Curriculum Vitæ

Yoram Burak

Racah Institute of Physics, and Edmond and Lily Safra Center for Brain Sciences
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Education

1998-2004 Tel-Aviv University, Israel
Graduate studies in physics.
Condensed matter, direct course of studies towards a Ph.D. in physics.
Title: "Solvent mediated interactions in electrolytes and related electrostatic systems."
Advisor: Prof. David Andelman.
2004 — **Ph.D.** — *With Distinction*.

1988-1991 Tel-Aviv University, Israel
Undergraduate studies in physics (major) and computer science (minor),
Disciplinary Program for Excellence.
1991 — **B.Sc.** — *Summa cum Laude*.

Professional experience

2024- Professor.
Racah Institute of Physics, and Edmond and Lily Safra Center for Brain Sciences,
Hebrew University of Jerusalem

2019-2024 Associate Professor.
Racah Institute of Physics, and Edmond and Lily Safra Center for Brain Sciences,
Hebrew University of Jerusalem.

2012-2019 Assistant Professor.
Racah Institute of Physics, and Edmond and Lily Safra Center for Brain Sciences,
Hebrew University of Jerusalem.

2007-2011 Swartz Fellow in Theoretical Neuroscience.
Center for Brain Science, Harvard University.

2004-2007 Research Associate.
Kavli Institute for Theoretical Physics, UC Santa Barbara.

1997-2004 Research and Teaching Assistant.
Tel-Aviv University.

1997-1998 Consultant.
Algotec Systems Ltd., Israel.

1991-1997 Military Service.
Israel Defense Forces.

Visiting appointments

2023 - Long-term Visiting Professor.
Centre for Algorithms of the Cortex, Kavli Institute for Systems Neuroscience, Norwegian University of Science and Technology, Trondheim, Norway.

2018 Visiting Scientist.
Simons Institute for the Theory of Computing, UC Berkeley, February-March, 2018.

2017 Visiting Professorship.
Physics Department, École Normale Supérieure, Paris.

Institutional Service

2024 - Head, Teaching Program in Brain Sciences, Edmond and Lily Safra Center for Brain Sciences.

2024 - Member, Executive Committee and Joint (hiring) Committee, Edmond and Lily Safra Center for Brain Sciences.

2018 - 24 Member, Recruitment Committee, Edmond and Lily Safra center for Brain Sciences.

2017-20 Scientific organizer: *Colloquium in Brain Science, Edmond and Lily Safra Center for Brain Science*, Hebrew University.

Organization of scientific meetings (past ten years)

2026 Co-organizer, *Workshop: the Hippocampus Across Disciplines and Species* (tentative title), *Max-Planck Society and the Hebrew University.*

2024 Co-organizer, *KISN Extended Workshop: Theories of neural computation in the era of large-scale recordings,* Kavli Institute for Systems Neuroscience, Trondheim, Norway.

2023 Co-organizer, *The Brain at the Crossroads of Theory and Experiments: a Worldwide Hommage to Carl van Vreeswijk (1962-2022)*, Jerusalem, Israel. Sponsors: CNRS, France National Research Agency, and Edmond and Lily Safra Center for Brain Sciences.

2020 Co-organizer, *Cosyne workshop*: *15 years of grid cells*, Breckenridge CO, USA, March 2020.

2019 Co-organizer, *Cosyne workshop on Neural Representations and Coding under Resource Limitations*, Cascais, Portugal, March 2019.

2017 Session co-organizer and chair, *Computational and Theoretical Neuroscience, Annual meeting of the Israel Society for Neuroscience (ISFN)*, Eilat, December 2017.

2017 Co-organizer, *Brainy Days in Jerusalem 2017,* Jerusalem, June 2017.

2015 Co-organizer, *Brainy Days in Jerusalem: the 5th Anniversary of the Edmond and Lily Safra Center for Brain Sciences,* Jerusalem, June 2015.

