UNIVERSITÄT BIELEFELD
Faculty of Mathematics

SFB 1283

Activity month conference: SPDEs, optimal control and mean field games

10.–14. July 2023

ZiF - Center for Interdisciplinary Research

This workshop is part of the DFG-funded CRC 1283

Taming uncertainty and profiting from randomness and low regularity in analysis, stochastics and their applications

at Bielefeld University

Location: ZiF - Center for Interdisciplinary Research
See: https://www.uni-bielefeld.de/(en)/ZiF/Allgemeines/anreise.html

Organisers: L'ubomír Baňas, Lars Diening, Benjamin Gess, Michael Röckner

https://www.sfb1283.uni-bielefeld.de/2023_SPDE/

Schedule

Local German time	Monday (10.07.23)	Tuesday (11.07.239	Wednesday (12.07.23)	Thursday (13.07.23)	Friday (14.07.23)
(CEST)					
09:00-09:30	Welcome Address				
09:30-10:00	**Sanz-Sole**	**Berglund**	**Souganidis**		**Tretyakov**
10:00-10:30					
10:30-11:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:00-11:30	**Cardaliaguet**	**Friz**	**Delarue**	**Holden**	**Buckwar**
11:30-12:00					
12:00-12:30	**de Bouard**	**Li**	**Schoenmakers**	**Prohl**	**D. Zhang**
12:30-13:00					
13:00-13:30	Lunch Break	Lunch Break and Conference Picture	Lunch Break	Lunch Break	Lunch Break
13:30-14:00					
14:00-14:30	Poster Session	Poster Session	**Debussche**	Poster Session	
14:30-15:00	**Millet**	**Achdou**		**Hausenblas**	
15:00-15:30			Ladies' Workshop		
15:30-16:00	Coffee Break	Coffee Break		Coffee Break	
16:00-16:30	**Cox**	**Perkowski**		**T. Zhang**	
16.30-17:00					
17:00-17:30	**Bloemker**	**Jakobsen**		**Hofmanova**	
17:30-18:00					
18:00-18:30			Football & Beer		
18:30-19:00	Reception @ ZIF				
From 19:00			Ladies' Dinner	Conference Dinner	

Abstracts

Yves Achdou (Paris)

A short-term model for the oil industry addressing commercial storage (with C. Bertucci, J.M Lasry, P.L Lions, A. Rostand, J. Scheinkman)

We propose a plausible mechanism for the short-term dynamics of the oil market based on the interaction of a cartel, a fringe of competitive producers, and a crowd of capacity-constrained physical arbitrageurs that store the resource. The model leads to a system of two coupled nonlinear partial differential equations, with a new type of boundary conditions that play a key role and translate the fact that when storage is either full or empty, the cartel has enhanced strategic power. We propose a finite difference scheme and report numerical simulations. The latter result in apparently surprising facts: 1) the optimal control of the cartel (i.e., its level of production) is a discontinuous function of the state variables; 2) the optimal trajectories (in the state variables) are cycles which take place around the discontinuity line. These patterns help explain remarkable price swings in oil prices in 2015 and 2020. (with C. Bertucci, J.M Lasry, P.L Lions, A. Rostand, J. Scheinkman)

Nils Berglund (Orléans)

Stochastic resonance in stochastic PDEs

Stochastic resonance can occur when a multi-stable system is subject to both periodic and random perturbations. For suitable parameter values, the system can respond to the perturbations in a way that is close to periodic. This phenomenon was initially proposed as an explanation for glacial cycles in the Earth's climate. While its role in that context remains controversial, stochastic resonance has since been observed in many physical and biological systems. This talk will focus on stochastic resonance in parabolic SPDEs, such as the Allen-Cahn equation, when they are driven by a periodic perturbation and by space-time white noise. We will discuss both the case of one spatial dimension, in which the equation is well-posed, and the case of two spatial dimensions, in which a renormalisation procedure is required. This talk is based on joint works with Barbara Gentz and Rita Nader.

Dirk Blömker (Augsburg)

Stabilization by rough noise

In this talk we consider a model from epitaxial thin-film growth, which was originally introduced as a phenomenological growth model in the presence of a Schwoebbel barrier, where diffusing particles on a terrace are not allowed to jump down. This leads to an instability and the formation of hills. Although the deterministic model exhibits no problems for existence and uniqueness of solutions, we show that in the presence of arbitrarily small additive space-time white noise (due to fluctuations in the incoming particles) surprisingly all non-linear interactions in the model are eliminated. Thus the spatial roughness of the noise stabilizes the dynamics and suppresses the growth of hills in these models. Joint work with Johannes Rimmele.

