Victor Yashunsky 30.10.2025

CURRICULUM VITAE

- **Personal Details**

Victor Yashunsky
Work: Midreshet Ben-Gurion 8499000, ISRAEL
Home: Teena 21, Alon Shvut 9043300, ISRAEL
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ORCID: 0000-0003-3175-3390

- **Education**

B.Sc. -
2004 - 2007, Hebrew University of Jerusalem, Racah Physics department

Ph.D. (*direct track*) -
2007 - 20013, Hebrew University of Jerusalem, Racah Physics department
Advisors: Prof. D. Davidov, Dr. M. Golosovsky and Prof. B. Aroeti
Title of thesis : ”*Living Cell Studies Using Infrared Surface Plasmon Spectroscopy*”

- **Employment History**

Academic appointments:
2022 - present, *Senior Lecturer* at The Swiss Institute for Dryland Environmental and Energy Research (SIDEER), The Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Israel

2018 - 2019, *Lecturer* at the Department of Biomedical Engineering, Ben-Gurion University of Negev, Israel

2015 - 2019, *Post-Doctorate*, Institut Curie, Pascal Silberzan, Laboratoire Physico-Chimie, Paris, France

2018, *Visiting Scientist*, Weizmann Institute of Science, Department of Chemical Physics, Rehovot, Israel

2013 - 2015, *Post-Doctorate*, Hebrew University of Jerusalem, Institute of Biochemistry, Rehovot, Israel

2008 - 2013, *Teaching assistant*, Hebrew University of Jerusalem, Physics department, Jerusalem, Israel

- **Professional Activities**

(b) Professional functions outside universities/institutions
2025 - Chair of Biophysics session at The 70th Annual Meeting of the Israel Physical Society, Technion, Israel

Reviewer for the following funding agencies:
Israel-USA Bi-National Science Foundation (BSF)

(e) Ad-hoc reviewer for journals
Soft Matter, Biophysical Reports, Tissue Engineering, Langmuir, Journal of Crystal Growth, Biosensors and Bioelectronics, Sensors and Actuators B, Journal of Biomedical Optics

I serve as a member of the advisory committee for Ph.D. students from the following institutes:
Ben-Gurion University of Negev.

(f) Membership in professional/scientific
2023 - present, Member of Israeli Physical Society

- **Educational activities**

(a) Courses taught (BGU course number is indicated in the brackets)
2026 - present, *Data-Based Research with Python* (3 CPT, 001-2-4065) - Albert Katz International School for Desert Studies, Ben-Gurion University of Negev

2024 - present, *Departmental Seminar* (1 CPT, 001-2-4444/54/64) - Albert Katz International School for Desert Studies, Ben-Gurion University of Negev

2024 - present, *Hands-on Image and Video Analysis without Coding: From Acquisition to Quantification*, graduate course (3 CPT, 001-2-4063) - Albert Katz International School for Desert Studies, Ben-Gurion University of Negev

2023 - present, *Mechanics and Dynamics of Living Multicellular Systems*, graduate and undergraduate course (3 CPT, 367-1-4061) - Department of Biomedical Engineering, Ben-Gurion University of Negev

2023 - 2025, *Fluid mechanics*, 3rd year undergraduate (3 CPT, 367-1-2311) - Department of Biomedical Engineering, Ben-Gurion University of Negev

2018, *Thermal and Mass Transfer*, 3rd year undergraduate (3 CPT, 367-1-3231) - Department of Biomedical Engineering, Ben-Gurion University of Negev

2008 - 2013, *Physics Laboratory*, 2rd year undergraduate, Hebrew University of Jerusalem, Physics department, Jerusalem, Israel

(b) Research students
M.Sc. Students:
2024 - present: Harsh Balaji, Ben-Gurion University

Post-docs:
2024 - 2025: Dr. Dov Neimand, Ben-Gurion University
2024 - 2025: Dr. Prayas Singh, Ben-Gurion University

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- **Awards, Citations, Honors, Fellowships**

(b) Fellowships

2016 - 2018, PRESTIGE Co-funded fellow and a Marie Curie fellow in Institut Curie
2015 - 2016, Labex CelTisPHyBio postdoctoral fellowship in Institut Curie

