Universität Bielefeld

SFB 701

Free Probability and Random Matrices

22–25 September 2014

Faculty of Mathematics
Bielefeld University
Lecture Room: V2–210/216, Main Building

This workshop is part of the DFG-funded CRC 701
Spectral Structures and Topological Methods in Mathematics
at Bielefeld University

Organisers: Friedrich Götze, Holger Kösters

`http://www.math.uni-bielefeld.de/sfb701/2014_FreeProbability`

Schedule

Monday, September 22nd, 2014
Lecture Room: **V2-210/216**

09:30 – 10:30	**Leonid Pastur** (Institute for Low Temperatures, Kharkiv) Eigenvalue distribution of sample covariance matrices with structured data matrices
10:30 – 11:00	*Coffee Break*
11:00 – 12:00	**Romuald Lenczewski** (Wroclaw University of Technology) Limit distributions of random matrices
12:00 – 14:00	*Lunch Break*
14:00 – 15:00	**Gennadiy Chistyakov** (Bielefeld University) Free infinitely divisible approximations of n-fold free convolutions
15:00 – 15:30	*Coffee Break*
15:30 – 16:30	**Moritz Weber** (Universität des Saarlandes, Saarbrücken) Quantum groups in free probability
16:40 – 17:15	**Thorsten Neuschel** (KU Leuven) Jacobi Polynomial Moments and Products of Random Matrices
17:15 – 17:50	**Martin Venker** (Bielefeld University) Local Statistics of Repulsive Particle Systems

Tuesday, September 23rd, 2014
Lecture Room: **V2-210/216**

09:30 – 10:30	**Victor Vinnikov** (Ben-Gurion University) Noncommutative functions and noncommutative Hardy spaces
10:30 – 11:00	*Coffee Break*
11:00 – 12:00	**Michael Anshelevich** (Texas A&M University) Operator-valued monotone convolution semigroups
12:00 – 14:00	*Lunch Break*
14:00 – 15:00	**Rajesh Rao Nadakuditi** (University of Michigan) Random matrix theory and universal perfect transmission in opaque media
15:00 – 15:30	*Coffee Break*
15:30 – 16:30	**Volodymyr Vasylchuk** (Institute for Low Temperatures, Kharkiv) Fluctuations of the eigenvalue distribution of the product of unitary random matrices
16:40 – 17:15	**Dries Stivigny** (KU Leuven) Singular values of products of random matrices
17:15 – 17:50	**Wiktor Ejsmont** (TU Graz) New characterization of the Wigner's semicircle law through the sample variance

Wednesday, September 24th, 2014
Lecture Room: **V2-210/216**

09:30 – 10:30	**Marek Bozejko** (University of Wroclaw) Generalized Gaussian processes and infinitely divisible laws in free additive convolution
10:30 – 11:00	*Coffee Break*
11:00 – 12:00	**Uwe Franz** (Université de Franche-Comté, Besancon) A Hunt formula for $U_q(N)$ and $SU_q(N)$ and related topics
12:00 – 14:00	*Lunch Break*
14:00 – 18:00	*depending on the weather:* *time for discussion / excursion*
19:00	*Conference Dinner* (Restaurant KDW im Bültmannshof)

Thursday, September 25th, 2014
Lecture Room: **V2-210/216**

9:30 – 10:30	**Roland Speicher** (Universität des Saarlandes, Saarbrücken) On the question of zero divisors for non-commuting variables
10:30 – 11:00	*Coffee Break*
11:00 – 12:00	**Mireille Capitaine** (Université Paul Sabatier, Toulouse) Outlier eigenvalues for deformed i.i.d. random matrices
12:00 – 14:00	*Lunch Break*
14:00 – 15:00	**Alexey Naumov** (Lomonosov Moscow State University) Limit theorems for non Hermitian random matrices
15:00 – 15:30	*Coffee Break*
15:30 – 16:30	**Franz Lehner** (TU Graz) Cumulants for spreadibility systems

Abstracts

Michael Anshelevich (Texas A&M University)

Operator-valued monotone convolution semigroups

We consider semigroups, under composition, of transformations of the upper-half-plane over a C^*-algebra. Under mild continuity assumptions, we show that such a semigroup has an infinitesimal generator, which determines it. Under stronger assumption that the transformations are F-transforms of distributions, we obtain a detailed description of the generator. This allows us to extend the operator-valued Bercovici-Pata bijection to the monotone convolution.

This is joint work with John D. Williams.