Evelyn Buckwar (Linz)

A stochastic hierarchical model for low grade glioma evolution

A stochastic hierarchical model for the evolution of low grade gliomas is proposed. Starting with the description of cell motion using piecewise diffusion Markov processes (PDifMPs) at the cellular level, we derive an equation for the density of the transition probability of this Markov process using the generalised Fokker-Planck equation. Then a macroscopic model is derived via parabolic limit and Hilbert expansions in the moment equations. After setting up the model, we perform several numerical tests to study the role of the local characteristics and the extended generator of the PDifMP in the process of tumour progression. The main aim focuses on understanding how the variations of the jump rate function of this process at the microscopic scale and the diffusion coefficient at the macroscopic scale are related to the diffusive behaviour of the glioma cells. This is joint work with Amira Meddah, JKU, and Martina Conte, Politecnico di Torino

Pierre Cardaliaguet (Paris)

Mean field game with an informed major player

In this joint work with C. Rainer (U. Brest) and P. Bergault (U. Paris Dauphine), we study stochastic differential games with infinitely many small players and a major one who possesses some private information. The major player uses his information to influence the behavior of the small players and optimize his payoff depending on the small players' density. We show that his optimal strategy in the game with infinitely players exists and remains almost optimal in games with finitely many players.

Sonja Cox (Amsterdam)

Infinite-dimensional Wishart processes

A Wishart process is a time-homogeneous Markov process $(X_t)_{t\geq 0}$ taking values in the space of positive semi-definite matrices such that X_t has a (generalized) Wishart distribution for every $t \geq 0$. Wishart processes were introduced in the '90s by Bru, in particular, it was shown that Wishart processes are affine processes and solve certain SDEs. As such, Wishart processes have become a popular choice for modelling stochastic covariance. For example, Wishart processes are used in multi-dimensional Heston models to describe the instantaneous volatility in a multi-dimensional stochastic differential equation. However, models for energy and interest rate markets involve stochastic *partial* differential equations, and thus call for infinite-dimensional covariance models. In our work, we introduce and analyze infinite-dimensional Wishart processes, and discuss some of their advantages and short-comings.

Anne de Bouard (Palaiseau)

Subsonic limit in a stochastic Zakharov system

We will consider in this talk a Zakharov system, coupling a linear Schrödinger equation for the envelope of the electric field with a wave equation for the ion density deviation

Arnaud Debussche (Rennes)

Global well-posedness of the 2D nonlinear Schrödinger equation with multiplicative spatial white noise on the full space"

We consider the nonlinear Schrödinger equation with multiplicative spatial white noise and an arbitrary polynomial nonlinearity on the two-dimensional full space domain. We prove global well-posedness by using a gauge-transform introduced by Hairer and Labbè (2015) and constructing the solution as a limit of solutions to a family of approximating equations. This paper extends a previous result by Debussche and Martin (2019) with a sub-quadratic nonlinearity."

François Delarue (Nizza)

On the Optimal Rate for the Convergence Problem in Mean Field Control

The goal of this work is to obtain optimal rates for the convergence problem in mean field control. Our analysis covers cases where the solutions to the limiting problem may not be unique nor stable. Equivalently the value function of the limiting problem might not be differentiable on the entire space. Our main result is then to derive sharp rates of convergence in two distinct regimes. When the data are sufficiently regular, we obtain rates proportional to $N^{-1/2}$, with N being the number of particles. When the data are merely Lipschitz and semi-concave with respect to the first Wasserstein distance, we obtain rates proportional to $N^{-2/(3d+6)}$. Noticeably, the exponent $2/(3d+6)$ is close to $1/d$, which is the optimal rate of convergence for uncontrolled particle systems driven by data with a similar regularity. The key argument in our approach consists in mollifying the value function of the limiting problem in order to produce functions that are almost classical sub- solutions to the limiting Hamilton-Jacobi equation (which is a PDE set on the space of probability measures). These sub-solutions can be projected onto finite dimensional spaces and then compared with the value functions associated with the particle systems. In the end, this comparison is used to prove the most demanding bound in the estimates. The key challenge therein is thus to exhibit a convenient form of mollification. We do so by employing sup-convolution within a convenient functional Hilbert space. To make the whole easier, we limit ourselves to the periodic setting. We also provide some examples to show that our results are sharp up to some extent. Joint work with S. Daudin (Nice, France) and J. Jackson (Austin, Texas, USA)

