

January 2025

Research Interests

Mathematical problems of fluid motion, especially singular limits involving the Navier-Stokes equations, Euler equations, and other equations of fluid mechanics.

Academic Positions

- 2024- **Chair Mathematics**, *University of California Riverside*
- 2024- **Professor**, *University of California Riverside*
- 2012-2024 **Associate Professor**, *University of California Riverside*
- 2018-2020 **Vice Chair Mathematics**, *University of California Riverside*
- 2014-2019 **Undergraduate Advisor Mathematics**, *University of California Riverside*
- 2008-2012 **Assistant Professor**, *University of California Riverside*
- 2005-2008 **Tamarkin Assistant Professor**, *Brown University*
- 2002-2005 **Assistant Instructor**, *University of Texas at Austin*
- 2000-2002 **Teaching Assistant**, *University of Texas at Austin*
- 1998-1999 **Teaching Assistant**, *George Mason University*

Degrees

- May 2005 **Ph.D.** Mathematics, *University of Texas at Austin*; advisor, *Misha Vishik*
- May 2000 **M.S.** Mathematics, *George Mason University*; advisor, *Flavia Colonna*
- May 1980 **B.S.** Mathematics & Physics, *University of Maryland, College Park*

Grants and Awards

- 2012-2016 **NSF Standard Grant**
Fluid flow in the presence of boundaries and singularities, co-PI *Gung-Min Gie*
- 2010-2014 **NSF Collaborative Research Grant**
Analysis of Incompressible High Reynolds Number Flows (one of 4 PIs)
- 2007-2011 **NSF Standard Grant**
Vanishing viscosity in the presence of a boundary
- May 2005 **Frank Gerth III Dissertation Award**
- 2004-2005 **VIGRE fellowship**, *UT Austin*
- Spring 2004 **Hubert S. Wall Fellowship**, *UT Austin*

PhD Students

- Aug 2020 **Taylor Baldwin**
Solutions to the 2D Euler Equations Satisfying the Serfati Condition With Relaxed Constraints on the Initial Vorticity
Defended 27 August 2020

Feb 2024 **Thomas Schellhous**
Striated Regularity of Vorticity in a Bounded Domain
Defended 2 February 2024

Visiting Positions

- Spring 2021 **Member MSRI**
Program on *Mathematical problems in fluid dynamics*
- Winter 2017 **Member ICERM**
Program on *Singularities and Waves In Incompressible Fluids*
- Spring 2014 **Member IMPA**
Thematic program in *Incompressible Fluid Dynamics*

Refereed Papers

- 33 **With David M. Ambrose and Fazel Hadadifard**, *Horizontally periodic generalized Surface Quasigeostrophic patches and layers*, Submitted, **2025**
- 32 **With Christophe Lacave, Milton C. Lopes Filho, and Helena J. Nussenzveig Lopes**, *Large time behavior for the 3D Navier-Stokes with Navier boundary conditions*, Submitted, **2023**
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- 31 **With Gung-Min Gie and Anna Mazzucato**, *The 3D Euler equations with inflow, outflow and vorticity boundary*, to appear, *Journal de Mathématiques Pures et Appliquées*, **2024**
- 30 **With David M. Ambrose and Fazel Hadadifard**, *Contour dynamics and global regularity for periodic vortex patches and layers*, To appear, *SIAM Journal on Mathematical Analysis*, Volume 56, Number 2, 2286-2311, **2024**
- 29 **Kelliher**, *The strong vanishing viscosity limit with Dirichlet boundary conditions*, *Nonlinearity*, Volume 36, Number 5, 1-33, **2023**
- 28 **With David Ambrose, Elaine Cozzi, and Daniel Erickson**, *Existence of Solutions to fluid equations in Hölder and Uniformly Local Sobolev Spaces*, *Journal of Differential Equations*, Volume 364, 15 August 2023, pages 107-151, **2023**
- 27 **With Gung-Min Gie and Anna Mazzucato**, *The linearized 3D Euler equations with inflow, outflow*, *Advances in Differential Equations*, Volume 28, Numbers 5-6, May/June, 373-412, **2023**
- 26 **With Hantaek Bae**, *Propagation of regularity of level sets for a class of active transport equations*, *Journal of Mathematical Analysis and Applications*, Volume 497, Issue 1, 1 May **2021**
- 25 **Kelliher**, *Stream functions for divergence-free vector fields*, *Quarterly of Applied Mathematics*, 79 (2021) 163-174
Published electronically: 18 June **2020**.
- 24 **With Gung-Min Gie, Milton C. Lopes Filho, Anna Mazzucato, and Helena J. Nussenzveig Lopes**, *The Vanishing viscosity limit for some symmetric flows*, *Annales de l'Institut Henri Poincaré (C) Non Linear Analysis*, 36(5), 1237-1280, **2019**
- 23 **With Elaine Cozzi**, *Well-posedness of the 2D Euler equations when velocity grows at infinity*, *Discrete & Continuous Dynamical Systems*, 39(5), 2361-2392, **2018**

