Dr. Jesse L. Silverberg

Updated **August 31, 2015**

Harvard University
Wyss Institute for Biologically Inspired Engineering
Center for Life Sciences, Room 530/4D
3 Blackfan Circle
Boston, MA 02115

Jesse.Silverberg@wyss.harvard.edu

Research Interests

- Multi-scale Biophysics
- Connections between geometry, mechanics, and microstructure
- Pattern formation in biological systems
- Image analysis and computer vision

My research interests focus on discovering how shape and structure at small scales gives rise to macroscopic emergent behavior. These studies are especially relevant for biological tissues where structure can be found across seven or eight orders of magnitude. Experimentally identifying, measuring, and rationally perturbing such microscopic features requires custom-built apparatuses used in conjunction with modern tools from synthetic biology. Thus, my training has emphasized quantitative image analysis, construction of bench-top mechanical testing devices, and DNA nanotechnology. With this experimental toolbox, I strive to push biology in the direction of a material science, and to move away from the predominantly observational nature of studies that examine biological tissues.

Education

- **Harvard University** — Cambridge, MA
  Postdoctoral Fellow, Wyss Institute for Biologically Inspired Engineering — *2014 - current*
  - Invited TEDx Speaker
  - Commercialized software related to the Molecular Atlas Project
- **Cornell University** — Ithaca, NY
  PhD, Physics — *2009 - 2014*
  MS, Physics
  - PhD thesis: *Experiments at the Intersection of Geometry, Mechanics, and Microstructure*
  - NSF Graduate Research Fellow
- **Northeastern University** — Boston, MA
  BS, Physics — *2004 - 2009*
  BS, Mathematics
  BS, Philosophy
  Minor, Graphic Design
  - Undergraduate thesis: *Fabrication and Investigation of Transport in Novel Nanostructures*
  - IGERT Fellow
  - Matthews Fellow

– Graduated *summa cum laude*
– Dean's list for 5 consecutive years

Professional Activities

MEMBERSHIPS

- Member of **American Physical Society** [2004 - current]
- Member of **Biophysical Society** [2014 - current]

SERVICE ACTIVITIES

- Referee for: Science · Physical Review Letters · Physical Review E · PLoS ONE · Physics Letters A · Osteoarthritis and Cartilage · ASME Journal of Applied Mechanics · Plant Methods · International Journal of Nanomedicine · Journal of Experimental Botany
- Co-organized and Co-hosted banquet entertainment for the 21st International Conference on DNA Computing and Molecular Programming [Aug 2015]
- Designed informational brochures and pens for **American Physical Society's Topical Group on Soft Matter Physics** (APS GSOFT) [Jul 2015]
- Session chair at **APS March Meeting** [Mar 2015]
- Poster judge for **Cornell Undergraduate Research Board's** 29th Annual spring research forum [Apr 2014]
- Invited contributor to **Physics Olympiad Resource Generation Camp** (Mumbai, India) Homi Bhabba Center [Sep 2007]
- Contributor to **National Knowledge Commission for Science Education** (Mumbai, India) Tata Institute of Fundamental Research [Aug 2007]
- Organized **NEU Topics in Applied Mathematics Seminar** [Apr 2008]

PROFESSIONAL DEVELOPMENT

- Attended 3 day intensive **optical microscopy bootcamp** run by Harvard Medical School's Imaging Core Facility Director Dr. Jennifer Walters covering diffraction-limited resolution fundamentals, signal-to-noise considerations, digital imaging, fluorescence microscopy, confocal microscopy, Total Internal Reflection Fluorescence (TIRF) microscopy, super-resolution microscopy, and digital image analysis [Jun 2015]
- Attended 12 week professional development course **Leadership: Theory and Practice** at Cornell University's Johnson Graduate School of Management [Sep - Dec, 2013]
- Visiting student at **Technical University of Munich** (Garching, Germany) Hosted by Prof. Andreas Bausch [Aug - Sep, 2012]
- Visiting student at **Tata Institute of Fundamental Research** (Mumbai, India) Hosted by Dr. Vikram Tripathi [Jul - Dec, 2007]

