# Mikail Khona

## Personal Info

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## Current Experience

May 2023 - September 2023 **Massachusetts Institute of Technology**, MA
*Research Scientist Intern*
Supervisor: Hidenori Tanaka
Studying causal reasoning in transformer-based large language models (LLMs). Developing mechanistic interpretability technique to reverse engineer transformers.

## Education and Research

2018 - 2024 (expected) **Massachusetts Institute of Technology**, MA
*PhD candidate in Physics*
Advisor: Ila Fiete, Secondary: Mehran Kardar
Graduate research in theoretical and computational systems neuroscience and deep learning.

Summer 2021 **Methods in Computational Neuroscience (MCN) Summer School**, Marine Biological Laboratory, Woods Hole MA

2014 - 2018 **Indian Institute of Technology (IIT), Bombay**, India
*Bachelor of Technology in Engineering*
Major: Engineering Physics (+honours in Physics)
minor: Mathematics

High School **The Bombay Scottish School**, Mahim, India

## Publications

- Khona, Mikail, Fiete, Ila. **Attractor and Integrator Networks in Neuroscience**. Nature Reviews Neuroscience. *[link]*
- Schaeffer, Rylan, Khona, Mikail, Meshulam, Leenoy, Fiete, Ila. **No Free Lunch from Deep Learning in Neuroscience: A Case Study through Models of the Entorhinal-Hippocampal Circuit**. NeurIPS. 2022. *[link]*
- Schaeffer, Rylan, Khona, Mikail, Fiete, Ila. **Reverse-engineering recurrent neural network solutions to a hierarchical inference task for mice**. NeurIPS. 2020. *[link]*
- Khona, Mikail*, Chandra, Sarthak*, Fiete, Ila. **Spontaneous emergence of topologically robust grid cell modules: A multiscale instability theory**. Submitted. *[link]*
- Duan, Sunny*, Khona, Mikail*, Bertagnoli, Adrian*, Fiete, Ila. **See and Draw: Generation of complex compositional movements from modular and geometric RNN representations**. Submitted. *link*
- Khona, Mikail*, Chandra, Sarthak*, Ma, Joy, Fiete, Ila. **Winning the lottery with neurobiology: faster learning on many cognitive tasks with neural connectivity constraints**. Neural Computation (2023). *[link]*
- G. Madirolas, A. Al-Asmar, L. Gaouar, L. Marie-Louise, A. Garza-Enriquez, M. Khona, C. Ratzke, J. Gore, A. Pérez-Escudero. **A taste for numbers: *Caenorhabditis elegans.* foraging follows a low-dimensional rule of thumb**. Nature communications biology (2023). *[link]*
- Schaeffer, Rylan*, Bordelon Blake*, Khona, Mikail*, Pan, Weiwei, Fiete, Ila. **Efficient Online Inference for Nonparametric Latent Variable Time Series**. UAI. 2021. *[link]*
- Rylan Schaeffer, Khona, Mikail, Zachary Robertson, Akhilan Boopathy, Kateryna Pistunova, Jason W. Rocks, Ila Rani Fiete, Oluwasanmi Koyejo. **Double Descent Demystified: Identifying, Interpreting**

**Ablating the Sources of a Deep Learning Puzzle**. *[arXiv link]*

### Publications in prep

- Mikail Khona*, Sarthak Chandra*, Talia Konkle, Ila Fiete. **Self-organized emergence of modularity, hierarchy, and topography from competitive synaptic growth in a developmental model of the visual pathway**
- Mikail Khona*, Rylan Schaeffer*, Ila Fiete. **Self-Supervised Learning of Representations for Space Generates Multi-Modular Grid Cells**

## Awards / Achievements

2022 - 2023 K. Lisa Yang ICoN Graduate Student Fellow ($100k)

2021 - 2022 MathWorks Science Fellowship (one of 20 across the School of Science at MIT) ($100k)

2018 - 2019 Seigel Fellowship, Department of Physics ($100k)

2016 - 2018 Institute Academic Award for the highest GPA among undergraduates in the Physics department at IIT Bombay (9.95/10)

2016 - 2017 DAAD-WISE scholarship for an undergraduate project in Germany in 2017 [declined].

2014 An All India Rank of 562/1.4M (Percentile 99.96) in the **IIT** - **JEE** 2014.

2014 INSPIRE Scholarship for Higher Education - A scholarship awarded by the Government of India to meritorious students in high school who plan to pursue a degree in the natural sciences.

## Peer-Review Conference and Workshop Posters

- Khona, Mikail, Schaeffer, Rylan, and Fiete, Ila. **Self-Supervised Learning of Efficient Algebraic Codes generates Grid Cells,** NeurIPS Self-Supervised Learning: Theory and Practice Workshop, 2022.
- Khona, Mikail, Chandra, Sarthak, Konkle, Talia and Fiete, Ila. **Modelling the development of the primate visual cortical hierarchy**. Cosyne Abstracts 2022, Lisbon, Portugal.
- **Khona, Mikail**, Chandra, Sarthak, Acosta, Francisco, Fiete, Ila **The emergence of discrete grid cell modules from smooth gradients in the brain**. Cosyne Abstracts 2021.
- Khona, Mikail, Xu, Qianli and Fiete, Ila. **A model of oscillatory gating of information flow between neural circuits as a function of local recurrence**. Cosyne Abstracts 2020.
- Schaeffer, Rylan, Khona, Mikail, and Fiete, Ila. **No Free Lunch from Deep Learning in Neuroscience: A Case Study through Models of the Entorhinal-Hippocampal Circuit,** ICML AI4Science Workshop. 2022.

## Invited Talks

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| September 2022 | brAIn seminar: Carnegie Mellon University |
| August 2022 | Harvard Vision lab |

## Academic Services

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| 2022 | Reviewer for NeurReps: Symmetry and Geometry in Neural Representations, Workshop, NeurIPS 2022, Reviewer for NeurIPS 2022 Workshop: Self-Supervised Learning - Theory and Practice |

## Teaching and Mentoring

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| Fall 2019 | 8.01L: Physics I |
| Spring 2021 | 8.592: Introduction to Biological Physics |
| Fall 2021 | Physics Mentorship program, Physics Department, MIT |

## Technical Skills

- Deep learning with Python: Pytorch
- Scientific computing with Python (NumPy, SciPy) and MATLAB.
- Scientific illustration with Adobe Illustrator.