

Kausik Sarkar

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University of Delaware
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Education

Ph.D. (1994) in Mechanical Engineering, The Johns Hopkins University, Baltimore
Thesis: "Effective Boundary Conditions for Rough Surfaces and Acoustics of Oceanic Bubbles"

M.S. (1990) in Mechanical Engineering, The Johns Hopkins University, Baltimore
Thesis: "A Numerical Study of the Ginzburg-Landau Equation in Thermo-capillary Flow"

B.Tech. (1988) Indian Institute of Technology, Kharagpur, India
Thesis: "Concepts of Ship-Propeller Design by Lifting Line and Lifting Surface Theory" and "Design of a Container Ship"

Professional Experience

2001- date	Assistant Professor of Mechanical Engineering, University of Delaware
1997-2001	Post-doctoral Research Associate, University of Illinois at Urbana Champaign
1994-1997	Research Scientist, Dynaflo Inc., Maryland
1988-1994	Research Assistant, Johns Hopkins University

Publications

Peer-reviewed journal articles

1. Li X, Sarkar K **2005** "Rheology of a viscous emulsion in an oscillating extensional flow at finite inertia," *Physics of Fluids*, in review.
2. Cao Q, Sarkar K, Prasad A K **2005** "Direct numerical simulation of three-layer viscosity-stratified flow," *The Canadian Journal of Chemical Engineering*, in review.
3. Li X, Sarkar K **2005** "Drop deformation and breakup in a potential vortex," *Journal of Fluid Mechanics*, accepted.
4. Li X, Sarkar K **2005** "Negative normal stress elasticity of emulsion of viscous drops at finite inertia," *Physical Review Letters*, 95, 256001.
5. Li X, Sarkar K **2005** "Effects of inertia on the rheology of a dilute emulsion of viscous drops in steady shear," *Journal of Rheology*, 49, 1377-1394.
6. Chatterjee D, Sarkar K, Jain P **2005** "Ultrasound mediated destruction of contrast microbubbles used for medical imaging and drug delivery," *Physics of Fluids*, 17,100603.
7. Sarkar K, Shi WT, Chatterjee D, Forsberg F **2005** "Characterization of ultrasound contrast microbubbles using *in vitro* experiments and viscoelastic models for encapsulation," *Journal of the Acoustical Society of America*, 118, 539-550.

8. Li X, Sarkar K **2005** "Numerical investigation of the rheology of a dilute emulsion of drops in an oscillating extensional flow," *Journal of Non-Newtonian Fluid Mechanics*, 102, 263-280.
9. Chatterjee D, Sarkar K, Jain P, Schreppler N **2005** "On the suitability of broadband attenuation measurement for characterizing contrast microbubbles," *Ultrasound in Medicine and Biology*, 31,781-786.
10. Li X, Sarkar K **2005** "Drop dynamics in an oscillating extensional flow at finite Reynolds numbers," *Physics of Fluids*, 17, 027103.
11. Cao Q, Sarkar K, Prasad AK **2004** "Direct numerical simulation of two-layer viscosity-stratified flow," *International Journal of Multiphase Flow*, 30, 1484-1508.
12. Chatterjee D, Sarkar K **2003** "A Newtonian rheological model for the interface of microbubble contrast agents," *Ultrasound in Medicine and Biology*, 29, 1749-1757.
13. Sarkar K, Schowalter WR **2002** "Computation of a viscous jet with embedded drops," *Journal of Non-Newtonian Fluid Mechanics*, 102, 263-280.
14. Sarkar K, Schowalter WR **2001** "Deformation of a two-dimensional drop at non-zero Reynolds number in time-periodic extensional flows: numerical simulation," *Journal of Fluid Mechanics*, 436, 177-206.
15. Sarkar K, Schowalter WR **2001** "Deformation of a two-dimensional drop in time-periodic extensional flows: analytic treatment," *Journal of Fluid Mechanics*, 436, 207-230.
16. Sarkar K, Schowalter WR **2000** "Deformation of a viscoelastic drop in time-periodic extensional flows at non-zero Reynolds number," *Journal of Non-Newtonian Fluid Mechanics*, 95, 315-342.
17. Duraiswami R, Sarkar K, Chahine GL **1998** "Efficient dual reciprocity boundary element techniques for electrical impedance tomography," *Engineering Analysis with Boundary Elements*, 22, 13-31.
18. Duraiswami R, Sarkar K, Chahine GL **1996** "Boundary element techniques for efficient 2D and 3D electrical impedance tomography," *Chemical Engineering Science*, 52, 2185-2196.
19. Sarkar K, Prosperetti A **1996** "Effective boundary conditions for Laplace Equation with a Rough Boundary," *Journal of Fluid Mechanics*, 316, 223-240.
20. Sarkar K, Prosperetti A **1995** "Effective boundary conditions for Stokes flow over a rough surface," *Proceedings of the Royal Society of London A*, 451, 425-453.
21. Sarkar K, Prosperetti A **1994** "Coherent and incoherent scattering by oceanic bubbles." *Journal of the Acoustical Society of America*, 96, 332-341.
22. Sarkar K, Prosperetti A **1993** "Backscattering of underwater noise by bubble clouds," *Journal of the Acoustical Society of America*, 93, 3128-3138.
23. Sarkar K, Meneveau C **1993** "Gradients of potential fields on rough surface: perturbative calculation of the singularity distribution function $f(\alpha)$ for small surface," *Physical Review E*, 47, 957-966.

