Matthew Robert Ballard

CONTACT INFORMATION

University of South Carolina
Department of Mathematics
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Columbia, South Carolina USA

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CITIZENSHIP

Born January 3, 1980 in Lansing, Michigan, United States.

INTERESTS

Categorical structures in algebraic and arithmetic geometry, noncommutative algebra, and mirror symmetry and formal verification.

POSITIONS

Simons-Laufer Mathematical Sciences Institute (formerly MSRI), Berkeley, California USA
Research Professor **January 2024 - May 2024**

University of South Carolina, Columbia, South Carolina USA
Professor (with tenure) **January 2022 - Current**

University of Michigan, Ann Arbor, Michigan USA
Visiting Scholar **January 2021 - May 2021**

University of South Carolina, Columbia, South Carolina USA
Associate Professor (with tenure) **January 2018 - December 2021**

Institute for Advanced Study, Princeton, New Jersey, USA
Member **September 2016 - July 2017**

University of South Carolina, Columbia, South Carolina USA
Assistant Professor **August 2013 - December 2017**

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. with honor, Mathematics. June 2002.

SELECTED LEADERSHIP ROLES

Executive Committee, Department of Mathematics, University of South Carolina. 2023–2025.

Director of Calculus Instruction, Department of Mathematics, University of South Carolina. 2023–2025.

Coordinator for Calculus I, Department of Mathematics, University of South Carolina. 2018–2020.

University of South Carolina Department of Mathematics Self-study Committee 2017–2018.

Chair of ad-hoc Committee on Calculus Instruction, College of Arts & Sciences, Department of Mathemetics, University of South Carolina, 2017–2018.

Selected Funding

National Science Foundation Standard Grant, PI DMS-2302263. $267,691. 2023–2026.

Simons Foundation Collaboration Grant, PI. $42,000. 2020–2023.

University of South Carolina ASPIRE I, Tracks 3 and 4. $15,000. 2020-2022.

Fields Institute, co-PI/organizer. $475,000 CAD. 2019.

Southeastern Conference Visiting Faculty Travel Award. $1,800. 2019.

National Science Foundation Standard Grant, PI DMS-1501813. $140,000. 2015–2019.

National Security Agency Young Investigators Grant, PI $18,574 2015–2017 (conflicted with NSF award).

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

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

Selected Awards

University of South Carolina Garnet Apple Award for Teaching Innovation. 2022.

University of South Carolina College of Arts & Sciences Teaching Incubator Fellow. 2019–2021.

University of South Carolina Breakthrough Star. 2018.

Papers and Preprints

Articles appear at `https://arxiv.org/a/ballard_m_1.html`

With Alicia Lamarche. *Detecing rational points with étale exceptional collections*. In preparation.

With Nitin Chidambaram and David Favero. *Kernels for stratified Mukai flops via the Q-construction*. In prepration.

With Srikanth B. Iyengar, Pat Lank, Alapan Mukhopadhyay, and Josh Pollitz. *High Frobenius pushforwards generate the bounded derived category*. arxiv:2303.18085. Submitted.

With Alexander Duncan, Alicia Lamarche, and Patrick McFaddin. *Consequences of the existence of exceptional collections in arithmetic and rationality*. arXiv:2009.10175. Submitted.

With Colin Diemer and David Favero. *Kernels from compactifications*. arXiv:1710.01418. Submitted.

With Alexander Duncan, Alicia Lamarche, and Patrick McFaddin. *Separable algebras and coflasque resolutions*. arXiv:2006.06876. To appear in Advances in Mathematics.

With Alexander Duncan and Patrick McFaddin. *Derived categories of centrally-symmetric smooth toric Fano varieties*. Mathematische Nachrichten. (2) 295 (2022), pp. 218–241.

With Blake Farman. *A category of kernels for noncommutative projective schemes*. Journal of Noncommutative Geometry. 15 (2021), 1129–1180.

With Nitin Chidambaram, David Favero, Patrick McFaddin, and Robert Vandermolen. *Kernels for Grassmann flops*. Journal de Mathématiques Pures et Appliquées. (9) 147 (2021), pp. 29–59.

