Orit Peleg, PhD

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Research Interests

My research is aimed at understanding how organisms buffer themselves against large environmental fluctuations and accommodate adaptation over a wide range of length and time scales. This includes protein assemblies that remain intact under varying external mechanical and chemical stimuli, beetles that navigate using volatile celestial cues, and honeybee clusters that change their morphology to both withstand mechanical stresses, and to regulate their bulk temperature.

Academic Appointments

2018–present **University of Colorado at Boulder**, USA
Assistant Professor at the Computer Science Department and the Biofrontiers Institute

2019–present **Santa Fe Institute**, USA
External Professor

2014–2017 **Harvard University**, USA
Postdoctoral fellow at SEAS (John A. Paulson School Of Engineering And Applied Sciences)

2012–2013 **Harvard University**, USA
Postdoctoral fellow at the Department of Chemistry and Chemical Biology

2012 **ETH Zürich** and **University of Zürich**, Switzerland
Research assistant at the Institute of Neuroinformatics (INI)

Education

2008–2012 **PhD in Materials Science, ETH Zürich, Switzerland**

Thesis title: "Simple Models of Competitive Interactions in Biophysical Systems", supervised by Prof. Martin Kröger, coadvised by Prof. Viola Vogel ETH Zürich and Prof. Yitzhak Rabin, Bar–Ilan University, Israel

2006-2007 **MSc degree in Physics, Bar–Ilan University, Israel** *summa cum laude*

Thesis title: "Simple Model of Microphase Separation in Polymer Gels; Molecular Dynamics Approach", supervised by Prof. Yitzhak Rabin

2003–2007 **BSc degree in Physics and Computer Science, Bar–Ilan University, Israel**

Journal Publications

G.K. Nave, N.T. Mitchell, J.A. Chan Dick, T. Schuessler, J.A. Lagarrigue, O. Peleg; Attraction, dynamics, and phase transitions in fire ant tower-building
Front. Robot. AI 7:25 (2020) ▶

S. Bidari, O. Peleg, Z.P. Kilpatrick; Social inhibition maintains adaptivity and consensus of foraging honeybee swarms in dynamic environments
J. R. Soc. Open Sci. 6:12 (2019) ▶

Journal Publications - Cont.

L. Khaldy, O. Peleg, C. Tocco, L. Mahadevan, M. Byrne and M. Dacke; The effect of step size on straight-line orientation
J. R. Soc. Interface 16: 20190181 (2019) ▶

J. Peters, O. Peleg, L. Mahadevan; Collective ventilation in honeybee nests
J. R. Soc. Interface 16: 20180561 (2019) ▶

O. Peleg; Mechanical hive mind
Phys. Today 72(4), 66 (2019) ▶

O. Peleg*, J. Peters*, M. Salcedo, L. Mahadevan; Collective mechanical adaptation of honeybee swarms
Nat. Phys. 14, 1193–1198 (2018) ▶ *Contributed equally to this work

O. Peleg, L. Mahadevan; Optimal switching between geocentric and egocentric strategies in navigation
J. R. Soc. Open Sci. 3, 160128 (2016) ▶

L.S. Shagolsem, D. Osmanovic, O. Peleg, Y. Rabin; Pair interaction ordering in fluids with random interactions *J. Chem. Phys.* 142, 051104 (2015) ▶

O. Peleg, J.M. Choi, E. Shakhnovich; Evolution of specificity in protein-protein interactions
Biophys. J. 107 (7), 1686-1696 (2014) ▶

M.B. Harasim, B. Wunderlich, O. Peleg, M. Kröger, A.R. Bausch; Direct observation of the dynamics of semiflexible polymers in shear flow *Phys. Rev. Lett.* 110, 108302 (2013) ▶

M. Tagliazucchi*, O. Peleg*, M. Kröger, Y. Rabin, I. Szleifer; Effect of charge, hydrophobicity and sequence of nucleoporins on the translocation of model particles through the nuclear pore complex
Proc. Natl. Acad. Sci. USA 110, 3363–3368 (2013) ▶ *Contributed equally to this work