- **Scientific Publications**

H-index (GS): **12** | i10-index (GS): **13**
Total number of citations of all articles (from GS): **1710**
Total number of citations without self-citations (from GS): **1701**
Journal rank within a category indicated by Journal Citation Indicator (JCI)
Note: An asterisk () signifies work published since my appointment as PI in October 2022.*

(c) Refereed chapters in collective volumes, Conference proceedings
Refereed chapters

1. Golosovsky M[C], **Yashunsky V**[S], Zilberstein A[S], Marciano T[S], Lirtsman V[C], Davidov D[PI], Aroeti B[PI]. 2010. *Infrared Surface Plasmon Spectroscopy of Living Cells*, Plasmons: Theory and Applications, 327-343, Nova Science Publishers, New York, NY

2. **Yashunsky V**[S,CA], Zilberstein A[S], Marciano T[S], Lirtsman V[C], Golosovsky M[C], Aroeti B[PI], Davidov D[PI]. 2012. *Studying living cells by infrared surface plasmon spectroscopy, Plasmons: Structure, Properties and Applications*, 131-144, Nova Science Publishers, New York, NY. [Times Cited: 1]

3. **Yashunsky V**[PD,CA] and Aroeti B[PI], 2015. *Infrared surface plasmon spectroscopy decodes early processes in epithelial host cells upon enteropathogenic Escherichia coli infection, Label-Free Biosensor* Methods in Drug Discovery. Methods in Pharmacology and Toxicology, 353-371, Humana Press, New York, NY,

4. Duclos G[S], Deforet M[S], Yevick H[S], Cochet-Escartin O[S], Ascione F[S], Moitrier S[S], Sarkar S[S], **Yashunsky V**[PD], Bonnet I[PI], Buguin A[PI], Silberzan P[PI]. 2018. *Controlling confinement and topology to study collective cell behaviors*, *Cell Migration.* Methods in Molecular Biology, 1749: 387-399, Humana Press, New York, NY. [Times Cited: 8]

*5. Singh P[PD], Neimand ED[PD], **Yashunsky V**[PI]. 2026. *Active Nematics: Exploring the Interplay between structure and dynamics in cell cultures, Biophysics of Tissue Self-Organization in Morphogenesis: The Role of Dynamics Along the Biointerface,* ISBN: 9780443300486, Elsevier Science, Academic Press (in press). [Times Cited: -]

Conference proceedings

1. **Yashunsky V**[S,CA], Zilberstein A[S], Marciano T[S], Lirtsman V[C], Golosovsky M[C], Davidov D[PI], Aroeti B[PI]. 2010. *Infrared surface plasmon spectroscopy of living cells,* AIP Conference Proceedings, 1:1617-1621. [Times Cited: 8]

2. **Yashunsky V**[S,CA], Zilbershtein A[S], Lirtsman V[C], Marciano T[S], Aroeti B[PI], Golosovsky M[C], Davidov D[PI]. 2012. *Infrared surface plasmon spectroscopy and biosensing,* Proceedings of SPIE, 8234:823419-823411. [Times Cited: 6]

3. Bahari L[T], **Yashunsky V**[PD], Braslavsky I[PI]. 2015. *Microscopic investigation of antifreeze proteins activity at cryogenic temperatures,* Cryobiology, 71: 570-573 [Times Cited: 3]

4. Savchenko I[S], Roth Z[S], **Yashunsky V**[PD], Braslavsky I[PI]. 2018. *Bovine ovary tissue cryopreservation* Cryobiology, 80: 185. [Times Cited: 1]

5. Bahari L[T], Bein A[PD], **Yashunsky V**[PD], Sirotinskaya V[S], Braslavsky I. 2018. *Cryopreservation of adherent mammalian cells on substrate by slow freezing,* Cryobiology, 80: 160. [Times Cited: 4]

6. Guy-Preis S[S], Lyn Y[S], Katz A[S], **Yashunsky V**[PD], Kaner A[S], Hayet H[C], Ullman S[PI], Braslavsky I[PI]. 2019. *Labyrinth ice pattern formation induced by near-infrared irradiation,* Cryobiology, 91: 174

