

## Debanjan Mukherjee, Ph.D.

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### CONTACT INFORMATION

Biomechanical Engineering Computations Laboratory    *Phone:* (510) 280-4915  
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### RESEARCH INTERESTS

- Biomedical: Image-based modeling for biomechanics & biofluids; Hemodynamics and vascular transport processes; Biomechanics of cardiovascular diseases - stroke, thrombosis, embolisms; Cardiovascular biomedical device design; Drug delivery.
- Industrial: Particle-based manufacturing processes; Design of particulate & particle-based materials; Multi-phase & particle-laden flows in industrial processes; Granular flows & granular dynamics.
- Computational: High-performance computing; Multiscale modeling; Discrete element method; Molecular Dynamics; Finite element method; Computational fluid dynamics; Fluid-particle & Fluid-structure interaction.
- Physics: Collective dynamics of particle systems; Statistical physics of particle dynamics & transport.

### EDUCATION

**University of California, Berkeley** - California, USA

*Ph.D., Mechanical Engineering, December 2013*

- Dissertation: *Discrete Particle Simulation Techniques For The Analysis Of Colliding And Flowing Particulate Media*
- Advisor: Prof. Tarek I. Zohdi

*M.S., Mechanical Engineering, May 2010*

- Thesis: *Computational Design & Modeling Of The Dynamics Of Floating Ocean Wave Energy Converters*
- Advisor: Prof. Alaa E. Mansour

**Indian Institute of Technology, Madras** - Tamil Nadu, India

*B.Tech, Ocean Engineering, July 2008*

- Thesis: *CFD Simulations Of Wave Resistance On Twin-Hull Catamarans*
- Advisor: Prof. P. Krishnankutty

### PROFESSIONAL EXPERIENCE

**Post-doctoral Fellow: Cardiovascular fluid mechanics**    *January, 2014 - present*  
Department of Mechanical Engineering, University of California, Berkeley  
Supervisor: Prof. Shawn C. Shadden

**Assistant Specialist Researcher: Magnetic particle flows**    *September, 2013 - January, 2014*  
Department of Mechanical Engineering, University of California, Berkeley  
Supervisor: Prof. Tarek I. Zohdi

### FUNDING EXPERIENCE

1. American Heart Association Post-doctoral Fellowship, 2015  
- Award Number: 16POST27500023; Award Amount: \$90,000
2. Burroughs Wellcome Fund Collaborative Research Travel Grant (CRTG), 2016  
- Award Number: 1016360; Award Amount: \$5,240
3. NSF-CMMI Conference Support Grant, 2016 (co-written with P. Rangamani, and J. C. del Alamo).  
- Award Number: 1642312; Award Amount: \$12,320

AWARDS &  
HONORS

1. Best Poster Award: 5th International Conference on Engineering Frontiers in Pediatric and Congenital Heart Disease, 2016 (3rd place in Young Investigator Competition).
2. Best Poster Award: Society of Petroleum Engineers (SPE) International Oilfield Corrosion Conference and Exhibition, 2014.
3. Selected as Institute Fellow for the ‘*Summer Institute for Preparing Future Faculty*’ by the Graduate Division, U.C. Berkeley, Summer 2013.
4. Outstanding Graduate Student Instructor Award: Graduate Introduction to Finite Element Analysis, Fall 2011.
5. Best Paper Award: 29th International Conference on Ocean & Offshore, and Arctic Engineering, 2010.
6. Outreach for Engineers Specialty Forum Scholarship by ASME-IPTI for the International Conference on Ocean & Offshore, and Arctic Engineering, 2010.
7. Allen D. Wilson Memorial Scholarship by the Department of Mechanical Engineering, U.C. Berkeley, Spring 2010.
8. Renewable Energy Scholarship Award by the Berkeley Energy & Resources Collaborative (BERC), Spring 2010.
9. Block Grant Award by the Department of Mechanical Engineering, U.C. Berkeley, Summer 2009.
10. Student delegate at the ‘*CSIR Programme for Youth Leadership in Science 2002*’ by the Council of Scientific and Industrial Research (CSIR), Government of India.

