Dr Arick Shao

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Employment

Reader in Mathematics: Queen Mary University of London, *2023–present*

Senior Lecturer in Mathematics: Queen Mary University of London, *2018–2023*

Lecturer in Mathematics: Queen Mary University of London, *2016–2018*

Research Associate: Imperial College London, *2014–2016*

Postdoctoral fellow: University of Toronto, *2011–2014*

Education

Ph.D., Mathematics: Princeton University, *2010*
Breakdown Criteria for Nonvacuum Einstein Equations
Supervisor: Sergiu Klainerman

B.S., Mathematics, Computer Science: University of Texas at Austin, *2004*

Research

Analysis, partial differential equations
Dispersive, hyperbolic, and wave equations

Differential geometry, mathematical relativity
Riemannian and Lorentzian geometry, geometric PDE, Einstein equations

Awards

LMS Research in Pairs (Scheme 4)
Project: *Collaboration with Bolys Sabitbek* (42528)
Duration: *Jun. 2026*
Funding amount: GBP 1,000

LMS Joint Research Groups (Scheme 3)
Project: *London PDE Seminar* (32521)
Duration: *2025–2026*
Funding amount: GBP 1,500

EPSRC Small Grant
Project: *Rigidity Problems in Holography and Relativity* (EP/Y021487/1)
Duration: *2024*
Funding amount: GBP 77,733

STFC Standard Grant
Title: *Astronomy at Queen Mary 2023–2026* (ST/X000931/1)
Project: *Early Universe Cosmology Beyond General Relativity* (co-investigator)
Duration: *2023–2026*

Geometry, Relativity and Partial Differential Equations
Mini-CDT (Centre for Doctoral Training) funded by Faculty of Science and Engineering, QMUL
Duration: *2020–2022*

EPSRC First Grant
Project: *Unique Continuation for Geometric Wave Equations, and Applications to Relativity, Holography, and Controllability* (EP/R011982/1)

Duration: *2018–2020*
Funding amount: GBP 100,891

Awarded special mention for Research Contributions
Recognition for research accomplishments at Queen Mary University of London, *winter 2018*

Faculty of Natural Sciences Prize for Excellence in the Support of Teaching and Learning
Award for teaching assistants at Imperial College London, *spring 2015*

Research Impulse Platform Grant
Funding awarded by Imperial College London for conference travel, *spring 2015*

Supervision

Postdoctoral Researchers
Vaibhav Jena, EPSRC Postdoctoral Researcher, *2021–2022*

PhD Students (as 1st supervisor)
Simon Guisset, *2020–2024*
Alexander McGill, *2018–2022*
Vaibhav Jena, *2017–2021*

Summer Research Projects
Viscous Relativistic Hydrodynamics (with Shabnam Beheshti), QMUL Summer Research Internships for BAME Undergraduate Students, *summer 2021*.
LMS Undergraduate Bursary, *summer 2021*.
Uniqueness in Wave Equations, Imperial College London Undergraduate Research Opportunies, *summer 2016*.
Nonlinear Wave Equations, Imperial College London Undergraduate Research Opportunies, *summer 2015*.

MSc Projects
Controllability of Differential Equations (1 student, *2022*)
Fourier Space Methods for PDEs (3 students, *2019–2024*)

3rd-Year Undergraduate Projects
Applications of Fixed Point Theorems (1 student, *2024*)
Higher-Dimensional Manifolds (1 student, *2021*)
Classical Curve and Surface Geometry (4 students, *2021–2023*)
Fourier Transformations and Applications (8 students, *2018–2024*)
Calculus of Variations (3 students, *2020–2021*)
Controllability of Differential Equations (5 students, *2019–2025*)
Integral Theorems in Differential Geometry (5 students, *2019–2024*)
Wave Equations (2 students, *2017–2018*)

Teaching

MTH4113/4213: Numbers, Sets and Functions
Lecturer, Queen Mary University of London, *fall 2025*, *fall 2024*

