C. NADIR KAPLAN, Ph.D.

Paulson School of Engineering and Applied Sciences
Harvard University
52 Oxford Street, Cambridge, MA 02138

Google Scholar Profile
Homepage
nadir@seas.harvard.edu

SCHOLARLY PROFILE

Applied mathematician and theoretical & computational physicist trained in a broad array of areas, including materials science, geometry, soft matter and biological physics, elasticity, fluid mechanics, chemical physics, liquid crystals, statistical physics and thermodynamics.

My current research focuses on:

- Synthetic biomimetic assembly with implications on additive manufacturing,
- Theory of bioinspired signal integration in hydrogels with implications in bioengineering,
- Low-Reynolds-number multiphase flow of colloidal and biological suspensions.

My past research focused on:

- Controlling drying-induced deposition in volatile suspensions,
- Modeling molecular order/morphology coupling in liquid crystalline membranes composed of chiral nanorods,
- Statistical mechanics of non-uniform spin systems: small-world networks, percolation, strongly correlated electronic systems, classical and quantum spin glasses with frozen disorder,
- Molecular dynamics simulations of water flow through carbon nanotubes.

RESEARCH EXPERIENCE

2016– **Research Associate in Materials Science & Mechanical Engineering**
Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, MA
Faculty advisor: Joanna Aizenberg, Professor of Materials Science, Professor of Chemistry and Chemical Biology

2012–16 **Postdoctoral Researcher in Applied Mathematics**
Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, MA
Faculty advisor: L. Mahadevan, Professor of Applied Mathematics, Professor of Organismic and Evolutionary Biology, Professor of Physics

EDUCATION

2012 **Ph.D. in Physics,** Brandeis University, Waltham, MA
Thesis: Colloidal membranes: The rich confluence of geometry and liquid crystals
Faculty advisor: Robert B. Meyer, Professor of Physics

2008 **M.S in Physics,** Koç University, Istanbul, Turkey
Thesis: Renormalization-group theory of classical and quantum systems with frozen disorder
Faculty advisor: A. Nihat Berker, Professor of Physics

2006 **B.S. in Engineering Physics,** Istanbul Technical University, Istanbul, Turkey

PUBLICATIONS

Preprint

P. A. Korevaar, **C. N. Kaplan,** A. Grinthal, R. M. Rust, J. Aizenberg, "Non-equilibrium signal integration in hydrogels." *to be submitted* (2019).

S. Srinivasan, **C. N. Kaplan,** L. Mahadevan, "Dynamics of spreading bacterial swarms and films." https://www.biorxiv.org/content/early/2018/06/11/344267 *in revision to* ***eLife*** (2019).

C. N. Kaplan, P. A. Korevaar, J. Aizenberg, "Theory of complex signal processing in hydrogels." *to be submitted* (2019).

Selected publications

1. **C. N. Kaplan*****,** W. L. Noorduin*, L. Li, R. Sadza, L. Folkertsma, J. Aizenberg, L. Mahadevan, "Controlled growth and form of precipitating microsculptures." ***Science*** 355, 1395 (2017). (*equal contribution)
2. **C. N. Kaplan,** N. Wu, S. Mandre, J. Aizenberg, L. Mahadevan, "Dynamics of evaporative colloidal patterning." ***Phys. Fluids*** 27, 092105 (2015).
3. **C. N. Kaplan,** L. Mahadevan, "Evaporation-driven ring and film deposition from colloidal droplets." ***J. Fluid Mech.*** 781, R2 (2015).

