Fourth International Workshop on
Zeta Functions in Algebra and Geometry

29 May – 02 June 2017

Faculty of Mathematics
Bielefeld University

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

sfb701.math.uni-bielefeld.de/2017_ZFW/  zeta2017@math.uni-bielefeld.de
### Schedule

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The workshop will take place at the

Center for Interdisciplinary Research (ZiF; [www.zif.de](http://www.zif.de))
Methoden 1
33615 Bielefeld
Germany

All talks will take place in the ZiF’s central meeting room, the Plenarsaal. Lunch will also be served at the ZiF. See Page 19 for directions to the ZiF.
Monday, May 29th

08:30 – 08:55  **Registration**  Also possible during first coffee break

08:55 – 09:00  **Opening**

09:00 – 10:00  **Mark Pollicott** (Warwick)
*Part 1: Zeta functions and closed geodesics*

We describe part of the theory of zeta functions for closed geodesics, beginning with the motivation from number theory, the classical harmonic analysis/trace formula approach to constant curvature surfaces and the dynamical approach to the more general setting of variable negative curvature.

**Coffee Break & Registration**

10:30 – 11:30  **Raf Cluckers** (Lille)
*Uniform $p$-adic integration and applications*

As a concrete variant of motivic integration, we will discuss uniform $p$-adic integration and constructive aspects of results involved. Uniformity is in the $p$-adic fields, and, for large primes $p$, in the fields $\mathbb{F}_p((t))$ and all their finite field extensions. Using real-valued Haar measures on such fields, one can study integrals, Fourier transforms, etc. We follow a line of research that Jan Denef started in the eighties, with in particular the use of model theory to study various questions related to $p$-adic integration. A form of uniform $p$-adic quantifier elimination is used. Using the notion of definable functions, one builds constructively a class of complex-valued functions which one can integrate (w.r.t. some of the variables) without leaving the class. One can also take Fourier transforms in the class. Recent applications in the Langlands program are based on Transfer Principles for uniform $p$-adic integrals, which allow one to get results for $\mathbb{F}_p((t))$ from results for $\mathbb{Q}_p$, once $p$ is large, and vice versa. These Transfer Principles are obtained via the study of general kinds of loci, some of them being zero loci. More recently, these loci are playing a role in the uniform study of $p$-adic wave front sets for (uniformly definable) $p$-adic distributions, a tool often used in real analysis. This talk contains various joint works with Gordon, Hales, Halupczok, Loeser, Raibaut.

11:45 – 12:45  **Pierrette Cassou-Noguès** (Bordeaux)
*Motivic Milnor fiber at infinity*

In this talk, we shall give the main ideas for computing the motivic Milnor fiber at infinity for a polynomial in two variables, using the Newton algorithm. This is a joint work with Michel Raibaut.

**Lunch Break**
14:45 – 15:45  **Anke Pohl** (Jena)
*Automorphic functions, resonances, and Selberg zeta functions via transfer operators*

We report on the current status of a program to develop transfer operator approaches to automorphic functions, resonances, and Selberg zeta functions for non-compact hyperbolic surfaces of finite or infinite area and finite-dimensional representations.

**Coffee Break**

16:15 – 17:15  **Mark Pollicott** (Warwick)
*Part 2: Zeta functions and higher Teichmüller theory*

The Selberg Zeta function $Z(s)$ for Fuchsian groups can be described in terms of representations of (surface) groups in $\text{PSL}(2,\mathbb{R})$. The higher Teichmüller theory can be formulated in terms of representations in $\text{PSL}(d,\mathbb{R})$, for $d > 2$, and we consider how properties of the analogous zeta function compare with those of $Z(s)$. 

Tuesday, May 30th

09:00 – 10:00  **Michel Raibaut** (Chambéry)

**Motivic invariants at infinity of plane algebraic curves**

Let \( f \) be a complex polynomial with isolated singularities. In this talk, we will start by recalling classical formulas of the Euler characteristic of a fiber of \( f \) in terms of Milnor numbers of the singularities of \( f \) and the defect of equisingularity at infinity in a compactification of \( f \). Then, recalling some notions of motivic integration and Denef-Loeser, Guibert-Loeser-Merle theorems, we will consider some motivic zeta functions and define for each value \( a \), a motivic invariant at infinity of the fiber of \( f \) at \( a \). This invariant does not depend on the chosen compactification, it is generically equal to zero and, under isolated singularities assumptions, its Euler characteristic is equal to the defect of equisingularity at infinity of \( f \) for the value \( a \).

