In particular, we will examine possibilities of a generalization of our results to the nonlinear system $x_i' = a_i(t)\Phi_{\alpha_i}(x_{i+1})$, $i = 1, \dots, n$, where x_{n+1} means x_1. This system includes, among other objects, nonlinear two-term differential equations of arbitrary order (even as well as odd). The concept of strongly increasing solutions will also be mentioned.

This is joint work with Serena Matucci, University of Florence, Italy.

Luigi Riba **Tue 4 Sep: 17.50-18.10**
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Continuous inversion formulas for multi-dimensional Stockwell transforms

Stockwell transforms as hybrids of Gabor transforms and wavelet transforms have been studied extensively. We introduce in this paper multi-dimensional Stockwell transforms that include multi-dimensional Gabor transforms as special cases. Continuous inversion formulas for multi-dimensional Stockwell transforms are proved.

Luigi Rodino **Wed 5 Sep: 9.30-10.10**
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Weyl asymptotics and Dirichlet divisors

We consider tensor products of self-adjoint partial differential operators or pseudo-differential operators on compact manifolds and Euclidean spaces. The Weyl asymptotics for the counting functions are then determined by solving related problems for Dirichlet divisors (results in collaboration with T.Gramchev, S.Pilipovic, J.Vindas).

David Rottensteiner **Wed 5 Sep: 12.10-12.30**
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The Heisenberg group of the Heisenberg group: Its representation theory and applications to ΨDO's and coorbit space theory

On the Heisenberg group $\mathbf{H}^n$, a construction similar to the one that leads from $\mathbb{R}^n$ to $\mathbf{H}^n$, gives rise to a 3-step nilpotent Lie group $\mathbf{N}^n$. As its representation theory can be studied by means of Kirillov's orbit method, it turns out all its important unitary irreducible representations are, as in case of $\mathbf{H}^n$, given by a family of operators parameterized in $\mathbb{R}^*$. An interesting exploitation of the latter lies in the formulation of a Weyl-quantization of pseudo-differential operators on $\mathbf{H}^n$.

A further interesting application arises through the definition of a class of coorbit spaces on $\mathbf{H}^n$ in analogy to Feichtinger and Gröchenig's modulation spaces on $\mathbb{R}^n$ as coorbit spaces induced by the reduced Schrödinger representation of $\mathbf{H}^n_{red}$.

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Wed 5 Sep: 11.25-12.05

Gevrey functions and ultradistributions on compact Lie groups and homogeneous spaces

In this talk we give characterisations to Gevrey spaces of ultradifferentiable functions and to spaces of ultradistributions on compact Lie groups and compact homogeneous spaces in terms of the representation theory of the group and the spectrum of the Laplace-Beltrami operator. Examples of spaces include real spheres, complex and quaternionic projective spaces. The talk will be based on the joint works with Aparajita Dasgupta (London) and with Ville Turunen (Helsinki).

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Thu 6 Sep: 12.35-12.55

On the completeness of impulsive gravitational waves

In this talk we will discuss the notion of N-fronted waves with parallel rays (NPWs), which are a generalization of pp-wave type space-times (plane-fronted waves with parallel rays). In these space-times one allows for an arbitrary wave surface N, where N is any connected Riemannian manifold. These space-times model for example gravitational waves in general relativity. We will show that in the impulsive limit NPWs are geodesically complete in a sense that can only be made mathematically rigorous in the setting of Colombeau's generalized functions.

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Fri 7 Sep: 11.25-12.05

Ideals of the ring of generalized constants with continuous parametrisation

We extend in the case of generalized constants with continuous parametrisation the methods used in the book of Gilmann and Jerison "Rings of continuous functions". We establish a correspondence between filters of characteristic closed subsets of $(0, 1]$ and ideals. on the set of characteristic closed subsets. We establish the notion of "extension" and a related topology which leads to correspondence between on one hand filters with the said topology and on the other ideals with the sharp topology. We define a notion of pseudoprime fitlers which corresponds to pseudoprime ideals and prove that maximal ideals are the closure of prime and pseudoprime ideals and they correspond to ultrafilters of characteristic closed subsets. Finally we investigate z-ideals and also the existence of rapid filters and ultrafilters in the case that the continuum hypothesis is true.
This is joint work with Khelif Anatole and Hans Vernaeve.

