# **Daniel Halpern-Leistner**

Department of Mathematics Cornell University Room 507, Malott Hall 301 Tower Rd, Ithaca, NY 14853 USA daniel.hl@cornell.edu http://www.math.cornell.edu/~danielhl/

### **Education:**

2007-2013	Ph.D. in Mathematics, University of California, Berkeley.
	Advisor: Constantin Teleman Thesis: "Geometric invariant theory and derived categories of coherent sheaves"
2003-2007	A.B. in Mathematics, Princeton University. <i>Undergraduate Thesis:</i> "On the algebraic structure of dynamical systems"

### **Positions held:**

2017-	Assistant Professor, Cornell University
2018 Spring	Post Doctoral Fellow, Mathematical Sciences Research Institute
2016-2017	Ritt Assistant Professor, Columbia University.
2013-2016	NSF Postdoctoral Fellow, Columbia University.
2014-2015	Member and NSF Postdoctoral Fellow, Institute for Advanced Study.
2010 Fall	Visiting graduate student, Max Planck Institute for Mathematics, Bonn
2008-2009	Visiting researcher, Stanford University (Applied Physics).

## Awards and grants:

2020-	NSF CAREER: Moduli problems and derived categories (DMS-1945478, \$400,000)
2019-	Simons Foundation Collaboration Grant (MPS-636636, \$42,000)
2017-	Visiting Fellowship at the Perimeter Institute for Theoretical Physics
2016-2019	NSF personal grant in Algebra & Number Theory (DMS-1762669, \$123,000)
2013-2016	NSF Postdoctoral Research Fellowship (MSPRF).
2013	Kenneth Ribet and Lisa A. Goldberg Award in Algebra (thesis prize in algebra).

### **Research interests:**

Moduli problems, derived algebraic geometry, derived categories of coherent sheaves, geometric invariant theory, geometric representation theory

## **Publications:**

1. Jarod Alper, Harold Blum, Daniel Halpern-Leistner, and Chenyang Xu, "Reductivity of the

- automorphism group of K-polystable Fano varieties." *Inventiones Mathematicae* (to appear). arXiv preprint arXiv:1906.03122. (2019)
- 2. Dylan Peifer, Michael Stillman, and Daniel Halpern-Leistner, "Learning selection strategies in Buchberger's algorithm," *Proceedings of machine learning and systems 2020*, 2020, pp. 10498-10508. arXiv preprint arXiv:2005.01917.
- 3. Alper, Jarod, Daniel Halpern-Leistner, and Jochen Heinloth, "Cartan-Iwahori-Matsumoto decompositions for reductive groups." *Proceedings of the Symposium Celebrating the Mathematical Work of David Mumford on his 80th Birthday* (to appear). arXiv preprint arXiv: 1903.00128 (2019)
- 4. Halpern-Leistner, Daniel, and Steven V. Sam. "Combinatorial constructions of derived equivalences." *Journal of the American Mathematical Society* (to appear). *arXiv preprint arXiv:1601.02030* (2016).
- 5. Halpern-Leistner, Daniel. "Θ-stratifications, Θ-reductive stacks, and applications." Algebraic geometry: Salt Lake City 2015, 349–379, *Proc. Sympos. Pure Math.*, 97.1, Amer. Math. Soc., Providence, RI, 2018.
- 6. Halpern-Leistner, Daniel, and Daniel Pomerleano. "Equivariant Hodge theory and noncommutative geometry." *Geometry & Topology* (to appear). *arXiv preprint arXiv:1507.01924* (2015).
- 7. Bhatt, Bhargav; Halpern-Leistner, Daniel. "Tannaka duality revisited." *Adv. Math.* 316 (2017), 576–612.
- 8. Halpern-Leistner, Daniel; Shipman, Ian. "Autoequivalences of derived categories via geometric invariant theory." *Adv. Math.* 303 (2016), 1264–1299.
- 9. Halpern-Leistner, Daniel. "The derived category of a GIT quotient." *Journal of the American Mathematical Society* 28, no. 3 (2015): 871-912.