In the last part of the talk, we will consider the case of plane curves, where computations of this invariant can be done in terms of Newton polygons at infinity, using an induction process based on Newton transformations and iterated Newton polygons.

This is a joint work with Pierrette Cassou-Noguès.

**Coffee Break**

10:30 – 11:30  **Lê Quy Thuong** (Hanoi)

**On motivic multiple nearby cycles**

We introduce a new product of two formal series with coefficients in distinct Grothendieck rings of algebraic varieties, which preserves the integrability and commutes with the limit of rational series. In the same context, we define a motivic multiple zeta function with respect to an ordered family of regular functions, which is integrable and connects closely to Denef-Loeser’s motivic zeta functions. The limit of the motivic multiple zeta function is called the motivic multiple nearby cycles. We will present an explicit formula for the motivic double zeta functions and the motivic double nearby cycles using resolution of singularities. A version of the Euler reflection formula for motivic double zeta functions will be also given, and by taking its limit the motivic Thom-Sebastiani theorem will be recovered.

11:45 – 12:45  **Chenyang Xu** (Beijing)

**Birational models and zeta functions**

The progress on birational geometry provides us new tools to study zeta functions via birational models. We will present some results along this line, including the solution of Vey’s conjecture (jointly with Johannes Nicaise) and a construction of an alternative motivic zeta function.

**Lunch Break**
14:45–15:45  **Avraham Aizenbud** (Weizmann Institute of Science)

*Counting representations of arithmetic groups and point of schemes*

We will discuss the following question: How many irreducible representations of a given dimension $n$ do groups like $\text{SL}_d(\mathbb{Z})$ have? We will see how this question is related to the number of $\mathbb{Z}/n\mathbb{Z}$-points of certain schemes. Those are related to singularities of moduli spaces, pushforward of smooth measures, commutators of random elements in finite groups, jet schemes and more.

As a result of those connections, we will show that the number of such representations is bounded by a polynomial in $n$ whose degree is universally bounded for high rank arithmetic groups (by 40).


This is a joint project with Nir Avni.

Coffee Break

16:15–16:45  **Tobias Weich** (Paderborn)

*Classical and quantum resonances on hyperbolic surfaces*

It is a classical consequence of Selberg’s trace formula, that for compact hyperbolic surfaces the zeros of the Selberg zeta-function are given by the Laplace eigenvalues and by topological zeros. Around 2000 this result has been extended to convex co-compact surfaces by Patterson-Perry and Bunke-Olbrich. In this talk we will see, that behind this correspondence of zeta-zeros and the Laplace spectrum, there is a deeper connection between so called classical and quantum resonant states.

This is joint work with C. Guillarmou (Orsay) and J. Hilgert (Paderborn).

16:50–17:10  **Miriam Bocardo Gaspar** (Mexico City)

*String Amplitudes and Multivariate Local Zeta Functions*

In this talk we will give some connections between local zeta functions and $p$-adic string amplitudes. A main connection is that the convergence of the $p$-adic Koba-Nielsen type string amplitudes strongly depends on the convergence of Igusa-type integrals with several complex parameters. String amplitudes are "essentially" local zeta functions, and thus, they are algebraic-geometric objects that can be studied over several ground fields, for instance $\mathbb{R}$, $\mathbb{C}$, $\mathbb{Q}_p$, $\mathbb{C}((t))$, and that on each of these fields these objects have similar mathematical properties.
Wednesday, May 31th

09:00 – 10:00  **Ann Lemahieu** (Nice)

*On the monodromy conjecture for nondegenerate hypersurface singularities*

The monodromy conjecture predicts a relationship between the poles of $p$-adic integrals associated to a complex polynomial $f$ and the monodromies of the complex hypersurface defined by $f$. In this talk we will concentrate on the monodromy conjecture at the level of the topological zeta function for hypersurface singularities that are nondegenerate w.r.t. their Newton polyhedron. We explain some partial results in higher dimension and we give a proof of the monodromy conjecture for ‘0-convenient’ singularities in dimension four. This is work in progress with Alexander Esterov (HSE, Moscow) and Kiyoshi Takeuchi (University of Tsukuba, Japan).