7. Sirotinskaya V[S], Bahari L[T], **Yashunsky V**[PD], Braslavsky I[PI]. 2019. *The effect of ice binding proteins on devitrification of Me2SO solutions,* Cryobiology, 91: 192. [Times Cited: 2]

(d) Refereed articles and refereed letters in scientific journals

1. Golosovsky M[C], Lirtsman V[C], **Yashunsky V**[S], Davidov D[PI], Aroeti B[PI]. 2009. *Midinfrared surface-plasmon resonance: A novel biophysical tool for studying living cells,* Journal of Applied Physics, 105 (10): 1020-1021. [Times Cited: 83, IF: 2.5; Rank in Physics: 80/187; Q2]

2. **Yashunsky V[S]**, Shimron S[S], Lirtsman V[C], Weiss AM[C], Melamed-Book N[C], Golosovsky M[C], Davidov D[PI], Aroeti B[PI], 2009. *Real-time monitoring of transferrin-induced endocytic vesicle formation by mid-infrared surface plasmon resonance,* Biophysical Journal, 97 (4): 1003-1012. [Times Cited: 47, IF: 3.1; Rank in Biophysics: 12/80; Q1]

3. **Yashunsky V**[S,CA], Lirtsman V[C], Golosovsky M[C], Davidov D[PI], Aroeti B[PI]. 2010. *Real-time monitoring of epithelial cell-cell and cell-substrate interactions by infrared surface plasmon spectroscopy,* Biophysical Journal, 99 (12): 4028-4036. [Times Cited: 80, IF: 3.1; Rank in Biophysics: 12/80; Q1]

4. **Yashunsky V**[S,CA], Lirtsman V[C], Zilbershtein A[S], Bein A[S], Schwartz B[PI], Aroeti B[PI], Golosovsky M[C], Davidov D[PI]. 2012. *Surface plasmon-based infrared spectroscopy for cell biosensing,* Journal of Biomedical Optics, 17 (8): 081409. [Times Cited: 25, IF: 2.9; Rank in Optics: 42/125; Q2]

5. **Yashunsky V**[S,CA ¶], Marciano T[S¶], Lirtsman V[C], Golosovsky M[C], Davidov D[PI], Aroeti B[PI]. 2012. *Real-time sensing of cell morphology by infrared waveguide spectroscopy,* PLoS One, 7 (10): e48454. (¶Equal contribution) [Times Cited: 22, IF: 2.6; Rank in Multidisciplinary Sciences: 37/135; Q2]

6. **Yashunsky V**[S,CA¶], Kharilker L[S¶], Zlotkin-Rivkin E[T], Rund D[S], Melamed-Book N[T], Zahavi EE[S], Perlson E[PI], Mercone S[C], Golosovsky M[C], Davidov D[PI], Aroeti B[PI]. 2013. *Real-time sensing of enteropathogenic E. coli-induced effects on epithelial host cell height, cell-substrate interactions, and endocytic processes by infrared surface plasmon spectroscopy,* PLoS One, 8 (10): e78431(¶Equal contribution) [Times Cited: 9, IF: 2.6; Rank in Multidisciplinary Sciences: 37/135; Q2]

7. Guo S[S], Stevens C[S], Vance T[S], Olijve L, Graham L[T], Campbell R[PI], Yazdi S[C], Escobedo C[PI], Bar-Dolev M[PD], **Yashunsky V**[PD], Braslavsky I[PI], Atkins D[PI], Langelaan D[PI], Smith S[PI], Allingham J[PI], Voets I[PI] and Davies P[PI]. 2017. *Structure of a 1.5-MDa adhesin that binds its Antarctic bacterium to diatoms and ice,* Science Advances, 3(8): e1701440. [Times Cited: 119, IF: 12.5; Rank in Multidisciplinary Sciences: 12/135; Q1]

8. Bahari L[T¶], Bein A[PD¶], **Yashunsky V**[PD¶], Braslavsky I[PI]. 2018. *Directional freezing for the cryopreservation of adherent mammalian cells on a substrate,* PLoS One, 13(2): e0192265. (¶Equal contribution) [Times Cited: 57, IF: 2.6; Rank in Multidisciplinary Sciences: 37/135; Q2]

