

BHARGAV RALLABANDI

Department of Mechanical Engineering, University of California, Riverside
Bourns Hall A375, Riverside CA 92521

Tel: +1 (217) 419-9487

email: bhargav@engr.ucr.edu

web: <https://flow.ucr.edu>

Research interests

Fluids, Soft materials and Transport processes. I am interested in fundamental problems involving transport, deformation and flow in complex multiscale systems, motivated by applications in environment, biology and microscale engineering. Current topics of interest include particulate flows, fluid-elastic interactions, and acoustically-driven flow. I specialize in developing analytic and computational models, which I complement with laboratory experiments involving microscopy and high-speed imaging.

Academic appointments

- 2024–present Associate Professor, Department of Mechanical Engineering,
University of California, Riverside
- 2018–2024 Assistant Professor, Department of Mechanical Engineering,
University of California, Riverside
- 2015–2018 Postdoctoral Researcher, *Princeton University* (Mentor: H. A. Stone)
- Lecturer (Fall 2016)

Education

- 2015 Ph.D. Theoretical and Applied Mechanics,
University of Illinois at Urbana-Champaign (Advisor: S. Hilgenfeldt)
- Visiting Graduate Researcher, *Bundeswehr University Munich*, 2014 (Mentor: C. Kähler)
- 2012 M.S. Theoretical and Applied Mechanics, *University of Illinois at Urbana-Champaign*
- 2010 B.Tech. Mechanical Engineering, *National Institute of Technology Karnataka*
- Visiting Undergraduate Researcher, *Indian Institute of Science*, Summer 2008, 2009

Awards and honors

- 2023 UCR Regents Faculty Development Award
- 2022 NSF CAREER Award
- 2021 USNC-TAM & NSF Early Career Fellowship
- 2021 UCR Honors Faculty Mentor of the Year
- 2020 Hellman Foundation Fellow
- 2020 UCR Regents Faculty Fellow
- 2019, 2022 UCR Omnibus Research and Travel Award
- 2016 Commendation for Outstanding Teaching, Princeton University
- 2017 Best Paper Award for Postdoctoral Fellows, Carbon Mitigation Initiative of Princeton University
- 2014 Hassan Aref Memorial Award for Theoretical and Applied Mechanics, UIUC
- 2012 List of Teachers Ranked as Excellent, UIUC

Peer-reviewed publications

(* indicates corresponding author; [†] indicates equal contribution)

Preprints

5. A continuum model of wind-driven formation of coastal polynyas
L. Zhu, B. Rallabandi, M. Winton and H. A. Stone. *Under Review*.
4. Enhancement and Suppression of Active Particle Movement Due to Membrane Deformations
A. H. Bialus, B. Rallabandi, and N. Oppenheimer. *Under Review*.
3. Wind-driven collisions between floes explain the observed dispersion of Arctic sea ice
B. Shaddy, P. A. Greaney and **B. Rallabandi***. preprint, arXiv:2502.17668
2. Hydrodynamic origin of friction between rough suspended particles
J. Minten and **B. Rallabandi***. *Under Review*.
1. Beyond Lucas–Washburn. Wicking in porous media with etched grooves
B. Rallabandi*, S. Modha, B. Kalish and H. Tsutsui. *Under Review*.

