

Department of Mechanical and Aerospace Engineering,
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BANAVARA SHASHIKANTH

RESEARCH INTERESTS

GENERAL AREAS: Theoretical Fluid Dynamics, Hamiltonian and Lagrangian Mechanics, Dynamical Systems, Control Theory

SPECIFIC INTERESTS: Vortex Dynamics, Dynamically Coupled Fluid-Structure Interactions, Interfacial Fluid Dynamics, Optimal Control

EDUCATION

Ph.D in Aerospace Engineering, **University of Southern California**, Los Angeles, USA, 1998 (Thesis Advisor: Paul K. Newton).

Master's (M.E.) in Aerospace Engineering, **Indian Institute of Science (IISc)**, Bangalore, India, 1991.

Bachelor's (B.Tech) in Aerospace Engineering, **Indian Institute of Technology (IIT)**, Madras, India, 1989.

WORK AND RESEARCH EXPERIENCE

- Associate Professor, Department of Mechanical and Aerospace Engineering, **New Mexico State University**, Las Cruces, USA, Aug 2010 to date.
- Assistant Professor, Department of Mechanical and Aerospace Engineering, **New Mexico State University**, Las Cruces, USA, 2001-2007, (with tenure) 2007-2010.
- Postdoctoral Scholar, Department of Control and Dynamical Systems, **California Institute of Technology**, Pasadena, USA, Mar. 1998 to Dec. 2000 (Postdoctoral Advisors: Jerrold E. Marsden (principal), Richard Murray and Joel W. Burdick).
- Research scientist at the Experimental Aerodynamics Division, **National Aerospace Laboratories**, Bangalore, India, 1991-1993.

AWARDS

- Fields Research Fellowship, Fields Institute of Mathematical Sciences, Toronto, Canada, May/June 2018.
- Alexander von Humboldt Research Fellowship, Germany, 2008—2010 (summers) and May 2015.

TEACHING

(all at NMSU)

- ME 234: MECHANICS-DYNAMICS (undergraduate)
- ME 240: THERMODYNAMICS (undergraduate)
- ME 228: ENGINEERING ANALYSIS I (undergraduate)
- ME 328: ENGINEERING ANALYSIS II (undergraduate)
- ME 338: FLUID MECHANICS (undergraduate)
- AE 339: AERODYNAMICS I (undergraduate)
- ME 405: INTERMEDIATE FLUID MECHANICS (undergraduate)
- ME 530: INTERMEDIATE FLUID MECHANICS (graduate)
- ME 533: COMPUTATIONAL AND THEORETICAL FLUID MECHANICS (graduate)
- ME 537: VORTEX DYNAMICS (graduate)
- ME 570: ENGINEERING ANALYSIS I (graduate)

Individualized Studies Classes

- ME 400: Topic: Rocket propulsion (undergraduate)
- ME 610: Topic: Optimal Control Theory (graduate)
- ME 509: Topic: Geophysical Fluid Dynamics (graduate)
- IE 505: Topic: Modeling of van der Waals forces (graduate)

PUBLICATIONS

BOOK

- *Dynamically Coupled Rigid Body-Fluid Flow Systems*, Springer, 2021.
<https://doi.org/10.1007/978-3-030-82646-8>

JOURNAL

- Application of Kirchhoff's equations of motion to the dynamically coupled system of a rigid body with a completely-liquid-filled cavity, B. N. Shashikanth, *Mathematics and Mechanics of Solids*, Page 108128652311513, DOI: 10.1177/10812865231151391, **2023**
- The centroid-deformation decomposition for buoyant vortex patch motion, B. N. Shashikanth and R. Kidambi, *Regular and Chaotic Dynamics*, vol. 26, pp. 577–599, **2021**.
- Poisson brackets for the dynamically coupled system of a free boundary and a neutrally buoyant rigid body in a body-fixed frame, B. N. Shashikanth, *Journal of Geometric Mechanics*, vol. 12 (1), pp.25–52, **2020**.
- Reconstruction phases in the planar three- and four-vortex problems, A. Hernández-Garduño and B. N. Shashikanth, *Nonlinearity*, vol. 31 (3), pp.783–814, **2018**.
- Kirchhoff's equations of motion via a constrained Zakharov system, B. N. Shashikanth, *Journal of Geometric Mechanics*, vol. 8(4), pp. 461--485, **2016**.
- Non-invasive determination of external forces in vortex-pair-cylinder interactions, D. Hartmann, W. Schröder and B. N. Shashikanth, *Physics of Fluids*, vol. 24, 061903, (27 pages), **2012**.
- Vortex dynamics in \mathbb{R}^4 , B. N. Shashikanth, *Journal of Mathematical Physics*, vol. 53, issue 1, 013103 (21 pages), **2012**.
- Dissipative N -point-vortex models in the plane, *Journal of Nonlinear Science*, vol.20, pp.81--103, **2010**.
- Hamiltonian Structure and Dynamics of a Neutrally Buoyant Rigid Sphere Interacting with Thin Vortex Rings, B. N. Shashikanth, A. Sheshmani, S. D. Kelly and M. J. Wei, *Journal of Mathematical Fluid Mechanics*, vol. 12, pp. 335-353, **2010**.
- Hamiltonian structure for a neutrally buoyant rigid body interacting with N vortex rings of arbitrary shape: the case of arbitrary smooth body shape, B. N. Shashikanth, A. Sheshmani, S. D. Kelly and J. E. Marsden, *Theoretical and Computational Fluid Dynamics*, vol. 22, pp.37–64, **2008**.
- Optimal approach to and alignment with a rotating rigid body for capture, Z. Ma, O. Ma and B. N. Shashikanth, *Journal of the Astronautical Sciences*, vol. 55(4), pp. 407--419, **2007**.

