Tristan A. Sharp

University of Pennsylvania
Physics and Astronomy

Education

2015 **PhD, Physics**, *The Johns Hopkins University*, Baltimore, MD.
Condensed Matter Simulation and Theory. Advisor: Professor Mark O. Robbins
Thesis: *Quasi-Static Contact and Sliding of Crystalline Materials*

2015 **MS, Physics**, *The Johns Hopkins University*, Baltimore, MD.
Condensed Matter Simulation and Theory

2008 **MS, Mechanical and Aerospace Engineering**, *UCLA*, Los Angeles, CA.
Computational Solid and Fluid Mechanics

2006 **BS, Physics**, *Harvey Mudd College*, Los Angeles, CA.
Computational Physics

Research Interests

Stiffness and rigidity of biological cells and tissues.

— Development and analysis of computational models to understand the non-linear mechanics of soft biological tissues and the stiffening of cancerous tissues.
— Theory of the fluid-solid phase transition in cell-only tissues such as cultured epithileal layers and some tumors, and the connection with cell-vertex models.
— Topological analysis of network environments that impede cell migration and metastasis.

Mechanics of solids at defects and interfaces.

— Theory of crystal-crystal friction and reduction of interfacial stresses between solids.
— Development of supervised learning algorithms to use particle trajectories to reverse-engineer the mechanics of disordered materials.
— Develop machine learning as an alternative to the "zoological" approach of studying diffusion and plasticity in poly-crystalline materials.
— Development of parallel algorithms for simulating coupled atomic-continuum mechanics.

Research and Teaching

2016–present **Postdoctoral Researcher, Physics**, University of Pennsylvania.
With Prof. Andrea J. Liu, in conjunction with the Physical Science of Oncology Center

— Designing and analyzing biophysics models of tissues while supporting experiments.
  - Combined the theory of mechanics of disordered solids with computational cell-vertex models to analyze the non-linear mechanics of real biological tissues.
  - Showed that the 3D generalization of the cell vertex model is unable to describe rigidity in real tissues.
— Using machine learning technique to study mechanics of poly-crystalline metals.
  - Uncovered the Arrhenius structure of the "atomic energy landscape" that governs atomic motions. Demonstrated a novel approach to defect analysis in common metals.

2016–present **Mentoring and Teaching**, University of Pennsylvania.

— Primary mentor for Sam Soik, undergraduate Vagelos Scholar, for two years.
  - Frequent discussions and weekly meetings, to steer the project, provide mentorship.
  - Paper in prepration, showing that seminal results of disordered and jammed sphere packings can be exteded to compressed containers of polymer chains.

— Primary mentor for Mike Congzhou Sha, for one year of his undergraduate degree.
  - Disorder at grain boundaries wreaks havoc on simple crystalline mechanics.

— Substitute lecturing for Principles of Physics, 36 students, two weeks.
  - Two lectures per week, covering electricty and magnetism.
  - Emphasis on interactive questions during lecture.
  - One active-learning group problem-solving session per week, in which the lecturer guides students in peer-teaching.

— Completed Course on College Teaching, University of Pennsylvania, a summer program about thoughtfully organizing and leading effective college classes.

2010–2015 **Research Assistant, Physics**, The Johns Hopkins University.

With Prof. Mark O. Robbins

— Extended continuum theoretical treatments of rough surface contact to apply to atomic systems. Specifically considered clean, crystalline surfaces which show greatest deviation.

— Identified new friction scaling regimes of non-adhesive crystalline asperities, including the breakdown of superlubricity in finite contacts, which are due to lattice dislocations.

— Introduced mechanics simulation of lattice Greens functions with many-body potentials.

2009–2010 **Teaching Assistant, Physics**, The Johns Hopkins University.

With Prof. Bob Leheney, Prof. Oleg Tchernyshyov

— Designed and conducted discussion sections for two semesters of Introductory Physics. The 50-minute course met weekly, with 20-30 students. Class begins with short, interactive lecture at the blackboard, then emphasis on solving example problems.

— Taught physics laboratory course for two semesters of Introductory Physics. Weekly, with 26 students. After a lecture and demonstration, discussions with students extended the remainder of 90-minutes or into the evening.