Marek Bozejko (University of Wroclaw)

Generalized Gaussian processes and infinitely divisible laws in free additive convolution

In my talk we will consider the following subjects:
1. Generalized Gaussian of type A, B/C and type D and connections with classical and q-Meixner-Pollaczek laws.
2. Free infinitely divisibility of $1/\cosh$ and others classical Meixner laws.
3. Generalized Gaussian processes connected with Thoma characters of the infinite permutation groups and positivity of generalized determinants (q-determinant, α-determinant and others).

References:

1. S.Belinschi, M.Bozejko, F.Lehner, R.Speicher, The normal distribution is free infinitely divisible, Adv.Math. 226(2011),3677-3698.
2. M.Bozejko, R.Speicher, Interpolations between bosonic and fermionic relations given by generalized Brownian motion, Math.Z. 222, 135-160, 1996.
3. M.Bozejko, M.Guta, Functors of white noise associated to characters of the infinite symmetric groups, Comm.Math.Phys. 229, 209-227, 2002.
4. M.Bozejko, T.Hasebe, On free infinitely divisibility for classical Meixner distributions, Prob.Math.Stat. 33(2013), 363-375.
5. M.Bozejko, T.Hirai, Gelfand-Raikov representations of Coxeter groups associated to positive definite norm functions, Prob. Math. Stat. 34(2014).
6. M.Bozejko, W.Bozejko, Generalized Gaussian processes and relations with random matrices and positive definite functions on permutations groups, arXiv 2013.
7. M.Bozejko, W.Bozejko, Generalized Gaussian processes and positivity of q-determinants and α-determinants, Preprint, Wroclaw 2014, 12 pp.

Mireille Capitaine (Université Paul Sabatier, Toulouse)

Outlier eigenvalues for deformed i.i.d. random matrices

We consider a square random matrix of size N of the form $A+Y$ where A is deterministic and Y has iid entries with variance $1/N$. Under mild assumptions, as N grows, the empirical distribution of the eigenvalues of $A+Y$ converges weakly to a limit probability measure β on the complex plane. This work is devoted to the study of the outlier eigenvalues, i.e. eigenvalues in the complement of the support of β. Even in the simplest cases, a variety of interesting phenomena can occur. As in earlier works, we give a sufficient condition to guarantee that outliers are stable and provide examples where their fluctuations vary with the particular distribution of the entries

of Y or the Jordan decomposition of A. We also exhibit concrete examples where the outlier eigenvalues converge in distribution to the zeros of a Gaussian analytic function.

This is joint work with Charles Bordenave.

Gennadiy Chistyakov (Bielefeld University)

Free infinitely divisible approximations of n-fold free convolutions

We study the problem of approximating n-fold additive free convolutions of probability measures by additive free infinitely divisible probability measures. Based on the method of subordinating functions we prove free analogs of bounds for approximations of n-fold convolutions of probability measures with infinitely divisible probability measures in classical probability theory.

Wiktor Ejsmont (TU Graz)

New characterization of the Wigner's semicircle law through the sample variance

A new characterizing property of the Wigner's semicircle law is proved which can be summarized as follows. Let $(\mathbb{X}_1,,\ldots,\mathbb{X}_n)$ be a free random sample of size $n \geq 2$ from a nondegenerate symmetric distribution with finite variance σ^2. Then $\sum_{i=1}^n (\mathbb{X}_i - \overline{\mathbb{X}}_n)^2/\sigma^2$ where $\overline{\mathbb{X}}_n = \sum_{i=1}^n \mathbb{X}_i/n$, is distributed as the free chi-square distribution with $n-1$ degrees of freedom if and only if the distribution of $\mathbb{X}_i$ is Wigner's semicircle law.

Uwe Franz (Université de Franche-Comté, Besancon)

A Hunt formula for $U_q(N)$ and $SU_q(N)$ and related topics

Hunt's formula gives a classification of convolution semigroups of probability measures, or equivalently, of Lévy processes on Lie groups in terms of their genererator. It shows how such processes are combinations of a continuous (or Gaussian) part and a jump part. We present an analog of Hunt's formula for the compact quantum groups $SU_q(N)$ and $U_q(N)$. It turns out that the generators of convolutions semigroups of states on $C(SU_q(N))$ and $C(U_q(N))$ can again be decomposed into a Gaussian part and a "jump" part. We also discuss the open question whether such a decomposition is always possible.

Based on joint work with Anna Kula, Martin Lindsay, and Michael Skeide.

Franz Lehner (TU Graz)

Cumulants for Spreadibility Systems

Spreadability systems generalize exchangeability systems in the same way quasisymmetric functions generalize symmetric functions. We provide a combinatorial framework and "cumulants" for this setting, in particular including monotone cumulants. As an application, we give yet another derivation of the Baker-Campbell-Hausdorff series.

