David Alexander Sher

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Education

Stanford University — **Stanford, CA**
Ph.D. in Mathematics — *June 2012*
Dissertation Title: *Conic Degeneration and the Determinant of the Laplacian*
Advisor: Rafe Mazzeo

Johns Hopkins University — **Baltimore, MD**
B.A. and M.A. in Mathematics — *May 2007*

Academic Appointments

DePaul University — **Chicago, IL**
Associate Professor — *2020 – present*
Department of Mathematical Sciences

DePaul University — **Chicago, IL**
Assistant Professor — *2016 – 2020*
Department of Mathematical Sciences

University of Michigan — **Ann Arbor, MI**
RTG Post-doctoral Assistant Professor — *2013 – 2016*
Department of Mathematics

McGill University/Centre de Recherches Mathématiques — **Montréal, QC, Canada**
CRM-ISM Fellowship (post-doctoral appointment) — *2012 – 2013*

Teaching Experience

Undergraduate Courses Taught:

DePaul University:

- MAT 150: Calculus I. — AQ 2016, AQ 2017, AQ 2020
- MAT 151: Calculus II. — WQ 2017, WQ 2018, SQ 2018, SQ 2020
- MAT 152: Calculus II. — SQ 2017
- MAT 215: Introduction to Mathematical Reasoning. — AQ 2016, SQ 2017, WQ 2019, AQ 2019
- MAT 216: Foundations of Advanced Mathematics. — SQ 2019, WQ 2020, WQ 2021
- MAT 260: Multivariable Calculus I. — AQ 2020
- MAT 261: Multivariable Calculus II. — WQ 2021
- MAT 304: Differential Equations. — SQ 2021

University of Michigan:

- MAT 217: Linear Algebra. — Fall 2014, Spring 2015, Fall 2015 (2x)
- MAT 285: Honors Multivariable Calculus. — Fall 2013
- MAT 433: Introduction to Differential Geometry. — Spring 2014

Graduate Courses Taught:

DePaul University:

- MAT 435: Measure Theory. AQ 2017, AQ 2018
- MAT 436: Functional Analysis. SQ 2018, SQ 2019, SQ 2020, SQ 2021
- MAT 482: Partial Differential Equations. WQ 2017, WQ 2018, WQ 2019, WQ 2020
- MAT 680: Real Analysis. AQ 2018, AQ 2019

Supervised Undergraduate Research Projects:

DePaul University:

- Maciej Piwowarczyk, USRP, "Frobenius Numbers of Three-Element Sets", Summer 2018.
- David Glass, USRP, "The Mystery of Frobenius Symmetry", Summer 2020.

Supervised Senior Honors Theses:

DePaul University

- As faculty advisor: Hailey Menkhus, "An Exploration of Mathematical Structures within Music", WQ 2020.
- As faculty reader: Maciej Piwowarczyk, "Irreducible representations of $R = \wedge(V)\#\mathbb{C}G$", WQ 2020.

Grants and Contracts

- Faculty Summer Research Grant, DePaul University, Summer 2020 and Summer 2017.
- Diversity and Equity Inclusion Initiative Grant, "CSH Climate Survey Design", $1,950, DePaul University, September 2020.

Publications

Refereed Journal Articles:

16. Pierre Albin, Frederic Rochon, and **David A. Sher**. A Cheeger-Muller theorem for manifolds with wedge singularities. To appear, *Analysis & PDE* (accepted October 2020). Preprint, arXiV: 1807.02178, p. 1-72.

15. Stanislas Krymski, Michael Levitin, Leonid Parnovski, Iosif Polterovich, and **David A. Sher**. Inverse Steklov spectral problem for curvilinear polygons. To appear, *International Mathematics Research Notices* (accepted July 2020). Preprint, arXiv:2004.03881, p. 1-24.