Peter K. Friz (Berlin)

On rough stochastic differential equations

I will survey the key ideas of [Rough stochastic differential equations, F-Hocquet-Lê, arXiv2106.10340], a hybrid theory that combines Itô's stochastic - and Lyons' rough differential equations. A major role is played by a new stochastic variant of Gubinelli's controlled rough paths spaces, with norms related to Lê's stochastic sewing lemma. Applications included filtering, pathwise stochastic control, the analysis of interacting particle systems with common noise and related classes stochastic partial differential equation. Time permitting, I will present recent discrete approximation results (joint work with Lê-Zhang), and an application to mathematical finance (joint wort with C. Bayer, P. Bank, L. Pelizzari).

Erika Hausenblas (Leoben)

The stochastic Klausmeier system: existence of a martingale solution

Nonlinear partial differential equations appear naturally in many biological or chemical systems. E.g., activator-inhibitor systems play a role in morphogenesis but also in ecology. The topic of the talk is a nonlinear partial differential equation disturbed by stochastic noise. In particular, we show the existence of a martingale solution to the stochastic Klausmeier system arising in ecology using a stochastic version of a Tychanoff-Schauder type Theorem. Here we have to mention that the stochastic Klausmeier system is not monotone, nor do they satisfy a maximum principle. If there is some time, we will show also path wise uniqueness in dimension one. This is a joint work with Jonas Tölle.

Martina Hofmanova (Bielefeld)

Anomalous and total dissipation due to advection by Navier-Stokes equations

We show the existence of a velocity field v, solution of (randomly) forced Navier-Stokes equations, which produces total dissipation of kinetic energy in finite time when advecting a passive scalar ρ. The total dissipation holds true uniformly in the viscosity parameter and the initial conditions ρ_0, in particular the dissipation is anomalous. Our results extend to the case when ρ is replaced by a solution to the two or three dimensional (deterministic) Navier-Stokes equations advected by v. Based on a joint work with U. Pappalettera, R. Zhu and X. Zhu.

Helge Holden (Trondheim)

On the stochastic Camassa—Holm equation with transport noise

We will discuss recent work regarding the stochastic Camassa-Holm equation $u_t + uu_x + P_x + \sigma u_x \circ dW = 0$ and $P - Pxx = u^2 + u_x^2/2$. This is joint work with L. Galimberti (NTNU),KH Karlsen (Oslo), and PHC Pang (NTNU/Oslo).

Espen Robstad Jakobsen (Trondheim)

The master equation for mean field games with fractional and nonlocal diffusions

The master equation was introduced to prove that mean field games (MFGs) are good approximations of games with a finite but large number of players, see the seminal work of Cardaliaguet, Delarue, Lasry and Lions. In this talk we discuss existence and uniqueness of solutions of the master equation associated to the MFG system

$$\begin{cases} -\partial_t u - \mathcal{L}u + H(x,u,Du) = F(x,m(t)) & \text{in } (t_0,T)\times\mathbb{R}^d, \\ \partial_t m - \mathcal{L}^* m - \operatorname{div}(mD_pH(x,u,Du)) = 0 & \text{in } (t_0,T)\times\mathbb{R}^d, \\ m(t_0) = m_0, \qquad u(T,x) = G(x,m(T)), \end{cases} \tag{1}$$

where $\mathcal{L}$ is a nonlocal diffusion operator of order $\alpha \in (1,2]$. This corresponds to MFGs with Levy processes as individual noises and no common noise. A large class of operators is covered, including $-(-\Delta)^{\alpha/2}$ with $\alpha \in (1,2]$, the CGMY model in finance, mixed local-nonlocal operators, and unsymmetric, anisotropic, and spectrally one-sided operators.

Xue-Mei Li (EPFL Lausanne)

SPDE with random coefficients and mild stochastic sewing lemma

I shall discuss an SPDE model with vector field in fast random environment, a convergence lemma and a stochastic mild sewing lemma.