Other Professional Service

2004 - Referee for the journals:

Physical Review Letters, Physical Review E, PLoS Computational Biology, PLoS One, Proceedings of the National Academy of Sciences (USA), Nature Communications, Neuron, E-Life, Frontiers in Neural Circuits, Neural Networks, Cell Reports, Nature Neuroscience, Current Opinion in Neurobiology, Scientific Reports, Hippocampus, Science Advances, Neural Computation, Journal of Vision, Macromolecules, Langmuir, The European Physical Journal E, Journal of Physical Chemistry, Journal of Statistical Mechanics: Theory and Experiment, Cell Reports, PRX Life.

2013 - Research proposal reviewer for:

ERC Consolidator Grants, The European Commission.
ERC Advanced Grants, The European Commission.
FET flagships program, The European Commission.
Individual Research Grants, Israel Science Foundation.
Long-term Research Grants, Rappaport Institute, Technion Israel Institute of Technology.

2019-23 Member, Program Committee, *Computational and Systems Neuroscience (Cosyne),* Montreal, Canada, February 2023; Lisbon, Portugal, February 2022; Online meeting, February 2021; Denver CO, ISA, February 2020.

2015- Associate Editor, *Frontiers in Computational Neuroscience*.

Prizes and honors

2020 - Incumbent of the *William N. Skirball Chair in Neurophysics*, Hebrew University of Jerusalem.

2007-2010 Swartz Fellowship in Theoretical Neuroscience.

2004 Ph.D. – awarded with distinction.

2003 Marejn Scholarship for Ph.D. Studies.

2001 The Wolf Foundation Award for Ph.D. Students.

2000 Award for excellence in Teaching, Tel-Aviv University.

1991 B.Sc. – *Summa cum Laude*.

1989,90,91 Dean Distinction, Tel-Aviv University.

Competitive research grants (past 10 years)

2024-9 **Individual Research Grant**, Israel Science Foundation. *Random Neural Codes for Space*.

2020-6 **Synergy Grant**, European Research Council. Co-PIs: Prof. Yoram Burak and Prof. Edvard Moser (NTNU, Norway). *KiloNeurons: Population Codes for Space in the Mammalian Cortex*.

2018-23 **Individual Research Grant**, Israel Science Foundation. *Mechanisms of grid cell coding in the entorhinal cortex: computational and theoretical approaches*.

2018-21 **Regular Program Research Grant**, German-Israeli Foundation for Scientific Research and Development. Co-PIs: Prof. Yoram Burak, Prof. Dori Derdikman (Technion), and Prof. Hannah Monyer (University of Heidelberg). *Understanding the function of long-range inhibitory connections in the hippocampal formation*.

2013-6 **Individual Research Grant**, Israel Science Foundation. *Invariant perception under dynamic transformations: Vision amid fixational eye motion*.

Invited teaching in international courses and schools

2025 **Mathematical Methods in Computational Neuroscience**, Fred Kavli Knowledge Center, Eresfjord, Norway, July 2025.
Lecture series: *Continuous attractor dynamics and exponential neural codes.*

2020 **EU Innovative Training Network: hippocampal-entorhinal training event**, Rechovot, Israel, February 2020.
Lecture: *Attractor dynamics in the hippocampal formation – theoretical perspectives.*

2019 **Computational Neuroscience Summer School**, Tsinghua University, China, August 2019.
Lecture series: *Theoretical perspectives on grid cell coding and dynamics*.

2018 **Neurobridges 2018 Computational Neuroscience Summer School**, Cluny, France, October 2018.
Lecture series: *Bumps, grids, and spatial coding*

2017 **Neurobridges 2017 Computational Neuroscience Summer School**, Cluny, France, September 2017.
Lecture series: *Bumps, grids, and spatial coding*.

2015 **aCNS Summer School:** Theoretical Perspectives on Neural Assemblies, Göttingen, Germany, September 2015.
Lecture series: *Short term memory and plasticity in stochastic neural networks*.

Courses taught at the Hebrew University

Neural Dynamics and Coding. Ph.D. program in computational neuroscience.

Computational and Theoretical Neuroscience. Ph.D. program in computational neuroscience.

Information and Coding in the Brain. Ph.D. program in computational neuroscience.

Electricity and Magnetism. B.Sc. in physics.

Biophysics. B.Sc. and M.Sc. in physics.

Statistical Physics of Soft Condensed Matter. M.Sc. in physics.

Electricity, Waves, and Optics. B.Sc. in biomedical sciences.