- 22 **With Gung-Min Gie and Anna Mazzucato**, *Boundary layers for the Navier-Stokes equations linearized around a stationary Euler flow*, Journal of Mathematical Fluid Mechanics, 20 (4), 1405-1426, **2018**
- 21 **With Elaine Cozzi and Gung-Min Gie**, *The aggregation equation with Newtonian potential: The vanishing viscosity limit*, Journal of Mathematical Analysis and Applications, 453(2), 841-893, 15 September **2017**
- 20 **Kelliher**, *Observations on the vanishing viscosity limit*, Transactions of the American Mathematical Society, 369, 2003-2027, **2017**
Published electronically: 2 June 2016.
- 19 **With Elaine Cozzi**, *Incompressible Euler Equations and the Effect of Changes at a Distance*, Journal of Mathematical Fluid Mechanics, 18(4), 765-781, **2016**
- 18 **Kelliher**, *A characterization at infinity of bounded vorticity, bounded velocity solutions to the 2D Euler equations*, Indiana University Mathematics Journal, 64(6), 1643-1666, **2015**
- 17 **With David M. Ambrose, Milton C. Lopes Filho, and Helena J. Nussenzveig Lopes**, *Serfatı solutions to the 2D Euler equations on exterior domains*, Journal of Differential Equations, 259(9), 4509-4560, **2015**
- 16 **With Mihaela Ignatova, Gautam Iyer, Robert L. Pego, Arghir D. Zarnescu**, *Global existence for two extended Navier-Stokes systems*, Communications in Mathematical Sciences, 13(1), 249-267, **2015**
- 15 **With Gung-Min Gie**, *Boundary layer analysis of the Navier-Stokes equations with generalized Navier boundary conditions*, Journal of Differential Equations, 253, pp. 1862-1892, **2012**
- 14 **Kelliher**, *On the flow map for 2D Euler equations with unbounded vorticity*, Nonlinearity, 24(9), 2599-2637, **2011**
- 13 **With Roger Temam and Xiaoming Wang**, *Boundary layer associated with the Darcy-Brinkman-Boussinesq model for convection in porous media*, Physica D: Nonlinear Phenomena, 240(7), 619-628, **2011**
- 12 **Kelliher**, *Eigenvalues of the Stokes operator versus the Dirichlet Laplacian for a bounded domain in the plane*, Pacific Journal of Mathematics, 244(1): 99-132, **2010**
- 11 **Kelliher**, *Infinite-energy 2D statistical solutions to the equations of incompressible fluids*, Journal of Dynamics and Differential Equations, 21(4): 631-661, **2009**
- 10 **With Milton C. Lopes Filho and Helena J. Nussenzveig Lopes**, *Vanishing viscosity limit for an expanding domain in space*, Annales de l'Institut Henri Poincaré (C) Analyse Non Linéaire, 26(6): 2521-2537, **2009**
- 9 **Kelliher**, *On the vanishing viscosity limit in a disk*, Mathematische Annalen, 343:701-726, **2009**
- 8 **With Dragoş Iftimie**, *Remarks on the vanishing obstacle limit for a 3D viscous incompressible fluid*, Proceedings of the AMS, 137(2):685-694, **2009**
- 7 **Kelliher**, *Vanishing viscosity and the accumulation of vorticity on the boundary*, Communications in Mathematical Sciences, 6(4):869-880, **2008**
- 6 **With Riad Masri**, *Analytic continuation of multiple Hurwitz zeta functions*, Mathematical Proceedings of the Cambridge Philosophical Society, 145(3):605-617, **2008**
- 5 **Expanding domain limit for incompressible fluids in the plane**, Communications in Mathematical Physics, 278(3):753-773, **2008**

