

Jeffrey Galkowski

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Research Interests

Scattering and spectral theory, microlocal analysis, quantum chaos, high energy eigenfunctions, high frequency numerical analysis

Employment

2022-present	Professor	University College London
2019-2022	Associate Professor	University College London
2018-2019	Assistant Professor	Northeastern University
2015-2018	NSF Postdoctoral Fellow	Stanford University
2015-2017	CRM-ISM Postdoctoral Fellow	McGill University

Fellowships and Grants

Leverhulme Research Project Grant: RPG-2023-325	2024-2029
EPSRC Early Career Fellowship: EP/V001760/1	2021-2026
EPSRC Standard Grant: EP/V051636/1	2022-2026
NSF Research Grant DMS-1900434	2019
NSF Mathematical Sciences Postdoctoral Research Fellow	2015-2019
NSF Graduate Fellow	2010-2015

Awards

2021	Adams Prize	University of Cambridge
2021	Faculty Education Award	University College London

Education

2010-2015	Ph.D.	Mathematics, University of California, Berkeley Dissertation topic: Distribution of Resonances in Scattering by Thin Barriers Dissertation advisor: Maciej Zworski
2007-2010	BSE	Electrical Engineering, University of Rochester

Research Papers

- [1] Jeffrey Galkowski, Shihua Gong, Ivan G. Graham, David Lafontaine, and Euan A. Spence. Convergence of overlapping domain decomposition methods with PML transmission conditions applied to nontrapping Helmholtz problems. *arXiv:2404.02156*, 2024.
- [2] Jeffrey Galkowski and Maciej Zworski. Classical-quantum correspondence in Lindblad evolution. *arXiv:2403.09345*, 2024.
- [3] Martin Averseng, Jeffrey Galkowski, and Euan A. Spence. Helmholtz FEM solutions are locally quasi-optimal modulo low frequencies. *arXiv:2304.14737*, 2023.
- [4] Yaiza Canzani and Jeffrey Galkowski. Improvements for eigenfunction averages: An application of geodesic beams. *Journal of Differential Geometry*, 124(3):443 – 522, 2023.
- [5] Yaiza Canzani and Jeffrey Galkowski. Weyl remainders: an application of geodesic beams. *Invent. Math.*, 232(3):1195–1272, 2023.
- [6] Kiril Datchev, Jeffrey Galkowski, and Jacob Shapiro. Semiclassical resolvent bounds for compactly supported radial potentials. *J. Funct. Anal.*, 284(7):Paper No. 109835, 28, 2023.