- Visiting student at **Indian Institute of Science** (Bangalore, India)
  Hosted by Prof. Arindam Ghosh [Nov 2007]
- Received **CLRA Level 1 tutor certification** [2008]

Honors and Awards

- **The Platypus Award for Innovations in Sound** *2014*
  An annual pop-sci award sponsored by *Mental Floss* for research on the physics of mosh pits
- **Cornell University Graduate Student Travel Grant** *2014*
  Support attendance at *6OSME Conference* (Tokyo, Japan)
- **APS-GSNP Student Speaker Finalist** *2014*
  For contributed talk at the 2014 APS March Meeting by a graduate student in the area of Statistical and Nonlinear Physics
- **Poster Award** *2013*
  Gordon Research Conference: Soft Condensed Matter
- **Douglas Fitchen Memorial Award** *2012*
  Support attendance at *Int'l Plant Biomechanics Conference* (Clermont-Ferrand, France)
- **Cornell University Graduate Student Travel Grant** *2012*
  Support attendance at *Int'l. Plant Biomechanics Conference* (Clermont-Ferrand, France)
- **Cornell University Graduate Student Travel Grant** *2012*
  Support attendance at *APS March Meeting* (Baltimore, MD)
- **Poster Award** *2011*
  Gordon Research Conference: Soft Condensed Matter
- **NSF Graduate Research Fellowship** *2010*
  "Mechanical Properties of Biological Shock Absorbers: A Study of Cartilage"
- **NSF Graduate Research Fellowship Honorable Mention** *2009*
  "Applications of Quantum Degenerate Plasma to Controlled Nuclear Fusion"
- **Matthews Undergraduate Fellowship** *2008*
  "Transport Studies of One Dimensional Nanostructures"
- **CEA-Way Scholarship** *2007*
  "Probing Fermi Liquids in Cold Atom Systems"
- **IGERT Research Fellowship** *2006*
  "Development and Fabrication of a Device For Neuronal Cell Stimulation"
- **Lawrence Award** *2006*
  "Fabrication and Investigation of Transport Phenomena in Novel Nanostructures"
- **Provost Undergraduate Research Award** *2006*
  "Fabrication and Magnetostatic Characterization of Ferromagnetic Bifurcated Nanowires"

- **First Place in Poster Competition** *2006*
  Women in Science and Engineering Expo

Publications

SCIENTIFIC ARTICLES

1. A. A. Evans, **J. L. Silverberg**, C. D. Santangelo, "Lattice mechanics of origami tessellations," *Phys. Rev. E* **92**, 013205-1 (2015). [see also arXiv:1503.05756] [**Editor's Choice**]

2. T. H. Tan, **J. L. Silverberg**, D. Floss, M. J. Harrison, C. L. Henley, I. Cohen, "How Grow-and-Switch Gravitropism Generates Root Coiling and Root Waving Growth Responses in *Medicago truncatula*" *Submitted* (2015).

3. A. M. Paya, **J. L. Silverberg**, J. Padgett, T. L. Bauerle, "X-ray Computed Tomography Uncovers Root-Root Interactions: Quantifying Spatial Relationships Between Interacting Root Systems in Three Dimensions," *Front. Plant Sci.* **6**, 274 (2015).

4. **J. L. Silverberg**, J. H. Na, A. A. Evans, B. Liu, T. Hull, C. D. Santangelo, R. J. Lang, R. C. Hayward, I. Cohen, "Origami Structures With a Critical Transition to Bistability Arising From Hidden Degrees of Freedom," *Nat. Mater.* **14**, 289-393 (2015). [**Featured in News and Views**]

5. W. T. Walker, L. A. Fortier, **J. L. Silverberg**, B. B. Nelson, C. E. Kawcak, "Initiation and Morphologic Progression of Medial Femoral Condyle Subchondral Bone Cysts in Adult Horses" *Submitted* (2014).

6. **J. L. Silverberg**, A. R. Barrett, M. Das, P. B. Peterson, L. Bonassar, I. Cohen, "Structure-Function Relations in Neonatal Bovine Articular Cartilage Under Shear," *Biophys. J.* **107**, 7 (2014). [**Cover article**]

7. D. J. Griffin, J. Vicari, M. R. Buckley, **J. L. Silverberg**, I. Cohen, L. Bonassar, "The Effects of Enzymatic Treatments on the Depth-Dependent Viscoelastic Shear Properties of Articular Cartilage," *J. Ortho. Res.* **32**, 1 (2014).

