

Louis Kang

Neural Circuits and Computations Unit

RIKEN Center for Brain Science

louis.kang@riken.jp

<https://louiskang.group>

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POSITIONS

Unit Leader (Junior Group Leader), Neural Circuits and Computations Unit 2020–
RIKEN Center for Brain Science, Wako, Japan

Miller Postdoctoral Fellow 2017–2020
University of California, Berkeley, USA
Host departments: Physics and Helen Wills Neuroscience Institute
Host faculty: Mike DeWeese

VISITING AND ADJUNCT POSITIONS

Adjunct Associate Professor, Graduate School of Informatics 2021–
Kyoto University, Japan

RESEARCH STATEMENT

I study how neural circuits in the hippocampal region enable us to remember events along with where they occurred. To do so, I use a variety of theoretical techniques, including neural network simulations and mathematical analysis. I aim to uncover how these circuits are disrupted in neurological diseases such as dementia and epilepsy. I also take inspiration from hippocampal computations to develop new algorithms for machine learning.

EDUCATION

MD, Perelman School of Medicine 2017
University of Pennsylvania, Philadelphia, USA

PhD, Department of Physics & Astronomy 2015
University of Pennsylvania, Philadelphia, USA
Thesis advisor: Tom Lubensky
Thesis title: *Chirality and its spontaneous symmetry breaking in two liquid crystal systems*

AB in Chemistry and Physics and Mathematics *summa cum laude* 2009
Harvard University, Cambridge, USA

PUBLICATIONS

*equal contribution †corresponding author

14. Wang S, **Kang L**, Salamon P, Wang X, Uchida N, Araoka F, Aida T, Dogic Z, Ishida Y[†]. Stimuli-responsive self-regulating assembly of chiral colloids for robust size and shape control. *Nat Commun* 15, 9891 (2024). doi:10.1038/s41467-024-54217-x.

13. Eydam S[†], Franović I, **Kang L**. Control of seizure-like dynamics in neuronal populations with excitability adaptation related to ketogenic diet. *Chaos* 34, 053128 (2024). doi:10.1063/5.0180954.
12. **Kang L**[†], Toyozumi T. Distinguishing examples while building concepts in hippocampal and artificial networks. *Nat Commun* 15, 647 (2024). doi:10.1038/s41467-024-44877-0.
11. **Kang L**[†], Toyozumi T. A Hopfield-like model with complementary encodings of memories. *Phys Rev E* 108, 054410 (2023). doi:10.1103/PhysRevE.108.054410.
10. Wang R, **Kang L**[†]. Multiple bumps can enhance robustness to noise in continuous attractor networks. *PLOS Comput Biol* 18, e1010547 (2022). doi:10.1371/journal.pcbi.1010547.
9. **Kang L**[†], Xu B, Morozov D. Evaluating state space discovery by persistent cohomology in the spatial representation system. *Front Comput Neurosci* 15, 616748 (2021). doi:10.3389/fncom.2021.616748.
8. **Kang L**[†], DeWeese MR. Replay as wavefronts and theta sequences as bump oscillations in a grid cell attractor network. *eLife* 8, e46351 (2019). doi:10.7554/eLife.46351.
7. **Kang L**[†], Balasubramanian V. A geometric attractor mechanism for self-organization of entorhinal grid modules. *eLife* 8, e46687 (2019). doi:10.7554/eLife.46687.
6. **Kang L**[†], Lubensky TC. Chiral twist drives raft formation and organization in membranes composed of rod-like particles. *Proc Natl Acad Sci USA* 114, E19 (2017). doi:10.1073/pnas.1613732114.
5. **Kang L**[†], Gibaud T, Dogic Z, Lubensky TC. Entropic forces stabilize diverse emergent structures in colloidal membranes. *Soft Matter* 12, 386 (2016). doi:10.1039/C5SM02038G.
4. Davidson ZS*, **Kang L***, Jeong J*[†], Still T, Collings PJ, Lubensky TC, Yodh AG. Chiral structures and defects of lyotropic chromonic liquid crystals induced by saddle-splay elasticity. *Phys Rev E* 91, 050501 (2015). doi:10.1103/PhysRevE.91.050501.
3. Jeong J*[†], **Kang L***, Davidson ZS, Collings PJ, Lubensky TC, Yodh AG. Chiral structures from achiral liquid crystals in cylindrical capillaries. *Proc Natl Acad Sci USA* 112, E1837 (2015). doi:10.1073/pnas.1423220112.
2. Idema T, Dubuis JO, **Kang L**, Manning ML, Nelson PC, Lubensky TC, Liu AJ[†]. The syncytial *Drosophila* embryo as a mechanically excitable medium. *PLOS ONE* 8, e77216 (2013). doi:10.1371/journal.pone.0077216.
1. Heo M, **Kang L**, Shakhnovich EI[†]. Emergence of species in evolutionary “simulated annealing”. *Proc Natl Acad Sci USA* 106, 1869 (2009). doi:10.1073/pnas.0809852106.