Additional publications

4. T. Gibaud, **C. N. Kaplan,** P. Sharma, A. Ward, M. J. Zakhary, R. Oldenbourg, R. B. Meyer, R. D. Kamien, T. R. Powers, Z. Dogic, "Achiral symmetry breaking and positive Gaussian modulus lead to scalloped colloidal membranes." ***Proc. Natl. Acad. Sci. U.S.A.*** 114, E3376 (2017).
5. M. J. Zakhary, T. Gibaud, **C. N. Kaplan,** E. Barry, R. Oldenbourg, R. B. Meyer, Z. Dogic, "Imprintable membranes from incomplete chiral coalescence." ***Nat. Commun.*** 5, 3063 (2014).
6. **C. N. Kaplan,** R. B. Meyer, "Colloidal membranes of hard rods: unified theory of free edge structure and twist walls." ***Soft Matter*** 10, 4700 (2014).
7. **C. N. Kaplan,** T. Gibaud, R. B. Meyer, "Intrinsic curvature determines the crinkled edges of crenellated disks." ***Soft Matter*** 9, 8210 (2013).
8. D. J. Bonthuis, K. F. Rinne, K. Falk, **C. N. Kaplan,** D. Horinek, A. N. Berker, L. Bocquet, R. R. Netz, "Theory and simulations of water flow through carbon nanotubes: prospects and pitfalls." ***J. Phys. Condens. Matter*** 23, 184110 (2011).
9. **C. N. Kaplan,** H. Tu, R. A. Pelcovits, R. B. Meyer, "Theory of depletion induced phase transition from chiral smectic A twisted ribbons to semi–infinite flat membranes" ***Phys. Rev. E*** 82, 021701 (2010). *The Stephan Berko research prize of Brandeis Physics*
10. D. J. Bonthuis, K. Falk, **C. N. Kaplan,** D. Horinek, A. N. Berker, L. Bocquet, R. R. Netz, "Comment on pumping of confined water in carbon nanotubes by rotation-translation coupling." ***Phys. Rev. Lett.*** 105, 209401 (2010).
11. **C. N. Kaplan,** "Theory of chiral smectic A liquid crystalline membranes." ***Physica A*** 389, 2962-2965 (2010), *Proceedings of the Nihat Berker 60th Birthday Symposium*.
12. **C. N. Kaplan,** M. Hinczewski, A. N. Berker, "Infinitely robust order and local order-parameter tulips in Apollonian networks with quenched disorder." ***Phys. Rev. E*** 79, 061120 (2009). *PRE kaleidoscope image, June 2009.*

13. **C. N. Kaplan,** A. N. Berker, M. Hinczewski, "Frustrated further-neighbor antiferromagnetic and electron-hopping interactions in the $d = 3$ $t-J$ model: Finite-temperature global phase diagrams from renormalization-group theory." ***Phys. Rev. B*** 80, 214529 (2009).
14. **C. N. Kaplan,** A. N. Berker, "Quantum-mechanically induced asymmetry in the phase diagrams of spin-glass systems" ***Phys. Rev. Lett.*** 100, 027204 (2008).

Media coverage

My 2017 *Science* publication was covered in various media outlets including Phys. Org., Harvard SEAS, Wyss Institute, Chemistry World, The Kavli Foundation, National Science Foundation, AMOLF (NL). My 2015 *Phys. Fluids* publication was covered in the media outlets American Institute of Physics, EurekAlert!, Harvard SEAS, Harvard Physics.

PRESENTATIONS

Invited talks

Morphing hard and soft matter by reaction-transport dynamics

01/2019 Materials and Interfaces Department Seminar, Weizmann Institute of Science, Rehovot, Israel
12/2018 Ringberg Castle Seminar: Matter to Life, Kreuth, Germany
10/2018 Symposium on Organoid Organization, Center for Systems Biology Dresden, Germany

Theoretical design of hard and soft biomimetic materials

12/2018 Biomaterials Department Seminar, MPI of Colloids and Interfaces, Golm, Germany
12/2018 Cellular Biophysics Seminar, MPI for Medical Research, Heidelberg, Germany
12/2018 Institute Seminar, MPI for Intelligent Systems, Stuttgart, Germany
10/2018 Engineering and Natural Sciences Seminar, Kadir Has University, Istanbul, Turkey
08/2018 Squishy Physics Seminar, Harvard University
04/2018 Oculus VR, Redmond, WA
03/2018 Physics Department Seminar, University of California, Merced
03/2018 Mechanical and Industrial Engineering Department Seminar, Northeastern University

