Building Bridges

Book of abstracts

5th EU/US Workshop on
Automorphic Forms and Related Topics

Dedicated to Lynne Walling

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Eisenstein series on arithmetic quotients of rank 2 Kac–Moody groups over finite fields

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keywords: *Eisenstein series, Bruhat-Tits building, Kac-Moody group, lattice*
MSC: 11F70

Abstract

Let G be a rank 2 Kac-Moody group over a finite field. The groups G comes equipped with a data (X, P_1^-), where X is the Tits building of G and P_1^- is the standard parabolic subgroup of the negative BN-pair. By using this data and the Iwasawa decomposition of G, we define Eisenstein series on the quotient graph $P_1^- \setminus X$, which is induced by a character on the set of vertices of X. In this talk, I will discuss this Eisenstein series, its convergence and meromorphic continuation.

Counting modular forms mod p

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keywords: *mod-p and p-power congruences, Brauer-Nesbitt theorem, mod-p modular forms, Atkin-Lehner involution, trace formula*
MSC: 11F33, 11F11, 11F72, 16G10, 11F80, 20C08

Abstract

The structure of the algebra of modular forms over finite fields has been widely studied, in part for its applications in establishing congruences. In this talk, after recalling classical geometric arguments of Ogg and Kenku, I will show how, for N prime with p, one can count the number of classical modular forms of level N_p and weight k with both a residual Galois representation and an Atkin-Lehner sign at fixed p, generalizing Martin's recent results, and dimension formulas given by Jochnowitz and by Bergdall-Pollack. Most of these results can be stated as equivariant isomorphisms for the Hecke operators between certain modules, thanks to a p-adic refinement of the Brauer-Nesbitt theorem. A theoretical framework for proving such isomorphisms is given, using the Eichler-Selberg trace formula. This method applies in the case where the level is divisible by the residual characteristic, contrary to the pre-existing approaches. This is work in progress with Alexandru Ghitza (University of Melbourne) and Anna Medvedovsky (Boston University).

Location of the zeros of certain complex-valued harmonic polynomials

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keywords: *analytic polynomials, harmonic polynomials, zero inclusion regions, trinomials*
MSC:30A

Abstract

Finding an approximate region containing all the zeros of analytic polynomials is a well-studied problem. But the number of the zeros and regions containing all the zeros of complex-valued harmonic polynomials is relatively a fresh research area. It is well known that all the zeros of analytic trinomials are enclosed in some annular sectors that take into account the magnitude of the coefficients. Following Kennedy and Dehmer, we provide the zero inclusion regions of all the zeros of complex-valued harmonic polynomials in general, and in particular, we bound all the zeros of some families of harmonic trinomials in a certain annular region.

On unitary dual of a p-adic group

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keywords: *unitary dual, p-adic special orthogonal group, non-unitary dual*
MSC: 22E50, 22E35, 11F70

Abstract

The problem of finding the unitary dual of a reductive algebraic group over a local non-archimedean field is an important aspect of research in the representation theory in the last few decades. The main approach is to first determine the non-unitary dual and then to extract the classes of unitarizable representations among the obtained irreducible subquotients. In this way the whole problem quickly becomes very complicated, but in studying the induced representations of groups of a small rank, besides directly studying all the possible cases of induced representations, one can also gain a good sense of the structure of a unitary dual in a general case. The main focus of this talk is going to be the p-adic group $SO(7)$ and its unitary dual supported on minimal parabolic subgroup. This research was supported in part by the Croatian Science Foundation under the project IP-2018-01-3628.

The first negative Fourier coefficient of an Eisenstein series newform

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keywords: *Eisenstein series newforms, Fourier coefficients, the large sieve*
MSC: 11F30, 11N36

Abstract

There have been a number of papers on statistical questions concerning the sign changes of Fourier coefficients of newforms. In one such paper, Linowitz and Thompson gave a conjecture describing when, on average, the first negative sign of the Fourier coefficients of an Eisenstein series newform occurs. In this talk, we correct their conjecture and prove the corrected version.

Dissipation of correlations of automorphic forms

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keywords: *quantum unique ergodicity, modular forms, L-functions*
MSC: 11F11, 11F67, 58J51

Abstract

Mass equidistribution of eigenfunctions is a central topic in quantum chaos and number theory. In this talk we highlight a generalisation of the Quantum Unique Ergodicity for holomorphic cusp forms in the weight aspect. We show that correlations of masses coming from off-diagonal terms dissipate as the weight tends to infinity. This corresponds to classifying the possible quantum limits along any sequence of Hecke eigenforms of increasing weight.

