

# Carl Wang-Erickson

## Curriculum Vitæ

### Personal Data

Address: 301 Thackeray Hall  
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### Employment history

**University of Pittsburgh**, Pittsburgh, Pennsylvania, USA.  
Assistant Professor of Mathematics, 2019 – present.

**Imperial College**, London, UK.

Research Associate in Pure Mathematics, 2016 – 2019.

Supported by EPSRC grant EP/L025485/1 of K. Buzzard and T. Gee.

**Brandeis University**, Waltham, Massachusetts, USA.

Postdoctoral Instructor in Mathematics, 2013 – 2016.

### Education

**Harvard University**, Cambridge, Massachusetts, USA.

PhD in Mathematics, May 2013.

Dissertation: *Moduli of Galois Representations*, supervised by M. Kisin.

**Churchill College, University of Cambridge**, Cambridge, UK.

Certificate of Advanced Study in Pure Mathematics, with Distinction, June 2008.

**Stanford University**, Stanford, California, USA.

BS with Distinction and Departmental Honors in Mathematics, June 2007.

BA with Distinction in Religious Studies, 2007.

### Professional Interests

**Number theory** — particularly Galois representations, modular and automorphic forms, and relations to arithmetic.

**Deformation theory and  $p$ -adic families** of the above, and related topics in deformation theory and algebraic geometry.

**Introducing students to research** at the undergraduate and graduate levels.

**K-12 outreach and enrichment** in mathematics involving university students.

### Research Articles

#### Publications

(12) *Explicit non-Gorenstein  $R = \mathbb{T}$  via rank bounds II: Computation*. With Catherine Hsu and Preston Wake.

**Res. Number Theory** 9 (2023), no. 1, Paper No. 16, 52 pp.

Part of the *Proceedings of the Fifteenth Algorithmic Number Theory Symposium (ANTS-XV)*.

C. Wang-Erickson CV page 1

- (11) *A base-change deformation functor. An appendix to Families of Bianchi modular symbols: critical base-change  $p$ -adic  $L$ -functions and  $p$ -adic Artin formalism*, by Daniel Barrera Salazar and Chris Williams.  
**Selecta Math.** (N.S.) 27 (2021), paper no. 82, 45 pp.
- (10) *Class groups and local indecomposability for non-CM forms.* With Francesc Castella.  
**J. Eur. Math. Soc. (JEMS)** 24 (2022), no. 4, 1103-1160. With an appendix by Haruzo Hida.
- (9) *The Eisenstein ideal at squarefree level.* With Preston Wake.  
**Advances in Mathematics** 380 (2021), paper no. 107543, 62 pp.
- (8) *A Harder-Narasimhan theory for Kisin modules.* With Brandon Levin.  
**Algebraic Geometry** 7 (2020), no. 6, 645-695.
- (7) *The rank of Mazur's Eisenstein ideal.* With Preston Wake.  
**Duke Math. Journal** 169 (2020), no. 1, 31-115.
- (6) *Deformation conditions for pseudorepresentations.* With Preston Wake.  
**Forum of Mathematics, Sigma** 7 (2019), e20, 44 pp.
- (5) *Ordinary pseudorepresentations and modular forms.* With Preston Wake.  
**Proc. Amer. Math. Soc. Ser. B** 4 (2017), 53-71.
- (4) *Pseudo-modularity and Iwasawa theory.* With Preston Wake.  
**Amer. J. Math** 140 (2018), no. 4, 977-1040.
- (3) *Algebraic families of Galois representations and potentially semi-stable pseudodeformation rings.*  
**Mathematische Annalen** 371 (2018), no. 3-4, 1615-1681.
- (2) *Orders at infinity of modular forms with Heegner divisors.* With Alison Miller and Aaron Pixton.  
**Proc. Amer. Math. Soc.** 135 (2007), no. 10, 3115-3126.
- (1) *Parameterized families of quadratic number fields with 3-rank at least 2.* With Nathan Kaplan, Neil Mendoza, Allison M. Pacelli, and Todd Shayler.  
**Acta Arithmetica** 130 (2007), no. 2, 141-147.

### Accepted for Publication

- (1) *Higher Yoneda product structures and Iwasawa algebras modulo  $p$ .*  
To appear in **Math. Res. Letters**. arXiv:2101.06295 [math.NT], 16 pages.

### Preprints

- (1) **Explicit non-Gorenstein  $R = \mathbb{T}$  via rank bounds I: Deformation theory.** With Catherine Hsu and Preston Wake.  
Preprint, 2022. arXiv:2209.00536 [math.NT], 57 pages.
- (2) **Deformations of residually reducible Galois representations via  $A_\infty$ -algebra structure on Galois cohomology.**  
Preprint, 2020. arXiv:1809.02484 [math.NT], 84 pages.

