

Assistant Professor of Physics
Emory University
Atlanta GA, USA

Email: shekhar@emory.edu

Website: <http://www.shekharlab.org>

SHASHANK SHEKHAR Ph.D.

RESEARCH INTERESTS

Cellular cytoskeletal networks undergo rapid, polarized dynamics, which arises from an interplay among numerous biochemical factors (i.e. proteins) combined with mechanical forces experienced by the cell. So far, we only have a limited understanding of the multicomponent molecular mechanisms involved in regulation of actin dynamics at the scale of individual filaments. My lab employs biophysical and biochemical approaches to investigate how cells control the dynamics of their actin cytoskeleton. My goal is to implement an integrated mechano-chemical approach to recapitulate physiological actin dynamics *in vitro*. Specifically, I am interested in:

1. Studying how multicomponent protein ecosystems control actin dynamics.
2. How the biochemical activities and effects of these proteins on actin filaments are influenced by mechanical forces.

MAJOR RESEARCH ACCOMPLISHMENTS

1. My lab demonstrated the multicomponent “decision complex” formation by simultaneous action of formin, capping protein and twinfilin at actin filament barbed ends (**Ulrichs et al, Nat. Comms., 2023**).
2. In collaboration with Kudryashov lab at Ohio State University, my lab discovered the first ever mechanism for processive pointed-end elongation of actin filaments (**Kudryashova et al; Science Advances, 2022**) [[link](#)].
3. My lab demonstrated how hydrodynamic coupling between unicellular *Stentor coeruleus* individuals is important for their multicellular like behaviour. Our work sheds light on physical principles underlying the unicellular-to-multicellular transition during animal evolution (**Shekhar et al; In revision at Nature Physics**).

PROFESSIONAL EXPERIENCE

- 08/2020 – Present **Tenure Track Assistant Professor, Department of Physics**
Secondary affiliation: Department of Cell Biology
Emory University, Atlanta, USA
- 01/2017 – 07/2020 **Senior postdoctoral associate in Biochemistry and Biology**
Brandeis University, Waltham USA.
Mentors: Profs. Bruce Goode, Jeff Gelles and Jane Kondev
- 06/2015 – 06/2019 **Whitman Scientist and Early Career Awardee** (Summer visiting position)
Marine Biological Laboratory (MBL), Woods Hole, USA.
Collaborators: Profs. Wallace Marshall, Eva Kanso and Jack Costello.
- 01/2013 – 09/2016 **Postdoctoral researcher in Biochemistry**

Curriculum vitae

CNRS, Gif-sur-Yvette, France.
Mentor: Prof. Marie-France Carlier

EDUCATION

- 06/2014- 08/2014 **MBL Physiology Course** at the Marine Biological Laboratory at Woods Hole.
Directors: Profs. Jennifer Lippincott-Schwartz, Wallace Marshall and Rob Phillips.
- 2007 – 2012 **Ph.D.** (Marie Curie Fellow) at University of Twente, The Netherlands.
Insights into phagosome maturation using magnetic tweezers.
Mentor: Prof. Vinod Subramaniam
Co-mentors: Profs. Hans Kanger and Alessandra Cambi.
- 2005 – 2007 Dual **M.Sc.** in Nanoscience and Molecular Bioengineering, TU Delft, Leiden University (NL) and TU Dresden (DE).
- 2002 – 2005 **B.Sc. Physics**, Loyola College, University of Madras, India.

GRANTS AND EXTERNAL FUNDING

Current

1. National Institutes of Health R35 MIRA (1R35GM143050) 08/01/2021 – 07/31/2026
\$1,935,414 (total)
Multicomponent mechanochemical regulation of actin filament end dynamics
2. National Institutes of Health instrument supplement 09/30/2022 – 08/31/2023
\$250,000(total)
iLas Ring TIRF to study multicomponent mechanochemical regulation of actin dynamics

Pending

1. National Science Foundation (NBF) – Biotechnology and Biological Sciences Research Council (BBSRC) – Multi-PI grant 09/01/2023 – 08/31/2023
\$503,281 (total, my share)
Designing Cytokinetic Actomyosin Rings for Synthetic Cells
3. National Institutes of Health instrument supplement 09/30/2023 – 08/31/2024
Multi-cuvette spectrofluorometer for studying multicomponent mechanochemical regulation of actin dynamics
\$70,842 (total)

