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Date of Birth: Oct 21 1983

Abhinav Sharma

Research Interests

Equilibrium and Nonequilibrium Statistical Mechanics applied to Soft Matter.

Positions held

Since May 2017 **Group Leader, Leibniz Institute for Polymer research, Dresden**

Sept 2011-2017 **Post-Doctoral Fellow**

2015-2017: University of Fribourg, Switzerland
Group Leader: Joseph Brader

2014-2015: University of Göttingen, Germany
Group Leader: Christoph Schmidt

2011-2014: Vrije Universiteit Amsterdam, The Netherlands
Group Leader: Fred MacKintosh

Education

June 2011 **Doctorate in Theoretical Physics**, *Technical University Eindhoven*, The Netherlands
Advisor: M. A. J. Michels
Thesis: "Modelling bias-induced changes of organic field-effect transistor characteristics"

June 2006 **Master of Technology in Electrical Engineering**, *Indian Institute of Technology Kanpur*, India
Advisor: B. Mazhari
Thesis: "Contact resistance of top-contact organic field-effect transistors"

Awards and Honors

Best Instructor Computational physics course, *Technical University Eindhoven* (2009)

Best Instructor Laboratory physics course, *Technical University Eindhoven* (2008)

Best Paper Student-paper award in International conference on systemics, cybernetics, and informatics, India (2005)

Chemistry Olympiad Reached the finals of Indian National Chemistry Olympiad organized by BARC (Bhabha Atomic Research Centre), India (2000)

Publications

The links are clickable. Google Scholar Statistics (Link) as of August 2017: 700 citations with h-index=13 and i10-index=17.

Key Papers

1. *Strain-controlled criticality governs the nonlinear mechanics of fibre networks*
A. Sharma, A. J. Licup, K. A. Jansen, R. Rens, M. Sheinman, G. H. Koenderink, F. C. MacKintosh ***Nature Physics*** **2016**, 12, 584.

2. *Anomalous Discontinuity at the Percolation Critical Point of Active Gels*
M. Sheinman, A. Sharma, J. R. Alvarado, G. H. Koenderink, F. C. MacKintosh ***Phys. Rev. Lett.*** **2015**, *114*, 098104.

3. *Stress controls the mechanics of collagen networks*
A. J. Licup, S. Münster, A. Sharma, M. Sheinman, L. M. Jawerth, B. Fabry, D. Weitz, F. C. MacKintosh ***Co-first author, PNAS*** **2015**, *12*, 9573.

4. *Nonlinear mechanics of branched athermal biopolymer networks*
R. Rens, M. Vahabi, A. J. Licup, F.C. MacKintosh, A. Sharma *Invited article,* ***Journal of Physical Chemistry B****, DOI: 10.1021/acs.jpcb.6b00259* **2016**.

5. *Molecular motors robustly drive active gels to a critically connected state*
J. R. Alvarado, M. Sheinman, A. Sharma, F. C. MacKintosh, G. Koenderink ***Nature Physics*** **2013**, *9*, 591.

Full list

6. *Uncoupling shear and uniaxial elastic moduli of semiflexible polymer networks: compression-softening and stretch-stiffening*
A. S. G. van Oosten, M. Vahabi, A. J. Licup, A. Sharma, F. C. MacKintosh, Paul A. Janmey ***Nature Scientific Reports*** **2016**, 6, 19270.

7. *On-site residence time in a driven diffusive system: Violation and recovery of a mean-field description*
J. Messelink, R. Rens, M. Vahabi, F.C. MacKintosh, A. Sharma ***Phys. Rev. E*** **2016**, 93, 012119.

8. *Elastic regimes of subisostatic athermal fiber networks*
A. Licup, A. Sharma, F. C. MacKintosh ***Phys. Rev. E*** **2016**, 93, 012407.

9. *Elasticity of fibrous networks under axial prestress*
M. Vahabi, A. Sharma, A. J. Licup, A. v Oosten, P. Janmey, F.C. MacKintosh ***Soft Matter*** **2016**, 12, 5050.

10. *Self organization of stress patterns drives state transitions in actin cortices*
T. H. Tan, M. M. Garbi, E. A. Shah, J. Li, A. Sharma, F. C. MacKintosh, K. Keren, C. F. Schmidt, N. Fakhri ***arXiv:1603.07600*** **2016**.

11. *Elasticity of 3D networks with rigid filaments and compliant crosslinks*
K. M. Heidemann, A. Sharma, F. Rehfeldt, C. F. Schmidt, M. Wardetzky ***Soft Matter*** **2015**, *11*, 343-354.

12. *Driven diffusive systems with mutually attractive Langmuir kinetics*
H. D. Vuijk, R. Rens, M. Vahabi, F.C. MacKintosh, A. Sharma ***Phys. Rev. E*** **2015**, *91*, 032143.

13. *Inherently unstable networks collapse to a critical point*
M. Sheinman, A. Sharma, J. R. Alvarado, G. Koenderink, F. C. MacKintosh ***Phys. Rev. E*** **2015**, *92*, 012710.

