

Deepak Krishnamurthy

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Research Interests

Ocean Biophysics; Engineering for biology, Fluid Mechanics; Soft Matter; Applied and Computational Mathematics

Education

Stanford University

SEP 2014-Present

Doctor of Philosophy (Mechanical Engineering), CGPA: 3.92/4.0

Bio-X Bowes Fellow, Advisor: Dr. Manu Prakash

Expected: July 2020

Jawaharlal Nehru Centre for Advanced Scientific Research

AUG 2011-AUG 2014

Master of Science (Engineering) (Advisor: Prof. Ganesh Subramanian)

CGPA: 7.5/8.0 (*1st in graduating class*)

Thesis title: *Heat Transfer from Drops in Shearing Flows & Collective Motion in Micro-scale Swimmer Suspensions.*

Roddam Family Best MS thesis award for 2014.

Birla Institute of Technology and Science (BITS)-Pilani

AUG 2007-MAY 2011

Bachelor of Engineering (Honours) (Mechanical Engineering)

CGPA: 9.15/10.00 (*Distinction - 5th in graduating class*), Undergraduate thesis grade: *Excellent*

Research Experience

PhD research, Prakash Lab, Stanford University

SEP 2014-Present

Scale-free Vertical Tracking Microscopy:

- Invented a novel, patent-pending vertical tracking microscope.
- Leading a multi-disciplinary team in microscope design, development and scale-up.
- Novel measurements, relevant to ocean biophysics, of microscale cell behavior over ecological scales.

Biophysics of Swimming and Host-seeking in Schistosoma mansoni cercariae:

- Experimental measurements, theoretical and robotics-based models to understand motility of a human parasite affection 200 Million people worldwide.

Emergent mechanics and hunting behavior in a unicellular predatory ciliate

- Using slender-body hydrodynamics and novel mechanical network models to understand emergent complex behaviors in a single-cell.

How cells jump? Energetics of microscale impulsive cell motility in Halteria grandinella:

- Understanding limits of single-cell motility by exploring cellular metabolic processes and ciliary mechanics.

Physiology course research, Marine Biological Laboratory, Woods Hole and HHMI, Janelia Farm:

JUN 2017-DEC 2017

- *Characterization of Protein Mobility in the Endoplasmic Reticulum (ER) using Single Molecule Tracking.*
Used super-resolution microscopy techniques along with image analysis to track ER luminal proteins.

M S Thesis, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)

AUG 2011-JUN 2014

- *Thesis part I: Heat Transfer from Drops in Shearing Flows:* Novel theory based on non-orthogonal transformations for heat transfer from drops at small but non-zero Reynolds number.
- *Thesis part II: Collective Motion in Micro-scale Swimmer Suspensions:* Simulation of suspension of microswimmers including hydrodynamics and orientation decorrelation mechanisms.

Summer Internship & Undergraduate thesis, Simon Fraser University, Vancouver, BC, Canada

JUNE – DEC 2010

- *Computational modelling of a microfluidic fuel cell with flow-through porous electrodes.*

Publications

Graduate Research

- **Deepak Krishnamurthy**, Hongquan Li, François Benoit du Rey, Pierre Cambournac, Adam Larson, and Manu Prakash. "Scale-free Vertical Tracking Microscopy: Towards Bridging Scales in Biological Oceanography." [\[bioRxiv\]](#) (2019): 610246 (under review at *Nature*).
- Scott M Coyle, Ellie Flaum, Hongquan Li, **Deepak Krishnamurthy**, Manu Prakash, "Coupled active systems encode emergent behavioral dynamics of the unicellular predator *Lacrymaria olor*", *Current Biology*, (2019) [\[biorxiv\]](#) [\[weblink\]](#)
- **Deepak Krishnamurthy**, Ganesh Subramanian, "Heat or mass transport from drops in shearing flows. Part 1. The open streamline regime", *Journal of Fluid Mechanics*, (July 2018). [\[weblink\]](#)
- **Deepak Krishnamurthy**, Ganesh Subramanian, "Heat or mass transport from drops in shearing flows. Part 2. Inertial effects on transport", *Journal of Fluid Mechanics*, (July 2018). [\[weblink\]](#)
- Ilton, M. , Bhamla, M. S., [et al, including **Deepak Krishnamurthy**] The principles of cascading power limits in small, fast biological and engineered systems, *Science*, (April 2018) [\[weblink\]](#)
[Wired Magazine](#) | [Quanta Magazine](#) | [IEEE Spectrum](#) | [Scientific American](#) | [EurekAlert](#) | [Discover Magazine](#) |
- **Deepak Krishnamurthy**, Georgios Katsikis, Arjun Bhargava, Manu Prakash, "Schistosoma mansoni cercariae exploit an elastohydrodynamic coupling to swim efficiently", *Nature Physics*, Oct 2016. [\[weblink\]](#)
[Stanford News](#) [\[youtube link\]](#) | [Physics World](#) | [Science Daily](#)
- **Deepak Krishnamurthy**, and Ganesh Subramanian. "Collective motion in a suspension of micro-swimmers that run-and-tumble and rotary diffuse.", *Journal of Fluid Mechanics*, September 2015. [\[weblink\]](#)