SEF015: Discrete Mathematics
Co-lecturer, Queen Mary University of London, *spring 2024*

MTH5113: Introduction to Differential Geometry
Lecturer and module creator, Queen Mary University of London, *spring 2023*, *spring 2022*, *spring 2021*, *spring 2020*, *spring 2019*

MTH5109: Geometry II: Knots and Surfaces
Lecturer, Queen Mary University of London, *fall 2017*, *fall 2016*

M4P41: Analytic Methods in PDEs
Lecturer, Imperial College London, *spring 2016*

Dispersive Equations (TCC)
Lecturer, Imperial College London, Mathematics Taught Course Centre, *fall 2015*

M3P7: Functional Analysis
Teaching assistant, Imperial College London, *spring 2015*

MAT336: Elements of Analysis
Instructor, University of Toronto, *spring 2014*

MAT244: Ordinary Differential Equations
Instructor, University of Toronto, *spring 2014*

MAT334: Complex Variables
Instructor, University of Toronto, *spring 2013*, *fall 2012*

MAT235: Calculus for Life Sciences II
Instructor, University of Toronto, *spring 2012*, *fall 2011*

Professional Membership

London Mathematical Society, *2025–present*

Community

Co-organizer, *London PDE Seminar*
Queen Mary University of London, Imperial College London, University College London, *2021–present*

Co-organizer, Workshop on *Nonlinear Waves and Fluids*
University College London, *June 2024*

Co-organizer, *QMUL/ICL Reading Seminar*
Queen Mary University of London, Imperial College London, *2020–2022*

Undergraduate Student Exam Board Chair
Queen Mary University of London, *2020–2023*

Organizer, *Mini-Workshop on Wave Equations*
Queen Mary University of London, *Jan. 2020*

Co-organizer, *Geometry and Analysis Seminar*
Queen Mary University of London, *2017–2020*

Co-organizer, *Geometry and Analysis Reading Seminar*
Queen Mary University of London, *2017–2019*

Co-organizer, *Bag Lunch Educational Seminar*
Queen Mary University of London, *2017–2018*

Co-organizer, *Workshop on Geometric Hyperbolic PDE*
Imperial College London, *Sept.–Oct. 2015*

Postdoc representative, Department of Mathematics
Imperial College London, *2015–2016*

Co-organizer, *Analysis and Applied Math Seminar*
University of Toronto, *2012–2014*

Invited Talks

Scattering and asymptotics for critically weakly hyperbolic and singular systems
Seminar in PDEs and Applied Mathematics, Fluminense Federal University (Brazil), *Apr. 2026*
Partial Differential Equations Seminar, University of Oxford (UK), *Feb. 2026*
Analysis Seminar, University of Edinburgh (UK), *Jan. 2026*
PDE Colloquium, University of Münster (Germany), *Nov. 2025*

Analysis Seminar, Loughborough University (UK), *Oct. 2025*
General Relativity and Hyperbolic PDE Seminar, Columbia University (USA), *Sept. 2025*
Advances in Hyperbolic Problems, Queen Mary University of London (UK), *Jun. 2025*
Seminar of Differential Equations and Numerical Analysis, University of Crete (Greece), *May 2025*
Methusalem Colloquium, Ghent University (Belgium), *Apr. 2025*

Control of parabolic equations with inverse square infinite potential wells
X Partial Differential Equations, Optimal Design and Numerics, Benasque Science Center (Spain), *Aug. 2024*
Analysis and PDE Seminar, National University of Singapore (Singapore), *Apr. 2024*
Seminar in Control, LJLL, Sorbonne Université (France), *Jan. 2024*
Analysis and PDE Seminar, Donghua University (China) *Nov. 2023*
IWOTA 2023, Spectral Inequalities and Null-Controllability (Finland) *Aug. 2023*
Analysis and PDE Seminar, SUSTech International Center for Mathematics (China) *Jun. 2023*
Ghent Methusalem Junior Seminar, Ghent University (Belgium) *May 2023*
London Analysis and Probability Seminar (UK), *Apr. 2023*
Geometric Aspects of Evolution and Control, FernUniversität Hagen (Germany), *Apr. 2023*

