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Shaoying (Kathy) Lu

Education:

Tsinghua University, Beijing	Applied Mathematics	B.S.	1995
Tsinghua University, Beijing	Applied Mathematics	M.S.	1997
University of California, San Diego	Mathematics	Ph.D.	2004
University of California, San Diego	BioE and Math	LJIS Fellow	2005

Professional Appointments:

Research Assistant Professor of Bioengineering, UI Urbana-Champaign	2005-2013
Project Scientist of Bioengineering, UC San Diego	2013-Now
Lecturer of Mathematics, UC San Diego	2013-Now

Peer-reviewed Publications: (in chronological order)

1. Bank RE and **Lu S** (2004), *A domain decomposition solver for parallel adaptive meshing algorithm.* ***SIAM J. Sci. Comput.*** (26), p. 105-127.
2. Ouyang M, **Lu S**, Li XY, Xu J, Seong J, Giepmans BN, Shyy JY, Weiss SJ, Wang Y. (2008) *Visualization of Polarized MT1-MMP activity in live cells by FRET Imaging.* ***Journal of Biological Chemistry***, 283(25):177740-8. PMCID: PMC2427332
3. **Lu S**, Seong J, Ouyang M, Zhang J, Chien S, Wang Y (2008), *The Spatiotemporal Pattern of Src Activation at Lipid Rafts Revealed by Diffusion-Corrected FRET Imaging*, ***PLoS Computational Biology***, 4(7):e1000127. **Featured Research Article.** PMCID: PMC2517613
4. Eichorst JP*****, **Lu S***, Xu J, Wang Y (2008), *Differential RhoA dynamics in migratory and stationary cells measured by FRET and automated image analysis.* ***PLoS ONE***, 3(12):e4082 (*Equal contribution authors). PMCID: PMC2603592
5. **Lu S**, Michailova A, Saucerman J, Cheng Y, Yu Z, Kaiser T, Li W, Bank RE, Holst M, McCammon JA, Hayashi T, Hoshijima M, Arzberger P, McCulloch AD (2009), *Multi-scale modeling in rodent ventricular myocytes: Contributions of structural and functional heterogeneities to excitation-contraction coupling*. ***IEEE EMB*** 28(2):46-57. PMCID: PMC3197248
6. Seong J, **Lu S**, Ouyang M, Huang H, Zhang J, Frame MC, Wang Y (2009), *Visualization of Src activity at different compartments of the plasma membrane by FRET imaging.* ***Chemistry and Biology***, 16(1):48-57. PMCID: PMC2647969
7. Kim T, Xu J, Dong R, **Lu S**, Nuzzo R., Wang Y (2009), *Visualizing the Effect of Microenvironment on the Spatiotemporal RhoA and Src Activities in Live Cells by FRET.* ***Small***, 5(12):1453-9. PMCID: PMC3373893
8. Wang Y, Flores L, **Lu S**, Miao H, Li Y-S, Chien S (2009), *Shear Stress Regulates the Flk-1/Cbl/PI3K/NF-kB Pathway via Actin and Tyrosine Kinases.* ***Cellular and Molecular Bioengineering***, 2(3):341-350. PMCID: PMC2790296
9. Seong J, **Lu S**, Wang Y (2011), *Live Cell Imaging of Src/FAK Signaling by FRET.* ***Cellular and Molecular Bioengineering***, 2(4):138-147. PMCID: PMC3157646
10. **Lu S,** Wang Y (2010). *Fluorescence Resonance Energy Transfer Biosensors for Cancer Detection and Evaluation of Drug Efficacy*, ***Clinical Cancer Research***, 16(15):3822-4. PMCID: PMC2913312