Dora Seleši **Mon 3 Sep: 15.45-16.05**
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Applications of chaos expansions to solving SPDEs

We present some applications of the Wiener-Ito chaos expansion in white noise spaces to solve certain classes of stochastic differential equations.

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Adelic wavelet bases and pseudo-differential operators

This talk (based on the papers [3]-[5]) is devoted to wavelet analysis on the adele ring $\mathbb{A}$ and the theory of pseudo-differential operators. We develop the technique which gives the possibility to generalize finite-dimensional results of wavelet analysis to the case of adeles $\mathbb{A}$ by using infinite tensor products of Hilbert spaces. We prove that $L^2(\mathbb{A}) = \otimes_{e,p\in\{\infty,2,3,5,\dots\}} L^2(\{\mathbb{Q}_p)$ is the infinite tensor product of the spaces $L^2(\mathbb{Q}_p)$. Here infinite tensor product depends on the special stabilization $e = (e_p)_p$, where $e_p(x_p) = \Omega(|x_p|_p)$, and $\Omega(t)$ is the characteristic function of $[0,1] \subset \mathbb{R}$. This description allows us to construct an infinite family of Haar wavelet bases on $L^2(\mathbb{A})$. Using the idea of constructing separable multidimensional MRA by means of the tensor product of one-dimensional MRAs suggested by Y. Meyer and S. Mallat, the adelic Haar multiresolution analysis (MRA) in $L^2(\mathbb{A})$ is constructed. In the framework of this MRA infinite family of Haar wavelet bases is constructed.
We introduce the adelic Lizorkin spaces of test functions $\Phi(\mathbb{A})$ and distributions $\Phi'(\mathbb{A})$. These spaces are constructed by using the original real Lizorkin spaces introduced in [6] and the p-adic Lizorkin spaces introduced in [2], [1]. The characterization of the adelic Lizorkin spaces in terms of wavelets is given. Namely, it is proved that any test function from $\Phi(\mathbb{A})$ can be represented in the form of a *finite* combination of adelic wavelet functions, and any distribution from $\Phi'(\mathbb{A})$ can be represented as an *infinite* linear combination of adelic wavelet functions.
Next, a class of pseudo-differential operators on the adelic Lizorkin spaces is introduced. The fractional operators $D^{\widehat{\gamma}}$, $\widehat{\gamma} \in \mathbb{C}^{\infty}$, and D^{γ}, $\gamma \in \mathbb{C}$ belong to this class. The Lizorkin spaces of test functions $\Phi(\mathbb{A})$ and distributions $\Phi'(\mathbb{A})$ are *invariant* under the above-mentioned pseudo-differential operators. Thus the Lizorkin spaces constitute "natural" domains of definition for this class of pseudo-differential operators. We derive a criterion for an adelic wavelet function to be an eigenfunction for a pseudo-differential operator. It is proved that any wavelet function is an eigenfunction of a fractional operator.

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Wave equations on non-smooth space-times

We consider wave equations on Lorentzian manifolds in case of low regularity. We first extend the classical solution theory to prove global unique solvability of the Cauchy problem for distributional data and right hand side on smooth globally hyperbolic space-times. Then we turn to the case where the metric is non-smooth and present a local as well as a global existence and uniqueness result for a large class of Lorentzian manifolds with a weakly singular, locally bounded metric in Colombeau's algebra of generalized functions.
(Joint work with Günther Hörmann and Michael Kunzinger, University of Vienna)

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Tue 4 Sep: 15.45-16.25

Invertible multipliers whose inverses can be written as multipliers

Let $\Phi = (\phi_n)_{n=1}^{\infty}$ and $\Psi = (\psi_n)_{n=1}^{\infty}$ be sequences with elements from a Hilbert space $\mathcal{H}$ and let $m = (m_n)_{n=1}^{\infty}$ be a complex scalar sequence. An operator of the form

