Shengquan Xiang

Curriculum Vitae

Peking University
School of Mathematical Sciences
shengquan.xiang@math.pku.edu.cn
www.math.pku.edu.cn/teachers/sxiang/site/

Personal information

Birth Sep 26, 1992, China

Language Chinese(native), French(fluent), English(fluent), German(basic)

Professional experience

Oct 2022 – present **Peking University**
Assistant professor and Researcher, School of Mathematical Sciences
Boya Young Fellow (since 2025)

Sep 2019 – Sep 2022 **École polytechnique fédérale de Lausanne (EPFL)**
Research Scientist (postdoc)

Jan 2017 – Dec 2017 **ETH (Zürich)**
Research Fellow at ETH-FIM

Education

Sep 2016 – Jun 2019 **Sorbonne Université (Paris)**
Ph.D. degree, advisor: Jean-Michel Coron
Stabilisation rapide d'équations de Burgers et de Korteweg-de Vries

Sep 2013 – Aug 2016 **École Normale Supérieure (Paris)**, Concours Sélection Internationale
Le Diplôme de l'ENS, 2017
M.Sc. degree (Paris 7), Mathematics, 2015

Sep 2010 – Jul 2015 **Peking University (Beijing)**
B.Sc. degree, Pure mathematics. *Diploma of Sciences* (2015)

Editorial activities

Since 2025 (Associate Editor) ESAIM: Control, Optimisation and Calculus of Variations

Visiting positions

2025 – 2026 CY Advanced Studies, Cergy Paris Université
○ Visiting Professorship, two weeks every year (2025.09, 2026.06)

Jun 2023 l'Ecole des Ponts Paristech (Paris)
○ Bézout Invited Professor, one month

Feb 2022 Oberwolfach (Germany)
○ Oberwolfach Research Fellow

Honors and Awards

Since 2025	Boya Young Fellow, Peking University
2024	IEEE ITS Institutional Lead Award (attributed to CIRCLES project)
2023	Bézout invited professorship
2022	Oberwolfach Research Fellow
2018	Chinese government award for outstanding graduate students abroad
2010	Member of the national mathematical olympiad training team of China

Grants and Projects

2026-2029	Control problems for KdV equations, NSFC (12571474), PI, 430,000 CNY
2024-2026	Stabilization problems and Fredholm backstepping, NSFC (12301562), PI, 300,000 CNY
2024	Overseas distinguished scholars lecture program (PKU), PI, 60,000 CNY
2023-2025	Some control problems for fluid models, Starting grant (PKU), PI, 400,000 CNY
2023-2028	Physical modelling and mathematical theory of liquid crystal (member), NSFC (12288101)
2020-2022	CIRCLES project on autonomous vehicles (member)
2017-2019	ANR Finite4SoS (member), Inria équipe CAGE (member)
2015	FSMP grant for master project, 1,500 Euros

Advising experiences

PhD students (current)

Wang Junyan	Pré-thèse, will officially start from 2026.09 (co-supervisor Gengsheng Wang)
Huang Bin	2025.09–present
Xiao Yu	2025.09–present (co-supervisor Can Zhang, officially at Wuhan University)
Lu Baoru	2024.09–present
Zhang Yusheng	2024.09–present (co-supervisor Zhifei Zhang)
Chen Yuxuan	2022.09–present (co-supervisor Zhifei Zhang)

Postdoctoral researchers (current)

Cao Hongyi	2025.07–present
Dong Huan	2025.07–present

Postdoctoral researchers (former)

Liu Ziyu	2023.07–2025.06 (co-mentor Zhifei Zhang) Now assistant professor at University of Science and Technology Beijing
Zhao Jia-Cheng	2023.04–2025.09. Now assistant professor at Shenzhen University

Selected undergraduate and master students

Peking University (Beijing).

2025–present Wang Junyan (undergraduate research): *Observability for some dispersive equations*

2025–present Zhu Hongjiang (undergraduate research): *Nonlinear control problems*

2024–2025 Meng Chengke (undergraduate research): *Control problems from a dynamical point of view*

2024–2025 Feng Junhe (undergraduate research): *Control problems from a dynamical point of view*

2023–2024 Lu Baoru (bachelor thesis): *On the controllability of the viscous Burgers equation*

EPFL (Lausanne), *supervise bachelor and master students*.

