

## Matthew Robert Ballard

---

- CONTACT INFORMATION** University of South Carolina  
Department of Mathematics  
1523 Greene Street  
Columbia, South Carolina USA  
Email: ballard@math.sc.edu  
Webpage: [people.math.sc.edu/ballard/](http://people.math.sc.edu/ballard/)  
Phone: +1 517 325 3165
- CITIZENSHIP** Born January 3, 1980 in Lansing, Michigan, United States.
- INTERESTS** Algebraic geometry, derived categories, and mirror symmetry.
- POSITIONS**
- University of South Carolina**, Columbia, South Carolina USA  
Assistant Professor **August 2013 - Current**
  - Institute for Advanced Study**, Princeton, New Jersey, USA  
Member **September 2016 - July 2017**
  - Institut Henri Poincaré**, Paris, France  
Member of Program of Mathematics of String Theory **June - July 2016**
  - University of Vienna**, Vienna, Austria  
Senior Researcher **July 2012 - July 2013**
  - University of Wisconsin**, Madison, Wisconsin USA  
Van Vleck Visiting Assistant Professor **September 2011 - May 2012**
  - University of Pennsylvania**, Philadelphia, Pennsylvania USA  
Postdoctoral Researcher **August 2008 - May 2011**
- EDUCATION**
- University of Washington**, Seattle, Washington USA  
Ph.D., Mathematics. June 2008. Advisor: Charles Doran.  
Thesis title: *Derived categories of quasi-projective schemes*.
  - California Institute of Technology**, Pasadena, California USA  
B.S., Mathematics. June 2002.
- PAPERS AND PREPRINTS**
- With Colin Diemer and David Favero. *Kernels from compactifications: the baby case*.
  - With Alexander Duncan, Patrick McFaddin. *The toric Frobenius morphism and a conjecture of Orlov*. arXiv:1709.07128.
  - With Blake Farman. *A category of kernels for noncommutative projective schemes*. arXiv:1709.06470.
  - With Alexander Duncan, Patrick McFaddin. *On derived categories of arithmetic toric varieties*. arXiv:1709.03574.
  - Wall crossing for derived categories of moduli spaces of sheaves on rational surfaces*. Algebraic Geometry 4 (3) (2017) 263–280.
  - With David Favero and Ludmil Katzarkov. *Variation of Geometric Invariant Theory quotients and*

*derived categories*. To appear in Journal für die reine und angewandte Mathematik.

With Dragos Deliu, David Favero, M. Umut Isik, and Ludmil Katzarkov. *On the derived categories of degree  $d$  hypersurface fibrations*. To appear Mathematische Annalen.

With Dragos Deliu, David Favero, M. Umut Isik, and Ludmil Katzarkov. *Homological Projective Duality via variation of Geometric Invariant Theory quotients*. Journal of the European Mathematical Society. Volume 19 Issue 14 (2017) 1127-1158.

With Dragos Deliu, David Favero, M. Umut Isik, and Ludmil Katzarkov. *Resolutions in factorization categories*. Advances in Mathematics. 295 (2016) 195-249.

With Colin Diemer, David Favero, Ludmil Katzarkov, and Gabriel Kerr. *The Mori Program and non-Fano toric Homological Mirror Symmetry*. Transactions of the AMS. 367 (2015) 8933-8974.

With David Favero and Ludmil Katzarkov. *A category of kernels for equivariant factorizations and its implications for Hodge theory, I*. Publications mathématiques de l’IHÉS 120 (2014), no. 1, 1-111.

With David Favero and Ludmil Katzarkov. *A category of kernels for equivariant factorizations, II: further implications*. Journal de Mathématiques Pures et Appliquées 102 (2014), no. 4, 702-757.

With David Favero and Ludmil Katzarkov. *Orlov spectra: bounds and gaps*. Inventiones Mathematicae 189 (2012), no. 2, 359-430.

With David Favero. *Hochschild dimensions of tilting complexes*. International Mathematical Research Notices 2012 (2012), no. 11, 2607-2645.

*Derived categories of sheaves on singular schemes with an application to reconstruction*. Advances in Mathematics 227 (2011), no. 2, 895-919.

*Equivalences of derived categories of sheaves on quasi-projective schemes*. arXiv:0905.3148.

*Sheaves on local Calabi-Yau varieties*. arXiv:0801.3499.

*Meet homological mirror symmetry* in Modular Forms and String Duality. Fields Institute Communications, 54, AMS, Providence, RI, 2008.