- Symmetry reduction and control of the dynamics of a 2-D rigid circular cylinder and a point vortex: vortex capture and scattering, B. N. Shashikanth, *European Journal of Control*, vol. 13(6), pp. 641--657, **2007**.
- Vortex interaction with a moving sphere, J. J. Allen, Y. Jouanne and B. N. Shashikanth, *Journal of Fluid Mechanics*, vol. 587, pp. 337-346, **2007**.
- Symmetric pairs of point vortices interacting with a neutrally buoyant 2D circular cylinder, B. N. Shashikanth, *Physics of Fluids*, vol.18, 127103, **2006**.
- Poisson brackets for the dynamically interacting system of a 2D rigid cylinder and N point vortices: the case of arbitrary smooth cylinder shapes, B. N. Shashikanth, *Regular and Chaotic Dynamics*, vol.10(1), pp. 1-14, **2005**.
- Leapfrogging Vortex Rings: Hamiltonian structure, geometric phases and discrete reduction, B. N. Shashikanth and J. E. Marsden, *Fluid Dynamics Research*, vol.33 (4), pp 333-356, **2003**.
- The Hamiltonian Structure of a 2-D rigid cylinder interacting dynamically with N point vortices, B. N. Shashikanth, J. E. Marsden, J. W. Burdick and S. D. Kelly, *Physics of Fluids*, vol.14 (3), pp. 1214—1227, **2002**.
- Geometric phases for co-rotating elliptical vortex patches, B. N. Shashikanth and P.K. Newton, *Journal of Mathematical Physics*, vol.41 (12), pp.8148-8162, **2000**.
- Vortex Motion and the Geometric Phase, Part 2: Slowly Varying Spiral Structures, B. N. Shashikanth and P. K. Newton, *Journal of Nonlinear Science*, vol.9 (2), pp.233-254, **1999**.
- Vortex Motion and the Geometric Phase, Part 1: Basic Configurations and Asymptotics, B. N. Shashikanth and P. K. Newton, *Journal of Nonlinear Science*, vol.8 (2), pp.183-214, **1998**.

CONFERENCE

- On the interaction of a vortex pair with a freely moving cylinder, D. Hartmann, L. Schneiders, W. Schroeder and B. N. Shashikanth, *AIAA 2010-4749, 40th Fluid Dynamics Conference and Exhibit, Chicago, Illinois, 28 June - 1 July, 2010*
- Dynamics and control of the system of a 2-D rigid circular cylinder and point vortices, Z. Ma and B. N. Shashikanth, *Proceedings of the 2006 American Control Conference, Minneapolis, Minnesota, USA, June14-16, 2006*.

- Optimal Control for Spacecraft to Rendezvous with a Tumbling Satellite in a Close Range, Z. Ma, O. Ma and B. N. Shashikanth, *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Beijing, China, October 9—15, 2006.*
- Investigation of van der Waals Forces in the assembly of Micro Devices, D. Vasquez, J. Cecil and B. Shashikanth, *Proceedings of the 2005 Industrial Engineering Research Conference, Atlanta, GA, May 14-18 2005.*

OTHER (ArXiv, Technical Reports, Extended Abstracts etc.)

- On the Hamiltonian structure of the intrinsic evolution of a closed vortex sheet, arXiv:2408.13462v2 [physics.flu-dyn] 1 Sep 2024
- Viscous vortex-pair-cylinder interactions near inviscid translating equilibria: a numerical study, B. N. Shashikanth and Yanxing Wang, arXiv:2206.09560v1 [physics.flu-dyn] 20 Jun 2022
- Extended Abstract: On compressible adiabatic inviscid flow equations in divergence form and their Lie-Poisson brackets, 17th U.S. National Congress on Theoretical and Applied Mechanics, Michigan State University, USA, 15-20 June 2014
- Coupled inviscid dynamics of rigid bodies and coherent vortices---2008 annual report of the Aerodynamics Institute of RWTH—Aachen, Germany (Chair of the Aerodynamics Institute: Wolfgang Schröder).
- Extended Abstract: Poisson brackets for rigid bodies in vortical fluids, Workshop on Dynamical Systems Methods in Fluid Dynamics (Organizers: Jerrold E. Marsden (Caltech) and Jürgen Scheurle (TU, Munich)), Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany, July 31—Aug 5, 2005, in Report No.34/2005 in Oberwolfach Reports, 2005

