Louis Kang

Neural Circuits and Computations Unit
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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

Visiting Scientist — Summer 2019
RIKEN Center for Brain Science, Wako, Japan
Host faculty: Taro Toyoizumi

Research Statement

Human cognition ultimately emerges from sophisticated computations performed by networks of neurons. I use and develop theoretical tools to investigate how our brains make sense of and respond to our dynamic environments. In particular, I am interested in how hippocampal circuits produce memory and how they are disrupted in neurological diseases.

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

–. Eydam S†, Franović I, **Kang L**. Control of seizure-like dynamics in neuronal populations with

excitability adaptation related to ketogenic diet. *arXiv* (2024). doi:10.48550/arXiv.2402.04388.

12. **Kang L**†, Toyoizumi 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**†, Toyoizumi 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 2022–2024
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*

Travel Award 2018
Computational Neuroscience Meeting (CNS*2018)

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

Conference Presentations ‡talk

Bernstein Conference, Berlin, Germany 2022
Multiscale encodings of memories in hippocampal and artificial networks

Computational and Systems Neuroscience (Cosyne), Lisbon, Portugal 2022
Multiscale encodings of memories in hippocampal and artificial networks

Computational and Systems Neuroscience (Cosyne), Denver, USA 2020
Complementary encoding pathways build a memory hierarchy in a model of hippocampus

Society for Neuroscience Meeting, Chicago, USA 2019
Replay as wavefronts and theta sequences as bump oscillations in a grid cell attractor network

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‡

Interdisciplinary Navigation Symposium (iNAV), Mont-Tremblant, Canada 2018
A geometric attractor mechanism for the self-organization of entorhinal grid modules‡

American Physical Society March Meeting, Los Angeles, USA 2018
Self-organization of entorhinal grid modules through commensurate lattice relationships‡

Computational and Systems Neuroscience (Cosyne), Denver, USA 2018
Self-organization of entorhinal grid modules through commensurate lattices

American Physical Society March Meeting, New Orleans, USA 2017
Membrane rafts stabilized by chiral liquid crystal correction to bare interfacial tension‡

Computational and Systems Neuroscience (Cosyne), Salt Lake City, USA 2017
Coupling between attractor networks naturally generates a discrete grid cell hierarchy

Gordon Research Conference & Seminar on Liquid Crystals, Biddeford, USA 2015
Roles of entropy and chirality in depletion-induced colloidal membranes‡

American Chemical Society Colloid & Surface Science Symposium, Philadelphia, USA 2014
A theory for depletion-induced colloidal membranes‡

American Physical Society March Meeting, Denver, USA 2014
A theory for depletion-induced colloidal membranes‡

IAS Program on Frontiers of Soft Matter Physics, Hong Kong 2014
A theory for depletion-induced colloidal membranes

American Physical Society March Meeting, Baltimore, USA 2013
Mitotic wavefronts mediated by mechanical signaling in early Drosophila *embryos*‡

Scientific Community Involvement

Workshop organizer, Computational and Systems Neuroscience (Cosyne) 2023
Seeking universality while celebrating heterogeneity among biological attractor networks
Speakers: Misha Tsodyks, Lisa Giocomo, Yi Gu, Kechen Zhang, Dan Turner-Evans, Laura Driscoll, Yoram Burak, Tatiana Engel, Ila Fiete, Christiane Linster, Kevin Franks, Kayvon Daie, Adit Radhakrishnan, Joanna Chang, Albert Compte, Luca Mazzucato, Valentin Schmutz, Nicolas Brunel

Peer 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

Mike DeWeese
Postdoctoral advisor
University of California, Berkeley
Redwood Center for Theoretical Neuroscience
deweese@berkeley.edu

Taro Toyoizumi
Research mentor
RIKEN Center for Brain Science
Neural Adaptation and Computation Lab
taro.toyoizumi@riken.jp

Tom McHugh
Experimental collaborator
RIKEN Center for Brain Science
Circuit and Behavioral Physiology Lab
thomas.mchugh@riken.jp

Yoram Burak
Expert in computational neuroscience
Hebrew University of Jerusalem
Safra Center for Brain Sciences
yoram.burak@elsc.huji.ac.il