- 4 **With Elaine Cozzi**, *Vanishing Viscosity in the plane for vorticity in borderline spaces of Besov type*, Journal of Differential Equations, 235(2):647-657, **2007**
- 3 **Kelliher**, *On Kato's conditions for vanishing viscosity*, Indiana University Mathematics Journal, 56(4):1711-1721, **2007**
- 2 **Kelliher**, *Navier-Stokes equations with Navier boundary conditions for a bounded domain in the plane*, SIAM Journal on Mathematical Analysis, 38(1):210-232, **2006**
- 1 **Kelliher**, *The inviscid limit for two-dimensional incompressible fluids with unbounded vorticity*, Mathematical Research Letters, 11(4):519-528, **2004**

Invited Talks

- 48 **Large time behavior for 2D and 3D Navier-Stokes with Navier boundary conditions**, Analysis and PDE Seminar, joint with The Chinese University of Hong Kong, The University of Hong Kong, and Ulsan National Institute of Science and Technology (delivered online), 7 April 2023
- 47 **3D Euler equations with inflow, outflow**, University of California San Diego, Analysis Seminar (delivered online), 3 May 2022
- 46 **Well-posedness and regularity of solutions to the 3D Euler equations with inflow, outflow**, AMS Spring Western Sectional Meeting 2021 (delivered online), 1 May 2021
- 45 **The 3D Euler equations with inflow, outflow**, MSRI Euler/Navier-Stokes Seminar (delivered online), 1 April 2021
- 44 **Vanishing Viscosity**, MSRI introductory 5 minute talk (delivered online), 9 February 2021
- 43 **Well-posedness and regularity of solutions to the 3D Euler equations with inflow, outflow**, Indiana University PDE/Applied Math Seminar, Indiana University (delivered online), Bloomington, Indiana, 12 October 2020
- 42 **The 3D Euler equations with inflow, outflow**, AMS Fall Western Sectional Meeting 2020 (delivered online), 24 October 2020
- 41 **2D Euler equations with non-decaying vorticity and velocity**, Mathematics of Fluid Motion III: Theory and Computation, Korea Institute for Advanced Study (KIAS), Seoul, South Korea, 19 December 2019
- 40 **Boundary Layers for Incompressible Fluids: The Annoyance of Characteristic Points**, SIAM Conference on Analysis of Partial Differential Equations (PD19), La Quinta, CA, 14 December 2019
- 39 **Striated Regularity in Fluid Equations and Related PDEs**, SIAM Conference on Analysis of Partial Differential Equations (PD19), La Quinta, CA, 12 December 2019
- 38 **The strong vanishing viscosity limit with Dirichlet boundary conditions: facts, speculations, and conjectures**, CAMS colloquium at USC, 1 April 2019
- 37 **Non-Decaying Solutions to the 2D Euler Equations**, Spring 2019 AMS Western Sectional Meeting, University of Hawaii, 23 March 2019
- 36 **Striated regularity for a class of active transport equations**, Geometry & Analysis Day University of Colorado Boulder, Boulder, CO October 2018
- 35 **Bounded vorticity, unbounded velocity solutions to the 2D Euler equations**, PDE and Analysis Seminar University of Pittsburgh, Pittsburgh, PA April 2018