This is joint work with T. Hasebe.

Romuald Lenczewski (Wroclaw University of Technology)

Limit distributions of random matrices

I am going to discuss the asymptotic $*$-distributions of blocks of certain classes of independent random matrices under the expectation of partial traces when the sizes of these matrices tend to infinity. For that purpose, I will use matricially free Gaussian operators built from certain partial isometries and their adjoints which $*$-generate certain Toeplitz-Cuntz-Krieger algebras. The underlying concept of independence is that of matricial freeness, encompassing freeness and matriciality. I will describe several applications of this approach to random matrix theory, including new random matrix models and some applications to free probability and combinatorics.

Rajesh Rao Nadakuditi (University of Michigan)

Random matrix theory and universal perfect transmission in opaque media

Materials such as eggshells, turbid water and white paper are considered opaque because scattering frustrates the passage of light through such media. Consequently, only a small portion of the incident light will emerge through the medium. Surprisingly, it turns out that it is "nearly always" possible to engineer a wavefront, tailored specifically to the medium, that will achieve near perfect transmission. In other words, the material will behave as though it is transparent to this specific wavefront.

We use free probability to study this phenomena and show that the theoretical predictions agree remarkably well with high-precision numerical simulations for systems containing hundreds of thousands of scatterers. Finally, we show why we might expect perfect transmission in nearly all sparse yet opaque random media.

Alexey Naumov (Lomonosov Moscow State University)

Limit theorems for non Hermitian random matrices

In my talk I will consider non Hermitian random matrices and mainly concentrate of the ensemble of random matrices with independent entries and the ensemble of random matrices with correlated entries. A fundamental problem in the theory of random matrices is to determine the limiting distribution of spectra of random matrix as its size tends to infinity. It is known that the limiting distribution of spectra of random matrix with independent or correlated entries is universal, which means that it depends on a few global characteristics of the distribution of the matrix entries, and is given by the circular or elliptic law. The proof of such results may be divided into two steps. On the first step one has to show the universality of singular spectra of the random matrix. On the second step one has to bound the smallest singular values of the random matrix. In the talk I will discuss the development of these questions and current state. The above result may be generalized in different directions. For example, one may consider the products or powers of random matrices. These questions will be also considered in my talk. The results are based on the joint work with F. Götze and A. Tikhomirov.

Thorsten Neuschel (KU Leuven)

Jacobi Polynomial Moments and Products of Random Matrices

In this talk we study the singular value distributions arising from prod- ucts of complex Gaussian random matrices and truncations of Haar distributed unitary matrices (which formally can be constructed by means of free multiplicative convolutions). To this end, we introduce an appropriate general class of measures with moments essentially given by specific Jacobi polynomials with

varying parameters. Solving the underlying moment problem is based on a study of the Riemann surfaces associated to a class of algebraic equations.

This is joint work with Wolfgang Gawronski and Dries Stivigny.

Leonid Pastur (Institute for Low Temperatures, Kharkiv)

Eigenvalue Distribution of Sample Covariance Matrices with Structured Data Matrices

We consider the $n \times n$ random matrices $M = X^*X$, where the entries of the $m \times n$ random data matrices X are independent random variables with zero mean and structured variance. In particular, X can be a band matrix. We find the functional equation for the Stieltjes transform of the limiting as $n \to \infty$, $m \to \infty$, $m/n \to c \in (0,\infty)$ Normalized Counting Measure of eigenvalues of M (or singular values of X), which is a natural analog of the corresponding equation for hermitian band matrices. We analyze its interesting particular cases. We also comment on some other functional equations of random matrix theory.

Roland Speicher (Universität des Saarlandes, Saarbrücken)

On the question of zero divisors for non-commuting variables

In order to understand the "non-commutative" distribution of a tuple of variables $X_1,...,X_n$, it is important to be able to decide whether the distribution of selfadjoint polynomials in those variables can have atoms. I will show how this is related with the free entropy and free Fisher information of those variables.

This is joint work with Tobias Mai and Moritz Weber.

Dries Stivigny (KU Leuven)

Singular values of products of random matrices

Recently, Akemann et al. showed that the squared singular values of products of complex Ginibre random matrices give rise to a determinantal point process. We show more generally that the product with a complex Ginibre random matrix preserves the determinantal structure. Using this theorem we obtain the joint probability density function for the squared singular values of the product of a truncated unitary matrix with M-1 complex Ginibre random matrices. For this ensemble, we look at the correlation kernel and obtain an integral representation. Using this, we calculate the limiting kernel at the origin (hard edge). We obtain the same kernel as Kuijlaars and Zhang obtained for the case of the product of M complex Ginibre random matrices. If time permits, we end this talk by shortly discussing the product with truncated unitary matrices and show that the same structural theorem as for the Ginibre case holds true.

