

# Yuanzhen Shao

## Curriculum Vitae

Assistant Professor  
Department of Mathematics  
The University of Alabama  
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## Research Interests

### Geometric Analysis

- geometric flows

### Partial Differential Equations

- free boundary problems
- nonlocal diffusions
- fluid dynamics

### Applied Mathematics

- mathematical biology

## Appointments

- 2019.08– Present **Assistant Professor (Tenure-track appointment),**  
*The University of Alabama.*
- 2017–2019.05 **Assistant Professor (Tenure-track appointment),**  
*Georgia Southern University.*
- 2015–2017 **Golomb Visiting Assistant Professor (Post-doc),**  
*Purdue University.*  
*Mentor: Changyou Wang*

## Education

- 2010–2015 **Ph.D., Mathematics,**  
*Vanderbilt University.*  
*Thesis Advisors: Gieri Simonett*
- 2008–2010 **M.S., Mathematics,**  
*Courant Institute of Mathematical Sciences, New York University.*
- 2003–2007 **B.S., Applied Mathematics and Actuary,**  
*Fudan University, China.*

## Papers published & Accepted before Coming to UA

- [1] “Real analytic solutions to the Willmore flow.” *Ninth MSU-UAB Conference on Differential Equations and Computational Simulations. Electron. J. Diff. Eqns., Conf. 20, 151-164 (2013).*

- [2] "Continuous maximal regularity on uniformly regular Riemannian manifolds." *J. Evol. Equ.* **14**, no. 1, 211-248 (2014). (With Gieri Simonett).
- [3] "A family of parameter-dependent diffeomorphisms acting on function spaces over a Riemannian manifold and applications to geometric flows." *NoDEA Nonlinear Differential Equations Appl.* **22**, no. 1, 45-85 (2015).
- [4] "On the regularity of the interface of a thermodynamically consistent two-phase Stefan problem". *Interfaces Free Bound.* **17**, no. 4, 555-600 (2015). (With Jan Prüss and Gieri Simonett).
- [5] "Some remarks on uniformly regular Riemannian manifolds". *Math. Nachr.* **289**, no. 2-3, 232-242 (2016). (With Marcelo Disconzi and Gieri Simonett).
- [6] "Singular parabolic equations of second order on manifolds with singularities." *J. Differential Equations* **260**, no. 2, 1747-1800 (2016).
- [7] "Continuous maximal regularity on manifolds with singularities and its applications." *J. Evol. Equ. and Control Theory* **5**, no. 2, 303-335 (2016).
- [8] "Wellposedness of a nonlocal nonlinear diffusion equation in image processing." *Nonlinear Anal.* **150**, 114-137 (2017). (With Patrick Guidotti).
- [9] "The Yamabe flow on incomplete manifolds." *J. Evol. Equ.* **18**, no. 4, 1595-1632 (2018).
- [10] "Harmonic map heat flow on conic manifolds." *Nonlinear Dispersive Waves and Fluids, 227-250, Contemp. Math., 725, Amer. Math. Soc., Providence, RI, 2019.* (With Changyou Wang).
- [11] "The surface diffusion and the Willmore flow for uniformly regular hypersurfaces." *Discrete Contin. Dyn. Syst. Ser. S.* **13**, no. 12, 3503-3524 (2020). (With Jeremy LeCrone and Gieri Simonett).

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## Papers published & Accepted while at UA

- [12] "New Variational Analysis on the Sharp Interface of Multiscale Implicit Solvation: General Expressions and Applications." *Communications in Information & Systems.* **21**, no. 1, 37-64 (2021). (With Zhan Chen and Elizabeth Hawkins).
- [13] "Local well-posedness in Sobolev spaces for first-order conformal causal relativistic viscous hydrodynamics." *Commun. Pure Appl. Anal.* **20**, no. 6, 2279-2290 (2021). (With Fabio S. Bemfica, Marcelo M. Disconzi and Casey Rodriguez).
- [14] "Functional inequalities involving nonlocal operators on complete Riemannian manifolds and their applications to the fractional porous medium equation." *Evol. Equ. Control Theory* **11**, no. 3, 793-825 (2022). (With Nikolaos Roidos).
- [15] "The fractional porous medium equation on manifolds with conical singularities I." *J. Evol. Equ.* **22**, no. 1, Paper No. 8, 39 pp (2022). (With Nikolaos Roidos).
- [16] "Maximal  $L_q$ -regularity of nonlocal parabolic equations in higher order Bessel potential spaces." *Pure Appl. Funct. Anal.* **7**, no. 3, 1037-1063 (2022). (With Nikolaos Roidos).

