

SHASHANK SHEKHAR Ph.D.

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RESEARCH INTERESTS

Cellular cytoskeletal networks undergo rapid, polarized dynamics, which arises from an interplay among numerous regulatory proteins (and complexes) 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. I am a biophysicist interested in understanding how cells control the size and dynamics of their 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 activities and effects of these proteins on actin filaments are influenced by mechanical forces.

To do this, I employ a unique combination of **quantitative multispectral single molecule imaging** and **microfluidics-assisted total internal reflection fluorescence microscopy (TIRF)**. For an overview of my research, please see [here](#).

MAJOR RESEARCH ACCOMPLISHMENTS

1. Discovered a novel multicomponent pathway of actin filament depolymerization in which cyclase-associated protein (Srv2/CAP) synergizes with cofilin to enhance pointed-end depolymerization of an actin filament by ~ 350 -fold (54 s^{-1}). These are the fastest rates of actin turnover ever observed *in vitro* (**Nature Communications, 2019**) [\[link\]](#).
2. The rate limiting step in a cell's ability to use actin polymerization for its motility is depolymerization of pre-existing actin networks to generate monomers required for polymerization of new filaments. We presented the first direct evidence of actin filament depolymerization by ADF/Cofilin protein family. Our experiments demonstrated its dual function on actin filaments – filament severing and enhanced depolymerization (**Shekhar and Carlier, Current Biology, 2017**) [\[link\]](#).
3. Demonstrated that profilin, a ubiquitous actin monomer binding protein, controls the balance between linear and branched actin networks and competes with formin and capping protein for barbed-end binding (**Pernier*, Shekhar* et al. Developmental Cell, 2016**) [\[link\]](#).
4. First demonstration of the multicomponent “decision complex” formation by simultaneous binding of capping protein and formin at actin filament barbed ends, in the process catalyzing each other's displacement. This unique mechanism provides a means for cells to exert fine control on filament growth rate and length (**Shekhar et al. Nature Communications, 2015**) [\[link\]](#).

Curriculum vitae

5. Demonstrated a direct link between a phagosome's centripetal transport and its maturation using magnetic tweezers (**Shekhar et al. Biophysical Journal, 2012**). Highlighted as “Emerging Biophysical Technology” of the year 2012 by Biophysical Journal [\[link\]](#).

PROFESSIONAL EXPERIENCE

- 08/2020 – Present **Tenure Track Assistant Professor**
Department of Physics, Emory University, Atlanta, USA
- 01/2017 – 07/2020 **Senior postdoctoral associate** at Brandeis University, Waltham USA.
Mentors: Profs. Bruce Goode, Jeff Gelles and Jane Kondev
- 06/2015 – Present **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** at 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.
Mentors: Profs. Vinod Subramaniam & Carl Figdor
Co-mentors: Profs. Hans Kanger and Alessandra Cambi.
- 2005 – 2007 Dual **M.Sc.** in Nanoscience (Applied Physics) and Molecular Bioengineering, TU Delft, Leiden University (NL) and TU Dresden (DE).
- 2002 – 2005 **B.Sc. Physics**, Loyola College, University of Madras, India.

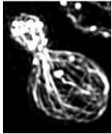
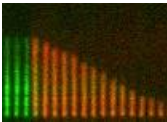
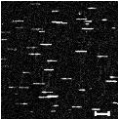
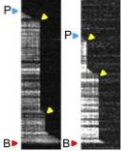
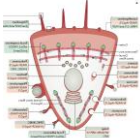
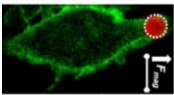

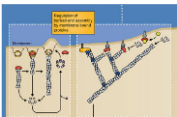
SELECTED HONORS AND AWARDS

1. Whitman Early Career Award for conducting independent summer research at Marine Biological Laboratory, USA (2019).
2. Brandeis Provost Innovator Inquiry Award and research grant (2018).
3. HHMI Interfaces Scholar Award at Brandeis University (2018).
4. Whitman Early Career Award for conducting independent summer research at Marine Biological Laboratory, USA (2017).
5. Best research-video award from Brandeis NSF-MRSEC (2017, [Video link](#)).
6. “Grand advances in Biology” Prize by French Academy of Sciences (2016).


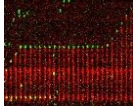

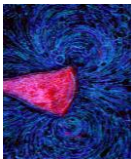
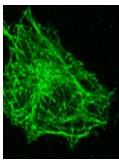
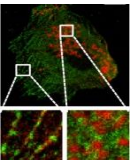
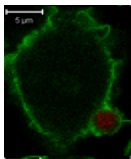
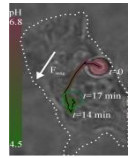
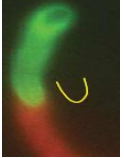
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7. Thomas B. Grave and Elizabeth F. Grave Scholarship and Arthur Klorfein Scholarship for the Physiology program at the Marine Biological Laboratory, Woods Hole, USA (2014).
8. Marie Curie PhD fellowship (2007-2011).
9. European Union Erasmus Mundus fellowship for the dual M.Sc. in Nanoscience and Molecular Bioengineering.
10. Gold medals (first in class) for three consecutive years in my B.Sc. at Loyola College, Chennai, India.

