SHASHANK SHEKHAR Ph.D.

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RESEARCH INTERESTS

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

1. Studying how multiprotein ecosystems control actin dynamics.
2. Understanding how biochemical interactions between actin-binding proteins and actin filaments are influenced by mechanical forces.

PROFESSIONAL EXPERIENCE

08/2020 – Present **Tenure Track Assistant Professor**
Primary appointment in Physics; Secondary appointment in Cell Biology and Biochemistry.
Emory University, Atlanta, USA

01/2017 – 07/2020 **Senior postdoctoral associate in Biochemistry, Biology and Physics**
Brandeis University, Waltham USA.
Mentors: Profs. Bruce Goode, Jeff Gelles and Jane Kondev.

06/2015 – 06/2019 **Whitman Scientist and Early Career Awardee** (Independent 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**
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 (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.

GRANTS AND OTHER FUNDING

Current

1. National Institutes of Health R35 MIRA (1R35GM143050) 08/01/2021 – 05/31/2026
   $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.

3. National Institutes of Health instrument supplement 09/30/2023 – 08/31/2024
   $70,842 (total)

   Multi-cuvette spectrofluorometer for studying multicomponent mechanochemical regulation of actin dynamics.

Previous funding

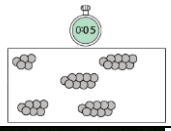
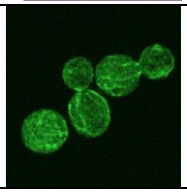
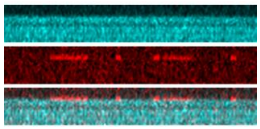
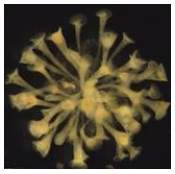
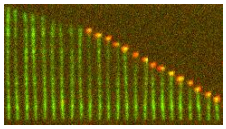
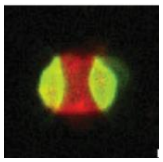
1. National Science Foundation International Physics of Living Systems Research Network (iPoLS SRN) 11/03/2021 – 08/31/2022 - **$25,000**
2. Whitman Early Career Award, Marine Biological Laboratory, USA (2017, 2019) – **$ 40,000**
3. Brandeis University Provost research grant (2018) – **$ 20,000**

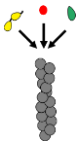
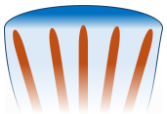
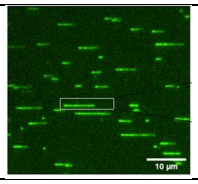
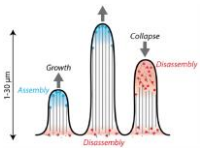
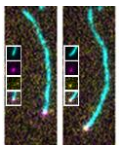
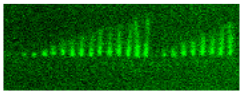
SELECTED HONORS AND AWARDS

1. Named “Cell Scientist to Watch” by Journal of Cell Science (2024).
2. Maximizing Investigators' Research Award for early career investigators, NIH (2021).
3. Whitman Early Career Award, Marine Biological Laboratory, USA (2019, 2017).
4. Provost Innovator Inquiry Award, Brandeis University (2018).
5. HHMI Interfaces Scholar Award (2018).
6. *“Grand advances in Biology”* Prize by French Academy of Sciences (2016).
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. European Union 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.