Bulk-boundary correspondence for vacuum asymptotically Anti-de Sitter spacetimes
24th International Conference on General Relativity and Gravitation, Glasgow (UK), *Jul. 2025* (short talk)
Workshop on Partial Differential Equations in Physics and Materials Science, FORTH (Greece), *May 2024*
PDE Seminar, Vanderbilt University (USA), *Apr. 2024*
Sanya Waves, Tsinghua Sanya International Mathematics Forum (China), *Jan. 2024*
Mathematical GR and Hyperbolic PDE Seminar, Columbia University (USA), *Oct. 2023*
Topics in General Relativity, University of Münster (Germany), *Jul. 2023*
Conference on Nonlinear Waves and Mathematical General Relativity, Tsinghua University (China), *Jul. 2023*
Seminar in Mathematical General Relativity, LJLL, Sorbonne Université (France), *May. 2023*
Princeton Gravity Initiative Seminar, Princeton University (USA), *Oct. 2022*
Hyperbolic Differential Equations in Geometry and Physics, MATRIX (Australia), *Apr. 2022*
CMSA General Relativity Seminar, Harvard University (USA), *Mar. 2022*
Geometric Analysis and Partial Differential Equations Seminar, University of Cambridge (UK), *Jan. 2022*
2021 Geometric Analysis and Hyperbolic PDE Conference, Guangxi Center for Mathematical Research (China), *Dec. 2021*

Extension of symmetries from conformal boundaries of vacuum asymptotically AdS spacetimes
2020 Geometric Analysis and Hyperbolic PDE Conference, Guangxi Center for Mathematical Research (China), *Dec. 2020*
GR and Hyperblic PDE Seminar, Princeton University (USA), *Dec. 2020*
Relativity Seminar, Universität Wien (Austria), *Nov. 2020*

Correspondence and rigidity results on asymptotically anti-de Sitter spacetimes
Time-like Boundaries in General Relativistic Evolution Problems, BIRS-CMO

(Mexico), *Aug. 2019*
Relativistic Mathematical Physics in Grenoble, Institut Fourier, Université Grenoble Alpes (France), *May 2019*
Mathematical Relativity Seminar, IST, Universidade de Lisboa (Portugal), *Sept. 2018*
International Conference on Nonlinear Waves and General Relativity, Chinese University of Hong Kong (Hong Kong), *Dec. 2017*
Workshop on General Relativity and AdS/CFT, Fields Institute (Canada), *Oct. 2017*

On controllability of waves and geometric Carleman estimates
X Partial differential equations, optimal design and numerics, Benasque Science Center (Spain), *Aug. 2024*
Webinar on PDEs and Related Areas, IIT-Kanpur (India), *Dec. 2020*
CRM-Montreal-Quebec Analysis Seminar (Canada), *Oct. 2020*
Séminaire EDP et Physique Mathématique, LAGA, Université Paris-XIII (France), *May. 2020*
2019 International Conference on Geometric Analysis and Hyperbolic Equations, Guangxi Center for Mathematical Research (China), *Dec. 2019*
London Mathematical Society Hyperbolic Network Meeting, Loughborough University (UK), *Mar. 2019*
Séminaire Laurent Schwartz, IHES (France), *Feb. 2019*
NCTS Seminar, NCTS, National Taiwan University (Taiwan), *Dec. 2018*
Geometry and Analysis Seminar, University of Oxford (UK), *Oct. 2018*
Analysis and Geometry Seminar, University of Bristol (UK), *Mar. 2018*

Uniqueness theorems for waves, Carleman estimates, and applications
Analysis and Applications Seminar, University of Leeds (UK), *Feb. 2018*