**Coffee Break**

10:30 – 11:30  **Sho Tanimoto** (Copenhagen)

*The space of rational curves and height zeta functions*

Manin’s conjecture is a conjectural asymptotic formula for the counting function of rational points on a Fano variety after removing the contribution of an exceptional set from the counting function. Recently there are many developments regarding birational geometry of exceptional sets in Manin’s conjecture due to Lehmann-Tanimoto-Tschinkel and Hacon-Jiang. In this talk I would like to explain some of applications of geometry of exceptional sets to the study of the space of rational curves on a Fano variety, and analytic properties of the height zeta function associated to the space of rational curves. This is joint work with Brian Lehmann.

11:45 – 12:45  **Daniel Loughran** (Manchester)

*Brauer groups and height zeta functions*

In this talk I present some results on a problem of Serre concerning specialisations of Brauer groups on algebraic varieties.

**Lunch Break**

**Excursion**

19:00 –  **Workshop dinner**
Thursday, June 1st

09:00 – 10:00  **Wen-Ch’ing Li** (Pennsylvania State)  
*Group based combinatorial zeta functions*

Similar to their counterparts in number theory, a combinatorial zeta function counts the geodesic closed cycles in a finite simplicial complex. In this survey talk we shall consider the complexes arising from finite quotients of buildings. The properties of such zeta functions will be discussed, and connection and comparison with number theoretical zeta functions will be mentioned.

Coffee Break

10:30 – 11:30  **Ming-Hsuan Kang** (Hsinchu)  
*Geometric zeta functions on reductive groups over non-archimedean local fields*

Ihara zeta functions is a geometric zeta function associated to a finite quotient of the building of PGL\(_2\) over a non-archimedean local field. In this talk, we will study geometric zeta functions on Tits buildings of split reductive groups of higher ranks via two different tools and the philosophy of the field with one element. For groups of adjoint type, we will first study the relation between Langlands \(L\)-functions and geometric zeta functions on a single apartment and then establish the result to the whole building. For simply connected groups, we will study zeta function using generalized Poincaré series associated to Iwahori Hecke algebra. Especially, our method can be applied to all groups of rank two including \(G_2\).

11:45 – 12:15  **Shai Shechter** (Be’er Sheva)  
*On regular characters of classical groups*

Regular characters of \(G = \text{GL}_n(\mathfrak{o})\), where \(\mathfrak{o}\) is a discrete valuation ring, form a considerable subset of the set of irreducible complex continuous characters of \(G\) and the largest class currently amenable to explicit construction. The definition of regular characters goes back to Shintani and Hill, who proved a variety of favourable properties of such characters and completed their construction in several key cases. Recently, the construction of all regular characters of \(\text{GL}_n(\mathfrak{o})\) was completed by Stasinski and Stevens and, independently, by Krakowski, Onn and Singla, who also computed the regular representation zeta function of the special and unitary groups over \(\mathfrak{o}\), i.e. the Dirichlet series \(\zeta^{\text{reg}}(s) = \sum \chi(1)^{-s}\), where \(\chi\) ranges over all regular characters of \(G\).

In my talk, I will report on a generalization of the definition and construction of regular characters to the classical groups over \(\mathfrak{o}\).

Lunch Break
14:45–15:45  **Christian Bogner** (HU Berlin)

*Part 1: Periods and Feynman integrals*

In particle physics, many computations rely on the evaluation of so-called Feynman integrals. It is well-known that zeta values, multiple zeta values and generalizations of polylogarithms appear very frequently in these computations. Over the last decade, a new mathematical perspective on Feynman integrals was established in which these integrals are related to period integrals in the sense of algebraic geometry. In this talk I give a brief introduction to Feynman integrals and review some of their relations to multiple zeta values and periods in general.