JOURNAL  
ARTICLES

1. **Mukherjee, D.**, Jani, N.D., Narvid, J., and Shadden, S.C. (2017). The Role Of Circle of Willis Anatomy In Cardio-embolic Stroke - A Patient-specific Simulation Based Study. (*submitted*) [*pre-print available: bioRxiv-190579*].
2. **Mukherjee, D.**, and Shadden, S.C. (2017). Modeling Blood Flow Around A Thrombus Using A Hybrid Particle-Continuum Approach. *Biomechanics and Modeling in Mechanobiology*. (*accepted, in press*) [*pre-print available on request*].
3. **Mukherjee, D.**, and Shadden, S.C. (2017). Inertial Particle Dynamics In Large Artery Flows - Implications For Modeling Arterial Embolisms. *Journal of Biomechanics*. 52(8):155-164.
4. Casas, G.\*, **Mukherjee, D.\***, Celigueta, M.A., Zohdi, T.I., and Onate, E. (2017). A Modular, Partitioned, Discrete Element Framework For Industrial Grain Distribution Systems With Rotating Machinery. *Journal of Computational Particle Mechanics*. 4(2):181-198.
5. **Mukherjee, D.**, Jani, N., Selvaganesan, K., Weng, C.L., and Shadden, S.C. (2016). Computational Assessment Of The Relation Between Embolism Source And Embolus Distribution To The Circle Of Willis For Improved Understanding Of Stroke Etiology. *Journal of Biomechanical Engineering*. 138(8):081008-081008-13.
6. **Mukherjee, D.**, Padilla, J., and Shadden, S.C. (2015). Numerical Investigation Of Fluid-particle Interactions For Embolic Stroke. *Theoretical and Computational Fluid Dynamics*. 30(1):23-39.
7. **Mukherjee, D.**, and Zohdi, T.I. (2015). A Discrete Element Based Simulation Framework To Investigate Particulate Spray Deposition Processes. *Journal of Computational Physics*, 290:298-317.
8. **Mukherjee, D.**, and Zohdi, T. I. (2015). Computational Modeling Of The Dynamics & Interference Effects Of An Erosive Granular Jet Impacting A Porous, Compliant Surface. *Granular Matter* 17(2):231-252.
9. **Mukherjee, D.**, Zaky, Z., Zohdi, T.I., Salama, A., and Sun, S. (2015). Investigation Of Guided Particle Transport For Noninvasive Healing Of Damaged Piping System Using Electro-Magneto-Mechanical Methods. *Journal of Society of Petroleum Engineers* 20(4):872-883.
10. **Mukherjee, D.**, and Zohdi, T. I. (2014). Electromagnetic Control Of Charged Particulate Spray Systems - Models For Planning The Spray-gun Operations. *Computer-Aided Design*, 46:211-215.

(\* indicates that authors contributed equally)

PEER-REVIEWED  
PROCEEDINGS

1. **Mukherjee, D.**, and Shadden, S.C. (2017). Fictitious Domain Particle-Based Modeling For Thrombosis. *Proceedings of the Summer Biomechanics, Bioengineering, and Biotransport Conference, Tucson, Arizona.*
2. **Mukherjee, D.**, Jani, N.D., and Shadden, S.C. (2017). Discrete Particle Modeling For Thrombotic And Embolic Phenomena In Arteries. *Proceedings of the 5th International Conference on Computational and Mathematical Biomedical Engineering, Pittsburgh, Pennsylvania.*
3. **Mukherjee, D.**, and Shadden, S.C. (2016). Towards Non-invasive, Computational Modeling Of The Transport Of Thrombo-Emboli And Athero-Emboli Along Arteries. *Proceedings of the Summer Biomechanics, Bioengineering and Biotransport Conference, National Harbor, Maryland.*
4. **Mukherjee, D.**, and Shadden, S.C. (2015). Insights Into The Hemodynamic Factors Affecting Embolus Transport For Stroke. *Proceedings of the Summer Biomechanics, Bioengineering and Biotransport Conference, Snowbird, Utah.*
5. **Mukherjee, D.**, and Zohdi, T.I. (2013). Computer Modeling and Simulation Framework for Particulate Spray Based Manufacturing Processes. *Proceedings of the ASME International Mechanical Engineering Congress & Exposition, San Diego, California.*
6. **Mukherjee, D.**, and Mansour, A.E. (2010). Preliminary Concept and Feasibility Studies on Ocean Energy Device Design from Used Ships. *Proceedings of the 29th International Conference on Ocean & Offshore, and Arctic Engineering, Shanghai, China.* - **[best paper award]**