11. Liu B, **Lu S**, Zheng S, Jiang Z, Wang Y (2011), *Two Distinct Phases of Calcium Signaling under Flow*. ***Cardiovascular Research***, 91(1):124-33. PMCID: PMC3112016
12. **Lu S***, Kim T*, Chen C, Ouyang M, Seong, J, Liao X, Wang Y (2011), *Computational Analysis for the Spatiotemporal Coordination of Polarized PI3K and Rac1 Activities in Micro-Patterned Live Cells.* ***PLoS ONE***, 6(6):e21293. PMCID: PMC3124492
13. Seong J, Ouyang M, Wen P, **Lu S,** Llewellyn NM, Schlaepfer DD, Guan J, Chien S, Wang Y (2011)*, Detection of Focal Adhesion Kinase Activations at Membrane Microdomains by Fluorescence Resonance Energy Transfer.* ***Nature Communications***. PMCID: PMC3373894
14. Liao X*, **Lu S***, Zhuo Y, Winter C, Xu W, Li B, Wang Y (2011). *Bone physiology, biomaterial and the Effect of mechanical/physical microenvironment on mesenchymal stem cell osteogenesis*. ***Cellular and Molecular Bioengineering***. (*Equal contribution authors). PMCID: PMC4288028
15. Liao X*, **Lu S***, Zhuo Y, Winter C, Xu W, Wang Y (2012). *Visualization of Src and FAK activity during the differentiation process from HMSCs to osteoblasts*. ***PLoS ONE***. (*Equal contribution authors) PMCID: PMC3416797
16. Tabdili H, Barry AK, Langer MD, Chien YH, **Lu S**, Shi Q, Lee KJ, Leckband DE (2012). *Cadherin Point Mutations Alter Cell Sorting and Modulate GTPase Signaling.* ***J Cell Sci.*** PMCID: PMC3516376
17. Qian T, **Lu S**, Ma H, Fang J, Zhong W, Wang Y (2013) *FRET imaging of calcium signaling in live cells in the microenvironment*, ***Integrative Biology***. PMCID: PMC4165894
18. Ouyang M*, **Lu S***, Kim T, Chen CE, Seong J, Leckband DE, Wang F, Reynolds AB, Schwartz MA, Wang Y (2013) *N-cadherin Differentially Couples with p120ctn and α-catenin to Regulate the Polarity of Distinct Molecular Activities*. ***Nature Communications*** (*Equal contribution authors). PMCID: PMC3602931
19. **Lu S,** He Huang, Wang YI, Wang Y (2013) *Highly Sensitive FRET Biosensors for Detecting MMP Activity in Live Breast Cancer Cells.* ***PLoS ONE.*** PMCID: PMC3596289
20. Lin L*, Grimme JM*, Sun J, **Lu S**, Gai L, Cropek DM*, Wang Y* (2013) *The antagonistic roles of PDGF and integrin αvβ3 in regulating ROS production at focal adhesions.* ***Biomaterials***. PMCID: PMC3602290
21. Sun J, **Lu S**, Ouyang M, Lin LJ, Zhuo Y, Liu B, Chan R, Chien S, Neel BG, Wang Y (2013) *Antagonism between binding site affinity and conformational dynamics tunes alternative cis-interactions within Shp2*, ***Nature Communication***. PMCID: PMC3777412
22. Liao X*, **Lu S***, Wu Y, Xu W, Zhuo Y, Peng Q, Li B, Zhang L, Wang Y (2013), *The effect of inducible reagent on Src and FAK activity during MSCs differentiation*, ***PLoS ONE***. PMCID: PMC3754985 (*Equal contribution authors)
23. Seong J, Tajik A, Sun J, Guan J-L, Humphries MJ, Craig SE, Shekaran A, Garcia AJ, **Lu S**, Lin MZ, Wang N, Wang Y (2013) *Distinct biophysical mechanisms of FAK mechanoactivation by different extracellular matrix proteins.* ***PNAS*** (Direct Submission), 110(48):19372-7. PMCID: PMC3845171
24. Lei L**, Lu S**, Wang Y, Kim T, Mehta D, Wang Y (2014) *The role of mechanical tension on lipid rafts dependent PDGF-induced TRPC6 activation.* ***Biomaterials***. PMCID: PMC3925146
25. Kim TJ, Sun J, **Lu S**, Zhang J, Wang Y. (2014) *The regulation of beta-adrenergic receptor-mediated PKA activation by substrate stiffness through microtubules in human mesenchymal stem cells*, ***Biomaterials.*** PMCID: PMC4144871