$$M_{m,\Phi,\Psi} = \sum_{n=1}^{\infty} m_n \langle f, \psi_n \rangle \phi_n$$

is called a *multiplier*. A multiplier $M_{m,\Phi,\Psi}$ defined on $\mathcal{H}$ is called *invertible* if it has a bounded inverse $M_{m,\Phi,\Psi}^{-1} : \mathcal{H} \to \mathcal{H}$.
It is known that if Φ and Ψ are Riesz bases for $\mathcal{H}$ and m satisfies $0 < \inf_n |m_n| \leq \sup_n |m_n| < \infty$, then the multiplier $M_{m,\Phi,\Psi}$ is invertible and

$$M_{m,\Phi,\Psi}^{-1} = M_{1/m,\widetilde{\Psi},\widetilde{\Phi}}, \tag{4}$$

where $\widetilde{\Phi}$ and $\widetilde{\Psi}$ denote the canonical dual frames of Φ and Ψ, respectively. This result has opened the questions: *Are there other invertible multipliers whose inverses can be written as multipliers? Are there other invertible multipliers $M_{m,\Phi,\Psi}$ whose inverses can be written as in* (4)*?*
In this talk we give affirmative answers to the above questions and present results connected to the questions.
The talk is based on a joint work with P. Balazs.

Nenad Teofanov **Fri 7 Sep: 17.00-17.20**
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Spectral asymptotic of a class of SG-type operators

We consider a class of pseudo-differential operators defined by smooth symbols which may have almost exponential growth or decay at infinity in phase space. Such operators might be considered as symbol-global type (SG-type) operators, which are studied by many authors in the context of PDE. Usually, the growth and decay of symbols of SG-type operators is bounded by a polynomial or an inverse polynomial and therefore their continuity properties might be formulated within tempered distributions. In our case, one should use techniques from ultradistribution theory and corresponding spaces of test functions. Furthermore, we use time-frequency methods and, in particular, Gabor frames in the study of spectral asymptotics.

Joachim Toft **Tue 4 Sep: 10.15-10.55**
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Multiplication properties in pseudo-differential calculus with small regularity assumptions on the symbols

There are four important products which appear on the symbol levels in pseudo-differential calculus. The composition of two Weyl quantizations corresponds on the symbol level on the so called *Weyl product*. The *convolution* appears when putting the theory of Toeplitz operators (the same as localization operators) on functions on $\mathbf{R}^d$ into the context of pseudo-differential calculus, using the fact that the Weyl symbol of a Toeplitz operator is a convolution by the Toeplitz symbol and an other convenient function. Finally, the *twisted convolution* and ordinary *multiplication* appear when applying the (symplectic) Fourier transform on Weyl products and ordinary convolutions, respectively.
In the talk we establish Young and Hölder relations for such products on Schatten-von Neumann symbols, Lebesgue spaces and modulation spaces. We use the results to extend the class of possible window functions in the definition of modulation spaces, and to prove that any Schatten-p symbol in the Weyl calculus gives rise to a Schatten-p Toeplitz operator. The Schatten-von Neumann classes here are of the form $\mathscr{I}_p(\mathscr{H}_1, \mathscr{H}_2)$, where $\mathscr{H}_1, \mathscr{H}_2$ are Hilbert spaces of (ultra-)modulation space type which stay between the Gelfand-Shilov space $\Sigma_1(\mathbf{R}^d)$ and its dual $\Sigma_1'(\mathbf{R}^d)$. Furthermore, the symbol classes of pseudo-differential operators stay between $\Sigma_1(\mathbf{R}^{2d})$ and its dual $\Sigma_1'(\mathbf{R}^{2d})$.

Giorgia Tranquilli **Fri 7 Sep: 16.10-16.30**
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Global properties and normal forms of second order Shubin type operators

We outline some new results on the reduction to simpler normal forms of second order linear differential operators of Shubin type. We use the normal forms for studying global regularity and global solvability in Gelfand–Shilov spaces.
The results are obtained in collaboration with T. Gramchev (University of Cagliari).

Ville Turunen
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Tue 4 Sep: 15.00-15.40

Pseudo-differential operators and symmetries: old and new

We will outline the historical development of the concepts involved in pseudo-differential calculus on spaces with ample symmetries (i.e. on homogeneous spaces of compact Lie groups, and on nilpotent Lie groups), up to the recent results obtained by e.g. D. Connolly (Imperial College London), V. Fischer (University of Padova, King's College London), M. Ruzhansky (Imperial College London) and J. Wirth (University of Stuttgart).