- [7] Jeffrey Galkowski and Euan A. Spence. Sharp preasymptotic error bounds for the Helmholtz h -FEM. *arXiv:2301.03574*, 2023.
- [8] Jeffrey Galkowski and Jared Wunsch. Propagation for Schrödinger operators with potentials singular along a hypersurface. *arXiv:2302.08154*, to appear in *Arch. Ration. Mech. Anal.*, 2023.
- [9] Jeffrey Galkowski and Maciej Zworski. An abstract formulation of the flat band condition. *arXiv:2307.04896* to appear in *Contemp. Math.*, 2023.
- [10] Yaiza Canzani and Jeffrey Galkowski. Logarithmic improvements in the Weyl law and exponential bounds on the number of closed geodesics are predominant. *arXiv:2204.11921*, 2022.
- [11] Yaiza Canzani, Jeffrey Galkowski, and Blake Keeler. Asymptotics for the spectral function on Zoll manifolds. *arXiv:2211.09644*, 2022.
- [12] Jeffrey Galkowski. Complete asymptotic expansions of the spectral function for symbolic perturbations of almost periodic Schrödinger operators in dimension one. *J. Spectr. Theory*, 12(1):105–142, 2022.
- [13] Jeffrey Galkowski. Lower bounds for piecewise polynomial approximations of oscillatory functions. *arXiv:2211.04757*, 2022.
- [14] Jeffrey Galkowski, David Lafontaine, Euan A. Spence, and Jared Wunsch. The hp -FEM applied to the Helmholtz equation with PML truncation does not suffer from the pollution effect. *arXiv:2207.05542* to appear in *Comm. Math. Sci.*, 2022.
- [15] Jeffrey Galkowski, Pierre Marchand, and Euan A. Spence. High-frequency estimates on boundary integral operators for the Helmholtz exterior Neumann problem. *Integral Equations Operator Theory*, 94(4):Paper No. 36, 68, 2022.
- [16] Jeffrey Galkowski, Pierre Marchand, Jian Wang, and Maciej Zworski. The scattering phase: seen at last. *SIAM J. Appl. Math.*, 84(1):246–261, 2024.
- [17] Jeffrey Galkowski, Leonid Parnovski, and Roman Shterenberg. Classical wave methods and modern gauge transforms: spectral asymptotics in the one dimensional case. *Geom. Funct. Anal.*, 33(6):1454–1538, 2023.
- [18] Jeffrey Galkowski and Jacob Shapiro. Semiclassical resolvent bounds for long-range Lipschitz potentials. *Int. Math. Res. Not. IMRN*, (18):14134–14150, 2022.
- [19] Jeffrey Galkowski and Jacob Shapiro. Semiclassical resolvent bounds for weakly decaying potentials. *Math. Res. Lett.*, 29(2):373–397, 2022.
- [20] J. Galkowski and E. A. Spence. Does the Helmholtz boundary element method suffer from the pollution effect? *SIAM Rev.*, 65(3):806–828, 2023.
- [21] Jeffrey Galkowski and Jared Wunsch. On non-diffractive cones. *J. Differential Geom.*, 120(3):505–518, 2022.
- [22] Jeffrey Galkowski and Maciej Zworski. Viscosity limits for zeroth-order pseudodifferential operators. *Comm. Pure Appl. Math.*, 75(8):1798–1869, 2022.
- [23] Pierre Marchand, Jeffrey Galkowski, Euan A. Spence, and A. Spence. Applying GMRES to the Helmholtz equation with strong trapping: how does the number of iterations depend on the frequency? *Adv. Comput. Math.*, 48(4):Paper No. 37, 63, 2022.
- [24] Yaiza Canzani and Jeffrey Galkowski. Eigenfunction concentration via geodesic beams. *J. Reine Angew. Math.*, 775:197–257, 2021.
- [25] Yaiza Canzani and Jeffrey Galkowski. Sectional sampler: Eigenfunction concentration via geodesic beams. *Notices Amer. Math. Soc.*, 68(3):417, 2021.
- [26] Jeffrey Galkowski, David Lafontaine, and Euan A. Spence. Local absorbing boundary conditions on fixed domains give order-one errors for high-frequency waves. *arXiv:2101.02154*, to appear in *IMA J. Numer. Anal.*, 2021.