26. **Lu S**, Seong J, Wang Y, Chang SC, Eichorst JP, Ouyang M, Li J, Chien S, and Wang Y (2014) *Decipher the dynamic coordination between enzymatic activity and structural modulation at focal adhesions in living cells*, ***Scientific Reports***. PMCID: PMC4108961
27. Hu Y-L, **Lu S**, Szeto KW, Sun J, Wang Y, Lasheras JC, Chien S (2014) *FAK and paxillin dynamics at focal adhesions in the protrusions of migrating cells, **Scientific Reports***, PMCID: PMC4129417
28. Aung A, Seo T, **Lu S**, Wang Y, Jamora C, del Alamo JC, and Varghese S (2014) *3D Traction stresses activate protease-dependent invasion of cancer cells*, ***Biophys. J.*** PMCID: PMC4255420
29. Liu B, **Lu S**, Hu Y-L, Liao X, Ouyang M, Wang Y (2014) *RhoA and Membrane Fluidity Mediates the Spatially Polarized Src/FAK Activation in response to Shear Stress*, ***Scientific Reports*** PMCID: PMC4228346
30. Zhuo Y, Qian T, Wu Y, Seong J, Gong Y, Ma H, Wang Y, **Lu S (**2015), *Subcellular and Dynamic Coordination between Src Activity and Cell Protrusion in Microenvironment*. ***Scientific Reports.*** PMCID: PMC4531316
31. Chung EY, Ochs CJ, Wang Yi, Lei L, Qin Q, Smith AM, Strongin AS, Kamm R, Qi Y-X*, **Lu S***, Wang Yingxiao* (2015), Activatable and Cell-Penetrable Multiplex FRET Nanosensor for Profiling MT1-MMP Activity in Single Cancer Cells. (*co-corresponding authors). ***Nano Letters***. PMID: 26203778
32. Wu Y, Zhang K, Wang Yi, Wang Y, **Lu S**, Sequential Signaling of Kinases and Focal Adhesion Dynamics in Cancer Cell Adhesion. ***(Nature) Scientific Reports.*** PMCID: PMC4935953

Refereed Conference Proceedings, Book Chapters, and Scientific Art:

1. Wang Y, **Lu S** (2008) *The Application of FRET Biosensors to Visualize Src Activation. Proc. of SPIE.* 6868 (68680A):1-9.
2. **Lu S**, Wang Y (2009) *Application of FRET Biosensors and Computational Analysis for Live Cell Imaging. Proc. of SPIE*, 7191 (719108):1-12.
3. Ouyang M, **Lu S**, Wang Y (2014) *Genetically Encoded Fluorescent Biosensors for Live-cell Imaging of MT1-MMP Protease Activity*. *Methods in Molecular Biology*. PMID: 24052388
4. **Lu S** and Wang Y (2014) *Single-Cell Imaging of Mechanotransduction in Endothelial Cells*. *Progress in Molecular biology and Translational Science*.
5. Malik S, Ouyang M, Wang Y, **Lu S** (2013) *Flavors of the Cell. San Diego International Airport Art Exhibit. Biocom*. http://ilusart.com
6. Chung EY, Qin Q, Bhattacharyya A, **Lu S**, Wang Y (2014) Nanotechnologies and FRET imaging in live cells, Micro and Nano Techniques in Cell Mechanobiology. *Cambridge University Press*.

Ph. D. Thesis:

- *Scalable Parallel Multilevel Algorithms for Solving Partial Differential Equations*, Advisor: Randolph E. Bank.

Grants:

1. UIUC Engineering Campus Research Fund. $200,000. Lu (PI) 2011-2012 Past.
   Computational analysis of spatiotemporal molecular activities in cancer cell migration

2. DMS-1361421 NSF/NIH MATH/BIO Initiative Lu (PI) 8/01/2014-7/31/2018

OPT-PDE Analysis and FRET Imaging of Constitutive Connections between Physics and Chemistry in Live Cells, $1,004,943 total cost. Current

3. 1R01HL121365-01 Chien (PI) 12/20/13-11/31/17
   NIH/NHLBI Lu (Key Personnel) Current
   Mechanism of Atheroprone Mechanotransduction Studied By Single Cell Imaging
   This project will develop FRET biosensors to examine the atheroprone molecular mechanisms, with an emphasis on the channel proteins and transcription factors-mediated gene expressions. Current.

Awards and Honors:

1. Second Price (No. 13 of Zhejiang Province), Chinese Mathematical Olympiad, 1990.
2. Progress Award; Tsinghua University, Beijing, China, 1994.
3. Lawrence Livermore National Lab Graduate Student Research Fellowship, 2003.
4. La Jolla Interface Science Postdoctoral Fellowship, Burroughs Welcome Fund, 2004.