Selective Topics in Neural Computation. Ph.D. program in computational neuroscience.

Supervision of students and postdocs

Current*:* Postdoctoral research associate: Ivan Davidovich.
Ph.D. candidates: Georg Chechelinzki, Rachel Cohen, Nischal Mainali, Yishai Gronich, Edward Tananyan

Former*:*

Ph.D. Nadav Ben-Shushan (2023, physics), Haggai Agmon (2022, computational neuroscience), Noga Mosheiff (2020, physics), Neta Ravid Tannenbaum (2019, computational neuroscience), Nimrod Shaham (2019, physics).

M.Sc. Tal Brucker (2024, physics). Edward Tananyan (2022, physics), Ishay Mor (2014, physics).

B.Sc. Supervised 15 undergraduate research projects, among them eight in the Honors Program of the Faculty of Sciences and the School of Computer Science and Engineering.

Invited talks (past 10 years)

2025 **The Brain Conference: Frontiers of Theoretical Neuroscience**, FENS and Lundbeck Foundation, Rungsted Kyst, Denmark, June 2024.
New insights on the synaptic organization underlying neural coding and dynamics.

2024 **KISN Extended Workshop: Theories of neural computation in the era of large-scale recordings**, Tronheim, Norway, July 2024.
Randomness and regularities in hippocampal circuits.

2023 **Bordeaux Neurocampus Brain Conference**, Bordeaux, France, September 2023.
Coordination between attractor networks in the hippocamapus and the entorhinal cortex.

Topics on Neuroscience, Collective Migration and Parameter Estimation*,* Oxford University, Oxford, UK, July 2023.
Stochastic drift in continuous attractor networks.

Symposium: Mathematical Properties of the Hippocampal Code, Kavli Institute for Systems Neuroscience, Trondheim, Norway, July 2023.
Mathematical laws governing the structure of the hippocampal neural code.

Cosyne Workshop on biological attractor networks, Mont-Tremblant, Canada, March 2023.
Is it possible to embed multiple continuous attractors in a single recurrent network?

Physics Modeling of Thought, Max Planck Institute for the History of Science, Berlin, Germany, January 2023.
Population dynamics residing on low dimensional manifolds.

2022 **A decade's Perspective on Integrated Neuroscience**, 10th anniversary of the Institut de Neurosciences de la Timone, Mareille, September 2022.
Stochastic dynamics of neural representations residing in low dimensional manifolds: from motor control to spatial cognition

2020 **World-Wide Theoretical Neuroscience Seminar Series**, CNRS, France. Online talk, December 2020.
Linking neural representations of space by multiple attractor networks in the entorhinal cortex and the hippocampus.

Zoom to the Brain: Online lecture series for the general public, Edmond and Lily Safra Center for Brain Sciences, Jerusalem, Israel.
What is the connection between neural networks, magnets, and spatial memory? (lecture given in Hebrew).

Computational and Systems Neuroscience (COSYNE) Workshop: 15 years of grid cells, Breckenridge CO, USA, March 2020.
Functional and emergent consequences of synaptic coupling between grid cells and place cells.

2019 **Spring Hippocampal Research Conference**, Taormina, Italy, June 2019.
Functional consequences of dynamic coupling between place cells and grid cells.

2018 **Annual meeting of the Israel Physical Society**, Jerusalem, Israel, December 2018.
Inference amid dynamic uncertainty may explain the contrast paradox in the vernier hyperacuity task.
The dynamic organism: from molecules to cognition. HUJI-UCL joint meeting, Hebrew University, Jerusalem, Israel, November 2018.
Velocity coupling of grid cell modules in the entorhinal cortex.

Interdisciplinary Institute for Neuroscience and Cognition: INC Day 2018, Paris Descartes University, Paris, France, October 2018.
Collective plasticity dynamics in recurrent neural networks.

Dynamics of learning and computations in neuronal circuits: Advanced Methods in Theoretical Neuroscience Workshop, Göttingen, Germany, June 2018.
Continuous parameter working memory in stochastic and chaotic neural networks.

Inter-academy meeting of the German Academy of Science (Leopoldina) and the Israel Academy of Sciences and Humanities, Berlin, Germany, May 2018.
Principles of neural coding in the grid cell system: implications for dynamics and organization.