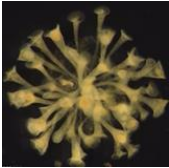
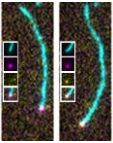
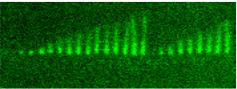

Previous funding

1. International Physics of Living Systems Student Research Network (iPoLS SRN) at Emory University.
11/03/2021 – 08/31/2022 - **\$25,000**
2. Whitman Early Career Investigator, Marine Biological Laboratory, USA (2017, 2019) – ~ **\$ 40,000**
3. Brandeis University Provost research grant (2018) – **\$ 20,000**

SELECTED HONORS AND AWARDS

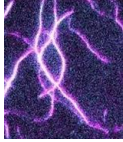
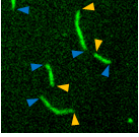
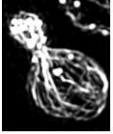
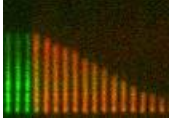
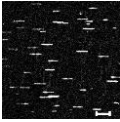
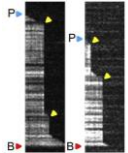
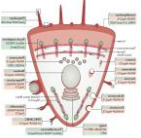
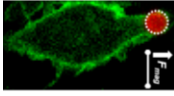
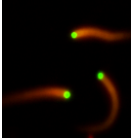
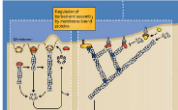
1. Maximizing Investigators' Research Award for early career investigators, NIH (2021).
2. Whitman Early Career Award for conducting independent summer research at Marine Biological Laboratory, USA (2019, 2017).
3. Provost Innovator Inquiry Award, Brandeis University (2018).
4. HHMI Interfaces Scholar Award (2018).
5. "Grand advances in Biology" Prize by French Academy of Sciences (2016).
6. Thomas B. Grave and Elizabeth F. Grave Scholarship and Arthur Klorfein Scholarship for the Physiology program at the Marine Biological Laboratory, Woods Hole, USA (2014).
7. Marie Curie PhD fellowship (2007-2011).
8. European Union Erasmus Mundus fellowship for the dual M.Sc. in Nanoscience and Molecular Bioengineering.
9. Gold medals (first in class) for three consecutive years in my B.Sc. at Loyola College, Chennai, India.

PUBLICATIONS FROM EMORY (#Corresponding author, *lab members)

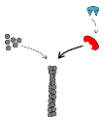
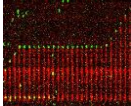

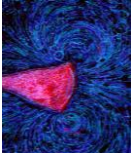
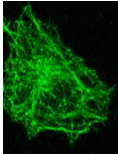
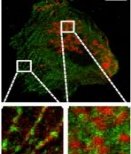
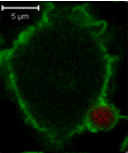
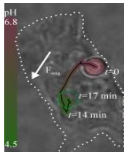
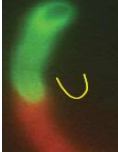
	<p>1. Cooperative hydrodynamics accompany multicellular-like colonial organization in the unicellular ciliate <i>Stentor</i>. Shekhar S.#, Guo H., Miller B*, Colin S.P. Marshall W., Kanso E. and Costello J.H. In revision at Nature Physics. [preprint link]</p> <p>In news: New Scientist.</p>
	<p>2. Ulrichs H.*, Gaska I*, Shekhar S#. Multicomponent regulation of actin barbed end assembly by twinfilin, formin and capping protein. Nature Communications (in press). [preprint link]</p>
	<p>3. Kudryashova E., Ankita*, Ulrichs H.*, Shekhar S. and Kudryashov D.S. Pointed-end processive elongation of actin filaments by Vibrio effectors VopF and VopL. Science Advances (2022). [article link]</p> <p>In news: Toxins force construction of 'roads to nowhere'. Science Daily, Phys.org, ReportWire, Microbiom News, News wise</p>
	<p>4. Devitt C.C, Lee C., Cox R.M., Papoulas O., Alvarado J., Shekhar S., Marcotte E.M., Wallingford J.B. Twinfilin1 controls lamellipodial protrusive activity and actin turnover during vertebrate gastrulation. Journal of Cell Science (2021). [article link]</p>

PUBLICATIONS (Pre-Emory: postdoctoral and graduate training) (#Co-corresponding author)

