# Daniel Halpern-Leistner

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## 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.
*Undergraduate Thesis:* "On the algebraic structure of dynamical systems"

## Positions held:

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|---|---|
| 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 arXiv:1812.01128* (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 arXiv:1502.03083* (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 arXiv:1402.3204* (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)
  - Fall 2018 - Linear algebra (Math 2210)
  - Graduate students mentored: Dylan Peifer, Kimoi Kemboi
  - 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.
  - 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)
  - 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,*
http://www.math.toronto.edu/rayan/MasterClassSpring13/

## 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*

2012

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)