Curriculum Vitae
Harold Williams

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Education/Employment

2020 –		Assistant Professor, University of Southern California
2017 – 2020		Postdoctoral Fellow, Center for Quantum Mathematics and Physics, University of California, Davis
2014 – 2017		RTG Instructor of Mathematics, University of Texas, Austin
2014	Ph.D.	University of California, Berkeley, Mathematics (advisor: Nicolai Reshetikhin)
2008	B.S.	University of Texas, Austin, Mathematics (Summa Cum Laude)
2008	B.A.	University of Texas, Austin, Music (Summa Cum Laude)

Grants/Scientific Honors

2022 –	NSF CAREER Grant DMS-2143922 (5 years, $450,000, "Cluster Algebras in Representation Theory, Geometry, and Physics")
2017 – 2021	NSF Standard Grant DMS-1801969 (3 years, $107,022, "Cluster Algebras in Representation Theory and Symplectic Geometry")
2015 – 2017	NSF Mathematical Sciences Postdoctoral Research Fellowship DMS-1502845 (sponsoring scientist: Andrew Neitzke)
2016	NSF Conference Grant DMS-1601967 (PI, Texas Algebraic Geometry Symposium)
2014	Kenneth Ribet and Lisa Goldberg Award in Algebra (UC Berkeley Dissertation Award)

Research Interests

Representation theory, algebraic geometry, symplectic geometry, mathematical physics, combinatorics, cluster algebras, integrable systems.

Papers

Published Articles

1. (with D. Treumann, E. Zaslow) *Kasteleyn operators from mirror symmetry*, Selecta Math. New Ser. (2019) 25: 60.

2. (with V. Shende, D. Treumann, E. Zaslow) *Cluster varieties from Legendrian knots*, Duke Math. J. 168 (2019), no. 15, 2801-2871.

3. (with S. Cautis) *Cluster theory of the coherent Satake category*, J. Amer. Math. Soc. 32 (2019), 709-778.

4. (with D. Rupel, S. Stella) *Affine cluster monomials are generalized minors*, Compositio Math. 155 (2019), 1301-1326.

5. (with D. Rupel, S. Stella) *On generalized minors and quiver representations.* Int. Math. Res. Not. IMRN (2018), doi.org/10.1093/imrn/rny053.

6. (with M. Cheung, M. Gross, G. Muller, G. Musiker, D. Rupel, S. Stella) *The greedy basis equals the theta basis*, J. Combin. Theory Ser. A 145 (2017), 150-171.

7. *Toda systems, cluster characters, and spectral networks*, Commun. Math. Phys. (2016), 1-41.

8. *Cluster characters and the combinatorics of Toda systems*, Theoret. and Math. Phys. 185 (2015), no. 3, 1789-1802.

9. *Q-Systems, factorization dynamics, and the twist automorphism.* Int. Math. Res. Not. IMRN (2015), no. 22, 12042-12069.

10. *Cluster ensembles and Kac-Moody groups*, Adv. Math. 247 (2013), 1-40.

11. *Double Bruhat cells in Kac-Moody groups and integrable systems*, Lett. Math. Phys. 103 (2013), no. 4, 389-419.

Preprints

12. (with S. Cautis) *Canonical bases for Coulomb branches of 4d $\mathcal{N} = 2$ gauge theories*, arXiv:2306.03023.

13. (with S. Cautis) *Tamely presented morphisms and coherent pullback*, arXiv:2306.03119.

14. (with S. Cautis) *Ind-geometric stacks*, 2306.03043.

15. (with V. Shende, D. Treumann) *On the combinatorics of exact Lagrangian surfaces*, arXiv:1603.07449.

Articles In Preparation

16. (with T. Gannon) *Differential operators on SL_n/U and quantized Coulomb branches*, expected 2023.

17. (with S. Cautis) *Clifford algebras and linear Koszul duality*, expected 2024.