Controlled growth and form of precipitating microsculptures

07/2017 Society of Engineering Science 54th Annual Meeting, Northeastern University
06/2017 Gordon Research Conference on Crystal Growth, University of New England
06/2017 Gordon Research Seminar on Crystal Growth, University of New England
04/2016 Simons Center for Data Analysis, Simons Foundation
03/2016 Physical Mathematics Seminar, Massachusetts Institute of Technology (MIT)
12/2015 Squishy Physics Seminar, Harvard University

Rational design of self-organization in chemical precipitation

01/2017 Applied Mathematics Seminar, University of Waterloo, Canada

Dynamics of evaporation-driven colloidal patterning

12/2013 Istanbul Technical University, Turkey

Evolution of colloidal deposits in evaporating fluid films

10/2013 Kavli Meetings, Harvard University

06/2013 20th Statistical Physics Days, Erciyes University, Turkey

Theory of colloidal monolayers assembled from chiral rod-like particles

02/2012 University of Massachusetts, Amherst

02/2012 Condensed Matter & Biological Physics Seminar, Syracuse University

Theory of chiral smectic A liquid crystalline membranes

05/2010 The 19th Annual Student Research Symposium, Brandeis University

The effect of chirality on self-assembly of attractive rod-like particles

04/2010 MRSEC Seminar, Brandeis University

Renormalization-group theory of $d = 3$ $t - J$ models

07/2006 Workshop on Solid State and Materials Chemistry, MPI Dresden, Germany

Contributed talks

Theory of non-equilibrium signal processing in hydrogels

03/2018 APS March Meeting, Los Angeles, CA

Controlled growth and form of precipitating microsculptures

10/2017 NEW.Mech 2017, MIT

10/2017 19th Greater Boston Area Statistical Mechanics Meeting, MIT

08/2017 26th International Materials Research Congress, Cancun, Mexico

Dynamics of water uptake in spreading bacterial colonies

11/2016 APS DFD Meeting, Portland, OR

Dynamics of clogging in drying porous media

11/2014 APS DFD Meeting, San Francisco, CA

Theory of the dynamics of evaporation-driven colloidal patterning

03/2014 APS March Meeting, Denver, CO

Unified theory of chiral smectic A monolayers and π-wall defects

02/2012 APS March Meeting, Boston, MA

10/2011 13th Greater Boston Area Statistical Mechanics Meeting, Brandeis University

Theory of depletion induced phase transition from chiral smectic A twisted ribbons to semi–infinite flat membranes

11/2010 MRS Fall Meeting, Boston, MA

10/2010 12th Greater Boston Area Statistical Mechanics Meeting, Brandeis University

09/2010 44th New England Complex Fluids Meeting, Brandeis University

05/2010 103rd Statistical Mechanics Meeting, Rutgers University

Theory of liquid crystalline membranes

10/2009 60th Birthday Symposium in Honor of Nihat Berker, MIT

Infinitely robust order and local order-parameter tulips in Apollonian networks with quenched disorder

03/2009 APS March Meeting, Pittsburgh, PA

12/2008 100th Statistical Mechanics Meeting, Rutgers University

Quantum induced asymmetric phase diagrams of spin-glass systems

03/2008 APS March Meeting, New Orleans, LA

12/2007 98th Statistical Mechanics Meeting, Rutgers University

Poster presentations

Controlled growth and form of precipitating microsculptures

06/2017 Gordon Research Conference on Crystal Growth, University of New England

11/2016 MRS Fall Meeting, Boston, MA

08/2015 Gordon Conference on Soft Matter, Colby-Sawyer College

Dynamics of evaporative colloidal patterning

11/2014 Wyss Institute Annual Retreat, Boston, MA

01/2014 AFOSR-MURI Annual Review Meeting, Harvard University

Morphogenesis of spinose forms in terrestrial plants

05/2014 9th Annual Plant Biology Symposium, Arnold Arboretum

Chiral smectics A: Isolated membranes versus π-twist-wall defects

06/2011 Gordon Conference on Liquid Crystals, Mount Holyoke College

TEACHING

Teaching Assistant

Taught classes & problem sections (20-25 students), graded assignments, held office hours.