9. Duclos G[S¶], Blanch-Mercader C[PD¶], **Yashunsky V**[PD¶], Salbreux G[PI], Joanny JF[PI], Prost J[PI], Silberzan P[PI]. 2018. *Spontaneous shear flow in confined cellular nematics,* Nature Physics, 14(7): 728-732. (¶Equal contribution) [Times Cited: 283, IF: 39.5; Rank in Physics, Multidisciplinary: 4/114; Q1]

10. Blanch-Mercader C[PD¶], **Yashunsky V**[PD,CA¶], Garcia S[S], Duclos G[S], Giomi L[PI], Silberzan P[PI]. 2018. *Turbulent dynamics of epithelial cell cultures,* Physical Review Letters, 120(20): 208101. (¶Equal contribution) [Times Cited: 227, IF: 9; Rank in Physics, Multidisciplinary: 6/114; Q1]

11. Guy-Preis S[S], Hayet H[C], Katz A[S], **Yashunsky V**[PD], Kaner A[S], Ullman S[PI], Braslavsky I[PI]. 2019. *Labyrinth ice pattern formation induced by near-infrared irradiation,* Science Advances, 5(3): eaav1598. [Times Cited: 4, IF: 12.5; Rank in Multidisciplinary Sciences: 12/135; Q1]

12. Gompper G[PI], Winkler RG[PI], Speck T, Solon A, Nardini C, Peruani F[PI], Löwen H[PI], Golestanian R[PI], Kaupp UB, Alvarez L, Kiørboe T, Lauga E, Poon WCK, DeSimone A, Muiños-Landin S, Fischer A, Söker NA, Cichos F[PI], Kapral R, Gaspard P, Ripoll M, Sagues F[PI], Doostmohammadi A[PI], Yeomans JM[PI], Aranson IS[PI], Bechinger C, Stark H, Hemelrijk CK, Nedelec FJ[PI], Sarkar T[S], Aryaksama T[S], Lacroix M[S], Duclos G[S], **Yashunsky V**[PD], Silberzan P[PI], Arroyo M[PD], Kale S[PI]. 2020. *The 2020 motile active matter roadmap.* J Phys Condens Matter, 8;32(19):193001. [Times Cited: 595, IF: 1.8; Rank in Physics, Condensed Matter: 59/79; Q3]

13. Chasnitsky M[S], **Yashunsky V**[PD,CA], and Braslavsky I[PI]. 2021. *Unidirectional freezing and melting on a translational temperature gradient stage - theory and experiments,* International Journal of Thermal Sciences, 161:106734. [Times Cited: -, IF: 5; Rank in Physics, Rank in Thermodynamics 13/79; Q1]

*14. **Yashunsky V**[PI,CA¶], Pearce D. J. G[PD¶], Blanch-Mercader C[C¶], Ascione F[T], Silberzan P[PI] and Giomi L[PI]. 2022. *Chiral edge currents in confined fibrosarcoma cells,* Physical Review X, 12(4):041017. (¶Equal contribution)[Times Cited: 44, IF: 15.7; Rank in Physics, Multidisciplinary: 3/114; Q1]

My contributions included research design, experimental execution, data analysis, paper writing and revision.

*15. Sarkar T[S], **Yashunsky V**[PI], Brézin L[S], Blanch-Mercader C[C], Aryaksama T[S], Lacroix M[S], Risler T[PI], Joanny JF[PI], Silberzan P[PI], 2023. *Crisscross multilayering of cell sheets,* PNAS Nexus, 12(4):041017. [Times Cited: 29, IF: 3.8; Rank in Multidisciplinary Sciences: 17/135; Q1]

My contributions included research design, experimental execution, data analysis.

*16. **Yashunsky V**[PI,CA], Pearce D. J. G[PD], Ariel G[PI], Be'er A[PI]. 2024. *Topological defects in multi-layered swarming bacteria,* Soft Matter, 20(21), 4237-4245. [Times Cited: 12, IF: 2.8; Rank in Physics, Multidisciplinary: 49/114; Q2]

My contributions included research design and funding, experimental execution, data analysis, paper writing and revision.