18. (with C. Kuo) *Bipartite graphs in T^n and toric mirror symmetry*, expected 2024.

Expository Writing

19. *Notes on derived categories as higher categories*, www.hwilliams.net/derivedhigher.pdf.

Conferences Organized

2023	June	2023 Los Angeles Workshop on Representations and Geometry, USC
2022	June	2022 Los Angeles Workshop on Representations and Geometry, USC
2011	Oct.	Representation Theory, Geometry, and Combinatorics RTG Conference, UC Berkeley
2016	April	Texas Algebraic Geometry Symposium, UT Austin

Invited Conference and Seminar Talks

2023	Nov	Kansas State University (M-Seminar): Differential operators on the base affine space and quantized Coulomb branches
——	Nov	UC Berkeley (Geometry and String Theory Seminar): Differential operators on the base affine space and quantized Coulomb branches
——	Oct	UT Austin (Geometry Seminar): Differential operators on the base affine space and quantized Coulomb branches
——	Jul	University of Oregon (Workshop on Algebra and Representation Theory on Oregonian Grounds): Categorified Coulomb Branches
——	Jun	CIRM, Trento, Italy ("Cluster algebra and Poisson geometry" Conference): Tamely presented algebraic geometry
——	Mar	UC Riverside (Lie Theory Seminar): Categorified Coulomb Branches
2022	Jun	Yale University ("On the Crossroads of Algebra, Geometry and Physics" Conference): Canonical Bases for Coulomb Branches
2021	Feb	Virtual (UCLA Topology Seminar): Kasteleyn Operators from Mirror Symmetry
2020	Dec	Virtual (CIRM Conference on Quantum Groups and Cohomology Theories of Quiver and Flag Varieties): Canonical Bases for Coulomb Branches
——	Dec	Virtual (Western Hemisphere Colloquium on Geometry and Physics): Canonical Bases for Coulomb Branches

——	Aug	Virtual (Dimers in Combinatorics and Cluster Algebras Conference): Kasteleyn Operators from Mirror Symmetry
2019	Nov	Rutgers University: Geometry and Representation Theory Through the Lens of Physics
——	Nov	UCSD: Geometry and Representation Theory Through the Lens of Physics
——	Nov	USC: Geometry and Representation Theory Through the Lens of Physics
——	Nov	AMS Western Sectional Meeting, UC Riverside (Special Session on Geometric Methods in Representation Theory): Canonical Bases for Coulomb Branches
——	Nov	AMS Western Sectional Meeting, UC Riverside (Special Session on Canonical Bases, Cluster Structures and Non-commutative Birational Geometry): Kasteleyn Operators from Mirror Symmetry
——	Oct	Universität Bonn (Representation Theory Seminar): Canonical Bases for Coulomb Branches
——	Oct	Center for Mathematical Physics, Hamburg (Colloquium): Canonical Bases for Coulomb Branches
——	Sept	Perimeter Institute for Theoretical Physics (Mathematics Seminar): Canonical Bases for Coulomb Branches
——	Sept	Giens, France (Conference on Integrability, Combinatorics, and Representations): Kasteleyn Operators from Mirror Symmetry
——	Aug	Centre de Recherches Mathématiques, Montréal (Quiver Varieties and Representation Theory): Representation Theoretic Interpretations of Acyclic Cluster Algebras
——	Jun	RIMS, Kyoto (Workshop on Cluster Algebras, Geometry, and Mathematical Physics): Canonical Bases for Coulomb Branches
——	Jun	International Centre for Mathematical Sciences, Edinburgh (Conference on Geometric Representation Theory, Topological Field Theory, and Low-dimensional Topology): Canonical Bases for Coulomb Branches
——	May	Centre de Recherches Mathématiques, Montréal (Faces of Integrability): Kasteleyn Operators from Mirror Symmetry
——	Apr	Kavli IPMU, Tokyo: Canonical Bases for Coulomb Branches
——	Feb	UT Austin (Texas Algebraic Geometry Symposium): Kasteleyn Operators from Mirror Symmetry
2018	Dec	University of Edinburgh (Algebra Seminar): Kasteleyn Operators from Mirror Symmetry
——	Nov	Mathematisches Forschungsinstitut Oberwolfach (Enveloping Algebras and Geometric Representation Theory): The Coherent Satake Category
——	Oct	Columbia University (Symplectic Geometry, Gauge Theory, and Categorification Seminar): Kasteleyn Operators from Mirror Symmetry
——	Oct	Northwestern University (Geometry and Physics Seminar): Kasteleyn Operators from Mirror Symmetry
——	Jun	Notre Dame University (Conference on Geometric Representation Theory and Symplectic Varieties): The Coherent Satake Category
——	Jun	Université Paris Diderot (3 lecture minicourse): Cluster Theory of the Coherent Satake Category
——	Jun	CIRM, Luminy (Representation Theory, Mathematical Physics, and Integrable Systems): The Coherent Satake Category
——	May	Michigan State University (Workshop on Cluster Algebras and Mathematical Physics): The Coherent Satake Category
——	Mar	CIRM, Luminy (Cluster Algebras: Twenty Years On): The Coherent Satake Category
——	Jan	Casa Matemática Oaxaca (Workshop on Cluster Varieties and Mathematical Physics): Renormalized R-matrices and Chiral Categories [3 lectures]

