



## Surya Ganguli

Assistant Professor of Applied Physics and, by courtesy, of Neurobiology, of Electrical Engineering and of Computer Science

 Curriculum Vitae available Online

### Bio

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#### ACADEMIC APPOINTMENTS

- Assistant Professor, Applied Physics
- Assistant Professor (By courtesy), Neurobiology
- Assistant Professor (By courtesy), Electrical Engineering
- Assistant Professor (By courtesy), Computer Science
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

#### HONORS AND AWARDS

- Investigator Award in Mathematical Modeling of Living Systems, Simons Foundation (2016)
- McKnight Scholar Award, McKnight Endowment Fund for Neuroscience (2015)
- Scholar Award in Human Cognition, James S. McDonnell Foundation (2014)
- Outstanding Paper Award, Neural Information Processing Systems Foundation (2014)
- Sloan Research Fellowship, Alfred P. Sloan Foundation (2013)
- Terman Award, Stanford University (2012)
- Career Award at the Scientific Interface, Burroughs Wellcome Foundation (2009)
- Swartz Fellow in Computational Neuroscience, Swartz Foundation (2004)

#### PROFESSIONAL EDUCATION

- Ph.D., UC Berkeley , Theoretical Physics (2004)
- M.A., UC Berkeley , Mathematics (2004)
- M.Eng., MIT , Electrical Engineering and Computer Science (1998)
- B.S., MIT , Mathematics (1998)
- B.S., MIT , Physics (1998)
- B.S., MIT , Electrical Engineering and Computer Science (1998)

#### LINKS

- Lab Website: <http://ganguli-gang.stanford.edu/index.html>
- Personal Website: <http://ganguli-gang.stanford.edu/surya.html>
- Applied Physics Website: <http://www.stanford.edu/dept/app-physics/cgi-bin/person/surya-gangulijanuary-2012/>

## Research & Scholarship

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### CURRENT RESEARCH AND SCHOLARLY INTERESTS

Theoretical / computational neuroscience

## Teaching

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### COURSES

#### 2018-19

- Introduction to Biophysics: APPPHYS 205, BIO 126, BIO 226 (Win)
- Theoretical Neuroscience: APPPHYS 293, PSYCH 242 (Spr)

#### 2017-18

- Artificial Intelligence, Entrepreneurship and Society in the 21st Century and Beyond: CS 28 (Aut)
- Introduction to Biophysics: APPPHYS 205, BIO 126, BIO 226 (Win)
- Theoretical Neuroscience: APPPHYS 293, PSYCH 242 (Spr)

#### 2016-17

- Introduction to Biophysics: APPPHYS 205, BIO 126, BIO 226 (Win)
- Theoretical Neuroscience: APPPHYS 293 (Spr)

#### 2015-16

- Introduction to Biophysics: APPPHYS 205, BIO 126, BIO 226 (Win)
- Theoretical Neuroscience: APPPHYS 293 (Spr)

### STANFORD ADVISEES

#### Doctoral Dissertation Reader (AC)

Andrew Lampinen

#### Postdoctoral Faculty Sponsor

Stephane Deny, Jonathan Kadmon, Sam Ocko

#### Postdoctoral Research Mentor

Sam Ocko

#### Doctoral (Program)

Rishi Patel

### GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (Phd Program)

## Publications

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### PUBLICATIONS

- **A mathematical theory of semantic development in deep neural networks.** *Proceedings of the National Academy of Sciences of the United States of America*  
Saxe, A. M., McClelland, J. L., Ganguli, S.  
2019
- **Shared Cortex-Cerebellum Dynamics in the Execution and Learning of a Motor Task** *CELL*