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Fri 7 Sep: 10.15-10.55

Distributions having a value at a point in the sense of Robinson

We characterize Schwartz distributions having a value at a single point in the sense introduced by means of nonstandard analysis by A. Robinson. They appear to be continuous functions in a neighborhood of the point. This characterization improves a result by P. Loeb which assumes the everywhere existence of point values.
(Joint work with Jasson Vindas.)

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Fri 7 Sep: 9.30-10.10

Asymptotic distribution of Beurling's generalized prime numbers

This talk is a survey on classical and recent results concerning the asymptotic distribution of generalized prime numbers. Some open problems and conjectures will be discussed.
The goal of Beurling's generalized prime number theory is to replace the ordinary prime numbers by a rather arbitrary non-decreasing sequence of positive real numbers (generalized primes), consider then the multiplicative semigroup generated by it (generalized integers), and then establish relations between asymptotic properties of the counting functions of generalized primes and integers.
We will discuss various conditions that ensure the validity of the prime number theorem. Interestingly, in the context of generalized number systems, the prime number theorem is not always true. It is therefore natural to ask whether at least Chebyshev type estimates are satisfied, we will also address the problem of finding conditions that guarantee such estimates.

Marko Vrdoljak **Tue 4 Sep: 17.25-17.45**
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Homogenisation theory for Friedrichs systems

Homogenisation theory was originally developed for the stationary diffusion equation; considering a sequence of such problems, with common boundary conditions, the homogenisation theory asks the question what form will the limiting equation take. The notions of G-convergence of corresponding operators, and of H-convergence (also known as the strong G-convergence) of coefficients are introduced. Similar questions were also studied for parabolic problems, the equations of linearised elasticity etc.
Friedrichs systems can be used to represent various boundary value problems for partial differential equations, therefore it is of interest to study the homogenisation in such a general framework, generalising the known situations. After introducing some additional assumptions, we are able to define the appropriate notions of G and H-convergence for particular families of Friedrichs systems, and to prove that they have the properties of compactness, locality etc.
This is a joint work with Krešimir Burazin.

Patrik Wahlberg **Tue 4 Sep: 12.10-12.30**
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Schrödinger type propagators, pseudodifferential operators and modulation spaces

We prove continuity results for Fourier integral operators with symbols in modulation spaces, acting between modulation spaces. The phase functions belong to a class of nondegenerate generalized quadratic forms that includes Schrödinger propagators and pseudodifferential operators. As a byproduct we obtain a characterization of all exponents $p, q, r_1, r_2, t_1, t_2 \in [1, \infty]$ of modulation spaces such that a symbol in $M^{p,q}(\mathbb{R}^{2d})$ gives a pseudodifferential operator that is continuous from $M^{r_1,r_2}(\mathbb{R}^d)$ into $M^{t_1,t_2}(\mathbb{R}^d)$.
This is a collaboration with E. Cordero and A. Tabacco.

Man Wah Wong **Tue 4 Sep: 9.30-10.10**
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The heat kernel and Green function of the twisted bi-Laplacian

After a recapitulation of some well-known facts on the spectral analysis on the twisted Laplacian, which comes from the sub-Laplacian on the Heisenberg group by taking the inverse Fourier transform with respect to the center, we give an introduction to the twisted bi-Laplacian. The aim of this talk is to describe the construction of "explicit" formulas for the heat kernel and Green function of the twisted bi-Laplacian. (This is joint work with Ms. Xiaoxi Duan who is my Ph.D. student at York University.)

Lukas Wurzer
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Mon 3 Sep: 17.50-18.10

Stochastic partial differential equations with random set coefficients

The talk is about an attempt to connect the theory of SPDEs with the theory of random sets. Thereby we focus on PDEs with a white noise inhomogenity. In the case of two or more space dimensions this requires to work out a theory of distribution-valued random sets. In general a random set is a set-valued random variable with certain measurability properties. Modelling the coefficients of SPDEs as intervals or random sets leads to solutions that can be considered as random sets in distribution spaces. The goal is to study the measurability properties of distribution-valued random sets and to develop methods for computing its upper and lower probabilities.
The talk is based on joint work with Michael Oberguggenberger.

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