Philip Milton Engel

CONTACT INFORMATION

University of Illinois, Chicago
Mathematics, Statistics, and Computer Science
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RESEARCH INTERESTS

My area of study is primarily algebraic geometry and Hodge theory. Some areas of interest are Calabi–Yau varieties, moduli spaces, degenerations, tilings, and Hurwitz theory.

CURRENT APPOINTMENT

Assistant Professor, University of Illinois, Chicago — August 2024 to present

PREVIOUS APPOINTMENTS

W2 Professor, "Bonn Junior Fellow", University of Bonn — August 2023 to July 2024

Assistant Professor, University of Georgia — August 2018 to July 2023

Research Member, Math Sciences Research Institute (SLMath) — Fall 2019

NSF Postdoctoral Scholar, Harvard University — August 2015 to July 2018

EDUCATION

Columbia University, New York, NY — September 2010 to June 2015

Ph.D., Department of Mathematics, June 2015

- Thesis Topic: *Looijenga's Conjecture via Integral-Affine Geometry*
- Advisor: Robert Friedman

M.Phil., Department of Mathematics, June 2013

M.Sc., Department of Mathematics, June 2011

Massachusetts Institute of Technology, Cambridge, MA — September 2006 to June 2010

B.Sc. Mathematics, B.Sc. Physics, June 2010

GRANTS

AWARDED

[1] Sloan Research Fellowship, **$75,000**, September 2026–

[2] Principal Investigator, NSF CAREER, DMS-2441240, "CAREER: Hodge theory of Calabi-Yau varieties," **$415,000**, August 2025–

[3] Principal Investigator, NSF Standard Grant DMS-2401104, "Combinatorics of Complex Curves and Surfaces," **$67,057**, February 2024–July 2025

[4] Principal Investigator, NSF Standard Grant DMS-2201221, "Combinatorics of Complex Curves and Surfaces," **$200,848**, August 2022–February 2024

[5] Co-Principal Investigator, NSF Collaborative Research Grant DMS-1902154, "Georgia Algebraic Geometry Symposium," **$34,920**, April 2019–July 2023

[6] Principal Investigator, NSF Postdoctoral Fellowship DMS-1502585, **$150,000**, October 2015–September 2018

PUBLICATIONS

POSTED TO ARXIV & SUBMITTED:

[1] With O. de Gaay Fortman and S. Schreieder. *Matroids and the integral Hodge conjecture for abelian varieties*. ArXiv: 2507.15704, 2025.

[2] With O. de Gaay Fortman and S. Schreieder. *Combinatorics and Hodge theory of degenerations of abelian varieties: A survey of the Mumford construction*. ArXiv: 2507.15695, 2025.

[3] With S. Filipazzi, F. Greer, M. Mauri, and R. Svaldi. *Boundedness of some fibered K-trivial varieties*. ArXiv: 2507.00973, 2025.

[4] With V. Alexeev. *On lattice-polarized K3 surfaces*. ArXiv: 2410.06387, 2025.

[5] With S. Tayou. *On the non-abelian Hodge locus I*. ArXiv: 2305.00943, 2023.

[6] With F. Greer and S. Tayou. *Mixed mock modularity of special divisors*. ArXiv: 2301.05982, 2023.

[7] With V. Alexeev. *Mirror symmetric compactifications of moduli spaces of K3 surfaces with a nonsymplectic involution*. ArXiv: 2208.10383, 2022.

ACCEPTED FOR PUBLICATION:

[8] With A. Lin and S. Tayou. *Shafarevich's conjecture for families of hypersurfaces over function fields*. Accepted to **IMRN**, 2025.

[9] With V. Alexeev, Z. Garza, and L. Schaffler. *Complete moduli of Enriques surfaces in Horikawa's model.* Accepted to **Nayoga Math Journal**, 2025.

[10] With F. Greer and A. Ward. *Periods of elliptic surfaces with* $p_g = q = 1$. Accepted to **Forum of Math: Sigma**, 2024.

[11] With P. Smillie, and an appendix by J. Geogdebeur. *Exact enumeration of fullerenes*. Accepted to **Duke Math Journal**, 2024.