Harvard University

Patterns in Fluids (Applied Math 217 - graduate level, Spring 2019)

Brandeis University

Introductory physics (Phys 11a – Fall 2008, Phys 11b – Spring 2009)

Graduate statistical physics and thermodynamics, (Phys 163a – Fall 2009, 2011)

Graduate quantum mechanics II, (Phys 162b – Spring 2011)

Feza Gürsey Research Institute, TUBITAK, Turkey

Phase transitions and renormalization group, Summer 2007, 2008

Koç University

Undergraduate statistical physics, (Phys 301 – Fall 2006)

Electricity and magnetism, (Phys 102 – Spring 2007)

Undergraduate solid state physics, (Phys 403 – Fall 2007)

Phase transitions and renormalization group, (Phys 409 – Spring 2008)

Tutor

Istanbul Technical University

Introductory physics laboratories, 2002-04

Advisor

Senior Honors Thesis at Brandeis University, 2010

AWARDS

2018 Postdoctoral Award for Professional Development, Office of Postdoctoral Affairs, Harvard University

2010 The Stephan Berko Prize For Outstanding Graduate Research, Martin Fisher School of Physics, Brandeis University

2009 GSA Travel and Research Award, Brandeis University Graduate Student Association (GSA)

2008 Travel and Research Award, The Scientific and Technological Research Council of Turkey (TUBITAK)

PROFESSIONAL ACTIVITIES

- Reviewer for *Phys. Rev. Lett., Phys. Rev. E, Nature Comm.*
- Co-organizer (with 2 faculty members, 3 postdocs, and staff) of the 9th Plant Biology Symposium (2014), Arnold Arboretum, Harvard University (100 attendants),
- Co-organizer (with 1 faculty member and staff) of the Annual Retreat (2017), Kavli Institute for Bionano Science & Technology, Harvard University (49 attendants),
- Organizer of Max Planck Schools "Matter to Life" Information Session at Paulson School of Engineering and Applied Sciences, Harvard University (2018).

REFERENCES

Joanna Aizenberg, Harvard University – Postdoctoral supervisor
E-mail marina@seas.harvard.edu (Marina DiDonato-McLaughlin, Faculty Administrator)
Phone 1-617-495-3558
Address Pierce Hall 229, Harvard University, 29 Oxford Street, Cambridge, MA 02138

L. Mahadevan, Harvard University – Postdoctoral supervisor
E-mail donohoe@seas.harvard.edu (Michael A. Donohoe, Faculty Administrator)
Phone 1-617-496-9599
Address Pierce Hall 322, Harvard University, 29 Oxford Street, Cambridge, MA 02138

Robert B. Meyer, Brandeis University – PhD supervisor
E-mail meyer@brandeis.edu
Phone +1-781-736-2870
Address Brandeis University MS057, 415 South Street, Waltham, MA 02454, USA.

Zvonimir Dogic, University of California, Santa Barbara; Brandeis University – Collaborator
E-mail zdogic@physics.ucsb.edu
Phone 1-805-893-2815
Address Department of Physics, Broida Hall 4419, University of California, Santa Barbara, CA 93106-9530

Wim L. Noorduin, AMOLF – Collaborator
E-mail w.noorduin@amolf.nl
Phone +31-20-754-7347
Address AMOLF, Science Park 102, 1098 XG Amsterdam, The Netherlands.