17.* Sirotinskaya V[S], Bar-Dolev M[C], **Yashunsky V[PI], Bahari L[C], Braslavsky I[PI]. 2024. *Extended temperature range of the ice-binding protein activity,* Langmuir, 40(14), 7395–7404. [Times Cited: 6, IF: 3.9; Rank in Chemistry, Multidisciplinary: 91/241; Q2]

My contributions included experimental design, establishment of one of the experimental setup and data analysis.

- **Lectures and Presentations at Meetings and Invited Seminars**

(a) Invited plenary lectures at conferences/meetings

1. 2017 - International Physics of Living Systems (iPoLS), IPGG, Paris, France
2. 2018 - Topology in Complex Fluids, Lorentz Center, Leiden University, Netherlands

☝ Since appointment as PI:

3. 2023 - The Sackler Biophysics Prize Symposium, Tel-Aviv University, Israel
4. 2025 - The Israel Society for Theoretical and Applied Mechanics, Israel
5. 2025 - Mechanobiology Conference III, ICISE, Quy Nhon, Vietnam

(b) Presentation of papers at conferences/meetings (oral/poster)

1. 2011 - Israel Society for Biotechnology Engineering Conference (ISBE), Tel-Aviv, Israel
2. 2013 - Israel Society for Biotechnology Engineering Conference (ISBE), Tel-Aviv, Israel
3. 2012 - 1st International Biophotonics meeting in Israel, Tel-Aviv, Israel
4. 2012 - The International Society for Optical Engineering (SPIE), San Francisco, CA, USA (oral)
5. 2014 - Israel Society for Biotechnology Engineering (ISBE), Tel-Aviv, Israel (oral)
6. 2014 - Israel Societies for Experimental Biology (ILANIT 2014) conference, Eilat, Israel (oral)
7. 2015 - 6th International on Delivery of Functionality in Complex Food Systems, Paris, France (oral)
8. 2015 - Active and Smart Matter conference, Syracuse University, NY, USA (oral)
9. 2016 - Labex annual meeting, Institut Curie, Paris, France (oral)

☝ Since appointment as PI:

10. 2023 - BGU vs Cancer, Ben-Gurion University, Israel (oral)
11. 2023 - Physics of Living Systems, EMBO Workshop, Dresden, Germany (poster)
12. 2024 - 57th Annual Meeting of the Israel Society for Microscopy, Israel (poster)
13. 2024 - TAU BioSoft Day #5, Israel (poster)
14. 2025 - TAU BioSoft Day #6, Israel (poster)
15. 2025 - Physics of Collective Cell Dynamics and Morphogenesis, University of Oxford, UK (oral)

(d) Seminar presentations at universities and institution

1. 2012 - The Racah Institute of Physics, Hebrew University, Jerusalem, Israel
2. 2014 - Biosensors and Bioelectronics Centre, IFM, Linköping, Sweden
3. 2015 - Institute of Physics, Academia Sinica, Taipei, Taiwan
4. 2015 - The Racah Institute of Physics, Hebrew University, Jerusalem, Israel
5. 2018 - Physics Department, Tel-Aviv University, Israel

6. 2018 - Biotechnology Engineering Department, Ben-Gurion University, Israel
7. 2018 - Physics Department, Bar-Ilan University, Israel
8. 2018 - Chemical Engineering Department, Ben-Gurion University, Israel
9. 2018 - ESPCI-ENS, École Normale Supérieure, Paris, France
10. 2018 - Biomedical Engineering Department, Ben-Gurion University, Israel
11. 2018 - Physics Faculty, Technion, Israel
12. 2018 - Chemical and Biological Physics, Weizmann Institute, Israel
13. 2019 - Applied Physics Department, Hebrew University, Israel
14. 2019 - Institutes for Desert Research, Ben-Gurion University, Israel
15. 2019 - Chemical Physics, Tel-Aviv University, Israel
16. 2019 - Bio-Soft seminar, Tel-Aviv University, Israel
17. 2019 - Clore seminar, Biological Physics Center at Weizmann Institute, Israel
18. 2020 - Mechanical Engineering Faculty, Technion, Israel
19. 2020 - Environmental Physics Department, Ben-Gurion University, Israel
20. 2020 - Physics Department, Bar-Ilan University, Israel
21. 2020 - School of Mechanical Engineering, Tel-Aviv University, Israel