14. Michael Levitin, Leonid Parnovski, Iosif Polterovich, and **David A. Sher**. Sloshing, Steklov and corners: asymptotics of sloshing eigenvalues. To appear, *Journale d'Analyse Mathématique* (accepted January 2020). Preprint, arXiv:1709.01891, p. 1-47.

13. **David Sher**, Alejandro Uribe, and Carlos Villegas-Blas. On the pseudospectra of Schrodinger operators on Zoll manifolds. To appear, *Memorias de la reunión de Matemáticos Mexicanos en el Mundo 2018*, Contemporary Mathematics Series, American Mathematical Society (accepted July 2019). Preprint, arXiV:1812.01769, p. 1-14.

12. Pierre Albin, Frederic Rochon, and **David A. Sher**. Resolvent, heat kernel, and torsion under degeneration to fibered cusps. To appear, *Memoirs of the American Mathematical Society* (accepted December 2017). Preprint, arXiV:1410.8406, p. 1-103.

11. Medet Nursultanov, Julie Rowlett, and **David Sher**. How to hear the corners of a drum. In *2017 Matrix Annals*, p. 243-278, MATRIX, Melbourne, Australia (2019). Available at: https://www.matrix-inst.org.au/2017-matrix-annals.

10. Pierre Albin, Frederic Rochon, and **David A. Sher**. Analytic torsion and R-torsion of Witt representations on manifolds with cusps. *Duke Mathematical Journal*, 167, no. 10, 1883-1950 (2018). DOI 10.1215/00127094-2018-0009.

9. Iosif Polterovich, **David A. Sher**, and John A. Toth. Nodal length of Steklov eigenfunctions on real-analytic Riemannian surfaces. *J. Reine Angew. Math. (Crelle's Journal)*, published online 4-20-17 (2017). DOI 10.1515/crelle-2017-0018.

8. Alexandre Girouard, Leonid Parnovski, Iosif Polterovich, and **David A. Sher**. The Steklov spectrum of surfaces: asymptotics and invariants. *Mathematical Proceedings of the Cambridge Philosophical Society*, 157, no. 3, p. 379-389 (2014). DOI 10.1017/S030500411400036X.

7. Colin Guillarmou and **David A. Sher**. Low energy resolvent for the Hodge Laplacian: Applications to Riesz transform, Sobolev estimates and analytic torsion. *International Mathematics Research Notices*, p. 1-75 (2015). DOI 10.1093/imrn/rnu119.

6. Iosif Polterovich and **David A. Sher**. Heat invariants of the Steklov problem. *Journal of Geometric Analysis* 25, no. 2, p. 924-950 (2015). DOI 10.1007/s12220-013-4951-4.

5. **David A. Sher**. The determinant on flat conic surfaces with excision of disks. *Proceedings of the American Mathematical Society* 143, no. 3, p. 1333-1346 (2015).

4. **David A. Sher**. Conic degeneration and the determinant of the Laplacian. *Journale d'Analyse Mathématique* 126, no. 1, p. 175-226 (2015). DOI 10.1007/s11854-015-0015-3.

3. **David A. Sher**. The heat kernel on an asymptotically conic manifold. *Analysis & PDE* 6, no. 7, 1755-1791 (2013).

2. Charles R. Johnson, Christopher Jordan-Squire, and **David A. Sher**. Eigenvalue assignments and the two largest multiplicities in an Hermitian matrix whose graph is a tree. *Discrete Applied Mathematics* 158, no. 6, pp. 681-691 (2010).

1. Charles R. Johnson, António Leal Duarte, Carlos M. Saiago, and **David Sher**. Eigenvalues, multiplicities and graphs. In *Algebra and its applications*, 167–183, Contemporary Mathematics, 419, American Mathematical Society, Providence, RI, 2006.

Manuscripts Under Review in Refereed Journals:

18. Michael Levitin, Leonid Parnovski, Iosif Polterovich, and **David A. Sher**. Sloshing, Steklov and corners: asymptotics of Steklov eigenvalues for curvilinear polygons. Re-submitted for publication, December 2020. Preprint, arXiV:1908.06455, p. 1-104.