This is joint work with Arno Kuijlaars and Mario Kieburg

Volodymyr Vasylchuk (Institute for Low Temperatures, Kharkiv)

Fluctuations of the eigenvalue distribution of the product of unitary random matrices

We consider the ensemble of n-dimentional unitary random matrices being the product of two unitary matrices rotated randomly one with respect to another by the unitary matrix uniformly distributed over $U(n)$. We obtain in the explicit form the leading term of the asymptotic n^{-1}-expansion of the covariance of traces of resolvents of ensemble and prove the Central Limit Theorem for sufficiently smooth linear eigenvalue statistics of the product as n tends to infinity.

Martin Venker (Bielefeld University)

Local Statistics of Repulsive Particle Systems

In this talk we will consider interacting particle systems on the real line with pairwise interaction mimicking the repulsion between random eigenvalues from invariant random matrix ensembles like GUE or GOE. We show that the universal random matrix distributions extend to this new class of models. Fine asymptotics for unitary-invariant matrix ensembles will be given and used to obtain precise information on local statistics of the repulsive particle systems. These include the distribution of the largest particle or the nearest-neighbor spacing distribution.

Victor Vinnikov (Ben-Gurion University)

Noncommutative functions and noncommutative Hardy spaces

I will start this talk with a review of some key features of the theory of noncommutative functions as developed in a recent joint monograph with Dmitry Kaliuzhnyi-Verbovetzkyi. Noncommutative functions are functions defined on a domain in the space of square matrices of all sizes over a vector space that respect direct sums and similarities. They admit a good difference-differential calculus and possess striking regularity properties.

I will then discuss joint work with Mihai Popa towards the theory of Hardy spaces on noncommutative bounded symmetric domains.

Moritz Weber (Universität des Saarlandes, Saarbrücken)

Quantum Groups in Free Probability

It is often useful to analyze the symmetries arising in a mathematical theory in order to get a feeling for its geometric nature. In noncommutative operator algebras, we often have to go beyond the concept of groups and pass to quantum groups. During the past few years, a framework particularly suitable for Free Probability was developed by Banica and Speicher, the so called easy quantum groups.

I will give a quick introduction into these objects highlighting the links to Free Probability. I will also give an overview on the classification of easy quantum groups, which has been completed in joint work with Sven Raum.