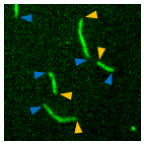
Curriculum vitae

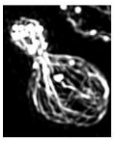
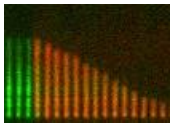
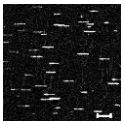
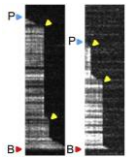
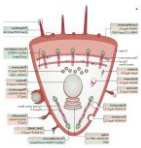
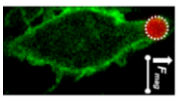
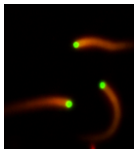
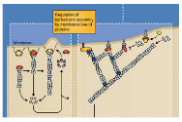
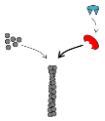
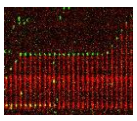
PUBLICATIONS AND PREPRINTS FROM EMORY (#Corresponding author, lab members underlined)

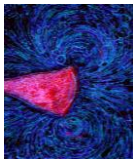
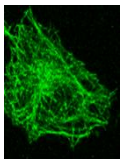
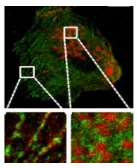
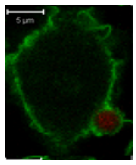
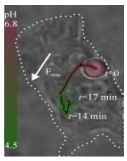
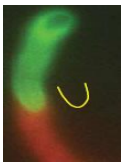
	1. Nandi M., **Shekhar S**#. and Choubey S. A generalized theoretical framework to investigate multicomponent actin dynamics. [preprint link]
	2. Dhar A., Bagyashree V.T., Biswas S., Kumari J., Sridhara A., Brahmendra J.S., **Shekhar S.**, Palani S. Functional redundancy and formin-independent localization of tropomyosin isoforms in Saccharomyces cerevisiae. **Preprint** (under revision at Journal of Cell Biology) [preprint link]
	3. Reddy, V, Arya A. and **Shekhar S.**#. Twinfilin is a non-processive depolymerase which synergizes with formin to dramatically accelerate actin filament uncapping by 300-fold. **PNAS (In press)** [preprint link]
	4. Yamashiro S.*, **Shekhar S.***, Novak S.M., Biswas S., Gregorio C. C. and Fowler V. M. Actin filament pointed ends: assays for regulation of assembly and disassembly by tropomodulin and tropomyosin. **Cytoskeleton (In press).** *Co-first author
	5. **Shekhar S.**#, Guo H., Colin S.P., Marshall W., Kanso E. and Costello J.H. Cooperative hydrodynamics accompany multicellular-like colonial organization in the unicellular ciliate *Stentor.* **Nature Physics (in press)**. [preprint link] In news: New Scientist., https://www.newscientist.com/article/2365535-how-did-multicellular-life-evolve-algae-and-yeast-give-some-hints/
	6. Towsif E.T. and **Shekhar S.**#. The actin filament pointed-end depolymerase Srv2/CAP depolymerizes barbed ends, displaces capping protein and promotes formin processivity. **PNAS** (2025) [article link] In news: The Scientist.
	7. Ulrichs H. and **Shekhar S.**#**.** Regulation of actin dynamics by Twinfilin. **Current Opinion in Cell Biology** (2025) [article link]
	8. Islam M.M., Gaska I., Oshinowo O., Otumala A., **Shekhar S.**, Yong N. A., Myers D.R. Single-pericyte nanomechanics measured by contraction cytometry. **APL Bioengineering** (2024) [article link]

	9. Arya A., Choubey S. and **Shekhar S.**[#]. Multicomponent rendezvous of cofilin, profilin and twinfilin at the actin filament barbed end. **PRX Life** (2024) [article link]
	10. Ulrichs H. and **Shekhar S.**[#]**.** Profilin affects microtubule dynamics via actin. **Journal of Cell Biology** (2024) [article link]
	11. Towsif E.T., Miller B.A., Ulrichs H. and **Shekhar S.**[#]. Multicomponent depolymerization of actin filament pointed ends by cofilin and cyclase-associated protein depends upon filament age. **European Journal of Cell Biology** (2024) [article link]
	12. Goode B.L., Eskin J. and **Shekhar S.**[#]. Mechanisms of actin disassembly and turnover. **Journal of Cell Biology** (2023) [article link]
	13. Ulrichs H., Gaska I. and **Shekhar S.**[#]. Multicomponent regulation of actin barbed end assembly by twinfilin, formin and capping protein. **Nature Communications** (2023). [article link]
	14. 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] In news: Toxins force construction of 'roads to nowhere'. Science Daily, Phys.org, ReportWire, Microbiom News, News wise
	15. 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]