ARTICLES IN  
PREPARATION

1. **Mukherjee, D.**, Diamond, S.L., and Shadden, S.C. Modeling Flow-mediated Transport In The Neighborhood Of Blood Clots.
2. **Mukherjee, D.**, and Zohdi, T.I. A Monte-Carlo Based Framework For Uncertainty Characterization And Durability Estimation For A Material Layer Impacted By A Particle.
3. **Mukherjee, D.**, and Zohdi, T.I. An Iterative Collide-and-stream Algorithm For Particle Ensembles With Non-Enduring Contacts.

ABSTRACTS &  
PRESENTATIONS

1. **Mukherjee, D.**, and Shadden, S.C. The Role Of Hemodynamics In Organizing Transport In Thrombus Neighborhood. *2018 Cellular and Molecular Bioengineering Conference, Biomedical Engineering Society, Key Largo, Florida.* January 2018. (*submitted*)
2. **Mukherjee, D.**, Garduno, J., and Shadden, S.C. Flow-mediated Transport Around A Macroscopic Arterial Thrombus. *70th Annual Meeting Of The American Physical Society Division Of Fluid Dynamics, Denver, Colorado.* November 2017.
3. Pyne, J., **Mukherjee, D.**, Narvid, J., Bowen, M., Dehkhargani, S., and Shadden, S.C. Approximating Ischemic Stroke Location And Abnormal Tissue Regions Through Subtracting NCCT And CTA Scans. *The 14th Annual UCSF Imaging Research Symposium, San Francisco, California.* October 2017.
4. **Mukherjee, D.**, and Shadden, S.C. Discrete Particle Techniques For Modeling Fragmentation Of Blood Clots. *14th United States National Congress On Computational Mechanics, Montreal, Canada.* July 2017.
5. **Mukherjee, D.**, and Shadden, S.C. Particle-based Computational Techniques For Stroke And Thrombosis. *Berkeley/Stanford Computational Mechanics Festival (CompFest), Berkeley, California.* April 2017.
6. **Mukherjee, D.**, and Shadden, S.C. Fictitious Domain Based Models For Resolving Interaction Of A Clot With Blood Flow. *69th Annual Meeting Of The American Physical Society Division Of Fluid Dynamics, Portland, Oregon.* November 2016.
7. Jani, N.D., **Mukherjee, D.**, and Shadden, S.C. Evaluating Blood Flow And Embolus Distribution In The Brain As A Function Of The Anatomy Of The Circle Of Willis. *69th Annual Meeting Of The American Physical Society Division Of Fluid Dynamics, Portland, Oregon.* November 2016.