*Derived categories of sheaves on quasi-projective schemes*. Thesis. 2008.

## AWARDS

Fields Institute, co-PI/organizer. \$400,000 CAD. 2019.

Pacific Institute for the Mathematical Sciences, co-PI. \$10,000 CAD. 2016.

Research in Pairs – Scheme 4 London Mathematical Society, co-PI. \$1,800. 2016.

National Science Foundation Standard Grant, PI DMS-1501813. \$140,000. 2015-2018.

Simons Foundation Collaboration Grant, PI. \$35,000. 2014-2015.

National Science Foundation Standard Grant, co-PI DMS-1343512. \$14,620. 2013.

VIGRE Graduate Fellowship. 2006-2007.

ARCS Fellowship. 2002-2005.

## LECTURES

Compactifications and kernels. Institute for the Mathematics and Physics of the Universe, Tokyo. June 2017.

Compactifications and kernels. Algebraic Geometry Colloquium. Johannes Gutenberg-University of Mainz. July 2016.

Zeta functions and phase changes for CICYs. Bethe Forum on Mirror Symmetry. University of Bonn. July 2016.

Compactifications and kernels. Algebraic Geometry Seminar. Cambridge University. May 2016.

Compactifications and kernels. Equivariant geometry and algebraic stacks. Australia National University – Kioloa. March 2016.

Derived categories of moduli spaces and wall-crossing. Algebra Seminar. University of Alberta. December 2015.

Where do derived equivalences come from? Preprojective Algebras Interacting with Singularities, Cohen-Macaulay Modules and Weighted projective Spaces. Casa Matematica Oaxaca. October 2015.

Orlov spectra in algebraic geometry and beyond. Invited lecture. AMS Summer Institute in Algebraic Geometry. University of Utah. July 2015.

Mirror Symmetry through exceptional collections. Lecture series. Geometric Algebra: Bridges between commutative algebra, noncommutative geometry and representation theory. Fields Institute. July 2015.

Derived categories of moduli spaces of sheaves on rational surfaces. Homological Mirror Symmetry and Hodge Theory. University of Warwick. June 2015.

A problem in linear algebra and its connection with homological algebra. Analysis, Logic, and Physics Seminar. Virginia Commonwealth University. April 2015.

Wall crossing for derived categories of moduli spaces of sheaves on rational surfaces. Algebra Geometry. Oberwolfach. March 2015.

Generation spectra: how complex is a category. Colloquium. Pennsylvania State University. February 2015.

Generation spectra: how complex is an algebra, how complex is a category. Colloquium. University of Nebraska. January 2015.

Wall crossing in moduli problems and semi-orthogonal decompositions. Colloquium. University of Oregon. January 2015.

Geometry and homological algebra of GLSMs. Computational and Commutative Algebra Seminar. Cornell University. December 2014.

Windows, compactifications, and kernels. Wall Crossing, Quantum Integrable Systems, and TQFT. Simons Center for Geometry and Physics. November 2014.

Wall crossing in moduli problems and semi-orthogonal decompositions. Workshop on Moduli Spaces, Derived Geometry, and Representation Theory. of North Carolina-Chapel Hill. October 2014.

Wall crossing in moduli problems and semi-orthogonal decompositions. Algebraic Geometry Seminar. Ohio State University. October 2014.

Wall crossing in moduli problems and semi-orthogonal decompositions. Algebra and Number Theory Seminar. Emory University. September 2014.

Wall crossing in moduli problems and derived categories. Algebraic Geometry Seminar. University of Georgia. September 2014.

Orlov spectra. Algebra and Number Theory Seminar. Clemson University. September 2014.

Wall crossing in moduli problems and derived categories. Geometry and Physics of Gauged Linear Sigma Model and its Related Topics. Korea Institute for Advanced Study. July 2014.

Derived categories and variation of GIT quotients. Plenary Talk. String-Math 2014. University of Alberta. June 2014.

Local VGIT and derived categories. Landau-Ginzburg Theory and Fano Varieties. Gyeongju. May 2014.

Mirror symmetry, another example of the unreasonable effectiveness of physics in mathematics. Colloquium. Georgia Southern University. April 2014.

Variation of stability and derived categories. Geometry and Physics Seminar. Pennsylvania State

University. April 2014.

Stability in moduli problems, local VGIT, and derived categories. Third Conference of the Institute for Geometry and Physics Miami-Cinvestav-Campinas. Xcaret. March 2014.