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

	16. 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]
	17. **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]

	18. Pollard L.W., Garabedian M.V., Alioto S.L., **Shekhar S.** and Goode B.L. Genetically-inspired *in vitro* reconstitution of *S. cerevisiae* actin cables from seven purified proteins. **Molecular Biology of the Cell** (2020). [article link]
	19. **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]
	20. **Shekhar S.**[#] Microfluidics-Assisted TIRF Imaging to Study Single Actin Filament Dynamics. **Current Protocols in Cell Biology** (2017). [article link]
	21. **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]
	22. 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]
	23. **Shekhar S[#].**, Subramaniam V., and Kanger J.S. Intracellular manipulation of phagosomes using magnetic tweezers. **Methods in Molecular Biology** (2017). [article link]
	24. Pernier J.*, **Shekhar S*.**, Jegou A, Guichard B. and 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]
	25. **Shekhar S.**, Pernier J. and Carlier M-F. Barbed-end regulators at a Glance. **Journal of Cell Science** (2016). [article link]
	26. **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]
	27. **Shekhar S.**, Kerleau M., Kuhn S., Pernier J., Romet-Lemonne G., Jegou A. and Carlier M.-F. Formin and Capping Protein together embrace the actin filament in a “ménage à trois”. **Nature Communications** (2015). [article link]

	28. Carlier M-F., Pernier J., Montaville P., **Shekhar S.** and Kühn S. Control of polarized assembly of actin filaments in cell motility. **Cellular and Molecular Life Sciences**, (2015). [article link]
	29. **Shekhar S#.**, Zhu L., Mazutis L., Sgro A.E., Fai T.G. and Podolski M. Quantitative biology: where modern biology meets physical sciences. **Molecular Biology of the Cell** (2014). [article link]
	30. Pereira A., Tudor C., Pouille P.A., **Shekhar S.**, Kanger J.S., Subramaniam V. and Martin-Blanco E. Plasticity of the MAPK Signaling Network in Response to Mechanical Stress. **PLoS ONE** (2014). [article link]
	31. 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]
	32. **Shekhar S.**, Figdor C.G., Cambi A., Subramaniam V., and 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**.
	33. **Shekhar S.**, Klaver A., Figdor C.G., Subramaniam V., and Kanger J.S. Spatially resolved local intracellular chemical sensing using magnetic particles. **Sensors and Actuators B: Chemical** (2010). [article link]
	34. Delatour V., **Shekhar S.,** Reymann A-C., Didry D., Lê K.H.D, Romet-Lemonne G., Helfer E. and Carlier M-F. Actin-based propulsion of functionalized hard versus fluid spherical objects. **New Journal of Physics** (2008). [article link]

INVITED SEMINARS AND ORAL PRESENTATIONS

1. Physics colloquium, North Carolina State University, Raleigh, USA (November 2024)
2. Invited speaker, Triangle Cytoskeleton Meeting, Raleigh, USA (September 2024)
3. Mechanobiology symposium, Vanderbilt University, Nashville, USA (May 2024)
4. Soft matter day symposium, Georgia Tech, USA (April 2024)
5. Tata institute of Fundamental Research (TIFR), Hyderabad, India (March 2024)
6. Indian Institute of Technology (IIT), Hyderabad, India (March 2024)
7. Institute of Microbial Technology, Chandigarh, India (March 2024)
8. Indian Institute of Science Education and Research, Pune, India (March 2024)