## PhD Thesis

*Moduli of Galois representations.*

Thesis, Harvard University, 2013. vii+299 pages.

Available at <http://dash.harvard.edu/handle/1/11108709>.

## Teaching

### Teaching at The University of Pittsburgh

- Spring 2024 **Topology 2** (graduate)
- Fall 2023 **Algebra 2** (graduate)
- Fall 2023 **Applied Elementary Number Theory**
- Spring 2023 **Algebraic Number Theory** (graduate)
- Fall 2022 **Business Calculus**
- Fall 2022 **Introduction to Theoretical Mathematics**
- Spring 2022 **Topology 2** (graduate)
- Fall 2021 **Topology 1** (graduate)
- Spring 2021 **Algebraic Number Theory** (graduate)
- Fall 2020 **Applied Elementary Number Theory**
- Spring 2020 **Topology 2** (graduate)
- Fall 2019 **Algebra 2** (graduate)

### Teaching at Brandeis University

- Spring 2016 **Algebra II** (graduate course)
- Spring 2016 **Topics in Number Theory**, algebraic number theory (graduate course)
- Fall 2015 **Real Analysis, Part I**
- Fall 2015 **Geometric Analysis** (graduate course)
- Spring 2015 **Algebraic Geometry** (graduate course)
- Fall 2014 **Real Analysis, Part I**
- Fall 2014 **Topics in Number Theory**, elliptic curves (graduate course)
- Spring 2014 **Multivariable Calculus**
- Spring 2014 **Topics in Algebra**, homological algebra and deformation theory (graduate course)
- Fall 2013 **Multivariable Calculus**
- Fall 2013 **Real Analysis, Part I**

### Teaching at Harvard University

- Spring 2013 **Multivariable Calculus**, Teaching Fellow
- Fall 2012 **Introduction to Functions and Calculus II**, Teaching Fellow
- Fall 2010 **Fat Chance** (Intro. to probability and statistics), Teaching Fellow

## Invited Research Activities

### Invited Conference Talks

- 6/2024 **Bellaïche Memorial Conference**  
Paris, France
- 10/2023 **Southern California Number Theory Day**  
University of California, Irvine  
*Moduli stacks of Galois representations*

- 8/2023 **Galois Representations and Automorphic Forms**  
 Bedlewo, Poland  
*Critical Lambda-adic Modular Forms*
- 1/2023 **Arithmetic Aspects of Deformation Theory**  
 Banff International Research Station  
*A-infinity algebras and deformation theory*
- 7/2022  **$p$ -adic  $L$ -functions and Eigenvarieties**  
 University of Notre Dame  
 *$p$ -adic families of critical overconvergent modular forms*
- 9/2021 **Algebra and Number Theory Day, Fall 2021**  
 Johns Hopkins University and University of Maryland  
*A fully faithful alternative to the Montreal functor*
- 4/2021 **Arbeitsgemeinschaft: Derived Galois Deformation Rings and Cohomology of Arithmetic Groups**  
 Mathematisches Forschungsinstitut Oberwolfach  
*Concluding lecture*
- 10/2020 **Special session on Galois representations and automorphic forms**  
 AMS eastern sectional meeting, online due to Covid-19  
*The Eisenstein ideal with squarefree level, Part I*
- 7/2019  **$p$ -adic Modular Forms and Galois Representations**  
 University of Sheffield  
*Bi-ordinary modular forms*
- 6/2019 **Workshop on Arithmetic of Eisenstein Ideals**  
 Morningside Center for Mathematics, Yau Mathematics Science Center  
*The Eisenstein ideal with squarefree level*
- 7/2018 **Workshop on Galois representations 2018**  
 University of Heidelberg  
*Residually reducible Galois deformations.*
- 6/2018 **Connecticut Summer School in Number Theory (CTNT 2018), Conference**  
 University of Connecticut  
*Mazur's Eisenstein ideal, Part 1: Prime level*
- 5/2018 **Iwasawa theory and related topics**  
 University of Heidelberg  
*On a question of Greenberg*
- 1/2018 **UK-Japan Winter School 2018: Galois Representations and Automorphic Forms**  
 King's College London  
*On a question of Greenberg*
- 6/2016 **Geometric methods in the mod  $p$  Langlands correspondence**  
 Centro di Ricerca Matematica Ennio De Giorgi, Pisa  
 Two invited talks: *Moduli stacks;  $A_\infty$ -algebras and Galois cohomology*