**Coffee Break**

16:15–17:15  **Sylvie Paycha** (Potsdam)

*Branched zeta functions and their renormalised values at poles*

Multizeta functions generalise the well-known ordinary zeta function and branched zeta functions are discrete sums attached to trees that generalise multizeta functions which correspond to ladder trees. We view branched zeta functions as discrete sums of pseudodifferential symbols and accordingly, we decorate the trees with pseudodifferential symbols. We then implement a multivariate regularisation procedure in replacing the symbols in the decoration by holomorphic families of symbols. Using the universal property of trees, we then build the corresponding regularised branched zeta functions and show that they are *multivariate meromorphic functions with linear poles*.

In order to renormalise branched zeta functions at poles, we need a good control of the poles. For this purpose, we use a refined universal property for trees, which involves the notion of locality, reminiscent of locality in quantum field theory. In our framework locality is encoded in a binary symmetric relation, with which we equip sets that we call localised sets. We introduce the localised monoid of properly decorated forests, which serves as a model for what we call *partially operated localised monoids*. A refined universal property for partially operated localised monoids provides us with a good knowledge of the pole structure of the branched zeta functions. Branched zeta functions are then renormalised at poles using a multivariate minimal subtraction scheme, which generalises the (univariate) minimal subtraction scheme known to physicists.

This talk is based on joint work with Pierre Clavier, Li Guo and Bin Zhang.
Friday, June 2nd

09:00 – 10:00  
**Tobias Rossmann** (Auckland)  
*The average size of the kernel of a matrix and orbits of linear groups*

Given a module $M$ of matrices over a compact discrete valuation ring $O$ of characteristic zero, we consider the generating function encoding the average sizes of the kernels of the elements of $M$ over the finite quotients of $O$. As we will see, special cases of these generating functions include conjugacy class and orbit-counting zeta functions of suitable groups.

**Coffee Break**

10:30 – 11:30  
**Johannes Nicaise** (London)  
*A motivic Fubini theorem for the tropicalization map*

This talk is based on joint work with Sam Payne. I will present a Fubini theorem for the tropicalization map in the context of Hrushovski and Kazhdan’s theory of motivic integration. As an application, I will prove a conjectural description by Davison and Meinhardt of the motivic nearby fiber of a weighted homogeneous polynomial. This conjecture emerged in the theory of motivic Donaldson-Thomas invariants. The same method yields a short proof of the integral identity conjecture of Kontsevich and Soibelman, which was proven by Lê Quy Thuong.

11:45 – 12:45  
**Steffen Kionke** (Düsseldorf)  
*Zeta functions associated to representations of compact $p$-adic Lie groups*

To an admissible smooth representation of a profinite group we associate a zeta function defined via a Dirichlet series which encodes the multiplicities and degrees of the irreducible constituents. This provides a new perspective on the well-known ‘representation zeta function’ of (profinite) groups. We give a short introduction to the topic and explain how this approach can yield a more detailed understanding of problems in the area of representation growth. In particular, we discuss induced representations of compact $p$-adic Lie groups (e.g. the general linear group over the $p$-adic integers). In this case the zeta functions can be related to certain series of Igusa integrals and classical methods can be used to prove rationality and functional equations. This is based on joint work with Benjamin Klopsch.

**Lunch Break**
14:45–15:45 **Uri Onn** (Be’er Sheva)

*Pro-isomorphic zeta functions of some $D^*$-groups*

Pro-isomorphic zeta functions are Dirichlet series associated with finitely generated nilpotent groups that enumerate finite index subgroups having the same finite quotients as the parent group. They constitute one of the natural non-commutative analogues of the classical Dedekind zeta functions. While other analogues, such as (normal) subgroup zeta functions, have been studied intensively, the study of pro-isomorphic zeta functions is in a far less advanced state. A unique feature of the latter is that they are closely related to zeta functions of algebraic groups, studied by Weil, Igusa and others. In this talk I will describe the main tools that are used to study pro-isomorphic zeta functions and report on some recent results regarding zeta functions associated with members of a family of class-2 nilpotent groups called $D^*$-groups. This is a joint work with Mark Berman and Benjamin Klopsch.