PUBLISHED:

[12] With V. Alexeev and C. Han. *Compact moduli of K3 surfaces with a nonsymplectic automorphism*. **Transactions of the AMS**, Series B 11: 144–163, 2024.

[13] With V. Alexeev. *The flex divisor of a K3 surface*. **IMRN**, rnac089, 2022.

[14] With V. Alexeev. *Compact moduli of K3 surfaces*. **Annals of Mathematics**, 198(2): 727–789, 2023.

[15] With V. Alexeev and A. Brunyate. *Compactifications of moduli of elliptic K3 surfaces: stable pair and toroidal*. **Geometry & Topology,** 26: 3525–3588, 2022.

[16] With V. Delecroix, E. Goujard, P. Zograf, A. Zorich. *Contribution of one-cylinder square-tiled surfaces to Masur-Veech volumes*. **Astérisque**, Vol. 415: 223–274, 2020.

[17] With V. Alexeev and A. Thompson. *Stable pair compactification of moduli of K3 surfaces of degree 2*. **Crelle's Journal**, Vol. 799: 1–56, 2023.

[18] *Hurwitz theory of elliptic orbifolds, I*. **Geometry and Topology**, Vol. 25: 229–274, 2021.

[19] With P. Smillie. *The number of convex tilings of the sphere by triangles, squares, or hexagons*, **Geometry and Topology**, Vol. 22: 2839–2864, 2018.

[20] With R. Friedman. *Smoothings and rational double point adjacencies for cusp singularities*. **Journal of Differential Geometry**, Vol. 118(1): 23–100, 2021.

[21] *A proof of Looijenga's conjecture via integral-affine geometry*, **Journal of Differential Geometry**, Vol. 109(3): 467–495, 2018.

POSTED PAPERS:

[22] With R. Krishnamoorthy and D. Litt. *The Manin-Mumford conjecture in genus* 2 *and rational curves on K3 surfaces*. ArXiv: 2208.08729, 2022.

[23] *Hurwitz theory of elliptic orbifolds, II*. ArXiv: 1809.07434, 2018.

INVITED LECTURE SERIES

[1] Algebraic Geometry (AG) Summer Research Institute, Bootcamp Mentor, Colorado State University (Fort Collins, CO), July 8–12, 2025
KSBA moduli (5 lectures)

[2] University of Michigan, "Moduli spaces of algebraic surfaces in Ann Arbor" (Ann Arbor, Michigan), May 20–22, 2025
Compact moduli of K3 surfaces (3 lectures)

[3] Università degli Studi di Milano (Milan, Italy), March 18–March 25, 2024
Compact moduli of K3 surfaces (3 lectures)

[4] Hausdorff Institute of Mathematics, Junior Trimester Program "Algebraic geometry: derived categories, Hodge theory, and Chow groups" (Bonn, Germany), September 15–29, 2023
Compact moduli of K3 surfaces (3 lectures)

[5] Humboldt University (Berlin, Germany), June 15–19, 2023
Compact moduli of K3 surfaces (3 lectures)

[6] "Recent Developments in Hodge Theory", Institute of the Mathematical Sciences of the Americas (IMSA), March 29–April 2, 2021 (recordings: Lecture 1, 2)
Comparing geometric and Hodge-theoretic compactifications (2 lectures)

INVITED CONFERENCE TALKS

[7] "Geometric aspects of Hodge theory and related areas", Algebraic Geometry Summer Research Institute, CSU (Fort Collins, CO), July 22–26, 2025

[8] "Curves, K3s and Hyperkählers Workshop", Mathematical Institute of Bonn (Bonn, Germany), June 20–12, 2025

[9] American Mathematics Society (AMS) sectional, "Interplay between birational geometry, complex geometry and Hodge theory", University of Kansas (Lawrence, KS), March 29–30, 2025
Boundedness of abelian fibrations

[10] "K-trivial varieties and their moduli", Simons Conference, UCSD (San Diego, CA), January 17–20, 2025
Boundedness of abelian fibrations