- Wagner, M. J., Kim, T., Kadmon, J., Nguyen, N. D., Ganguli, S., Schnitzer, M. J., Luo, L.  
2019; 177 (3): 669+
- **Cortical layer-specific critical dynamics triggering perception.** *Science (New York, N.Y.)*  
Marshel, J. H., Kim, Y. S., Machado, T. A., Quirin, S., Benson, B., Kadmon, J., Raja, C., Chibukhchyan, A., Ramakrishnan, C., Inoue, M., Shane, J. C., McKnight, D. J., Yoshizawa, et al  
2019
  - **A Unified Theory of Early Visual Representations from Retina to Cortex through Anatomically Constrained Deep CNNs** *International Conference on Learning Representations (ICLR)*  
Lindsay, J., Ocko, S., Ganguli, S., Deny, S.  
2019
  - **An analytic theory of generalization dynamics and transfer learning in deep linear networks** *International Conference on Learning Representations (ICLR)*  
Lampinen, A., Ganguli, S.  
2019
  - **Accurate estimation of neural population dynamics without spike sorting** *Neuron*  
Trautmann, E. M., Stavisky, S. D., Lahiri, S., Ames, K. C., Kauffman, M. T., O'Shea, D. J., Vyas, S., Sun, X., Ryu, S. I., Ganguli, S., Shenoy, K. V.  
2019; 103: 1-17
  - **Emergent elasticity in the neural code for space.** *Proceedings of the National Academy of Sciences of the United States of America*  
Ocko, S. A., Hardcastle, K., Giocomo, L. M., Ganguli, S.  
2018
  - **Inferring hidden structure in multilayered neural circuits.** *PLoS computational biology*  
Maheswaranathan, N., Kastner, D. B., Baccus, S. A., Ganguli, S.  
2018; 14 (8): e1006291
  - **Principles governing the integration of landmark and self-motion cues in entorhinal cortical codes for navigation.** *Nature neuroscience*  
Campbell, M. G., Ocko, S. A., Mallory, C. S., Low, I. I., Ganguli, S., Giocomo, L. M.  
2018
  - **SuperSpike: Supervised Learning in Multilayer Spiking Neural Networks.** *Neural computation*  
Zenke, F., Ganguli, S.  
2018: 1–28
  - **The emergence of multiple retinal cell types through efficient coding of natural movies** *Neural Information Processing Systems (NIPS)*  
Deny, S., Lindsey, J., Ganguli, S., Ocko, S.  
2018
  - **Task-Driven Convolutional Recurrent Models of the Visual System** *Neural Information Processing Systems (NIPS)*  
Nayebi, A., Bear, D., Kubilius, J., Kar, K., Ganguli, S., Di Carlo, J., Sussillo, D., Yamins, D.  
2018
  - **Statistical mechanics of low-rank tensor decomposition** *Neural Information Processing Systems (NIPS)*  
Kadmon, J., Ganguli, S.  
2018
  - **Unsupervised Discovery of Demixed, Low-Dimensional Neural Dynamics across Multiple Timescales through Tensor Component Analysis.** *Neuron*  
Williams, A. H., Kim, T. H., Wang, F., Vyas, S., Ryu, S. I., Shenoy, K. V., Schnitzer, M., Kolda, T. G., Ganguli, S.  
2018
  - **The emergence of spectral universality in deep networks** *Artificial Intelligence and Statistics (AISTATS)*  
Pennington, J., Schoenholz, S., Ganguli, S.  
2018
  - **An International Laboratory for Systems and Computational Neuroscience** *NEURON*  
Abbott, L. F., Angelaki, D. E., Carandini, M., Churchland, A. K., Dan, Y., Dayan, P., Deneve, S., Fiete, I., Ganguli, S., Harris, K. D., Hausser, M., Hofer, S., Latham, et al  
2017; 96 (6): 1213–18