**Coffee Break**

16:15–17:15 **Christian Bogner** (HU Berlin)

*Part 2: Algorithms for multiple polylogarithms*

Multiple polylogarithms and multiple zeta values serve as a useful framework of functions and numbers for the computation of many Feynman integrals. They can be expressed in terms of a particular class of iterated integrals on moduli spaces of curves. In this talk I discuss algorithms for computations with these iterated integrals and present a resulting computer program whose main purpose is the evaluation of a certain class of Feynman integrals. I will also refer to other possible applications of this program.
**List of participants**

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<td>Bar-Ilan University</td>
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<td>Universität Bielefeld</td>
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<td>Miriam Bocardo</td>
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<td>(Universidad Pontificia Javeriana Bogotá-Colombia)</td>
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<td>René Chipot</td>
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<td>Lin Weng</td>
<td>Kyushu University</td>
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<tr>
<td>Stefan Witzel</td>
<td>Universität Bielefeld</td>
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<tr>
<td>Chenyang Xu</td>
<td>Beijing International Center of Mathematics Research</td>
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<tr>
<td>Michele Zordan</td>
<td>KU Leuven</td>
</tr>
<tr>
<td>Wilson Zúñiga-Galindo</td>
<td>CINVESTAV, Mexico</td>
</tr>
</tbody>
</table>
Local information

Emergency telephone numbers

Police: 110. Fire and rescue services: 112.

Contact

The local organizers may be contacted via email (zeta2017@math.uni-bielefeld.de).

Online map

A google map with some of the mentioned locations is available at https://drive.google.com/open?id=1cDbdaOLmq8N-cPVbrINE9Omq53w&usp=sharing

Leineweber-Market

Sunday, May 28th is the last day of the Leineweber-Market, a fair in the centre of town. It closes at 10 pm.

Food and drink

Here is a selection of Bielefeld’s numerous bars, cafes and restaurants, with some partial indication on the price range (€ – €€€). Beware that not all places accept credit cards.

- BAR 383, Karl-Eilers-Str. 20a
- Zwanzig Dreizehn Bar & Cuisine, Klosterplatz 13
- €€ Numa, Obernstraße 26
- €€€ Bernstein, Niederwall 2
- €€ Kachelhaus, Hagenbruchstr. 13
- €€ Brauhaus Joh. Albrecht, Hagenbruchstr. 8
- €€ Wernings Weinstube, Alter Markt 1
- €€€ Klötzers Kleines Restaurant, Niedernstr. 41
- €€ Der Koch, Rolandstr. 15
- €€€ Vin pur – Heinrich sein Enkel, Rolandstr. 20 (wine bar, cafe, light meals)
- € Piro, Mercatorstr. 13 - 15
- €€ Univarza, in the University’s main building

Weekends

Most shops, including grocery stores and supermarkets, will be closed on Sunday. Some convenience stores and petrol stations might sell food. Most restaurants and cafes should be open.

ATM, postal services, grocery shop, book store

Bielefeld’s central Post Office is located in Nahariyastr. 1, not far from the central station. In the University’s main building, which is quite close to the ZiF, you will find

- the ATMs of Sparkasse, a local bank,
- the grocery shop ‘Eddy in der Uni’,
- the book store with post office ‘Luce Buchhandlung in der Uni Bielefeld’

Supermarkets

- Combi, Wertherstr. 266
- Aldi, Große-Kurfürsten-Str. 82
- EDEKA, Große-Kurfürsten-Str. 66
- REWE, August-Bebel-Str. 116
- REAL, Teutoburger Str. 98
Leisure and sports; excursion

There are a number of footpaths from the ZiF into the *Teutoburger Wald*, a range of wooded hills, making for ideal walking and running tracks. In fact, the nicest way from the ZiF to the city centre is a walk of around 50 minutes through the woods.

The excursion on Wednesday afternoon will be a guided walk through the countryside south-west of the ZiF. It will end at the *Bauernhausmuseum*, a small open air exhibition of historical buildings ([http://www.bielefelder-bauernhausmuseum.de/](http://www.bielefelder-bauernhausmuseum.de/)), or rather the small café on its premises. Alternatives include Bielefeld’s *Historisches Museum* ([www.historisches-museum-bielefeld.de/](http://www.historisches-museum-bielefeld.de/)), which documents the city’s manufacturing resp. industrial heritage. The *Kunsthalle* ([www.kunsthalle-bielefeld.de/?lang=en](http://www.kunsthalle-bielefeld.de/?lang=en)) is a small but not unappealing art centre in the centre of town (and home of an interesting café, too).