Curriculum vitae

	<p>5. Hoeprich G.H., Sinclair A.N., Shekhar S. and Goode B.L. Single-molecule imaging of IQGAP1 regulating actin filament dynamics. Molecular Biology of the Cell (2021). [article link]</p>
	<p>6. Shekhar S.#, Hoeprich G., Gelles J. and Goode B. L. Twinfilin bypasses assembly conditions and actin filament aging to drive barbed end depolymerization. Journal of Cell Biology (2020). [article link]</p>
	<p>7. Pollard L.W., Garabedian M.V., Alioto S.L., Shekhar S. and Goode B.L. Genetically-inspired <i>in vitro</i> reconstitution of <i>S. cerevisiae</i> actin cables from seven purified proteins. Molecular Biology of the Cell (2020). [article link]</p>
	<p>8. Shekhar S., Chung J., Kondev J., Gelles J. and Goode B. L. Synergy between Cyclase-associated protein and Cofilin accelerates actin filament depolymerization by two orders of magnitude. Nature Communications (2019). [article link]</p>
	<p>9. Shekhar S. Microfluidics-Assisted TIRF Imaging to Study Single Actin Filament Dynamics. Current Protocols in Cell Biology (2017). [article link]</p>
	<p>10. Shekhar S#. and Carlier M-F. Enhanced Depolymerization of Actin Filaments by ADF/Cofilin and Monomer Funneling by Capping Protein Cooperate to Accelerate Barbed-End Growth. Current Biology (2017). [article link]</p>
	<p>11. Carlier M-F. and Shekhar S#. Global treadmilling coordinates actin turnover and controls the size of actin networks. Nature Reviews Molecular Cell Biology (2017). [article link]</p>
	<p>12. Shekhar S#., Subramaniam V., & Kanger J.S. Intracellular manipulation of phagosomes using magnetic tweezers. Methods in Molecular Biology (2017). [article link]</p>
	<p>13. Pernier J.*, Shekhar S*., Jegou A, Guichard B., Carlier M-F. Profilin interaction with actin filament barbed end controls dynamic instability, capping, branching and motility. Developmental Cell (*=co-first author) (2016). [article link]</p>
	<p>14. Shekhar S., Pernier J. and Carlier M-F. Barbed-end regulators at a Glance. Journal of Cell Science (2016). [article link]</p>

Curriculum vitae

	<p>15. Shekhar S[#]. and Carlier M-F. Kinetic studies provide key insights into regulation of actin-based motility. Molecular Biology of the Cell (2016). [article link]</p>
	<p>16. Shekhar S., Kerleau M, Kuhn S., Pernier J., Romet-Lemonne G., Jegou A., Carlier M.-F. Formin and Capping Protein together embrace the actin filament in a “ménage à trois”. Nature Communications (2015). [article link]</p>
	<p>17. Carlier MF, Pernier J, Montaville P, Shekhar S, Kühn S. Control of polarized assembly of actin filaments in cell motility. Cellular and Molecular Life Sciences, (2015). [article link]</p>
	<p>18. Shekhar S[#]., Zhu L., Mazutis L., Sgro A.E., Fai T.G., Podolski M. Quantitative biology: where modern biology meets physical sciences. Molecular Biology of the Cell (2014). [article link]</p>
	<p>19. Pereira A., Tudor C., Pouille P.A., Shekhar S., Kanger J.S., Subramaniam V., Martin-Blanco E. Plasticity of the MAPK Signaling Network in Response to Mechanical Stress. PLoS ONE (2014). [article link]</p>
	<p>20. Van den Dries K., Meddens M., de Keijzer S., Shekhar S., Subramaniam V., Figdor C.G. and Cambi A. Interplay between myosin IIA-mediated contractility and actin network integrity orchestrates podosome composition and oscillations. Nature Communications (2013). [article link]</p>
	<p>21. Shekhar S., Figdor C.G., Cambi A., Subramaniam V., & Kanger J.S. A method for spatially resolved local intracellular mechanochemical sensing and organelle manipulation. Biophysical Journal (2012) [article link]. Highlighted as “Emerging Biophysical Technology” for 2012 by Biophysical Journal.</p>
	<p>22. Shekhar S., Klaver A., Figdor C.G., Subramaniam V., & Kanger J.S.; Spatially resolved local intracellular chemical sensing using magnetic particles. Sensors and Actuators B: Chemical (2010). [article link]</p>
	<p>23. Delatour V., Shekhar S., Reymann A-C., Didry D., Lê K.H.D, Romet-Lemonne G., Helfer E., Carlier M-F. Actin-based propulsion of functionalized hard versus fluid spherical objects. New Journal of Physics (2008). [article link]</p>