☝ Since appointment as PI:

22. 2022 - Biomedical Engineering Department, Ben-Gurion University, Israel
23. 2023 - Biological and soft-matter physics seminar, Ben-Gurion University, Israel
24. 2023 - Bio-Soft seminar, Tel-Aviv University, Israel
25. 2023 - Racah Institute of Physics, Hebrew University, Israel
26. 2023 - Leiden Institute of Physics seminar, Leiden University, Netherlands
27. 2023 - Laboratoire Physico-Chimie Curie seminar, Institut Curie, Paris, France
28. 2024 - Racah Institute of Physics, Hebrew University, Israel
29. 2024 - Material Engineering Department, Ben-Gurion University, Israel
30. 2024 - Molecular Biology Department, Ariel University, Israel

- **Patents**

2015 - Lapidot S, Roth Shalev S, Slattegard R, Shoseyov O, Azerraf C, Braslavsky I, **Yashunsky V**. *Porous nanocrystalline cellulose structures*, US10669390B2, Granted at EP CN JP KR AU US CN IL, Commercialized by Melodea [Times Cited: 41*]

2016 - Shoseyov O, Braslavsky I, **Yashunsky V**, Baruch-Sharon S. *3-dimensional printing of food*, US20180192686A1, Granted at AU CN, Commercialized by SavorEat [Times Cited: 33*]

2018 - Braslavsky I, **Yashunsky V**, Bein, A, Bahari L, Schwartz B. *Cryopreservation method of biological specimen*, US20200077642A1, PCT, Pending at EP US, Provisional filed 2017. [Times Cited: 7*]

2025 - Mizrahi N, **Yashunsky V**, Zohar O, Ezra Y. *Micromixer and method for concentration measurement of unknown sample,* Pending at IL US, Application filed by E.F.A. Engineering For All Ltd.

**Google Patents citations*

- **Research Grants**

(a) Competitive Grants listed by VATAT

2023 – 2027: Personal research grant #838/23, Israel Science Foundation (Annual Amount: $85,250; Total Amount: $325,000).

2023 – 2026: New-faculty equipment grant #2044/23, Israel Science Foundation (Total Amount: $325,000)

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- **Present Academic Activities**

  Research in progress

  (b) Submitted for publication

1. Beer A[PI], Neimand ED[PD], Corbett D[PD], Pearce DJ[PI], Ariel G[PI], **Yashunsky V**[PI,CA]. 2025. *Irreversibility and symmetry breaking in the creation and annihilation of defects in active living matter,* arXiv.2508.15622. [Times Cited: 2] Submitted for publication to *Nature Physics*

   My contributions included research design and funding, experimental execution, data analysis, student supervision, paper writing and revision.

2. Adar C[S], Baron Y[S], Rofman B[S], Bar-Dolev M[C], Bahari L[T], **Yashunsky V**[PI], Sirotinskaya V[S], Shoseyov O[PI], Braslavsky I[PI]. 2025. *Biomimetic Engineering of a Fortified Ice Composite with Enhanced Mechanical Properties,* arXiv:2507.22068. Submitted for publication to *Composites Science and Technology*

   My contributions included experimental design, establishment of one of the experimental setup, data analysis and paper writing.

3. Chen S[PD], Gökmen DE[S], Fruchart M[C], Krumbein M[T], Silberzan P[PI], **Yashunsky V**[PI,CA] and Vitelli V[PI,CA]. 2025. *Chirality across scales in tissue dynamics,* arXiv.2506.12276. Submitted for publication to *Nature*

   My contributions included research design and funding, experimental execution, data analysis, student supervision, paper writing and revision.

- **Synopsis of research, including reference to publications and grants in above lists (NOT to exceed three single-spaced pages.)**

Executive Summary

Living matter defies the conventional rule that energy drives disorder: instead, it uses energy to self-organize into functional structures. My research identifies the physical principles that govern how collectives of self-propelled units organize and move. These collective behaviors—seen in tissues, bacterial colonies, animal flocks, and human crowds—follow universal rules that bridge scales and species.

