Peter Xu

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https://xretep.github.io/pdfs/

Education

2017 - 2023 PhD in Mathematics at **McGill University**
2012 - 2016 BA in Mathematics at the **University of Chicago** (minor: Human Rights)

Employment

2023 - present Hedrick Assistant Adjunct Professor at **UCLA**

Articles and research

Symbols for toric Eisenstein cocycles and arithmetic applications

Preprint. Obtains explicit expressions for Eisenstein cocycles for arithmetic group actions on self-products of $\mathbf{G}_m$, by constructing explicit symbols in motivic cohomology complexes. Improves existing Hecke and integrality results for Sharifi's map ϖ_N relating the Eisenstein geometry of $\mathrm{GL}_2(\mathbb{Q})$ and the motivic cohomology of cyclotomic fields. Establishes a duality relationship of the de Rham regulator to smoothed Shintani generating functions, and thereby obtains a new Shintani-style proof of the 2-adic congruences of Deligne–Ribet. Available at https://xretep.github.io/pdfs/toric.pdf.

Symbols for elliptic Eisenstein cocycles and the Sharifi conjectures

In preparation. Obtains explicit expressions for Eisenstein cocycles for arithmetic group actions on self-products of elliptic schemes, by constructing explicit symbols in motivic cohomology complexes. Improves existing Hecke and integrality results for Sharifi's map ϖ_N relating the Eisenstein geometry of $\mathrm{GL}_2(\mathbb{K})$ and the motivic cohomology of abelian extensions of a CM field K. Constructs and proves Hecke properties of the analogous Sharifi map relating Eisenstein geometry of $\mathrm{GL}_3(\mathbb{Q})$ and the motivic cohomology of modular curves. Uses Kato's reciprocity law to relate a p-adic regulator of families of Beilinson-Kato classes with p-adic families of toric modular forms, or restricted Hilbert-Eisenstein series.

Eisenstein class of a torus bundle and log-rigid classes for $\mathrm{SL}_n(\mathbb{Z})$

Joint with Martí Roset Julià, preprint. Uses purely topological methods (part of the "topological polylogarithm" class, to be precise) to produce a $(n-1)$-cocycle for $\mathrm{SL}_n(\mathbb{Z})$ valued in differential forms on Drinfeld's p-adic upper half-space. Conjectures a relationship between evaluations of these classes and logarithms of Gross–Stark units, and proves this in some cases using the work of Dasgupta–Kakde. Available at https://xretep.github.io/pdfs/RX1.pdf.

Rigid analytic Eisenstein cocycles for $\mathrm{SL}_n(\mathbb{Z}[1/p])$

Joint with Martí Roset Julià, preprint. Uses symbols in a cohomological complex for a smooth torus to produce explicit $(n-1)$-cocycles for $\mathrm{SL}_n(\mathbb{Z}[1/p])$ valued in invertible analytic functions on Drinfeld's p-adic upper half-space, generalizing existing results on rigid analytic cocycles from the case $n = 2$, in

the "Eisenstein" setting. Relates the evaluations to periods of Eisenstein series. Conjectures a relation to Brumer–Stark units for certain inert primes, and proves it in certain cases using the work of Dasgupta–Kakde. Available at https://xretep.github.io/pdfs/RX2.pdf.

Eisenstein duality for Dedekind sums, cocycle comparisons, and Gross–Stark unit formulas

Joint with Martí Roset Julià, in preparation. Establishes a duality between two kinds of smoothed formulas for Dedekind sums, one appearing in the previous article ("Rigid analytic Eisenstein cocycles..."), and one appearing in the article "Symbols for toric...". Exhibits a geometric origin for this duality, and relates it to the functional equation for archimedean families of Eisenstein series. Shows the latter type of formulas essentially coincide with smoothed Shintani-style formulas used in Dasgupta–Kakde's work on Hilbert's 12th problem, and thereby shows that evaluations of the previous article's rigid analytic cocycles are Gross–Stark units for totally real fields (up to a factor of $p^{\mathbb{Z}}$). Extends this relationship beyond the case of inert p by extending to the boundary.

Eisenstein cocycles for Drinfeld modular varieties.

Joint with Romyar Sharifi, in preparation. Constructs cocycles valued in products of the analogues of Siegel units on Drinfeld modular varieties, in motivic cohomology. Proves Hecke equivariance properties for these cocycles; in particular, in certain dimensions, constructing proving the Eisenstein property of Sharifi's map ϖ_N relating the Eisenstein geometry of $\mathrm{GL}_n(A)$ and the motivic cohomology of a rank-$(n-1)$ Drinfeld modular variety over A, for A any function field.

Classical periods of Eisenstein series and Bernoulli polynomials in the equivariant cohomology of a torus

Preprint. Uses explicit elements in cohomology complexes of 2-tori to obtain a conceptual proof of a classical *unsmoothed* formula of Siegel for the periods of classical weight-2 holomorphic Eisenstein series. Available at https://xretep.github.io/pdfs/classical.pdf.

Explicit formula for the $(\mathrm{GL}_2, \mathrm{GL}_2)$ theta lift via Bruhat decomposition

Preprint. Uses explicit elements in cohomology complexes of families of squared elliptic curves to obtain an explicit *unsmoothed* formula for the Bergeron–Charollois–Garcia theta correspondence for the pair $(\mathrm{GL}_2(\mathbb{Q}), \mathrm{GL}_2(\mathbb{Q}))$, and exhibits some resulting relations between L-values. The analogous computation for a squared CM elliptic curve recovers an analytic period formula of Ito. Available at https://xretep.github.io/pdfs/bruhat.pdf.

Talks

Combinatorial Eisenstein cocycles 2024 Bielefeld Workshop, et. al. (see below)

Talk on the construction of explicit Eisenstein cocycles in the toric/elliptic cases (preprints mentioned above). Also gave a variation of this talk at several department seminars, including UCLA, Columbia, UC Santa Barbara, and Caltech.

Higher Kato elements and equivariant complexes 2022 Quebec-Maine Number Theory

Talk on a part of my thesis work in a concrete setting.

Deformations of formal groups 2018 Montreal-Toronto Number Theory

Expository talk on the Gross-Hopkins construction of deformation spaces of formal groups.

Awards and scholarships

McGill Graduate Excellence Award 2017 - 2023

Kenneth Eade Fellow 2018 - 2019

McGill Chair Graduate Award 2021 - 2022

Teaching and outreach

Lectureships

McGill University:

- MATH 141 Calculus II, Summer 2018 and Fall 2022

University of California, Los Angeles:

- MATH 131a Analysis, Fall 2023, Winter/Spring/Fall 2024, Winter/Fall 2025
- MATH 184 Enumerative Combinatorics, Spring 2024
- MATH 61 Introduction to Discrete Structures, Winter 2025
- MATH 111 Introduction to Number Theory, Spring 2025.

Directed Reading Program

Organized a mentorship program pairing McGill undergraduates interested in mathematics research with graduate students in corresponding fields. Solicited and paired graduate student volunteers with interested undergraduates, organized events, reviewed student expository write-ups, and participated as a mentor (in the first two years). The program has now expanded to be well-funded, with stipends for the graduate mentors, funds for resources for the students, and writing/presentation workshops.

UCLA–CSU Summer Bridge

August 2025. Prepared and taught an intensive one-week course (seven hours per day, with breaks) on representation theory of finite groups for a small group of students preparing to apply for doctorates in mathematics, coming from California State system universities which traditionally do not have strong programs for mathematical research. Wrote syllabus, assigned exercises, and gave personalized attention to each student throughout the long teaching sessions.