9. Tata institute of Fundamental Research (TIFR) Mumbai, India (March 2024)
10. Indian Institute of Science Education and Research, Mohali, India (March 2024)
11. Biophysical Society (BPS) annual meeting platform speaker, Philadelphia, USA (February 2024)
12. Cell & Developmental Biology Center Seminar, NHLBI, NIH, Bethesda, USA (February 2024)
13. Genetics, Cell Biology and Anatomy colloquium, University of Nebraska Medical, Omaha, USA, Center (January 2024)
14. American Society of Cell Biology (ASCB) annual meeting, Boston, USA (December 2023)
15. Chemistry colloquium, Georgia State University, USA (November 2023)
16. Physics of living systems colloquium, Georgia Tech, USA (September 2023)
17. SynCell 2023 - Engineering Synthetic Cells and Organelles conference, Minneapolis, USA (May 2023)
18. “Actin Assembly for Intracellular Functions” meeting, University of Freiburg, Germany (May 2023)
19. Biochemistry department colloquium, Emory University, Atlanta, USA (May 2023)
20. Penn Muscle institute colloquium, University of Pennsylvania, USA (April 2023)
21. “Motors in Quarantine” virtual seminar series (April 2023)
22. Centre for Cellular and Molecular Biology (CCMB), Hyderabad, India (October 2022)
23. Biochemistry colloquium, Indian Institute of Science (IISc), Bangalore, India (October 2022)
24. Physics colloquium, Augusta University, Augusta, USA (September 2022)
25. European Cytoskeletal Forum, Hanover, Germany (May 2022)
26. “CAP proteins from Buds to Beds” virtual symposium (November 2021)
27. Chemistry and Biochemistry department colloquium (virtual), Ohio State University (September 2021)
28. Cell migration seminar series (virtual) (April 2021)
29. Build-a-cell seminar series (virtual) (March 2021)
30. Physics department colloquium (virtual), Lehigh University, Bethlehem, USA (March 2021)
31. Chemistry department colloquium (virtual), Wichita State University, Wichita, USA (October 2020)
32. Virtual Biology department, Kennesaw State University, Kennesaw, USA (October 2020)
33. Biochemistry, Cell and Developmental Biology Program, Emory University, Atlanta, USA (July 2020)
34. Materials Research Science and Engineering Center Seminar, Brandeis University, Waltham, USA (April 2020)
35. Molecular Physiology and Biophysics Department colloquium, University of Vermont, Burlington, USA (February 2020).
36. Gordon Research Conference on Motile and Contractile Systems, August 2019 (New London, USA)
37. Department of Mechanical Engineering & Materials Science, Washington University at St. Louis, St. Louis, USA (March 2019)
38. Department of Mechanical Engineering, Virginia Tech., Blacksburg, USA (February 2019)
39. Department of Physics, University of Florida, Gainesville, USA (February 2019)
40. Department of Physics, Emory University, Atlanta, USA (February 2019)
41. Cell Division and Cytoskeleton seminar series, Woods Hole, USA (July 2019)

42. New England Society for Microscopy Annual Spring Meeting, Waltham, MA (March 2018)
43. Cell Biology and Biophysics Unit, EMBL, Heidelberg, Germany (August 2017)
44. Cell Biology Department, Radboud University, Nijmegen, The Netherlands (September 2016)
45. Nanobiophysics group, University of Twente, Enschede, The Netherlands (September 2016)
46. Tarun Kapoor lab, Rockefeller University (April 2016)
47. Sabine Petry lab, Princeton University (April 2016)
48. Gordon Research Conference on Motile and Contractile Systems, New London, USA (August 2015)
49. Julie Theriot lab, Stanford University, USA (August 2015)
50. Biomechanics across scales, Ecole Polytechnique, Palaiseau, France (2015)
51. Invited talk at the Carlier Lab, CNRS, Gif-sur-Yvette, France (2012)
52. Royal Netherlands Academy of Biophysics, Amsterdam, Netherlands (2012)
53. Annual Dutch Biophysical meeting Veldhoven, The Netherlands (2012)
54. Biophysics and biosensors based on magnetic particles, Eindhoven, The Netherlands (2011)
55. Immunanomap symposium, Debrecen, Hungary (2009)
56. Annual Dutch Biophysical meeting, Veldhoven, The Netherlands (2008)