Annie Millet (Paris)

Rate of convergence to time Euler scheme for a 2D Boussinesq model

We prove that an implicit time Euler scheme for the 2D-Boussinesq model on the torus D converges. Various moments of the $W^{1,2}(D)$-norms of the velocity and temperature, as well as their discretizations, are computed. We obtain the optimal rate of convergence in probability, and a logarithmic one for the convergence in $L^2(\Omega)$. These results are deduced from a time regularity of the solution both in $L^2(D)$ and $W^{1,2}(D)$, and from an $L^2(\Omega)$ convergence restricted to a subset where the $W^{1,2}(D)$-noms of the solutions are bounded. This is a joint work with Hakima Bessaih.

Nicolas Perkowski (Berlin)

Supercritical singular SDEs via energy solutions

We consider an SDE with distributional, divergence-free drift $b \in B^{-\gamma}_{p,\infty}$ and additive Brownian noise and show that for absolutely continuous initial conditions with L^2 density there are unique "energy solutions" (admissible weak solutions) to such equations, as long as $\gamma < 1$ and $p > 2/(1-\gamma)$. In particular $b \in L^2$ is allowed in any dimension. The construction is based on relatively soft estimates and we need no input from PDE theory beyond L^2 energy estimates and the maximum principle. This is joint work with Ana Djurdjevac, Lukas Gräfner, Xiaohao Ji.

Andreas Prohl (Tübingen)

Numerical Analysis for Optimal Control problems with SPDE constraints

I compare two main numerical strategies, which are based on Pontryagin's maximum principle or - for linear quadratic problems - the Riccati equation. I explain why numerical schemes which base on the 2nd strategy are far less complex, and detail derivation of optimal rates of convergence for it. This is joint work with Yanqing Wang (Southwest University, Chongqing).

Marta Sanz-Sole (Barcelona)

Linear SPDEs driven by Lévy generators: optimal regularity of the solution

We consider parabolic and hyperbolic SPDEs on $(0,\infty)\times\mathbb{R}^d$ of the form $\partial_t u = Lu + g(u)+\dot{W}$ and $\partial_t^2 u = Lu+c+\dot{W}$, with suitable initial data, forced with a space-time homogeneous Gaussian noise $\dot{W}$ that is white in its time variable and correlated in its space variable, and where L is the generator of a non-degenerate d-dimensional Lévy process X. We will exhibit optimal Hölder continuous conditions for the respective random-field solutions to these SPDEs. These conditions are stated in terms of indices that describe thresholds on the integrability of some functionals of the characteristic exponent of the process X with respect to the spectral measure of the spatial covariance of W. This talk is based on joint work with Davar Khosnevishan.

John Schoenmakers (Berlin)

Primal-dual regression approach for Markov decision processes with general state and action spaces

We develop a regression-based primal-dual martingale approach for solving discrete time,finite horizon MDPs with state and action spaces that are general in the sense that they may be finite or infinite (but regular enough) subsets of Euclidean space. As a result, our method allows for the construction of tight upper and lower biased approximations of the value functions and provides tight approximations to the optimal policy. In particular, we prove error bounds for the estimated duality gap featuring polynomial dependence on the time horizon and sublinear dependence of the stochastic part of the error on the cardinality/dimension of the state and action spaces. From a computational point of view, the proposed method is efficient since, in contrast to the usual duality-based methods for optimal control problems in the literature, the Monte Carlo procedures involved here do not require nested simulations. Joint work with D. Belomestny.

Panagiotis E. Souganidis (Chicago)

The planning problem for mean-field games and large deviations of the surface height in the KPZ equation

Motivated by a problem about large deviations for the surface height in the KPZ equation, we study the convergence of second-order mean field game to the planning problem with Dirac masses at terminal and initial times in one space dimension. The result then provides a rigorous proof for the large deviations as well as the convergence of the rate functionals. This is joint work with Pierre-Louis Lions.

Michael Tretyakov (Nottingham)

Jump-diffusion consensus-based optimization

A new consensus based optimization (CBO) method, where an interacting particle system is driven by jump-diffusion stochastic differential equations, is introduced. Well-posedness of the particle system and of its mean-field limit is studied. Convergence of the interacting particle system to the mean-field limit and convergence of a discretized particle system to the continuous-time dynamics in the mean-square sense are proved. Convergence of the mean-field (McKean-Vlasov) jump-diffusion SDEs to global minimizers for a large class of objective functions is also considered. Numerical tests performed on benchmark objective functions demonstrate improved performance of the proposed CBO method over earlier CBO models. The talk is based on a joint work with Dante Kalise (Imperial College) and Akash Sharma (University of Nottingham).