- [27] Jeffrey Galkowski, David Lafontaine, and Euan Spence. Perfectly-matched-layer truncation is exponentially accurate at high frequency. *SIAM J. Math. Anal.*, 55(4):3344–3394, 2023.
- [28] J. Galkowski, D. Lafontaine, E. A. Spence, and J. Wunsch. Decompositions of high-frequency Helmholtz solutions via functional calculus, and application to the finite element method. *SIAM J. Math. Anal.*, 55(4):3903–3958, 2023.
- [29] Jeffrey Galkowski, Pierre Marchand, and Euan A. Spence. Eigenvalues of the truncated Helmholtz solution operator under strong trapping. *SIAM J. Math. Anal.*, 53(6):6724–6770, 2021.
- [30] Jeffrey Galkowski and John A. Toth. Lower bounds for Steklov eigenfunctions. *Pure Appl. Math. Q.*, 19(4):1873–1898, 2023.
- [31] Jeffrey Galkowski and Steve Zelditch. Lower bounds for Cauchy data on curves in a negatively curved surface. *Israel J. Math.*, 244(2):971–1000, 2021.
- [32] Jeffrey Galkowski and Maciej Zworski. Analytic hypoellipticity of Keldysh operators. *Proc. Lond. Math. Soc.* (3), 123(5):498–516, 2021.
- [33] Jeffrey Galkowski and Maciej Zworski. Outgoing solutions via Gevrey-2 properties. *Ann. PDE*, 7(1):Paper No. 5, 13, 2021.
- [34] Oscar P. Bruno and Jeffrey Galkowski. Domains without dense Steklov nodal sets. *J. Fourier Anal. Appl.*, 26(3):45, 2020.
- [35] Yaiza Canzani and Jeffrey Galkowski. Growth of high L^p norms for eigenfunctions: an application of geodesic beams. *Anal. PDE*, 16(10):2267–2325, 2023.
- [36] Jeffrey Galkowski and Matthieu Léautaud. Control from an interior hypersurface. *Trans. Amer. Math. Soc.*, 373(5):3177–3233, 2020.
- [37] Jeffrey Galkowski, Euan A. Spence, and Jared Wunsch. Optimal constants in nontrapping resolvent estimates and applications in numerical analysis. *Pure Appl. Anal.*, 2(1):157–202, 2020.
- [38] Jeffrey Galkowski and John A. Toth. Pointwise bounds for joint eigenfunctions of quantum completely integrable systems. *Comm. Math. Phys.*, 375(2):915–947, 2020.
- [39] Yaiza Canzani and Jeffrey Galkowski. On the growth of eigenfunction averages: Microlocalization and geometry. *Duke Math. J.*, 168(16):2991–3055, 2019.
- [40] Jeffrey Galkowski. Defect measures of eigenfunctions with maximal L^∞ growth. *Ann. Inst. Fourier (Grenoble)*, 69(4):1757–1798, 2019.
- [41] Jeffrey Galkowski. Distribution of resonances in scattering by thin barriers. *Mem. Amer. Math. Soc.*, 259(1248):ix+152, 2019.
- [42] Jeffrey Galkowski. The quantum Sabine law for resonances in transmission problems. *Pure Appl. Anal.*, 1(1):27–100, 2019.
- [43] Jeffrey Galkowski, Eike H. Müller, and Euan A. Spence. Wavenumber-explicit analysis for the Helmholtz h -BEM: error estimates and iteration counts for the Dirichlet problem. *Numer. Math.*, 142(2):329–357, 2019.
- [44] Jeffrey Galkowski and Euan A. Spence. Wavenumber-explicit regularity estimates on the acoustic single- and double-layer operators. *Integral Equations Operator Theory*, 91(1):Art. 6, 35, 2019.
- [45] Jeffrey Galkowski and John A. Toth. Pointwise bounds for Steklov eigenfunctions. *J. Geom. Anal.*, 29(1):142–193, 2019.
- [46] Jeffrey Galkowski and Maciej Zworski. An introduction to complex microlocal deformations. [arXiv:1912.09845](https://arxiv.org/abs/1912.09845), 2019.
- [47] Yaiza Canzani, Jeffrey Galkowski, and John A. Toth. Averages of eigenfunctions over hypersurfaces. *Comm. Math. Phys.*, 360(2):619–637, 2018.