8. Jani, N.D., **Mukherjee, D.**, and Shadden S.C. Influence Of Variations In Circle Of Willis Anatomy On Cerebral Circulation & Embolus Distribution. *Annual Meeting Of The Biomedical Engineering Society, Minneapolis, Minnesota*. October 2016.
9. **Mukherjee, D.**, and Shadden, S.C. Thrombus Hemodynamics Interactions: From Intra-Thrombus Transport To Macro-Scale Flow Structures. *Mechbio Symposium: Putting Together The Cell Mechanome, San Diego, California*. August 2016.
10. **Mukherjee, D.**, and Shadden, S.C. Modeling Embolus Transport & Thrombus Interaction With Arterial Hemodynamics & Its Relevance To Improving Treatment Procedures. *The 5th International Conference on Engineering Frontiers In Pediatric & Congenital Heart Disease, Orlando, Florida*. June 2016. - [**best poster award**]
11. **Mukherjee, D.**, Jani, N.D., and Shadden, S.C. Characterizing Embolus Transport To The Circle Of Willis. *The 8th International Bio-Fluids Symposium, Pasadena, California*. February 2016.
12. **Mukherjee, D.**, Jani, N.D., and Shadden, S.C. Modeling And Simulation Of Cardiogenic Embolic Particle Transport To The Brain. *68th Annual Meeting Of The American Physical Society Division Of Fluid Dynamics, Boston, Massachusetts*. November 2015.
13. Casas, G., **Mukherjee, D.**, Celigueta, M.A., Zohdi, T.I., and Onate, E. Large-Scale Grain Distribution Simulations With Rotating Machinery Using Efficient Discrete Element Models. *Particles 2015 - IV International Conference On Particle-Based Methods: Fundamentals And Applications, Barcelona, Spain*. September 2015.
14. **Mukherjee, D.**, and Shadden, S.C. Embolus Interactions With Blood Flow And Its Role In Stroke. *13th United States National Congress On Computational Mechanics, San Diego, California*. July 2015.
15. **Mukherjee, D.**, and Shadden, S.C. A Patient-Specific CFD-Based Study Of Embolic Particle Transport For Stroke. *67th Annual Meeting Of The American Physical Society Division Of Fluid Dynamics, San Francisco, California*. November 2014.
16. **Mukherjee, D.**, Zaky, Z., Zohdi, T.I., Salama, A., and Sun, S. Investigation Of Noninvasive Healing Of Damaged Piping System Using Electro-Magneto-Mechanical Methods. *Society Of Petroleum Engineers International Oilfield Corrosion Conference And Exhibition, Aberdeen, United Kingdom*. May 2014. - [**best poster award**]
17. **Mukherjee, D.**, and Zohdi, T.I. Collision Driven Particle Dynamics Simulations For Analyzing Flows Of Particulate Sprays And Jets. *66th Annual Meeting Of The American Physical Society Division Of Fluid Dynamics, Pittsburgh, Pennsylvania*. November 2013.
18. **Mukherjee, D.**, and Zohdi, T.I. Electromagnetic Control Of Charged Particulate Spray Systems - Planning The Spray-Gun Operations. *SIAM Conference On Geometrical And Physical Modeling, Denver, Colorado*. November 2013.
19. **Mukherjee, D.**, and Zohdi, T.I. Discrete Particle Simulation For The Analysis Of Colliding And Flowing Particulate Media. *Berkeley/Stanford Computational Mechanics Festival (CompFest), Berkeley, California*. October 2013.
20. **Mukherjee, D.**, and Zohdi, T.I. Development Of A Computer Simulation Tool For Discrete Element Method And Collision Driven Particle Dynamics Simulations. *12th United States National Congress On Computational Mechanics, Raleigh, North Carolina*. July 2013.

#### INVITED TALKS

1. *Understanding Blood Flow And Flow Mediated Transport Around Arterial Blood Clots* - invited talk at the Berkeley Fluids Seminar Series, U.C. Berkeley, October 2017.
2. *Discrete Particle Based Computational Techniques For Investigating The Role Of Hemodynamics In Stroke And Thrombosis* - invited talk at Department of Mathematics, University of Houston, September 2017.
3. *Exploring The Hemodynamic Underpinnings Of Stroke, Thrombosis, And Embolisms* - invited talk at Auburn University Seminar Series, September 2017.