- **Cell types for our sense of location: where we are and where we are going** *NATURE NEUROSCIENCE*  
Hardcastle, K., Ganguli, S., Giocomo, L. M.  
2017; 20 (11): 1474–82
- **A Multiplexed, Heterogeneous, and Adaptive Code for Navigation in Medial Entorhinal Cortex** *NEURON*  
Hardcastle, K., Maheswaranathan, N., Ganguli, S., Giocomo, L. M.  
2017; 94 (2): 375-?
- **The temporal paradox of Hebbian learning and homeostatic plasticity.** *Current opinion in neurobiology*  
Zenke, F., Gerstner, W., Ganguli, S.  
2017; 43: 166-176
- **A saturation hypothesis to explain both enhanced and impaired learning with enhanced plasticity.** *eLife*  
Nguyen-Vu, T. B., Zhao, G. Q., Lahiri, S., Kimpo, R. R., Lee, H., Ganguli, S., Shatz, C. J., Raymond, J. L.  
2017; 6
- **Social Control of Hypothalamus-Mediated Male Aggression.** *Neuron*  
Yang, T., Yang, C. F., Chizari, M. D., Maheswaranathan, N., Burke, K. J., Boriuss, M., Inoue, S., Chiang, M. C., Bender, K. J., Ganguli, S., Shah, N. M.  
2017; 95 (4): 955–70.e4
- **On the expressive power of deep neural networks** *International Conference on Machine Learning (ICML)*  
Raghu, M., Poole, B., Kleinberg, J., Ganguli, S., Sohl-Dickstein, J.  
2017
- **Resurrecting the sigmoid in deep learning through dynamical isometry: theory and practice** *Neural Information Processing Systems (NIPS)*  
Pennington, J., Schoenholz, S., Ganguli, S.  
2017
- **Variational Walkback: Learning a Transition Operator as a Stochastic Recurrent Net** *Neural Information Processing Systems (NIPS)*  
Ke, R., Goyal, A., Ganguli, S., Bengio, Y.  
2017
- **Continual Learning with Intelligent Synapses** *International Conference on Machine Learning (ICML)*  
Zenke, F., Poole, B., Ganguli, S.  
2017
- **Deep information propagation** *International Conference on Learning Representations (ICLR)*  
Schoenholz, S., Gilmer, J., Ganguli, S., Sohl-Dickstein, J.  
2017
- **Statistical Mechanics of Optimal Convex Inference in High Dimensions** *PHYSICAL REVIEW X*  
Advani, M., Ganguli, S.  
2016; 6 (3)
- **Direction Selectivity in Drosophila Emerges from Preferred-Direction Enhancement and Null-Direction Suppression.** *journal of neuroscience*  
Leong, J. C., Esch, J. J., Poole, B., Ganguli, S., Clandinin, T. R.  
2016; 36 (31): 8078-8092
- **An equivalence between high dimensional Bayes optimal inference and M-estimation** *Neural Information Processing Systems (NIPS)*  
Advani, M., Ganguli, S.  
2016
- **Deep Learning Models of the Retinal Response to Natural Scenes.** *Advances in neural information processing systems*  
McIntosh, L. T., Maheswaranathan, N., Nayebi, A., Ganguli, S., Baccus, S. A.  
2016; 29: 1369–77
- **Exponential expressivity in deep neural networks through transient chaos** *Neural Information Processing Systems (NIPS)*  
Poole, B., Subhaneil, L., Raghu, M., Sohl-Dickstein, J., Ganguli, S.  
2016: 3360–3368

