Paths to, from and in renormalization

At the confluence of rough paths, algebra, analysis and geometry

Photo by Botaurus - Havel Neue Fahrt Potsdam.

Universität Potsdam - Institut für Mathematik
8-12 February, 2016

Meeting program
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Foreword

Renormalisation techniques, initiated by physicists in the context of quantum field theory to make sense of a priori divergent expressions, have since then been revisited, transposed and further developed by mathematicians in various disguises. Ideas borrowed from renormalisation have inspired mathematicians with very different domains of expertise and given new impulses in many a field such as analysis (with Ecalle's theory of resurgence, resolution of singularities), algebra (Birkhoff-Hopf factorization, Rota-Baxter operators), differential geometry (quantum field theory on Lorentzian space-time), algebraic geometry (motives, multi-zeta values) and probability (regularity structures).

This profusion of approaches to and inspired from renormalisation techniques is propitious for fruitful interdisciplinary interactions, which this workshop aims at identifying and stimulating. It aims at bringing together mathematicians (algebraists, geometers and analysts) and physicists, who will present their work involving renormalisation, thus encouraging the dialogue between various communities using the concept of renormalisation.

A previous interdisciplinary meeting of this kind, "Renormalisation from Quantum Field Theory to Random and Dynamical Systems", organized by two of the present coorganisers (D. Manchon and S. Paycha, together with M. Högele) in Potsdam in November 2013, proved extremely successful insofar as it actually stimulated interactions between researchers from different communities, in particular between geometers, physicists and probabilists. Many participants expressed their enthusiasm for this rather unusually broad interdisciplinary meeting yet with enough common ground for fruitful interactions. Two years later, we feel that the time has come to organise another confrontation of ideas around renormalisation related issues, in the form of a meeting involving some of the participants of the previous one and new ones who can bring in yet another outlook on these issues.

The meeting will be organised around 4 mini-courses (3 hours each in total) in the mornings and 50 minute talks in the afternoons. The mini-courses will serve as introductions to specific active research topics where renormalisation plays a central role.

Acknowledgements: Thanks to Jean Downes, Magdalena Georgescu, Steffanie Rahn and Jana Tesch, who helped us sort out some of the organizational details.

In addition, many thanks to Deutsche Forschungsgemeinschaft, Groupement de Recherche Renormalisation, SFB Raum, Zeit und Materie, Technische Universität (Berlin), Université Blaise-Pascal (Clermont-Ferrand), Weierstrass Institute and Universität Potsdam for their support towards making this meeting possible.

The organizers: Peter Friz, Dominique Manchon and Sylvie Paycha

Talks

Index Theory on Lorentzian Manifolds

Christian Bär, Universität Potsdam

We show that the Dirac operator on a compact globally hyperbolic Lorentzian spacetime with spacelike Cauchy boundary is a Fredholm operator if appropriate boundary conditions are imposed. We prove that the index of this operator is given formally by the same expression as in the index formula of Atiyah-Patodi-Singer for Riemannian manifolds with boundary.

This is the first index theorem for Lorentzian manifolds. We explain the methods which enter the proof; they are, from an analytic perspective, quite different from the classical Riemannian case. Finally, we discuss an application in quantum field theory.

This is joint work with Alexander Strohmaier.

Ecalle's Alien Calculus and Schwinger-Dyson Equations

Marc Bellon, CNRS, Paris

The Borel resummation procedure is a powerful tool that allows to extract information from certain divergent series. Ecalle's Alien calculus then provides a way to control singularities of the Borel transform of a function, which in turn give access to non-perturbative terms in the original function. We will see in simple cases how a family of such terms, proportional to some non-perturbative scale, is given by the renormalisation group. These terms are of particular relevance for they may combine to give masses to initially massless states. In our example, this will be carried out by summing this family of terms as a geometric series.

Wonderful Renormalization

Marko Berghoff, HU Berlin

In the position space formulation of QFT renormalization translates into an extension problem for distributions, as was shown by Epstein and Glaser already in the early seventies. Quite recently a more geometric approach to this problem was introduced by Bergbauer, Brunetti and Kreimer, using so-called wonderful models of subspace arrangements. These models provide a systematic way to resolve the singularities of distributions associated to Feynman graphs and thus allow for a definition of (canonical) extension operators.