### Invited Seminar Talks

- 11/2023 **Penn State University** Algebra and number theory seminar  
 10/2023 **UC Santa Barbara** Arithmetic and geometry seminar  
 06/2022 **University of Groningen** Online research seminar

02/2022 **University of Nevada, Reno** Algebraic geometry and topology seminar  
 10/2021 **Caltech** Number theory seminar  
 10/2021 **Temple University** Algebra seminar  
 05/2021 **Chalmers U./U. of Gothenburg** Algebraic geometry and number theory seminar  
 02/2021 **University of Arizona** Number theory seminar  
 06/2020 **UPC Barcelona** Number theory seminar  
 05/2020 **UC San Diego** Number theory seminar  
 03/2020 **University of Oregon** Number theory seminar  
 02/2020 **Penn State University** Number theory seminar  
 02/2020 **Bryn Mawr College** Philadelphia area number theory seminar  
 10/2019 **Michigan State University** Number theory seminar  
 10/2019 **University of Michigan** Number theory seminar  
 09/2019 **University of Pittsburgh** Algebra-Combinatorics-Geometry seminar  
 06/2019 **Université de Lille** Séminaire arithmétique  
 03/2019 **University of Reading** Pure maths seminar  
 02/2019 **Princeton/IAS** Number theory seminar  
 12/2018 **University of Bristol** Heilbronn seminar  
 11/2018 **University of Oxford** Derived geometry and Galois theory seminar (2 talks)  
 08/2018 **Université du Luxembourg** Number theory seminar  
 05/2018 **Institut Mathématiques de Jussieu** Séminaire de théorie des nombres  
 01/2018 **University of Oxford** Number theory seminar  
 12/2017 **UPC Barcelona** Number theory seminar (two talks)  
 11/2017 **University of Sheffield** Number theory seminar  
 11/2017 **University of Wisconsin** Number theory seminar  
 11/2017 **University of Notre Dame** Algebraic geometry seminar  
 10/2017 **University of Chicago** Number theory seminar  
 10/2017 **Northwestern University** Number theory seminar  
 06/2017 **Cambridge University** Number theory seminar  
 11/2016 **Imperial College London** Number theory seminar  
 04/2016 **Purdue University** Number theory seminar  
 04/2016 **University of Connecticut** Algebra seminar  
 02/2016 **Johns Hopkins University** Number theory seminar  
 11/2015 **Harvard University** Number theory seminar  
 11/2015 **UCLA** Number theory seminar  
 10/2015 **Columbia University** Automorphic forms seminar  
 10/2015 **Boston College** Algebra & number theory seminar  
 09/2015 **Georgia Institute of Technology** Algebra seminar  
 06/2015 **Boston University** Number theory seminar  
 05/2015 **Université Laval** Quebec–Vermont number theory seminar  
 04/2015 **MIT** Number theory seminar.  
 04/2015 **Yale University** Number theory seminar  
 11/2014 **Boston University** Number theory seminar  
 10/2014 **University of Chicago** Number theory seminar  
 10/2014 **Northwestern University** Number theory seminar  
 04/2014 **UC-Irvine** Number theory seminar  
 10/2013 **Brandeis University** EveryTopic seminar  
 05/2013 **Princeton/IAS** Number theory seminar

- 02/2013 **UC-Berkeley** Number theory seminar
- 12/2012 **MIT** Lie groups seminar
- 11/2012 **Boston University** Number theory seminar

### Invited Conference Participation

- 07/2022 Invited project co-leader, with Catherine Hsu. **A pair of automorphic workshops in 2022**, University of Oregon
- 08/2020 **Low-Dimensional Topology and Number Theory**, Mathematisches Forschungsinstitut Oberwolfach (*anceled due to Covid-19*)
- 10/2018 **Fermat's Last Theorem: A celebration 25 years on**, Issac Newton Institute, Cambridge
- 06/2018 **Mathematics is a long conversation: a celebration of Barry Mazur**, Harvard University
- 11/2017 **Workshop on the Langlands program**, IAS
- 06/2016 **New developments in Iwasawa theory**, Banff International Research Station
- 07/2009 **Arithmetic of  $L$ -functions**, Park City Mathematics Institute
  - Course assistant for Benedict Gross.