With Alexander Duncan, Patrick McFaddin. *The toric Frobenius morphism and a conjecture of Orlov*. European Journal of Mathematics. 5 (2019), no. 3, 640–645.

With Alexander Duncan, Patrick McFaddin. *On derived categories of arithmetic toric varieties*.

Annals of K-Theory 4 (2019), no. 2, 211–242.

With David Favero and Ludmil Katzarkov. *Variation of Geometric Invariant Theory quotients and derived categories*. Journal für die reine und angewandte Mathematik (Crelle). Issue 746 (2019) 235–304.

With Dragos Deliu, David Favero, M. Umut Isik, and Ludmil Katzarkov. *On the derived categories of degree d hypersurface fibrations*. Mathematische Annalen 371 (2018), no. 1–2, 337–370.

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.

Wall crossing for derived categories of moduli spaces of sheaves on rational surfaces. Algebraic Geometry 4 (3) (2017) 263–280.

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.

Books

Superschool on derived categories and D-branes. Edmonton, Canada, July 17–23, 2016. Lectures from the PIMS Superschool. Edited with Charles Doran, David Favero and Eric Sharpe. Springer Proceedings in Mathematics & Statistics, 240. Springer, Cham, 2018.

Teaching

University of South Carolina, Columbia, South Carolina USA

- Math 141 Calculus I — **Fall 2014, Fall 2018, Spring 2019, Fall 2019x2**
- Math 141 Honors Calculus I — **Fall 2015**
- Math 142 Calculus II — **Fall 2013**
- Math 241 Calculus III — **Fall 2023x2**
- Math 241 Honors Calculus III — **Fall 2017**
- Math 300 Honors Transition to Advanced Mathematics — **Fall 2020, Fall 2022**
- SCHC 411 Formalization and Mathematics — **Spring 2023**
- Math 544 Linear Algebra — **Fall 2013**
- Math 544 Honors Linear Algebra — **Fall 2021**
- Math 546 Algebraic Structures I — **Spring 2014**
- Math 587 Introduction to Cryptography — **Fall 2022**

- Math 701 Foundations of Algebra I **Fall 2015**
- Math 702 Foundations of Algebra II **Spring 2016**
- Math 732 Algebraic Topology I **Fall 2014**
- Math 733 Algebraic Topology II **Spring 2015**
- Math 737 Introduction to Complex Geometry I **Fall 2017**
- Math 738 Derived Categories I **Fall 2021**
- Math 748 Derived Categories II **Spring 2022**

University of Wisconsin, Madison, Wisconsin USA
- Math 475 Introduction to Combinatorics **Fall 2011**
- Math 541 Modern Algebra I **Spring 2012**

University of Pennsylvania, Philadelphia, Pennsylvania USA
- Math 104 Calculus II **Fall 2010**
- Math 114 Calculus III **Spring 2009**
- Math 505 Graduate Proseminar in Mathematics **Spring 2011**
- Math 622 Complex Algebraic Geometry I **Fall 2009**
- Math 623 Complex Algebraic Geometry II **Spring 2010**

University of Washington, Seattle, Washington USA
- Math 126 Calculus and Analytic Geometry III **Summer 2004**
- Math 307 Introduction to Differential Equations **Summer 2005**
- Math 308 Introduction to Linear Algebra **Summer 2007**
- Math 309 Linear Analysis **Summer 2008**