— Hosted popular office hours, tutoring room, and pre-exam review sessions (2 hours/week).

Work Experience in Aerospace Industry

2006–2009 **Research Analyst**, Arete Associates, Los Angeles, CA.

— Developed simulations of dynamical systems, solid/fluid mechanics, and remote sensing.

— Scientific computing techniques of large datasets to analyze image processing algorithms.

— Led a small team for one year in a large-scale software development effort.

— Received perfect score in 2009 employee annual review.

Publications

2017 TA Sharp, L Pastewka, V Ligneres, MO Robbins. Scale- and load-dependent friction in commensurate sphere-on-flat contacts. Physical Review B 96.15 (2017): 155436.

2017 (Submitted, Physical Review Letters, preprint available.) TA Sharp, SL Thomas, ED Cubuk, S Schoenholz, DJ Srolovitz, AJ Liu. Using machine learning to extract atomic energy barriers in polycrystalline materials.

2017 (Preprint available) TA Sharp, MM Merkel, ML Manning, AJ Liu. 3D cell geometry from 2D slices for material mechanics.

2017 (Preprint available) TA Sharp, L Pastewka, MO Robbins. Plasticity in rough contact of atomic materials.

2017 (Preprint available) TA Sharp, L Pastewka, MO Robbins. Mechanical lattice Green's functions for many-body potentials.

2016 TA Sharp, L Pastewka, MO Robbins. Elasticity limits structural superlubricity in large contacts. Physical Review B 93.12, 121402.

2016 TA Sharp. Quasi-Static Contact and Sliding of Crystalline Materials. Thesis, The Johns Hopkins University.

2013 L Pastewka, TA Sharp, MO Robbins. Seamless elastic boundary conditions for atomistic calculations. Physical Review B 86, 075459.

2011 S Akarapu, TA Sharp, MO Robbins. Stiffness of contacts between rough surfaces. Physical Review Letters 106, 204301.

2006 Guo, S. et al. Office-based optical coherence tomographic imaging of the human vocal cords. Journal of Biomedical Optics 11(3), 030501.

2006 Cecka, C., M Martin, TA Sharp. AIDS: Modeling a Global Crisis. The UMAP Journal (Undergraduate Mathematics and its Applications), 27 (2) (2006) 145-161.

Awards and Fellowships

2014 DAAD, Graduate Student Research Grant Awardee (Deutsche Akademischer Austausch Dienst, German Academic Exchange Office).

2010-2013 Integrated Graduate Education Research Traineeship (IGERT) Fellowship.

2009 Donald E. Kerr Sr. and Barbara Kerr Stanley Fellowship

2006 Interdisciplinary Contest in Modeling - Outstanding. Resulting publication in COMAP Journal.

2002 Science Award, La Costa Canyon High School

2002 Scholar Athlete Award, La Costa Canyon High School

1999-2002 Qualcomm Award Recipient

Invited and Conference Presentations and Posters

2017 Connecting cell shape and mechanics using vertex models. Physical Science of Oncology Center, July 10, Philadelphia, PA.

2017 Finite-deformation mechanics of generalized cell vertex models. American Physical Society March Meeting, March 20-26, New Orleans, LA.

2017 Poster: Fast 3D cell geometry from 2D slices. Mathematical Oncology Meeting, National Cancer Institute, February 26-28, Scottsdale, AZ.

2017 Poster: Modeling the mechanics of liver tissue. Gordon Research Conferece, Physical Science of Cancer, February 5-10, Galveston, TX.

2016 Invited: Limits of structural superlubricity in large contacts. Materials Research Society Spring Meeting, March 28-April 1, Phoenix, Az.

2016 Elastic deformations disrupt structural superlubricity in large contacts. American Physical Society March Meeting, March 14-18, Baltimore, MD.

2015 Invited: Friction during quasi-static sliding of crystalline asperities. Gordon Research Seminar (Postdoc/grad forum), July 25-26, South Hadley, MA.

2015 Poster: Slip in crystalline multi-asperity contact. Gordon Research Conference, July 26-31, South Hadley, MA.

2015 Single-asperity friction during quasi-static sliding. American Physical Society March Meeting, March 2-7, San Antonio, TX.