Computational and Systems Neuroscience (COSYNE) Workshop: The multiple facets of activity-dependent synaptic plasticity: shaping circuits, generating representations, modulating behavior. Breckenridge, Colorado, USA, March 2018.
How high-order synaptic interactions shape the global structure of recurrent neural circuits.

2017 **Raymond and Beverly International Sackler Prize in Biophysics:**
The Sackler Biophysics Symposium on Physical Principles in Biological Systems, Tel-Aviv, Israel, December 2017.
Encoding of an animal's trajectory by grid cells in the entorhinal cortex.

Spring Hippocampal Research Conference, Taormina, Italy, June 2017.
Grid cell coding and decoding of dynamic rat trajectories.

2016 **Finding the Right Balance: on the interplay of excitation and inhibition in neural dynamics**, Mitzpe Ramon, Israel, December 2016.
Storage of a continuous variable in a balanced neural network: Is chaotic irregular activity equivalent to intrinsic neural noise?

BioSoft Frontiers: Physics of Soft and Biological Matter, Rechovot and Tel-Aviv, Israel, September 2016.
Encoding of an animal's trajectory by grid cells in the entorhinal cortex.

6th French-Israel Neuroscience Conference, Marseille, France, July 2016.
What principle may determine the allocation of grid cells to modules in the entorhinal cortex?

Departmental seminars and colloquia (past 10 years)

2026 **Tel-Aviv University**, Medicine and Life Sciences joint seminar, Tel-Aviv, Israel. *TBD*.

2025 **Weizmann Institute of Science**, Department of Neurobiology, Rehovot, Israel. *TBD*.
Janelia Reesarh Campus, Ashburn VA, USA
Mathematical regularities of irregular neural codes for space.

Ben Gurion University, Zelman Center for Cognition and Brain Sciences, Beer Sheva, Israel.
Mathematical regularities of irregular neural codes for space.

Bernstein Center for Computational Neuroscience, Berlin, Germany.
Mathematical regularities of irregular neural codes for space.

Max Planck Institute for Biological Cybernetics, Tübingen, Germany.
Mathematical regularities of irregular neural codes for space.

Massachusetts Institute of Technology, Cambridge MA, USA.
Mathematical regularities of irregular neural codes for space.

Harvard University, Center for Brain Science, Cambridge MA, USA.
Mathematical regularities of irregular neural codes for space.

2024 **New York University**, Neuroscience Institute, New-York NY, USA.
Mathematical regularities of irregular neural codes for space.

2023 **Technion Israel Institute of Technology**, Department of Neuroscience, Haifa, Israel.
Stochastic dynamics of neural representations residing in low dimensional manifolds: from motor control to spatial cognition.

2022 **Bernstein Center for Computational Neuroscience**, Munich, Germany.
Two explorations into the dynamic representation of continuous variables in the brain.

2021 **Harvard University**, School of Engineering and Applied Science, Cambridge MA, USA.
Dynamics of spatial representation by attractor networks in the entorhinal cortex.

Norwegian University of Science and Technology, Kavli Institute for Systems Neuroscience, Trondheim, Norway.
Two explorations into the dynamic representation of continuous variables in the brain.

Weizmann Institute of Science, Department of Neurobiology, Rehovot, Israel.
New insights on continuous attractor neural networks.

2020 **Ben Gurion University**, Biological and Soft Matter Physics Seminar, Beer Sheva, Israel.
Neural representation of position by grid cells in the mammalian brain.

Friedrich Miescher Institute for Biomedical and University of Basel, Computational Neuroscience Initiative, Basel, Switzerland.
Linking neural representations of space by grid cells and place cells in the hippocampal formation (seminar)
Spatial computation as a window into principles of neural network dynamics, computation, and coding (workshop).

2019 **Hebrew University**, Department of Medical Neurobiology, Jerusalem, Israel.
Linking neural representations of space by grid cells and place cells in the hippocampal formation: computational principles and functional consequences.

Tel-Aviv University, Electrical Engineering seminar, Tel Aviv, Israel.
Spatial coding and computation by grid cells in the mammalian brain.