I will explain this "wonderful renormalization" process and show how the poset of divergent subgraphs serves as the main tool to describe the wonderful model construction and the definition of the renormalization operators. The main motivation for this approach is the fact that both procedures are governed by the combinatorics of this poset. Not only does this simplify the exposition considerably, but it also allows to explore the renormalization group in this setting.

Asymptotic Expansions and Combinatorial Dyson Schwinger Equations

Michael Borinsky, Humboldt University Berlin

Most perturbative expansions in QFT are asymptotic series. This divergence is believed to be dominated by the factorial growth of the number of Feynman diagrams. Asymptotic expansions of this type have many interesting properties. In my talk, I will present some of these and discuss applications to 'post-perturbative' physics, in the scope of Dyson-Schwinger equations, as well as applications to combinatorial problems, which can be formulated as generalized Dyson-Schwinger-equations.

Polymer Measure with White Noise Potential and Renormalization

Giuseppe Cannizzaro, Technische Universität Berlin

The Polymer measure is the measure describing the motion of a brownian particle in a random environment, that in our case is the gaussian white noise. Due to the singularity of the medium in which the particle evolves such a measure is tremendously ill-posed and an argument is needed in order to make sense of it. As an application of the approach developed by Gubinelli, Imkeller and Perkowski in their, by now, celebrated paper "Paracontrolled Distributions and Singular SPDEs", we construct the Polymer measure with white noise potential in dimension d=2,3. We will explicitly point out how renormalization plays a crucial role not only in rigorously defining it but also in establishing some of its intrinsic properties such as its singularity with respect to the measure that would govern the motion of the particle in absence of noise. This is a joint work with Dr. Khalil Chouk.

Renormalizable Tensorial Field Theories as Models of Quantum Geometry

Sylvain Carrozza, University of Bordeaux

I wish to review recent works on tensorial field theories, which are combinatorially non-local field theories generalizing matrix models. In the same way as the latter are used to model random 2d surfaces, tensorial field theories are tentative models of random geometries in dimension higher than 3. Several renormalizable classes of theories have been studied in the last couple of years, from purely combinatorial models to more elaborate ones incorporating additional group-theoretic data from loop quantum gravity. Focusing on archetypical examples of such theories, I will illustrate how they resemble or differ from ordinary local quantum field theories. This will include a discussion of asymptotic freedom, and of non-trivial fixed points of the renormalization group flow.

An Analytic BPHZ Theorem for Regularity Structures

Ajay Chandra, University of Warwick

Within regularity structures divergences appear when performing moment estimates for the stochastic objects that are used in the expansion of the solution to the given SPDE. In order to tame these divergences using counterterms two things must be verified:

(i) the insertion of the counterterm corresponds to a renormalization of the equation and is allowed by the algebraic structure of regularity structures, and

(ii) there is a way to choose the value of counterterms which make the moment estimates finite and of the correct homogeneity.

This verification is difficult when the divergences become numerous and are nested/overlapping. Recent work by Bruned, Hairer, and Zambotti provides a robust framework to handle the first issue; I will describe how the second can be treated with multiscale analysis. This is joint work with Martin Hairer.

Continous Anderson Hamiltonian in Dimension Two

Khalil Chouk, Humboldt University

I will present in this talk a way to construct Schrodinger operator with exteremly rough potential. As an application we will focus on the special case of the white noise potential for wich is necessary to introduce a renormalization procedure to get a non trivial limit.

Resurgence Monomials

Frederic Fauvet, IRMA, Université de Strasbourg

A great number of divergent series appearing in solutions of dynamical systems at singularities, or else in perturbative expansions in quantum mechanics or quantum field theory share common features — namely, they are of resurgent type — and their divergence pattern can be tackled with the help of Ecalles' alien calculus. Resurgence monomials constitute explicit families of functions which are dual to the so-called alien derivations. We shall describe their use for some specific problems, introducing all the necessary concepts along the way.

Loop of Formal Diffeomorphisms

Alessandra Frabetti, Institut Camille Jordan, Université Lyon 1

Joint work with Ivan P. Shestakov (Sao Paulo). A model for QED renormalization makes use of a non-commutative version of the Faà di Bruno Hopf algebra. The commutative Hopf algebra represents the proalgebraic group of formal diffeomorphisms in one variable, while the non-commutative one of course does not. We will show that it represents a proalgebraic loop, which is not a Moufang loop, and how it is related to Sabinin algebras (also called hyperalgebras).