4. *Hybrid Particle-continuum Modeling For Thrombosis And Embolism - An Overview* - invited talk at the Diamond Lab, Institute for Medicine and Engineering, University of Pennsylvania, August 2017.
5. *Collective Dynamics And Flow Of Particle Systems: Applications In Industry And Healthcare* - invited talk at the Department of Mechanical Engineering, Stony Brook University, April 2017.
6. *Image-driven, Particle Based Computational Models For Thrombotic And Embolic Phenomena In Large Arteries* - invited talk at the Berkeley Fluids Seminar series, U.C. Berkeley, October 2016.
7. *Image-based Computational Modeling Of Thrombotic And Embolic Phenomena In Large Arteries* - invited talk at Medtronic Neurovascular, Irvine, California, June 2016.
8. *Discrete Particle Simulations For The Analysis Of Colliding And Flowing Particulate Media* - invited talk at the Berkeley Fluids Seminar series, U.C. Berkeley, October, 2013.
9. *Discrete Element And Collision Driven Particle Dynamics Simulations For Manufacturing* - invited talk at Siemens Energy, Orlando, Florida, April, 2013.
10. *The Story Of Sprays, Grains, And Computers - An Overview Of Probing Granular & Particulate Material Using Computer Simulations* - invited talk at the Department of Physics, Indian Institute of Science Education & Research, Bhopal, India, January 2013.

RESEARCH  
EXPERIENCE

- **Multi-scale biomechanics of thrombosis**
  - Developing meso-scale computational models for thrombus deformation and embolization under flow.
  - Developed tools to investigate flow-mediated transport phenomena in the thrombus neighborhood.
- **Image-based computational modeling for stroke**
  - Devised a modeling framework for embolus transport in large arteries for elucidating mechanics and etiology of stroke and embolisms.
  - Coupled multi-scale fluid dynamics models with medical imaging to study cerebrovascular flow for stroke and ischemia.
- **Multi-physics modeling of particulate media**
  - Modeling and analysis of electromagnetically guided particulate flows for industrial applications.
  - Devised numerical methods for modeling particle deposition for modern manufacturing applications.
- **Numerical methods for collision driven particle dynamics**
  - Devised neighbor-list collision driven particle dynamics techniques for flowing particulate media.
  - Created simulation tools for applications in manufacturing processes involving functionally engineered surface coatings.
- **Other experiences**
  - Finite element modeling of effective properties of heterogeneous particulate composite materials.
  - Design and computational analysis for a novel wave-energy device based on decommissioned ships.
  - Investigated system reliability methods for wave energy device operations.
  - Performed fluid-structure interaction modeling for twin-hull ocean vessels.

TEACHING &  
ACADEMIC  
EXPERIENCE

1. Teaching Assistant: Graduate courses at Department of Mechanical Engineering, U.C. Berkeley
  - ME280A: Graduate Introduction to Finite Element Analysis. (*Fall 2011*) [**outstanding GSI award**]
  - ME202: Computational Design of Multifunctional Materials. (*Spring 2012*)
2. Teaching Assistant: Undergraduate courses at Department Of Mechanical Engineering, U.C. Berkeley
  - ME107A: Experimentation & Measurements. (*Fall 2008, Spring 2009, Fall 2009*)
  - ME102A: Measurement Systems for Mechatronics. (*Spring 2010*)
  - ME135: Microprocessor Based Mechanical Systems. (*Spring 2010*)
3. Selected for an Intensive College Level Teaching Course organized by the Postdoc Teaching Opportunities Program (P.T.O.P), U.C. Berkeley, October 2015 (*20 out of 73 applicants were selected*).

4. Organizer of a bootcamp session on basics of Matlab programming for students at the Transfer To Excellence (TTE) Research Experience for Undergraduates (REU) program funded by National Science Foundation. (*Summer 2014*)
5. Guest lecturer on software tools for hemodynamics modeling for graduate course titled '*Fluid Mechanics of Biological Systems*', Dept. of Mechanical Engineering, U.C. Berkeley. (*Spring 2014*)
6. Co-organizer and instructor for the '*Freshman Energy Engineering Seminar Series*' for the College of Engineering, U.C. Berkeley. (*Fall 2013*)
7. Math Instructor for the Pre-Collegiate Academy, Incentive Awards Program, U.C. Berkeley. Developed and taught a complete six-week course on calculus from scratch, including assignments and examinations. (*Summer 2010*)