INVITED SEMINARS AND PRESENTATIONS

Curriculum vitae

1. SynCell 2023 - Engineering Synthetic Cells and Organelles conference, Minneapolis, USA (May, 2023)
2. "Actin Assembly for Intracellular Functions" meeting, University of Freiburg, Germany (May, 2023)
3. Biochemistry department colloquium, Emory University (May, 2023)
4. Penn Muscle institute colloquium, University of Pennsylvania (April, 2023)
5. "Motors in Quarantine" virtual seminar series (April, 2023)
6. Centre for Cellular and Molecular Biology (CCMB), India (October, 2022)
7. Biochemistry colloquium, Indian Institute of Science (IISc), India (October, 2022)
8. Physics colloquium, Augusta University, USA (September, 2022)
9. European Cytoskeletal Forum, Hanover, Germany (May 2022)
10. "CAP proteins from Buds to Beds" virtual symposium (November, 2021)
11. Chemistry and Biochemistry colloquium, Ohio State University (September, 2021)
12. Virtual cell migration seminar series (April 2021)
13. Virtual build-a-cell seminar series (March 2021)
14. Physics department colloquium, Lehigh University, March 2021 (Bethlehem, USA)
15. Chemistry Department Colloquium, Wichita State University, October 2020 (Wichita, USA)
16. Biology department, Kennesaw State University, October 2020 (Kennesaw, USA)
17. Biochemistry, Cell and Developmental Biology Program, Emory University, July 2020 (Atlanta, USA)
18. Materials Research Science and Engineering Center Seminar, Brandeis University, April 2020 (Waltham, USA)
19. Biophysics Colloquium at Molecular Physiology and Biophysics Department, University of Vermont, February 2020 (Burlington, USA)
20. Gordon Research Conference on Motile and Contractile Systems, August 2019 (New London, USA)
21. Department of Mechanical Engineering & Materials Science, Washington University at St. Louis, March 2019 (St. Louis, USA)
22. Department of Mechanical Engineering, Virginia Tech., February 2019 (Blacksburg USA)
23. Department of Physics, University of Florida, February 2019 (Gainesville, USA)
24. Department of Physics, Emory University, February 2019 (Atlanta, USA)
25. Cell Division and Cytoskeleton seminar series, July 2019 (Woods Hole, USA)
26. New England Society for Microscopy Annual Spring Meeting, March 2018 (Waltham, MA)
27. Cell Biology and Biophysics Unit, EMBL, August 2017 (Heidelberg, Germany)
28. Cell Biology Department, Radboud University, September 2016 (Nijmegen, The Netherlands)
29. Nanobiophysics group, University of Twente, September 2016 (Enschede, The Netherlands)
30. Invited talk at the Kapoor lab, April 2016 (Rockefeller University)
31. Invited talk at the Petry lab, April 2016 (Princeton University)
32. Gordon Research Conference on Motile and Contractile Systems 2015 (New London, NH)
33. Invited talk at the Theriot lab, August 2015 (Stanford University)
34. Biomechanics across scales 2015 (Ecole Polytechnique, Palaiseau, France)

Curriculum vitae

35. Invited talk at the Carlier Lab, 2012 (CNRS, Gif-sur-Yvette, France)
36. Royal Netherlands Academy of Biophysics 2012 (Amsterdam, Netherlands)
37. Annual Dutch Biophysical meeting 2012 (Veldhoven, The Netherlands)
38. Gordon Research Seminar on Phagocytosis 2011 (North Carolina, USA) – Discussion leader.
39. Biophysics and biosensors based on magnetic particles 2011 (Eindhoven, The Netherlands)
40. Immunonomap symposium – 2009 (Debrecen, Hungary)
41. Annual Dutch Biophysical meeting 2008 (Veldhoven, The Netherlands)

TEACHING EXPERIENCE

Emory University

1. Physics for Scientists & Engineers II, PHYS 152 (Spring 2022), ~ 80 students.
2. Freshman Seminar: “Biomolecular Nanomachines”, PHYS 190, (Fall 2020, Spring 2023), ~20 students
3. Foundations in BCDB (Biochemistry, Cell and Developmental Biology graduate program) (2020 -), ~10 students

Other teaching experiences

1. Guest lecturer in Advanced Experimental Methods in Soft Condensed Matter Physics, California State University, May 2022 (Long Beach, USA). Host – Prof. Alex Klotz.
2. Guest lecturer in Mechanobiology, Virginia Tech., April 2020 (Blacksburg, USA). Host – Prof. Amrinder Nain.
3. Guest lecturer in the Quantitative Biology Research Community (QBReC) program, Brandeis University 2017 – 2020 (Waltham, USA). Host – Dr. Lishibanya Mohapatra