- [17] "A constrained variational model of biomolecular solvation and its numerical implementation." *Comput. Math. Appl.* **107**, 17-28 (2022). (With Zhan Chen, Elizabeth Hawkins and Kai Wang).
- [18] "A regularization approach for solving the super-Gaussian Poisson-Boltzmann model with heterogeneous dielectric functions." *J. Comput. Phys.* **464**, Paper No. 111340, 23 pp. (2022). (With M Siwen Wang, Emil Alexov and Shan Zhao).
- [19] "The fractional porous medium equation on manifolds with conical singularities II." *Mathematische Nachrichten.* **296**, no. 4, 1616-1650 (2023). (With Nikolaos Roidos).
- [20] "Convergence of a diffuse interface Poisson-Boltzmann (PB) model to the sharp interface PB model: a unified regularization formulation." *Appl. Math. Comput.* **436**, Paper No. 127501 (2023). (With Mark McGowon, Siwen Wang, Emil Alexov and Shan Zhao).
- [21] "Well-posedness for magnetoviscoelastic fluids in 3D." *Nonlinear Anal. Real World Appl.* **69**, Paper No. 103759 (2023). (With Hengrong Du and Gieri Simonett).
- [22] "A new approach to constrained total variation solvation models and the study of solute-solvent interface profiles." *A new approach to constrained total variation solvation models and the study of solute-solvent interface profiles. Comput. Math. Appl.* **130**, 119-136 (2023). (With Zhan Chen).
- [23] "On a thermodynamically consistent model for magnetoviscoelastic fluids in 3D." *J. Evol. Equ.* **24**, no. 1, Paper no. 9 (2024). (With Hengrong Du and Gieri Simonett).

## Preprints

- [P1] "Modeling and analysis of ensemble average solvation energy and solute-solvent interfacial fluctuations." *arXiv:2301.08560* (With Zhan Chen and Shan Zhao).
- [P2] "Strongly hyperbolic quasilinear systems revisited, with applications to relativistic fluid dynamics." *arXiv:2308.09851* (With Marcelo Disconzi).
- [P3] "The Navier-Stokes equations on manifolds with boundary." *arXiv:2311.01221v2* (With Gieri Simonett and Mathias Wilke).
- [P4] "A  $p$ -Laplacian approach and its analysis for the calculation of ensemble average solvation energy." (With Zhan Chen and Shan Zhao).

## Awards and Honors

- 2024 The University of Alabama, 2024 Excellence in Community-Engaged Scholarship Award.
- 2024 May - August The University of Alabama, Department of Mathematics, Summer research group initiative (Together with Shao, Shan Zhao and Zhan Chen).
- 2023-2026 National Science Foundation DMS-2306991 (Principal Investigator, Co-PI: Shan Zhao).
- 2023-2024 The University of Alabama, College Academy for Research, Scholarship and Creative Activity (CARSCA), Research Grant.
- 2015 Vanderbilt University Bjarni Jónsson Prize for Outstanding Research.

2014 Vanderbilt University Graduate Student travel grant.

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## Invited Research Visits

- Purdue University, West Lafayette, Indiana, USA. May 3-11, 2022.
- Vanderbilt University, Nashville, Tennessee, USA. April 29-May 2, 2022.
- Vanderbilt University, Nashville, Tennessee, USA. February 9-23, 2022.
- Vanderbilt University, Nashville, Tennessee, USA. November 15-18, 2019.
- Vanderbilt University, Nashville, Tennessee, USA. July 30-August 3, 2018.
- Institut für Analysis, Leibniz Universität Hannover, Germany. September 26-October 3, 2015.
- Institut für Mathematik, Martin-Luther-Universität Halle-Wittenberg, Germany. March 28-April 8, 2014.

