

Shibabrat Naik

Ph.D., Engineering Mechanics

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Education

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| 2010–2016 | Ph.D., Engineering Mechanics, Virginia Tech, USA.
Title: Geometric Approaches in Phase Space Transport and Partial Control of Escaping Dynamics
Advisor: Prof. Shane D. Ross |
| 2016 | Graduate Certificate in Computational Engineering Science and Mechanics, Virginia Tech, USA. |
| 2006–2010 | B.E., Civil Engineering, Jadavpur University, India. |

Experience and academic posts

- June, 2018 – : **Postdoctoral Research Associate** in Applied Mathematics, School of Mathematics, University of Bristol. Advisor: Prof. Stephen Wiggins. Project: CHemistry And Mathematics in Phase Space ([CHAMPS](#))
- Sept, 2017 – June, 2018: **Research Associate** in Engineering Mechanics, Ross Dynamics Lab, Virginia Tech. Advisor: Prof. Shane D. Ross.
- Apr–Aug, 2017: **Postdoctoral Researcher** in Scalable Autonomous Systems Lab, part of GRASP Lab, Mechanical Engineering and Applied Mechanics, University of Pennsylvania. Advisor: Prof. M. Ani Hsieh.
- Jan–Mar, 2017: **Postdoctoral Researcher** at Mechanical Engineering, University of Delaware and **Visiting Scholar** at Mechanical Engineering and Mechanics, Drexel University. Advisors: Prof. M. Ani Hsieh and Prof. Herbert G. Tanner.
- Aug–Oct, 2016: **Tutoring Lab Staff** at Virginia Tech in Math Emporium, Department of Mathematics, Virginia Tech.
- 2012–2016: **Graduate Research Assistant** in Ross Dynamics Lab, Virginia Tech. Advisor: [Prof. Shane D. Ross](#)
- June–Dec, 2013: **Research Intern** in Mechatronics group at Mitsubishi Electric Research Laboratory, Boston, Massachusetts. Advisor: Dr. Piyush Grover.
- 2010–2011: **Graduate Teaching Assistant** at Virginia Tech for Statics, Mechanics of deformable bodies and Dynamics, Department of Engineering Science and Mechanics.
- 2009–2010: **Undergraduate Research Assistant** at Indian Statistical Institute (Kolkata) in Physics and Applied Mathematics Unit.
- 2007–2010: **Undergraduate Research Assistant** at Jadavpur University in Structural Mechanics Laboratory, Department of Civil Engineering.

Awards and recognitions

- **Front cover image** in *International Journal of Bifurcation and Chaos*, [April 2020 issue](#).
- **Outstanding Student Paper** award by Nonlinear Geophysics focus group for poster on “Lobe dynamics and homoclinic tangles in atmospheric flows”, American Geophysical Union, Fall meeting, San Francisco, CA, 2012.

- **Pratt Presidential Fellowship**, Virginia Tech, 2010-2011.
- **First prize** for the Industrial Design Problem in student design competition, MEGALITH, organized by Indian Institute of Technology, Kharagpur, India, 2010.
- **Best student proposal** award for project “Correlation of Air and Noise Quality with Urban Traffic Characteristics for Kolkata Metropolis” for the Project Proposal Competition for “Services to Community and Economy” under Technical Education Quality Improvement Program, Jadavpur University, India, 2009.