14. *Elastic response of filamentous networks with compliant crosslinks*
A. Sharma, M. Sheinman, K. M. Heidemann, F. C. MacKintosh ***Phys. Rev. E*** **2013**, *88*, 052705.

15. *Myosin Activity Drives Cytoskeletal Networks to a Critically Connected State*
J. R. Alvarado, M. Sheinman, A. Sharma, F. C. MacKintosh, G. Koenderink ***Biophysical Journal*** **2013**, *104*, 550.

16. *Analytical approximation for chemical potential in organic materials with Gaussian density of states*
A. Sharma, M. Sheinman ***Journal of Physics D*** **2013**, *46*, 125106.

17. *Operational Stability of Organic Field-Effect Transistors*
P. A. Bobbert, A. Sharma, S. G. J. Mathijssen, M. Kemerink, D. M. de Leeuw ***Advanced Materials*** **2012**, *24*, 1146-1158.

18. *Dimensionality of charge transport in organic field-effect transistors*
A. Sharma, F. W. A. van Oost, M. Kemerink, P. A. Bobbert ***Phys. Rev. B*** **2012**, *85*, 235302.

19. *Influence of the semiconductor oxidation potential on the operational stability of organic field-effect transistors*
A. Sharma, S. G. J. Mathijssen, P. A. Bobbert, D. M. de Leeuw ***Appl. Phys. Lett.*** **2011**, *99*, 103302.

20. *Effect of Coulomb scattering from trapped charges on the mobility in an organic field-effect transistor*
A. Sharma, N. M. A. Janssen, S. G. J. Mathijssen, M. Kemerink, D. M. de Leeuw, P. A. Bobbert ***Phys. Rev. B*** **2011**, *83*, 125310.

21. *Proton migration mechanism for operational instabilities in organic field-effect transistors*
A. Sharma, S. G. J. Mathijssen, E. C. P. Smits, M. Kemerink, D. M. de Leeuw, P. A. Bobbert ***Phys. Rev. B*** **2010**, *82*, 075322.

22. *Bias stress effect and recovery in organic field effect transistors: proton migration mechanism*
A. Sharma, S. G. J. Mathijssen, M. Kemerink, D. M. de Leeuw, P. A. Bobbert ***SPIE Proceedings*** **2010**, *7778*, 77780q.

23. *Anomalous current transients in organic field-effect transistors*
A. Sharma, S. G. J. Mathijssen, T. Cramer, M. Kemerink, D. M. de Leeuw, P. A. Bobbert ***Appl. Phys. Lett.*** **2010**, *96*, 103306.

24. *Proton migration mechanism for the instability of organic field-effect transistors*
A. Sharma, S. G. J. Mathijssen, M. Kemerink, D. M. de Leeuw, P. A. Bobbert ***Appl. Phys. Lett.*** **2009**, *95*, 253305.

25. *Charge trapping at the dielectric of organic transistors visualized in real time and space*
S. G. J. Mathijssen, M. Kemerink, A. Sharma, M. Cölle, P. A. Bobbert, R. A. J. Janssen, D. M. de Leeuw ***Advanced Materials*** **2008**, *20*, 975-979.

26. *Scalable General High Voltage MOSFET Model inlcuding Quasi-Saturation and Self-Heating effect*
Y. S. Chauhan, C. Anghel, F. Krummenacher, C. Maier, R. Gillon, B. Bakeroot, B. Desoete, S. Frere, A. Baguenier Desormeaux, A. Sharma, M. Declercq, and A. M. Ionescu ***Solid State Electronics*** **2006**, *50*, 1801-1813.

Comment

27. *Reply to Comment on "Anomalous Discontinuity at the Percolation Critical Point of Active Gels"*
M. Sheinman, A. Sharma, F. C. MacKintosh ***Phys. Rev. Lett.*** **2016**, 116, 189802.

Drafts available upon request

28. *Strain-driven criticality underlies nonlinear mechanics of fibrous networks*
A. Sharma, A. J. Licup, R. Rens, M. Vahabi, K. A. Jansen, G. H. Koenderink, F.C. MacKintosh **To be submitted 2016**.

29. *Stress-stabilized sub-isostatic networks*
A. Licup, A. Sharma, F. C. MacKintosh **To be submitted 2016**.

30. *Architecture and normal stress in collagen network mechanics*
K. A. Jansen, A. J. Licup, A. Sharma, F.C. MacKintosh, G. H. Koenderink **To be submitted 2016**.

31. *Loops count: random spring networks on the unit circle*
K. M. Heidemann, A. Sharma, C. F. Schmidt, M. Wardetzky **To be submitted 2016**.

Research Summary

Current

Nonequilibrium Statistical Mechanics of Active systems
I have recently found that active system can be approximately mapped to an effective equilibrium system without introduction of an effective temperature. The questions that most interest me are: Can the effective equilibrium describe the static and dynamic properties of an active sytem? Can one model the run-and-tumble behavior of bacteria using the effective equilibrium approach? How to take the confining geometry explicitly into account for description of active systems? I am using Density Functional Theory and Brownian Dynamics simulations to address these questions.