2021–2022 Nathan Schaeffer (bachelor project): *Exact controllability of the nonlinear transport equation*

2021–2022 Essayouti Mohamed (bachelor project): *Stability and stabilization of traffic jams using a single autonomous vehicle*

2020–2021 Haeberle Matthieu Nicolas (master thesis): *Semiclassical Weyl's law*

2020–2021 Müller Benoît (bachelor project): *On the dynamics of Lotka-Volterra systems and its application*

2020–2021 Vincent Valterio (master project): *Exact controllability of a linearized KdV equation on interval*

2019–2020 Brunner Nathan (bachelor project): *Controllability of a one-dimensional wave equation*

IMSP (Bénin), *supervise a master student*.

2020–2021 Méricel Ayamou (master thesis): *Local controllability and stability of a KdV equation on interval*

Research

My research focuses on controlled partial differential equations, with connections to random dynamical systems. A central theme of my work is the role of control as an organizing principle for revealing structure in problems arising in geometry, propagation, and randomness.

My work includes controlled geometric flows of maps, structural aspects of controllability and observability for wave and dispersive equations, mixing and ergodic properties of randomly forced PDEs, and quantitative stabilization.

- **Controlled geometric flows of maps**
  In [12, 17, 18, 28] we initiated the research topic on the controlled geometric flows of maps, based on the heat flow and wave maps, where control acts as an intrinsic mechanism within geometric evolution equations. In contrast to classical Euclidean control theory, geometric and topological features of the target manifold directly shape the evolution and its controllability, leading to phenomena absent in flat settings. This perspective reveals new mechanisms governing short-time global controllability and yields structural characterizations, such as equivalences between controllability and homotopy classes, highlighting a fundamentally geometric nature of controlled dynamics.

- **Structural aspects of controllability and observability for wave and dispersive equations**
  This research line studies controllability and observability for wave and dispersive equations from a structural perspective, emphasizing the interplay between propagation, geometry, and nonlinearity. A central contribution is the introduction of the Observable Symmetry Condition in a spacetime framework [30], which identifies an additional constraint complementing the classical geometric control condition (GCC) for wave equations.

- **Randomly forced wave and dispersive equations**
  We formulated a control-oriented framework for the study of mixing and long-time statistical behavior in randomly forced wave and dispersive equations, and obtained results for NLW [22], NLS [26], and KdV. Within this framework, our contributions identify three core driving mechanisms: exponential asymptotic compactness arising from dispersive nonlinear smoothing; global dissipation induced by localized damping; and, localized control and quantitative stabilization playing a central role in the mixing mechanism.

- **Quantitative stabilization**
  This line of work develops quantitative and constructive approaches to the stabilization of PDEs, focusing on how structural information from control, spectral, and operator-theoretic analyses can be translated into effective and implementable feedback mechanisms. Representative contributions include the frequency Lyapunov method [13] and related quantitative approaches to stabilization of nonlinear systems. This perspective also informs the methodology underlying the three research themes above.

- **Application: Smoothing traffic with autonomous vehicles (CIRCLES)**
  These applications illustrate how the theoretical developments can be deployed in concrete models. We designed algorithm on autonomous vehicles to stabilize stop-and-go waves, which has been used in MegaVanderTest (Nov 2022). This test deployed 100 vehicles, and was the largest coordinated open-road test to smooth traffic flow.

Selected Works (by topic)

Controlled geometric flows of maps

12) Semi-global controllability of a geometric wave equation (with Krieger), *PAMQ*, 2024

17) Global controllability and stabilization of the wave maps equation from a circle to a sphere (with Coron, Krieger), *CVPDE*, 2025

18) Global controllability to harmonic maps of the heat flow from a circle to a sphere (with Coron), *JMPA*, 2025.