8. **J. L. Silverberg**, A. A. Evans, L. McLeod, R. C. Hayward, T. Hull, C. D. Santangelo, I. Cohen, "Using Origami Design Principles to Fold Reprogrammable Mechanical Metamaterials," *Science* **345**, 647 (2014). [**Featured in Perspective Piece**]

9. H. Holmes, B. Wilson, J. Goerger, **J. L. Silverberg**, I. Cohen, L. Fortier, "BMAC and PRP Enhance Endogenous Stem Cell Migration" *Submitted* (2014).

10. **J. L. Silverberg**, M. Bierbaum, J. P. Sethna, I. Cohen, "Collective Motion of Moshers at Heavy Metal Concerts," *Phys. Rev. Lett.* **110**, 228701-1 (2013). [see also arXiv:1302.1886]

11. **J. L. Silverberg**, S. Dillavou, L. Bonassar, I. Cohen, "Anatomic Variation of Depth-Dependent Mechanical Properties in Neonatal Bovine Articular Cartilage," *J. Ortho. Res.* **31**, 686-691 (2013).

12. **J. L. Silverberg**, R. D. Noar, M. S. Packer, M. J. Harrison, C. L. Henley, I. Cohen, S. Gerbode, "3D Imaging and Mechanical Modeling of Helical Buckling in Medicago truncatula Plant Roots," *Proc. Natl. Acad. Sci.* **109**, 16794-16799 (2012).

13. A. Widom, J. Swain, **J. Silverberg**, S. Sivasubramanian, Y.N. Srivastava, "Theory of the Maxwell Pressure Tensor and the Tension in a Water Bridge," *Phys. Rev. E* **80**, 016301-1 (2009).

14. **J. Silverberg**, "A Model for Conductive Percolation in Ordered Nanowire Arrays," *J. Appl. Phys.* **105**, 044306-1 (2009).

15. B. Aycock, A. Roe, **J. Silverberg**, A. Widom, "Classical Hamiltonian Dynamics and Lie Group Algebras," arXiv:0807.4725v1 (2008).

16. **J. Silverberg**, A. Friedman, L. Menon, "Growth and Magnetic Properties of Polycrystalline Self-Assembled Bifurcated Co Nanowires," *J. Nanomaterials* **2008**, 782930 (2008).

17. S. Saha, **J. Silverberg**, D. O'Malley, L. Menon, "Nanowire Array Technologies for Investigation of Neural Activity," *Proc. 2007 NSTI Nano Conf.* **2**, 795-798 (2007).

18. **J. Silverberg**, S. Saha, D. O'Malley, L. Menon, "Development of Au Nanowires for Recording Electrical Activity in Neural Cells," *Mater. Res. Soc. Symp. Proc.* **951**, 0951-E08-10 (2007).

19. **J. Silverberg**, A. Widom, "Classical Analytical Mechanics and Entropy Production," *Am. J. Phys.* **75**, 993-996 (2007).

COMMENTARIES and OP-EDs

1. **J. L. Silverberg**, "A Big Tent for Soft Matter," *APS News, The Back Page* **24**, 5 (2015).

2. **J. L. Silverberg**, "Soft Matters Matter," *Physics Today* **68**, 8 (2015).

Conferences and Workshops

1. Attendee @ **21st International Conference on DNA Computing and Molecular Programming** (Boston, MA) *Aug 2015*

2. Presented Talk @ **APS March Meeting** *Mar 2015*
"Geometry, Mechanics, and Microstructure: The Physics of Origami"

3. Presented Poster @ **Biophysical Society Meeting** *Feb 2015*
"DNA-PAINT and Exchange-PAINT for Multiplexed 3D Super-Resolution Microscopy"

4. Presented Talk @ **Molecular Systems Lab Symposium 4.2** *Oct 2014*
"Microstructure in Super-Resolution: Molecular detail of biomaterials seen with 3D Q-PAINT"

