

# Shiping Liu

*Curriculum Vitae*

## Personal Data

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Date of Birth: 21 July, 1984  
Place of Birth: Shandong Province, China  
Gender: Male  
Nationality: China

## Contact Information

Address: School of Mathematical Sciences  
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## Education

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2008–2012 **Ph. D. (Dr. rer. nat.)**, *CAS-MPG Doctoral Promotion Programme*,  
Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany.  
2006–2008 Postgraduate student majored in *Geometric analysis*,  
Institute of Mathematics, Academy of Mathematics and Systems Science,  
Chinese Academy of Sciences (CAS), Beijing, China.  
2002–2006 **B. Sc.**, School of Mathematics, Shandong University, Ji'nan, China.

## Ph. D. Thesis

Title: Synthetic notions of curvature and applications in graph theory  
University of Leipzig, 2012. Supervisor: Prof. Dr. Jürgen Jost

## Employment History

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Oct. 2016– Professor (The Young Thousand Talents Plan)  
School of Mathematical Sciences,  
University of Science and Technology of China, Hefei, China  
Oct. 2013– Sep. 2016 Research Associate  
Department of Mathematical Sciences, Durham University  
Durham, United Kingdom  
Dec. 2012–Sep. 2013 Postdoc Researcher  
Max Planck Institute for Mathematics in the Sciences  
Leipzig, Germany

## Research interests

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- Spectral geometry: interaction between discrete and continuous spectral analysis, interaction with theoretical computer sciences.
- Discrete geometry: discrete curvatures and applications
- Geometric analysis on spaces with synthetic curvature bounds
- Expander graphs and extensions

## Publications

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### Preprints

6. (with David Cushing, Supanat Kamtue, Riikka Kangaslampi and Norbert Peyerimhoff) *Curvature, graph products and Ricci flatness*, arXiv 1909.11565.
5. (with D. Cushing, S. Kamtue, J. Koolen, F. Münch and N. Peyerimhoff) *Rigidity of the Bonnet-Myers inequality for graphs with respect to Ollivier Ricci curvature*, arXiv 1807.02384.
4. (with M. Keller and N. Peyerimhoff) *A note on eigenvalue bounds for non-compact manifolds*, arXiv 1706.02437.
3. (with F. Münch and N. Peyerimhoff) *Rigidity properties of the hypercubes via Bakry-Émery curvature*, arXiv 1705.06789.
2. *An optimal dimension-free upper bound for eigenvalue ratios*, arXiv 1405.2213.
1. W. Li, J. Gu, **S. Liu**, Y. Zhu, S. Deng, L. Zhao, J. Han, X. Cai, *Optimal Transport in Worldwide Metro Networks*, arXiv:1403.7844.

### Published or accepted articles

24. (with M. Bonnefont, S. Golénia, M. Keller and F. Münch) *Magnetic sparseness and Schrödinger operators on graphs*, **Ann. Henri Poincaré**, accepted.
23. (with D. Cushing, R. Kangaslampi, V. Lipiäinen and G. W. Stagg) *The graph curvature calculator and the curvature of cubic graphs*, **Exp. Math.**, published online.
22. (with D. Cushing, R. Kangaslampi, Y. Lin, L. Lu and S.-T. Yau) *Ricci-flat cubic graphs with girth five*, **Comm. Anal. Geom.**, accepted.
21. (with D. Cushing, R. Kangaslampi, Y. Lin, L. Lu and S.-T. Yau) *Erratum for Ricci-flat graphs with girth at least five*, **Comm. Anal. Geom.**, accepted.
20. (with F. M. Atay) *Cheeger constants, structural balance, and spectral clustering analysis for signed graphs*, **Discrete Math.**, published online.
19. (with N. Peyerimhoff and A. Vdovina) *Signatures, lifts, and eigenvalues of graphs*, accepted in: *Discrete and Continuous Models in the Theory of Networks* (F. Atay, P. Kurasov and D. Mugnolo Eds.), **Operator Theory: Advances and Applications**, Springer.