2017 Nov   UNAM, Mexico City (US-Mexico Meeting on Representation Theory, Categorification, and Noncommutative Algebra): Affine Cluster Monomials are Generalized Minors
—— Nov   University of Toronto (Geometric Representation Theory Seminar): The Coherent Satake Category
—— Nov   AMS Western Sectional Meeting, UC Riverside (Special Session on Non-commutative Birational Geometry, Cluster Structures, and Canonical Bases): Quiver Representations and Generalized Minors
—— Mar   Johannes Gutenberg-Universität, Mainz (Spring School on Cluster Algebras in Mathematical Physics): Microlocal Sheaves and Mirror Symmetry for Toric Varieties
—— Mar   Institut Henri Poincaré (Trimester on Combinatorics and Interactions, Research Seminar): From Dimer Models to Integrable Systems via Mirror Symmetry
—— Mar   Institut de Mathématiques de Jussieu (Algebra Seminar): Quiver Representations and Generalized Minors
—— Jan   UC Berkeley (String-Math Seminar): Cluster Theory of the Coherent Satake Category
—— Jan   University of British Columbia (Colloquium): Canonical Bases and Physical Mathematics
—— Jan   University of British Columbia (Algebraic Geometry Seminar): Cluster Theory of the Coherent Satake Category
2016 Dec   Perimeter Institute for Theoretical Physics (Mathematics Seminar): Cluster Theory of the Coherent Satake Category
—— Nov   University of Virginia (Algebra Seminar): Cluster Theory of the Coherent Satake Category
—— Nov   UCLA (Colloquium): The Affine Grassmannian as an Object of Symplectic Geometry
—— Nov   USC (Algebra Seminar): The Affine Grassmannian as an Object of Symplectic Geometry?
—— Oct   Kavli IPMU, Tokyo: The Coherent Satake Category and Line Operators
—— Oct   RIMS, Kyoto (Differential Geometry Seminar): Skeletal Surgery and the Combinatorics of Exact Lagrangian Surfaces
—— Oct   RIMS, Kyoto (Geometric Representation Theory Conference): Cluster Theory of the Coherent Satake Category
—— July   ETH Zürich (Poisson 2016): Cluster Algebra as the Moduli Theory of A-branes in 4-manifolds
—— May   Perimeter Institute for Theoretical Physics (Mathematics Seminar): Cluster Theory is the Moduli Theory of A-branes in 4-manifolds
—— May   Notre Dame London Global Gateway (Quivers and Bipartite Graphs Conference): Clusters are Exact Lagrangian Surfaces
—— Mar   MSRI (Hot Topics: Cluster Algebras and Wall-Crossing Workshop): Cluster Algebras and Exact Lagrangian Surfaces
—— Mar   UC Berkeley (Simons Collaboration Conference on Mirror Symmetry and Wall-Crossing): Skeletal Surgery and the Combinatorics of Exact Lagrangian Surfaces
—— Jan   Simons Center for Geometry and Physics (Geometric Representation Theory Workshop): Microlocal Sheaves and Cluster Algebras
2015 Nov   UT Austin (Geometry Seminar): Moduli Spaces of Microlocal Sheaves and Cluster Combinatorics
—— Nov   University of British Columbia (Algebraic Geometry Seminar): Moduli Spaces of Microlocal Sheaves and Cluster Combinatorics
—— Oct   Northwestern University (Geometry and Physics Seminar): Moduli Spaces of Microlocal Sheaves and Cluster Combinatorics
—— Sept   Texas A&M University (Texas Algebraic Geometry Symposium Workshop): Moduli Spaces of Microlocal Sheaves and Cluster Combinatorics
—— Sept   Notre Dame (Felix Klein Seminar): Cluster Combinatorics of Symplectic 4-Manifolds and Legendrian Knots