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## Invited Colloquium and Seminar Talks

- *Multiscale Modeling and Computation Seminar*, Illinois Institute of Technology, Chicago, IL, April 16, 2024.
- *Colloquium*, Georgia Southern University, Statesboro, GA, February 4, 2022.
- *Colloquium*, Old Dominion University, Norfolk, VA, December 10, 2021.
- *PDE Seminar*, Purdue University, West Lafayette, IN, November 19, 2020.
- *Colloquium*, Georgia Southern University, Statesboro, GA, September 25, 2020.
- *PDE Seminar*, Purdue University, West Lafayette, IN, April 2, 2020. (Cancelled due to COVID-19)
- *PDE Seminar*, Vanderbilt University, Nashville, TN, November 15, 2019.
- *PDE Seminar*, Vanderbilt University, Nashville, TN, April 12, 2019.
- *Analysis Seminar*, University of Alabama, Tuscaloosa, AL, February 2, 2018.
- *PDE Seminar*, Indiana University, Bloomington, IN, October 19, 2015.
- *PDE Seminar*, Purdue University, West Lafayette, IN, April 2, 2015.
- *Analysis Seminar*, Binghamton University, Binghamton, NY, November 5, 2014.
- *PDE and Differential Geometry Seminar*, University of Connecticut, Storrs, CT, November 3, 2014.
- *Geometry-Topology Seminar*, University of Tennessee, Knoxville, TN, October 6, 2014.
- *Nonlinear PDEs Seminar*, University of California, Irvine, CA, September 30, 2014.
- *Analysis and Partial Differential Equations Seminar*, University of Kentucky, Lexington, KY, March 11, 2014.

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## Presentations at Conferences

- *The 5th TSIMF conference on Computational and Mathematical Bioinformatics and Biophysics*, TSIMF, Sanya, China, December 11-15, 2023
- *Fall Southeastern AMS Sectional Meeting*, University of South Alabama, Mobile, AL, October 13-15, 2023. (Two talks)

- *The 10th International Congress on Industrial and Applied Mathematics*, Waseda University, Tokyo, August 20 - 25, 2023.
- *The 13th AIMS Conference on Dynamical Systems, Differential Equations and Applications*, Wilmington, NC, May 31 - June 4, 2023.
- *Spring Central AMS Sectional Meeting*, University of Cincinnati, Cincinnati, April 15-16, 2023.
- *Fall Central AMS Sectional Meeting*, The University of Texas at El Paso, El Paso, September 17-18, 2022.
- *SIAM Conference on the Life Sciences*, David L. Lawrence Convention Center, Pittsburgh, July 11-15, 2022.
- *Spring Central AMS Sectional Meeting*, Purdue University, West Lafayette, March 26-27, 2022.
- *UNC Greensboro PDE Conference of 2021*, Virtual Conference, July 24-25, 2021.
- *Spring Central AMS Sectional Meeting*, Purdue University, West Lafayette, April 4-5, 2020. (Cancelled due to COVID-19)
- *SIAM Conference on Analysis of Partial Differential Equations*, La Quinta Resort & Club, La Quinta, December 11-14, 2019.
- *Fall Central AMS Sectional Meeting*, University of Michigan, Ann Arbor, MI October 20-21, 2018.
- *Spring Southeastern AMS Sectional Meeting*, Vanderbilt University, Nashville, April 14-15, 2018.
- *The 37th Southeastern-Atlantic Regional Conference on Differential Equations*, Kennesaw State University, Kennesaw, October 7-8, 2017.
- *Shanks Workshop on Mathematical Aspects of Fluid Dynamics*, Vanderbilt University, Nashville, April 8-9, 2017.
- *Spring Central AMS Sectional Meeting*, Indiana University, Bloomington, April 1-2, 2017.
- *Spring Southeastern AMS Sectional Meeting*, College of Charleston, Charleston, March 10-12, 2017.
- *XXVI Southeast Geometry Seminar*, Georgia Institute of Technology, Atlanta, February 26, 2017.
- *International Conference on Evolution Equations*, Vanderbilt University, Nashville, May 16-20, 2016.
- *Fall Western AMS Sectional Meeting*, California State University, Fullerton, October 24-25, 2015.
- *Workshop on Analysis and PDE*, Leibniz Universität Hannover, Germany, September 29-October 1, 2015.
- *AMS Sectional Meeting, Spring Southeastern Sectional Meeting, Special Session on Nonlinear Operator Theory and Partial Differential Equations*, University of Alabama in Huntsville, Huntsville, March 29, 2015.
- *AMS Sectional Meeting, Spring Southeastern Sectional Meeting, Special Session on Recent Progress in Differential Equations*, University of Alabama in Huntsville, Huntsville, March 28 2015. (Two talks)