18. (with D. Cushing, F. Münch and N. Peyerimhoff) *Curvature calculations for antitrees*, accepted in: *Analysis and geometry on graphs and manifolds* (M. Keller, D. Lenz and R. Wojciechowski Eds.), **London Mathematical Society Lecture Notes Series**, Cambridge University Press.
17. (with F. Münch, N. Peyerimhoff and C. Rose) *Distance bounds for graphs with some negative Bakry-Émery curvature*, **Anal. Geom. Metr. Spaces** 7 (2019), no. 1, 1-14.
16. (with M. Egidi, F. Münch, and N. Peyerimhoff) *Ricci curvature and eigenvalue estimates for the magnetic Laplacian on manifolds*, **Comm. Anal. Geom.**, accepted.
15. (with F. Münch and N. Peyerimhoff) *Curvature and higher order Buser inequalities for the graph connection Laplacian*, **SIAM J. Discrete Math.** 33 (2019), no. 1, 257-305.
14. A. Samal, R. P. Sreejith, J. Gu, S. Liu, E. Saucan and J. Jost, *Comparative analysis of two discretizations of Ricci curvature for complex networks*, **Scientific Reports** 8 (2018), Article Number 8650.
13. (with D. Cushing and N. Peyerimhoff) *Bakry-Émery curvature functions of graphs*, **Canad. J. Math.**, published online.
12. (with D. Cushing and N. Peyerimhoff) *Bakry-Émery curvature and diameter bounds on graphs*, **Calc. Var. Partial Differential Equations** 57 (2018), no. 2, Article 67.
11. (with D. Bourne, D. Cushing, F. Münch and N. Peyerimhoff) *Ollivier-Ricci idleness functions of graphs*, **SIAM J. Discrete Math.** 32 (2018), no. 2, 1408-1424.
10. (with N. Peyerimhoff) *Eigenvalue ratios of nonnegatively curved graphs*, **Combin. Probab. Comput.** 27 (2018), no. 5, 829-850.
9. (with B. Hua and C. Xia) *Liouville theorems for  $f$ -harmonic maps into Hadamard spaces*, **Pacific J. Math.** (2017), no. 2, 381-402.
8. (with C. Lange, N. Peyerimhoff and O. Post) *Frustration index and Cheeger inequalities for discrete and continuous magnetic Laplacians*, **Calc. Var. Partial Differential Equations** 54 (2015), no. 4, 4165-4196.
7. (with J. Gu, J. Jost, P. F. Stadler) *Spectral classes of regular, random, and empirical graphs*, **Linear Algebra Appl.** 489 (2016), 30-49.
6. (with J. Gu, B. Hua) *Spectral distances on graphs*, **Discrete Appl. Math.** 190/191 (2015), 56-74.
5. *Multi-way dual Cheeger constants and spectral bounds of graphs*, **Adv. Math.** 268 (2015), 306-338.
4. (with B. Hua, J. Jost) *Geometric analysis aspects of infinite semiplanar graphs with nonnegative curvature*, **J. Reine Angew. Math.** 700 (2015), 1-36.

3. (with F. Bauer, J. Jost) *Ollivier-Ricci curvature and the spectrum of the normalized graph Laplace operator*, **Math. Res. Lett.** 19(6), 2012, pp. 1185–1205.
2. (with J. Jost) *Ollivier's Ricci curvature, local clustering and curvature dimension inequalities on graphs*, **Discrete Comput. Geom.** 51(2), 2014, pp. 300–322.
1. *Gradient estimates for solutions of the heat equation under Ricci flow*, **Pacific J. Math.** 243(1), 2009, pp. 165–180.

### Book chapter

1. (with F. Bauer, B. Hua, J. Jost, G. Wang) *The geometric meaning of curvature. Local and nonlocal aspects of Ricci curvature*, a Chapter in **Modern Approaches to Discrete Curvature** edited by L. Najman and P. Romon, to appear in **Lecture Notes in Mathematics**, Springer.

### Conference Proceedings

2. *Cheeger constants with signatures and spectral clustering via quotient space metrics*, Mini-Workshop: Discrete p-Laplacians: Spectral Theory and Variational Methods in Mathematics and Computer Science, **Oberwolfach Reports**, 2015.
1. (with F. Bauer, B. Hua and J. Jost) *Generalized Ricci curvature and the geometry of graphs*, **Actes des rencontres du CIRM 3** (2013), no. 1: Discrete curvature: Theory and applications, 69-78.