[11] Algebraic Geometry MATRIX, Matrix Institute (Creswick, Australia), December 9–13, 2024
The non-abelian Hodge locus

[12] "School on Hodge Theory and Shimura Varieties", Essen University (Essen, Germany), September 13–17, 2024 (recording)
Local systems underlying variation of Hodge structure

[13] AIM workshop "Higher-dimensional log Calabi-Yau pairs" (Pasadena, CA), September 30–October 4, 2024
Deformation theory of log symplectic varieties

[14] "A panorama of moduli spaces", Goethe University (Frankfurt am Main, Germany), February 26–March 1, 2024 (recording)
Compact moduli of K3 and Enriques surfaces

[15] "Moduli, K-trivial Varieties, and Related Topics", IBS-CCG (Daejeon, Korea), February 21–29, 2024
Compact moduli of Enriques surfaces

[16] Chattanooga AMS sectional meeting "Arithmetic and Geometry of Hyperkahler Varieties" (Chattanooga, TN), October 15–16, 2022
Compact moduli of K3 surfaces

[17] "Mirror symmetry for Looijenga interiors," Bogazici University (Istanbul, Turkey), July 18–29, 2022
Looijenga's conjecture and *Compact moduli of K3 surfaces*

[18] "Algebraic Geometry and Singularities", University of Washington (Seattle, WA), June 20–26, 2022
Compact moduli of K3 surfaces

[19] 7th KTGU Mathematics Workshop for Young Researchers, (remote; Kyoto, Japan) February 14–15, 2022
Compact moduli of K3 surfaces

[20] "Teichmuller Theory, Hyperbolicity and Dynamics" at IMPA (Rio de Janeiro, Brazil), June 24–28, 2019 (recording)
Compact moduli of K3 surfaces

[21] "Flat Surfaces and Dynamics on Moduli Space", Casa Matematica Oaxaca (Oaxaca, Mexico), May 8–13, 2019
The elliptic orbifold of order 5

[22] "Workshop on modular structures in Gromov-Witten theory and related topics", University of Michigan (Ann Arbor, MI), January 25–27, 2019
The elliptic orbifold of order 5

[23] "Workshop on Holomorphic Differentials", Simons Center for Geometry and Physics, Stonybrook University (Stonybrook, NY), February 4–8, 2019
The elliptic orbifold of order 5

[24] "Character Varieties and TQFT", University of Auckland (Auckland, New Zealand), December 17–20, 2018
Tilings of Riemann Surfaces

[25] "Flat Surfaces and Algebraic Curves", Oberwolfach, September 16–22, 2018
Lattice point enumeration in moduli spaces of higher differentials

INVITED COLLOQUIA

[26] University of Kansas (Lawrence, KS), Departmental Colloquium, March 28, 2025
Counting buckyballs

[27] University of Florida (Gainesville, FL), Departmental Colloquium, February 10, 2025
Counting buckyballs

[28] Boston University (Boston, MA), Departmental Colloquium, October 29, 2024
Moduli of K3 surfaces

[29] University of Toronto (Toronto, Canada), Colloquium, January 20, 2023
Triangulations of the sphere and K3 moduli

[30] UIC (Chicago, IL), Colloquium, December 2, 2022
Triangulations of the sphere and K3 moduli

[31] Cornell University (Cornell, NYC), "Oliver Club" Departmental Colloquium, March 31, 2022
Compact moduli of K3 surfaces

[32] University of Kansas (Lawrence, KS), Departmental Colloquium (remote), February 24, 2022
Looijenga's cusp conjecture and triangulations of the sphere