Uniqueness theorems for waves from infinity, and applications
Analysis Seminar, Cardiff University (UK), *Jan. 2017*
Analysis Seminar, University of Edinburgh (UK), *Nov. 2015*
Analysis Seminar, Kings College London (UK), *Nov. 2015*
100 Years of General Relativity, Workshop on Nonlinear Wave Equations, Fields Institute (Canada), *Jun. 2015*
Junior Warwick-Imperial-Cambridge Seminar, London (UK), *Dec. 2014* (short talk)

Uniqueness theorems on asymptotically Anti-de Sitter spacetimes
Seminar on Mathematical General Relativity, UPMC, IHES (France), *Jul. 2017*
2016-17 Warwick EPSRC Symposium: Geometric PDEs, University of Warwick (UK), *Dec. 2016*
Geometry and Analysis Seminar, Queen Mary University of London (UK), *Oct. 2016*
London Analysis and Probability Seminar (UK), *Oct. 2016*

Unique continuation from infinity, Carleman estimates, and applications
Workshop on Carleman Estimates, Unique Continuation, and Applications, University College London (UK), *Nov. 2016*

Correspondence properties for waves on asymptotically Anti-de Sitter spacetimes
Gravity Seminar, University of Southampton (UK), *Nov. 2015*

Unique continuation for massive waves in asymptotically Anti-de Sitter spactimes
100 Years of General Relativity, Workshop on Black Hole Stability, Fields Institute (Canada), *Jun. 2015*
Equadiff 2015, Minisymposium on Mathematical Problems of General Relativity (France), *Jul. 2015*

Unique continuation, Carleman estimates, and blow-up for nonlinear waves

Partial Differential Equations Seminar, University of Oxford (UK), *Feb. 2015*

Unique continuation from infinity for linear waves
Geometry and Analysis Seminar, Imperial College London (UK), *Nov. 2014*
Seminar of Analysis and Applications, EPFL (Switzerland), *Nov. 2014*
Geometric Analysis and PDE Seminar, Cambridge University (UK), *Oct. 2014*
Analysis and PDEs Seminar, Imperial College London (UK), *Oct. 2014*
Analysis Seminar, University of Warwick (UK), *Oct. 2014*
Seminar on Mathematical General Relativity, Université Pierre et Marie Curie (France), *Sept. 2014*
Geometric Analysis Colloquium, Fields Institute (Canada), *Dec. 2013*

Null cones to infinity, curvature flux, and Bondi mass
Conference on Nonlinear Wave Equations, IHP (France), *May 2013*
Seminar on Mathematical General Relativity, Université Pierre et Marie Curie (France), *Jan. 2013*
Analysis and Applied Math Seminar, University of Toronto (Canada), *Oct. 2012*
Workshop in *Evolution equations of physics, fluids, and geometry*, BIRS (Canada), *Sept. 2012*
Workshop in *Mathematical aspects of general relativity*, MFO (Germany), *Jul. 2012*

A representation formula for tensor wave equations on curved spacetimes
Fields Analysis Working Group, Fields Institute (Canada), *Mar. 2012*

Breakdown criteria for nonvacuum Einstein equations
Analysis and Applied Math Seminar, University of Toronto (Canada), *Oct. 2011*
2010 Joint Mathematics Meetings (USA), *Jan. 2010*
Analysis Seminar, Princeton University (USA), *Dec. 2009*

Outreach

Speaker, Queen Mary Open Days, *2024–2025*
Outreach event to prospective undergraduate students.
Title: *My infinity is bigger than your infinity*

Speaker, Queen Mary Futures, *2024–2025*
Event introducing underrepresented A-level students to university mathematics.
Title: *My infinity is bigger than your infinity*

Speaker, Wonderful World of Maths (Taster Event), *December 2022, March 2023*
Event introducing A-level students to university mathematics.
Title: *My infinity is bigger than your infinity*

Volunteer, I'm a Mathematician, *summer 2020*
Online chats with school classes and youth groups in the UK.