### Other Conferences Attended, including Contributed Conference Talks

- 2021 ParaDIGMS spring conference, AMS/IMSI (online)
- 2020 ParaDIGMS fall conference, AMS/IMSI (online)
- 2017 Nisyros conference on automorphic forms
- 2016 The  $p$ -adic Langlands program and related topics, Indiana University
- 2016 Recent developments in integral  $p$ -adic cohomology theories, Hausdorff Center
- 2016 Geometric Methods and Langlands Functoriality, CIRM
  - Contributed talk: *Lafforgue's notion of  $G$ -valued pseudorepresentation*
- 2015 Palmetto Number Theory Series, Emory University
  - Contributed talk: *Ordinary Hecke algebras*
- 2015 BU-Keio Workshop in Number Theory, Boston University
  - Contributed talk: *The structure of ordinary Hecke algebras.*
- 2015 AMS Summer Institute in Algebraic Geometry, University of Utah
  - Contributed talk: *Singularities of the ordinary eigencurve.*
- 2015 Iwasawa 2015, King's College London
- 2015 Upstate Number Theory Conference, Cornell University
  - Contributed talk: *Pseudo-modularity and Iwasawa theory.*
- 2015  $p$ -adic methods in the theory of classical automorphic forms, CRM
- 2014 Automorphic forms, Shimura varieties, Galois representations and  $L$ -functions, MSRI
- 2014 New Geometric Methods in Number Theory and Automorphic Forms, MSRI
- 2014  $p$ -adic Variation in Number Theory (Glennfest), Boston University
- 2013 Summer graduate school: New Geometric Techniques in Number Theory, MSRI
  - Contributed talk: *Representations and pseudorepresentations.*
- 2011 Conference on the Birch and Swinnerton-Dyer Conjecture, University of Cambridge
- 2011 Galois Representations and Automorphic Forms, IAS
- 2011 Abel Conference in Honor of John Tate, Institute for Mathematics and its Applications
- 2010 Instructional workshop on  $p$ -adic  $L$ -functions, UCLA
- 2010 Number Theory and Representation Theory, in honor of Dick Gross, Harvard University

### Awards and Funding

## External Funding

- NSF Grant (\$20000) *Conference: Pittsburgh Links among Analysis and Number Theory (PLANT)* in support of the PLANT conference at Pitt and CMU, co-PIs Theresa Anderson and Armin Schikorra, 2024.
- Number Theory Foundation conference support for junior participants (\$3000), co-PI Bogdan Ion, 2023.
- Simons Foundation Collaboration Grant (\$42000), award #846912, 2021-2026.
- AMS-Simons Travel Grant (\$4800), 2014-2016.

## Internal Funding

- Pitt Seed Grant (\$75000), team co-lead with Kelsey Voltz-Poremba, 2022-2023. In support of the *Magical Math* outreach program.
  - Pitt Seed Cohort (\$2000), 2022. (Earlier stage Pitt Seed Grant program.)
- Pitt Math Department MRC – Mini-conference support (\$8000), co-PI Bogdan Ion, 2022-2023.
- Pitt Math Department MRC – Mini-workshop support (\$3000), 2021-2022.
- Pitt Momentum Funds – Seeding Grant (\$16000), 2020-2021.
- Pitt Math Department MRC – Research support (\$2200, canceled due to Covid-19), 2020.
- Imperial College Mathematics Platform Grant
  - Research Support award for collaboration with Preston Wake (£2810), 2018.
  - Research Impulse award for travel support (£1500), 2017.

## Graduate and Undergraduate Awards

- National Science Foundation Graduate Research Fellowship, 2009-2012.
- Winston Churchill Scholarship for study at Churchill College, University of Cambridge, 2007.
- NDSEG Graduate Research Fellowship (declined), 2007.
- Undergraduate Research Award, Stanford Mathematics Department, 2007.
- Barry M. Goldwater Scholarship, 2006.

## Organization, Outreach, and Service

### Conference Organization

- 2024 Pittsburgh Links among Analysis and Number Theory (“PLANT”, with Armin Schikorra and Theresa Anderson)
- 2023 Representation Theory,  $L$ -functions, and Arithmetic (with Bogdan Ion)
- 2022 A Pair of Automorphic Workshops, University of Oregon (supporting organizer)
- 2022 Mini-workshop on Eisenstein ideals and  $L$ -functions, University of Pittsburgh Mathematics Research Center (lead organizer)
- 2021 Workshop on Rational Points and Galois representations, University of Pittsburgh (online)

### Seminar Organization

- 2023– **Pittsburgh Number Theory Day** at the University of Pittsburgh and Carnegie Mellon University, which I initiated along with Theresa Anderson (CMU) and Shabnam Akhtari (Penn State)