O. Peleg, T. Savin, G. Kolmakov, I. Salib, M. Kröger, A.C. Balazs, V. Vogel; Fibers with integrated mechano-chemical switches: Minimalistic design principles derived from fibronectin
Biophys. J. 103, 1909 (2012) ▶

I. Salib, G. Kolmakov, B. Bucior, O. Peleg, T. Savin, M. Kröger, V. Vogel, K. Matyjaszewski, A.C. Balazs; Using mesoscopic models to design strong and tough biomimetic polymer networks
Langmuir 27, 13796–13805 (2011) ▶

O. Peleg*, M. Tagliazucchi*, M. Kröger, Y. Rabin, I. Szleifer; Morphology control of hairy nanopores *ACS Nano*, 5(6), 4737, (2011) ▶ *Contributed equally to this work

O. Peleg, R.Y.H. Lim; Converging on the function of intrinsically disordered nucleoporins in the nuclear pore complex *Biol. Chem.* 391, 719–730 (2010) ▶

M. Kröger, O. Peleg, A. Halperin; From dendrimers to dendronized polymers and forests: Scaling theory and its limitations *Macromolecules* 43, 6213–6224 (2010) ▶

S. Fransson, O. Peleg, N. Lorén, A.-M. Hermansson, M. Kröger; Modelling and confocal microscopy of biopolymer mixtures in confined geometries *Soft Matter* 6, 2713–2722 (2010) ▶

O. Peleg, M. Kröger, Y. Rabin; Effect of network topology on phase separation in two–dimensional Lennard–Jones networks
Phys. Rev. E 79, 040401(R); also included in the Virtual *J. Biol. Phys.* 17:8 (2009) ▶

O. Peleg, M. Kröger, Y. Rabin; Model of microphase separation in two-dimensional gels
Macromolecules 41, 3267–3275 (2008) ▶

M. Kröger, O. Peleg, Y. Ding, Y. Rabin; Formation of double helical and filamentous structures in models of physical and chemical gels *Soft Matter* 4, 18–28 (2008) ▶

O. Peleg, M. Kröger, I. Hecht, Y. Rabin; Filamentous networks in phase-separating two-dimensional gels
Europhys. Lett. 77, 58007 (2007) ▶

Papers in Review

G.G. Fard, E. Bradley, O. Peleg; Data-driven modeling of resource distribution in honeybee swarms
Submitted to The 2020 Conference on Artificial Life (2020) ▶

R. Sarfati, J. Hayes, E. Sarfati, O. Peleg ; Spatiotemporal reconstruction of emergent flash synchronization in firefly swarms via stereoscopic 360-degree cameras
Submitted, pre-print on bioRxiv (2020) ▶

Conference Presentations and Seminar Talks; Invited [I], Contributed [C]

[I] [**Plenary**] Collective Ecophysiology and Physics of Honeybees. *the 10th International Conference on Complex Systems*, Nashua, NH, USA (2020)

[I] Collective Aggregation via Directed Pheromone Signaling in Honeybee Swarms. *SIAM Conference on the Life Sciences*, Garden Grove, CA, USA (2020)

[I] Collective Aggregation via Directed Pheromone Signaling in Honeybee Swarms. *CAJAL Training Course on Quantitative Approaches to Behavior*, Champalimaud Centre, Lisbon (2020)

[I] Navigational Algorithms and Neural Circuit Computations Directing Olfactory Search Across Species. *HHMI-Janelia Research Campus*, Ashburn, VA, USA (2020)

[C] Collective Aggregation via Directed Pheromone Signaling in Honeybee Swarms. *American Physical Society (APS) March Meeting*, Boston, MA, USA (2020) ▶

[I] Collective Ecophysiology and Physics of Honeybees. *Nonlinear Science & Mathematical Physics*, Georgia Institute of Technology, Atlanta, GA, USA (2020)