Academic speaker, Year 11 Maths Summer School, *summer 2018*
Week-long summer school for year 11 students interested in mathematics
Gave taster lecture (title: *Why my infinity is bigger than your infinity*)

Academic consultant, Year 11 Maths Summer School, *summer 2017*
Week-long summer school for year 11 students interested in mathematics
Developed lecture and project material (topic: waves, sound waves)

Speaker, University of London Taster Day, *April 2017*
Event with brief taster lectures for year 12 students.
Title: *The Mathematics Behind Einstein's Theory of Relativity*

Plenary speaker, Warwick Imperial Spring Meeting, *spring 2016*

Conference for upper-year undergraduate, master's, and early-year PhD students.
Title: *A Brief Introduction to Mathematical Relativity*

Postdoc Pizza Seminar, Imperial College London, *fall 2014*
Title: *Introduction to Mathematical General Relativity*

Math Mentorship Program, *spring 2012*
Mentor for local high school students

Science Rendezvous, volunteer, *May 2012*
Festival at Canadian universities for promoting science and mathematics to public

Publications

Preprints and Submitted Papers

1. N. De Nitti, A. Shao, *Controllability of a one-dimensional dynamic debonding model*
   arXiv: *http://www.arxiv.org/abs/2508.19755*

2. B. Sabitbek, A. Shao, *Asymptotics and scattering for critically weakly hyperbolic and singular systems*
   arXiv: *http://www.arxiv.org/abs/2506.11348*

Accepted and Published Papers

1. A. Enciso, A. Shao, B. Vergara, *Controllability of parabolic equations with inverse square infinite potential wells via global Carleman estimates*, Anal. PDE, 19 (2025), 241–280
   arXiv: *http://www.arxiv.org/abs/2112.04457*

2. V.K. Jena, A. Shao, *Control of waves on Lorentzian manifolds with curvature bounds*, ESAIM: Control, Optimisation and Calculus of Variations, 30 (2024), 65
   arXiv: *http://www.arxiv.org/abs/2112.09539*

3. A. Shao, B. Vergara, *Approximate boundary controllability for parabolic equations with inverse square infinite potential wells*, Nonlinear Anal., 248 (2024), 113624
   arXiv: *http://www.arxiv.org/abs/2311.01628*

4. S. Guisset, A. Shao, *On counterexamples to unique continuation for critically singular wave equations*, J. Differential Equations, 395 (2024), 223–261
   arXiv: *http://www.arxiv.org/abs/2308.03525*

5. G. Holzegel, A. Shao, *The bulk-boundary correspondence for the Einstein equations in asympotically Anti-de Sitter spacetimes*, Arch. Ration. Mech. Anal., 247 (2023), 56
   arXiv: *http://www.arxiv.org/abs/2207.14217*

6. L. D. Cha, A. Shao, *Global stability of traveling waves for* $(1+1)$*-dimensional systems of quasilinear wave equations*, J. Hyperbol. Differ. Eq., 19 (2022), 549–586
   arXiv: *http://www.arxiv.org/abs/2008.09991*

7. A. Chatzikaleas, A. Shao, *A gauge-invariant unique continuation criterion for waves in asymptotically Anti-de Sitter spacetimes*, Commun. Math. Phys. 395 (2022), 521–570
   arXiv: *http://www.arxiv.org/abs/2201.06010*

8. A. Enciso, A. Shao, B. Vergara, *Carleman estimates with sharp weights and boundary observability for wave operators with critically singular potentials*, J. Eur. Math. Soc. 23 (2021), 3459–3495
   arXiv: *http://www.arxiv.org/abs/1902.00068*

9. A. McGill, A. Shao, *Null Geodesics and Improved Unique Continuation for Waves in Asymptotically Anti-de Sitter Spacetimes*, Class. Quantum Grav., 38 (2020), 054001
   arXiv: *http://www.arxiv.org/abs/2008.07416*