CONFERENCE AND INVITED TALKS

- *16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics, Vancouver, British Columbia, Canada, July 21—26, 2024*
- *Regular and Chaotic Dynamics, Sirius Mathematical Center, Sochi, Russia, Dec 4th—8th, 2023 (online)*
- *Keynote Talk: SES 2019 – Society of Engineering Science, 56th Annual Technical Meeting, Washington University, St. Louis, Missouri, October 13-15, 2019*
- *The IV AMMCS International Conference, Waterloo, Ontario, Canada, August 20-25, 2017*

- *Seminar, Department of Mathematics, University of Toronto, Toronto, Canada, June 12th, 2018*
- *Seminar, Department of Mathematics, University of Toronto, Toronto, Canada. March 20th, 2015*
- *17th U.S. National Congress on Theoretical and Applied Mechanics, Michigan State University, USA, 15-20 June 2014*
- *Focus Program on Geometry, Mechanics and Dynamics: the Legacy of Jerry Marsden, The Fields Institute, Toronto, Canada, July, 2012*
- *Center for Fluid Dynamics, Technical University of Denmark (DTU), Lyngby, Denmark, May 6, 2008*
- *Fluid Dynamics Seminar Series, Department of Mathematical Sciences, Center for Applied Mathematics and Statistics, and Department of Mechanical Engineering, New Jersey Institute of Technology, Newark, March 3, 2008*
- *Interdisciplinary Transport Phenomena V, Bansko, Bulgaria, October 14-19, 2007*
- *Universidad Nacional Autónoma de México, Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas, Mexico city, Mexico, May 17, 2007*
- *IUTAM Symposium on Hamiltonian Dynamics, Vortex Structures and Turbulence, Russian Academy of Sciences, Moscow, Russia, August 25--30, 2006*
- *77th Annual Meeting of the Gesellschaft für Angewandte Mathematik und Mechanik (GAMM), Technische Universität, Berlin, Germany, March 27—31, 2006*
- *Workshop on Dynamical Systems Methods in Fluid Dynamics (Organizers: Jerrold E. Marsden and Jurgen Scheurle), Mathematisches Forschungsinstitut Oberwolfach, Oberwolfach, Germany, July31—Aug5, 2005*
- *AIMS' Fifth International Conference on Dynamical Systems and Differential Equations, Cal State Polytechnic, Pomona, California, June 16-19, 2004*
- *Colloquium, Department of Mathematics, University of New Mexico, Albuquerque, Oct 31, 2003*
- *SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 27-31, 2003*
- *Annual Spring Meeting of the American Geophysical Union, Washington DC, May 28--31, 2002*

- *SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 19-24, 2001.*

- *Annual General Assembly of the European Geophysical Society, Nice, France, March 26-30, 2001.*

FUNDED GRANTS

- Team member: Flapping/Twisting Aeroelastic Wings for Propulsion, Army High Performance Computing Research Center, Stanford-led Multi-University Program, Grant Amount: \$100,000 per annum (approx.), Period: 2006---2010.

- Co-PI: *Development of scaled hummingbird models for studying the dynamics of hovering and low speed forward flight*, Department of Defense/Air Force Office of Scientific Research, Historically Black Colleges and University and Minority Institutions Support Program, Total Grant Amount: \$410,000 (approx.), Period: 2006—2009 (PI: James Allen).

- Co-PI: *Flapping Wing Aerodynamics and Control for Maneuverable Hovering Micro Air Vehicles*, Air Force-STTR (Small Business Technology Transfer Program), Total Grant Amount: \$40,000, Period: 2006—2007 (PI: James Allen).

- PI: *Buoyant airfoil for distributed wind power technology*, Space Alliance Technology Outreach Program (SATOP), Total Grant Amount: \$1,200, Period: 11/2002—01/2003.

- PI: *Wind-tunnel tests for a helikite*, Space Alliance Technology Outreach Program (SATOP), Total Grant Amount: \$2,000, Period: 03/2003—06/2003.

Other:

- Technical Personnel: *NUE: Nanotechnology*, National Science Foundation, Amount Received: \$3,000 (approx.), Duration: 09/2003—08/2004.

- Technical Personnel: *New Mexico State University Engineering Research Council Grant*, Amount Received: \$2,800 (approx.), Duration: 06/2005—08/2005.

PROFESSIONAL SERVICE

- *Mechanical and Aerospace Engineering Department and College of Engineering, NMSU:*

Past and continuing: Faculty Search Committees, Graduate Committee, Undergraduate Course Rotation Committee, Graduate Course Rotation Committee, Aerospace Engineering Program Committee, Departmental ABET Committee, College Engineering Math Task Force Committee and College Awards Committee.

- *Paper reviewing*

Journals

- Journal of Fluid Mechanics
- Journal of Nonlinear Science
- Regular and Chaotic Dynamics
- Physics of Fluids
- Journal of Physics A
- Journal of Mathematical Physics
- Mechanics Research Communications
- ZAMM (Zeitschrift für Angewandte Mathematik und Mechanik)
- Chinese Physics Letters
- Scientific Reports

Conferences

- American Control Conference, 2004, 2012, 2019
- IEEE Conference on Control Applications, 2001

Grant Proposals

- NSF Panel, DCSD, 2021