[I] Collective Ecophysiology and Physics of Honeybees. *Physics Colloquium*, Emory University, Atlanta, GA, USA (2020)

[I] Collective Ecophysiology and Physics of Honeybees. *Institute of Cognitive Science Colloquium*, CU Boulder, CO, USA (2020)

[I] Collective Ecophysiology and Physics of Honeybees. *Princeton Ecology and Evolutionary Biology Seminar*, Princeton, NJ, USA (2019)

[C] Collective Mechanical Adaptation of Honeybee Swarms. *SIAM Conference on Dynamical Systems*, Snowbird, UT, USA (2019) ▶

[I] Physics of social insects. *Computations in Science Seminars*, University of Chicago, IL, USA (2019) ▶

[I] Physics of social insects. *Los Alamos National Laboratory, Center for Nonlinear Studies Colloquia*, Los Alamos, NM, USA (2019) ▶

[I] Collective mechanical adaptation of honeybee swarms. *American Physical Society (APS) March Meeting*, Boston, MA, USA (2019) ▶

[I] Physics of social insects. *The Boulder School in Condensed Matter and Materials Physics*, Boulder, CO, USA (2019) ▶

[I] Collective Adaptation in Honeybee Swarms. *Bio-mechanics workshop on "Cell membrane dynamics and micro-circulation in tissue"*, University of Oslo, Norway (2018)

[I] The Physics of Disordered Living Systems: Collective Adaptation in Honeybee Swarms. *PIER Graduate Week 2018*, Hamburg, Germany (2018) ▶

[I] Intrinsically Disordered Living Systems. *Santa Fe Institute Seminar*, Santa Fe, NM, USA (2018) ▶

[I] Collective Ecophysiology and Physics of Honeybees. *Active Matter Workshop at CU Boulder*, Boulder, CO, USA (2018) ▶

[I] Collective Ecophysiology and Physics of Honeybees. *SIAM Conference on the Life Sciences*, Minneapolis, MI, USA (2018) ▶

Presentations Cont.

[I] Collective Ecophysiology and Physics of Honeybees. *Robinson Lab Seminar, University of Illinois*, Urbana Champaign, IL, USA (2018)

[I] Local Sensing in Disordered Living Systems. *Janelia/MSRI Summer Graduate School on Mathematical Analysis of Behavior*, Ashburn, VA (2018) ▶

[C] Collective Mechanical Adaptation of Honeybee Swarms. *Dynamics Days*, Denver, CO, USA (2018) ▶

[I] Honeybee Collective Behavior. *Summer Program of the Aspen Center for Physics (ACP)*, Aspen, CO (2018) ▶

[I] Collective Ecophysiology and Physics of Social Insects. *UCSD QBio Seminar*, San Diego, CA (2018) ▶

[I] Collective Ecophysiology and Physics of Social Insects. *Bioinformatics Supergroup Seminar*, Boulder, CO, USA (2018)

[C] Collective Mechanical Adaptation of Honeybee Swarms. *Distributed, Collective Computation in Biological and Artificial Systems*, Janelia Farm, Ashburn, VA, USA (2018) ▶

[I] Collective Ecophysiology and Physics of Social Insects. *2nd Week on Complexity Sciences at C3-UNAM*, Mexico City, Mexico (2018) ▶

[I] Local Sensing in Disordered Living Systems. *Biophysics Seminar, Department of Physics, Princeton University*, Princeton, NJ, USA (2017) ▶

[I] Local Sensing in Disordered Living Systems. *Mechanical Engineering Special Seminar, MIT*, Cambridge, MA, USA (2017)

[I] Local Sensing in Disordered Living Systems. *Complex Systems Seminar, University of Michigan*, Ann Arbor, MI, USA (2017)

[I] Local Sensing in Disordered Living Systems. *BioFrontiers Symposium and Computer Science Colloquium*, Boulder, CO, USA (2017)

[C] Mechanical adaptation in adhesive bee swarms. *American Physical Society (APS) March Meeting*, New Orleans, LA, USA (2017) ▶