PUBLICATIONS (*Co-first author, #Co-corresponding author)

	<p>1. 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>2. 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>3. Shekhar S. Microfluidics-Assisted TIRF Imaging to Study Single Actin Filament Dynamics. Current Protocols in Cell Biology (2017). [Article link]</p>
	<p>4. 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>5. 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>6. Shekhar S#., Subramaniam V., & Kanger J.S. Intracellular manipulation of phagosomes using magnetic tweezers. Methods in Molecular Biology (2017). [article link]</p>
	<p>7. 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>8. 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>9. 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>10. 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>11. 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>12. 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>13. 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>14. 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>15. 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 [link].</p>
	<p>16. 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>17. 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 PRESENTATIONS

1. Invited seminar at Biochemistry, Cell and Developmental Biology Program, Emory University, July 2020 (Atlanta, USA)
2. Invited seminar Materials Research Science and Engineering Center Seminar, Brandeis University, April 2020 (Waltham, USA)
3. Biophysics Colloquium at Molecular Physiology and Biophysics Department, University of Vermont, February 2020 (Burlington, USA)
4. Guest lecturer in Mechanobiology, Virginia Tech., April 2020 (Blacksburg, USA)
5. Conference talk at Gordon Research Conference on Motile and Contractile Systems, August 2019 (New London, USA)
6. Invited seminar at Department of Mechanical Engineering & Materials Science, Washington University at St. Louis, March 2019 (St. Louis, USA)
7. Invited seminar at Department of Mechanical Engineering, Virginia Tech., February 2019 (Blacksburg USA)
8. Invited seminar at Department of Physics, University of Florida, February 2019 (Gainesville, USA)
9. Invited seminar at Department of Physics, Emory University, February 2019 (Atlanta, USA)
10. Invited talk at Cell Division and Cytoskeleton seminar series, July 2019 (Woods Hole, USA)
11. Invited talk at New England Society for Microscopy Annual Spring Meeting, March 2018 (Waltham, MA)
12. Invited talk at the Cell Biology and Biophysics Unit, EMBL, August 2017 (Heidelberg, Germany)
13. Invited talk at the Cell Biology Department, Radboud University, September 2016 (Nijmegen, The Netherlands)
14. Invited talk at the Nanobiophysics group, University of Twente, September 2016 (Enschede, The Netherlands)
15. Invited talk at the Kapoor lab, April 2016 (Rockefeller University)
16. Invited talk at the Petry lab, April 2016 (Princeton University)
17. Conference talk at Gordon Research Conference on Motile and Contractile Systems 2015 (New London, NH)
18. Invited talk at the Theriot lab, August 2015 (Stanford University)
19. Biomechanics across scales 2015 (Ecole Polytechnique, Palaiseau, France)
20. Invited talk at the Carlier Lab, 2012 (CNRS, Gif-sur-Yvette, France)
21. Royal Netherlands Academy of Biophysics 2012 (Amsterdam, Netherlands)
22. Annual Dutch Biophysical meeting 2012 (Veldhoven, The Netherlands)
23. Gordon Research Seminar on Phagocytosis 2011 (North Carolina, USA) – Discussion leader.
24. Biophysics and biosensors based on magnetic particles 2011 (Eindhoven, The Netherlands)
25. Immunonomap symposium – 2009 (Debrecen, Hungary)
26. Annual Dutch Biophysical meeting 2008 (Veldhoven, The Netherlands)

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MEMBERSHIPS AND SERVICE

1. International reviewer of grants for:
 - a. Germany: DFG German Research Foundation (Deutsche Forschungsgemeinschaft)
 - b. France: Pierre-Gilles De Gennes Institute (part of Curie Institute)
 - c. Belgium: Research Foundation - Flanders (Fonds Wetenschappelijk Onderzoek - Vlaanderen, FWO)
2. Invited reviewer for peer reviewed journals (Cytoskeleton, Journal of muscle research and cell motility, Frontiers in Immunology).
3. Member, American Society for Cell Biology (ASCB).
4. Former Board member, 'Promovendi Netwerk Nederland – Het PNN' (Dutch PhD students' network).
5. Former Board member, PhD Network of the University of Twente (P-NUT).
6. Liaison Group member, Erasmus Mundus Alumni Association.