Peer-reviewed conference proceedings

1. Sarkar K, Jain P, Chatterjee, D **2005** "Characterization and ultrasound-pulse mediated destruction of ultrasound contrast microbubbles," *Proceeding of the 17th International Symposium on Nonlinear Acoustics*.
2. Sarkar K, Jain P, Chatterjee D **2004** "Modeling thin-walled microbubbles for medical ultrasound," *Proceedings of ASME-International Mechanical Engineering Congress and R&D Expo*.
3. Sarkar K, Jain P, Chatterjee D **2004** "Destruction of Definity® microbubbles used for ultrasound contrast imaging," *Proceedings of ASME-International Mechanical Engineering Congress and R&D Expo*.

4. Sarkar K, Li X **2004** "Finite Reynolds number two-phase flow with drops," *Proceedings of IUTAM Symposium on "Computational Approaches to Disperse Multi-phase Flow"*.
5. Sarkar K, Li X **2004** "Oscillating extensional rheology of emulsion of drops at finite Reynolds number," *Proceedings of 2004 ASME Heat Transfer-Fluids Engineering Summer Conference*, HT-FED04-56648.
6. Sarkar K, Duraiswami R, Chahine GL **1996** "Numerical Simulation of Separated Cavitation Behind a Sphere," *ASME Cavitation Multiphase Flow Forum*, FED-**236**, 479-484.
7. Sarkar K, Duraiswami R, Chahine GL **1995** "Three-dimensional numerical simulation of bubble-vortical flow interaction," *ASME Cavitation Multiphase Flow Forum*, FED-**210**, 135-143.
8. Ohearn TJO, Torczynski J, Ceccio SL, Tassin AL, Chahine GL, Duraiswami R, Sarkar K **1995** "Development of an Electrical Impedance Tomography, System for an Air-Water Vertical Bubble Column," *Proceedings of the Forum on Measurement Techniques in Multiphase Flows the Winter Annual Meeting of the ASME*.

Conference presentations

1. Sarkar K, Li X **2005** "Computational modeling of leucocyte adhesion cascade (LAC)," presented at the 58th *Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, Chicago, Illinois, November 20-22 2005.
2. Li X, Sarkar K **2005** "Effects of inertia on the rheology of a dilute emulsion of drops in steady shear," presented at the 58th *Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, Chicago, Illinois, November 20-22 2005.
3. Sarkar K, Jain P, Chatterjee, D **2005** "Destruction of contrast microbubbles used for ultrasound imaging and drug delivery," presented at the 150th *Annual Meeting of the Acoustical Society of America*, Minneapolis, Minnesota, October 17-21 2005.
4. Sarkar K, Jain P, Chatterjee, D **2005** "Characterization and ultrasound mediated destruction of ultrasound contrast microbubbles," presented at the 17th *International Symposium on Nonlinear Acoustics*, State College, Pennsylvania, July 18-22 2005.
5. Sarkar K, Li X **2005** "Rheology of emulsion of viscous drops at finite inertia," Direct numerical simulation of three-layer viscosity-stratified flow," presented at the 2005 *Eastern Sectional Meeting of American Mathematical Society*, Newark, Delaware April 2-3 2005. **(Invited Talk)**.
6. Prasad A, Cao Q, Sarkar K **2004** "Direct numerical simulation of three-layer viscosity-stratified flow," presented at the 57th *Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, Seattle, Washington, November 23-25 2004.
7. Li X, Sarkar K **2004** "Oscillating extensional rheology of emulsion of drops at finite Reynolds number : Negative elasticity," presented at the 57th *Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, Seattle, Washington, November 23-25 2004.
8. Sarkar K, Jain P, Chatterjee D **2004** "Characterization and destruction of Definity® microbubbles used for ultrasound imaging and drug delivery," presented at the 57th *Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, Seattle, Washington, November 23-25 2004.
9. Sarkar K, Jain P, Chatterjee D **2004** "Modeling thin-walled microbubbles for medical ultrasound," presented at the 2004 *ASME International Mechanical Engineering Congress and R&D Expo*, Anaheim, California, November 13-19 2004.
10. Sarkar K, Chatterjee D, Jain P **2004** "Destruction of Definity® microbubbles used for ultrasound contrast imaging," presented at the 2004 *ASME International Mechanical Engineering Congress and R&D Expo*, Anaheim, California, November 13-19 2004.