On the regularized 4th moment of Eisenstein series

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keywords: *Eisenstein series, equidistribution, L^4-norm, regularized inner products, quantum chaos, random wave conjecture, L-functions*
MSC: 11F12, 11M99

Abstract

We will explain a connection between the regularized fourth moment of Eisenstein series for the full modular group and a certain mean value of L-functions.

Distributions on integer partitions

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keywords: -
MSC: -

Abstract

Many partition statistics, once suitably normalized, approach nice distributions as the particular integer partitioned grows sufficiently large. For example, Bringmann showed that for a fixed modulus M, the "ranks" of the partitions of a number n become uniformly distributed modulo M as n grows. In joint work with Ken Ono, Larry Rolen, and Wei-Lun Tsai, we consider several other examples of the limiting distributions of various partition statistics. In a particularly nice example we consider the "t-hooks" in the partitions of n. We show that the proportion of the partitions of n with a specified number of t-hooks is approximately normally distributed with an explicit mean and variance.

Spectral constructions of elliptic-type Eisenstein series and automorphic forms

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keywords: -
MSC: -

Abstract

We will describe results in which we use analytic techniques from spectral theory to construct non-holomorphic Eisenstein series, determine their Kronecker limit functions, and identity such functions as log-norms of holomorphic modular forms. When the underlying space is complex projective space, we further develop a means by which one can evaluate certain Mahler measures as convergent series. As time permits, we will describe further applications. The research is joint with James Cogdell and Lejla Smajlovic.

Solving Fermat type equations by modular approach

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keywords: *Diophantine equations, modular method, Galois representations*
MSC: 11D41, 11F80, 11F03, 11F75

Abstract

The asymptotic Fermat conjecture (AFC) states that for a number field K not containing ζ_3, there is a bound B_K depending only on the field K such that for all prime exponents $p > B_K$, the equation $x^p + y^p + z^p = 0$ has only trivial solutions. The strategy which is referred as the "modular method" to solve the Fermat equation, used by Wiles in his famous proof, can be adapted to attack AFC and its several different generalizations. Similar results are quite rare for other Fermat type equations such as $x^p + y^q = z^r$ although the solutions of this equation have been studied over rationals. In this talk, we will mention some recent asymptotic results for the classical Fermat equation as well as some other Fermat type equations over number fields by assuming some standard modularity conjecture. Moreover, we will explain how this bound can be made explicit for some specific number fields. This talk is based on joint works with Erman Isik and Ekin Ozman.

Quadratic twists of genus one curves

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keywords: *genus one curves, quadratic twists, Selmer group, Diophantine m-tuples*
MSC: 11G05

Abstract

In this talk, we investigate the existence of a rational point on genus one curves $dy^2 = (x^2 - x - 3)(x^2 + 2x - 12)$, where $|d| = p$ is a prime. Consequently, for those d's for which such point exists, we conclude that there are infinitely many rational $D(d)$-quintuples.

The Vinogradov's mean value formula and bounds for shifted convolution sums

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keywords: *Automorphic forms, Whittaker-Fourier coefficients, Vinogradov mean value, circle method*
MSC: 11F30, 11P55, 11P05

Abstract

In this talk I'll explain how to make use of the main conjecture in the Vinogradov's mean value theorem, recently proved by Bourgain-Demeter-Guth via the decoupling techniques in harmonic analysis, to bound certain shifted convolution sums.

Asymptotics for canonical Green's functions associated with congruence subgroups at cusps

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keywords: *canonical Green's functions, Eisenstein series, congruence subgroups*
MSC: 14G40, 30F10, 11F72, 30C40

Abstract

The motivation to study canonical Green's functions comes from the Arakelov geometry. In 1974, Arakelov defined an intersection theory for divisors on arithmetic surfaces, which is the sum of a geometric part and an analytic part. The analytic part is computed from asymptotics for the canonical Green's function at cusps. In 2006, Jorgenson and Kramer gave bounds for canonical Green's function associated with cofinite Fuchsian groups which have no elliptic and parabolic elements. To derive bounds for canonical Green's function, Jorgenson and Kramer have used the hyperbolic heat kernels. In my talk, I will explain their method for any arbitrary cofinite Fuchsian subgroup of PSL(2,R). We bound the canonical Green's function in terms of scattering constants, Kronecker limit functions, Selberg zeta function and a term involving the smallest nonzero eigenvalue of the hyperbolic Laplacian. Using this bound we obtain asymptotics for canonical Green's functions associated with congruence subgroups at cusps.