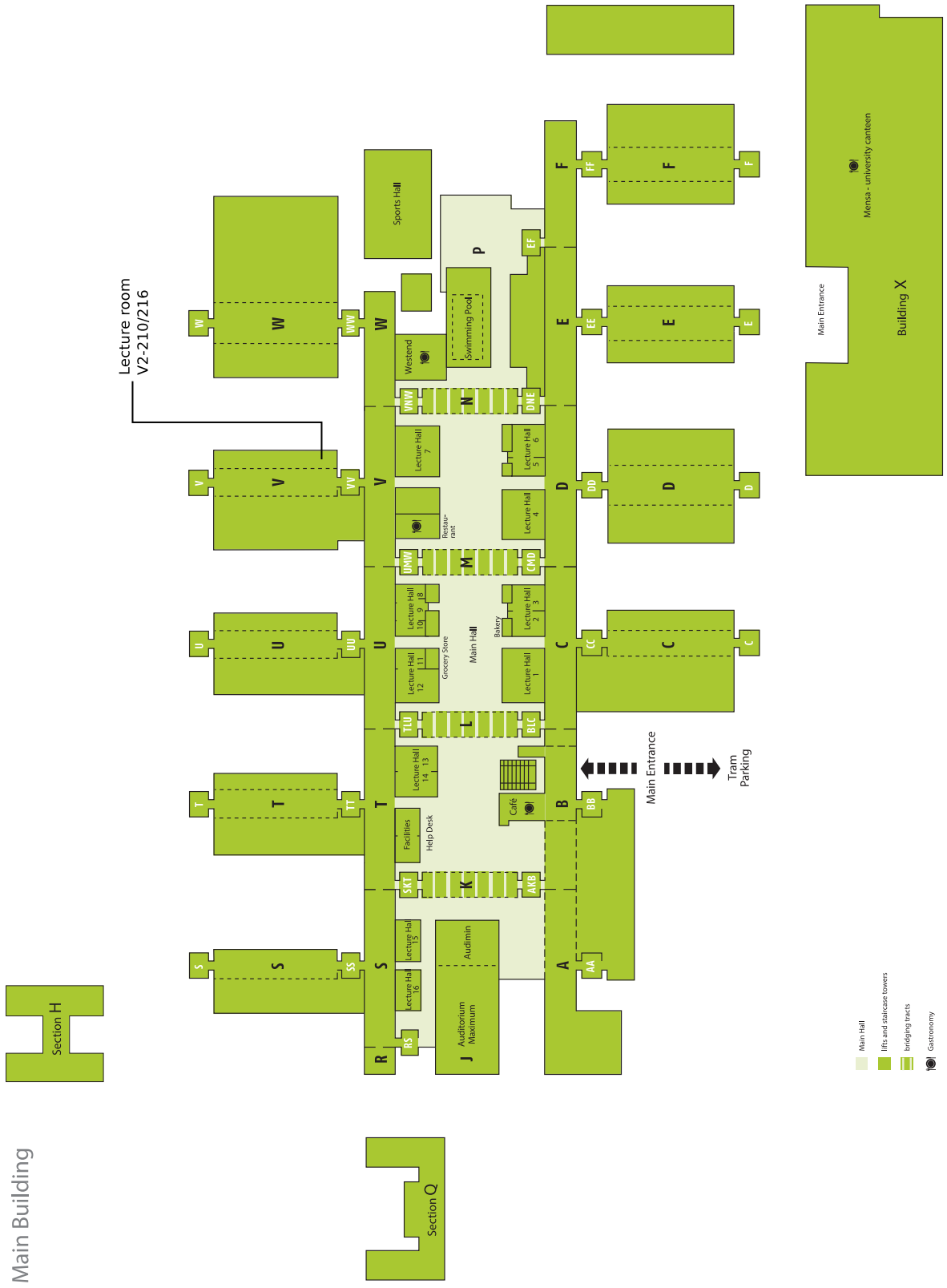
Participant list

Michael Anshelevich	(Texas A&M University)
Guisi Alfano	(Politecnico di Torino)
Marek Bozejko	(University of Wroclaw)
Mireille Capitaine	(Université Paul Sabatier, Toulouse)
Gennadiy Chistyakov	(Bielefeld University)
Wiktor Ejsmont	(TU Graz)
Uwe Franz	(Université de Franche-Comté, Besancon)
Friedrich Götze	(Bielefeld University)
Holger Kösters	(Bielefeld University)
Franz Lehner	(TU Graz)
Romuald Lenczewski	(Wroclaw University of Technology)
Mehmet Madensoy	(Universität des Saarlandes, Saarbrücken)
Rajesh Rao Nadakuditi	(University of Michigan)
Alexey Naumov	(Lomonosov Moscow State University)
Thorsten Neuschel	(KU Leuven)
Leonid Pastur	(Institute for Low Temperature Physics and Engineering, Kharkov)
Jolanta Pielaszkiewicz	(Linköping University)
Anna Reshetenko	(Bielefeld University)
Konrad Schrempf	(TU Graz)
Roland Speicher	(Universität des Saarlandes, Saarbrücken)
Dries Stivigny	(KU Leuven)
Michael Ulrich	(Université de Franche-Comté, Besancon)
Vladimir Vasilchuk	(Institute for Low Temperature Physics and Engineering, Kharkov)
Martin Venker	(Bielefeld University)
Victor Vinnikov	(Ben-Gurion University)
Moritz Weber	(Universität des Saarlandes, Saarbrücken)
John D. Williams	(Texas A&M University)

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
Landgericht
Adenauerplatz
Bethel
Friedrich-List-Straße
Eggeweg
Brackwede Bahnhof
Gaswerkstraße
Normannenstraße
Brackwede Kirche
Windelsbleicher Straße
Rosenhöhe
Sennefriedhof
Senne
1
August-Bebel-Straße
Teutoburger Straße
Mozartstraße
Prießallee
Sieker
2
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


Lecture room
V2-210/216
Sports Hall
Swimming Pool
Westend
Mensa - university canteen
Main Entrance
Building X
Lecture Hall 7
Lecture Hall 6
Lecture Hall 5
Restaurant
Lecture Hall 4
Lecture Hall 8
Lecture Hall 9
Lecture Hall 10
Lecture Hall 3
Bakery
Main Hall
Grocery Store
Lecture Hall 12
Lecture Hall 11
Lecture Hall 1
Lecture Hall 14
Lecture Hall 13
Café
Facilities
Help Desk
Lecture Hall 15
Lecture Hall 16
Audimin
Auditorium Maximum
Main Entrance
Tram
Parking
Section H
Section Q
Main Building
Main Hall
lifts and staircase towers
bridging tracts
Gastronomy