- *The 34th Southeastern Atlantic Regional Conference on Differential Equations*, Department of Mathematics, University of Memphis, October 11-12, 2014.
- *The 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications*, the Universidad Autónoma de Madrid, Madrid, Spain, July 07-July 11, 2014.
- *Maxwell-Stefan meets Navier-Stokes, Modeling and Analysis of Reactive Multi-Component Flows*, Martin-Luther Universität Halle-Wittenberg, Germany, March 31-April 2, 2014.
- *The 4th Ohio River Analysis Meeting*, University of Kentucky, Lexington, March 8-9, 2014.
- *SIAM Conference on Analysis of Partial Differential Equations*, Hilton Orlando Lake Buena Vista, Lake Buena Vista, Orlando, December 7-10, 2013.
- *The 33rd Southeastern-Atlantic Regional Conference on Differential Equations, 2013*, the University of Tennessee, Knoxville, September 21-22, 2013.
- *The 9th Mississippi State - UAB Conference on Differential Equations and Computational Simulations*, Mississippi State University, Starkville, October 4-6, 2012.

## Departmental Colloquium and Seminar Talks

- *Applied Math Seminar*, The University of Alabama, Tuscaloosa, AL, September 29, 2023.
- *Applied Math Seminar*, The University of Alabama, Tuscaloosa, AL, April 23, 2021.
- *Applied Math Seminar*, The University of Alabama, Tuscaloosa, AL, April 9, 2021.
- *Applied Math Seminar*, The University of Alabama, Tuscaloosa, AL, March 12, 2021.
- *Applied Math Seminar*, The University of Alabama, Tuscaloosa, AL, February 19, 2021.
- *Applied Math Seminar*, The University of Alabama, Tuscaloosa, AL, February 5, 2021.
- *Analysis Seminar*, The University of Alabama, Tuscaloosa, AL, October 25, 2019.
- *Math/Physics Seminar*, Georgia Southern University, Statesboro, GA, March 28, 2019.
- *Physics Colloquium*, Georgia Southern University, Statesboro, GA, March 26, 2018.
- *Math Department Colloquium*, Georgia Southern University, Statesboro, GA, December 1, 2017.
- *Math/Physics Seminar*, Georgia Southern University, Statesboro, GA, November 16, 2017.
- *PDE Seminar*, Purdue University, West Lafayette, IN, December 1, 2016.
- *PDE Seminar*, Purdue University, West Lafayette, IN, September 17, 2015.
- *Partial Differential Equations Seminar*, Vanderbilt University, Nashville, TN, March 14, 2015.
- *Partial Differential Equations Seminar*, Vanderbilt University, August 29, 2014.
- *Partial Differential Equations Seminar*, Vanderbilt University, March 21, 2014.

- *Partial Differential Equations Seminar*, Vanderbilt University, October 4, 2013.
- *Partial Differential Equations Seminar*, Vanderbilt University, October 19, 2012.