28) Wave maps from circle to Riemannian manifold: global controllability is equivalent to homotopy (with Coron, Krieger), *preprint*, 2025

Structural aspects of controllability and observability for wave and dispersive equations

30) Symmetry for the wave equation on torus: sharp unique continuation and observability conditions for spacetime regions (with Niu, Wang), *preprint*, 2025

24) Small-time local controllability of a KdV system for all critical lengths (with Niu), *preprint*, 2025

1) Local exponential stabilization for a class of Korteweg-de Vries equations by means of time-varying feedback laws (with Coron, Rivas), *Anal. PDE*, 2017

Randomly forced wave and dispersive equations

22) Exponential mixing for random nonlinear wave equations: weak dissipation and localized control (with Liu, Wei, Zhang, Zhao)), *preprint*, 2024

26) Exponential mixing for the randomly forced NLS equation (with Chen, Zhang, Zhao), *preprint*, 2025

Quantitative stabilization

13) Quantitative rapid and finite time stabilization of the heat equation, *ESAIM: COCV*, 2024

3) Null controllability of a linearized Korteweg-de Vries equation by backstepping approach, *SICON*, 2019.

5) Small-time global stabilization of the viscous Burgers equation with three scalar controls (with Coron), *JMPA*, 2021

16) Fredholm backstepping for critical operators and application to rapid stabilization for the linearized water waves (with Gagnon, Hayat, Zhang), *Annales de l'institut Fourier*, 2025

Publications

1) Local exponential stabilization for a class of Korteweg-de Vries equations by means of time-varying feedback laws (with J.-M. Coron and I. Rivas), **Analysis** & **PDE** 10 (2017), no.5, 1089–1122.

2) Small-time local stabilization for a Korteweg-de Vries equation, **Systems** & **Control Letters** 111 (2018), 64–69.

3) Null controllability of a linearized Korteweg-de Vries equation by backstepping approach, **SIAM J. Control Optim.** 57(2), 1493–1515, 2019.

4) Cost for a controlled linear KdV equation (with J. Krieger), **ESAIM Control Optim. Calc. Var.**, 27 S21, 41p, 2021

5) Small-time global stabilization of the viscous Burgers equation with three scalar controls (with J.-M. Coron), **Journal de Mathématiques Pures et Appliquées**, 151(7), 212-256, 2021.

6) Stabilization of the linearized water tank system (with J.-M. Coron, A. Hayat, and C. Zhang), **Archive for Rational Mechanics and Analysis**, 244, 1019-1097, 2022.

7) Fredholm transformation on Laplacian and rapid stabilization for the heat equation (with L. Gagnon, A. Hayat, and C. Zhang), **Journal of Functional Analysis**, 283 (12), 67pp., 2022.

8) Small-time local stabilization of the two dimensional incompressible Navier-Stokes equations, **Annales de l'I.H.P. Analyse non linéaire**, 40 (6), 2023.

9) On the global approximate controllability in small time of semiclassical 1-D Schrödinger equations between two states with positive quantum densities (with J.-M. Coron and P. Zhang), **Journal of Differential Equations**, 345 (1), 1-44, 2023.

10) Stability of multi-population traffic flows (with A. Hayat and B. Piccoli), **Networks and Heterogeneous Media**, special issue by invitation to traffic control via automated vehicles no. 2, 877–905, 2023.

11) Boundary stabilization of focusing NLKG near unstable equilibria: radial case (with J. Krieger), **Pure and Applied Analysis**, 62pp., 2023

12) Semi-global controllability of a geometric wave equation (with J. Krieger), **Pure and Applied Mathematics Quarterly**, special issue by invitation to Demetrios Christodoulou's 70th birthday, 20 (4) 61pp., 2024

13) Quantitative rapid and finite time stabilization of the heat equation, **ESAIM Control Optim. Calc. Var.**, 40, 25pp., 2024

14) Traffic smoothing via connected & automated vehicles: A modular, hierarchical control design deployed in a 100-cav flow smoothing experiment (with A. Bayen, A. Hayat, B. Piccoli et. al.), **IEEE Control Systems**, 2025