MENTORING EXPERIENCE

Emory University – I am currently mentoring 1 postdoc, 5 graduate students, 1 research specialist and 3 undergrad students. Current members include:

1. Surbhi Garg, Postdoctoral fellow (January 2023 – present)
2. Ankita, Ph.D. student, Physics graduate program (January 2021 – present)
3. Heidi Ulrichs, Ph.D. student, Biochemistry, Cell and Developmental Biology graduate program (February 2021 - present)
4. Ekram Towsif, PhD student, Physics graduate program (January 2022 – present)
5. Sudipta Biswas, Ph.D. student, Biochemistry, Cell and Developmental Biology graduate program (January 2023 - present)
6. Shady Fouad PhD student, Physics graduate program (January 2023 – present)
7. Blake Miller, BS Biology (September 2022 – present)
8. Vishal Reddy, BS Physics (May 2022 – present)
9. Matthew Baker, BS Physics (May 2023 – present)
10. Nayana Sah, BS – undeclared (May 2023 – present)

Curriculum vitae

Previous trainees

1. Ignas Gaska, Postdoctoral fellow, Emory University (January 2021 –November 2022)
2. Luther Pollard, Postdoctoral fellow, Brandeis University (April 2017 - February 2020)
3. Greg Hoepflich, Postdoctoral fellow, Brandeis University (January 2017 – August 2020)
4. Sophie Lou, Undergraduate student, Brandeis University (May 2018 – August 2018)
5. Bianca Edozie, Undergraduate student, Brandeis University (May 2018 – August 2018)
6. Burcu Celikkol, PhD student, University of Twente (August 2010 – March 2012)
7. Wieneke Breed, M.Sc. thesis student, University of Twente (April 2010 - December 2010)

Rotation students

1. Taylor Hailstock (BCDB, January 2021 – April 2022)
2. Hannah Gilbonio (Physics, November 2021 – January 2022)
3. Mohamed Barmada (BCDB, September 2022 – October 2022)
4. Megan Hinrichsen (BCDB, September 2022 – October 2022)
5. Ian Pyne (BCDB, October 2022 – December 2022)
6. Brandon Wehmiller (BCDB, October 2022 – December 2022)

MEMBERSHIPS AND SERVICE

Emory University

1. Member, Biochemistry, Cell and Developmental Biology graduate admissions interview committee (2021 -).
2. Member, Physics graduate program admissions interview committee (2021 -).
3. Member, Physics Department Strategic committee (2021 -).
4. Member, Physics graduate student awards committee (2021 -).
5. Organized a half-day virtual workshop entitled “On being the right size: Is the search for underlying physical principles a wild-goose chase?” as part of the Theory and Modelling of Living Systems (TMLs) initiative.
6. Member, American Society for Cell Biology (ASCB) (2017 -)
7. PhD Qualification and thesis committee
 - a. Katie Whitcomb (Physics graduate student)
 - b. Kate Hardin (BCDB graduate student)
 - c. Jin Qian (Physics graduate student)
 - d. Yasmin Ibrahim (BCDB graduate student)
 - e. Sahand Emamian (Physics graduate student)
 - f. Jose Castro (BCDB graduate student)
8. International reviewer of grants for:

Curriculum vitae

- a. Germany: DFG German Research Foundation (Deutsche Forschungsgemeinschaft)
 - b. France: Pierre-Gilles De Gennes Institute (part of the Curie Institute)
 - c. Belgium: Research Foundation - Flanders (Fonds Wetenschappelijk Onderzoek - Vlaanderen, FWO)
9. Reviewer for peer reviewed journals:
- Nature Chemical Biology
 - Nature Reviews Molecular Cell Biology
 - Nature Communications
 - PNAS
 - Current Biology
 - Scientific Reports
 - Biophysical Journal
 - Journal of Cell Science
 - PloS Biology
 - Cytoskeleton
 - Journal of muscle research and cell motility
 - Frontiers in Immunology
 - Frontiers in Cell and Developmental Biology

Previous Service

1. Former Board member, 'Promovendi Netwerk Nederland – Het PNN' (Dutch PhD students' network).
2. Former Board member, PhD Network of the University of Twente (P-NUT).
3. Former Liaison Group member, Erasmus Mundus Alumni Association.