Asit Pal

Computational Neuroscience & NeuroAI Researcher · Ph.D. Candidate, New York University

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SUMMARY

Ph.D. researcher (NYU, expected Spring 2027) building theory-driven, neuroscience-inspired models of neural circuits and the deep learning tools to analyze them. First-author eLife paper deriving a hierarchical recurrent circuit theory that unifies divisive normalization, gamma-band coherence and inter-areal communication subspaces. Hands-on with stochastic dynamical systems, recurrent neural networks, spectral and information-theoretic analysis of time series, and generative models (autoencoders, VAEs, GANs), implemented end to end in Python and PyTorch. Seeking research scientist roles in NeuroAI, brain-computer interfaces and neural signal processing.

RESEARCH EXPERIENCE

Graduate Research Associate, New York University · Martiniani Lab — Aug 2021 – Present

Hierarchical recurrent circuit theory of normalization and inter-areal communication (eLife 2026, first author)

- Built hierarchical stochastic differential equation models of recurrently coupled cortical areas (e.g., V1–V4) with feedforward and feedback connections.
- Derived the conditions under which feedback produces dynamical divisive normalization, and analyzed network stability and feedback-driven bifurcations.
- Derived power spectra and inter-areal coherence analytically, showing distinct frequency channels for feedforward vs. feedback signals that match empirical recordings.
- Developed an analytical model of communication subspaces showing how feedback controls inter-areal communication and subspace dimensionality, a framework for dynamic control of functional connectivity.

Molecular traces of long-term memory (Advanced Science 2026, co-author)

- Co-developed C-SCoRe, a correlation-based co-clustering method that uses mutual information and KL divergence to capture weak linear and non-linear gene–behavior relationships in hippocampal transcriptomic data from mice.
- Identified gene-network changes predictive of memory persistence that standard differential-expression analysis misses.

Research Associate, Tata Institute of Fundamental Research (TIFR) · Prof. Jagannath Mondal — Aug 2020 – Aug 2021

Learning slow collective variables with deep learning

- Used time-lagged autoencoders to extract slow modes governing protein–ligand binding from high-dimensional simulation trajectories.
- Trained deep generative models to learn Boltzmann distributions from trajectories and generate new samples.

Master's Thesis Researcher, IIT Kanpur · Prof. Nisanth N. Nair — Dec 2019 – Jul 2020

Mean-force temperature-accelerated sliced sampling (J. Comput. Chem. 2021, first author)

- Designed TASS-MF, an enhanced-sampling algorithm that removes the need for costly WHAM reweighting when reconstructing high-dimensional free-energy landscapes, and quantified its statistical error.

SKILLS

Modeling & theory	Recurrent neural networks, stochastic differential equations, dynamical systems & stability/bifurcation analysis, mean-field and neural-field models, divisive normalization (ORGaNICs)
Signal & data analysis	Power spectra & coherence, communication subspaces / dimensionality reduction, mutual information & KL-divergence methods, time-series analysis, transcriptomic data analysis
Machine learning	PyTorch, deep generative models (autoencoders, time-lagged AEs, VAEs, GANs), scikit-learn, end-to-end training & evaluation pipelines
Programming & tools	Python (NumPy, Pandas, Matplotlib), SQL, Fortran, shell; MATLAB, Mathematica; Git, VS Code, Cursor

EDUCATION

New York University, New York, USA — Aug 2021 – Spring 2027 (expected)

Ph.D. in Chemistry (research: computational neuroscience), GPA 3.8/4.0

Advisor: Prof. Stefano Martiniani; collaborator Prof. David J. Heeger. Henry M. MacCracken Doctoral Fellow.

Indian Institute of Technology Kanpur, Kanpur, India 2018 – 2020
M.S. in Chemistry, GPA 9.0/10.0

University of Calcutta, Kolkata, India 2015 – 2018
B.S. in Chemistry

PUBLICATIONS

1. **A. Pal**, S. Rawat, D. J. Heeger, S. Martiniani. Hierarchical neural circuit theory of normalization and inter-areal communication. *eLife* (Reviewed Preprint), 2026. doi:10.7554/eLife.111297
2. J. Han, A. Grau-Perales, R. M. Harris, E. Lesburguères, H.-Y. Kao, **A. Pal**, J. M. Alarcon, T. C. Sacktor, S. Martiniani, H. A. Hofmann, A. A. Fenton. Persistently increased expression of PKMζ and unbiased gene expression profiles identify hippocampal molecular traces of a long-term active place avoidance memory and "shadow" proteins. *Advanced Science*, 2026.
3. **A. Pal**, S. Pal, S. Verma, M. Shiga, N. N. Nair. Mean force based temperature accelerated sliced sampling: efficient reconstruction of high dimensional free energy landscapes. *J. Comput. Chem.* 42, 2021. doi:10.1002/jcc.26727

SELECTED TALKS & POSTERS

- **COSYNE, Lisbon** (2026). Poster: Hierarchical neural circuit theory of normalization and inter-area communication
- **APS March Meeting, Minneapolis** (2024). Contributed talk: Multi-stage cortical recurrent circuit implementing normalization
- **Cognitive Computational Neuroscience (CCN), Boston** (2024). Poster: Multi-stage cortical recurrent circuit implementing normalization
- **From Neuroscience to Artificially Intelligent Systems (NAISys), Cold Spring Harbor** (2024). Poster
- **Minds, Brains and Machines, NYU Center for Data Science** (2024). Poster: A recurrent neural circuit theory of normalization and inter-area communication
- **Mathematics of Neuroscience and AI, Rhodes** (2023). Poster: Feedback-dependent communication subspace in a multistage recurrent circuit model

HONORS

2024 Selected for the Analytical Connectionism Summer School, Flatiron Institute

2024 Dean's Conference Fund, NYU GSAS

2021 Henry M. MacCracken Doctoral Fellowship, NYU GSAS

2018 CSIR-JRF All India Rank 61; IIT JAM All India Rank 43

2015 INSPIRE Fellowship (top 1% of state board), Dept. of Science & Technology, India