11. Sarkar K, Li X **2004** "Finite Reynolds number two-phase flow with drops," presented in *IUTAM Symposium on "Computational Approaches to Disperse Multi-phase Flow"*, Argonne, IL, October 4-7, 2004.
12. Sarkar K, Li X **2004** "Oscillating extensional rheology of emulsion of drops at finite Reynolds number," presented at the *Annual Summer Meeting of ASME Heat Transfer-Fluids Engineering*, Charlotte, North Carolina, July 11-15 2004.
13. Sarkar K, Chatterjee D **2003** "An interfacial rheological model of encapsulated microbubble contrast agents for medical ultrasound," presented at the *56th Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, New Jersey, November 23-25 2003.
14. Sarkar K, Li X **2003** "Hydrodynamic interaction between two drops in an oscillatory shear flow: do they attract or repel?," presented at the *56th Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, New Jersey, November 23-25 2003.
15. Li X, Sarkar K **2003** "Inertial dynamics in time-periodic straining flows: resonance and nonlinearity," presented at the *56th Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, New Jersey, November 23-25 2003.
16. Sarkar K, Chatterjee D **2003** "Characterization of ultrasound contrast agent Definity® through experiments and modeling," presented at the *56th Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, New Jersey, November 23-25 2003.
17. Sarkar K, Chatterjee D, Shi WT, Forsberg F **2003** "An interfacial rheological model of ultrasound contrast agents: theory & experiments," presented at the *146th Annual Meeting of the Acoustical Society of America*, Austin, Texas, November 10-14.
18. Sarkar K **2002** "Effect of shear waves on viscoelastic drop deformation," presented at the *74th Annual Meeting of the Society of Rheology*, Minneapolis, Minnesota, October 13-17.
19. Sarkar K **2001** "Expansion of a drop-laden jet," presented at the *54th Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, San Diego, California, Albuquerque, 21-23 November 2001.
20. Sarkar K, Schowalter WR **2001** "Computation of a free jet with embedded drops," presented at the *Acrivos Symposim*, Greece, 2001.
21. Sarkar K, Schowalter WR **2000** "Viscous/viscoelastic drop deformation in time-dependent straining flow: numerical and analytical analysis," presented at the *53rd Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, San Diego, California, Albuquerque, 21-23 November 2001.
22. Sarkar K, Schowalter WR **1999** "Viscous drop deformation in a time-dependent straining flow: numerical and theoretical Analysis," presented at the *Annual Meeting of the American Institute of Chemical Engineers*, Dallas, Texas, October 31-November 5, 1999.
23. Sarkar K, Schowalter WR **1999** "Further studies on the deformation of a viscoelastic drop in a potential vortex," presented at the *71st Annual Meeting of the Society of Rheology*, Madison, Wisconsin, October 17-21, 1999.
24. Sarkar K, Schowalter WR **1998** "Deformation of a viscoelastic drop in the flow induced by a potential vortex," presented at the *70th Annual Meeting of the Society of Rheology*, Monterey, California, October 4-8, 1998.
25. Schowalter WR, Sarkar K **1998** "Recent advances in the modeling of suspensions," presented at the *2nd Meeting of the Hellenic Society of Rheology and International Symposium*, Crete, Greece, August 31-September 2, 1998.
26. Sarkar K, Chahine GL, Duraiswami R **1996** "Numerical simulation of separated cavitation behind a sphere," presented at *Cavitation Multiphase Flow Forum, Summer Meeting, American Society of Mechanical Engineers*, San Diego, California, 7-11 July 1996.