Mentoring

- Uttaran Dutta, Ph.D., USC, Mathematics, Expected 2027.
- Anirban Bhaduri, Ph.D., USC, Mathematics, Expected 2025.
- Patrick Lank, Ph.D., USC, Mathematics, Expected 2024. Postdoctoral researcher at Università degli Studi di Milano starting Fall 2024.
- Keller Vandebogert, Ph.D., USC, Mathematics, May 2021. (co-advised with Andrew Kustin). Currently NSF Mathematical Sciences Postdoctoral Fellow at the Univeresity of Notre Dame.
- Alicia Lamarche. Ph.D., USC, Mathematics, May 2020. Currently NSF Mathematical Sciences Postdoctoral Fellow at the University of Utah.
- Robert Vandermolen. Ph.D., USC, Mathematics, May 2020. Currently tenure track assistant professor at Saint Mary College of the Woods.
- Patrick McFaddin. Postdoc, USC. 2016 – 2019. Currently tenure-track assistant professor at Fordham University.
- Jessisa Otis, M.S., USC, Mathematics. 2019.
- Blake Farman. Ph.D., USC, Mathematics. 2018. Currently tenure track assistant professor and Capitol One Endowed Professor at University of Louisiana-Monroe.
- Ross Berkowitz. Masters, UPenn, Mathematics. May 2011. Currently Gibbs Assistant Professor at Yale University.

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, Banff International Research Station, Cambridge Mathematical Journal, Communications in Algebra, Compositio Mathematica, Duke Mathematical Journal, European Research Council, Inventiones Mathematicae, Journal of Algebra, Journal of Algebra and its Applications, Journal of Algebraic Geometry, Journal of Differential 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, National Se-

curity Agency, National Science Foundation, Natural Sciences and Engineering Research Council of Canada, Proceedings of the AMS, Proceedings of the Fields' Institute, Proceedings of String-Math, and Transactions of the AMS.

Service

- Maintainer for Mathlib, the mathematical library for Lean programming language, 2023–2025.
- Faculty senator 2013–2016, 2022–2025. USC.
- Co-chair Service Teaching Committee. 2023-2024. USC.
- Graduate Advisory Committee. 2015–2016, 2017–2019, 2022-2024. USC.
- Education Committee, Department of Mathematics. 2021–2022. USC.
- Undergraduate mathematics advisor 2013–2015, 2021. USC.
- Carolina Top Scholar Selection Reviewer. 2020. USC.
- Course coordinator for Calculus I 2018–2020. USC.
- Chair of Special Committee on Calculus Sequence. 2018. USC.
- co-Editor of proceedings of Superschool on Derived Categories and D-branes. 2018.
- Faculty liason for ΠME Honor Society and Gamecock Math Club 2013–2016. USC.
- Hiring committee 2013–2016. USC.
- Graduate Admission Committee 2009–2011. UPenn.
- Member of Comprehensive Exam committee for Bailey Heath, 2021; Jonathan Smith, 2021; Jaree Hudson, 2015; USC Masters Thesis committee for Marvin Jones, 2014; USC Ph.D. committee for Richard Oh, 2014.

Organizing

- USC Algebra, Geometry, and Number Theory Seminar 2013–2024.
- AMS Mathematical Research Community on Derived Categories, Arithmetic, and Geometry. July 2023.
- Special Session on Derived Categories and Birational Geometry at joint Meeting of the American Mathematical Society, Société Mathématique de France, and European Mathematical Society. July 2022.
- Birational, Categorical, and Derived Algebraic Geometry. Banff International Research Station. November 2021.
- Special Session on Mathematical-Physical Aspects of Toric and Tropical Geometry at the Mathematical Congress of the Americas. July 2021.
- Session on Derived Categories and (Non)Commutative Algebraic Geometry. Winter Meeting of the Canadian Mathematical Society. December 2020.
- Birational, Categorical, and Derived Algebraic Geometry. Banff International Research Station. November 2020.
- Thematic Program on Homological Mirror Symmetry. Fields Institute. August-December 2019.
- USC Graduate Colloquium 2015–2016.
- Superschool on Derived Categories and D-branes. July 2016.
- Banff International Research Station Workshop on Homological Mirror Geometry. March 2016.
- AMS Special Session on Interactions between Algebraic and Tropical Geometry. March 2016.
- AMS Special Session on Mirror Symmetry. Southeast Section. November 2014.
- Commutative Algebra – Algebraic Geometry in the Southeast, November 2013.
- Geometry of D-branes thematic period, Erwin Schrödinger Institute, April – July 2013.
- Birational Geometry and Derived Categories conference, University of Vienna, August 2012.