Post-Doctoral

Mechanical Properties of Biomaterials
My focus has been on theoretical understanding of linear and nonlinear mechanics of biopolymer networks. Working together with experimentalists, I have studied how different fields such as bending rigidity, stress, and strain can stabilize an otherwise floppy network. Some of the important results of my post-doctoral research are:
- Nonlinear mechanics are not sensitive to the detailed microstructure of the network
- Motor-activity induced failure of a network exhibits remarkable similarity to percolation transition
- Stress governs the mechanics of collagen networks over a wide range of concentration

Doctorate

Charge Conduction and Electrical Instablities in Organic Field-Effect Transistors
Organic transistors are electrically unstable; under operation they gradually stop conducting on time scale ranging from hours to days. Surprisingly, this effect is fully reversible and on similar time scale. Working together with experimentalists, I solved this decades old puzzle using a combination of concepts from electrochemistry, interfacial physics and charge-transport in disordered materials. This work laid the groundwork for fundamental investigations into effect of coulomb scattering and spatial confinement on charge transport in organic transistors.

Collaborators

Fred MacKintosh	*Rice University*
Gijsje Koenderink	*AMOLF*
Christoph Schmidt	*University of Göttingen*

Paul Janmey	*University of Pennsylvania*
David Weitz	*Harvard University*
Joseph Brader	*University of Fribourg*

Teaching

Master Level
- Statistical Physics of Biological systems, *University of Fribourg*, Switzerland
- Active Processes in Biology, *Göttingen University*, Germany

Bachelor Level
- Statistical Mechanics, *University College Amsterdam*, The Netherlands
- Computational Physics, *Technical University Eindhoven*, The Netherlands
- Physics Laboratory, *Technical University Eindhoven*, The Netherlands

Advisor

The links below are clickable. Theses reports can be provided upon request.

M.Sc. Thesis
- *On-site residence time in a driven diffusive system*
Student: Joris Messelink, *Vrije Universiteit Amsterdam*, The Netherlands 2015
J. Messelink, R. Rens, M. Vahabi, F.C. MacKintosh, A. Sharma ***Phys. Rev. E*** **2016**, 93, 012119.
- *Nonlinear elasticity of branched networks*
Student: Robbie Rens, *Vrije Universiteit Amsterdam*, The Netherlands 2014
R. Rens, M. Vahabi, A. J. Licup, F.C. MacKintosh, A. Sharma ***Journal of Physical Chemistry B****, DOI: 10.1021/acs.jpcb.6b00259* **2016**.

B.Sc. Thesis
- *Cooperativity in Cin8-Kinesin motors transporting Microtubules*
Student: Tobias Kramer, *Göttingen University*, Germany 2015
- *Driven diffusive systems with mutually interactive Langmuir kinetics*
Student: Hidde Vuijk, *Vrije Universiteit Amsterdam*, The Netherlands 2014
H. D. Vuijk, R. Rens, M. Vahabi, F.C. MacKintosh, A. Sharma ***Phys. Rev. E*** **2015**, *91*, 032143.
- *Effect of Coulomb scattering from trapped charges on the mobility in an organic field-effect transistor*
Student: Niels Janssen, *Technical University Eindhoven*, The Netherlands 2010
A. Sharma, N. M. A. Janssen, S. G. J. Mathijssen, M. Kemerink, D. M. de Leeuw, P. A. Bobbert ***Phys. Rev. B*** **2011**, *83*, 125310.

Invited Talks

- Molecular motors drive criticality in an active network, *MIT*, Boston (2015)
- Strain driven criticality in a passive network, *Harvard University*, Boston (2015)
- Strain driven criticality in a passive network, *University of Chicago*, Chicago (2015)
- Strain controlled criticality governs the mechanical behavior of fibrous networks, Third-infinity Conference, Göttingen (2015)
- Residence time of particle in a driven diffusive system with Langmuir Kinetics, *Sapienza University*, Rome (2015)
- Nonlinear elasticity of biopolymer networks, *University of Basel*, Switzeraland (2015)
- Nonlinear elasticity as an athermal critical phenomenon, *Orsay University*, Paris (2014)

Workshops

- Active Dynamics on Microscales: Molecular Motors and Self-Propelling Particles, Leiden (Netherlands) 2012
- 10th Dutch Chromatin Meeting, Amsterdam (Netherlands) 2012
- Postgraduate School Statistical Physics and Theory of Condensed Matter, Driebergen (Netherlands) 2008 and 2009

Professional References

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J. M. Brader
Associate Professor
Department of Physics, Soft Matter Theory Group
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1700CH Fribourg, Switzerland
mail: joseph.brader@unifr.ch

Languages

Hindi	**Native**
English	**Fluent**
French	**B1**
Dutch	**A2**

Leisure activities

Sports	Competitive squash Running and biking
Circuit designing	Designing games using discrete components, micro-controller, and oscilloscope