27. Duraiswami R, Sarkar K., Chahine GL **1996** "2D and 3D electrical impedance tomography using dual reciprocity BEM," presented in *Symposium on Industrial Applications and Recent Developments in BEM, ASME Appl. Mech. & Mat. Meeting*, JHU, Baltimore, Maryland, June 12-14, 1996.
28. Sarkar K, Duraiswami R, Chahine GL **1996** "Coupling of vortex element and boundary element methods for simulating vortical flows with free surfaces," presented in *Symposium on Industrial Applications and Recent Developments in BEM, ASME Appl. Mech. & Mat. Meeting*, JHU, Baltimore, MD., June 12-14, 1996.
29. Sarkar K, Duraiswami R, Chahine GL **1995** "Three dimensional numerical simulation of bubble-vortical flow interaction," presented at *Cavitation Multiphase Flow Forum, Summer Meeting, American Society of Mechanical Engineers*, Hilton Head, South Carolina, 13-18 August 1995.
30. Sarkar K, Prosperetti A **1993** "Smoothed boundary conditions for Stokes flow over a rough surface," presented at the *46th Annual Meeting of the Division of Fluid Dynamics, American Physical Society*, Albuquerque, New Mexico, 21-23 November 1993.
31. Sarkar K, Prosperetti A **1993**, "Coherent and incoherent scattering from oceanic bubbles," presented at the *125th Meeting of the Acoustical Society of America*, Ottawa, Canada, 17 May - 21 May 1993.
32. Sarkar K, Prosperetti A **1993** "A unified approach for scattering from bubbles in the ocean," presented at the *1st Graduate Meeting of the American Society of Mechanical Engineers*, Ithaca, New York, 19 March - 20 March 1993.
33. Prosperetti A, Sarkar K **1992** "Enhanced backscattering from bubble cloud distributions on the ocean surface," presented at the *122nd Meeting of the Acoustical Society of America*, Salt Lake City, Utah, 11 May - 15 May 1992.

Technical reports

1. Duraiswami R, Sarkar K, Chahine GL **1995** "2DynaEIT: A Boundary Element Code for Efficient Electrical Impedance Tomography--- Theory and Test Cases," Dynaflow, Inc. Tech Rep. 95012-1.
2. Duraiswami R, Sarkar K., Prabhukumar S, Chahine GL **1995** "BEM Methods for Efficient 2D and 3D Electrical Impedance Tomography," Dynaflow, Inc. Tech Rep. 95006-1NSF.
3. Chahine GL, Sarkar K, Duraiswami R **1994** "Letter Report -- Estimation of Bubble Dynamics Forces," Dynaflow, Inc. Tech. Rep. 94010-1.
4. Sarkar K, Smith MK **1990** "Spontaneous Violation of Reflection Symmetry in Complex Ginzburg-Landau equation," Johns Hopkins University Technical Report.
5. Sarkar K **1988** "Concepts of Ship-Propeller Design by Lifting-Line and Lifting-Surface Theory," B.Tech Project report, IIT, Kharagpur, India.

Invited talks

1. **2005** "Encapsulated Microbubbles for ultrasound imaging and drug delivery ," at Department of Aerospace Engineering and Mechanics, University of Minnesota, 09/20/05.
2. **2005** "Dynamics of encapsulated microbubbles for ultrasound imaging and drug delivery," at Polymer Division, NIST, 08/15/05.
3. **2005** "Modeling contrast microbubbles for ultrasound imaging and drug delivery," at Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign, 06/30/05.
4. **2005** "Modeling contrast microbubbles for ultrasound imaging and drug delivery," at Department of Mechanical Engineering, University of Pennsylvania, 04/21/05.

5. **2005** “Encapsulated Microbubbles for ultrasound imaging and drug delivery,” at Department of Mathematics, University of Delaware, 04/05/05.
6. **2004** “Microbubble contrast agents for ultrasound imaging and drug delivery,” at Department of Mechanical Engineering, Boston University, 12/10/04.
7. **2004** “Microbubble based Ultrasound Contrast Agents,” at Department of Mechanical Engineering, New Jersey Institute of Technology, 9/8/04.
8. **2004** “Ultrasound Contrast Agents: Modeling and characterization of its interfacial rheology,” at Department of Mechanical Engineering, National University of Singapore, 1/28/04.
9. **2003** “Ultrasound Contrast Agents: A fresh look at its interfacial rheology,” at DuPont Experimental Station, 5/12/03.