At the Living Matter Lab, we combine advanced experimental tools—microfabrication, robotics, and computer vision—with theoretical frameworks in active matter physics to uncover the laws shaping living tissues.

Since joining Ben-Gurion University in 2022, I have established an experimental research group with state-of-the-art infrastructure for studying cellular organization. My work has appeared in leading journals including *Physical Review X*, *PNAS Nexus*, *Soft Matter*, and *Langmuir*, with additional manuscripts under review at *Nature* and *Nature Physics*. Supported by competitive Israel Science Foundation grants totaling $650,000, my research advances both the fundamental understanding of active matter and its applications in tissue engineering and biomimetic material design.

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Research Overview

My research investigates the physical principles that govern the organization of living matter, focusing on collective movement and self-shaping phenomena in multicellular tissues and bacterial systems. Despite biological diversity, these systems display remarkably similar emergent patterns, suggesting the existence of universal laws of organization. At the Living Matter Lab, we integrate experimental, computational, and theoretical approaches to uncover these principles, with implications for developmental biology, tissue engineering, and synthetic morphogenesis.

The central goal of our work is to understand how local cellular interactions give rise to large-scale structures and collective dynamics. Addressing this question requires high-resolution live microscopy to track cellular self-organization, microfabricated environments to control cell behavior, and computer vision algorithms to quantify multicellular motion and structure.

Over the past three years, I have published several papers based on experiments conducted during my postdoctoral training (*Physical Review X*, 2022; *PNAS Nexus*, 2023) while establishing the core infrastructure of my laboratory at Ben-Gurion University. The lab now includes two robotic live-microscopy imaging setups, a cleanroom for microfabrication, and a fully operational cell-culture facility, all supporting ongoing experimental research by my team.

The establishment of this infrastructure was supported by personal research and new faculty equipment grants from the Israel Science Foundation (ISF), awarded in 2023 and totaling $650,000. My ISF-funded project, *"Control of Multicellular Turbulence with Regulated Topological Defect Unbinding,"* introduces an innovative approach to controlling multicellular dynamics through substrate microstructure. Many cell monolayers behave like self-propelled liquid crystals—cells align with their neighbors while maintaining chaotic, turbulent motion. My research leverages the correlation between structure and motion to manipulate multicellular organization. Specifically, we use topological defects—regions where cell orientation changes abruptly—as organizing centers for collective flows. By patterning the spatial distribution of these defects, we aim to guide cell motion and program tissue organization.

After two years, we have established in-lab protocols for substrate patterning and long-term live microscopy, along with computer vision algorithms capable of tracking cell flows, structural organization, and defect dynamics. In the project's initial phase, we discovered that defect creation and annihilation events spontaneously break mirror symmetry—a previously unpredicted behavior within active nematic theory. This finding, summarized in *"Irreversibility and Symmetry Breaking in the Creation and Annihilation of Defects in Active Living Matter,"* is currently under revision at *Nature Physics* (arXiv:2508.15622).

To expand the biological scope of our research, I am collaborating with **Prof. Avraham Beer** (Zuckerberg Institute for Water Research, BIDR, BGU) to study bacterial swarming. Using analytical tools developed for tissue dynamics, we revealed active nematic hydrodynamics in *Bacillus subtilis* swarms (*Soft Matter*, 2024). In collaboration with **Dr. Nina Kamennaya** (The French Associates Institute for Agriculture and Biotechnology of Drylands, BIDR, BGU), we are developing image-based methods to quantify biomass in field experiments.

International collaborations continue to enrich the theoretical dimension of our research. In partnership with Dr. Dan Pearce (University of Geneva), Prof. Vincenzo Vitelli (University of Chicago), Prof. Luca Giomi (Leiden University), and Dr. Carles Blanch-Mercader (Institut Curie), we integrate experimental observations with theoretical modeling to uncover fundamental physical principles governing living systems. Together with the Vitelli group, we explore how chiral forces within cells drive tissue-scale flows. By comparing physics-informed machine learning models with experimental data across diverse cell types, we have developed a data-calibrated microscopic framework that quantitatively captures proliferation-driven tissue dynamics. These findings are currently under review at *Nature*

(see: “Chirality Across Scales in Tissue Dynamics,” arXiv:2506.12276).

