Joshua Southerland

University of Washington
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Current position

Fifth Year Graduate Student, University of Washington, Seattle

Research Interests

My primary research interests are in flat surfaces and homogeneous dynamics. I enjoy when problems can be approached via the use of geometric or topological methods in combination with techniques from harmonic analysis or number theory. I have recently extended a method that Vladimir Finkelshtein used to prove a shrinking target property for toral automorphisms to show that the action of derivatives of affine linear automorphisms (the Veech group) of square-tiled surfaces exhibit a similar shrinking target property. This provides new arithmetic information about congruence subgroups of $SL_2(\mathbb{Z})$. There is a very natural question that follows from this work: can a similar theorem be proven for lattice surfaces? I am currently exploring avenues to extend my previous work to this setting. Another question coming out of this work involves more classical mathematics: the proof method involves an extension of Fourier analysis to a non-commutative setting and I am hopeful to extend this line of exploration to trace formulas and their relation to geodesics on singular surfaces.

Additionally, I have been studying the tropical geometry analogue of the Riemann-Roch theorem from an analytical perspective. This has led to two primary areas of study: Laplacians on vector bundles over graphs and trace formulas for metric (quantum) graphs. I hope to on day merge this work with my work in flat surfaces.

Education

2022 PhD in Mathematics, University of Washington (expected)
2019 MSc in Mathematics, University of Washington
2009 BSc in Mechanical Engineering, Minor in Music, Columbia University

Work Experience

2009-2016 Senior Mechanical Engineer and Sustainability Consultant, BuroHappold Consulting Engineers, New York

Honors & awards

2020-2021 Nominated for Excellence in Teaching Award, University of Washington
2018-2019 Excellence in Teaching, University of Washington Mathematics Departmental Award

Publications

2021 Shrinking Targets on Primitive Square-Tiled Surfaces, arXiv:2104.09634
2019 The Laplacian: An Exploration and Historical Survey Tailored for Translation Surfaces, Master's Thesis, pdf

Mentorship

Spring 2021 Washington Directed Reading Program: M.C. Escher and Hyperbolic Tesselations, Mentee: Emma Favier sites.uw.edu/wdrp/spring-2021
Spring 2021 Washington Directed Reading Program: M.C. Escher and Hyperbolic Tesselations, Mentee: Zheng (James) Cao sites.uw.edu/wdrp/spring-2021
Winter 2021 Washington Directed Reading Program: M.C. Escher and Hyperbolic Tesselations, Mentee: Haley Riggs sites.uw.edu/wdrp/winter-2021

Talks

Graduate Dynamics Seminar, University of Washington

Feb 2021 *Arnoux-Rauzy IETs: Minimality and Unique Ergodicity (following Dynnikov, Hubert, and Skripchenko)*
Mar 2020 *Structure Theory of Veech Groups*
Mar 2020 *Examples of Shrinking Target Problems*
Feb 2020 *Hyperbolic Toral Automorphisms are Mixing*
Jan 2020 *Borel-Cantelli and Shrinking Targets*
Nov 2019 *Quantum-Classical Correspondence on the Upper Half-Plane*
Oct 2019 *An Analytic Approach to Real Hodge Theory*
Jan 2019 *Complex Exponentials, Eigenfunctions, Algebra Homomorphisms and Invariant Subspaces of L^2G*
Jan 2019 *Fourier Analysis on $\mathbb{R}^n$ and the n-Torus*
Nov 2018 *Lie Algebras and Representation Theory: Vector Fields on Lie Groups*
Oct 2018 *Lie Algebras and Representation Theory: Engel's Theorem*
Apr 2018 *The Laplacian on a Graph*
Apr 2017 *Definition of Topological Entropy*
Jan 2017 *Continued Fractions*

Defenses & Exams

Apr 2020 *Shrinking Targets on a Square-Tiled Surface*
Mar 2019 *The Laplacian: An Exploration and Historical Survey Tailored for Translation Surfaces*

Teaching

Spring 2021	Teaching Assistant, Linear Algebra *(Remote)*
Winter 2021	Teaching Assistant, Linear Algebra *(Remote)*
Fall 2020	Teaching Assistant, Linear Algebra *(Remote)*
Summer 2020	Pre-Doctoral Instructor, Linear Algebra *(Remote)*
Spring 2020	Pre-Doctoral Instructor, Linear Algebra *(Remote)*
Winter 2020	Pre-Doctoral Instructor, Linear Algebra
Fall 2019	Pre-Doctoral Instructor, Linear Algebra
Summer 2019	Pre-Doctoral Instructor, Linear Algebra
Spring 2019	Pre-Doctoral Instructor, Multivariable Calculus
Winter 2019	Pre-Doctoral Instructor, Multivariable Calculus
Fall 2018	Teaching Assistant, Topology
Summer 2018	Pre-Doctoral Instructor, Multivariable Calculus
Spring 2018	Teaching Assistant, Precalculus
Winter 2018	Teaching Assistant, Introductory Multivariable
Fall 2017	Teaching Assistant, Differential Calculus
Summer 2017	Teaching Assistant, Introductory Real Analysis
Spring 2017	Teaching Assistant, Introductory Multivariable
Winter 2017	Teaching Assistant, Differential Calculus
Fall 2016	Teaching Assistant, Integral Calculus

Service to the Community

2020 - 2021	Co-Organizer, Washington Directed Reading Program, sites.uw.edu/wdrp
2019 - 2020	Co-Organizer, Washington Directed Reading Program, sites.uw.edu/wdrp

References

Jayadev Athreya

Associate Professor, Department of Mathematics, University of Washington, jathreya@uw.edu

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