Research Grants/Contracts

1. “Ultrasound Activated Contrast Imaging of Prostate Cancer Detection” Department of Defense DAMD17-03-1-0119, co-PI 3/03-3/06.
2. “Modeling and Characterization of Definity by measuring in vitro attenuation” Bristol-Myers Squibb Imaging, PI, 3/03-9/03.
3. “Modeling and Characterization of Microbubble Contrast Agent for Medical Ultrasound” University of Delaware Research Foundation (UDRF), PI, 6/03-5/04.
4. “Summer Undergraduate Research program” University of Delaware Research Foundation (UDRF), PI, 6/04-8/04.
5. “Dynamics of Encapsulated Microbubbles for Medical Ultrasound” National Science Foundation, CTS-0352829, PI, 3/04-2/05.
6. “Ultrasound and Gelatinase Triggered Release of Liposomal Content” National Institute of health, PI, 10/05-03/07, pending.
7. “Noninvasive Subharmonic Pressure Estimation to Monitor Breast Cancer during Neoadjuvant Therapy” Department of Defense, co-PI, 01/01/06-12/31/06 pending.
8. “Subharmonic Microbubble Signals for Pressure Estimation” National Institute of Health, co-PI, 01/01/06-12/31/06 pending.
9. “Ultrasonic Characterization of Contrast Agents for Medical Imaging and Drug Delivery: An Interfacial Rheology Approach” National Science Foundation, PI, 06/01/06-05/31/09 pending.
10. “Ultrasound Mediated Controlled Drug Release from Leaky Liposomes” National Science Foundation, PI, 06/01/06-05/31/09 pending.

Research Supervision

PhD:

- Qing Cao, awarded PhD 2004 “Experimental and numerical investigation of viscosity stratified two- and three- layer flow,” Co-advised with Ajay Prasad
- Xiaoyi Li 2003-date “Computational emulsion rheology ”

MS:

- Pankaj Jain 2004-date “Experimental investigation of ultrasound contrast agents”
- Nishith Aggrawal 2004-date “Computation of viscoelastic drop dynamics”

Post-Doctoral:

- Dhiman Chatterjee 2002-2004 “Experiments and modeling of ultrasound contrast agents”
(*Currently, Assistant Professor of Mechanical Engineering in IIT Madras, India*)

Undergraduate:

- Nathan Schreppler 2003-2004
- Brian Tuchband 2003-2004
- Stephanie Frangiaikis 2003
- Julia Li 2005
- Aaron Winn 2005
- Dale Heintzelman 2005

Teaching

- Spring 2002 MEEG640 Intermediate Heat Transfer
- Fall 2002 MEEG630 Intermediate Fluid Mechanics
- Spring 2003 MEEG640 Intermediate Heat Transfer
- Fall 2003 MEEG331 Fluid Mechanics I

- Spring 2004 MEEG640 Intermediate Heat Transfer
- Spring 2004 MEEG667 Microscale Flows
- Fall 2004 MEEG331 Fluid Mechanics I
- Spring 2005 MEEG640 Intermediate Heat Transfer
- Spring 2005 MEEG667 Microscale Flows with Biological Applications
- Fall 2005 MEEG331 Fluid Mechanics I

University Service

Departmental Committees

2002-2004	Computer Committee
2002-2003	Departmental Webmaster
2003-2004	Faculty Search Committee
2004-	Graduate Committee

College Committees

2004-2003	e-CALC-II Committee
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Professional Society Committees

2004-	ASME Fluids Engineering Multiphase Flow Technical Committee
2004-	ASME Micro- and Nano-Fluid Dynamics Technical Committee

Professional Activity

Membership in professional organizations

- *American Society of Mechanical Engineers*
- *Acoustical Society of America*
- *Society of Rheology*
- *American Physical Society-Division of Fluid Dynamics*

Reviewer for the following journals

- *Journal of Fluid Mechanics*
- *International Journal of Multiphase flow*
- *Journal of Fluids Engineering*
- *Journal of Rheology*
- *Journal of Non-Newtonian Fluid Mechanics*
- *Physics of Fluids*
- *Journal of the Acoustical Society of America*
- *Journal of Hydraulic Engineering*
- *Journal of Computational Physics*

Reviewer for the following funding agencies

- *NSF Advanced Materials and Manufacturing System Panel*
- *NSF Chemical and Transport Division*
- *US Civilian Research & Development Foundation (CRDF)*