Towards Homological Projective Duality for Grassmannians. Workshop on Calabi-Yau Manifolds, Mirror Symmetry and Related Topics. University of Tokyo. February 2014.

Stratifications under group actions and derived categories. Workshop on Calabi-Yau Manifolds, Mirror Symmetry and Related Topics. University of Tokyo. February 2014.

Griffiths residue theorem via Landau-Ginzburg models. Workshop on Hodge Theory and String Theory. Fields Institute. November 2013.

GIT, stratifications, and derived categories. Algebraic Geometry and Number Theory Seminar. Johns Hopkins University. November 2013.

Kernels for equivariant factorizations, I. AMS Fall Central Sectional Meeting. Special Session on Algebraic Cycles and Coherent Sheaves. Washington University in St. Louis. October 2013.

Homological Projective Duality for higher Veronese embeddings. AMS Fall Eastern Sectional Meeting. Special Session on Higher Structures in Algebra, Geometry, and Physics. Temple University. October 2013.

Mini-course on windows. Erwin Schrödinger Institute. June 2013.

Exceptional collections from VGIT. Erwin Schrödinger Institute. May 2013.

Kernels for equivariant factorizations. Erwin Schrödinger Institute. May 2013.

Orlov spectra: bounds and gaps. Mathematical Sciences Research Institute. March 2013.

Derived categories and variation of GIT quotients. Algebraic geometry seminar. Princeton University. December 2012.

Kernels for graded matrix factorizations. Algebra seminar. University of Hamburg. November 2012.

Exceptional collections on moduli spaces of rational curves via phase change in the B-model. Homological projective duality and quantum gauge theory. Institute for the Physics and Mathematics of the Universe, Tokyo. November 2012.

VGIT and Orlov's theorem. Algebra seminar. University of California, Los Angeles. October 2012.

Phases of the B-model. Duke regional string workshop. Duke University. September 2012.

VGIT and derived categories of moduli spaces of rational curves. Algebraic geometry seminar. Duke University. September 2012.

Variation of geometric invariant theory quotients and exceptional collections on  $\overline{M}_{0,n}$ . Birational geometry and derived categories. University of Vienna. August 2012.

Derived categories and variation of geometric invariant theory quotients. Algebraic geometry and theoretical physics. University of Warwick. July 2012.

Variation of GIT quotients and matrix factorizations. PASI 2012: Commutative algebra and its interactions with algebraic geometry, representation theory, and physics. Centro de Investigaci3n en Matemáticas. May 2012.

Variation of GIT quotients, birational geometry, and derived categories. Algebraic geometry seminar. Ohio State University. April 2012.

Variation of GIT quotients and derived categories. AMS special session. University of Kansas. March 2012.

Variation of the GIT quotient for Abelian gauged linear sigma-models. Algebraic geometry seminar. University of Wisconsin. February 2012.

Some new cases of the Hodge Conjecture via graded matrix factorizations. International School on

TQFT, Langlands and Mirror Symmetry. Huatulco, Mexico. February 2012.

Phases of the B-model: Variation of GIT for toric LG-models. Conference on Homological Mirror Symmetry. University of Miami. January 2012.

Phases of the B-model for GLSMs. Algebra seminar. University of North Carolina. January 2012.

Some new cases of the Hodge Conjecture via categories of graded matrix factorizations. Hodge Theory and String Duality. Banff International Research Station. December 2011.

Some new cases of the Hodge Conjecture via categories of graded matrix factorizations. Algebra Seminar. Michigan State University. November 2011.

You got your Hodge conjecture in my matrix factorizations. Algebraic Geometry Seminar. University of Wisconsin. September 2011.

Categories of matrix factorizations for complete intersections. Workshop on Mirror Symmetry. University of Vienna. August 2011.

Graded matrix factorizations. Deformation Theory Seminar. University of Pennsylvania. July 2011.

Matrix factorization categories for complete intersections with applications to Orlov spectra of triangulated categories. Number theory and Physics at the Crossroads. Banff International Research Station. May 2011.

## TEACHING

### **University of South Carolina**, Columbia, South Carolina USA

#### *Instructor*

Solely responsible for lectures, exams, homework assignments, and grades.