Computing Fourier coefficients of cusp forms

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keywords: *cusp forms, Fourier coefficients, congruence subgroups*
MSC: 11F30

Abstract

We explain how to compute Fourier coefficients of cusp forms of weight 2 for congruence subgroups of prime level p, containing $-I$, starting from the Fourier coefficients of a basis of cusp forms of weight 2 with respect to the classical subgroup $\Gamma_0(p^2)$. In particular, if time permits, we show an explicit formula to compute Fourier coefficients for congruence subgroups associated to the normalizer of non-split Cartan subgroups of $GL(2, \mathbb{Z}/p\mathbb{Z})$.

Superzeta functions associated to the Ruelle zeta function on hyperbolic Riemann surfaces

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keywords: *Ruelle zeta function, superzeta functions, regularized products*
MSC: 11M36

Abstract

Let M denote a finite volume, non-compact hyperbolic Riemann surface, possibly with elliptic fixed points, and let χ denote a finite dimensional unitary representation of the fundamental group of M. The sets of non-trivial zeros and poles of the Ruelle zeta function $R_\chi(s)$ associated to M and χ are related to the spectral data, i.e. discrete eigenvalues and resonances of the hyperbolic Laplacian. For this reason, it is of interest to study the superzeta function associated to the divisor of $R_\chi(z)$. We define completed function associated to $R_\chi(s)$ and investigate superzeta functions associated to it. Meromorphic continuation is derived and polar structure is described for the superzeta function associated to the trivial zeros. This talk is based on joint work with Lejla Smajlović and Yasemin Kara.

Lorentzian forms for generalized ultra log concavity

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keywords: *Lorentian polynomial, log concavity, quadratic form, matroid*
MSC: 11Cxx

Abstract

Following the introduction of Tutte-Whitney Dichromate polynomial succeeding Chromatic polynomial of a graph, we see how symmetric quadratic form of homogeneous polynomial plays the role of projective space. We will build details toward Branden-Huh (2019) characterizing a Lorentzian Polynomial. We do a basic example motivating the work of Backman-Eur-Simpson via a novel representation of the Chow ring for a matroid to prove Rota's log concavity conjecture. The simplicial generators in the new presentation are motivated by nef divisors on projective toric varieties so we will introduce the corresponding matroid definition.

A simple extension of Ramanujan-Serre derivative map and some applications

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keywords: *modular forms*
MSC: 11F11

Abstract

We derive a simple extension of Ramanujan-Serre derivative map and

use it to get a general method to derive certain convolution sums of the divisor functions. We shall provide explicit expressions for four types of convolution sums.

Subconvexity for $GL_3(\mathbb{R})$ L-functions: the key identity via integral representations

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keywords: *automorphic form, subconvexity problem for $GL_3(\mathbb{R})$, key identity, special Whittaker function*
MSC: 11F70, 32N10

Abstract

We study the subconvexity problem for $GL_3(\mathbb{R})$ L-functions in the t-aspect using integral representations by combining techniques employed by Michel–Venkatesh in their study of the corresponding problem for GL_2 with ideas from recent works of Munshi, Holowinsky–Nelson and Lin. Our main objective is to give – from the perspective of integral representations of L-functions and automorphic representation theory – a possible explanation of the origin of the "key identity" arising in the latter series of works.

A short proof of the Macdonald identities

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keywords: -
MSC: -

Abstract

We present a new and short proof of the well-known Macdonald identities. The proof is rather self-contained since it uses merely some easy combinatorial arguments, a basic (though subtle) geometrical fact about root systems and a bit of 'modular forms magic' (presented in the language of Jacobi forms). The proof suggests the possibility that there might be more, not yet discovered Macdonald type identities.

Integer factorisation based on diffusion process

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keywords: *integer factorisation, diffusion computing*
MSC: 11Y05, 11Y16

Abstract

We discuss how to use the diffusion process on a suitably constructed graph as a computational engine. More precisely, we describe the construction of the graph and implementation of the "diffusion-based" algorithm for factorization of a given integer N which is not a prime or a prime power. Along the way, the definition of a "diffusion step" which is analogous to "quantum step" is introduced, and it is shown, using analysis of short exponential sums, that the factorization algorithm uses at most $O((\log N)^2)$ diffusion steps to terminate.

This is a joint work with Carlos A. Cadavid, Paulina Hoyos, Jay Jorgenson and Juan D. Vélez.