17. Medet Nursultanov, Julie Rowlett, and **David Sher**. The heat kernel for curvilinear polygonal domains in surfaces. Submitted for publication, May 2019. Preprint, arXiV: 1905.00259, p. 1-69.

Manuscripts In Progress:

- Work with Asma Hassannezhad on counting nodal domains for Dirichlet-to-Neumann eigenfunctions.
- Work with Clara Aldana and Julie Rowlett on a Polyakov formula for curvilinear polygons.
- Work with Richard Laugesen on closed formulae for determinants of Laplacians.
- Work on joint asymptotic expansions of Bessel functions.
- Work with David Glass (undergraduate, USRP 2020) on Frobenius numbers for four-element sets.

Scholarly Papers Presented

Invited Research Presentations:

"Inverse Steklov spectral problem for curvilinear polygons." Canadian Mathematical Society Winter Meeting (virtual), special session on "Geometric and Computational Spectral Theory", December 5th, 2020.

"Inverse Steklov spectral problem for curvilinear polygons." Analysis & Geometry Seminar (virtual), University of Bristol, United Kingdom, December 3rd, 2020.

"The Four-Vertex Theorem." Math Club, DePaul University, May 29, 2020.

"Steklov eigenvalue asymptotics for curvilinear polygons", Miniconference on Sharp Eigenvalue Estimates for Partial Differential Operators (replacing Purdue AMS Sectional Meeting Special Session), virtual, April 4, 2020.

"Steklov spectral asymptotics for polygons", SIAM Conference on Analysis of Partial Differential Equations, La Quinta, CA, December 12, 2019.

"Steklov spectral asymptotics for polygons", Harmonic Analysis and Differential Equations Seminar, University of Illinois, December 3, 2019.

"The Steklov eigenvalue problem on polygons." Canadian Mathematical Society Winter Meeting, session on "Geometric Analysis and Spectral Geometry", Vancouver, British Columbia, Canada, December 9, 2018.

"The Steklov eigenvalue problem for surfaces." Geometry Seminar, Indiana University (Bloomington, IN), November 15, 2018.

"The Gauss-Bonnet Theorem." Math Club, DePaul University, October 12, 2018.

"The heat kernel on surfaces with corners." Invited talk, "Geometric Singular Analysis and Mathematical Physics", Oldenburg, Germany, September 17-21, 2018.

"Eigenvalues of Steklov-type problems on curvilinear polygons." Invited talk, BIRS Workshop, "Spectral Geometry: Theory, Numerical Analysis and Applications", Banff, Alberta, Canada, July 4, 2018.

"Spectral geometry: an introduction." Math Club, DePaul University, April 6, 2018.

"Eigenvalues of the sloshing problem." Special seminar, Universite de Montreal, July 17, 2017.

"Eigenvalues of the sloshing problem." Analysis/PDE Seminar, University of North Carolina, March 22, 2017.

"A Cheeger-Muller theorem for manifolds with cusps." Invited talk, BIRS Workshop, Oaxaca, Mexico, "Geometric and Spectral Methods in Partial Differential Equations." December 14, 2016.

"Nodal length of Steklov eigenfunctions." Analysis Seminar, Northwestern University, October 24, 2016.

"The heat equation in spectral geometry." Analysis Seminar, DePaul University, October 14, 2016.

"The Steklov spectrum of surfaces." Invited talk, BIRS Workshop, Oaxaca, Mexico, "Dirichlet-to-Neumann Maps: Spectral Theory, Inverse Problems and Applications", May 30, 2016.

"The Steklov spectrum of surfaces." Spectral and Scattering Theory seminar, Purdue University, March 2, 2016.

"An inverse problem in spectral geometry." Invited talk, University of Puget Sound, February 12, 2016.

"An inverse problem in spectral geometry." Seminar, Reed College, January 28, 2016.