2014 Scale effects in single-asperity friction. American Vacuum Society, November, Baltimore, MD.

2014 Poster: Scale effects in static friction between rough solids. Institute for Data Intensive Engineering and Science, October, Baltimore, MD.

2014 Scale effects in single-asperity friction. Multiscale Modeling of Materials, October 20-25, Berkeley, CA.

2014 Poster: Scale effects in single-asperity friction. Gordon Research Conference on Tribology, July 20-24, Waltham, MA.

2014 Plasticity in contact of rough solids. German Physics Society (DPG) Spring Meeting, Dresden, Germany.

2014 Effects of atomic-scale geometry in contact of rough surfaces. American Physical Society March Meeting, March 18-22, Denver, CO.

2014 Contact of rough surfaces at the atomic scale. Tribotalk Series of the Fraunhofer Institute IWM, Freiberg, Germany.

2014 Poster: Contact between stepped rough surfaces. International Nanotribology Forum, January 6-10, Kerala, India.

2013 Poster: When rough solids come into contact. Tribology Conference. International Centre for Theoretical Physics, November 5-8, Trieste, Italy.

2013 Poster: USER-GFMD: Greens function molecular dynamics. LAMMPS Users' Workshop, August 7-8, Alburquerque, NM.

2013 Consequences of atomic-scale geometry in rough contacts. US National Congress on Computational Mechanics, July 22-25, Raleigh, NC.

2013 Poster: Effects of atomic-scale geometry of contact of rough solids. Gordon Research Conference on Adhesion, July 14-19, South Hadley, MA.

2013 Effects of atomic-scale geometry in contact of rough surfaces. American Physical Society March Meeting, March 18-22, Baltimore, MD.

2013 IGERT Online Competition. http://posterhall.org/igert2012/posters/246

2013 Effects of atomic-scale geometry on rough contact. IGERT PI Meeting, May 30-June 1, Washington DC.

2012 Participant at: Soft solids and complex fluids Summer School, University of Massachusetts Amherst, MA.

2012 Effects of atomic-scale geometry on rough contact. American Chemical Society Colloids Meeting, July 8-12, Baltimore, MD.

2012 Poster: Mechanics of atomic fractal surfaces. Gordon Research Conference, July 8-12, Waterville, ME.

2012 Participant at: Mid-Atlantic Soft Condensed Matter Working Group Meeting.

2012 Effects of Atomic-Scale Geometry on Rough Contact. American Physical Society March Meeting, March 17-22, Baltimore, MD.

2011 Stiffness of Contacts of Self-Affine Surfaces. American Physical Society March Meeting, March 21-25, Dallas, TX.

Computing and Other Tools

Operating Systems	Linux, Unix, Windows
Favorites	C, C++, PYTHON, IDL, Fortran, MATLAB, Mathematica
Active areas	Big data, machine learning, parallel programming (GPUs and MPI)
Development	Git/SVN, GitHub, GNU tools, debuggers, IDEs
Experiment	Shear rheometry, confocal microscopy, ImageJ, Volocity

Service and Outreach

2017 Mentor for high school teacher, Joji Thompson, during 8-week program to involve inner-city educators in STEM research. Directed research daily and introduced Joji to several research groups in the community. Successful investiation into the mechanics of disordered materials for application to biotissue modeling.

2017 Referee, *Biophysical Journal* (Elsevier)

2016-2017 Referee, *Soft Matter* (Royal Society of Chemistry)

2016-2017 Referee, *New Journal of Physics* (Institute of Physics)

2012-2015 Presentations to Condensed Matter Journal Clubs: "Hard Times" and "Soft Matters"

2012-2015 Design and teach graduate-student only IGERT colloquium 1-2 weeks per year

2009-2015 Science demonstrations annually at Baltimore Science Fair, and occasionally at Baltimore-area high schools. Science communication with members of the public.

2009 Guest lectures at Santa Monica College and Pierce College on differential equations and aerospace engineering

Additional activities

- Acryllic and digital art
- Running, Biking, Swimming
- Flying model aircraft
- DIY engineering projects
- Languages: Spanish (Advanced), German (Advanced), Bulgarian (Basic)

References

Available upon request.