5. Presented Talk @ **Society of Rheology** *Oct 2014*
"Structure-Function Relations and Rigidity Percolation in Bovine Articular Cartilage"

6. Presented Talk @ **New England Complex Fluids Workshop** *Sep 2014*
"Revenge of the Mosh Pits: Raw Data and Preliminary Observations"

7. Presented Talk @ **6th International Meeting on Origami in Science, Mathematics, and Education (6OSME)** *Aug 2014*
"Mechanics of Snap-Through Transitions in Twisted Origami"

8. Presented Talk @ **APS March Meeting** *Mar 2014*
"Mechanics of Miura-ori Origami Lattice Defects"

9. Presented Talk @ **APS March Meeting** *Mar 2014*
"Structure-function relations in cartilage under shear: Does fiber organization matter?"

10. Presented Talk @ **Gordon Research Conference: Soft Condensed Matter** *Aug 2013*
"Origami Mechanics: Measurements of Miura Ori Moduli and Lattice Defects"

11. Presented Poster @ **Gordon Research Conference: Soft Condensed Matter** *Aug 2013*
"Origami Mechanics: Measurements of Miura Ori Moduli and Lattice Defects"

12. Presented Talk @ **APS March Meeting** *Mar 2013*
"Spatially Localized Structure-Function Relations in the Elastic Properties of Sheared AC"

13. Presented Talk @ **7th International Plant Biomechanics Conference** *Aug 2012*
"Helical Buckling of Plant Roots: Mechanics and Morphology"

14. Presented Poster @ **Next-Generation Materials Characterization Symposium** *May 2012*
"Cartilage Mechanics: Measuring the Depth-Dependent Properties of Biological Materials"

15. Presented Talk @ **APS March Meeting** *Mar 2012*
"Helical Buckling of Plant Roots: Mechanics and Morphology"

16. Presented Talk @ **Orthopedic Research Society Conference** *Jan 2012*
"Anatomical Variation of Shear Energy Absorption in Articular Cartilage"

17. Presented Talk @ **Gordon Research Conference: Soft Condensed Matter** *Aug 2011*
"Self-Organization in the Mosh Pit: Collective Motion in Human Crowds"

18. Presented Poster @ **Gordon Research Conference: Soft Condensed Matter** *Aug 2011*
"Self-Organization in the Mosh Pit: Collective Motion in Human Crowds"

19. Presented Talk @ **APS March Meeting** *Mar 2011*
"Helical Root Buckling: A Transient Mechanism for Stiff Interface Penetration"

20. Presented Poster @ **UMass Amherst Soft Solids & Complex Fluids Workshop** *Jun 2010*
"Helical Root Buckling: A Transient Mechanism for Stiff Interface Penetration"

21. Presented Poster @ **Northeastern University Honors Evening Expo** *Apr 2009*
"Development of Au Nanowires for Recording Electrical Activity in Neural Cells"

22. Presented Talk @ **Yale Conference for Undergraduate Women in Physics** *Jan 2009*
"Observations and Questions of Localization in One-Dimensional Wires"

23. Presented Talk @ **NEU Topics in Applied Mathematics Seminar** *Apr 2008*
"A Model for Conductive Percolation in Ordered Nanowire Arrays"

24. Attendee @ **New England Peer Tutoring Association Conference** *Mar 2007*

25. Attendee @ **Correlated Electrons and Frustrated Magnetism Workshop** *Dec 2007*
Organized by International Centre for Theoretical Sciences (Goa, India)

26. Presented Poster @ **NEU Research and Scholarship Expo** *Mar 2007*
"Nanowire Array Technologies for Investigation of Neural Activity"

27. Presented Talk @ **Materials Research Society Meeting** *Nov 2006*
"Development of Gold Nanowires for Recording Electrical Activity in Neural Cells"

28. Presented Poster @ **Gordon Research Conference: Nanostructure Fabrication** *Nov 2006*
"Development of Gold Nanowires for Recording Electrical Activity in Neural Cells"

29. Presented Poster @ **Women in Science and Engineering Expo** *Apr 2006*
"Non-Lithographic Nanofabrication using Porous Alumina Membranes"