- [48] Sourav Chatterjee and Jeffrey Galkowski. Arbitrarily small perturbations of Dirichlet Laplacians are quantum unique ergodic. *J. Spectr. Theory*, 8(3):909–947, 2018.
- [49] Jeffrey Galkowski. A microlocal approach to eigenfunction concentration. *Journées équations aux dérivées partielles*, pages 1–14, 2018.
- [50] Jeffrey Galkowski and John A. Toth. Eigenfunction scarring and improvements in L^∞ bounds. *Anal. PDE*, 11(3):801–812, 2018.
- [51] Semyon Dyatlov and Jeffrey Galkowski. Fractal Weyl laws and wave decay for general trapping. *Nonlinearity*, 30(12):4301–4343, 2017.
- [52] Jeffrey Galkowski. A quantitative Vainberg method for black box scattering. *Comm. Math. Phys.*, 349(2):527–549, 2017.
- [53] Jeffrey Galkowski. The L^2 behavior of eigenfunctions near the glancing set. *Comm. Partial Differential Equations*, 41(10):1619–1648, 2016.
- [54] Jeffrey Galkowski. Resonances for thin barriers on the circle. *J. Phys. A*, 49(12):125205, 22, 2016.
- [55] Jeffrey Galkowski. Pseudospectra of semiclassical boundary value problems. *Journal of the Institute of Mathematics of Jussieu*, 14(2):405–449, August 2015.
- [56] Jeffrey Galkowski and Hart F. Smith. Restriction bounds for the free resolvent and resonances in lossy scattering. *Int. Math. Res. Not. IMRN*, (16):7473–7509, 2015.
- [57] X. Han and M. Tacy. Semiclassical single and double layer potentials: boundedness and sharpness with an appendix by J. Galkowski. *J. Funct. Anal.*, 269:2890–2926, 2015.
- [58] Jeffrey Galkowski. Quantum ergodicity for a class of mixed systems. *J. Spectr. Theory*, 4(1):65–85, 2014.
- [59] Jeffrey Galkowski. Nonlinear instability in a semiclassical problem. *Comm. Math. Phys.*, 316(3):705–722, 2012.
- [60] D. Mott, J. Galkowski, L. Wang, J. Luo, and C. J. Zhong. Synthesis of size-controlled and shaped copper nanoparticles. *Langmuir*, 23:5740–5745, 2007.

Expository Work

- [1] Y. Canzani and J. Galkowski, *Geodesics Beams in Eigenfunction Analysis*, Synthesis Lectures on Mathematics and Statistics, Springer Nature, 2023.

Editorial and Committee Work

Associate Editor, *Mathematika* 2021-present
 Associate Editor, *Pure and Applied Analysis* 2023-present

Professional Activities

Member,	AMS-Simons Travel Grants Committee	2024-present
Member	EPSRC College	2022- present
Organizer	LMS Bath Meeting: Advances in Spectral Theory	2024
Scientific Committee	Weyl Laws Across Mathematics	2025
Associate Member	EPSRC College	2021
Organizer	UCL Departmental Colloquium	09/2020-present
Organizer	London Analysis Seminar	12/2019-present
Presenter	STEM for Britain	03/2020
Organizer	Summer School on Semiclassical Analysis at Northwestern University	08/2019
Organizer	Research in Teams Program at Banff International Research Station	10/2017
Officer	Mathematics Graduate Student Association UC Berkeley	1/2011–1/2014

Research Talks

Additional Upcoming talks

- May 2024 Franco-American Conference in Analysis and PDE
June 2024 Conference on microlocal analysis and quantum dynamics in honor of Steve Zelditch

The finite element method in high frequency scattering: non-uniform meshes defined by ray-dynamics

- December 2023 Paris–London Analysis Seminar
April 2024 LMS-Midlands Conference

The pollution effect in boundary integral methods

- August 2022 Harmonic analysis and waves, University of Washington

Classical wave methods and modern gauge transforms

- April 2022 Banff International Research Station - Almost-Periodic Spectral Problems
July 2022 University College London - Workshop on Microlocal Analysis and PDEs
November 2022 Scattering and Inverse Scattering workshop RICAM
November 2023 Spectral and Resonance Problems for Imaging, Seismology and Materials Science

Weyl laws and closed geodesics on typical manifolds

- February 2022 Leeds Geometry Seminar
February 2022 Stanford Analysis and PDE Seminar
March 2022 Harmonic Analysis and Differential Equations Seminar, Berkeley
September 2022 Global Harmonic Analysis a conference in honor of Steve Zelditch
November 2022 London Analysis and Probability Seminar- University College London
January 2023 Analysis Seminar, University of Warwick
April 2023 British Mathematics Colloquium
May 2023 Loughborough Analysis Seminar
February 2024 Pseudodifferential Operators and Related Topics

Exponential accuracy for the method of perfectly matched layers

- May 2021 UC Berkeley Analysis Seminar
July 2021 Mini Conference in Loughborough
February 2022 Conference on Mathematics of Wave Phenomena (Karlsruhe, German)