GRANTS, AWARDS, AND HONORS
KAKENHI Grant-in-Aid for Early-Career Scientists

2022–2025

Japan Society for the Promotion of Science

Project role: PI

Project title: *The influence of attractor topology on seizure initiation in the hippocampal region (22K15209)***Collaborative Research Travel Grant**

2019–2020

Burroughs Wellcome Fund

Project role: PI

Project title: *Complementary input pathways enhance associative memory in a model of CA3*

Miller Research Fellowship

2017–2020

University of California, Berkeley

Mary Ellis Bell Prize

2016

University of Pennsylvania, Perelman School of Medicine

“This prize is given to a student in the School of Medicine who is engaged in noteworthy research in any field related to medicine.”

Werner Teutsch Memorial Prize

2012

University of Pennsylvania, Department of Physics & Astronomy

“Awarded annually to the graduate student who, by his or her performance in the first year courses, shows the most promise for outstanding achievement in research.”

Medical Scientist Training Program

2009–2017

National Institutes of Health (USA), awarded through the University of Pennsylvania

Phi Beta Kappa

2009

Harvard University

INVITED AND ACCEPTED CONFERENCE TALKS

Korean Society for Brain and Neural Sciences Annual Meeting, Gyeongju, Korea 2024

Computational demands can influence seizure susceptibility in recurrent neural networks

Simons Institute for the Theory of Computing, Berkeley, USA 2024

Summer Cluster in AI, Psychology, and Neuroscience

Distinguishing examples while building concepts in hippocampal and artificial networks

Simons Collaboration for the Global Brain, online 2020

West Coast Postdoc/Student Meeting

Topological discovery in spatial representation circuits with persistent homology

Bernstein Conference, Berlin, Germany 2018

Replay arises naturally as a traveling wavefront in an entorhinal attractor network

Computational Neuroscience Meeting (CNS*2018), Seattle, USA 2018

A geometric attractor mechanism for the self-organization of entorhinal grid modules

SCIENTIFIC COMMUNITY INVOLVEMENT

Conference Co-organizer, RIKEN CBS Co-Creation International Conference 2025

Intelligent neural systems: what, how, and why?

Speakers: Shun-ichi Amari, Anne Collins, Tomoki Fukai, Pulin Gong, Ryo Karakida, Taegon Kim, Máté Lengyel, Anna Levina, Yukie Nagai, Mizuki Oka, Masafumi Oizumi, Tomoyo Shiramatsu

Workshop Co-organizer, Computational and Systems Neuroscience (Cosyne) 2023

Seeking universality while celebrating heterogeneity among biological attractor networks

Speakers: Nicolas Brunel, Yoram Burak, Joanna Chang, Albert Compte, Kayvon Daie, Laura Driscoll, Tatiana Engel, Ila Fiete, Kevin Franks, Lisa Giocomo, Yi Gu, Christiane Linster, Luca Mazzucato, Adit Radhakrishnan, Valentin Schmutz, Misha Tsodyks, Dan Turner-Evans, Kechen Zhang

Grant Reviewer

Swiss National Science Foundation

Journal Reviewer

Nature Communications, PLOS Computational Biology, Neural Computation, Physical Review E, Frontiers in Computational Neuroscience, Neural Networks, Cosyne conference submissions

TEACHING

An introduction to computational neuroscience

2022–

RIKEN Center for Brain Science, Brain Science Training Program

Two-hour lecture for graduate students once a year

Recurrent neural networks in the brain

2021–

Kyoto University, Graduate School of Informatics

Three-hour lecture for graduate students once a year

REFERENCES

Taro Toyozumi

Research mentor

RIKEN Center for Brain Science

Neural Adaptation and Computation Lab

taro.toyoizumi@riken.jp

Yoram Burak

External expert in attractor networks

Hebrew University of Jerusalem

Safra Center for Brain Sciences

yoram.burak@elsc.huji.ac.il

Tom Lubensky

PhD advisor

University of Pennsylvania

Department of Physics & Astronomy

tom@physics.upenn.edu

Tom McHugh

Experimental collaborator

RIKEN Center for Brain Science

Circuit and Behavioral Physiology Lab

thomas.mchugh@riken.jp

Mike DeWeese

Postdoctoral advisor

University of California, Berkeley

Redwood Center for Theoretical Neuroscience

deweese@berkeley.edu

Vijay Balasubramanian

Research mentor

University of Pennsylvania

Department of Physics & Astronomy

vijay@physics.upenn.edu