Journal Articles

44. Time-averaged interactions between a pair of particles in oscillatory flow
X. Zhang and **B. Rallabandi***. *J. Fluid Mech.* (2025)
43. Non-monotonic frictional behavior in the lubricated sliding of soft patterned surfaces
A. Kargar-Estahbanati and **B. Rallabandi***. *Soft Matter*. (2025)
– Invited; Soft Matter Emerging Investigators Series
42. Elasto-inertial rectification of oscillatory flow in an elastic tube
X. Zhang and **B. Rallabandi***. *J. Fluid Mech.* (2024)
41. In situ enzymatic control of colloidal phoresis and catalysis through hydrolysis of ATP
E. Shandilya, **B. Rallabandi*** and S. Maiti*. *Nature Comm.* (2024)
40. Particle hydrodynamics in acoustic fields: Unifying acoustophoresis with streaming X. Zhang,
J. Minten and **B. Rallabandi***. *Phys. Rev. Fluids* (2024)
39. Fluid-Elastic Interactions at Low Reynolds Numbers
B. Rallabandi*. *Annu. Rev. Fluid Mech.* (2024)
– Invited review article
38. Diffusioosmotic dispersion in a long narrow channel
J. Teng, **B. Rallabandi** and J. T. Ault*. *J. Fluid Mech.* (2023)
37. Three-dimensional streaming around a cylindrical obstacle in a Hele-Shaw cell
X. Zhang and **B. Rallabandi***. *J. Fluid Mech.* (2023).
36. Rotation-translation coupling of soft objects in lubricated contact
A. Kargar-Estahbanati and **B. Rallabandi***. *Soft Matter* (2022)
35. Self-sustained three-dimensional beating of a model eukaryotic flagellum
B. Rallabandi*, Q. Wang* and M. Potomkin. *Soft Matter* (2022)
34. Coupling of translation and rotation in the motion of finite-length rods near solid boundaries
J. Teng, **B. Rallabandi**, H. A. Stone and J. T. Ault, *J. Fluid Mech.* (2022)

33. Motion of a tightly-fitting axisymmetric object through a lubricated elastic tube
B. Rallabandi*, J. Eggers, M. A. Herrada, and H. A. Stone. *J. Fluid Mech.* 926 (2021)
32. An unrecognized inertial force induced by flow curvature in microfluidics
S. Agarwal, F. K. Chan, **B. Rallabandi**, M. Gazzola, and S. Hilgenfeldt, *Proc. Natl. Acad. Sci.* 118 (2021)
31. Lift forces on three-dimensional elastic and viscoelastic lubricated contacts
A. Kargar-Estahbanati and **B. Rallabandi***, *Phys. Rev. Fluids* 6 (2021)
30. Inertial forces in the Maxey–Riley equation in nonuniform flows
B. Rallabandi*, *Phys. Rev. Fluids* 6 (2021)
29. CO₂-Driven diffusiophoresis for maintaining a bacteria-free surface
S. Shim, S. Khodaparast, C.-Y. Lai, J. Yan, J. T. Ault, **B. Rallabandi**, O. Shardt and H. A. Stone, *Soft Matter* (2021)
28. Electrostatic wrapping of a microfiber around a curved particle
J. K. Nunes, J. Li, I. M. Griffiths, **B. Rallabandi** and H. A. Stone, *Soft Matter* 6 (2021)
27. Size-dependent particle migration and trapping in three-dimensional microbubble streaming flows
A. Volk, M. Rossi, **B. Rallabandi**, C. J. Kähler, S. Hilgenfeldt and A. Marin, *Phys. Rev. Fluids* 5 (2020)
26. Silver-Based Self-Powered pH-Sensitive Pump and Sensor
K. Gentile, S. Maiti, A. Brink, **B. Rallabandi***, H. A. Stone* and A. Sen*, *Langmuir* 36 (2020)
25. Rotation of a submerged finite cylinder moving down a soft incline
B. Saintyves, **B. Rallabandi**, T. Jules, T. Salez, C. Shönecker, T. Salez, H. A. Stone and L. Mahadevan, *Soft Matter* 16 (2020)
24. Effect of swarm configuration on fluid transport during vertical collective motion
M. Martinez, J. Nawroth, **B. Rallabandi** and J. O. Dabiri. *Bioinspiration and Biomimetics*, 15 (2020)
23. Curvature regularization near contacts with stretched elastic tubes
B. Rallabandi*[†], J. Marthelot[†], E. Jambon-Puillet, P. T. Brun and J. Eggers*, *Phys. Rev. Lett.* 123 (2019).
22. Representative subsampling of sedimenting blood
B. Rallabandi*, J. K. Nunes, A. Perazzo, S. Gershtein and H. A. Stone*, *Proc. Roy. Soc. A* 475 (2019).
21. Pattern formation in oil-in-water emulsions exposed to a salt gradient
Y. Liu, **B. Rallabandi**, A. Gupta, L. Zhu and H. A. Stone *Phys. Rev. Fluids* 4 (2019).
20. Diffusiophoretic and diffusioosmotic velocities for mixtures of valence-asymmetric electrolytes,
A. Gupta, **B. Rallabandi** and H. A. Stone, *Phys. Rev. Fluids* 4 (2019).
19. Migration of ferrofluid droplets in shear flow under a uniform magnetic field
J. Zhang, M. R. Hassan, **B. Rallabandi** and C. Wang, *Soft Matter* 15 (2019).
18. Autophoresis of two adsorbing/desorbing particles in an electrolyte solution
F. Yang, **B. Rallabandi** and H. A. Stone *J. Fluid. Mech.* 865 (2019).