10. A. Shao, *The Near-Boundary Geometry of Einstein-Vacuum Asymptotically Anti-de Sitter Spacetimes*, Class. Quantum Grav., 38 (2020), 034001
    arXiv: *http://www.arxiv.org/abs/2008.07396*

11. A. Shao, *On Carleman and observability estimates for wave equations on time-dependent domains*, Proc. Lond. Math. Soc., 119 (2019)
    arXiv: *http://www.arxiv.org/abs/1805.07859*

12. G. Holzegel, A. Shao, *Unique continuation from infinity in asymptotically Anti-de Sitter spacetimes II: Non-static boundaries*, Comm. Partial Differential Equations, 42 (2017), 1871–1922
    arXiv: *http://www.arxiv.org/abs/1608.07521*

13. G. Holzegel, A. Shao, *Unique continuation from infinity in asymptotically Anti-de Sitter spacetimes*, Commun. Math. Phys., 347 (2016), 1–53
    arXiv: *http://www.arxiv.org/abs/1508.03820*

14. S. Alexakis, A. Shao, *On the profile of energy concentration for subconformal focusing nonlinear waves*, Trans. Amer. Math. Soc., 369 (2017), 5525–5542
    arXiv: *http://www.arxiv.org/abs/1412.6844*

15. S. Alexakis, A. Shao, *Global uniqueness theorems for linear and nonlinear waves*, J. Funct. Anal., 269 (2015), 3458–3499
    arXiv: *http://www.arxiv.org/abs/1412.1537*

16. S. Alexakis, V. Schlue, A. Shao, *Unique continuation from infinity for linear waves*, Adv. Math., 286 (2016), 481–544
    arXiv: *http://www.arxiv.org/abs/1312.1989*

17. S. Alexakis, A. Shao, *Bounds on the Bondi energy and momentum by the flux of curvature*, J. Eur. Math. Soc., 18 (2016), 2045–2106
    arXiv: *http://www.arxiv.org/abs/1308.4170*

18. S. Alexakis, A. Shao, *On the geometry of null cones to infinity under curvature flux bounds*, Class. Quantum Grav., 31 (2014) 195012
    arXiv: *http://www.arxiv.org/abs/1303.1260*

19. D. Egli, J. Fröhlich, Z. Gang, A. Shao, I.M. Sigal, *Hamiltonian dynamics of a particle interacting with a wave field*, Comm. Partial Differential Equations, 38 (2013), 2155–2198
    arXiv: *http://www.arxiv.org/abs/1211.6154*

20. A. Shao, *New tensorial estimates in Besov spaces for time-dependent* $(2+1)$*-dimensional problems*, J. Hyperbol. Differ. Eq., 11 (2014), 821–908
    arXiv: *http://www.arxiv.org/abs/1202.1295*

21. A. Shao, *On breakdown criteria for nonvacuum Einstein equations*, Annales Henri Poincaré, 12 (2011), 205–277
    arXiv: *http://www.arxiv.org/abs/1008.1605*

22. A. Shao, *A generalized representation formula for systems of tensor wave equations*, Commun. Math. Phys., 306 (2011), 51–82
    arXiv: *http://www.arxiv.org/abs/1005.4509*

Seminar Proceedings

1. A. Shao, *Control of parabolic equations with inverse square infinite potential wells*, Ghent Analysis Center, Research Perspectives, 3 (2024) 177–188

2. A. Shao, *Bulk-boundary correspondences and unique continuation in asymptotically anti-de Sitter spacetimes*, MATRIX Annals, (2021–2022)

3. A. Shao, *On controllability of waves and geometric Carleman estimates*, Séminaire Laurent Schwartz — EDP et applications, (2018–2019)

Dissertation

1. A. Shao, *Breakdown Criteria for Nonvacuum Einstein Equations*,
   PhD thesis, Princeton University, Jun. 2010