Teaching:

1. *Molecular imaging and quantitation in living cells*, UC San Diego, Guest Lecturer (2015)
2. *Linear Algebra*, UC San Diego, Lecturer (2015)
3. *Linear Algebra*, UC San Diego, Lecturer (2014)
4. *Vector Calculus*, UC San Diego, Lecturer (2014)
5. *Linear Algebra,* UC San Diego, Lecturer (2013)
6. *Molecular and Cellular Bioengineering*, University of Illinois, Urbana-Champaign, Guest Lecturer (2011)
7. *NanoBiophotonics Summer School*, University of Illinois, Urbana-Champaign, Guest Lecturer (2011).
8. *Introductory Biomechanics*, University of Illinois, Urbana-Champaign, Guest Lecturer (2010)
9. *Computational Bioengineering and Systems Biology*, University of Illinois, Urbana-Champaign, Guest Lecturer (2006)
10. *Pre-Calculus, Calculus, Linear Algebra, Introduction to PDEs, Scientific Computing,* UC San Diego, Teaching Assistant (1999-2002)
11. *Calculus*, University of Michigan, Ann Arbor, Graduate Student Instructor (1998)
12. *Pre-Calculus*, University of Michigan, Ann Arbor, Graduate Student Instructor (1997)
13. *Numerical Analysis,* Tsinghua University, Beijing, Teaching Assistant (1995-1997)

Patent Disclosures

1. Wang Y., Chien S., Peng Q, **Lu S**, Wang Y, *A FRET-based Biosensor for the Detection of Histone H3K9 tri-Methylation and Stem Cell Reprogramming and Differentiation*
2. Wang Y., **Lu S**, *Development of MT1-MMP FRET Biosensors to Detect Circulating Tumor Cells in Breast Cancer*, Application UIUC Case No. TF08083, Provisional patent filed.
3. Wang Y and **Lu S**, *A Software Package for Analyzing Live Cell Migration and Movement*, TF10084

Software Packages

1. **Lu S**, Michailova A, McCulloch AD, *Cell3D for three-dimensional simulation of calcium dynamics in cardiac myocytes*.
2. **Lu S** and Wang Y, *Fluocell for fluorescent image visualization and analysis in live cells*.

Invited Speech:

1. *Scalable Parallel Algebraic Multigrid Methods*, SIAM Conference on Parallel Processing for Scientific Computing, San Francisco, CA, 2004.
2. *Computational Biology and Live-cell Imaging, Signal Processing Seminar, Department of electrical and Computer Engineering*, UIUC, 2008.
3. *Computational Biology for Live-cell FRET Imaging*, Bioengineering Seminar Series, UIUC, 2009.
4. *Computational Bioimaging for Live Cells*, Image Visualization Seminar, UIUC, 2010.
5. *Molecular Engineering, Live Cell Imaging, and Mechanobiology*, NanoBiophotonics Summer School, UIUC, 2011.
6. *MT1-MMP biosensors for profiling live cancer cells*, Cancer Research Forum, UIC Cancer Centre, Chicago, IL, 2012.
7. *Rac1 and Integrins Differentially Affect Src-mediated Focal Adhesion Disassembly Deciphered by Correlative FRET Imaging*, Cold Spring Harbor Conference on Automated Imaging & High-Throughput Phenotyping, Cold Spring Harbor, NY, 2012.
8. *Computational Analysis of Spatiotemporal Molecular Hierarchy in Single Live Cells.* CCom Seminar, UC San Diego, 2013.
9. *Single Cell Imaging of Mechanotransduction under Different Extracellular Matrices.* The 14th SCBA International Symposium Conference Agenda, Xi'an, China, July 18-22, 2013.
10. *Computational Analysis of Spatiotemporal Molecular Hierarchy in Single Live Cells.* The 5th Sino-American Workshop on biomedical Engineering and China-Oversea Joint Workshop on Biomechanics, Beijing, China, Aug 1-5, 2013.
11. *Image-based systems biology in live cells*, 6th Bioinformatics and Systems Biology Expo, UC San Diego, Sep 29, 2014.
12. *Image-driven Analysis of Molecular Transport and Activation in Single Live Cells.* Seminar on Mathematics and Biochemistry-Biophysics, UC San Diego, April 29, 2015.
13. *Image-driven Analysis in Single Live Cells.* Seminar in Department of Mathematics, Peking University, Beijing, China, July 3rd, 2015.

Synergistic Activities:

Software and Other Projects: Primary developer and project lead for *Fluocell*, which has been designed to address the needs of the multi-channel and multi-position, time sequences of live-cell imaging. *Fluocell* has been freely shared at Google Code and Github (http://github.com/lu6007/fluocell) since February 2011 and downloaded hundreds of times. *Fluocell* has also been used in quantitative analysis and statistical inference of single live cell imaging data in various publications by our group, collaborators, and other researchers.