17. Membrane induced hydroelastic migration of a particle surfing its own wave
B. Rallabandi[†], N. Oppenheimer[†], M. Y. Ben Zion and H. A. Stone, *Nature Phys.* 14 (2018)
16. Enhanced boiling heat transfer using self-actuated nano-bimorphs
S. Shin, G. Choi, **B. Rallabandi**, D. Lee, D. I. Shim, B. S. Kim and H. H. Cho, *Nano Lett.* 18 (2018)
15. Inertial particle attraction and repulsion near oscillating interfaces
S. Agarwal, **B. Rallabandi** and S. Hilgenfeldt, *Phys. Rev. Fluids* 3 (2018)
– Editor’s suggestion
14. Foam-driven fracture
C.-Y. Lai, **B. Rallabandi**, A. Perazzo, Z. Zheng, S. Smiddy and H. A. Stone, *Proc. Natl. Acad. Sci.* 115 (2018)
13. Reciprocal theorem for the prediction of the normal force induced on a particle translating parallel to an elastic membrane
A. D.-M. Ider[†], **B. Rallabandi**[†], S. Gekle and H. A. Stone, *Phys. Rev. Fluids* 3 (2018)
– Editor’s suggestion
12. Formation of sea ice bridges in narrow straits in response to wind and water stresses
B. Rallabandi, Z. Zheng, M. Winton and H. A. Stone, *J. Geophys. Res. Oceans* 112 (2017)
11. Rotation of an immersed cylinder sliding near a thin elastic coating
B. Rallabandi, B. Saintyves, T. Jules, T. Salez, C. Shönecker, T. Salez, L. Mahadevan and H. A. Stone, *Phys. Rev. Fluids* 2 (2017)
10. Analysis of optimal mixing in open-flow mixers with time-modulated vortex arrays
B. Rallabandi, C. Wang and S. Hilgenfeldt, *Phys. Rev. Fluids* 2 (2017)
9. Fast inertial manipulation of particles in oscillatory flows
R. Thameem, **B. Rallabandi** and S. Hilgenfeldt, *Phys. Rev. Fluids*. 2 (2017)
8. Wind-driven ice bridge formation in straits
B. Rallabandi, Z. Zheng, M. Winton and H. A. Stone, *Phys. Rev. Lett.* 118 (2017)
– Featured in *Physics*, *PhysicsWorld*
7. Hydrodynamic force normal to an obstacle on a sphere in a non-uniform flow
B. Rallabandi, S. Hilgenfeldt and H. A. Stone, *J. Fluid Mech.* 818 (2017)
6. Entry and exit flow in curved pipes
J. T. Ault, **B. Rallabandi**, O. Shardt, K. K. Chen and H. A. Stone, *J. Fluid Mech.* 815 (2017)
5. Particle migration and sorting in microbubble streaming flows
R. Thameem, **B. Rallabandi** and S. Hilgenfeldt, *Biomicrofluid.* 10 (2016)
4. Three-dimensional streaming flows in confined geometries
B. Rallabandi, A. Marin, M. Rossi, C. J. Kähler, and S. Hilgenfeldt, *J. Fluid Mech.* 777 (2015)
3. Three-dimensional phenomena in microbubble acoustic streaming
A. Marin, M. Rossi, **B. Rallabandi**, S. Hilgenfeldt, and C. J. Kähler, *Phys. Rev. Appl.* 3 (2015)
2. Two-dimensional streaming flows driven by sessile semicylindrical microbubbles
B. Rallabandi, C. Wang and S. Hilgenfeldt, *J. Fluid Mech.* 739 (2014)
1. Frequency dependence and frequency control of microbubble streaming flows
C. Wang, **B. Rallabandi**, and S. Hilgenfeldt, *Phys. Fluids* 25 (2013)

Conference abstracts and presentations

Presented, directed and co-authored several conference abstracts (non-refereed) at meetings of the *American Physical Society* (March Meeting and Division of Fluid Dynamics Meeting), *American Chemical Society*, *American Geophysical Union*, *Society of Engineering Science*, and *Southern California Fluids Symposium*.