Undergraduate Research

- **Deepak Krishnamurthy**, Erik O. Johansson, Jin Wook Lee, Erik Kjeang, "Computational modeling of microfluidic fuel cells with flow-through porous electrodes", *Journal of Power Sources*, December 2011. [\[weblink\]](#)
- **Deepak Krishnamurthy**, J. S. Rathore, and N. N. Sharma, "Nanorobot Propulsion Using Helical Elastic Filaments at Low Reynolds Numbers", *ASME Journal of Nanotechnology in Engineering and Medicine*, February 2011. [\[weblink\]](#)

In Preparation

- L. Cirillo*, T.C. Fadero*, **Deepak Krishnamurthy***, N. Wadhwa*, J. NixonAbell, C.J. Obara, J. Lippincott-Schwartz, "Single Molecule Tracking of ER luminal proteins reveals interplay between membrane morphology and luminal mobility", (*equal contribution)
- **Deepak Krishnamurthy**, Fabien Cockenpot, Scott Coyle, Manu Prakash, "Metabolic Processes and Ciliary Dynamics underlying the extreme motility of *Halteria grandinella*"

Patents

- **Deepak Krishnamurthy** and Manu Prakash. "Hydrodynamic Treadmill: A Tracking Device to Study Biotic/Abiotic Systems in Gravitational and Hydrodynamic fields." U.S. Patent Application No. 16/021,988. [\[weblink\]](#)

Fellowships

- **Bio-X Bowes family fellowship**. Awarded to 20 Stanford Students each year.
- **Stanford Graduate Fellowship** (declined). Awarded for standing first in the department qualifying examinations.
- **Pfizer Inc. Endowed Scholarship, Marine Biological Laboratory- Physiology Course Funding**: Full tuition fee support for attending the Marine Biological Laboratory's Physiology Course.
- **HHMI Visiting Scientist grant**: Partial financial support for carrying out post-course research or 3 weeks at the HHMI, Janelia Farm, research campus
- **JNCASR Senior Research Fellowship, Government of India**: Awarded full-tuition fee support and stipend for my Master's degree at JNCASR.
- **DST Travel fellowship, Government of India**: Travel award to attend international conferences
- **CSIR Travel fellowship, Government of India**: Travel award to attend international conferences

Honors and Awards

- **Best Lightning Talk**, Microscale Ocean Biophysics meeting, Whistler, BC, Canada 2018
- **Rowland Junior Fellowship Finalist, Harvard University** 2018
- **Best Poster Award across categories**, at the Mechanical Engineering Conference, Stanford University, 2016.
- **Roddam family award for Best MS thesis** at JNCASR in December 2014.
- **All India Rank – 4** in the **Graduate Aptitude Test in Engineering (GATE)** 2012 in Engineering Sciences category.
- **Ranjit Singh Chauhan Award for Excellence in undergraduate research** by BITS-Pilani in 2011.
- **Research Productivity Award** for research contributions at *Simon Fraser University*, Canada.
- **MITACS Globalink Scholar 2010** - awarded a scholarship to carry out 3 months of research in Canada.
- **Best Student Project**, APOGEE Annual Technical Festival, BITS-Pilani
- **BITS-Pilani Merit scholarship**