Publications

Peer-reviewed articles

10. P. Pandey, [S. Naik](#), and S. Keshavamurthy. Classical and quantum dynamical manifestations of index-2 saddles: concerted versus sequential reaction mechanisms. *arXiv:2009.07716*, September 2020, *To appear in Regular and Chaotic Dynamics*. [arXiv](#)
9. W. Lyu, [S. Naik](#), and S. Wiggins. The Role of Depth and Flatness of a Potential Energy Surface in Chemical Reaction Dynamics. *Regular and Chaotic Dynamics*, 25(5):453–475, September 2020. [doi](#)
8. [S. Naik](#) and S. Wiggins. Detecting reactive islands in a system-bath model of isomerization. *Physical Chemistry Chemical Physics*, 22(32):17890–17912, 2020. [doi](#)
7. W. Lyu, [S. Naik](#), and S. Wiggins. UPOsHam: A Python package for computing unstable periodic orbits in two-degree-of-freedom Hamiltonian systems. *Journal of Open Source Software*, 5(45):1684, January 2020. [doi](#)
6. V. J. García-Garrido, [S. Naik](#), and S. Wiggins. Tilting and Squeezing: Phase Space Geometry of Hamiltonian Saddle-Node Bifurcation and its Influence on Chemical Reaction Dynamics. *International Journal of Bifurcation and Chaos*, 30(04):2030008, March 2020 [doi](#)
5. [S. Naik](#) and S. Wiggins. Finding normally hyperbolic invariant manifolds in two and three degrees of freedom with Hénon-Heiles-type potential. *Physical Review E*, 100(2):022204, August 2019. [doi](#)
4. [S. Naik](#), V. J. García-Garrido, and S. Wiggins. Finding NHIM: Identifying high dimensional phase space structures in reaction dynamics using Lagrangian descriptors. *Communications in Nonlinear Science and Numerical Simulation*, 79:104907, December 2019. [doi](#)
3. S. D. Ross, A. E. BozorgMagham, [S. Naik](#), and L. N. Virgin. Experimental validation of phase space conduits of transition between potential wells. *Physical Review E*, 98(5):052214, 2018. [doi](#)
2. [S. Naik](#), F. Lekien, and S. D. Ross. Computational method for phase space transport with applications to lobe dynamics and rate of escape. *Regular and Chaotic Dynamics*, 22(3):272–297, 2017. [doi](#)
1. [S. Naik](#) and S. D. Ross. Geometry of escaping dynamics in nonlinear ship motion. *Communications in Nonlinear Science and Numerical Simulation*, 47:48–70, 2017. [doi](#)

Contributions to symposia and compiled volumes

2. [S. Naik](#) and S. D. Ross. Partial control and avoidance of escape from a potential well. XXIV ICTAM, 21-26 August 2016, Montréal, Canada.
1. S. D. Ross, A. E. BozorgMagham, [S. Naik](#), and L. N. Virgin. Escape from potential wells in multi-dimensional experimental systems. XXIV ICTAM, 21-26 August 2016, Montréal, Canada.

Open-source books and technical reports

6. M. Agaoglou, B. Aguilar-Sanjuan, V. J. García-Garrido, R. García-Meseguer, F. González-Montoya, M. Katsanikas, V. Krajňák, [S. Naik](#), and S. Wiggins. *Lagrangian Descriptors: Discovery and Quantification of Phase Space Structure and Transport*. Zenodo v1.0.0, Jul 2020. <https://champsproject.github.io/lagrangian-descriptors> (EPSRC Grant Number: EP/P021123/1)
5. W. Lyu, [S. Naik](#), and S. Wiggins. Elementary exposition of realizing phase space structures relevant to chemical reaction dynamics. *arXiv:2004.05709*, April 2020
4. M. Agaoglou, B. Aguilar-Sanjuan, V. J. García-Garrido, R. García-Meseguer, F. González-Montoya, M. Katsanikas, V. Krajňák, [S. Naik](#), and S. Wiggins. *Chemical Reactions: A Journey into Phase Space*. Zenodo v0.1.0, Dec 2019. <https://www.chemicalreactions.io> (EPSRC Grant Number: EP/P021123/1)
3. T. Mandal, S. Ghosh, and [S. Naik](#). Study on the strength of fly ash based geopolymer concrete, 2010
2. [S. Naik](#) and W. Malik. Experimental modal testing for estimating the dynamic properties of a cantilever beam, 2010
1. [S. Naik](#) and H. P. Majumdar. Group Theoretic approach to the analysis of boundary layer flow over shrinking sheet with suction, 2010.

Contributed and invited talks

9. Finding NHIM: Identifying High Dimensional Phase Space Structures using Lagrangian Descriptors; [S. Naik](#), S. Wiggins; SIAM-DS 2019, Salt Lake, Utah, USA.
8. Geometry of Escaping Dynamics in the Presence of Dissipative, Gyroscopic and Stochastic Forces; [S. D. Ross](#), J. Zhong, S. Naik, A. E. Bozorg Magham, Lawrence N. Virgin; SIAM-DS 2019, Salt Lake, Utah, USA.
7. Optimizing Vehicle Autonomy in Geophysical Flows; [M. Ani Hsieh](#), S. Naik, D. Kularatne, S. Bhat-tacharya, E. Forgoston; SIAM-DS 2017, Salt Lake, Utah, USA.
6. Escape from potential wells in multi-degree of freedom systems: phase space geometry and partial control; [S. Naik](#), S. D. Ross; SIAM-DS 2015, Salt Lake, Utah, USA.
5. Lagrangian coherent structures as mesoscale transport barriers in atmospheric flows; S. Naik, [S. D. Ross](#); APS Division of Fluid Dynamics, Boston, Massachusetts, USA.
4. Partial control approach for avoiding capsizes; [S. Naik](#), S. D. Ross; SIAM Mid-Atlantic Student Conference, Washington D.C., USA.
3. Probabilistic approaches of phase space transport and mixing; [S. Naik](#), S. D. Ross, P. Grover; Invited talk for SIAM Student Chapter at Virginia Tech, Blacksburg, USA.
2. Thermal coherent sets and heat transfer in chaotic laminar flows; [S. Naik](#), P. Grover; APS Division of Fluid Dynamics 2013, Pittsburgh, PA, USA.
1. Lobe dynamics and homoclinic tangles in atmospheric flows; [S. Naik](#), S. D. Ross; Poster at AGU fall meeting 2012, San Francisco, CA, USA.