Invited talks

- 2024 International Centre for Theoretical Science, *TIFR, Bengaluru*
- 2023 Department of Mechanical Engineering and Materials Science, *Yale University*
- 2022 Department of Mathematics and Statistics, *University of Strathclyde, UK*
- 2021 Department of Bioengineering, *Cornell University*
- 2021 Department of Mathematics, *University of Bristol, UK*
- 2020 Department of Mechanical Science and Engineering, *University of Illinois at Urbana–Champaign*
- 2020 Graduate Aerospace Laboratories, *Caltech*
- 2019 Department of Mechanical Engineering, *University of California, Santa Barbara*
- 2019 Department of Mechanical and Aerospace Engineering, *University of California, San Diego*
- 2019 Department of Mechanical and Aerospace Engineering, *University of Nevada, Las Vegas*
- 2019 Department of Mathematics, *University of California, Riverside*
- 2019 Symposium of the American Chemical Society, *Orlando, Florida*
- 2018 Department of Physics, *California State University, Fullerton*
- 2018 Department of Chemical and Biological Engineering, *University of Wisconsin at Madison*
- 2018 School of Engineering and Applied Sciences, *Harvard University*
- 2018 Department of Mechanical Engineering, *University of Washington, Seattle*
- 2018 Department of Mechanical and Aerospace Engineering, *Case Western Reserve University*
- 2018 Department of Mathematics, *Princeton University*
- 2017 Department of Mechanical Engineering, *Brown University*
- 2017 Geophysical Fluid Dynamics Laboratory, *Princeton*
- 2014 Physics of Fluids, *University of Twente*

Research Grants

Total awarded to Bhargav Rallabandi $\approx$ \$1.15M

Current projects

1. NSF CAREER: National Science Foundation, Particulate and Multiphase Processes, CBET-2143943, CAREER: *Unsteady inertial dynamics of suspensions: transport, assembly and propulsion*, B. Rallabandi (PI), \$540k, 03/2022 – 02/2027
2. National Science Foundation, NSF-BSF: *Dynamics of flowing particles in soft confined systems.*, B. Rallabandi (PI), \$336k, 10/2023 – 09/2026
3. American Chemical Society Petroleum Research Fund (New Directions), *Capillary and Gravity Driven Flows in Multiscale Porous Media: Single and Multiphase Flows.*, B. Rallabandi (PI), Hideaki Tsutsui (co-PI) \$125k, 09/2025 – 08/2027
4. National Science Foundation, Particulate and Multiphase Processes, CBET-2126465, *ISS: Wicking in gel-coated tubes*, E. Dressaire (PI), B. Rallabandi (sub-awardee), total \$647k (\$125k to BR),

10/2021 – 09/2025

5. University of California Regents Faculty Development Award, *Uncovering the mechanics of touch for haptic sensing of textured materials*, B. Rallabandi (PI) \$7.5k 07/2023 – 06/2025

Completed projects

1. University of California Regents Faculty Fellowship, *Bridging the gap: A multi-scale approach to sea-ice dynamics*, B. Rallabandi (PI) \$8k, 07/2020 – 06/2022
2. Hellman Foundation Fellowship, *Multiscale modeling of sea-ice: linking ice floe dynamics to climate*, B. Rallabandi (PI) \$30k, 07/2020 – 06/2022

Education Grants

GAANN Fellowships in Mechanical Engineering (PI, ~ \$0.9M)

Department of Education Grant to support UCR Mechanical Engineering PhD students with a financial need. I have supported over a dozen students on this grant (10/2021 – 09/2025)