INVITED SEMINAR TALKS

[33] NCTS AG seminar, Laboratory of Birational Geometry, Taiwan, Fall 2025

[34] Birational Geometry Seminar (UCLA), Fall 2025

[35] AG seminar, University of Michigan, Fall 2025

[36] AG seminar, Humboldt University, Berlin, Summer 2025

[37] AG seminar, University of Notre Dame, Spring 2025

[38] AG seminar, University of Maryland, Spring 2025

[39] "No boundaries" seminar, University of Chicago, Winter 2025

[40] AG seminar, New York University, Fall 2024

[41] AG seminar, Northwestern University, Fall 2024

[42] AG seminar, University of Chicago, Fall 2024

[43] AG seminar, University of Illinois, Chicago, Fall 2024

[44] AG seminar, University of Sheffield, Summer 2024

[45] AG seminar, University of Cambridge, Summer 2024

[46] AG seminar, University of Bonn, Summer 2024

[47] AG seminar, University of Marburg, Summer 2024

[48] AG seminar, École Polytechnique Fédérale de Lausanne (EPFL), Fall 2023

[49] AG seminar, Hannover University, Fall 2023

[50] AG seminar, University of Utah, Fall 2022

[51] AG seminar, Princeton University, Fall 2022

[52] Dynamics seminar, Harvard University, Fall 2022

[53] Algebra/Topology seminar, Copenhagen University (remote), Spring 2022

[54] AG seminar, Hausdorff Center of Mathematics, Fall 2021

[55] AG seminar, Stonybrook University, Fall 2021

[56] Geometry & Topology seminar, California Institute of Technology, Fall 2021

[57] Free Mathematics Seminar (remote), Fall 2021

[58] AG seminar, Humboldt University, Summer 2021

[59] AG seminar, Princeton University, Spring 2021

[60] AG seminar, Stonybrook University, Spring 2021

[61] AG seminar, University of Wisconsin, Madison (remote), Spring 2021

[62] AG seminar, Université Pierre-et-Marie-Curie (Jussieu), Fall 2020

[63] Geometry & Physics seminar, Boston University, Fall 2020

[64] Harvard/MIT AG seminar, Spring 2020

[65] AG seminar, Bonn University, Spring 2020

[66] Topology seminar, Berkley, Fall 2019

[67] AG seminar, University of Oregon, Fall 2019

[68] AG seminar, Iowa State, Spring 2019

[69] Geometry & Topology seminar, University of Toronto, Fall 2018

[70] Geometry & Topology seminar, California Institute of Technology, Fall 2018

[71] AG seminar, University of South Carolina, Fall 2018

TEACHING

AS INSTRUCTOR OF EXISTING COURSES:

Math 215: **Introduction to Advanced Mathematics**, Fall 2025, University of Illinois, Chicago, 3 credits (24 students)

Math 210: **Calculus III**, Spring 2025, University of Illinois, Chicago, 3 credits (24 students)

Math 210: **Calculus III**, Spring 2025, University of Illinois, Chicago, 3 credits (23 students)

Math 552: **Algebraic Geometry I**, Fall 2024, University of Illinois, Chicago, 3 credits (5 students)

MATH2250: **Calculus I**, Fall 2022, University of Georgia, 4 credits (18 students)

MATH2250: **Calculus I**, Fall 2022, University of Georgia, 4 credits (12 students)

MATH2270: **Calculus III**, Spring 2022, University of Georgia, 4 credits (32 students)

MATH8310: **Geometry of Schemes**, Fall 2021, University of Georgia, 3 credits (8 students)

MATH8300: **Introduction to Algebraic Geometry**, Fall 2020, University of Georgia, 3 credits (12 students)

MATH2270: **Calculus III**, Spring 2020, University of Georgia, 4 credits (27 students)

MATH8310: **Geometry of Schemes**, Spring 2019, University of Georgia, 3 credits (9 students)

MATH2250: **Calculus I**, Fall 2018, University of Georgia, 4 credits (19 students)

MATH2250: **Calculus I**, Fall 2018, University of Georgia, 4 credits (19 students)

MATH1A: **Calculus I**, Spring 2018, Harvard University, 3 credits (18 students)

MATH232B: **Algebraic Geometry II**, Spring 2017, Harvard University, 3 credits (10 students)

MATH232A: **Algebraic Geometry I**, Fall 2016, Harvard University, 3 credits (10 students)

MATH1101: **Calculus I**, Columbia University, Spring 2014, 3 credits (20 students)

MATH215: **Precalculus**, Columbia University, Spring 2013, 3 credits (45 students)

AS INSTRUCTOR OF NEW COURSES (CURRICULUM DEVELOPMENT):

Graduate student seminar, **Topics in Algebraic Geometry: Torelli theorems**, Fall 2025, University of Illinois, Chicago, 4 credits (14 students)

In this course, I developed a graduate-level introduction to active areas of modern mathematical research, focusing especially on Hodge theory. The course serves as an introduction to the essential tools of the modern researcher in algebraic geometry.