- **Role of the site of synaptic competition and the balance of learning forces for Hebbian encoding of probabilistic Markov sequences** *FRONTIERS IN COMPUTATIONAL NEUROSCIENCE*  
Bouchard, K. E., Ganguli, S., Brainard, M. S.  
2015; 9
- **On simplicity and complexity in the brave new world of large-scale neuroscience** *CURRENT OPINION IN NEUROBIOLOGY*  
Gao, P., Ganguli, S.  
2015; 32: 148-155
- **Environmental Boundaries as an Error Correction Mechanism for Grid Cells** *NEURON*  
Hardcastle, K., Ganguli, S., Giocomo, L. M.  
2015; 86 (3): 827-839
- **Evidence for a causal inverse model in an avian cortico-basal ganglia circuit** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Giret, N., Kornfeld, J., Ganguli, S., Hahnloser, R. H.  
2014; 111 (16): 6063-6068
- **Fast large scale optimization by unifying stochastic gradient and quasi-Newton methods** *International Conference on Machine Learning (ICML)*  
Dickstein, J. S., Poole, B., Ganguli, S.  
2014
- **Exact solutions to the nonlinear dynamics of learning in deep neural networks** *International Conference on Learning Representations (ICLR)*  
Saxe, A., McClelland, J., Ganguli, S.  
2014
- **Identifying and attacking the saddle point problem in high-dimensional non-convex optimization** *Neural Information Processing Systems (NIPS)*  
Dauphin, Y., Pascanu, R., Gulchere, C., Cho, K., Ganguli, S., Bengio, Y.  
2014
- **Investigating the role of firing-rate normalization and dimensionality reduction in brain-machine interface robustness.** *Conference proceedings : ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference*  
Kao, J. C., Nuyujukian, P., Stavisky, S., Ryu, S. I., Ganguli, S., Shenoy, K. V.  
2013; 2013: 293-298
- **A Hebbian learning rule gives rise to mirror neurons and links them to control theoretic inverse models** *FRONTIERS IN NEURAL CIRCUITS*  
Hanuschkin, A., Ganguli, S., Hahnloser, R. H.  
2013; 7
- **Statistical mechanics of complex neural systems and high dimensional data** *JOURNAL OF STATISTICAL MECHANICS-THEORY AND EXPERIMENT*  
Advani, M., Lahiri, S., Ganguli, S.  
2013
- **A memory frontier for complex synapses** *Neural Information Processing Systems (NIPS)*  
Lahiri, S., Ganguli, S.  
2013
- **Learning hierarchical category structure in deep neural networks** *Proceedings of the Cognitive Science Society*  
Saxe, A., McClelland, J., Ganguli, S.  
2013: 1271-1276
- **Vocal learning with inverse models** *Principles of Neural Coding*  
Hahnloser, R., Ganguli, S.  
CRC Press.2013
- **Spatial Information Outflow from the Hippocampal Circuit: Distributed Spatial Coding and Phase Precession in the Subiculum** *JOURNAL OF NEUROSCIENCE*  
Kim, S. M., Ganguli, S., Frank, L. M.  
2012; 32 (34): 11539-11558

- **Compressed Sensing, Sparsity, and Dimensionality in Neuronal Information Processing and Data Analysis** *ANNUAL REVIEW OF NEUROSCIENCE, VOL 35*  
Ganguli, S., Sompolinsky, H.  
2012; 35: 485-508
- **Short-term memory in neuronal networks through dynamical compressed sensing** *Neural Information Processing Systems (NIPS)*  
Gangui, S., Sompolinsky, H.  
2010
- **Feedforward to the Past: The Relation between Neuronal Connectivity, Amplification, and Short-Term Memory** *NEURON*  
Ganguli, S., Latham, P.  
2009; 61 (4): 499-501
- **Memory traces in dynamical systems** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Ganguli, S., Huh, D., Sompolinsky, H.  
2008; 105 (48): 18970-18975
- **One-dimensional dynamics of attention and decision making in LIP** *NEURON*  
Ganguli, S., Bisley, J. W., Roitman, J. D., Shadlen, M. N., Goldberg, M. E., Miller, K. D.  
2008; 58 (1): 15-25
- **Function constrains network architecture and dynamics: A case study on the yeast cell cycle Boolean network** *PHYSICAL REVIEW E*  
Lau, K., Ganguli, S., Tang, C.  
2007; 75 (5)
- **E10 Orbifolds** *Journal of High Energy Physics*  
Brown, J., Ganguli, S., Ganor, O., Helfgott, C.  
2005; 06 (057)
- **Twisted six dimensional gauge theories on tori, matrix models, and integrable systems** *JOURNAL OF HIGH ENERGY PHYSICS*  
Ganguli, S., Ganor, O. J., Gill, J.  
2004
- **Holographic protection of chronology in universes of the Godel type** *PHYSICAL REVIEW D*  
Boyda, E. K., Ganguli, S., Horava, P., Varadarajan, U.  
2003; 67 (10)