Living Matter Lab Team

Over the past three years, the Living Matter Lab has evolved into a diverse, interdisciplinary team. Key contributors have included:

– Dr. Miriam Krumbein, Lab Manager (Cell Biologist)
– Dr. Dov Neimand, former Postdoctoral Fellow (Mathematician, Computer Vision Lead)
– Dr. Prayas Singh, former Postdoctoral Fellow (Biophysicist, Microenvironment Fabrication Lead)
– Harsh Balaji, M.Sc. Student (Joined 2024)
– Meryam Abo Gama, M.Sc. Student (Joining 2025)

Project students from Biomedical Engineering Department:
– Hallel Hetzroni
– Sharon Sason
– Amit Mordoch
– Roni Katz

Future Research Directions

One of my upcoming research directions arises from a particularly intriguing finding related to nematic defects and their symmetries (arXiv:2508.15622, under revision in *Nature Physics*), which point toward an underlying mechanism of polar propulsion. This previously unreported material phase appears to require self-propulsion, making it unique to active matter. In collaboration with Dr. Dan Pearce (University of Geneva), we are currently preparing an application for an Israeli-Swiss research grant to further investigate this phenomenon. Additionally, a key future objective is to integrate cell proliferation into existing physical theories. To support this effort, my team is developing specialized algorithms and engineered cell lines that enable tracking of cell cycles and divisions, with the goal of incorporating this dynamic information into our physical models.

- **Teaching Statement (NOT to exceed two single-space pages)**

As a physicist working at the interface of biology, physics, and engineering, I view teaching as a form of scientific mentorship—an opportunity to cultivate curiosity, analytical thinking, and a deep respect for the unknown. My goal is to equip students with the conceptual and practical tools to explore complex systems that cross disciplinary boundaries. I believe that students learn most effectively when they are actively engaged in discovery, and when theoretical understanding is integrated with hands-on experimentation and real-world relevance.

Teaching Philosophy and Approach

My teaching philosophy is grounded in three principles: active engagement, conceptual clarity, and accessibility. I design every course to challenge students to think critically, reason quantitatively, and communicate effectively across disciplines. I strive to create classrooms that function as collaborative learning communities, where inquiry is encouraged, mistakes are part of the process, and students gain the confidence to ask ambitious scientific questions.

My courses frequently bridge biology and physics, inviting students to view living systems through the lens of physical principles. In *Mechanics and Dynamics of Living Multicellular Systems*, students explore how collective behaviors and mechanical interactions shape tissue

function and morphogenesis. In *Fluid Mechanics* and *Thermal and Mass Transfer*, I focused on building intuition and problem-solving skills through examples drawn from biological and biomedical contexts—helping students connect classical physics to real-world challenges in health and engineering.

Pedagogical Innovation and Interdisciplinary Teaching

Innovation is central to my teaching. Recognizing that not all students arrive with programming backgrounds, I created *Hands-on Image and Video Analysis without Coding*, a graduate course that democratizes access to quantitative microscopy. Using open-source, code-free tools, students learn to extract quantitative data from complex biological images—skills they immediately apply to their own research.

Similarly, I developed *Data-Based Research with Python*, which introduces data science as an integral part of experimental inquiry. The course emphasizes reproducibility, visualization, and the synergy between computation and experimentation, preparing students for modern interdisciplinary research.

Through the Departmental Seminar, I mentor students in scientific communication, critical reading, and peer feedback—skills essential for academic and professional success. Across all courses, I weave together experimental data, theory, and computation to help students see science as an evolving, interconnected process rather than a collection of facts.

Many of my courses are offered through the Albert Katz International School for Desert Studies, where I teach students from a wide range of cultural and disciplinary backgrounds. This international environment has taught me the value of inclusive pedagogy—of meeting students where they are, recognizing diverse perspectives, and creating equitable pathways to participation in science. By integrating project-based learning, collaborative problem-solving, and open discussions of research ethics and integrity, I aim to foster independence and intellectual honesty in my students.