Malliavin Calculus and Regularity Structures

Paul Gassiat, Université Paris Dauphine

Many nonlinear stochastic PDEs arising in statistical mechanics are ill-posed in the sense that one cannot give a canonical meaning to the nonlinearity. Nevertheless, Martin Hairer's theory of regularity structures provides us with a good notion of solution for a large class of such equations. In this talk, I will explain how this theory can be combined with classical tools of Malliavin calculus, which allows in particular to obtain absolute continuity results for the marginal laws of the solutions.

Renormalization and the Euler-Maclaurin Formula on Cones

Li Guo, Rutgers University at Newark

The concepts of lattice cones and polar meromorphic germs are introduced to study regularized conical zeta values. The Algebraic Birkhoff Factorization of Connes and Kreimer, adapted and generalized to this context, then gives rise to a convolution factorization of exponential sums on lattice points in lattice cones. We show that this factorization gives the classical Euler-Maclaurin formula generalized to convex rational polyhedral cones by Berline and Vergne. This is joint work with Sylvie Paycha and Bin Zhang.

From Super Mapping Spaces to Renormalisation

Florian Hanisch, Institut für Mathematik, Universität Potsdam

The (formal) path integral quantisation of theories containing Fermions usually relies on some notion of mapping space for anticommuting fields. These spaces can be rigorously defined within the framework of supergeometry; the construction systematically involves higher chain rules. In particular, a smooth map (e.g. the exponential of the action) on such a space comes along with a certain combinatorial structure arising from Faa-di-Bruno-type formulas. Furthermore, the

Bochner-Minlos theorem is available in this setting since the mapping spaces are nuclear.

I am now interested in the following question(s): Is there an interpretation of the aforementioned combinatorial structure in terms of perturbation expansions / Feynman diagrams? If yes, does renormalisation theory provide a link between the combinatorial aspects and the analytical structures obtained from the Bochner-Minlos theorem? The aim of the talk is the discussion of ideas rather than presenting complete results.

φ-deformed Shuffle Bialgebras and Renormalization in Quantum Field Theory

Vincel Hoang Ngoc Minh, Université Lille 2

We treat φ-deformations of the shuffle product, where φ is the law of a semi-group and then of a general associative algebra :

- We show that associativity, commutativity and dualizability of the resulting law are equivalent respectively to associativity, commutativity and local finiteness of φ.
- Even better, the moderate growth of φ ensures the existence and an effective construction of the primitive elements through the logarithm of the diagonal series.
- Constructions of bases of Lie algebras of primitive elements and of pure transcendence bases become then effective as well as those of pairs of bases, in duality (which, in this case, remains within polynomials), of the obtained bi-algebras.

As applications, we give a process to renormalize globally the polyzetas, at positive multi-indices as well as at negative multi-indices, and draw a precise picture of their structure thanks to the infinite factorizations of the noncommutative generating series of polylogarithms and of harmonic sums.

Renormalisation and Resurgent Transseries in Quantum Field Theory

Lutz Klaczynski, Institut fuer Physik, Humboldt Universität zu Berlin

It is generally believed that the perturbative expansions encountered in quantum field theory are divergent series. A 'nonperturbative completion' involving resurgent transseries is thus required for a full characterisation of the sought-after functions, where the rationale is that they at least belong to Ecalle's class of analysable functions. However, the form of these series is currently only known for some toy models in lower and partly compactified dimensions. After a brief discussion of the path integral-based ideas currently floated in favour of a certain form of transseries, I will explain how renormalisation acts as a decisive game changer and why we probably have to reckon with quite exotic transseries when we hopefully one day manage to pass the threshold to fully fledged renormalisable theories like the Standard Model. To support this view, I present my latest negative yet interesting results concerning Dyson-Schwinger equations.

From Renormalization to Cutkosky rules

Dirk Kreimer, Humboldt-Universität zu Berlin

To understand the analytic structure of Feynman graphs, one needs to combine the renormalization Hopf algebra with the core Hopf algebra. Together, they allow to analyse Cutkosky rules in an efficient way.