- 34 *Techniques of 2D fluids applied to the aggregation equation*, 2018 Joint Math Meeting, San Diego, CA January 2018
- 33 *Mathematical Analysis in Incompressible Fluid Dynamics - Part I of II*, 2017 SIAM Conference on Analysis of Partial Differential Equations, Baltimore, MD, December 2017
- 32 *Bounded Vorticity, unbounded velocity solutions to the 2D Euler equations*, Nonlinear Partial Differential Equations Seminar, Texas A&M University, College Station, Texas, Sept 2017
- 32 *Non-decaying solutions to the 2D Euler equations*, DyCoV: Local and global dynamics of concentrated vortices, University of Rennes, Rennes (France), May 2017
- 31 *Vanishing viscosity*, Dynamics of Small Scales in Fluids, ICERM, Providence, RI, February 2017
- 30 *Of Kato and Prandtl*, Dynamics of Small Scales in Fluids, ICERM, Providence, RI, February 2017
- 29 *Does the vanishing viscosity limit hold? (Parts I and II)*, Madison Workshop in Analysis and PDE, University of Wisconsin, Madison, WI, 30 September, 1 October 2016
- 28 *Recent progress on the vanishing viscosity limit in the presence of a boundary*, The 7th Pacific RIM Conference on Mathematics, Seoul, South Korea, July 2016
- 27 *Aggregation equations and 2D incompressible fluids*, 2016 Joint Math Meeting, Seattle, WA January 2016
- 26 *Striated Regularity of Velocity for the Euler Equation*, SIAM Conference on Analysis of Partial Differential Equations, Scottsdale, AZ December 2015
- 25 *Observations on the Vanishing Viscosity Limit*, SIAM Conference on Analysis of Partial Differential Equations, Scottsdale, AZ December 2015
- 24 *Conservation of striated regularity for Eulerian velocities*, AMS Western Sectional Meeting, Las Vegas, NV, April 2015
- 23 *Serfati's approach to vortex patches*, Autumn School and Workshop on Mathematical Fluid Dynamics, Bad Boll Germany, 28 October 2014
- 22 *Vortex patches, a short history*, Claremont Center for the Mathematical Sciences (CCMS) Colloquium, Claremont, CA, 24 September 2014
- 21 *Vortex patches redux*, Fourth Workshop on Fluids and PDE, IMPA, Rio de Janeiro, 26 May 2014
- 20 *On the behavior of bounded vorticity, bounded velocity solutions to the 2D Euler equations*, Mathematical Congress of the Americas, Guanajuato, Mexico, August 2013; SIAM Conference on Analysis of Partial Differential Equations, Orlando, FL December 2013
- 19 *Bounded solutions to the 2D Euler equations*, Applied math seminar, Claremont Graduate University, March 2013
- 18 *A characterization of 2D bounded solutions to the Euler equations*, PDE and Analysis Seminar, University of Pittsburgh, March 2013
- 17 *Fluids and boundaries*, Mathematics Colloquium, California State University, Long Beach, October 2012