- 2022– **Algebra–Combinatorics–Geometry Seminar** at the University of Pittsburgh, jointly with colleagues in algebra and proximate fields
- 2019 **London Number Theory Study Group**, joint with Alice Pozzi, Ashwin Iyengar, and Pol van Hoften
- 2018 **London Number Theory Seminar**, joint with Ana Caraiani and Chris Williams
- 2017 **London Number Theory Seminar**, joint with Jean-Stefan Koskivirta and Martin Orr
- 2015-16 **Brandeis EveryTopic Seminar** (departmental colloquium), joint with Arunima Ray

### Outreach Activities

- Fall 2022– *Magical Math* outreach and enrichment program to grades 3-5, in partnership with Pitt’s Community Engagement Center in the Hill District through their *STEAM Saturdays* program
- Fall 2023– *Magical Math* expands to grades 6-8

### Other committee service

- 2022– PhD Thesis Committees, University of Pittsburgh (2 students)
- 2021– Comprehensive exam committees for PhD students, University of Pittsburgh (8+ students)
- 2020 MRC Postdoc hiring committee member, University of Pittsburgh
- 2018 MSc oral exams committee member, Imperial College (5 students)
- 2015-16 PhD dissertation committee member, Brandeis University (2 students)

### Graduate Student Research Supervision

- 2020– PhD student advising (2 students)
- 2020-2021 MSc thesis supervision, Carnegie Mellon University (1 student)
- 2019 MSc thesis supervision, Imperial College (1 student)

### Undergraduate Student Research and Reading Supervision

- 2020– Summer undergraduate research supervision, with support from various competitive departmental and college-wide fellowships (6 students)
- 2020 SURF program, Carnegie Mellon University (1 student)
- 2019 UROP program for undergraduate research, Imperial College (2 students)
- 2018 UROP program for undergraduate research, Imperial College (2 students)
- 2015 Brandeis University, joint with Daniel Ruberman (1 student)

### Expository talks

- 2024 Pitt ACoG seminar (expository talk on geometric invariant theory)
- 2022 Pitt ACoG seminar (2 expository talks on the Langlands program)
- 2021 Pitt Affine Grassmannians learning seminar
- 2021 Pitt Algebra-Combinatorics-Geometry seminar (3 expository talks on the Weil conjectures)
- 2020-21 Pitt Math Club (2 talks for undergraduates)
- 2019 University of Pittsburgh Undergraduate Mathematics Seminar
- 2019 Imperial College Mathematics Department postdoc pizza seminar
- 2018 Imperial College Mathematics Department Postdoc and Fellows’ Day



- 2018 London junior number theory seminar (for graduate students)
- 2017-19 London number theory study group (3 talks)
- 2015 Brandeis EveryTopic seminar
- 2011 PROMYS program (for undergraduates)

### **Other Professional Service**

- **Referee** for *Forum Math. Pi*, *Ann. Sci. ENS*, *Duke Math. J.*, *Algebra and Number Theory*, *Compositio Math.*, *Math. Ann.*, *Adv. Math.*, *Math. Zeit.*, *Math. Research Letters*, *IMRN*, *Amer. J. Math.*, *JEMS*, *Manuscripta Math.*, *Ramanujan J.*, *J. Algebra*, *Pacific J. Math.*, *Res. Math. Sci.*, *Annales de l'Institut Fourier*, *Proc. AMS*, *Research in Number Theory*, *J. Math Society of Japan*, *American Mathematical Monthly*, etc.
- **Reviewer** for *Mathematical Reviews*, Banff International Research Station
- 2023 Reading course in quadratic forms (4 undergraduates)
- 2020-21 **Reading courses** in number theory and cryptography (2 undergraduates)
- 2014-16 **Reading courses** in algebraic number theory, Brandeis University (1 undergraduate, 1 graduate)
- 2013-16 **Undergraduate advising and mentoring**, Brandeis University (for example, reference letters for at least 17 students)
- 2010 **Teaching “Vistas in Mathematics”** during the January term at Harvard University – selected by the Harvard Graduate Student Council, I taught a 10-session mini-course for non-mathematicians interested in learning why and how mathematicians do mathematics. Course website: <https://www.pitt.edu/~caw203/vistas.html>.
- 2009 Jointly with Jack Thorne, wrote up notes of Benedict Gross’s lectures at PCMI as the basis for his article in the proceedings, and contributed the appendices. (Gross, Benedict H. **Lectures on the conjecture of Birch and Swinnerton-Dyer**. *Arithmetic of L-functions*, 169-209, IAS/Park City Math. Ser., 18, Amer. Math. Soc., Providence, RI, 2011.)
- 2008 **Counselor** for the PROMYS program, Boston University (4 high school students)