Invited Talks and Seminars

- “*Novel Multi-scale tools for ocean biophysics*”, Rowland Institute, Harvard University (October 2018)
- “*Life under gravity: bridging scales in the ocean*”, MCB, University of California, Berkeley (October 2018)
- “*Biophysics of Swimming and Host-seeking in Schistosoma mansoni cercariae*” Presented at Carbon Inc. Redwood City, California, USA on 27th January, 2016.
- “*Biophysics of Swimming and Host-seeking in Schistosoma mansoni cercariae*” Presented at the Applied Mechanics Seminar, IIT-Madras, India, 30th November, 2016.
- “*Investigation of the swimming mechanics of Schistosoma mansoni cercariae and its role in disease transmission*” Presented at the Molecular, Cell and Developmental Biology Department of University of California, Santa Cruz, 9th February, 2016

Selected Conference Talks

- **Deepak Krishnamurthy, et al.** "Anti-gravity Machine: Multi-scale Imaging and Measurement of Plankton Behavior using a Novel Tracking Microscope." Society for integrative and comparative biology. Vol. 59.
- **Krishnamurthy, Deepak, et al.** "The (Anti) Gravity Machine: A Tracking Microscope to Study Biotic/Abiotic Systems in Gravitational Fields." Bulletin of the American Physical Society(2018).
- **Krishnamurthy, Deepak**, Fabien Cockenpot, and Manu Prakash. "How cells jump: Ultrafast motions in the single-celled micro-organism *Halteria grandinella*." *APS Meeting Abstracts*. 2017.
- **Deepak Krishnamurthy**, Prakash, Manu. "The deadly swimming of Cercariae: an unusual Stokesian swimmer." *Bulletin of the American Physical Society* 59 (2014).
- **Deepak Krishnamurthy**, and Ganesh Subramanian. “Collective Motion in Micro-scale Swimmer Suspensions : Effects of Tumbling and Rotary Diffusion”, Presented at *Active Fluids: Bridging Complex Fluids and Biofluids* (Aspen Centre for Physics)
- **Krishnamurthy, Deepak**, and Ganesh Subramanian. “Simulation of collective behaviour in micro-scale swimmers: Effects of tumbling and rotary diffusion.” *Bulletin of the American Physical Society* 58 (2013).
- **Krishnamurthy, Deepak**, and Ganesh Subramanian. "Effects of microscale inertia on heat or mass transfer from a drop." *Bulletin of the American Physical Society* 57 (2012).
- **Deepak Krishnamurthy**, Erik Kjeang, “Numerical modeling of cross-over and vanadium side reactions in a microfluidic fuel cell with flow-through porous electrodes”, presented at the 9th ASME Fuel Cell Science, Engineering and Technology Conference, August 2011, Washington, DC
- **Deepak Krishnamurthy**, Erik Johannson, Erik Kjeang, “Numerical Model of a Microfluidic Fuel Cell with Flow-Through Porous Electrodes”, presented at the Hydrogen & Fuel Cells 2011 Conference, May 2011, Vancouver, BC
- Wook Lee, Jin, **Deepak Krishnamurthy**, Peter Hsiao, and Erik Kjeang. "A Parametric Study on Microfluidic Vanadium Fuel Cells." In *ASME 2011 9th International Conference on Fuel Cell Science, Engineering and Technology*

Field Research

- **(Dec 2019): Scale-free Tracking Microscopy of plankton sampled during the HOT-317 cruise: On-board R/V Kilo Moana**
 - First ever measurements of single plankton behavior on-board a research vessel.
 - Assembled database consisting of >30 plankton species, adding to the largest ever such database.
- **(Nov 2018) Single-cell measurements of planktonic diatoms using vertical tracking microscopy: Isla Magueyes Marine Station, Puerto Rico**
 - Discovered novel dynamic sinking behaviors in marine diatoms, and new methods for drag control.
- **(Jan-July 2018) Behavioral Quantification of Planktonic Microorganisms using a novel Vertical Tracking Microscope: Hopkins Marine Station, Monterey California**
 - Novel behavior measurements using a vertical tracking microscope of marine planktonic larvae of species indigenous to Monterey Bay
- **(October 2016) Field Study of Schistosomiasis: Connecting microscale behavior of parasite to macroscale ecology: Ranomafana National Park, Madagascar.**
 - Snail sampling to locate hotspots of Schistosomiasis, a disease affecting 250 million people across the world

Teaching Experience

Undergraduate

- Lab assistant for the course Prime movers and Fluid machines. Assisted with setting up and conducting experiments on water turbines, pumps and IC engines. Redesigned the laboratory manual and prepared lecture notes.