### **Preprints:**

- 10. Alper, Jarod and Daniel Halpern-Leistner and Jochen Heinloth, "Existence of good moduli spaces for algebraic stacks." *arXiv preprint* <u>arXiv:1812.01128</u> (2019) (submitted).
- 11. Halpern-Leistner, Daniel. "The equivariant Verlinde formula on the moduli of Higgs bundles." With an appendix by Constantin Teleman. *arXiv preprint arXiv:1608.01754* (2016).
- 12. Halpern-Leistner, Daniel. "Remarks on Theta-stratifications and derived categories." *arXiv* preprint <u>arXiv:1502.03083</u> (2015).
- 13. Halpern-Leistner, Daniel. "On the structure of instability in moduli theory." *arXiv preprint arXiv:1411.0627* (2014).
- 14. Halpern-Leistner, Daniel, and Anatoly Preygel. "Mapping stacks and categorical notions of properness." *arXiv preprint* <u>arXiv:1402.3204</u> (2014) (submitted).
- 15. Halpern-Leistner, Daniel. "Lefschetz Hyperplane Theorem for Stacks." *arXiv preprint arXiv:1008.0891* (2010) (submitted).

### In preparation:

"Yangian actions on derived categories of coherent sheaves", with Davesh Maulik and Andrei Okounkov

We construct ``stable envelope functors' in equivariant derived categories of coherent sheaves and categorify the results of Maulik & Okounkov's paper ``Quantum groups and quantum cohomology' (arXiv:1211.1287)

"Theta-stratifications and derived categories"

An extension of "Remarks on Theta-stratifications and derived categories" which will prove that any two birational moduli spaces of Gieseker semistable coherent sheaves on a K3 surface (with primitive Mukai vector and with respect to a generic polarization) have equivalent derived categories of coherent sheaves.

"Harder-Narasimhan theory for gauged maps"

Given a Riemann surface C, a reductive group G, and a projective variety with a G action, we construct a Theta-stratification, i.e. a generalized Harder-Narasimhan stratification, for the moduli problem of a G-bundle on C along with a twisted map to X. We then apply this to the computation of the Gromov-Witten invariants of a GIT quotient of X.

# **Teaching:**

- Cornell University:
  - Spring 2020 Topics in algebraic geometry (Math 7670)
  - Fall 2019 Multivariable calculus (Math 1920)
  - o Fall 2018 Linear algebra (Math 2210)
  - o Graduate students mentored: Dylan Peifer, Kimoi Kemboi
  - o Post doctoral fellows mentored: Harrison Chen
- Columbia University:
  - Spring 2017 Analysis and optimization
  - Fall 2016 "Taming moduli problems in algebraic geometry" (graduate topics course in algebraic geometry) Designed a course which covers geometric representation theory from the point of view of algebraic stacks, and discusses the moduli of G-bundles on a curve in some depth.
  - o Summer 2016 Co-organized the Columbia Research Experience for Undergraduates program on the "properties of random varieties over finite fields."
  - Spring 2016 Calculus III (Multivariable calculus)
- UC Berkeley:
  - Served as the primary instructor for two courses
    - Spring 2013 Math 191 (undergraduate topics course) Designed an upper level undergraduate course on the complex and differential geometry of Riemann surfaces
    - Summer 2009 Math 1B (second semester calculus)
  - o 2007-2013 served 5 semesters as a Graduate Student Instructor for calculus, multivariable calculus, and linear algebra.

### Service and other activities at Cornell:

- Member for the A-exams at Cornell: David Mehrle, Hannah Keese, Brandon Shapiro, Andres Fernandez Herrero, Elise McMahon
- Co-organized the Lie groups and algebraic geometry seminar, Cornell 2017-2020
- Served on Putnam committee, placement exam committee, and graduate admissions committee, Cornell 2017-2020

## Membership in professional organizations:

• Mentor for the *Math Alliance*, and organization to support underrepresented or underserved American students in pursuing doctoral degrees in mathematics.

# **Conference organization:**

• Lead organizer for American Institute in Mathematics (AIM) workshop, *Moduli problems beyond geometric invariant theory* (scheduled Feb 2021).