Deng Zhang (Shanghai)

Recent progress on multi-bubble blow-ups and multi-solitons to focusing (stochastic) nonlinear Schrödinger equations

We mainly review the recent results on multi-bubble blow-ups and multi-solitons to the focusing (stochastic) nonlinear Schrödinger equations. In the mass-critical case, the construction and conditional uniqueness of multi-bubble Bourgain-Wang type blow-up solutions will be presented, which provide new examples for the mass quantization conjecture. In the deterministic case without noise, this also gives first examples of non-pure multi-solitons (including dispersive part) for the soliton resolution conjecture. Further refined uniqueness of pure multi-bubble blow-ups and multi-solitons in the very low asymptotic regime is obtained. At last, in both the mass critical and subcritical cases, we also show the direct construction of stochastic multi-solitons, particularly, in the absence of the classical pseudo-conformal symmetry.

Tusheng Zhang (Manchester)

Irreducibility of SPDEs driven by pure jump noise

The irreducibility is fundamental for the study of ergodicity of stochastic dynamical systems. In the literature, there are very few results on the irreducibility of stochastic partial differential equations (SPDEs) and stochastic differential equations (SDEs) driven by pure jump noise. The existing methods on this topic are basically along the same lines as that for the Gaussian cases. They rely on that the driving noises are additive type and more or less in the class of stable processes. The use of such methods to deal with the case of other types of additive pure jump noises appears to be unclear, let alone the case of multiplicative noises. In this paper, we develop a new, effective method to obtain the irreducibility of SPDEs and SDEs driven by multiplicative pure jump noise. The conditions placed on the coefficients and the driving noise are very mild, and in some sense they are necessary and sufficient. This leads to not only significantly improving the results in the literature, but also to new irreducibility results of a much larger class of equations driven by pure jump noise with much weaker requirements than those treatable by the known methods. As a result, new applications apply to SPDEs with locally monotone coefficients, SPDEs/SDEs with singular coefficients, Euler equations etc.

List of Participants

Ehsan Abedi (Bielefeld University)
Yves Achdou (Paris)
Wasim Akram (Indian Institute of Technology Bombay)
Florian Bechtold (Universität Bielefeld)
Nils Berglund (Orleans)
Wolf-Jürgen Beyn (Bielefeld University)
Dirk Blömker (Augsburg)
Jidjou Moghomye Boris (Montanuniversität Leoben)
Evelyn Buckwar (Linz)
Federico Cannerozzi (University of Milan)
Pierre Cardaliaguet (Université Paris Dauphine)
Javier Castro (Bielefeld University)
Sonja Cox (University of Amsterdam)
Anne de Bouard (Ecole Polytechnique, Palaiseau Cedex)
Anna De Crescenzo (Université Paris Cité)
Filippo de Feo (Politecnico di Milano)
François Delarue (Côte d'Azur)
Sebastian Ertel (TU Berlin)
Kistosil Fahim (Institut Teknologi Sepuluh Nopember)
Giorgio Ferrari (Bielefeld University)
Peter K. Friz (TU Berlin)
Barbara Gentz (Bielefeld University)
Sebastian Grube (Bielefeld University)
Emanuela Gussetti (Bielefeld University)
Erika Hausenblas (Leoben)
Daniel Heydecker (Max Planck Institute for Mathematics in the Sciences)
Martina Hofmanova (Bielefeld)
Helge Holden (Norwegian University of Science and Technology)
Wei Huang (FU Berlin)
Shanshan Hu (Bielefeld University)
Espen Robstad Jakobsen (Trondheim)
Likai Jiao (HU Berlin)
Boris Jidjou Moghomye (Montanuniversitaet Leoben)
Xiaohao Ji (FU Berlin)
Dianetti Jodi (Bielefeld University)
Cardona Gaviria Jorge Eduardo (Friedrich Schiller University)
Josué Knorst (University of Campinas)
Fatima Zahra Lahbiri (Fernuniversität Hagen)
Theresa Lange (Bielefeld University)
Adrienne Le Meur (ENS Rennes)
Chengcheng Ling (TU Wien)
Xue-Mei Li (London/Lausanne)
Mattia Martini (Université Côte d'Azur)
Stefan Metzger (Friedrich-Alexander Universität Erlangen-Nürnberg)
Youness Mezzan (Laboratory of Mathematics and Populations Dynamic)
Annie Millet (Université de Paris 1 Panthéon Sorbonne)