"An inverse problem in spectral geometry." Colloquium, DePaul University, January 15, 2016.

"An inverse problem in spectral geometry." Invited talk, New College of Florida, November 16, 2015.

"The Steklov spectrum of surfaces." CRM-SMS summer school on "Geometric and Computational Spectral Theory", Montreal, June 16, 2015.

"Nodal length of Steklov eigenfunctions." "Geometric Spectral Theory" conference, Lisbon (Portugal), June 9, 2015.

"Spectral geometry: an introduction." Guest lecture (undergraduate talk, second-year audience), Lawrence University, May 20, 2015

"Spectral geometry and the heat equation." Colloquium, Dartmouth College, April 30, 2015.

"The Steklov spectrum of surfaces." Geometry/topology seminar, Dartmouth College, April 30, 2015.

"Spectral geometry and the heat equation." Colloquium, Wesleyan University, January 26, 2015.

"Spectral geometry and the heat equation." Colloquium, University of Kentucky, January 15, 2015.

"A Cheeger-Müller theorem on manifolds with cusps." BIRS Workshop, "Geometric scattering theory and applications", November 3, 2014.

"Inverse spectral problems for the Dirichlet-to-Neumann map." Geometric Analysis Day, CRM (Montreal), June 6, 2014.

"Inverse spectral problems for the Dirichlet-to-Neumann map." Analysis seminar, Northwestern University, April 28, 2014.

"Inverse spectral problems for the Dirichlet-to-Neumann map." Geometry seminar, Stanford University, March 5, 2014.

"Heat invariants of the Steklov problem." Special Session on Geometric and Spectral Analysis, AMS sectional meeting, Philadelphia PA, October 12-13, 2013.

"Heat invariants and inverse spectral theory for the Dirichlet-to-Neumann map." Inverse Problems seminar, University of Michigan, October 9, 2013.

"Heat invariants and inverse spectral theory for the Dirichlet-to-Neumann operator." Geometry seminar, University of Michigan, September 27, 2013.

"Heat invariants of the Steklov problem." Workshop on Spectral Theory and Geometry, Universite de Neuchatel (Switzerland), June 3-7, 2013.

"Heat invariants of the Steklov eigenvalue problem." CIRGET seminar, Montreal, April 19th, 2013.

"Heat invariants of the Steklov eigenvalue problem." PDE/Analysis seminar, University of Kentucky, April 16, 2013.

"Heat invariants of the Steklov eigenvalue problem." Special Session on Complex Geometry and Microlocal Analysis, AMS sectional meeting, Chestnut Hill MA, April 6-7, 2013.

"The determinant of the Laplacian on moduli space." Differential Geometry seminar, University of Illinois, March 12, 2013.

"The determinant on conic surfaces with excision of disks." Special Session on Spectral and Scattering Theory, AMS sectional meeting, Akron OH, October 20-21, 2012.

Invited talk. Conference on Microlocal Methods in Mathematical Physics and Global Analysis, University of Tubingen (Germany), June 13-17, 2011.

Other Invited Conferences::

"Analysis, Geometry and Topology of Singular PDE", MFO (Oberwolfach), June 6-12, 2021.

"Analysis on Singular Spaces (Online')", BIRS Workshop, Oaxaca, Mexico, May 16-21, 2021.

"Analysis and geometric singularities", MFO (Oberwolfach), May 6-12, 2012.

International Conference on Spectral Geometry & Spectral Geometry Workshop, Dartmouth College, July 16-23, 2010.

Service

University:

- Liberal Studies Council: CSH voting representative, October 2020–present; alternate, April 2019–October 2020.
  - Assessment committee for Learning Outcome #4, January 2021–present.
  - LSC Assessment committee, Fall 2020.