NTNU, Kavli Institute for Systems Neuroscience seminar, Trondheim, Norway.
Coupling between attractors in the hippocampal formation: computational principles and functional consequences.

Tel-Aviv University, Physics colloquium, Tel Aviv, Israel.
Neural representation of position by grid cells in the mammalian brain.

2018 **Bar Ilan University,** Applied mathematics semin ar, Ramat Gan, Israel.
Grid cells in the entorhinal cortex: spatial encoding and representation in the mammalian brain.

UC Berkeley, Simons Institute for the Theory of Computing (Brain and Computation Seminar series), Berkeley, California, USA.
Stochasticity, coding, and dynamics in continuous-parameter working memory.

2017 **École Normale Supérieure, Paris**, Group for Neural Theory, Laboratoire de Neurosciences Cognitives, Paris, France.
Grid cell spikes as a neural code for a moving target: why are grid cells with large spacing relatively scarce?

2016 **Weizmann Institute of Science**, Department of Neurobiology, Rehovot, Israel.
Shaping neural circuits by high order synaptic interactions.

Yoram Burak: Publications

1. N. Mainali, R. Azeredo da Silveira, R., **Y. Burak**, Universal statistics of hippocampal place fields across species and dimensionalities.
Neuron, 113, 1110-1120.e3 (2025).

2. S. B. Malerba, **Y. Burak**, R. Azeredo da Silveira, Random Compressed Coding with Neurons.
Cell Reports 44, 115412 (2025).

3. H. Agmon, **Y. Burak**, Simultaneous embedding of multiple attractor manifolds in a recurrent neural network using constrained gradient optimization.
Neural Systems and Information Processing (2023).

4. T. Waaga, H. Agmon, V.A. Normand, A. Nagelhus, R.J. Gardner, M.-B. Moser, E.I. Moser, **Y. Burak**, Grid-cell modules remain coordinated when neural activity is dissociated from external sensory cues.
Neuron 110, 1843-1856.e6 (2022).

5. N. Ben-Shushan, N. Shaham, M. Joshua, **Y. Burak**, Fixational drift is driven by diffusive dynamics in central neural circuitry.
Nature Communications **13,** 1697 (2022).

6. R.J. Gardner, E. Hermansen, M. Pachitariu, **Y. Burak**, N.A. Baas, B.A. Dunn, M.-B. Moser, and E.I. Moser, Toroidal topology of population activity in grid cells.
Nature, https://doi.org/10.1038/s41586-021-04268-7 (2022).

7. G. Ginosar, J. Aljadeff, **Y. Burak**, H. Sompolinsky, L. Las, and N. Ulanovsky, Locally ordered representation of 3D space in the entorhinal cortex.
Nature 596, 404-409 (2021).

8. H. Agmon, **Y. Burak**, A theory of joint attractor dynamics in the hippocampus and the entorhinal cortex accounts for artificial remapping and grid cell field-to-field variability.
eLife 9, e56894 (2020).

9. N. Mosheiff, **Y. Burak**, Velocity coupling of grid cell modules enables stable embedding of a low dimensional variable in a high dimensional neural attractor.
eLife 8, e48494 (2019).

10. A. Rotem, T. Gefen, S. Oviedo-Casado, J. Prior, S. Schmitt, **Y. Burak**, L. McGuiness, F. Jelezko, A. Retzker,
Limits on spectral resolution measurements by quantum probes.
Physical Review Letters **122**, 060503 (2019).

11. N. Ravid Tannenbaum and **Y. Burak**,
Theory of nonstationary Hawkes processes.
Physical Review E **96**, 062314 (2017). *Editor's Suggestion, December 2017.*

12. N. Mosheiff, Haggai Agmon, Avraham Moriel, and **Y. Burak**,
A theory for efficient coding of a dynamic trajectory predicts non-uniform allocation of grid cells to modules in the entorhinal cortex.
PLoS Computational Biology **13**, e1005597 (2017)

13. N. Shaham and **Y. Burak**,
Slow diffusive dynamics in a chaotic balanced neural network.
PLoS Computational Biology **13**, e1005505 (2017).