#### **Invited mini-courses and other honors:**

ICTS discussion meeting on moduli of bundles and related structures (February 2020)

Beyond geometric invariant theory

University of Bonn (Winter 2019)

Daniel Huybrechts organized a semester-long seminar on my "beyond geometric invariant theory" program.

http://www.math.uni-bonn.de/~georgo/note/BGIT.pdf

Freie Universitaet Berlin (New techniques in GIT conference, September 2015)

Beyond geometric invariant theory

http://userpage.fu-berlin.de/hoskins/workshop GIT.html

University of Toronto (March 2013)

Master class on geometric invariant theory and derived categories of coherent sheaves, <a href="http://www.math.toronto.edu/rayan/MasterClassSpring13/">http://www.math.toronto.edu/rayan/MasterClassSpring13/</a>

### **Invited lectures:**

2020

Yale University (January)

Harder-Narasimhan theory for gauged maps

2019

Workshop on 3D mirror symmetry and the AGT conjecture, Zhejiang University, Hangzhou China (October)

Infinite dimensional GIT and gauged Gromov-Witten theory

Quantum Structures in Algebra and Geometry, Northeastern University (August)

*Infinite dimensional GIT and gauged Gromov-Witten theory* 

Vector Bundles over Algebraic Curves, at the Center for Quantum Geometry of Moduli Spaces,

Aarhus University (June)

Harder-Narasimhan theory for gauged maps

MIT (May)

Stable envelopes

University of Michigan (April)

Stable envelopes

University of Bonn (January)

Beyond geometric invariant theory (2 lectures)

### 2018

University of Edinburgh (May)

Beyond geometric invariant theory

Stanford University (April)

Wall crossing formulas in Donaldson theory

UC Davis (March)

Beyond geometric invariant theory

MSRI member seminar (February)

Beyond geometric invariant theory

### 2017

Route 81 conference (October)

Filtrations in moduli problems

Algebraic Geometry Northeastern Series, Northeastern (October)

Beyond geometric invariant theory

Perimeter Institute for Theoretical Physics (October)

Beyond geometric invariant theory

Vector Bundles over Algebraic Curves, Essen (September)

Beyond geometric invariant theory

Helvetic Algebraic Geometry Workshop (June)

Beyond geometric invariant theory, 2 lectures

Massachusetts Institute of Technology (May)

Equivariant geometry and Calabi Yau manifolds

Western Algebraic Geometry Symposium, UBC (April)

Equivariant geometry and Calabi Yau manifolds

Institute for Advanced Study, Princeton (March)

Equivariant geometry and Calabi Yau manifolds

University of Oregon (March)

Equivariant geometry and Calabi Yau manifolds

Cornell University (February)

Equivariant geometry and Calabi Yau manifolds

University of Waterloo (February)

Equivariant geometry and Calabi Yau manifolds

University of Toronto (January)

Equivariant geometry and Calabi Yau manifolds

Northwestern University (January)

Equivariant geometry and Calabi Yau manifolds

University of California, Berkeley (January)

Equivariant geometry and Calabi Yau manifolds

Non-abelian localization and the Verlinde formula

Duke University (January)

Equivariant geometry and Calabi Yau manifolds

Yale (November)

Equivariant geometry and Calabi Yau manifolds

2016

UC San Diego (December)

Equivariant geometry and Calabi Yau manifolds

Yale (November)

Equivariant geometry and Calabi Yau manifolds

Northwestern University (October)

(Lecture 1) Equivariant hodge theory and noncommutative geometry

(Lecture 2) Equivariant Morse theory in algebraic geometry

University of California, Los Angeles (October)

(Lecture 1, colloquium) Equivariant Morse theory in algebraic geometry

(Lecture 2, algebra seminar) The equivariant verlinde formula on the moduli of Higgs bundles

University of Virginia (algebra seminar, September)

Magic windows and representations of generalized braid groups on the derived category of a GIT quotient

Simons Center (conference, September)

Derived equivalences between moduli spaces of coherent sheaves on a K3 surface

ICTP Trieste (conference, August)

Magic windows and representations of generalized braid groups on the derived category of a GIT quotient

Banff International Research Station (Homological mirror geometry conference, March)

Magic windows and representations of generalized braid groups on the derived category of a GIT quotient

2015

University of Oxford (seminar, December)

(Lecture 1) The structure of instability in moduli theory

(Lecture 2) Applications of Theta-stratifications

UNC Chapel Hill (workshop on new developments in moduli and geometric invariant theory, November)

*Applications of Theta-stratifications* 

Northeastern University (algebraic geometry seminar, November)

Tannaka duality and the unreasonable effectiveness of linear algebra.