College:

- Retention and Inclusivity Strategic Planning subcommittee, August 2018–present.
  - Inclusivity subcommittee. Lead author for a DIIG grant, "CSH Climate Survey Design", for a Psychology graduate student to help design an inclusivity climate survey for CSH to be implemented AY 2020-2021. Funding amount: $1,950.

- STEM Center informal advisory group, June 2019–June 2020.

- Undergraduate Showcase Committee, June 2019–present.

- **(Paid service:)** CSH New Student Advising, 30–40 hours each, summer 2019 and summer 2020.

Department:

- Personnel Committee (service), September 2020–present.
- Diversity, Equity, and Inclusion Committee, June 2020–present.
- Faculty Search Committee, September 2019–present (analysis/applied mathematics search).
  - Hired one tenure-track faculty member, September 2019–February 2020.

- Faculty Search Committee, September 2018–June 2019.
  - Hired one tenure-track faculty member, September 2018–March 2019.
  - Hired two non-tenure-track faculty members, April 2019–June 2019.
  - Hired one non-tenure-track faculty member, September 2018–December 2018.

- Mathematics Undergraduate Curriculum Committee, September 2016–present.
  - Subcommitee: made changes to Math/CS combined degree program. November 2019–present.
  - MAT 216: wrote original set of inquiry-based lecture notes, April 2019–June 2019.
  - MAT 216 subcommittee. Co-wrote successful proposal to introduce new course, and supervised implementation, 2016–present.
  - Calculus subcommittee. Wrote common assignments and made minor content changes, 2016–2017.

- Committee on the Master's Program in Pure Mathematics, September 2016–present.
  - Evaluated candidates and made recommendations to the committee chair, 2016–present.
  - Gave advice for distribution of tuition waivers and assistantships, 2016–present.
  - Wrote problems for comprehensive exams in both Pure Mathematics and Applied/Computational Mathematics, 2018–present.

- Adjunct Personnel Committee, January 2017–present.
  - Evaluated ten adjunct faculty members, including classroom visits.

- Virginia Tech Regional Mathematics Contest.
  - Organized and supervised DePaul's participation, 2016–present.

Previous Service:

- University of Michigan: developed curriculum for Math 217 (proof-based linear algebra). Participated in inquiry-based learning program.

Professional Activities

Conferences Organized (Upcoming)::

- BIRS-CMO Workshop 22w1549, Analytic and Geometric Aspects of Spectral Theory. Organizers: O. Post (University of Trier), C. Aldana (Universidad del Norte), D. Sher (DePaul University), M. Winklmeier (Universidad de los Andes). To be hosted in Oaxaca, Mexico from August 14-19, 2022.

Ad Hoc Reviewer:

July 2020–present:

- *Journal de l'École polytechnique – Mathematiques.* (In progress).
- *Annals of Global Analysis and Geometry.*
- *DePaul Discoveries.*

September 2016–June 2020:

- *Journal of Functional Analysis*.
- *Journal of Geometric Analysis*.
- *Journal of Spectral Theory*.
- *Communications in Partial Differential Equations (x4)*.

- *Journal of Pseudo-Differential Operators and Applications*.
- *Swiss National Science Foundation*.
- *Canadian Mathematical Bulletin*.
- *Centre de Recherches Mathématiques (conference proceedings)*.
- *DePaul Discoveries.*

Before September 2016:

- *Journal of Geometric Analysis*.
- *Communications in Partial Differential Equations*.
- *Analysis & PDE*.
- *Communications in Analysis and Geometry*.
- *Pacific Journal of Mathematics*.
- *Revista Matematica Iberoamericana*.
- *Centre de Recherches Mathématiques (conference proceedings)*.

Professional Development:

- The IBL Conference. Austin, TX, June 25-27, 2015.
- MAA Prep Workshop on Inquiry-Based Learning, Portland, OR, August 3-6, 2014.

Awards and Recognitions

- George Polya Teaching Award, Stanford University, 2012.
- Centennial TA Award, Stanford University, 2011.
- Phi Beta Kappa, inducted 2006.