- 16 *Some recent results on an extended Navier-Stokes system*, 9th AIMS Conference on Dynamical Systems, Differential Equations, and Applications, Orlando, Florida, July 2012; AMS Western Sectional Meeting, University of Arizona, Tucson, 27 October 2012
- 15 *Bounded vorticity, bounded velocity (Serfati) solutions to 2D Euler equations*, Oregon State University Analysis Seminar, 20 February 2012; Spring 2012 AMS Western Sectional Meeting, University of Hawaii, 3 March 2012; Carnegie Mellon Center for Nonlinear Analysis Seminar, 27 March 2012; 9th AIMS Conference on Dynamical Systems, Differential Equations, and Applications, Orlando, Florida, July 2012
- 14 *Boundary Layer Analysis of the Navier-Stokes Equations with Generalized Navier Boundary Conditions*, SIAM Conference on Analysis of Partial Differential Equations (PD11), San Diego, CA, November 2011
- 13 *Boundary Layer Correctors for Curved Boundaries*, SIAM Conference on Analysis of Partial Differential Equations (PD11), San Diego, CA, November 2011
- 12 *On uniqueness and properties of the flow map for weak solutions to the 2D Euler equations*, 3rd Workshop on Fluids and PDE, UNICAMP, Brazil, 27 June to 1 July 2011
- 11 *Boundary layers in fluid mechanics*, CAMS colloquium at USC, 15 October 2010
- 10 *Boundary layer associated with the Darcy-Brinkman-Boussinesq model for convection in porous media*, Fall AMS Western Section Meeting, UCLA, October 9-10 2010
- 9 *An inverse problem associated with flow maps*, Fall AMS Western Section Meeting, UCLA, October 9-10 2010
- 8 *On the Uniqueness of Weak Solutions to the 2D Euler Equations (properties of the flow)*, SIAM Conference on Analysis of Partial Differential Equations (PD09), Miami, FL, December 2009
- 7 *Infinite-energy statistical solutions to the equations of incompressible fluids in the plane*, Carnegie Mellon and Penn State, December 2009; University of California Irvine, November 2009; 2009 SIAM annual meeting, Denver, Colorado, July 2009
- 6 *Vanishing viscosity and the accumulation of vorticity on the boundary*, April 2009 Spring AMS Western Section Meeting; March 2009 Spring AMS Central Sectional Meeting; Brown University, December 2008; University of Texas at Austin, September 2008
- 5 *Vanishing viscosity in the presence of a boundary*, Carnegie Mellon University, March 2008
- 4 *Eigenvalues of the Stokes operator versus the Dirichlet Laplacian*, University of Texas at Austin, September 2007
- 3 *A connection between the Pompeiu problem and incompressible fluid mechanics*, Rio de Janeiro, Brazil, Workshop on Partial Differential Equations, August 2007
- 2 *Vanishing viscosity in the presence of a boundary*, UNICAMP, Campinas, Brazil, First annual workshop in PDE and Fluids, August 2007

- 1 *Unbounded [Expanding] domain limit for Navier-Stokes and Euler equations*, Analytical and Stochastic Fluid Dynamics Seminar, MSRI and George Mason University, October 2005

Professional Service

- December 2019 **Co-organizer of the minisymposium, *Incompressible Fluid Mechanics*, SIAM Conference on Analysis of Partial Differential Equations, La Quinta, CA**
- Oct 2019 **Co-organizer of Special Session, *Fluid Dynamics: from theory to numerics*, at the American Mathematical Society Fall 2017 Western Sectional Meeting, 11 November 2017, Riverside, CA**
- Oct 2017 **Co-organizer of Special Session on Mathematical Fluid Mechanics at the American Mathematical Society Fall 2017 Western Sectional Meeting, 11 November 2017, Riverside, CA**
- June 2016 **Co-organizer of the workshop, *Recent Advances in Hydrodynamics*, 6-10 June 2016, Banff International Research Station for Mathematical Innovation and Discovery (BIRS), Banff, Alberta, Canada**
- January 2016 **Co-organizer of the special session on *Equations of Fluid Motion*, 2016 Joint (AMS/MAA) Mathematics Meeting, Seattle, WA**
- December 2015 **Co-organizer of the minisymposium, *Analytical Methods in Fluid Mechanics*, SIAM Conference on Analysis of Partial Differential Equations, Scottsdale, AZ**
- May 2014 **Member of Scientific Committee, 26-30 May 2014, Fourth Workshop on Fluids and PDE, held at IMPA, Rio de Janeiro, Brazil**
- Dec 2013 **Co-organizer of the *minisymposium, Recent Progress on the Incompressible Euler Equations*, 8-9 December 2013, SIAM Conference on Analysis of Partial Differential Equations, Orlando, FL**
- March 2012 **Co-organizer of the AMS special session on *Fluids and Boundaries*, Fall 2013 AMS Western Sectional Meeting, 2-3 November 2013, held at the University of California Riverside**
- May 2012 **Co-organizer of the *Analysis and applications of evolutionary PDEs workshop*, 5-6 May 2012, held at the University of California Riverside**
- March 2012 **Co-organizer of the AMS special session on *Nonlinear Partial Differential Equations of Fluid and Gas Dynamics*, Spring 2012 AMS Western Sectional Meeting, 3-4 March 2012, held at the University of Hawaii at Manoa, Honolulu**
- Oct 2011 **Co-organizer of the *Fourth Southern California Symposium on the Mathematics of Fluids*, October 2011, held at the University of California Riverside**
- Nov 2009 **Co-organizer of the AMS special session on *Fluid Mechanics*, Fall 2009 AMS Western Sectional Meeting, 7-8 Nov 2009, held at the University of California Riverside**