[C] How a bee swarm adapts to dynamic mechanical stress. *Society for Integrative and Comparative Biology (SICB) Annual Meeting*, New Orleans, LA, USA (2017) ▶

[C] Optimal switching between geocentric and egocentric strategies in navigation. *Insect Navigation Workshop*, Janelia Farm, VA, USA (2016) ▶

[C] Ecophysiology of honeybee swarms. *18th Annual Greater Boston Area Statistical Mechanics Meeting*, Brandeis University, Waltham, MA, USA (2016) ▶

[C] Dynamic Morphology in Honeybee Swarms. *Annual Meeting of the International Physics of Living Systems (iPoLS) Network*, Harvard University, MA, USA (2016) ▶

[C] Dynamic Morphology in Honeybee Swarms. *Active and Smart Matter: A New Frontier for Science and Engineering*, Syracuse University, NY, USA (2016) ▶

[C] Dynamic Morphology in Honeybee Swarms. *Social Insects In the North East Regions*, Pennsylvania State University, PA, USA (2016) ▶

[I] Systems Biophysics of Protein–Protein Interactions. *Green Center for Systems Biology*, UT Southwestern Medical Center, TX, USA (2015)

[C] Optimal Intermittent Reorientation in Insect Navigation. *Gordon Research Conference on Stochastic Physics in Biology*, Ventura, CA, USA (2015) ▶

[C] Evolution of Specificity in Protein-Protein Interactions. *16th Annual Greater Boston Area Statistical Mechanics Meeting*, Brandeis University, Waltham, MA, USA (2014) ▶

[C] Phase separation in randomly crosslinked elastic Lennard–Jones networks. *EU STREP meeting*, Gothenburg, Sweden and *Soft Matter Days*, Bonn, Germany (2008)

Teaching Experience

CSCI–5/4314, Dynamic Models in Biology, University of Colorado at Boulder; *Spring 2019, 2020*

Janelia/MSRI Summer Graduate School on Mathematical Analysis of Behavior; *Summer 2018*

CSCI–5423, Bio–inspired Multi–agent Systems, University of Colorado at Boulder; *Spring 2018, 2019, 2020*

CSE Capstone Project Course, Harvard University; *Spring 2016*

Inverse Problems in Science and Engineering, Harvard University; *Spring 2016*

2014 Brains, Minds and Machines Summer Course, The Marine Biological Laboratory; *Summer 2014*

Laboratory Course in Simulation Methods, Department of Materials, ETH Zürich; *Fall 2009 and 2011*

Computational Polymer Physics, ETH Zürich; *Spring 2008, 2009 and 2010*

Programming and Simulation Techniques in Materials Science, ETH Zürich; *Spring 2008*

Computational Physics, Bar–Ilan University; *Winter 2007*

Numerical Analysis, Bar–Ilan University; *Winter 2006*

Thesis Committees

2018	Tyler Schuessler, Honors Thesis, BS Applied Math, University of Colorado Boulder
2018–present	Abhijit Suresh, PhD Program, Department of Computer Science, University of Colorado Boulder
2018–present	Ignacio Tripodi, PhD Program, Department of Computer Science, University of Colorado Boulder
2019–present	Katherine Hernandez, PhD Program, Department of EEBio, University of Colorado Boulder
2019–present	Connor Thompson, Chemical Engineering, University of Colorado Boulder
2019–present	Haichao Wu, Chemical Engineering, University of Colorado Boulder

Postdoctoral Researchers

2018–present	Dr. Gary K. Nave, Project: Self–organized mechanical load bearing in bee swarms: 3D structure reconstruction via x–ray
2019–present	Dr. Chantal Nguyen, Project: Trade–offs in rapid plant movement
2019–present	Dr. Raphael Sarfati, Project: Physics and information theory of firefly communication