30. Attendee @ **New England Peer Tutoring Association conference** *Mar 2006*

Invited Talks

1. **Lewis-Sigler Institute at Princeton University** (Princeton, NJ) *May 2015*
2. **University of California, Irvine** (Irvine, CA) *Apr 2015*
3. **Kavli Institute at Harvard University** (Cambridge, MA) *Apr 2015*
4. **Tufts University** (Somerville, MA) *Apr 2015*
5. **TEDx Conference** (Yale University, New Haven, CT) *Apr 2015*
6. **Bridgewater State University** (Bridgewater, MA) *Mar 2015*
7. **APS March Meeting** (San Antonio, TX) *Mar 2015*
8. **Institute for Advanced Study at HKUST** (Clear Water Bay, Hong Kong) *Dec 2014*
9. **Boston Area Physics of Living Systems Hangout at MIT** (Boston, MA) *Sep 2014*
10. **Tel Aviv University** (Tel Aviv, Israel) *Aug 2014*
11. **Weizmann Institute** (Rehovot, Israel) *Aug 2014*
12. **University of Eastern Finland** (Kuopio, Finland) *Aug 2014*
13. **University of Jyväskylä** (Jyväskylä, Finland) *Aug 2014*
14. **Aalto University** (Helsinki, Finland) *Jul 2014*
15. **University of Leiden** (Leiden, the Netherlands) *Jul 2014*
16. **AMOLF** (Amsterdam, the Netherlands) *Jul 2014*
17. **TU Delft** (Delft, the Netherlands) *Jul 2014*
18. **University of Amsterdam VU** (Amsterdam, the Netherlands) *Jul 2014*
19. **Wyss Institute for Biologically Inspired Engineering** (Boston, MA) *Dec 2013*
20. **University of Massachusetts Amherst** (Amherst, MA) *Nov 2013*
21. **Rochester Institute of Technology** (Rochester, NY) *Nov 2013*
22. **Nerd Nite** (Ithaca, NY) *Oct 2013*
23. **Chennai Mathematical Institute** (Chennai, India) *Jul 2009*
24. **Indian Institute of Science** (Bangalore, India) *Oct 2007*

Teaching

- Mentored graduate student **Lauren McLeod** [Jul - Dec, 2013]
  Currently continuing studies at Cornell University, Physics Department
- Mentored M.S. student **Hannah Holmes** [May 2013 - Aug 2014]
  Currently DVM student at Cornell College of Veterinary Medicine
- Mentored undergraduate student **Tzer Han Tan** [Jan 2013 - current]
  Currently graduate student at MIT, Applied Physics
- Mentored undergraduate student **Karen Cronk** [Sep - Dec, 2012]
- Graduate student adviser for **Chris Heidelberger** [Feb - May, 2012]
- Mentored undergraduate student **Sam Dillavou** [Jan 2011 - Mar 2012]
  Currently graduate student at Harvard University, Physics Department
- Mentored undergraduate student **Michael Packer** [May - Sep 2010]
  Currently graduate student at Harvard University, Biophysics Program
- Teaching Assistant for **Phys 101: Introductory Physics for Life Sciences** [Sep - Dec, 2009]
  Worked one-on-one with students in an experimental self-paced auto-tutorial course helping setup/run labs, answer homework questions, and performing 15 minute "notebook checks," which are individualized ungraded quizzes.
- Teaching Assistant for **Phys 102: Introductory Physics for Life Sciences** [Jan - May, 2010]
  Worked one-on-one with students in an experimental self-paced auto-tutorial course helping setup/run labs, answer homework questions, and performing 15 minute "notebook checks," which are individualized ungraded quizzes.
- Tutored at **Northeastern University Peer Tutoring Center** in all levels of physics and mathematics courses [2007 - 2009]

Outreach Activities

- Presented research at **TEDx: "Moment of Impact"** event hosted by Yale University. The talk focused on human collective motion at heavy metal concerts and was recorded for broader online viewing [Apr 2015].
- Presented research on cartilage mechanics in a press-only event at the American Physical Society March Meeting [Mar 2015].
- Significant media attention developed around research on origami mechanical metamaterials including press interviews and news articles featured on the New York Times, NBC, LA Times, Washington Post, Boston Globe, Phys.org, Physics World, APS News, MRS Magazine, Inside Science, Sydney Morning Herald, Value Walk, Science Codex, Science Daily, Spiegel Online, Christian Science Monitor, Factor Tech, Next, The Age, Red Orbit, Nanowerk, TechiDec, and INCH Magazine [Aug 2014].