Masters student seminar, **Moduli of K3 Surfaces**, Spring 2024, University of Bonn, 3 credits (9 students)

In this course, I developed a student seminar, based on my earlier course "Moduli of K3 Surfaces". I mentored masters students and had them prepare 90-minute talks on a sequence of topics presenting the course material.

Hodge Theory, Fall 2023, University of Bonn, 3 credits (50 students)

I developed a course on Hodge theory at the University of Bonn, based on Griffiths' and Harris' book "Principles of Algebraic Geometry."

MATH8330: **Topics in Algebraic Geometry, "Moduli of K3 Surfaces"**, Spring 2023, University of Georgia, 4 credits (18 students)

I developed a course on moduli spaces of K3 surfaces and the Torelli theorem, primarily based on research papers from the early 1980's.

MATH8330: **Topics in Algebraic Geometry, "Algebraic Surfaces and** 4**-Manifolds"**, Spring 2021, University of Georgia, 3 credits (6 students)

I developed a course on the interaction between algebraic surfaces and the theory of smooth manifolds, and differential-geometric invariants. I made the course notes publicly available on my website.

MATH8850: **Collaborative Research (Vertical Research Group on Tilings)**, Spring 2020, University of Georgia, 3 credits (5 students)

After an introductory series of lectures, students at various mathematical levels spoke on research papers about the Hurwitz theory of elliptic curves and orbifolds. Then students collaborated to program in SAGE (Jupyter Notebook) Fock space computations encoding the representation theory of the symmetric groups.

MATH137: **Topics in Algebraic Geometry, "Mirror Symmetry and Hurwitz Theory"**, Fall 2017, Harvard University, 3 credits (12 students)

I developed a new course on the basic statements of mirror symmetry, enumeration of branched covers, representation theory of the symmetric group, and the relation to the modular forms and the enumeration of square-tiled surfaces.

CONFERENCES ORGANIZED

UPCOMING:

Conference at the Institute for Computational and Experimental Research in Mathematics (ICERM), on "Moduli of K3 surfaces", November 2026, and co-organized with Kristin deVleming and Klaus Hulek

We will organize a one-week workshop at the ICERM Fall 2026 program on "Computations on K3 Surfaces and Related Varieties."

LMS–Sheffield mathematical symposium on "Rationality problems, Cremona groups, and motivic invariants", planned for July 2–10, 2026, co-organized with Julia Schneider and Evgeny Shinder

We are organizing an international summer school and conference, focusing on birational algebraic geometry, to take place in Sheffield, UK. Our aims are to consolidate advances in the field and to foster collaboration in a friendly, inclusive environment.

PREVIOUSLY ORGANIZED:

Georgia Algebraic Geometry Symposium, April 28–30, 2023 (website), co-organized with Valery Alexeev, Hülya Argüz, Pierrick Bousseau, and Dino Lorenzini

This conference, funded by Collaborative Research Grant DMS-1902154 and by the college of Arts & Sciences, is part of a long-standing conference series jointly organized by the University of Georgia, Emory University and Georgia Tech.

RepTile, "A conference on representation theory and tilings", February 22–24, 2019 (website), co-organized with Nikon Kurnosov

This conference, funded by my start-up grant at UGA, brought together a small group of early career researchers (primarily postdocs and PhD students) to have the opportunity to speak on their work and collaborate on research concerning square-tiled surfaces.