## Teaching Experiences

### The University of Alabama

- Spring 2024 **Instructor**, *Math 681, Real Analysis II.*
- Spring 2024 **Instructor**, *Math 355, Theory Of Probability.*
- Fall 2023 **Instructor**, *Math 580, Real Analysis I.*
- Fall 2023 **Instructor**, *Math 145, Honors Calculus I.*
- Spring 2023 **Instructor**, *Math 587, Introduction to Real Analysis II.*
- Spring 2023 **Instructor**, *Math 238, Appl Diff Equations I.*
- Fall 2022 **Instructor**, *Math 586, Introduction to Real Analysis I.*
- Fall 2022 **Instructor**, *Math 238, Appl Diff Equations I.*
- Fall 2021 **Instructor**, *Math 485/585, Intro Complex Variables.*
- Fall 2021 **Instructor**, *Math 145, Honors Calculus I.*
- Spring 2021 **Instructor**, *Math 355, Theory Of Probability.*
- Fall 2020 **Instructor**, *Math 580, Real Analysis I.*
- Fall 2020 **Instructor**, *Math 355, Theory Of Probability.*
- Spring 2020 **Instructor**, *Math 684, Complex Analysis II.*
- Spring 2020 **Instructor**, *Math 238, Appl Diff Equations I.*
- Fall 2019 **Instructor**, *Math 583, Complex Analysis.*

### Georgia Southern University, Statesboro

- Spring 2019 **Instructor**, *MATH 7331, Real Analysis.*
- Spring 2019 **Instructor**, *MATH 2442, Calculus II.*
- Fall 2018 **Instructor**, *MATH 5331, Analysis I.*
- Fall 2018 **Instructor**, *MATH 1441, Calculus I.*
- Spring 2018 **Instructor**, *MATH 3230, Ordinary Differential Equation.*
- Fall 2017 **Instructor**, *MATH 1441, Calculus I.*

### Purdue University, West Lafayette

- Spring 2017 **Instructor**, *MA26500, Linear Algebra.*
- Fall 2016 **Instructor**, *MA26200, Linear Algebra and Differential Equations.*
- Spring 2016 **Instructor**, *MA26500, Linear Algebra.*
- Fall 2015 **Instructor**, *MA26200, Linear Algebra and Differential Equations.*

### Vanderbilt University

- Fall 2014 **Teaching Assistant**, *MATH 196, Differential Equations with Linear Algebra.*
- Spring 2014 **Teaching Assistant**, *MATH 155B, Accelerated Single-Variable Calculus II.*
- Fall 2013 **Teaching Assistant**, *MATH 155A, Accelerated Single-Variable Calculus I.*
- Summer 2013 **Teaching Assistant**, *MATH 218, Introduction to Probability and Mathematical Statistics.*



- Spring 2013 **Teaching Assistant**, *MATH 205B, Multivariable Calculus and Linear Algebra.*  
Fall 2012 **Teaching Assistant**, *MATH 205A, Multivariable Calculus and Linear Algebra.*  
Summer 2012 **Teaching Assistant**, *MATH 218, Introduction to Probability and Mathematical Statistics.*  
Spring 2012 **Teaching Assistant**, *MATH 150B, Single-Variable Calculus II.*  
Fall 2011 **Teaching Assistant**, *MATH 150A, Single-Variable Calculus I.*

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## Mentoring

- Master Student: Meghan Talley, 2022- 2023.
- Master Student: Elizabeth Hawkins (joint with Zhan Chen at Georgia Southern University), 2019-2020 (Position after graduation: PhD candidate at Clemson University).

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## Service

- Referee for several mathematical journals.
- Organizer (with Changyou Wang), Minisymposium “Analysis of Fluid Dynamics and Free Boundary Problems”, 10th International Congress on Industrial and Applied Mathematics, Waseda University, Tokyo, August 20-25, 2023.
- Organizer (with Hengrong Du and Patrick Guidotti), special session on “Analysis and Applications of Nonlinear Elliptic and Parabolic Equations”, The 13th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Atlanta, GA, June 5-9, 2020. (Postponed to May 31-June 4, 2023 in Wilmington, NC, due to COVID-19)
- Organizer (with Yi Hu, Yongki Lee, Shijun Zheng), special session on “Analysis of Geometric and Evolutionary Partial Differential Equations”, Fall Southeastern AMS Sectional Meeting, University of Florida, Gainesville, FL, November 2-3, 2019.
- Co-organizer (with Patrick Guidotti and Gieri Simonett), mini-symposium on “Nonlinear Parabolic Equations and Applications”, SIAM Conference on Analysis and Partial Differential Equations, Scottsdale, AZ, USA, December 7-10, 2015.
- Coordinator of MATHCOUNTS Tuscaloosa Chapter