15) Traffic smoothing using explicit local controllers (with A. Bayen, A. Hayat, B. Piccoli et. al.), **IEEE Control Systems**, 2025

16) Fredholm backstepping for critical operators and application to rapid stabilization for the linearized water waves (with L. Gagnon, A. Hayat, and C. Zhang), 79pp, **Annales de l'institut Fourier**, 2025

17) Global controllability and stabilization of the wave maps equation from a circle to a sphere (with J.-M. Coron and J. Krieger), **Calculus of Variations and Partial Differential Equations**, 2025

18) Global controllability to harmonic maps of the heat flow from a circle to a sphere (with J.-M. Coron), **Journal de Mathématiques Pures et Appliquées**, 2025.

19) Exponential mixing for the Boussinesq equation with Haar coloured noise (with Z. Liu and J.-C. Zhao), **Journal of Dynamics and Differential Equations**, special issue by invitation to stochasic dynamics 2025.

20) Sharp control cost for dispersive equations on the torus (with J. Niu and M. Wang), 30pp, **Chinese Annals of Mathematics (series B)**, special issue by invitation to Jean-Michel Coron's 70th birthday.

21) Donsker-Varadhan large deviation principle for locally damped and randomly forced NLS equations (with Y. Chen), **Annales Henri Poincaré** to appear

Preprints

22) Exponential mixing for random nonlinear wave equations: weak dissipation and localized control (with Z. Liu, D. Wei, Z. Zhang, and J.-C. Zhao)), **preprint** arXiv:2407.15058 (2024), 79pp, submitted

23) Local large deviations for randomly forced nonlinear wave equations with localized damping, (with Y. Chen, Z. Liu, and Z. Zhang), **preprint** arXiv:2409.11717 (2024), 37pp, submitted

24) Small-time local controllability of a KdV system for all critical lengths (with J. Niu), **preprint** arXiv:2501.13640 (2025), 49pp, submitted

25) Quantum ergodicity for Dirichlet-truncated operators on $\mathbb{Z}^d$ (with H. Cao), **preprint** arXiv:2505.02339 (2025), 23pp, submitted

26) Exponential mixing for the randomly forced NLS equation (with Y. Chen, Z. Zhang, and J.-C. Zhao), **preprint** arXiv:2506.10318 (2025), 60pp, submitted

27) The periodic KdV with control on space-time measurable sets (with J. Niu and M. Wang), **preprint** arXiv:2507.13740v1 (2025), 37pp, submitted

28) Wave maps from circle to Riemannian manifold: global controllability is equivalent to homotopy (with J.-M. Coron and J. Krieger), **preprint** arXiv:2509.12779 (2025), 95pp, submitted

29) An abstract setting for the Fredholm backstepping transformation: self-adjoint case (with L. Gagnon, A. Hayat, S. Marx, and C. Zhang), **preprint** hal-05354436, 74pp

30) Symmetry conditions for spacetime observability of wave equations on the torus (with J. Niu and M. Wang), **preprint** arXiv:2512.09873, 31pp

Teaching

Peking University, *in Chinese*.

Fall 2023-2025 Linear Algebra B

Spring 2024-2025 Calculus A or B

Spring 2023 Topics in PDEs Control (master course)

EPFL (Lausanne), *in French and English*.

2019–2021 TA for Harmonic Analysis, ODE

ETH (Zürich), *in English*.

2017 TA for Functional Analysis, Measure and Integration

Sorbonne Université (Paris), *in French*.

2016 TA for Analyse et algèbre pour les sciences

Chinese Academy of Sciences (Beijing), *in Chinese*.

2019 Nonlinear Geometric Control (12 hours mini course)

2016 Control Theory (10 hours mini course)

Research presentations

Conferences.