Teaching

University of California Riverside

- Spring 2024 **Topics in Nonlinear Analysis (Math 259)**
- Winter 2024 **Grad Real Analysis (Math 209b)**
- Fall 2023 **Grad Complex Analysis (Math 210a)**
- Spring 2023 **Calculus (Sequences and Series) (Math 9c)**
- Winter 2023 **Calculus (Sequences and Series) (Math 9c)**

Grad Complex Analysis (Math 210b)
 Fall 2022 ODE (Math 146a)
 Spring 2022 Calculus (Sequences and Series) (Math 9c) two sections
 Winter 2022 Grad Complex Analysis (Math 210b)
 Fall 2021 ODE (Math 146a)
 Winter 2021 Integral Calculus (Math 9b) two sections
 Fall 2020 Grad Real Analysis (Math 209a)
 Winter 2020 Multivariable Calculus (Math 10a)
 Undergrad Complex Analysis (Math 165a)
 Fall 2019 Grad Complex Analysis (Math 210a)
 Winter 2019 Multivariable Calculus (Math 10a)
 Fall 2018 Grad ODE (Math 207A)
 Winter 2018 Grad PDE (Math 207B)
 Fall 2017 ODE (Math 46) two sections
 Spring 2017 Grad PDE (Math 207c)
 Fall 2016 Grad ODE (Math 207a)
 Winter 2016 Integral Calculus (Math 9b)
 Grad PDE (Math 207b)
 Fall 2015 Integral Calculus (Math 9b)
 Winter 2015 Grad PDE (Math 207b)
 Fall 2014 ODE (Math 46), Grad ODE (Math 207a)
 Winter 2014 ODE (Math 146b), Grad ODE (Math 207a)
 Fall 2013 Grad ODE (Math 207a)
 Spring 2013 Multivariable Calculus (Math 10a)
 Winter 2013 ODE (Math 146b)
 Fall 2012 Applied Linear Algebra (Math 113), Grad ODE (Math 207a)
 Spring 2012 ODE (Math 46), Graduate Real Analysis (Math 209c)
 Winter 2012 Integral Calculus (Math 9b), Multi-variable Calculus (Math 10b)
 Spring 2011 Calculus (Sequences and Series) (Math 9c)
 Winter 2011 Grad ODE (Math 211a), Integral Calculus (Math 9b)
 Fall 2010 Ordinary Differential Equations (Math 146a)
 Spring 2010 Graduate Real Analysis (Math 209c)
 Winter 2010 Numerical Analysis (Math 135b), Differential Calculus (Math 9a)
 Fall 2009 Real Analysis (Math 151a)
 Spring 2009 Graduate PDE (Math 212)
 Winter 2009 Ordinary Differential Equations (Math 146b)
 Fall 2008 Ordinary Differential Equations (Math 146a)
 Brown University
 Spring 2008 Multivariable calculus (MA0180)
 Fall 2007 Graduate Real Analysis (MA2210, APMA2110)
 Spring 2007 Partial Differential Equations (MA112)

Fall 2006 **Honors Multivariable Calculus (MA35), Analysis: Functions of Several Variables (MA113)**

Spring 2006 **Multivariable Calculus (MA18), Analysis: Functions of One Variable (MA101)**

Fall 2005 **Multivariable Calculus (MA20)**
University of Texas at Austin

Summer **Instructor for Math 305G (precalculus)**
2004

Fall 2002 **Instructor for Emerging Scholars Program workshop**