Cornell University (topology seminar, October)

Equivariant topology and non-commutative geometry

Massachusetts Institute of Technology (algebraic geometry seminar, September)

Equivariant Hodge theory

AMS Summer institute in algebraic geometry (conference, July)

Theta-reductive moduli problems, stratifications, and applications

University of Warwick (workshop on derived categories and birational geometry, June)

Equivariant Hodge theory

University of Edinburgh (EDGE seminar, May)

Equivariant Hodge theory

Rutgers-Newark (colloquium, April)

Beyond geometric invariant theory

Mathematisches Forschungsinstitut Oberwolfach (algebraic geometry conference, March)

Theta-reductive moduli problems, stratifications, and applications

Stony Brook University (algebraic geometry seminar, March)

Reductive moduli problems, stratifications, and applications

Harvard University (gauge theory, topology, and symplectic geometry seminar, Feb)

Morse-like stratifications of moduli problems in algebraic geometry

Rutgers University (geometry, symmetry, and physics seminar, Feb)

Equivariant noncommutative Hodge theory

University of Chicago (algebraic geometry seminar, Feb)

Reductive moduli problems, stratifications, and applications

UIUC (algebraic geometry seminar, Feb)

Reductive moduli problems, stratifications, and applications

#### 2014

Rice University (algebraic geometry seminar, Nov)

*Instability in moduli theory* 

Cal Tech (algebraic geometry seminar, Oct)

The structure of instability in moduli theory

KIAS (ICM satellite conference: Geometry and Physics of Gauged Linear Sigma Model, July)

The structure of instability in moduli theory

University of Pennsylvania (Math-physics joint seminar, April)

Instability in Moduli Theory

UBC (PIMS geometry and physics seminar, Feb)

*Instability in algebraic geometry* 

UIUC (algebraic geometry seminar, Feb)

Mapping stacks and the notion of properness in algebraic geometry

#### 2013

Rutgers University (geometry, symmetry, and physics seminar, Oct)

*Instability in algebraic geometry* 

Columbia University (algebraic geometry seminar, Oct)

Instability in algebraic geometry

University of Michigan (conference, Geometry and Physics of Gauged Linear Sigma Model, March)

Stratifications of algebraic stacks and derived categories

Institute for the Physics and Mathematics of the Universe (conference, Homological Projective Duality and Quantum Gauge Theory, march)

Fractional grade restriction rules and autoequivalences of derived categories

UC Berkeley (workshop, Tensors and their Geometry in High Dimensions, Sept)

Geometric invariant theory and derived categories

University of Vienna (workshop, Birational Geometry and Derived Categories, Aug)

Derived Kirwan surjectivity and autoequivalences of derived categories

University of Warwick (conference, School on Algebraic Geometry and Theoretical Physics, July)

Localization and the derived category of a GIT quotient

Institute for the Physics and Mathematics of the Universe (DMM seminar, June)

*The derived category of a GIT quotient* 

UC Berkeley (RTGC seminar, March)

*The derived category of a GIT quotient* 

2011

University of Georgia (Southeastern Section Meeting of the AMS)

The Lefschetz Hyperplane Theorem for stacks.

### **Previous service and other activities:**

- Served as departmental representative (official faculty contact and organizer) for Columbia Summer Session in Mathematics, Summer 2016.
- Experimented with news ways of communicating mathematical ideas: created HTML/Java code to produce interactive concept maps which can be used to illustrate the key concepts, theorems, and papers in a subject and how they are related
- Served as a mentor for younger graduate students in the geometry group through the Math Graduate Student Association at UC Berkeley, 2010-2013
- Organized graduate seminars at UC Berkeley: Moduli spaces in algebraic geometry (Spring 2013), Gromov-Witten Theory (Spring 2010), Weekly student Lunch Seminar (2010-2013)