Path Integrals, Asymptotic Expansions and Zeta Determinants

Matthias Ludewig, Universität Potsdam

It is “well-known” in quantum mechanics that the values of certain path integrals are given by associated zeta-determinants “up to a multiplicative constant”, by which is usually meant that one can only calculate the ratio of path integrals by the ratio of zeta functions. We investigate path integral formulas for the heat kernel of a Riemannian manifold and give a rigorous meaning to the above statements in this case. Furthermore, we show how the heat kernel asymptotics are related to formal asymptotic expansions on path space.

Discretisations of Rough Stochastic PDEs

Konstantin Matetski, University of Warwick

Due to a recent breakthrough of Martin Hairer, a notion of solution was given to a large class of rough stochastic PDEs, including the KPZ equation, the parabolic Anderson model and so on. In my talk I will give a basic description of a framework, which allows to consider spatial discretisations of rough equations, and investigate convergence to their continuous counterparts.

Elementary Renormalization for Linear Algebra and Differential Equations

Frederic Menous, Laboratoire de Mathématique, Paris-Sud University

The work of A. Connes and D. Kreimer in perturbative quantum field theory has made possible an algebraic interpretation of some renormalization schemes, as the Birkhoff decomposition of regularized characters, that is of elements of the group of algebra morphisms from a graded commutative Hopf algebra to the algebra of Laurent series. I will try to explain on very elementary examples, how this method of regularization-renormalization arises in very simple situations in mathematics: linear algebra, differential equations, and finally, in the study of resonant vector fields.

Regularization of Hyperlogarithms

Erik Panzer, All Souls College

Hyperlogarithms form an algebra and are defined by the character of iterated integration on a shuffle algebra of differential forms. They have logarithmic singularities and I will discuss how one can define regularized limits at these singular points using minimal subtraction. Combinatorial identities in the shuffle algebra play a crucial role to obtain explicit formulas for these limits. Finally, it will become clear how changing the basepoint of the iterated integrals is related to renormalization.

A Martingale Problem for the KPZ Equation

Nicolas Perkowski, Humboldt Universität zu Berlin

I will present a probabilistic approach to the Kardar-Parisi-Zhang equation, a singular stochastic PDE that could be solved rigorously for the first time by Hairer with the help of rough path integrals. By using martingale techniques and a certain forward-backward structure of the solution we are able to give an alternative formulation that turns out to be a very powerful tool for proving stochastic limit theorems. I will discuss how to obtain the uniqueness of martingale solutions and how to apply this to study the equilibrium fluctuations of certain growth processes. Based on joint works with Joscha Diehl and Massimiliano Gubinelli.

Renormalization for Stochastic PDEs with non-Gaussian Noise

Hao Shen, Columbia University

Many singular SPDEs driven by (Gaussian) white noise have recently been solved (i.e. shown to be well-posed) using regularity structure theory or the alternative theories. If ζ is a non-Gaussian random field which converges to the white noise under scaling, one might think that the solution to the SPDE driven by ζ also converges to the same solution. We show that in general this is not true, unless extra renormalization, which depends on higher cumulants of ζ, is incorporated. Examples are the KPZ equation, dynamical Phi4 equation and stochastic heat equation with multiplicative noise. The talk is based on joint works with Ajay Chandra, Martin Hairer and Weijun Xu.

Dynamical Φ^4_3 on Large Scales

Hendrik Weber, University of Warwick

One of the first spectacular applications of Hairer's theory of regularity structures was the construction of a canonical Markov process which is reversible with respect to the Φ^4_3 measure on finite volume. However, in this breakthrough contribution only a local existence and uniqueness theorem was provided and the possibility of finite time blow-up was not ruled out.

In this talk I will explain how to address this issue. I will first explain an alternative to Hairer's point of view, which was developed by Catellier and Chouk based on previous work by Gubinelli, Imkeller and Perkowski. Then I will show how this framework can be used to derive energy inequalities that show that solutions cannot blow up. This is joint work with J.C. Mourrat (Lyon).

Laurent Theory for Meromorphic Germs with Linear Poles

Bin Zhang, Sichuan University

Germs of meromorphic functions with linear poles at zero naturally arise in various contexts in mathematics and physics. We provide a version of Laurent theory of the algebra of such germs into the holomorphic part and a linear complement by means of an inner product, using our results on cones and the associated fractions in an essential way.

Minicourses: Description

There are four minicourses, each lasting 3 hours in total. The minicourse talks are scheduled Monday-Thursday during the morning session. We give here an overview of the minicourses; the abstracts start on the next page.