Jean Daniel Mukam (Bielefeld University)
Antonio Ocello (LPSM - Sorbonne Université)
Nicolas Perkowski (Freie Universität Berlin)
Andreas Prohl (Tübingen)
Tsiry Randrianasolo (Montanuniversität Leoben)
Marta Sanz-Sole (Barcelona)
John Schoenmakers (Berlin)
Deven Sethi (University of Edinburgh)
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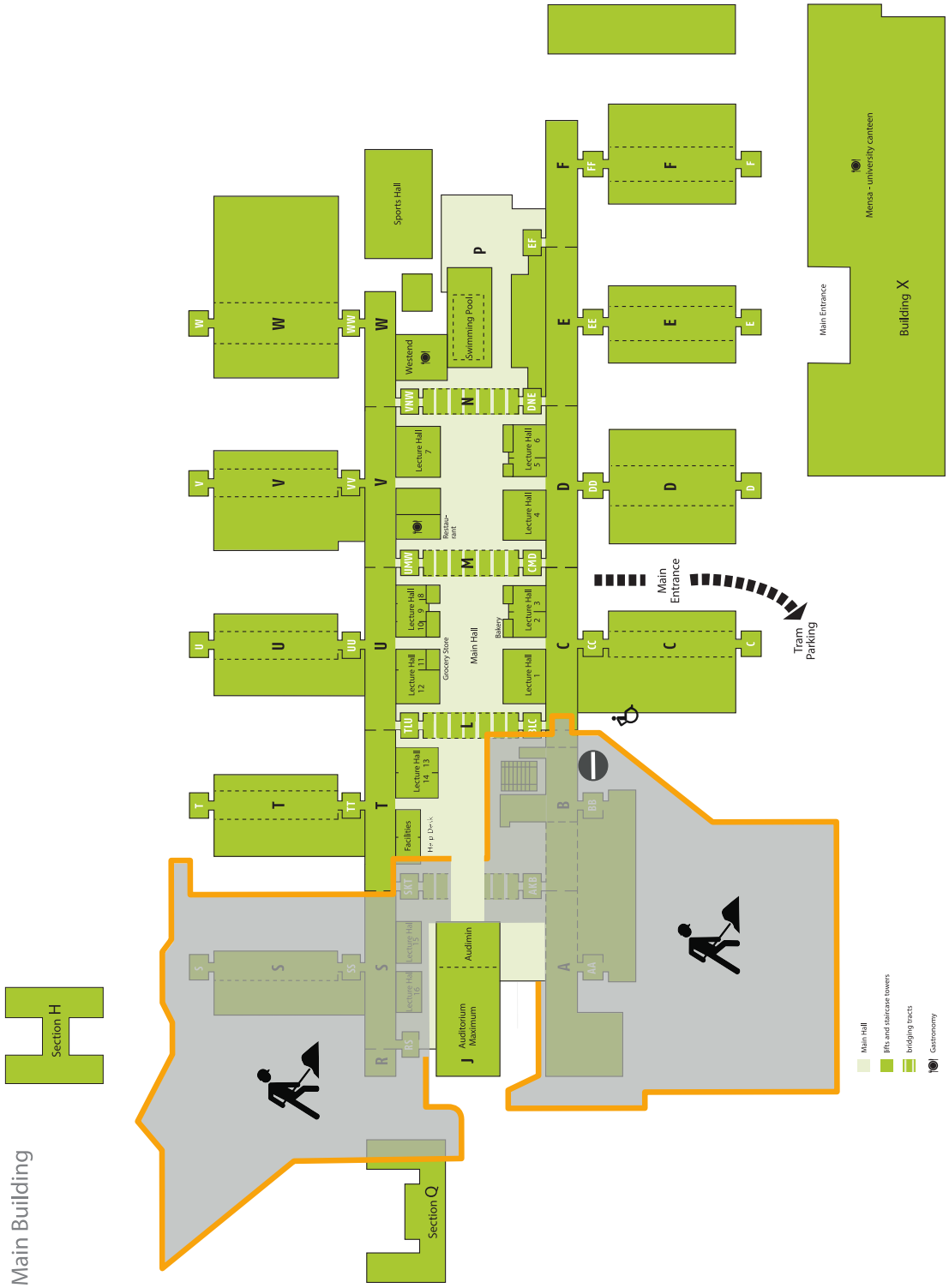
Julia Struwe (Universität Bielefeld)
Yuchen Sun (Humboldt University)
Theresa Traxler (Vienna University of Economics and Business)
Michael Tretyakov (Nottingham)
Ioannis Tzouanas (Bielefeld University)
Jean Vereecke (ENS Rennes)
Alexander Weiß (Universität Leipzig)
Weina Wu (Bielefeld University)
Zhengyan Wu (Bielefeld university)
Deng Zhang (Shanghai Jiao Tong University)
Tusheng Zhang (The University of Manchester)
Xianliang Zhao (Bielefeld University)