Ph.D. Students

2018–present	Dieu My Nguyen, IQ Biology PhD Program, and the Computer Science PhD Program, University of Colorado Boulder. Project: "Adaptive pheromone communication networks in honeybees"
2018–present	Golnar G. Fard, co–advised with Prof. Elizabeth Bradley, Computer Science PhD Program, University of Colorado Boulder. Project: "Efficiency of food distribution via trophallaxis in honeybees"

Ph.D. Rotation and Short Term Projects

Fall 2019	Ellen Marie Waddle, Rotation IQ Biology PhD Program at University of Colorado Boulder
Fall 2018	Kathleen Murphy, Rotation IQ Biology PhD Program at University of Colorado Boulder
Fall 2018	Sierra Jech, Rotation IQ Biology PhD Program at University of Colorado Boulder
Fall 2018	Timothy Thorn, Rotation IQ Biology PhD Program at University of Colorado Boulder
June 2018	Nina Ning, Feng Ling, and Samantha Hill, Janelia/MSRI Summer Graduate School on Mathematical Analysis of Behavior
Spring 2018	Scott Nordstrom, Rotation IQ Biology PhD Program at University of Colorado Boulder
Spring 2018	Grant Vogel, Rotation IQ Biology PhD Program at University of Colorado Boulder

Undergraduate Students

2019–present	Aubrey Kroger, Discovery Learning Apprenticeship (DLA) program, University of Colorado Boulder
2018 – 2019	Christopher Mulligan, Undergraduate Research Opportunities Program (UROP) program, University of Colorado Boulder
2019	Spencer Moore, Matthew Miller, Maya Brody, REU program at UNC Greensboro, USA
2018–present	Aaron Mankel, Bachelor of Science in Physics Program at University of Colorado Boulder
2018–present	Julie Hayes, Bachelor Program in Ecology and Evolutionary Biology at University of Colorado Boulder
2018–2019	Brianna Boeyink, Discovery Learning Apprenticeship Program at University of Colorado Boulder
2018–2019	Huy Tran, Bachelor Program in Chemical and Biological Engineering at University of Colorado Boulder
2018	Chloe Bruce, Summer Program for Undergraduate Research at University of Colorado Boulder
2017	Dominic Bosco, Ethan Hobbs, Rebecca Wayne, James Worsham Harvard Paulson School of Engineering and Applied Sciences TRiCAM research program
2015–2016	Aditya Raguram Harvard Paulson School of Engineering and Applied Sciences REU program

High School Students

2019	Jackson Bremen, April Tong, Sloan Woodberry, CU Science Discovery program, University of Colorado Boulder
2018–present	Charlotte Gorgemans, Boulder High School
2018–2019	William (Jake) Hofgard, Boulder High School

Honors and Grants

Research Grants

Main PI on Human Frontiers Science Program (https://www.hfsp.org/) Young Investigator Grant, 1.1M USD, The Dynamics of Information Flow in a Social Network of Mutually Shading Plants (with Co PIs Yasmine Meroz and Alex Jordan, 2019-2021)

NSF Grant, Physics of Living Systems Program, 474K USD, Collective Ecophysiology and Physics of Social Insects, Award Abstract 1606895 (with L. Mahadevan, 2016)

Swiss National Science Foundation Fellowship for Prospective Researcher, 44K CHF, Evolutionary Design of Intrinsically Disordered Proteins, grant number PBEZP3 140130 4 (2012)

ETH Research Grant ETH-17 10-1, 53.6K CHF (with M. Kröger, 2010)

Seed Grants

CU Boulder, Research and Innovation Seed Grant, 44K USD, Bee-honeycomb Formation under Geometric Frustration (with F. L. Jimenez, 2020–2021)

CU Boulder, Multi-functional Materials IRT, 10K USD, Self-Organized Mechanical Load Bearing in Bee Swarms: 3D Structure Reconstruction via X–ray (with F. Vernerey, 2018)

CU Boulder, Autonomous Systems IRT, 5K USD, Autonomous Distributed Computation in Honeybee Swarms (2018)

Travel Grants

Participant Travel Grant for *Insect Navigation Workshop, Janelia Farm* (2016)