#### MENTORSHIP EXPERIENCE

1. Supervisor and mentor for five undergraduate researchers working on computational fluid dynamics of the cerebral vasculature: (*January, 2015 - present*)
  - Abhinav Koppu
  - Aditya Aiyer
  - Neel D. Jani (*currently a staff research associate at UCSF and San Francisco VA Medical Center*)
  - Kartiga Selvaganesan (*currently an NIH Postbaccalaureate Fellow*)
  - Christopher Lee Weng (*currently a graduate student at Johns Hopkins*)
2. Mentor for three undergraduate exchange students for the National Science Foundation (NSF) funded Transfer To Excellence (TTE) Research Experience for Undergraduates (REU) Program, at U.C. Berkeley: (*Summer 2014, 2015, 2017*)
  - Jose Padilla
  - Tiffany Pan
  - Jocelyn Garduno
3. Mentor for the New York Academy of Sciences STEM Scholar Mentorship Program aimed at high-school STEM students from around the world. (*2017-present*)
4. Mentor for two K-12 teachers as a part of the Berkeley Engineering Research Experience for Teachers (RET) program funded by National Science Foundation: (*Summer 2016*)
  - Suzanne LeBaron - science teacher from the Oakland High School district.
  - Russel Bierle - pre-service teacher from the CalTeach program at U.C. Berkeley.
5. Mentor and supervisor for a capstone project for the professional Masters of Engineering program at U.C. Berkeley on gas turbine blade thermo-mechanical design, in collaboration with Siemens Corporation. (*Fall 2012 & Spring 2013*)
6. Organizer of a '*Discipline Cluster Workshop*' for the teaching conference for training and mentoring first-time GSIs (teaching assistants), with the U.C. Berkeley GSI Teaching & Resource Center. (*Fall 2012*)

#### PROFESSIONAL SERVICE

1. Organizer of minisymposium on '*Computational Multiphysics Modeling Of Cardiovascular Systems*' for the upcoming World Congress on Computational Mechanics, 2018 alongwith A. Krishnamurthy and M.C. Hsu from Iowa State University.
2. Co-organizer of the AmeriMech mechanobiology symposium titled *Putting Together The Cell Mechanome: Finding The Pieces, Building The Puzzle* organized on August 4-5, 2016, at U.C. San Diego; sponsored by the National Academies of Sciences, Engineering, and Medicine, and National Science Foundation.
3. Volunteer for outreach event for middle school students named '*Biomechanical Engineering in Healthcare*', organized through the Johns Hopkins Center For Talented Youth (JHU-CTY), September 2015.
4. Co-organizer of the Berkeley/Stanford Computational Mechanics Festival (CompFest) workshop held at U.C. Berkeley on October 19th, 2013, alongwith Prof. Tarek Zohdi.

5. Reviewer:

- Computational Mechanics
- Journal of Computational Particle Mechanics
- Journal of Computational Physics
- Journal of Biomechanical Engineering
- British Journal of Radiology
- International Journal for Numerical Methods in Engineering
- PLoS One
- Journal of Biomechanics

6. Member:

- American Heart Association (A.H.A)
- American Physical Society (A.P.S)
- Society for Industrial and Applied Mathematics (S.I.A.M)

7. Served on departmental student committee to help interview during multiple departmental faculty searches, and on multiple student panels addressing departmental student affairs.

- COLLABORATIONS
- Scott Diamond, University of Pennsylvania - Multi-scale modeling of thrombosis guided by experimental data on human blood clotting.
  - Jared Narvid, University of California, San Francisco - Clinical collaboration on characterization of cerebrovascular flow and embolic stroke risks using patient radiological datasets.
  - Eugenio Onate, Guillermo Casas, International Center for Numerical Methods in Engineering (CIMNE), Technical University of Catalonia, Barcelona - Efficient numerical methods for large-scale, industrial handling of granular materials.
  - Shuyu Sun, Amgad Salama, King Abdullah University of Science & Technology (KAUST), Saudi Arabia - Designing magnetically guided particle streams for non-invasive oil pipeline healing technology.

SOFTWARE

Developed a general purpose Discrete Element simulation library from scratch, and continue to actively develop and maintain the code. The library is capable of simulating a broad range of multi-physics phenomena involving discrete particle systems, and involving particle based numerical methods, with support to external libraries like VTK (for visualization), and OpenMP (for parallelization)

REFERENCES

Available upon request.