Geodesic beams and Weyl remainders

- December 2020 Spectral geometry session - Canadian Mathematical Society Sectional Meeting
March 2021 Spectral Theory and Mathematical Physics Seminar - Euler Institute
May 2021 UCLA Analysis Seminar
May 2021 Munich-Aarhus-Santiago Mathematical Physics Seminar
July 2021 Spectral geometry session -Mathematical Congress of the Americas
February 2022 Analysis Seminar - Yale University

Viscosity limits for 0^{th} order operators

- August 2022 Tallinn University of Technology Department of Cybernetics Colloquium
June 2020 IHP mathematical physics seminar
May 2020 Montreal Analysis Seminar - McGill University

L^p norms via geodesic beams

- May 2020 Spectral Theory and Dynamical Systems Seminar - Insitut Mathématique de Jussieu

On non-diffractive cones

- June 2020 Analysis Seminar - Cardiff University
May 2020 Monza seminar - MIT

Interior Behavior of Steklov Eigenfunctions

November 2020 Spectral Geometry in the Clouds
September 2020 Differential Geometry and Geometric Analysis Seminar - Princeton University
April 2020 London Analysis and Probability Seminar- Kings College London
November 2019 Analysis and Geometry Seminar - University of Bristol

Concentration and growth of eigenfunctions

December 2019 London Analysis Seminar
November 2019 Analysis Seminar - University of Leeds
October 2019 Recent Developments in Microlocal Analysis - MSRI
October 2019 Analysis Seminar - University of Wisconsin, Madison
January 2019 Analysis Seminar - Northwestern University
January 2019 Analysis Seminar - UC San Diego
February 2019 PDE Analysis Seminar - University of Massachusetts Amherst
April 2019 Colloquium - University of New Mexico
April 2019 Analysis and PDE Seminar - Brown University
May 2019 Microlocal Methods in Analysis and Geometry - CIRM Luminy
June 2019 Fudan Conference on Microlocal Analysis - Shanghai

Optimal Constants in Non-trapping Resolvent Estimates

December 2018 PDE Minischool - University of North Carolina Chapel Hill
July 2019 PDE/Analysis seminar - Tsinghua University - Beijing

A Novel Approach to Quantitative Improvements for Eigenfunction Averages

July 2018 Around Quantum Chaos, Banff Research Station
September 2018 Analysis and Geometry Seminar, Northeastern University
November 2018 PDE Analysis Seminar, Massachusetts Institute of Technology

Steklov Eigenfunctions and Nodal Geometry: a Semiclassical Approach

May 2018 Workshop on Steklov Eigenproblems, American Institute of Mathematics

Concentration of Eigenfunctions: Sup-norms and Averages

January 2018 Analysis and PDE Seminar, UC Berkeley
January 2018 Special Seminar, Northeastern University
February 2018 Special Seminar, University of Cambridge
February 2018 Analysis Seminar, McGill University
March 2018 Workshop on Microlocal Analysis, Australian National University
April 2018 Analysis and PDE Seminar, Stanford University
May 2018 Mathematical Physics Seminar, UC Irvine
June 2018 Journées Équations aux Dérivées Partielles, Obernai, France

Fractal Weyl laws for general trapping

July 2017 Third Symposium on Scattering and Spectral Theory, UFSC, Florianópolis, Brazil
December 2017 Spectral Geometry, Graphs, and Semiclassical Analysis, Aussois, France
February 2018 Spectral Geometry Seminar, Université de Montreal

Defect Measures for Eigenfunctions with Maximal L^∞ Growth

March 2017 PDE/Analysis Seminar, Massachusetts Institute of Technology
March 2017 Mathematical Physics and Harmonic Analysis Seminar, Texas A&M University
April 2017 Analysis Seminar, Northwestern University

Pointwise Bounds for Steklov eigenfunctions

December 2016 Spectral and Scattering Theory Seminar, Purdue University
January 2017 Analysis Seminar, University of North Carolina, Chapel Hill
February 2017 Bay Area Microlocal Analysis Seminar, UC Berkeley
March 2017 Spectral Geometry Seminar, Université de Montreal
April 2017 Analysis Seminar, Université Laval