Oct 2026 (planned) Sino-French conference on PDE control, in honor of Professor Jean-Michel Coron for his 70th birthday, Chengdu

Sep 2026 (planned) Recent Trends in Applied Mathematics and Machine Learning 2026, Jilin

Jul 2026 (planned) The 15th AIMS conference: from PDE control to the qualitative study of (random) dynamical systems, Athens

Jun 2026 (planned) PDE-constrained Optimization: Theory, Numerics and Applications, TianYuan Mathematical Research Center, Yunnan

Apr 2026 (planned) NYU Shanghai–Peking–Westlake Probability conference, Beijing

Nov 2025 CSIAM conference on system and control 2025, Sanya

Sep 2025 Quantissima-sur-Oise conference on quantum theory, CY Advanced Studies, Paris

Jul 2025 Control of PDEs and related topics conference, Toulouse, France

Jun 2025 Analysis and Computation of dispersive PDE and fluid dynamics conference, IHP, Paris

Aug 2024 Partial Differential Equations: Deterministic and Probabilistic conference, Banff International Research Station (IAS-Hangzhou)

Jun 2024 Random and stochastic dynamics conference, Qingdao

Nov 2023 Sino-Russian Interdisciplinary Mathematical Conference, Beijing

Aug 2023 Speaker at Minisymposium, International Council for Industrial and Applied Mathematics (ICIAM), Tokyo

Aug 2023 14th Chinese Control Theory Conference, Chengdu

Jul 2023 Fluid Mechanics Conference, Tianyuan Mathematics Center, Yunnan

Jun 2023 Traffic and Autonomy conference, Amalfi Coast, Italy

Aug 2018 ICM 2018, 20 min communication session, Rio de Janeiro

Jun 2017 Congrès SMAI, Ronce-les-Bains

Workshops.

Oct 2025 PDEs control workshop, Shantou (online)

Sep 2025 PDE control youth workshop, Taiyuan

May 2025 Mathematical control youth workshop, Shenzhen

Apr 2025 Dispersive equations and related topics youth workshop, Beijing

May 2024 Miniworkshop on Partial Differential Equations, Capital Normal University, Beijing

Mar 2024 PDEs workshop, Beijing

Nov 2023 PDEs control workshop, Chengdu

Feb 2023 Hydrodynamics workshop, Peking University, Beijing

Jul 2021 Loo-Keng Hua forum (5 hours including 1 hour of School Colloquium), Chinese Acamady of Sciences, Beijing

Jun 2019 Journée jeunes contrôleurs Workshop, Sorbonne Université, Paris

Mar 2018 Journée Finite4SoS, École des Mines, Paris

Colloquiums and Seminars.

Feb 2026 (planned) Groupe de Travail Contrôle, Paris

Nov 2025 PDE seminar, Shenzhen University, Shenzhen

Nov 2025 Applied mathematics seminar, Wuhan University, Wuhan

Nov 2025 Joint UNSW - USYD Stochastic PDEs Seminar, University of Sydney and University of New South Wales (online)