On a Generalization of Alder's Conjecture

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keywords: *Alder's Conjecture, partitions with difference conditions, partitions with congruence conditions, saddle point method*
MSC: 11P82

Abstract

In 1956, Alder conjectured that the number of d-distinct partitions of an integer n is greater than or equal to the number of partitions of n into parts congruent to plus or minus one modulo d+3. Andrews and Yee proved Alder's conjecture for all but finitely many values of d using intricate combinatorial methods. We discuss the asymptotic method used by Alfes, Jameson, and Lemke Oliver to prove Alder's conjecture for the remaining values of d and ongoing work on a related conjecture of Kang and Park.

A-points of the Selberg zeta function

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keywords: *Selberg trace formula, Selberg zeta function*
MSC: 11M36

Abstract

Suppose we have $f(x) = a$. Then a is called an a-point of the function f. We discuss the distribution of such a-points in the complex plane when f is the Selberg zeta function associated with compact or finite Riemann surfaces.

On the sup-norm of automorphic forms in higher rank

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keywords: *automorphic forms, sup-norm, trace formula, amplification, Hecke operators, orders, division algebras*
MSC: 11F55, 11F72, 11D45, 11R52

Abstract

The theory of arithmetic quantum chaos predicts that there should be strong bounds on the sup-norm of L^2-normalised automorphic forms, as their eigenvalues grow. The problem of proving such bounds is connected to and shares many technical features with the subconvexity problem for L-functions. The aim of this talk is to present some recent results for automorphic forms on compact quotients of $\mathrm{SL}(n, \mathbb{R})$, giving sup-norm bounds uniform in both the eigenvalue, as well as the volume of the quotient.

A Hardy Littlewood Conjecture for Artin Primes

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keywords: *Artin Primitive Roots; Hardy Littlewood Conjecture*
MSC: 11N05

Abstract

We say that a prime p is an Artin prime for g if g is a primitive root mod p. For appropriately chosen g, we present a conjecture for the asymptotic number of prime k-tuples $(p + d_1, \cdots, p + d_k)$ such that, for all $1 \leq i \leq k$, $p + d_i$ is an Artin prime for g. Our results suggest that the distribution of Artin prime k-tuples, amongst the ordinary prime k-tuples, is largely governed by a Poisson binomial distribution (Joint work with Magdaléna Tinková and Mikuláš Zindulka; and with August Liu).

Integral bases and invariant vectors for Weil representations

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keywords: *Weil representations, invariant spaces, representations over rings*
MSC: 11F27

Abstract

Weil representations associated with finite quadratic modules play an important role in the theory of modular forms and theta functions. Their invariants are the modular forms of weight 0, and they are the obstruction space for certain uniqueness results about liftings. We present a method for finding the dimension of the space of invariants in many cases, based on formulae for explicit bases for the Weil representations in which the action involves only algebraic integers, formulae that are interesting on their own right.

Modular Gelfand pairs and multiplicity-free triples

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keywords: *Gelfand pairs, multiplicity-free triples, modular representations, Hecke algebras, uniqueness of Whittaker models, self-projective modules*
MSC: 20C20, 20G05, 20G40, 20C05, 20C08, 16D40, 16D50, 11F70

Abstract

The classical theory of Gelfand pairs and its generalizations over the complex numbers has many applications to number theory and automorphic forms, such as the uniqueness of Whittaker models and the non-vanishing of the central value of a triple product L-function. With an eye towards similar applications in the modular setting, this talk presents an extension of the classical theory to representations over algebraically closed fields with arbitrary characteristic.

On the boundedness of Euler-Stieltjes constants for the Rankin-Selberg L-function

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keywords: *Euler-Stieltjes coefficients, Rankin-Selberg L-function, upper bound*
MSC: 11S40, 11Y60

Abstract

Let E be Galois extension of $\mathbb{Q}$ of finite degree and let π and π' be two irreducible automorphic unitary cuspidal representations of $GL_m(E_{\mathbb{A}})$ and $GL_{m'}(E_{\mathbb{A}})$, respectively. Let $L(s, \pi \times \widetilde{\pi}')$ Rankin-Selberg L-function attached to the product $\pi \times \widetilde{\pi}'$, where $\widetilde{\pi}'$ denotes the contragredient representation of π'. The Euler-Stieltjes constants of Rankin-Selberg $L-$function $L(s, \pi \times \widetilde{\pi}')$ are the coefficients in Laurent (Taylor) series expansion around $s = 1+it_0$ of $L(s, \pi \times \widetilde{\pi}')$. In this paper, we derive an upper bound of these constants.