14. N. Ravid Tannenbaum and **Y. Burak**,
Shaping neural circuits by high order synaptic interactions.
PLoS Computational Biology **12**, e1005056 (2016).

15. **Y. Burak**.
Spatial coding and attractor dynamics of grid cells in the entorhinal cortex.
Current Opinion in Neurobiology **25**, 169 (2014). *F1000 Prime recommended*.

16. A. Farhan, T.M. Otchy, C. Pehlevan, A.L. Fantana, **Y. Burak**, and B.P. Ölveczky.
The basal ganglia is necessary for leaning spectral, but not temporal features of birdsong.
Neuron **80**, 494 (2013).

17. **Y. Burak** and I.R. Fiete.
Fundamental limits on persistent activity in networks of noisy neurons.
Proceedings of the National Academy of Sciences, USA **109**, 17645 (2012).

18. **Y. Burak**, U. Rokni, M. Meister, and H. Sompolinsky,
A Bayesian model of dynamical images stabilization in the visual system.
Proceedings of the National Academy of Sciences, USA **107** *cover*, 17645 (2010).

19. **Y. Burak**, S. Lewallen, and H. Sompolinsky.
Stimulus-dependent correlations in threshold-crossing spiking neurons.
Neural Computation **21**, 2269 (2009).

20. **Y. Burak** and I.R. Fiete.
Accurate path integration in continuous attractor network models of grid cells.
PLoS Computational Biology **5**, e1000291 (2009).

21. **Y. Burak** and B.I. Shraiman,
Order and stochastic dynamics in Drosophila planar cell polarity.
PLoS Computational Biology **5**, e1000628 (2009).

22. P.E. Welinder, **Y. Burak**, and I.R. Fiete.
Grid cells: The position code, neural network models of activity, and the problem of learning.
Hippocampus **18**, 1283 (2008).

23. I.R. Fiete, **Y. Burak**, and T. Brookings,
What grid cells convey about rat position.
Journal of Neuroscience **28**, 6856 (2008).
Related to: **Y. Burak**, T. Brookings, and I.R. Fiete,
Triangular lattice neurons may encode rat position using an advanced numeral system.
arxiv.org, q-bio.NC/0606005.

24. M. Kanduč, M. Trulsson, A. Naji, **Y. Burak**, J. Forsman, and R. Podgornik,
Weak- and strong- coupling electrostatic interactions between asymmetrically charged planar surfaces.
Physical Review E **78**, 061105 (2008)

25. M. Thattai, **Y. Burak**, and B.I Shraiman
The origins of specificity in polyketide synthase protein interactions.
PLoS Computational Biology **3**, 1827 (2007)

26. D. Ben-Yaakov, **Y. Burak**, D. Andelman, and S. A. Safran,
Electrostatic interactions of asymmetrically charged membranes.
Europhysics Letters **79**, 48002 (2007).

27. **Y. Burak** and I.R. Fiete,
Do we understand the emergent dynamics of grid cell activity?
Journal of Neuroscience **26**, 9352 (2006).

28. **Y. Burak** and H. Orland,
Manning condensation in two dimensions.
Physical Review E (Rapid Communications) **73**, 010501 (2006).

29. **Y. Burak**, G. Ariel, and D. Andelman,
Competition between condensation of monovalent and multivalent ions in DNA aggregation.
Current Opinion in Colloid and Interface Science **9**, 53 (2004).

30. **Y. Burak**, H. Orland, and D. Andelman
Test-charge theory for the electric double layer.
Physical Review E **70**, 016102 (2004).

31. **Y. Burak** and R.R. Netz,
Charge regulation of interacting weak polyelectrolytes.
Journal of Physical Chemistry B **108**, 4840 (2003).

32. **Y. Burak**, G. Ariel, and D. Andelman,
Onset of DNA aggregation in presence of monovalent and multivalent counterions.
Biophysical Journal **85**, 2100 (2003).

33. **Y. Burak** and D. Andelman,
Discrete Aqueous Solvent Effects and Possible Attractive Forces.
Journal of Chemical Physics **114**, 3271 (2001).

34. **Y. Burak** and D. Andelman,
Hydration Interactions: Aqueous Solvent Effects in Electric Double Layers,
Physical Review E **62**, 5296 (2000).