Oct 2025 Stochastic analysis seminar, Chinese Academy of Sciences, Beijing

Sep 2025 PDE seminar, Zhongshan University (Zhuhai), Zhuhai

Apr 2025	Control and stochastic seminar, Fudan University, Shanghai
Apr 2025	Stochastic webinar, China
Apr 2025	Control seminar, Sichuan University, Chengdu
Mar 2025	Control theory seminar, Northeast Normal University, Changchun
Feb 2025	Mathematics department Colloquium, Peking University, Beijing
Dec 2024	PDE seminar, Chinese Academy of Sciences, Beijing
Nov 2024	Control seminar, Central South University, Changsha
Oct 2024	Applied mathematics seminar, Shandong University, Jinan
May 2024	ECNU-NYU Shanghai Day Mathematics Colloquium, Shanghai
Apr 2024	Seminar on PDE Control, Chengdu
Jun 2023	Bezout Labex Colloquium, CERMICS, Paris
May 2023	Control theory seminar, Northeast Normal University, Changchun
May 2023	PDE seminar, NYU-Shanghai, Shanghai
Mar 2023	Analysis and PDE seminar, Peking University, Beijing
Feb 2023	Control seminar, Wuhan University, Wuhan
Nov 2022	Analysis and PDE seminar, Fudan University, Shanghai
Jul 2022	DCN-seminar, FAU Erlangen-Nürnberg university, Germany
Apr 2022	Séminaire du CERMICS, l'Ecole des Ponts Paristech, Paris
Mar 2022	PDE seminar, Chinese Acamady of Sciences, Beijing
Jan 2022	Séminaire du SPHINX, Institut Élie Cartan de Lorraine, Nancy
Jun 2021	Analysis and PDE seminar, Peking University, Beijing
Feb 2021	Control in Times of Crisis Online seminar
Jan 2021	Automatic and Control seminar, Grenoble
Jan 2020	PDE seminar, Academy of Mathematics and Systems Science (CAS), Beijing
Jan 2020	PDE seminar, Wuhan University, Wuhan
Aug 2019	Analysis and PDE seminar, Peking University, Beijing
Apr 2019	Mathematical school seminar, Shandong University, Jinan
Mar 2019	Analysis and PDE seminar, Peking University, Beijing
Oct 2018	Groupe de Travail des Thésards, Sorbonne Université, Paris
Sep 2018	Analysis and PDE seminar, Fudan University, Shanghai
Sep 2018	Mini lecture (3 hours), NYU Shanghai, Shanghai
Sep 2018	Réunion CAGE, Inria, Paris
Apr 2018	Analysis and PDE seminar, Peking University, Beijing
Apr 2018	PDE seminar, Academy of Mathematics and Systems Science (CAS), Beijing
Dec 2017	Graduate Analysis Seminar, ETH, Zürich
Aug 2016	Analysis and PDE seminar, Fudan University, Shanghai
Jul 2016	PDE seminar, BICMR, Beijing
Jul 2016	PDE seminar, Academy of Mathematics and Systems Science (CAS), Beijing
May 2016	Groupe de Travail EDP, École des Mines, Paris
May 2016	Groupe de Travail des Thésards, Sorbonne Université, Paris

Academic activities

Committee

Evaluation for grant application to National Natural Science Foundation of China, 2025–present

Blind reviewer for China's PhD dissertation evaluation system (section: PDE, control), 2024–present

Evaluation for postdoc application to Peking University, 2023–present

Selection and evaluation for PhD students application to Peking University, 2023–present

Jury

Chen Yilin (PhD defence, advisor Zhifei Zhang and Weijun Xu)

Cao Hongyi (PhD defence, advisor Zhifei Zhang)

Conference

Co-organizer of minisymposium *Control and stabilization of PDEs: recent advances and applications* at ICIAM 2023, Tokyo

Seminar

Co-organizer of *Analysis and PDE* seminar at School of Mathematical Sciences, Peking University, 2023–present

Workshop

Co-organizer of *Mathematical aspects of fluid equations workshop* mini-course (Jan 2026), Peking University

Organizer of *Random dynamical systems* mini-course (May 2025), Peking University

Co-organizer of *Mathematical Control Day* workshop(Apr 2025), Peking University

Organizer of *Harmonic Analysis and Observability* workshop (Nov 2024), Peking University

Co-organizer of *PDE workshop* (Apr 2023), Peking University

Co-organizer of *Mathematical control theory* mini-course at BICMR (Apr 2023), Peking University

Referee

Evaluation of more than ten papers per year.

Journal de Mathématiques Pures et Appliquées, Trans. Amer. Math. Soc., Comptes Rendus Mathematiques, Communications in Mathematical Sciences, Communications in Contemporary Mathematics, Science China Mathematics

Archive for Rational Mechanics and Analysis , Calculus of Variations and Partial Differential Equations, Journal of Differential Equations, Advances in Differential Equations, Differential and Integral Equations, Journal of Evolution Equations, Journal of Mathematical Physics, Acta Applicandae Mathematicae, Journal of Mathematical Analysis and Applications, Nonlinearity

SIAM Journal on Control and Optimization, ESAIM: COCV, Automatica IEEE Transactions on Automatic Control, Applied Mathematics and Optimization, Mathematical Control and Related Fields, Mathematics of Control Signals and Systems, Systems & Control Letters, Evolution Equations and Control Theory, European Journal of Control, Networks and Heterogeneous Media, Journal of Dynamical and Control Systems

Annals of Applied Probability