—— July   Université de Montréal (CRM Workshop on Positive Grassmannians and Applications): Bipartite Graphs and Microlocal Geometry

—— June   University of Minnesota (Sage Days 64.5): Cluster Algebras IV

—— May   Woods Hole Oceanographic Institute (Maurice Auslander International Conference): Cluster Algebras as Legendrian Knot Invariants

—— May   MIT (Lie Theory Seminar): Cluster Algebras as Microlocal Knot Invariants

—— Apr   Northeastern University (Geometry and Physics Seminar): Legendrian Knots and Cluster Varieties

—— Apr   Boston College (Geometry Seminar): Legendrian Knots and Cluster Varieties

—— Mar   AMS Central Sectional Meeting, Michigan State University (Special Session on Integrable Combinatorics): Legendrian Knots and Cluster Varieties

—— Jan   UNAM, Mexico City (US-Mexico Meeting on Noncommutative Algebra and Representation Theory): Toda Systems, Cluster Characters, and Spectral Networks

—— Jan   Joint Mathematics Meetings, San Antonio (Special Session on Cluster Algebras): Toda Systems, Cluster Characters, and Spectral Networks

2014 Dec   Korea Institute for Advanced Study (Workshop on Strings, Quivers, and Cluster Algebras in Mathematical Physics): Toda Systems, Cluster Characters, and Spectral Networks

—— Nov   Perimeter Institute for Theoretical Physics (Workshop on Mathematical Physics): Toda Systems, Cluster Characters, and Spectral Networks

—— Oct   University of California, Berkeley (Geometry and Representation Theory Seminar): Cluster Integrable Systems, Quiver Representations, and Line Operators

—— Sept   Kavli IPMU, Tokyo: Relativistic Integrable Systems, Quiver Representations, and Line Operators

—— Sept   Nagoya University (Summer School on Cluster Algebras and Mathematical Physics): Toda Systems, Quiver Representations, and $\mathcal{N} = 2$ Field Theory [3 lectures]

—— June   Independent University of Moscow (Workshop on Combinatorics of Moduli Spaces, Cluster Algebras, and Topological Recursion) Integrable Systems, Canonical Bases, and $\mathcal{N} = 2$ Gauge Theory

—— May   Northwestern University (Workshop on Representation Theory, Integrable Systems, and Quantum Fields): Integrable Systems, Canonical Bases, and $\mathcal{N} = 2$ Field Theory [3 lectures]

—— May   University of Hong Kong: Integrable Systems, Canonical Bases, and $\mathcal{N} = 2$ Field Theory [3 lectures]