- Math 141 Calculus I **August - December 2014**
- Math 141 Honors Calculus I **August - December 2015**
- Math 142 Calculus II **August - December 2013**
- Math 241 Honors Calculus III **August - December 2017**
- Math 544 Linear Algebra **August - December 2013**
- Math 546 Algebraic Structures I **January - May 2014**
- Math 701 Foundations of Algebra I **August - December 2015**
- Math 702 Foundations of Algebra II **January - May 2016**
- Math 732 Algebraic Topology I **August - December 2014**
- Math 733 Algebraic Topology II **January - May 2015**
- Math 737 Introduction to Complex Geometry I **August - December 2017**

### **University of Wisconsin**, Madison, Wisconsin USA

#### *Instructor*

Solely responsible for lectures, exams, homework assignments, and grades.

- Math 475 Introduction to Combinatorics **September - December 2011**
- Math 541 Modern Algebra I **January - May 2012**

### **University of Pennsylvania**, Philadelphia, Pennsylvania USA

#### *Instructor*

Solely responsible for lectures, exams, homework assignments, and grades.

- Math 104 Calculus II **September - December 2010**
- Math 114 Calculus III **January - May 2009**
- Math 505 Graduate Proseminar in Mathematics **January - May 2011**
- Math 622/623 Complex Algebraic Geometry **September 2009 - May 2010**
- Math 999 Independent Study in Derived Categories **September - December 2010**

### **University of Washington**, Seattle, Washington USA

#### *Instructor*

Solely responsible for lectures, exams, homework assignments, and grades.

- Math 126 Calculus and Analytic Geometry III **June - August 2004**
- Math 307 Introduction to Differential Equations **June - August 2005**
- Math 308 Introduction to Linear Algebra **June - August 2007**
- Math 309 Linear Analysis **June - August 2008**

#### MENTORING

- Patrick McFaddin. Postdoc, USC. August 2016 - May 2019.
- Blake Farman. Ph.D., USC, Mathematics, Expected May 2018.
- Alicia Lamarche. Ph. D., USC, Mathematics, Expected 2020.
- Robert Vandermolen. Ph. D., USC, Mathematics, Expected 2020.
- Ross Berkowitz. Masters, UPenn, Mathematics, May 2011.

#### PROFESSIONAL MEMBERSHIP

Member of the American Mathematical Society

#### REVIEWER

- Reviewer for Advances in Mathematics, Advances in Theoretical and Mathematical Physics, Algebraic Geometry, Applied Categorical Structures, Annals of K-theory, Communications in Algebra, Compositio Mathematica, Duke Journal of Mathematics, Inventiones Mathematicae, Journal of Algebra, Journal of Algebra and its Applications, Journal of Algebraic Geometry, Journal de Mathématiques Pures et Appliquées, Journal of Pure and Applied Algebra, Journal für die Reine und Angewandte Mathematik, Mathematical Research Letters, Mathematische Annalen, Mathematische Zeitschrift, Michigan Journal of Mathematics, NSA Mathematical Sciences Grant Program, NSF Algebraic Geometry Panel, Proceedings of the AMS, Proceedings of the Fields' Institute, Proceedings of String-Math 2013, and Transactions of the AMS.

#### SERVICE

- UPenn AP/Make-up Exam Committee 2008-2009.
- UPenn Graduate Admission Committee 2009-2011.
- USC Faculty liaison for *IIIME* Honor Society and Gamecock Math Club 2013-2016.
- USC Undergraduate mathematics advisor 2013-2015.
- USC Hiring committee 2013-2016.
- USC Faculty senator 2013-2016.
- USC Graduate Advisory Committee. 2015-2016, 2017-2018.
- USC Mathematics Self-study Committee 2017-2018.
- Member of Comprehensive Exam committee for Jaree Hudson, 2015; USC Masters Thesis committee for Marvin Jones, 2014; USC Ph.D. committee for Richard Oh, 2014.

#### ORGANIZING

- UPenn Graduate Student Algebra Seminar 2008-2011.
- USC Graduate Colloquium 2015-2016.
- USC Algebraic Geometry, Commutative Algebra, and Number Theory Seminar 2013-2016.
- Birational Geometry and Derived Categories conference, University of Vienna, August 2012.
- Geometry of D-branes thematic period, Erwin Schrödinger Institute, April - July 2013.
- Commutative Algebra – Algebraic Geometry in the Southeast, November 2013.
- AMS Special Session on Mirror Symmetry. Southeast Section. November 2014.
- AMS Special Session on Interactions between Algebraic and Tropical Geometry. March 2016.
- Banff International Research Station Workshop on Homological Mirror Geometry. March 2016.
- Superschool on Derived Categories and D-branes. July 2016.
- Thematic Program on Homological Mirror Symmetry. Fields Institute. August-December 2019.