

# Subhaneil Lahiri

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## Education

*Harvard University, Cambridge MA:* Ph.D., Physics, June 2009.

Ph.D. Thesis: Black holes from fluid mechanics. Advisor: Shiraz Minwalla.

Research in string theory: studying black holes via a correspondence with the physics of fluids.

*Oxford University, Oxford, UK:* M.Phys., 1st class honors, Merton college, 2003.

M.Phys. Project: Monte Carlo simulations of galactic heating.

## Skills

Mathematical modeling · Data analysis · Data visualization · Numerical Optimization · Scientific computation · Python · NumPy · SciPy · Matplotlib · Git · C/C++ · Matlab · LaTeX · Mathematica

## Current occupation

*Research Scientist:* Ganguli Lab (Stanford University, Stanford CA, January 2016 – present).

Research in theoretical and computational Neuroscience: studying mathematical models of brain function and methods for the analysis of brain data.

- Projects involving: optimizing stochastic processes, reinforcement learning, deep neural networks, recurrent neural networks, Gaussian processes, random projections, differential geometry, large deviation theory.
- Wrote Python packages for most projects, including optimization, simulation, data visualization.

## Experience

*Postdoctoral Fellow* in the Ganguli Lab (Stanford University, Stanford CA, Mar. 2012 – Jan. 2016).

Research in Theoretical and Computational Neuroscience: studying mathematical models of brain function and methods for the analysis of brain data.

- Projects involving: optimizing stochastic processes, hidden markov models, random matrix theory, information geometry.
- Wrote Python/Matlab packages for most projects, including optimization, simulation, data visualization.

*Postdoctoral Research Fellow* in the Samuel Lab (Harvard University, Cambridge MA, Jul. 2009 – Aug. 2011).

Research in Behavioral Neuroscience: performing quantitative analysis of behavioral data from the *Drosophila* larva and *C. elegans*.

- Designed a method to measure and visualize muscle use during navigation using image analysis in Matlab.

## Selected publications

EM Trautmann, SD Stavisky, S Lahiri, KC Ames, MT Kaufman, DJ O'Shea, S Vyas, X Sun, SI Ryu, S Ganguli, and KV Shenoy, "Accurate Estimation of Neural Population Dynamics without Spike Sorting," *Neuron* **103.2**, 292–308.e4, (June 2019). [bioRxiv:229252](https://doi.org/10.1016/j.neuron.2019.05.022).

We show that the onerous step of spike sorting in neural data analysis is often unnecessary by reanalyzing data and using the theory of random projections.

B Poole, S Lahiri, M Raghu, J Sohl-Dickstein, and S Ganguli, "Exponential expressivity in deep neural networks through transient chaos," in: *Adv. Neural Inf. Process. Syst.* **29**, pp. 3360–3368. (Dec. 2016). [arXiv:1606.05340 \[stat.ML\]](https://arxiv.org/abs/1606.05340).

We show that the class of functions that can be expressed by a deep neural network grows exponentially with depth when they are in a chaotic regime.

S Lahiri and S Ganguli, "A memory frontier for complex synapses," in: *Adv. Neural Inf. Process. Syst.* **26**, pp. 1034–1042. (2013).

In artificial neural networks each connection is described by a single number - the weight - while biological synapses have complex substructure. We show how incorporating internal synaptic dynamics can dramatically increase memory capacity.

- Winner of the NeurIPS Outstanding Paper Award.

M Advani, S Lahiri, and S Ganguli, "Statistical mechanics of complex neural systems and high dimensional data," *J. Stat. Mech.* **2013.03**, P03014, (Jan. 2013). [arXiv:1301.7115 \[q-bio.NC\]](https://arxiv.org/abs/1301.7115).

High-dimensional statistics suffers from illusions of structure in noise. We review how the methods of statistical physics can be used to predict these phenomena.

See <https://scholar.google.com/citations?user=2nEwLGcAAAAJ> for a complete list.

## Awards

- Highest rated abstract out of ~500 submissions (Computational and Systems Neuroscience, Feb 2014).
- Winner of the Neural Information Processing Systems Outstanding Paper Award, given to 3 papers out of 1420 submissions (Neural Information Processing Systems, Dec. 2013).
- Certificate of distinction in teaching (Harvard University, Cambridge MA, Spring 2008).
- Scott Prize for best performance in M.Phys. examination (Oxford University, Oxford, UK, 2003).