Mentoring at UC Riverside

Graduate students

- Arash-Kargar Estahbanati (PhD candidate, 2019–2024)
Thesis: Elastohydrodynamics of Soft Lubricated Contacts
- Xirui Zhang (PhD candidate, 2020–present)
Thesis: Elastoinertial Manipulation of Microscale Transport in Confined, Compliant, and Textured Flows
- Xiaokang Zhang (PhD candidate, 2020–present)
Oscillatory particle dynamics
- Jake Minten (PhD candidate, 2023–present)
Rough particle hydrodynamics
- Adewale Oluwatimehin (MS, 2023)
Thesis: Analysis of Flows Driven by Gravity and Chemical Potential in a Microfluidic Channel

Undergraduate students

- Rupin Nagireddy (BS ME at UCR; current)
- Fardad Haratian (BS ME at UCR; current)
- Hannah Fuertez (BS ME at UCR; current)
- Andrew Obermiller (2023 BS ME at UCR; next position: MS student at UC San Diego)
- Najeeb Gohil (2023 BS ME at UCR; next position: MS student at USC)
- Bryan Shaddy (2021 BS ME at UCR; next position: PhD candidate at USC)
- Aliasgar Badani (2020 BS ME at UCR; next position: engineer at Lockheed Martin)

High-school students

- Rohan Vasireddy (current; *Drag reduction on flexible surfaces*)

Teaching

At UC Riverside (2018–present)

- ME240A *Fundamentals of Fluid Mechanics* (G) (Winter, Fall 2022, Fall 2023)
ME201 *Computational Methods in Engineering* (G) (Winter 2020, Spring 2024)
ME18B *Introduction to Computational Modeling in Mechanical Engineering* (UG)
(Spring 2019, Fall 2020, Winter 2024)
ME137 *Environmental Fluid Dynamics* (UG) (Winter, Fall 2019)

At Princeton (2016)

Low-Reynolds-Number Hydrodynamics (Graduate special topics)
(Fall 2016; co-taught with H. A. Stone)

Professional Activities and Service

Member, American Physical Society (2012 – present)

Contribution to APS DFD Meetings

- Session chair, *Microscale Flows: Locomotion*, 2019
- Session chair, *Geophysical Fluid Dynamics: Cryosphere*, 2021

Workshop Organizing

Organized an invited session on “Mathematics of microswimming” with Q. Wang (UCR) and M. Potomkin (UCR) at the Annual Society of Mathematical Biology Symposium (2021).

Journal Reviewer

Physical Review Letters, Journal of Chemical Physics, Physical Review Applied, Journal of Fluid Mechanics, Physical Review Fluids, Physical Review E, European Physical Journal E, Acta Mechanica, ACS Applied Materials & Interfaces

Grant Proposal Reviewer

- National Science Foundation, 2024
- American Chemical Society Petroleum Research Fund, 2023
- University of Nebraska Collaboration Initiative Grant, 2021

Departmental and University Service

Director, GAANN Fellowships in Mechanical Engineering (PI, ~ \$0.9M)

Department of Education Grant to support UCR Mechanical Engineering PhD students with a financial need. I have supported over a dozen students on this grant (10/2021 – 09/2024)

Mechanical Engineering Departmental Colloquium, organizer (2022–2023)

Preliminary Examination for Fluid Mechanics, preparer (2019–2024)

Faculty Advisor, UCR Mechanical Engineering Graduate Student Association (2018–2020)

Exam committee member for several PhD and MS students (preliminary exams, candidacy exams and final defenses)

Departmental committee member:

- Graduate committee (2 years)
- Undergraduate committee (2 years)
- Faculty search committee (1 year)

Public outreach and engagement

- Designed and conducted a hands-on workshop for middle- and high-school teachers, focused on building a swimming robot, titled *Engineered to Swim: A hands on project connecting biomechanics, robotics and physics*. The workshop was a part of the 2022 and 2023 Educator STEP Conference, Riverside.
- Presenter, Rube Goldberg Competition, Rialto High School (2024)
- Judge, UCR National Engineering Design Challenge Competition for high-school and middle-school students (2022)
- Presented a demonstration on sea ice to children and families at the Earth Day event of the Ameal Moore Nature Center, Riverside (2019)
- Volunteer for Holiday Science Lecture, Princeton (2017)
- Tutor for freshmen undergraduate students from under-represented minority communities, Surathkal, India (2009)