Graduate

- Teaching assistant for the course *Introductory Fluid Mechanics* (Jan –April 2013). Responsible alongside the course instructor for preparing lecture notes, homework assignments and solutions and conducting tutorial sessions.
- Teaching assistant for the course *Physical biology of macromolecules* (Jan-Mar 2015) at Stanford University. Involved in conducting weekly tutorial sections, design of problem sets and designing experimental demos.

Research Mentorship

Directly mentored the following Undergraduate, Masters and PhD students for their summer research and research rotations at the Prakash Lab, Stanford University:

- Arjun Bhargava, MS Student, Applied Physics (now at Otherlab) DEC 2014-DEC 2015
Project: Design and construction of a scaled-up robot to study swimming of Schistosoma cercariae
- Fabien Cockenpot, Graduate student, Ecole Polytechnique (now a graduate from ISAE-SUPAERO) APR-JULY 2016
Project: Biophysics of ultrafast cell motility in Halteria grandinella
- Pierre Cambournac, Graduate student, Ecole Polytechnique APR-JULY 2017
Project: Hydrodynamic Treadmill as basis for a novel tracking microscope
- Elgin Korkmazhan, PhD Student, Bioengineering, Stanford University AUG-DEC 2017
Project: Controlling transient flows in a hydrodynamic treadmill with applications to tracking microscopy.
- Francois Benoit Du Rey, Graduate student (Mechanics), Ecole Polytechnique APR - JULY 2018
Project: Hydrodynamic Treadmill as basis for a novel tracking microscope
- Delphine Mion, Graduate student (Mechanics), Ecole Polytechnique APR – JUN 2019
Project: Rapid modulation of single-cell density in planktonic diatoms.
- Matteo Massey, Undergraduate Student (Engineering Physics) Stanford University MAR 2019-PRESENT
Project: Virtual-Reality paradigm for single-cells to mimic the oceanic environment in the lab.
- Ethan Li, 1st year PhD Student (Bioengineering) Stanford University JUN 2019 - PRESENT
Project: Design and fabrication of a novel mechanical stage for vertical tracking microscopy.

Professional courses completed

- Marine Biological Laboratories' (MBL) Cell **Physiology** course 2017 (Woods Hole, Massachusetts)
- CISM Summer School on "Interaction Of Microscopic Structures And Organisms With Fluid Flows", Udine, Italy
- COMPFLU Winter School on Complex Fluids, IIT-Guwahati 2015
- Professionally Certified in the Stanford Varian Physics Machine shop.

Outreach & Professional Service

- Journal Referee for: *Advanced Science*, *Wiley Online Library*.
- Machine shop director for Shriram center basement lab cluster.
- Volunteer, Bio-X Science Day **2015** and **2016, 2019**: Set up stalls and scientific demos to communicate scientific concepts to the public.
- Volunteer, APS-DFD Annual Meeting, San Francisco, 2014
- Foldscope workshops in several locations in Bay area, Stanford, and also conducted at two schools in San Juan, and one school in Magueyes, Puerto Rico
- Student member of **American Physical Society**
- Member of **American Society for Cell Biology**.

References

Prof. Manu Prakash (PhD advisor)

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Prof. Ganesh Subramanian (Masters advisor)

Associate Professor,
Engineering Mechanics Unit
Jawaharlal Nehru Centre for Advanced Scientific Research
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Prof. Sanjiva Lele (PhD thesis committee member)

Professor
Department of Mechanical Engineering and Department of
Aeronautics and Astronautics
Stanford University
California, USA
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Prof. Rama Govindarajan

Professor
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Prof. Jeniffer Lipincott-Schwartz

Senior Group Leader
Howard Hughes Medical Institute
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Prof. Erik Kjeang (Undegraduate thesis advisor)

Associate Professor,
School of Mechatronic Systems Engineering
Simon Fraser University
Vancouver, BC, Canada
ekjeang[at]sfu.ca

Non-Academic Engagement

- Professional Indian Classical Vocalist & Drummer (Mridangam) – **30 Performances** to date across USA and India
- President, **Stanford Society for the Promotion of Indian Classical Music And Culture Amongst Youth** 2016-Present
- Elected Student Representative, **JNCASR, Bangalore** 2012-13
- Coordinator, **Ragamalika (Classical music and dance club), BITS-Pilani** 2009-10