

# 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

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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. 2013- Current Research Associate  
Department of Mathematical Sciences, Durham University  
Durham, United Kingdom  
Oct. 2012-Sep. 2013 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

8. (with C. Lange, N. Peyerimhoff and O. Post) *Frustration index and Cheeger inequalities for discrete and continuous magnetic Laplacians*, submitted. arXiv:1502.06299.
7. (with N. Peyerimhoff and A. Vdovina) *Signatures, lifts, and eigenvalues of graphs*, submitted. arXiv:1412.6841.
6. (with F. M. Atay) *Cheeger constants, structural balance, and spectral clustering analysis for signed graphs*, submitted. arXiv:1411.3530.
5. (with J. Gu, J. Jost, P. F. Stadler) *Spectral classes of regular, random, and empirical graphs*, submitted. arXiv:1406.6454.
4. (with N. Peyerimhoff) *Eigenvalue ratios of nonnegatively curved graphs*, arXiv 1406.6617.
3. *An optimal dimension-free upper bound for eigenvalue ratios*, arXiv 1405.2213.
2. W. Li, J. Gu, **S. Liu**, Y. Zhu, S. Deng, L. Zhao, J. Han, X. Cai, *Optimal Transport in Worldwide Metro Networks*, submitted, arXiv:1403.7844.
1. (with B. Hua, C. Xia) *Liouville theorems for  $f$ -harmonic maps into Hadamard spaces*, submitted, arXiv:1305.0485.

### Published or accepted articles

6. (with J. Gu, B. Hua) *Spectral distances on graphs*, Discrete Appl. Math. (2015), in press.
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*, to appear as a chapter in a lecture notes volume about *Discrete Curvature* edited by P. Romon.

### 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.

### Teaching undergraduate and postgraduate students

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- 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.

### Academic Activities

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#### Invited Talks

- "Cheeger constant, spectral clustering and eigenvalue ratios of Laplacian", Seminar (*Dr. Xiaoli Han*), Department of Mathematical Sciences, Tsinghua University, Beijing, China, March 1, 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.

#### 2014

- "Eigenvalue ratios on closed Riemannian manifolds with nonnegative Ricci curvature", Oberseminar Geometric Analysis (*Prof. Alexander Grigor'yan*), University of Bielefeld, Germany, November 18, 2014.

- "Cheeger constant, spectral clustering and eigenvalue ratios of Laplacian", Algebra-Geometry seminar, School of Mathematics & Statistics, Newcastle University, UK, October 21, 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.
- "Multiway dual Cheeger constant and spectral clustering of graphs", Forschungsseminar Diskrete Geometrie (*Prof. Ivan Veselić*), TU Chemnitz, Germany, July 15, 2014
- "Cheeger constant, spectral clustering and eigenvalue ratios of Laplacian", Oberseminar Analysis, Geometrie und Stochastik, Friedrich-Schiller-Universität Jena, Germany, July 9, 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.

### 2013

- "Kendall-type theorem for generalized harmonic maps", Geometry and Topology Seminar, Durham University, UK, November 21, 2013.
- "Ricci curvature and spectra estimates on graphs", LMS-EPSRC 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.

### 2012

- "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.
- "Infinite semiplanar graphs with nonnegative combinatorial curvature", Symposia, School of Mathematics and Statistics, Wuhan University, Wuhan, China, March 17, 2012.

### 2011

- "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, ICERM, Brown University, Providence, USA, April 7-11, 2014.

### Other Participations

- January 6-9, 2015 Winter Meeting on Bruhat-Tits building, Imperial College London, UK.
- October 29, 2014, Yorkshire Durham Geometry Day, University of York, UK.
- October 23, 2013, Yorkshire Durham Geometry Day, University of York, UK.
- September 14, 2013, Workshop on Geometric aspects in probability and analysis, Friedrich-Schiller-Universität Jena, Germany.
- May 7-11, 2012, ERC Summer School on Analysis and Geometry in Metric Measure Spaces, Centro di Ricerca Matematica Ennio De Giorgi, Pisa, Italy.
- June 27-July 8, 2011, Séminaire de Mathématiques Supérieures (SMS) 50th edition, Metric Measure Spaces: Geometric and Analytic Aspects, Université de Montréal, Canada.
- July 23-24, 2009, Workshop Geometric Analysis and Riemannian Geometry, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany.
- March 29-April 4, 2009, Arbeitsgemeinschaft Optimal Transport and Geometry, organizers: *Prof. Felix Otto* and *Prof. Karl-Theodor Sturm*, Mathematisches Forschungsinstitut Oberwolfach (MFO), Germany.

I presented the talk 9, "*Formal Riemannian structure for space of probability measures, its sectional curvature*".

### Scholarship and Awards

- 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; Linear and Multilinear Algebra; Transport Problems.
- Reviewer for Mathematical Reviews, since 2015.

## Professional Membership

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- Associate Member, London Mathematical Society, since 2014.

## References

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