Reviewer: Served as a reviewer for these scientific journals - Angewandte Chemie, Biophysical Journal, Cell, Cellular and Molecular Bioengineering, European Biophysics Journal, IEEE Transactions on Biomedical Engineering, Journal of Biological Chemistry, Matrix Biology, PLoS Computational Biology, PLoS ONE, Small, Journal of Biological Methods, Scientific Reports.

Collaborators:

Randolph Bank (Mathematics, UCSD), Shu Chien (Bioengineering, UCSD), Cheng-Ming Chuong (Pathology, USC), Mark Ellisman (Neurosciences, UCSD), Philip Gill (Mathematics, UCSD), Michael Holst (Mathematics, UCSD), Andrew Lowy (Surgery,

UCSD), Jiayu Liao (Bioengineering, UC Riverside), Jihye Seong (KIST, Korean), Gina Sosinsky (Neurosciences, UCSD), Jie Sun (Beckman Institute, UIUC), Ning Wang (Mechanical Engineering, UIUC), Peter Yingxiao Wang (Bioengineering, UCSD), Don Xiangdong Xu (Pathology, UCSD), Shyni Varghese (Bioengineering, UCSD), Chao-Yuan Yeh (Pathology, USC).

Students and Lab-members Mentored:

Graduate Students:

Pranjali Beri (2016, Rotation student of UCSD-BioE), Xiaojian Jin (2015-2016, UCSD-MATH/CSME), Yiwen Shi (201-2016, UCSD-MATH/CSME), Yiqian Wu (2014, UCSD-BioE); Lexie Qin Qin (2013, UCSD-BioE, current a Research Associate Programmer at UCSD); John Eichorst (2007, UIUC-Physics, currently a postdoctoral researcher at UMN); Real Chih-En Chen (2009, UIUC, currently a PhD student in U of Toronto); Kaiwen Zhang (2013, UIUC-BioE); Yue Zhuo (2012, UIUC-BioE, Beckman Fellow); Eddie Chung (2013, UCSD-BioE, Currently a Process Engineer in Devacell Inc).

Undergraduate Research Students:

Rinoka Sato (2016, UCSD-BioE); Katherine Lowe (2016, UCSD-BioE); Shannon Laub (2016, UCSD-BioE); Christopher Blackburn (2015, PSU-BioE, Star Summer Program), Taylor Cavazos (2015, UCSD-BioE); Jonathan Chan (2015, UCSD-Math); Parth Patel (2015, UCSD-CS); Ya Gong (2013-current, UCSD-BioE); Shreya Malik (2013, UCSD-BioE); Agamoni Bhattacharyya (2014, UCSD-BioE). Shuzhen Fiona Chen (2007, UIUC-BioE); Dan Knipmeyer (2007, UIUC-BioE); Andrew Naber (2007, UIUC-BioE); Shiou-chi Steve Chang (2008, UIUC-ChemE, currently in MIT-ChemE); Christina Winter (2011, UIUC-BioE, currently a Project Engineer at Intertek Corporate); Jack Krieger (2011, UIUC-Physics, currently in GIT-BioE PhD program). Yiqian Wu (2012, UIUC-BioE, currently in UCSD-BioE PhD program); Jason Fan (2013, U of Toronto-CS).

Workshops:

1. *Professional Grant Development workshop*, Grant Training Center (Instructor: Dr. Maria Esformes), University of Chicago, June 2012.
2. *Biosensing BioActuation BioNanotechnology Summer Institute* (Poster Judge), University of Illinois, Urbana-Champaign, 2012.
3. *HPC Meets Big Data - SDSC Summer Institute*, San Diego, August of 2014.
4. *Bioengineering Day* (Poster Judge) – *UC San Diego*, April of 2014.
5. *Bioengineering Day* (Poster Judge) – *UC San Diego*, April 0f 2015.
6. *FRET Live-Cell Imaging and Quantitation Summer Workshop* (Co-organizer and Speaker) – *UC San Diego*, August 3rd, 2015.
7. *College Classroom Teaching Workshop* by Peter Newbury at Center for Engaged Teaching – UC San Diego, Fall, 2015.

Community Outreach Activities:

Volunteer: Next Generation School (2005-2010); Champaign-Urbana Kids Math Club (2012-2013); Barkstall Elementary School (2011-2012); Ashley Falls Elementary School (2011-2014); Carmel Valley Middle School Math League (2014).