## Academic Activities

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### Selected Invited Talks

- "Spherical graphs and discrete curvature notions" The International Conference and PhD-Master Summer School: Groups and Graphs, Designs and Dynamics (G2D2), China Three Gorges University, Yichang, August 24, 2019.
- "Discrete Ricci curvature and related graph classification problems" The 8th International Congress of Chinese Mathematicians (**ICCM 2019**), Tsinghua University, Beijing, June 9-14, 2019.
- "What are discrete spheres?" The 4th Workshop on Differential Geometry and Differential Equations, Suzhou Campus, Renmin University of China, September 1, 2018.
- "Discrete Bonnet-Myers Theorem and rigidity properties of hypercubes" Young Geometric Analysts Forum 2018, **TSIMF**, Sanya, February 02, 2018.
- "Magnetic sparseness and Schrödinger operators on graphs" Final Conference: Discrete and Continuous Models in the Theory of Networks, **ZiF, Bielefeld University**, November 27-December 1, 2017.
- "Discrete Bonnet-Myers Theorem and rigidity properties of hypercubes" TM02 Geometry and Topology, **Chinese Mathematical Society 2017 Annual Conference**, Xiangtan, October 20-24, 2017.

- "Magnetic sparseness and Schrödinger operators on graphs" International Conference "Analysis and PDEs on Manifolds", Nankai University, Tianjin, September 21-23, 2017.
- "Random metric partitions and higher order eigenvalue estimates" The Conference on Harmonic Analysis, 2017, University of Science and Technology of China, Hefei, May 28-June 3, 2017.
- "Bakry-Émery curvature functions of graphs" Workshop on Curvatures of Graphs, Simplicial Complexes and Metric Spaces, Tsinghua Sanya International Mathematics Forum (**TSIMF**), Sanya, Hainan, China, March 13-17, 2017.
- "Ricci curvature and eigenvalues estimates for discrete and continuous magnetic Laplacian" Workshop on spectral geometry, Fudan University, Shanghai, China, December 22-23, 2016.
- "Cheeger constant, spectral clustering and eigenvalue ratios of Laplacian" Workshop on Geometric analysis, Wuhan University, Wuhan, China, December 5, 2016.
- "Bakry-Émery curvature functions of graphs", BIRS Workshop Algebraic and Spectral Graph Theory, Banff International Research Station (**BIRS**), Canada, July 31-August 5, 2016.
- "Higher order Buser inequalities for the graph connection Laplacian", Conference Heat Kernels and Analysis on Manifolds and Fractals, a **satellite event of 7ECM**, Bielefeld University, Germany, July 11-16, 2016.
- "Higher order Buser inequalities for the graph connection Laplacian", **EPSRC Workshop** Geometry and Computation on Groups and Complexes, Newcastle University, Newcastle, UK, June 6-10, 2016.
- "Cheeger inequalities for magnetic Laplacians on graphs and manifolds", FUDAN-USTC Joint Workshop on Spectral Geometry, Fudan University, Shanghai, and University of Science and Technology of China, Hefei, China, December 12, 2015.
- "Cheeger constants and Eigenvalue ratios of the Laplacian", Differential Geometry Seminar, Graduate Center, City University of New York, November 5, 2015.
- "Signed Laplacians and Spectral Clustering Via Quotient Space Metrics", MS6: Recent Spectral Approaches for Graph Clustering, **SIAM Conference on Applied Linear Algebra**, Hyatt Regency Atlanta, Atlanta, Georgia, USA, October 26, 2015.
- "Cheeger constant, spectral clustering and eigenvalue ratios of Laplacian", Non-Combinatorial Combinatorics, Mathematics Institute, University of Warwick, September 16, 2015.
- "Eigenvalues of magnetic Laplacians on graphs and manifolds: Cheeger inequalities and Ramanujan property", Oberseminar Differentialgeometrie, **Max Planck Institute for Mathematics, Bonn**, Germany, July 9, 2015.
- "Cheeger inequalities for magnetic Laplacians", Oberseminar Geometric Analysis (*Prof. Alexander Grigor'yan*), University of Bielefeld, Germany, June 2, 2015.