I: **Combinatorial Hopf algebras of Trees and Applications**

- Y. Bruned, parts i) and ii): Hopf Algebras on Labelled Forests: Application to Regularity Structures
- L. Foissy, part iii): Systems of Dyson-Schwinger Equations with Several Coupling Constants

II: **Renormalization in Regularity Structures**

- L. Zambotti, parts i)-iii): Renormalization in Regularity Structures

III: **Renormalization of (q-)multiple Zeta Values**

- J. Singer, part i): On the Renormalization Problem of Multiple Zeta Values
- K. Ebrahimi-Fard, part ii): q-Multiple Zeta Values I: from Double Shuffle to Regularization
- J. Singer, part iii): q-Multiple Zeta Values II: from Regularization to Shuffle Renormalization

IV: **Perturbative algebraic quantum field theory**
A mathematical (perturbative) quantum field theory of gauge fields and gravitation has been recently achieved by using tools from distribution theory and infinite-dimensional analysis. In this minicourse, the distribution theoretical aspects will be described in detail and the general framework will be presented.

- C. Brouder, part i): Multiplication of Distributions and Renormalization
- N. Dang, part ii): Multiplication of Distributions and Renormalization (cont'd)
- K. Rejzner, part iii): Epstein-Glaser Renormalization on Curved Spacetimes: Algebraic Structures and Analytic Properties

Minicourses: Abstracts

Multiplication of Distributions and Renormalization

Christian Brouder, Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie

Renormalization can be interpreted as a way to multiply distributions. Hörmander gave a powerful condition to multiply two distributions by comparing their wave front sets. In the first lecture, the concept of a wave front set will be introduced in detail and examples of its use to multiply distributions will be given. Some topological aspects of the multiplication of distributions will be sketched. In quantum field theory, Hörmander's condition is not sufficient to multiply distributions everywhere. The missing piece of the product is obtained as an extension of a distribution. In the second lecture, a general method will be given to extend distributions, the relationship with more classical methods like the meromorphic regularization will be discussed and concrete calculations will be carried out.

Hopf Algebras on Labelled Forests: Application to Regularity Structures

Yvain Bruned, University of Warwick

We present two Hopf algebras on labelled forests which play a major role in the context of Regularity Structures. One is used for the definition of the structure group and can be viewed as a positive renormalisation. The other one is used to define the renormalisation group which allows us to modify our regularised model and to prove its convergence. These constructions are inspired by the Connes-Kreimer Hopf algebra of rooted forests and the substitution Hopf algebra used in the context of Rung-Kunta methods.

Multiplication of Distributions and Renormalization

Nguyen-Viet Dang, ICJ Lyon 1

The abstract is the same as for Christian Brouder, as it is a shared minicourse.

q-Multiple Zeta Values I: from Double Shuffle to Regularization

Kurusch Ebrahimi-Fard, Instituto de Ciencias Matemáticas

Generalizations of multiple zeta values (MZVs) to power series in Q[[q]] are commonly referred to as q-analogues of MZVs (q-MZVs). More recently, certain q-MZVs were shown to satisfy regularized double shuffle relations. Several of these q-MZVs can be defined for any integer arguments since the q-parameter provides an appropriate regularization. This talk is the first part of a series of talks to be presented together with J. Singer. It provides an introduction to joint works with D. Manchon, J. Singer and J. Zhao.

Systems of Dyson-Schwinger Equations with Several Coupling Constants

Loïc Foissy, Université du Littoral

In a quantum field theory, the propagators satisfy a system of Dyson-Schwinger equations in a Hopf algebra of Feynman graphs. Using a universal property, these systems can be lifted to the Hopf algebra of decorated rooted trees with the help of grafting operators. The coupling constant induces a gradation on this Hopf algebra, and one question is to know if the graded subalgebra H_S generated by the unique solution of such a system is Hopf. In the φ^3 and the QED case, this gradation, given by the loop number, H_S is indeed a Hopf subalgebra, but this is false for QCD. A solution is to introduce more coupling constants, that is to say to refine the gradation by the loop number by a $\mathbb{N}^N$-gradation. We will construct a family of examples of systems given a Hopf algebra for such a gradation, including the QCD case, and discuss the minimal value of N needed to obtain a Hopf subalgebra.