Research funding

- **London Mathematical Society** summer research bursary 2019 (Grant ref: 18-19-58, Wenyang Lyu, project title: Comparative Overview of Numerical Methods for Computing Unstable Periodic Orbits in Hamiltonian Mechanics) and 2020 (Grant ref: 19-20-28, Piero Sarti, project title: Computation and visualization of phase space structures in two degrees of freedom Hamiltonian systems). Joint recipient with Prof. Stephen Wiggins. Amount: £ 3160.00

Research interests

- Dynamical systems theory
 - Geometric and statistical methods of chaotic dynamics.
 - Discovery of structures in phase space transport.
 - Partial control of escape and transition dynamics.
 - Phase space structures based control.
- Data-driven methods
 - Transport barriers in atmosphere and ocean.
 - Machine learning phase space structures.
 - Reduced order modelling.
 - Defect and anomaly detection in structural dynamics.
- Applications
 - Engineering science and mechanics: ship dynamics and capsize, transport and optimization in fluid mechanics.
 - Chemical physics: isomerization and solution-phase reaction dynamics, machine learning of phase space structures.
 - Robotics: multi-agent systems, distributed control and coordination.
 - Mathematical biology: theoretical and computational neuroscience, data-driven modelling of neurological disorders, learning, and memory.

Synergistic Activities

Professional service

- Serving as co-organizer for the Institute of Applied Mathematics *Fluids and Materials seminar* since 2020.
- Volunteer member of Equality, Diversity, and Inclusion Committee in the School of Mathematics, University of Bristol.
- Served as session chair for [Topics in Bifurcation Theory](#) at SIAM-DS 2015. Co-organizer of minisymposium on [High Dimensional Phase Space Structures in Chemical Reaction Dynamics](#) at SIAM-DS 2019.
- Reviewed for Journal of Open Source Software, Communications in Computational Physics, PLOS ONE, Discrete and Continuous Dynamical Systems - Series B.
- Member of Society of Industrial and Applied Mathematics, American Physical Society.

Students supervised

- Supervised Bing En Gan, Annie Hu, Wenyang Lyu, Piero Sarti, Sam Spedding for summer projects funded by LMS Summer Research bursary 2020, School of Mathematics, and EPSRC funded project, [CHAMPS](#).
- Co-supervised Wenyang Lyu for LMS Summer Research Bursary 2019.

Outreach

- Collaborative art on mathematics behind my research for the international Pint of Science festival 2019, [Creative Reactions](#).

Training and skills

- 2016: Certified Tutor, Level I, CRLA's International Tutor Training Program, Dept. of Mathematics, Virginia Tech Math Emporium, USA.
- Attended training workshops for staff development on research methods, project planning, peer-review, and related academic skills.
- Workshop on Machine learning and dynamical systems at Imperial College, London and University of Washington, Seattle. Democracy hackthon at PyData London 2019.
- Computational science: Jupyter, C/C++, Python, MATLAB, \LaTeX , MPI, OpenMP, Fortran, Java, Javascript, Julia, Xmgrace, COMSOL, Paraview, Tecplot, GNU-Scientific Library, C++ Standard Template Library, Numpy, Scipy, Matplotlib, Pandas, Scikit-learn.
- MOOC courses and certifications: Machine Learning, Linear and Integer programming, Computing for Data analysis, Python: Data Analysis, C++ Essential Training, Learning C++, Computational Engineering Science and Mechanics. Extensive coursework in machine learning and data science using online courses on LinkedIn and Coursera.

References

- Stephen Wiggins, Professor of Applied Mathematics, School of Mathematics, University of Bristol, UK.
Contact: s.wiggins@bristol.ac.uk
- Shane D. Ross, Professor, Department of Aerospace and Ocean Engineering, Virginia Tech, USA.
Contact: sdross@vt.edu

Personal information

- Date of Birth: 10-Nov-1988
- Nationality: Indian
- Status in UK: Tier-2 (General), Leave to remain
- Languages: English (fluent), Hindi (native), Bengali (native), and Odia (native)
- Erdős Number: 5