ADVISING AND MENTORING

POSTDOCTORAL ADVISEES

- **David Wen**, 2018–2019

PH.D. STUDENTS

- **Amelia Ernst**, 2022–

MASTERS STUDENTS

- **Mian Wen**, 2024–2025
  Thesis Title: *Type II Models for Degeneration of K3 Surfaces*
- **Jose Galindo Jimenez**, 2023–2025
  Co-advised by: Evgeny Shinder
  Thesis Title: *Kulikov models with the Minimal Model Program*
- **Sanskar Agrawal**, Summer 2024
  Research visit to University of Bonn

READING COURSES

- **Amelia Ernst**, UGA, "Tropical Geometry", Fall 2020
- **Amelia Ernst**, UGA, "Algebraic surfaces", Spring 2021
- **Amelia Ernst**, UGA, "K3 surfaces", Summer 2021
- **Daniel Zach Garza**, UGA, "Hyperbolic Geometry", Summer 2021

GRADUATE STUDENT SEMINARS

- Course on **"Moduli of K3 surfaces"**, UIC, Fall 2024

Thesis Reader/Defense Committee

- **Zhehao Li** (advisor: Izzet Coskun)
- **Chen Song** (advisor: Izzet Coskun)
- **Mauro Varesco** (advisor: Daniel Huybrechts)
- **Daniel Zack Garza** (advisor: Valery Alexeev)
- **Nolan Schock** (advisor: Valery Alexeev)
- **Xian Wu** (advisor: Valery Alexeev)

Service

Committee Service

- UIC undergraduate studies committee (2025–)
- UIC colloquium committee (2024–)
- UGA head appointment committee (2021–2023)
- UGA qualifying exam committee (2019–2023)
- UGA search committee (2018–2023)
- Member (2015–2017) and Chair (2017–2018) of BHMN (Brandeis-Harvard-MIT-Northeastern) joint colloquium committee

Referee Service (Full Reports)

- Crelle's Journal
- Journal of Differential Geometry
- Algebraic & Geometric Topology
- Mathematische Zeitschrift
- Geometry & Topology
- Épijournal de Géométrie Algébrique
- Duke Mathematical Journal
- Journal de l'École Polytechnique
- Memoirs of the EMS
- Geometriae Dedicata
- Advances in Mathematics
- Annales de l'Institut Fourier
- EMS Surveys
- Mathematische Nachrichten
- Asian Journal of Mathematics
- Michigan Mathematical Journal

Seminar Organization

- UIC AG seminar organizer (2024–)
- UGA AG seminar organizer (2018–2023)
- Harvard-MIT AG seminar (2015–2018)

Outreach

- **Outreach lecture at the Young Scholars Program at UIC** (Summer 2025).

  This program is a free program held at UIC for high schoolers, with the goal of inspiring high school students to pursue a degree and career in STEM. I gave a lecture on buckyballs to the students.

- **Outreach on the interaction of art and mathematics** 2020–2024. I co-developed a project with artist Victoria Manganiello, on mathematics and weaving. We created math-inspired weaving art works, funded by NSF grant DMS-2201221 and have shown them at the Greenwich Academy in New York, a preparatory school for girls, and spoke on the pieces, discussing the interacting between weaving and mathematics.

  With further funding from the University of Bonn, we created a permanent installation in the mathematics library at the Mathematisches Institut. Photos are available at https://philip-engel.github.io/weaving_quasicrystals/.

- **Guest lecture for the Enrichment Program for Young Mathematics Talents** (Fall 2023).

  I spoke on buckyballs to high school students in Hong Kong.

- **Second-year course instructor at PROMYS India program** for four weeks, at India Institute of Sciences (IISc) in Bangalore, India (Summer 2023).

  PROMYS India was developed by Ila Varma to provide an opportunity for the many talented students from India, especially women and underprivileged groups of scheduled caste, to have the experience of discovering mathematics.

- **Guest lecture at the PROMYS program** (Summer 2018 and Summer 2021).

  I spoke on buckyballs at the original PROMYS program in Boston, MA.

References

- **Robert Friedman** (Ph.D. advisor)
- **Joseph Harris** (postdoctoral advisor)
- **Valery Alexeev**
- **Daniel Huybrechts**
- **Eduard Looijenga**
- **Curtis McMullen**
- **Mark Gross**
- **Shing-Tung Yau**
- **Anton Zorich**