—— Apr   Northwestern University (Geometry and Physics Seminar): Integrable Systems and Canonical Bases

—— Feb   Stanford University (Workshop on Lie Groups, Lie Algebras, and their Representations): Quivers and Toda Systems

—— Jan   University of Texas, Austin (Geometry and Strings Seminar): Seiberg-Witten Curves and Double Bruhat Cells

2013 Dec   Mathematisches Forschungsinstitut Oberwolfach (Workshop on Cluster Algebras and Related Topics): Q-Systems, Double Bruhat Cells, and $\mathcal{N} = 2$ Yang-Mills

—— Nov   University of Illinois, Urbana-Champaign: Q-Systems, Factorization Dynamics, and Twisting

—— Oct   University of Bonn: Q-Systems, Factorization Dynamics, and Twisting

—— Oct   University of Strasbourg: Q-Systems, Factorization Dynamics, and Twisting

—— Sept   University of California, Berkeley (Representation Theory Seminar): Q-Systems, Factorization Dynamics, and Twisting

—— June   UNAM, Mexico City (Workshop on Cluster Algebras and BPS Invariants): Seiberg-Witten Curves and Cluster Algebras [3 lectures]

2012 Oct   Tulane (AMS Southeastern Sectional Meeting): Cluster Ensembles and the Chamber Ansatz

—— Sept   Aarhus University (Algebra Seminar): Cluster Ensembles and the Chamber Ansatz
—— July   Maui (Subfactors in Maui Conference): From Planar Algebras to Loop Groups via Triple Crossings
—— Apr   University of California, Berkeley (Combinatorics Seminar): Loop Groups and Cluster Integrable Systems

Teaching Activities

PhD Students

1. Jishnu Bose (expected 2024)
2. Tina Peng (expected 2025)
3. Tianle Liu (expected 2026)

USC

2023	Spring	Theory of Numbers (Math 430)
2022	Fall	Algebraic Topology (Math 540)
2022	Spring	Vector Analysis and Introduction to Differential Geometry (Math 435)
2021	Fall	Topics in Topology (Math 641)
2021	Spring	Vector Analysis and Introduction to Differential Geometry (Math 435)
2020	Fall	Topics in Algebraic Geometry (Math 614)

UT Austin

2015	Spring	Differential Calculus (Math 408K)
2014	Fall	Differential and Integral Calculus II (Math 408D)

UC Berkeley (Graduate Student Instructor)

2011	Spring	Analytic Geometry and Calculus (Math 16A)
2010	Spring	Calculus II (Math 1B)
2009	Fall	Calculus I (Math 1A)
2009	Spring	Calculus II (Math 1B)
2008	Fall	Calculus II (Math 1B)

Other Mentorship

2014	June	Teaching Assistant for AMS Mathematics Research Community on Cluster Algebras, Snowbird, UT

Service Activities

1. Served on qualifying exam committees of Grant Bowling, Sam Armon, Jian Zhou, Haoyang Liu, Wenhan Jiang, and Alex Sahakian.

2. Served on Geometry/Topology Screening Exam committee (3 times).

3. Served on Math Department Graduate Committee since Spring 2022.

4. Served as a co-organizer of the USC Topology Seminar and of the Los Angeles Joint Topology Seminar (Spring 2023).

5. Served on two NSF grant review panels.

Teaching Awards

2011 Spring Outstanding Graduate Student Instructor (UC Berkeley)

Scientific Consulting

2017 – 2020   Research consultant for Helm.ai on machine learning and perception algorithms for autonomous driving.

Journals Refereed

Advances in Mathematics
Algebra and Number Theory
Communications in Mathematical Physics
Compositio Mathematica
Comptes Rendus Mathematique
Duke Mathematical Journal
International Mathematics Research Notices
Inventiones Mathematicae
Journal of the American Mathematical Society
Journal of Integrable Systems
Journal of Physics A
SIGMA