Epstein-Glaser Renormalization on Curved Spacetimes: Algebraic Structures and Analytic Properties

Kasia Rejzner, University of York

In this talk I will give an overview of Epstein-Glaser renormalization in the modern approach of Brunetti, Fredenhagen and Duetsch. Since this renormalization scheme is working in position space, it is a natural framework for QFT on curved spacetime, where the Fourier transform (and hence the momentum space picture) is not readily available. I will start with describing the algebraic structures appearing in this approach (focusing on BV algebras and Hopf algebras) and then present the functional analytic aspects. The latter require the tools which will be introduced by Christian Brouder and Nguyen-Viet Dang in the first two lectures of the minicourse.

On the Renormalization Problem of Multiple Zeta Values

Johannes Singer, Friedrich-Alexander-Universität Erlangen-Nürnberg

Multiple zeta values (MZVs) are multidimensional generalizations of the Riemann zeta function which are usually studied at positive integer values. Calculating MZVs at arguments of arbitrary sign such that the meromorphic continuation is verified and the compatibility with respect to the quasi-shuffle product is assured, is commonly known as the renormalization problem of MZVs.

In this talk we present all solutions to this problem and provide a natural framework for comparing them in terms of a group action. Finally, we clarify the relation between different renormalizations at non-positive values appearing in the recent literature. This is a joint work with Kurusch Ebrahimi-Fard, Dominique Manchon and Jianqiang Zhao.

q-multiple Zeta Values II: from Regularization to Shuffle Renormalization

Johannes Singer, Friedrich-Alexander-Universität Erlangen-Nürnberg

In the talk we study the Hopf algebra of multiple polylogarithms and the corresponding q-analogue at non-positive arguments which are closely related to the shuffle product of MZVs. In order to obtain renormalized MZVs for all non-positive arguments we apply the procedure of renormalization introduced by Connes and Kreimer in perturbative quantum field theory. This talk is the second part of a series of talks to be presented together with K. Ebrahimi-Fard. It is based on a joint work with K. Ebrahimi-Fard and D. Manchon.

Renormalization in Regularity Structures

Lorenzo Zambotti, Université Pierre et Marie Curie

The theory of Regularity Structures has been developed recently by Martin Hairer in order to solve a class of singular stochastic partial differential equations. Such equations are ill-posed in a classical sense since they contain non-linearities of random objects which are distributions (generalized functions). One of the steps of this theory is the renormalization of regularized solutions. In this step the original equation is modified in a consistent way in order to obtain a well-defined and unique limit when the regularization is removed. I plan to give an introduction to regularity structures and to focus on the renormalization step, following an approach recently developed in collaboration with Yvain Bruned and Martin Hairer.

Schedule

	Mon, Feb 8	Tues, Feb 9	Wed, Feb 10	Thurs, Feb 11
9:00 - 9:50	L. Zambotti I	C. Brouder	N. Dang	Y. Bruned II
Coffee Break				
10:10 - 11:00	Y. Bruned I	L. Zambotti II	L. Zambotti III	K. Rejzner
11:10 - 12:00	J. Singer I	K. Ebrahimi-Fard	J. Singer II	L. Foissy
Lunch Break				
13:30 - 14:10	A. Frabetti	S. Carrozza	M. Borinksy	L. Guo
14:20 - 15:00	C. Bär	E. Panzer	P. Gassiat	H. Weber
Coffee Break				
15:20 - 16:00	F. Hanisch	D. Kreimer	H. Shen	A. Chandra
16:10 - 16:50	G. Cannizzaro	N. Perkowski	M. Berghoff	M. Bellon
17:00 - 17:40	K. Matetski	K. Chouk	F. Menous	M. Ludewig

Fri, Feb 12	
V. Minh	9:00 - 9:40
B. Zhang	9:50 - 10:30
Coffee Break	
F. Fauvet	10:50 - 11:30
L. Klaczynski	11:40 - 12:20

The slots for mini-course talks are highlighted.

List of Participants

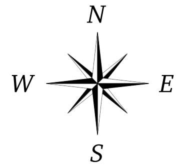
For the participants who are giving a talk, the page number of the abstract is shown.