There is a public swimming pool not far from the central station ([www.ishara.de/](http://www.ishara.de/)).

German survival guide

Do you speak English? Sprechen Sie Englisch?

How are you? Wie geht es Ihnen?

Would you help me please? Würden Sie mir bitte helfen?

What’s your name? Wie heißen Sie?

What time is it? Wie viel Uhr ist es?

What’s the weather like? Wie ist das Wetter?

How much does . . . cost? Wie viel kostet . . . ?

Where do I find . . . ? Wo finde ich . . . ?

Where are the bathrooms? Wo sind die Toiletten?

Do you have . . . ? Haben Sie . . . ?

Where is . . . ? Wo ist . . . ?

Could you please talk more slowly? Könnten Sie bitte langsamer sprechen?

Could you repeat that, please? Könnten Sie das bitte wiederholen?

Hello! Hallo!

Good day! Guten Tag!

Good evening! Guten Abend!

Good-bye! Auf Wiedersehen!

Please. / You’re welcome. Bitte.

Thank you. Danke.

Sorry. Entschuldigung.

My name is . . . . Ich heiße . . . .

Pleased to meet you. Freut mich.

Help! Hilfe!

Police! Polizei!

Fire! Feuer!

Get a doctor! Holen Sie einen Arzt!

I am ill. Ich bin krank.

I don’t know my way around here. Ich kenne mich hier nicht aus.

The menu, please. Die Speisekarte bitte.

I’d like . . . . Ich hätte gern . . .

Could you recommend something? Könnten Sie etwas empfehlen?

Another (beer) please. Noch (ein Bier) bitte.

Excuse me. Entschuldigen Sie bitte.

The bill, please. Die Rechnung bitte.

A receipt, please. Eine Quittung bitte.

Enjoy your meal. Guten Appetit.

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Getting to the ZiF – public transport in Bielefeld

Public transport in Bielefeld is run by moBiel; see [www.mobiel.de](http://www.mobiel.de) for timetables and ticket options.

- **Ticketing** For a single ride between the centre of town and the ZiF you will need a ticket (*Fahrschein*) in the fare-zone *Preissstufe 1 BI*. A single such ticket costs EUR 2.50. A more economical option is to buy a *4er Ticket*, comprising four individual tickets, for € 8.40. Tickets need to be validated for each trip; this can be done within busses and/or tramways. You can validate tickets for several people on a single *4er Ticket*. Tickets are on sale, in particular, from machines at tramway stations, but not inside tramways.

- **Tram (Stadtbahn)** Bielefeld is served by the *Stadtbahn*, a tramway. The relevant line for the workshop is Line no. 4 (marked in red on the map overleaf), its relevant stops include:
  - Rathaus (closest to Arcadia Hotel),
  - Jahnplatz (closest to aappartel boardinghouse),
  - Hauptbahnhof (= central station, closest to B&B and Kolpinghaus),
  - Bültmannshof (closest to the ZiF),
  - Universität (most straightforward for the ZiF).

  Trams towards the ZiF will head for *Lohmannshof* or *Universität*, those towards the centre of town will have *Rathaus* as their destination.

- **Bus** The ZiF can also be reached, at least as quickly and easily, by bus. Bus lines 21, 61 and 62 serve the nearby stop *Uni/Stud.-Wohnheim*.
  - Bus line 21 departs from *Jahnplatz* (ideal for those staying at aappartel boardinghouse or Arcadia Hotel) with destination *Werther Gesamtschule* towards the ZiF.
  - Bus lines 61 and 62 depart from *Hauptbahnhof* (ideal for those staying at the B&B or the Kolpinghaus) with directions *Borgholzhausen* or *Schützenhaus* towards the ZiF.

The local organizing team will be happy to assist with any questions you may have!
Tram map

University
Line 4 - direction 'Lohmannshof'

1. Senne – Jahnplatz – Schildesche
2. Sieker – Jahnplatz – Milse
3. Steighorst – Jahnplatz – Babenhausen Süd