- Contributed to the 2014 APS March Meeting *Gallery of Images* art exhibit with the poster contribution "Origami Mechanics and Reprogrammable Metamaterials." This event showcased artistic images from scientific studies and included a hands-on demonstration of origami-inspired mechanical metamaterials [Mar 2014].
- Launched the "Soft Matters: Talking Physics, Talking Life" project in collaboration with fellow PhD student Kathryn McGill. The aim of this outreach effort is to showcase research from the frontiers of physics, as well as personal stories from the people doing it. Soft Matters combines video interviews with written blogs (available on the Huffington Post science section) with an emphasis that minimizes technical jargon. A "Science-to-English dictionary" is always included to enhance accessibility for a broader audience, as well as links to additional resources and materials [Sep - Nov 2013].
- Significant media attention developed around research of human collective motion at heavy metal concerts including TV features (Discovery Channel's Daily Planet, Japan's WOWOW Nightly News), radio interviews (NPR, CBC, WHCU, WTOP, and 3 separate occasions on Australian public radio), print media (New Scientist), and online media (ABC, NBC, National Geographic, Popular Science, The Atlantic, Physics World, The Telegraph, as well as 85 separate online news sites and blogs). The work was awarded a 2014 Platypus Award from Mental Floss Magazine, which in their words: "The Platties honor ideas that are interdisciplinary: a bit duck, a bit beaver, a bit otter. These are the new ideas and innovations that made us do a double take. At first, we wondered whether they could be real. And when they proved to be, it wasn't just the little idea, but the little idea's enormous potential that delighted us" [Feb - Mar 2013, and periodic ongoing media features].
- Participated in panel discussion for a press-only event at the American Physical Society March Meeting highlighting mosh pit related research [Mar 2013].
- Classifying and categorizing activity at the Ithaca Library through the Families Learning Science Together program [Jan 2013; kids 6-12].
- Participated in Northeast Conference for Undergraduate Women in Physics to promote women in physics [Jan 2013].
- Invited contributor to Huffington Post Science Blog [2012 - current].
- Participated in panel discussion for a press-only event at the American Physical Society March Meeting highlighting plant-related research [Feb 2012].
- Interviewed for APS Podcast series Physics Buzz focusing on general interest physics [Feb 2012].
- Polymer science activity at the Ithaca Youth Bureau through the Big Brothers Big Sisters program [Jan 2012; kids age 6-12].
- Polymer science activity at the Greater Ithaca Activities Center [Jan 2012; 5th graders].
- Optics science activity at the Greater Ithaca Activities Center [Jan 2012; 5th graders].
- Professional development activities for New York State high school teachers through the Cornell Institute for Physics Teachers program [Oct 2011].
- Participated in the "Physics of bubbles," and "Insect zoo" activities at the Expanding Your Horizons conference [Apr 2011; 6-7th grade girls].
- Molecular fluorescence activity at the Ithaca Science Center during the NISE Nano Days event [Apr 2011; all ages].

- Bridge building activity at the Ithaca Library through the Families Learning Science Together program [Mar 2011; kids 6-12].
- Density of fluids activity at the Ithaca Library through the Families Learning Science Together program [Feb 2011; kids 6-12].
- "Science from Junk" activity at the Ithaca Library through the Families Learning Science Together program [Jan 2011; kids 6-12].
- Physics of waves activity through the Ithaca Science Center Homeschooling Program [Dec 2010; kids 6-12].
- "Drop tubes" and "Density of fluids" activities at the Harlem Children's Zone in the Bronx, New York City [Dec 2010; 6th graders].
- Electricity and magnetism activities at the Ithaca Library through the Families Learning Science Together program [Nov 2011; kids 6-12].
- Participated in International Co-op Mentor Program, and spoke on two discussion panels [Feb and Apr, 2008].