The L^2 Behavior of Eigenfunctions Near the Glancing Set

October 2016 Analysis Seminar, University of Rochester

Arbitrarily Small Perturbations of the Laplacian are QUE

April 2016 Student Harmonic Analysis and Differential Equations Seminar, UC Berkeley

August 2016 Probabilistic Methods in Spectral Geometry and PDE, CRM Montreal

Resonance Free Regions and Average Smoothing Times

December 2015 Partial Differential Equations/Analysis Seminar, UC Berkeley

September 2016 Analysis/Spectral Theory Seminar, McGill University

A Quantum Sabine Law for Transmission Problems

October 2015 Spectral and Scattering Theory Seminar, Purdue University

February 2016 Bay Area Microlocal Analysis Seminar, Stanford University

April 2016 Evolution Equations on Singular Spaces, CIRM

June 2016 Dirichlet-to-Neumann Maps, Oaxaca Research Station

Distribution of Resonances in Scattering by Thin Barriers

July 2015 Mathematics Colloquium, University of Reading

November 2014 Geometric Scattering Theory and Applications, Banff International Research Station

October 2014 Analysis and PDE Seminar, University of California Los Angeles

October 2014 PDE Seminar, Brown University

October 2014 PDE/Analysis Seminar, Massachusetts Institute of Technology

June 2014 Séminaire Géométrie et Analyse, Université de Nice

May 2014 Bay Area Microlocal Analysis Seminar, Stanford University

April 2014 Partial Differential Equations Mini School, University of North Carolina, Chapel Hill

October 2013 Student Harmonic Analysis and Differential Equations Seminar, UC Berkeley.

Pseudospectra for Semiclassical Boundary Value Problems

February 2013 Student Harmonic Analysis and Differential Equations Seminar, UC Berkeley

Quantum Ergodicity for a Class of Mixed Systems

October 2012 Student Harmonic Analysis and Differential Equations Seminar, UC Berkeley

February 2013 Analysis, Dynamics, and Applications Seminar, University of Arizona

Nonlinear Instability in a Semiclassical Problem

February 2012 Analysis, Dynamics, and Applications Seminar, University of Arizona

August 2012 Partial Differential Equations/ Analysis Seminar, UC Berkeley

November 2011 Student Harmonic Analysis and Differential Equations Seminar, UC Berkeley

Teaching

2024	High frequency numerical analysis of the Helmholtz equation	instructor
2020,2023	Introduction to Mathematical Scattering Theory, London Taught Course Center	instructor
2021	Introduction to Semiclassical Analysis, London Taught Course Center	instructor
2020-21, 2024	Mathematical Analysis for Economists and Statisticians, University College London	instructor
Summer 2019	Eigenfunctions course at Summer School on Semiclassical Analysis, Northwestern University	instructor
Spring 2019	Math 7350: Pseudodifferential Equations, Northeastern University	instructor
Spring 2019	Math 5102: Analysis II, Northeastern University	instructor
Fall 2018	Math 1342: Calculus II for Scientists and Engineers, Northeastern University	instructor
March 2018	Minicourse on Microlocal Analysis, Australian National University	instructor
Fall 2017	Microlocal Analysis of Boundary Value Problems, Stanford University	instructor
Fall 2017	Elementary Functional Analysis, Stanford University	instructor
Winter 2017	Minicourse on Vasy's method, McGill University	instructor
Fall 2016	Advanced Real Analysis, McGill University	instructor
Winter 2016	Minicourse on Vasy's method, Stanford	instructor
Spring 2014	Math 1B (Calculus II), UC Berkeley	TA
Fall 2013	Math 16A (Calculus I), UC Berkeley	TA
Spring 2013	Math 16B (Calculus II), UC Berkeley	TA
Fall 2012	Math 55 (Discrete Math), UC Berkeley	TA
Spring 2011	Math 53 (Multivariable Calculus), UC Berkeley	TA
Fall 2010	Math 1A (Calculus I), UC Berkeley	TA