Junior Scientist Travel Grant for *Active and Smart Matter, Syracuse University* (2016)

Contributed Lecture Travel Grant *GRC on Stochastic Physics in Biology* (2015)

Honors

Featured on *Nature Podcast*: Negative emissions and swarms under strain (2018) ▶

Selected to participate at *Rising Stars in Physics, MIT* (2016)

Chosen for a Junior Scientist Lecture *GRC on Stochastic Physics in Biology* (2015)

"Evolution of Specificity in Protein-Protein Interactions" paper chosen among Biophys. J. *Best of 2014* (2014)

"Fibers with Integrated Mechanochemical Switches" paper featured on Biophys. J. *New and Notable* (2012)

"Fibers with Integrated Mechanochemical Switches" paper *featured on the cover* of Biophys. J. (2012)

"Converging of the function of intrinsically disordered nups..." *featured on the cover* of Biol. Chem. (2010)

"Formation of double helical and filamentous structures" paper *featured on the cover* of Soft Matter (2008)

Service

Peer Review Contribution

Polymers, MDPI; Scientific Reports, Nature Publishing; Chemical Physics Letters, Elsevier; Proceedings of the Royal Society B; Journal of the Royal Society, Interface; 2018 Int. Symp. on Distributed Autonomous Robotic Systems; Physical Biology, IOP; Science Advances, AAAS; Robotics and Autonomous Systems, Elsevier, Animal Behaviour, eLife

Conferences and Professional Societies

Co-organizer of *Physics of Social Interactions* Focus Session at APS (American Physical Society) March Meeting 2020, March 2-6, 2020 Denver, CO, USA (2020) ▶

Co-organizer of *Mechanics of growth, morphogenesis and evolution of biological solids* Symposium at Society for Engineering Science (SES) 2019 meeting, Washington University, St. Louis, USA (2019) ▶

Chair of *CP31 Collective Behavior* Session at *SIAM Conference on Dynamical Systems*, Snowbird, UT, USA (2019) ▶

Co-chair of *Neuromechanics II* session at Society for Integrative and Comparative Biology (SICB) Annual Meeting, New Orleans, LA, USA (2017)

Executive Committee of the Division of Biological Physics, American Physical Society, Member–at–Large, (2020-2023)

University Service

Member, BioFrontiers NSF NRT grant committee (2019–present)

Member, BioFrontiers NSF T32 grant committee (2019–present)

Member, BioFrontiers undergrad curriculum committee (2019–present)

Member, BioFrontiers Institute Council (formerly Task Force) (2018–present)

Member, BioFrontiers NSF grant for Sustained Availability of Biological Infrastructure (SABI) Core Program (2019–present)

Member, Engineering College Materials Science faculty Search (2018-2019)

Member, advisory committee CMAP (the center for media arts and performance) in ATLAS (2019–present)

Outreach

Public talk about Honeybee and Dung Beetle research at Engineering Exploration Lecture series, Denver CO, USA (2019)

Research and Career talk Woman Physicists, Bar Ilan University, Israel (2020)

Public talk about Honeybee research at MileHiveBeeClub, Denver CO, USA (2019)

Participant in Chords and Codons: Music About Science at the BioFrontiers CU BoulderMultidisciplinary multimedia with live and electronic music and visualizations (2019)

Volunteer at Code Wagon: Girls Computer Coding Camp a program to introduce girls and women to CS in CU Boulder (2018) ▶

Skype with a Scientist sessions with middle schools students in Israel, Costa Rica and the USA (2018-2019)

Volunteer at the Mentoring Program of Harvard Graduate Women in Science connecting female graduate students in science, math, and engineering with faculty (2016-2017) ▶

Volunteer at ProjectCS Girls Competition for Middle School Girls (mentee, a 6th–grader, made it to the semifinals by building a virtual medical diagnostic program) (2016) ▶

Volunteer at Girls Who Code (Harvard Club) and Big Sister Boston (2015)