Name	*e-mail address*	*Page*
Christian Bär	baer@math.uni-potsdam.de	3
Carlo Bellingeri	carlobellingeri@alice.it	
Marc Bellon	marc.bellon@upmc.fr	3
Marko Berghoff	berghoff@math.hu-berlin.de	3
Michael Borinsky	borinsky@physik.hu-berlin.de	4
Christian Brouder	christian.brouder@impmc.upmc.fr	12
Yvain Bruned	yvain.bruned@upmc.fr	12
Giuseppe Cannizzaro	giuse.cannizzaro@gmail.com	4
Sylvain Carrozza	sylvain.carrozza@gmail.com	4
Ajay Chandra	Ajay.Chandra@warwick.ac.uk	5
Ilya Chevyrev	Ilya.Chevyrev@maths.ox.ac.uk	
Khalil Chouk	khalil.chouk@gmail.com	5
Pierre Clavier	clavier@math.uni-potsdam.de	
Charles Curry	charles.curry@math.ntnu.no	
Yoann Dabrowski	dabrowski@math.univ-lyon1.fr	
Nguyen-Viet Dang	dang@math.univ-lyon1.fr	12
Gérard H. E. Duchamp	gheduchamp@gmail.com	
Catherine Ducourtioux	ducourtioux@univ-corse.fr	
Kurusch Ebrahimi-Fard	kurusch@icmat.es	12
Henri Elad Altman	henrielad@yahoo.fr	
Frédéric Fauvet	frederic.fauvet@gmail.com	5
Loïc Foissy	foissy@lmpa.univ-littoral.fr	13
Alessandra Frabetti	frabetti@math.univ-lyon1.fr	6
Peter Friz	friz@math.tu-berlin.de	
Marco Furlan	furlan@ceremade.dauphine.fr	
Ilmar Gahramanov	ilmar.gahramanov@aei.mpg.de	

(continued on next page)

Name	*e-mail address*	*Page*
Paul Gassiat	gassiat@ceremade.dauphine.fr	6
Marcel Golz	mgolz@physik.hu-berlin.de	
Li Guo	liguo@rutgers.edu	6
Florian Hanisch	fhanisch@uni-potsdam.de	6
Vincel Hoang Ngoc Minh	vincel.hoangngocminh@univ-lille2.fr	7
Peter Imkeller	imkeller@math.hu-berlin.de	
Lutz Klaczynski	klacz@math.hu-berlin.de	7
Dirk Kreimer	kreimer@math.hu-berlin.de	8
Matthias Ludewig	matthias_ludewig@gmx.de	8
Terry Lyons	Terry.Lyons@maths.ox.ac.uk	
Dominique Manchon	manchon@math.univ-bpclermont.fr	
Konstantin Matetski	K.Matetski@warwick.ac.uk	8
Frédéric Menous	frederic.menous@math.u-psud.fr	8
Daniele Oriti	daniele.oriti@aei.mpg.de	
Erik Panzer	erik.panzer@all-souls.ox.ac.uk	9
Sylvie Paycha	paycha@math.uni-potsdam.de	
Nicolas Perkowski	perkowsk@math.hu-berlin.de	9
Rosa Preiß	preiss@live.de	
Julian Purkart	purkart@physik.hu-berlin.de	
Ngo Quoc Hoan	quochoan_ngo@yahoo.com.vn	
Kasia Rejzner	kasia.rejzner@york.ac.uk	13
Hao Shen	pkushenhao@gmail.com	9
Johannes Singer	singer@math.fau.de	13
Christoph Stephan	christophstephan@gmx.de	
Nikolas Tapia	nikolas.tapia@etu.upmc.fr	
Johannes Thürigen	Johannes.Thuerigen@aei.mpg.de	
Hendrik Weber	hendrik.weber@warwick.ac.uk	10
Lorenzo Zambotti	lorenzo.zambotti@upmc.fr	14
Bin Zhang	zhangbin@scu.edu.cn	10

Map



Luisenplatz Süd
Bus and tram stop
approx. 10min walk

Waisenhaus Hotel
Lindenstr. 28
approx. 10min walk via Dortustr.

Altstadt Hotel
Dortustr. 9/10
approx. 15min walk via Dortustr.

Potsdam
Charlottenhof
Train station
approx. 15 min walk
via Zeppelinstr.

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Potsdam
Hauptbahnhof
approx. 17 min walk
via Breite Str.
past Länge Brücke

Kiezstr. 16
Location of talks
all walking distances shown
are measured from here