TEACHING EXPERIENCE

Emory University

1. Undergraduate teaching
    a. Physics for Scientists & Engineers II, PHYS 152 (Spring 2022), ~ 80 students.
    b. Freshman Seminar: “Biomolecular Nanomachines”, PHYS 190, (Fall 2020, Spring 2023, Spring 2024), ~16 - 20 students

2. Graduate teaching
    a. Foundations in BCDB (Biochemistry, Cell and Developmental Biology graduate program) (Spring 2021, Spring 2022, Spring 2024, Fall 2024), ~10 – 18 students
    b. Single molecule biophysics, PHYS 556 (Fall, 2023) - 11 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

I am currently mentoring 4 graduate students, and 1 undergraduate student:

1. Ankita Arya, Ph.D. student, Physics graduate program (January 2021 – present)
2. Heidi Ulrichs, Ph.D. student, Biochemistry, Cell and Developmental Biology graduate program (February 2021 - present)

3. Ekram Towsif, Ph.D. student, Physics graduate program (January 2022 – present)
4. Sudipta Biswas, Ph.D. student, Biochemistry, Cell and Developmental Biology graduate program (January 2023 - present)
5. Jonathan Martinez-Lopez, (May 2024 – present)

Previous trainees

1. Ignas Gaska, Postdoctoral fellow, Emory University (January 2021 –November 2022)
2. Dr. Surbhi Garg, Postdoctoral fellow (January 2023 – April 2024)
3. Matthew Baker, Undergraduate researcher, Emory University (May 2023 – August 2023)
4. Blake Miller, Undergrad researcher and research specialist, Emory University (September 2022 – December 2023)
5. Nayana Sah, Undergrad researcher, Emory University (May 2023 – Feb 2024)
6. Vishal Reddy, Undergrad researcher, BS Physics (May 2022 – June 2024)

Graduate rotation students

1. Hannah Gilbonio (Physics, November 2022 – January 2021)
2. Taylor Hailstock (BCDB, January 2021 – April 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)
7. David Cai (Physics, September 2023 – December 2023)
8. Jordan Ma (Physics, January 2025 - present)
9. David Banks (BCDB, January 2025 – present)

MEMBERSHIPS AND SERVICE

Department and University

1. Member, Physics department faculty search committee (2023 – 2024).
2. Member, Biochemistry, Cell and Developmental Biology graduate admissions committee (2021-2023, 2025 - present).
3. Member, Physics graduate program admissions interview committee (2021 - present).
4. Member, Physics Department Strategic committee (2021 - 2025).
5. Member, Physics graduate student awards committee (2021 - present).
6. Member, Machine shop committee (2023 – 2024).
7. PhD Qualification and thesis committee
    a. BCDB graduate program: Kate Hardin, Shuristeen Joubert, Yasmin Ibrahim and Jose Castro.
    b. Physics graduate program: Katie Whitcomb, Jin Qian, Alex Couturier, Sahand Emamian and David Meer.
8. Reviewer of grants, University Research Committee (URC).

9. Interviewer for admissions, MD PhD program (2022 – present)

Non-university service

10. Reviewer for peer-reviewed journals:
    - Nature Reviews Molecular Cell Biology, Nature Communications, Nature Chemical Biology, PNAS, Current Biology, Journal of Cell Biology, Current Opinion in Cell Biology, Scientific Reports, Biophysical Journal, Journal of Cell Science, PloS Biology, Biology Open, FEBS Journal, Cytoskeleton, Journal of muscle research and cell motility, Frontiers in Immunology, Frontiers in Cell and Developmental Biology
11. Member of the associate editorial board of journal Cytoskeleton.
12. 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. October 2020.
13. Member, American Society for Cell Biology (ASCB) (2017 -)
14. Member, Biophysical Society (BPS) (2023 -)
15. International grant reviewing
    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)
    d. European Union: Marie Sklodowska-Curie postdoctoral fellowships

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.