Campus map with ZiF

Tram map


3
Babenhausen Süd
Voltmannstraße
Koblenzer Straße
Lange Straße
Auf der Hufe
Nordpark
Witte-kind-straße
1
Schildesche
Heidegärten
Kattenkamp
Deciusstraße
Johannesstift
Sudbrackstraße
2
Milse
Schelpmilser Weg
Baumheide
Seidenstickerstraße
Schüco
Ziegelstraße
Finkenstraße
Schillerstraße
Stadtheider Straße
Beckhausstraße
4
Lohmannshof
Wellensiek
Universität
Bültmannshof
Graf-von-Stauffenberg-Straße
Rudolf-Oetker-Halle
Siegfriedplatz
Hauptbahnhof
Jahnplatz
4 Rathaus
August-Schroeder-Straße
Ravensberger Straße
Krankenhaus Mitte
Oststraße
Hartlager Weg
Sieker Mitte
Luther-Kirche
Roggenkamp
Elpke
Gesamtschule Stieghorst
Stieghorst
3
Adenauerplatz
Landgericht
August-Bebel-Straße
Teutoburger Straße
Mozartstraße
Prießallee
Sieker
2
Bethel
Friedrich-List-Straße
Eggeweg
Brackwede Bahnhof
Gaswerkstraße
Normannenstraße
Brackwede Kirche
Windelsbleicher Straße
Rosenhöhe
Sennefriedhof
Senne
1
University
Line 4 - direction
'Lohmannshof'
1 Senne – Jahnplatz – Schildesche
2 Sieker – Jahnplatz – Milse
3 Stieghorst – Jahnplatz – Babenhausen Süd
4 Rathaus – Jahnplatz – Universität – Lohmannshof

Campus map


Main Building
Section H
Section Q
Sports Hall
Swimming Pool
Westend
Mensa - university canteen
Building X
Main Entrance
Tram
Parking
Lecture Hall 1
Lecture Hall 2
Lecture Hall 3
Lecture Hall 4
Lecture Hall 5
Lecture Hall 6
Lecture Hall 7
Lecture Hall 8
Lecture Hall 9
Lecture Hall 10
Lecture Hall 11
Lecture Hall 12
Lecture Hall 13
Lecture Hall 14
Lecture Hall 15
Lecture Hall 16
Main Hall
Grocery Store
Bakery
Restaurant
Facilities
Audimin
Auditorium Maximum
Main Hall
lifts and staircase towers
bridging tracts
Gastronomy

Some recommendations for restaurants

(1) **Argentina-Steakhouse** (https://argentina-steakhouse.de/)
Argentinian beef at its best

(2) **Brauhaus Joh. Albrecht** (https://bielefeld.brauhaus-joh-albrecht.de/)
Home made beer plus German style food

(3) **Kometsu** (http://www.kometsu.de/index.html)
Authentic Japanese place for sushi

(4) **KDW** (http://www.kdw-restaurant.de/index.html)
Fine Greek cuisine

(5) **Numa** (http://www.numa.de/)
Asia meets East-Westphalia

(6) **Wernings Weinstube** (https://www.wernings-weinstube.de/)
Some regional dishes plus a good selection of wines

(7) **Sparrenburg** (https://www.restaurant-sparrenburg.de/)
German style food at the castle above Bielefeld

(8) **Wilde Kuh/ Wilde Kuh 2** (https://www.facebook.com/WildeKuhBurger/)
Excellent “build your own burger" place

(9) **Three sixty** (http://bielefeld.three-sixty.de/)
Sports bar with burgers and other snacks

(10) **Jivino** (http://www.jivino-enoteca.de/)
Spanish tapas

(11) **Bernstein** (https://www.the-bernstein.com/)
Dinner plus cocktails in a fancy rooftop restaurant

Notes