- "Cheeger constants with signatures and spectral clustering via quotient space metrics", Mini-workshop: *Discrete  $p$ -Laplacians: Spectral Theory and Variational Methods in Mathematics and Computer Science*, Mathematisches Forschungsinstitut Oberwolfach (MFO), Germany, February 8-14, 2015.
- "Eigenvalue ratios on closed Riemannian manifolds with nonnegative Ricci curvature", Oberseminar Geometric Analysis (*Prof. Alexander Grigor'yan*), University of Bielefeld, Germany, November 18, 2014.
- "Spectral clustering via metrics of projective spaces", Summer Session 2014 ZiF cooperation group "*Discrete and Continuous Models in the Theory of Networks*", ZiF, University of Bielefeld, Germany, July 29, 2014.
- "Cheeger constant, spectral clustering and eigenvalue ratios of Laplacian", Oberseminar Geometrie, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, June 23, 2014.
- "Ricci curvature and spectra estimates on graphs", LMS-EPSC Durham Symposium: *Graph theory and interactions*, Durham University, UK, July 16, 2013.
- "Eigenvalues and number of common neighbors of finite graphs", Workshop 1 of ZiF cooperation group "*Discrete and Continuous Models in the Theory of Networks*", ZiF, University of Bielefeld, Germany, June 26, 2013.
- "Ricci curvature, local clustering and spectrum of finite graphs", Strukturtheorie-Seminar (*Prof. Wolfgang Woess*), Department of Mathematical Structure Theory, TU Graz, Austria, September 18, 2012.
- "Harmonic functions on infinite semiplanar graphs", Conference on Applications of Graph Spectra in Computer Science, CRM, Bellaterra (Barcelona), Spain, July 16-20, 2012.
- "Ollivier's Ricci curvature and neighborhood graphs", Arbeitsgruppenseminar (*Prof. Karl-Theodor Sturm*), Institut für Angewandte Mathematik, Universität Bonn, Germany, June 27, 2012.
- "Ollivier-Ricci curvature on neighborhood graphs", Oberseminar Analysis, Geometrie und Stochastik, Friedrich-Schiller-Universität Jena, Germany, November 16, 2011.
- "Ricci curvature and local clustering of graphs", Graduate student symposium at the TU Chemnitz within the International Summer School on "*Graphs and Spectra*", Chemnitz, Germany, July 18-23, 2011.
- "Curvature, random walks, and the spectrum of the graph Laplace operator", joint talk with *Dr. Frank Bauer* at the Spring School on "*Limits of finite graphs*", Leipzig, Germany, April 26-30, 2011.

## Poster presentation

- "Multi-way dual Cheeger constants and hostile spectral clustering", Electrical Flows, Graph Laplacians, and Algorithms: Spectral Graph Theory and Beyond, **ICER-M, Brown University**, Providence, USA, April 7-11, 2014.

### Longer visit

- Guest researcher, Max Planck Institute for Mathematics, Bonn, Germany, July 1-31, 2015.
- visit Prof. Alexander Grigor'yan in Bielefeld University, Germany, May 23-June 30, 2015.

### Scholarship and Awards

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- CAS-MPG Doctoral Promotion Programme, Chinese Academy of Sciences and Max Planck Society, 2008.
- Pan Chengdong Prize from Shandong University, 2005. (An award for outstanding students in Mathematics, in memory of *Prof. Chengdong Pan*, a mathematician and former president of Shandong University.)

### Services

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- Referee: Annales de la Faculté des Sciences de Toulouse, Axioms, European Journal of Combinatorics, Israel Journal of Mathematics, Discrete Applied Mathematics, Calculus of Variations and Partial Differential Equations, SIAM Journal on Computing, Communications in Analysis and Geometry, SCIENCE CHINA Mathematics, etc.
- Reviewer: Mathematical Reviews, since 2015.

### Professional Membership

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- Associate Member, London Mathematical Society, 2014-2016.

### Teaching experience

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- Riemannian Geometry, Spring semester 2017, 2018, 2019, University of Science and Technology of China.
- Differential Geometry, Autumn semester 2017, 2018, University of Science and Technology of China.
- (with N. Peyerimhoff) Level III and Level IV project supervision, academic year 2015/16, Durham University.
- Linear Algebra 1H Tutorials, academic year 2015/16, Durham University.

- Analysis 1H Tutorials, academic year 2014/15, Durham University.
- Minicourse: Optimal transport meets graph spectra, four lectures plus one tutorial, delivered to postgraduate students from Mathematics and Physics (in English, lecture notes developed partially based on my research articles), *Murray Gell-Mann Forum*, Central China Normal University, Wuhan, China, October 8-12, 2013.

## References

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