

# Shengquan Xiang

## Curriculum Vitae

Peking University  
School of Mathematical Sciences  
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🌐 [www.math.pku.edu.cn/teachers/sxiang/site/](http://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, registered in 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 explores controlled partial differential equations and random dynamical systems. A central theme of my work is the role of control as an organizing principle for uncovering structural mechanisms across 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.

### o **Controlled geometric flows of maps**

In [12, 17, 18, 25] 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 discovery of the Observable Symmetry Condition in a spacetime framework [28], which provides a completion of the classical geometric control condition (GCC) for wave equations. These structural ideas extend naturally to KdV equations and semiclassical nonlinear Schrödinger 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 [19], NLS [23], 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.
- 25) 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

- 28) Symmetry for the wave equation on torus: sharp unique continuation and observability conditions for spacetime regions (with Niu, Wang), *preprint*, 2025
- 21) 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

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

## Preprints

- 19) 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
- 20) 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
- 21) Small-time local controllability of a KdV system for all critical lengths (with J. Niu), **preprint** arXiv:2501.13640 (2025), 49pp, submitted
- 22) Quantum ergodicity for Dirichlet-truncated operators on  $\mathbb{Z}^d$  (with H. Cao), **preprint** arXiv:2505.02339 (2025), 23pp, submitted
- 23) Exponential mixing for the randomly forced NLS equation (with Y. Chen, Z. Zhang, and J.-C. Zhao), **preprint** arXiv:2506.10318 (2025), 60pp, submitted
- 24) The periodic KdV with control on space-time measurable sets (with J. Niu and M. Wang), **preprint** arXiv:2507.13740v1 (2025), 37pp, submitted

- 25) 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
- 26) Donsker-Varadhan large deviation principle for locally damped and randomly forced NLS equations (with Y. Chen), **preprint** arXiv:2510.24119, 19pp, submitted
- 27) 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
- 28) Symmetry for the wave equation on torus: sharp unique continuation and observability conditions for spacetime regions (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 Academy of Sciences, Beijing

Jun 2019 Journée jeunes contrôleur 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 Academy 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

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## Academic activities

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| Committee  | Evaluation for grant application to National Natural Science Foundation of China, 2025–present<br>Blind reviewer for China's PhD dissertation evaluation system (section: PDE, control), 2024–present<br>Evaluation for postdoc application to Peking University, 2023–present<br>Selection and evaluation for PhD students application to Peking University, 2023–present   |
| Jury       | Chen Yilin (PhD defence, advisor Zhifei Zhang and Weijun Xu)<br>Cao Hongyi (PhD defence, advisor Zhifei Zhang)   |
| Conference | Co-organizer of minisymposium <i>Control and stabilization of PDEs: recent advances and applications</i> at ICIAM 2023, Tokyo  |
| Seminar    | Co-organizer of <i>Analysis and PDE</i> seminar at School of Mathematical Sciences, Peking University, 2023–present  |
| Workshop   | Co-organizer of <i>Mathematical aspects of fluid equations workshop</i> mini-course (Jan 2026), Peking University<br>Organizer of <i>Random dynamical systems</i> mini-course (May 2025), Peking University<br>Co-organizer of <i>Mathematical Control Day</i> workshop (Apr 2025), Peking University<br>Organizer of <i>Harmonic Analysis and Observability</i> workshop (Nov 2024), Peking University<br>Co-organizer of <i>PDE workshop</i> (Apr 2023), Peking University<br>Co-organizer of <i>Mathematical control theory</i> mini-course at BICMR (Apr 2023), Peking University  |
| Referee    | Evaluation of more than ten papers per year.<br><br><i>Journal de Mathématiques Pures et Appliquées</i> , <i>Trans. Amer. Math. Soc.</i> ,<br><i>Comptes Rendus Mathématiques</i> , <i>Communications in Mathematical Sciences</i> ,<br><i>Communications in Contemporary Mathematics</i> , <i>Science China Mathematics</i><br><br><i>Archive for Rational Mechanics and Analysis</i> , <i>Calculus of Variations and Partial Differential Equations</i> , <i>Journal of Differential Equations</i> , <i>Advances in Differential Equations</i> , <i>Differential and Integral Equations</i> , <i>Journal of Evolution Equations</i> , <i>Journal of Mathematical Physics</i> , <i>Acta Applicandae Mathematicae</i> , <i>Journal of Mathematical Analysis and Applications</i> , <i>Nonlinearity</i><br><br><i>SIAM Journal on Control and Optimization</i> , <i>ESAIM: COCV</i> , <i>Automatica</i> ,<br><i>IEEE Transactions on Automatic Control</i> , <i>Applied Mathematics and Optimization</i> ,<br><i>Mathematical Control and Related Fields</i> , <i>Mathematics of Control Signals and Systems</i> , <i>Systems &amp; Control Letters</i> , <i>Evolution Equations and Control Theory</i> ,<br><i>European Journal of Control</i> , <i>Networks and Heterogeneous Media</i> , <i>Journal of Dynamical and Control Systems</i><br><br><i>Annals of Applied Probability</i> |