Louis Kang

Neural Circuits and Computations Unit
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Positions

Unit 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

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 pursuing a unified understanding for how the hippocampus and entorhinal cortex allow us to form memories and navigate through space.

Education

MD, Perelman School of Medicine — 2017
University of Pennsylvania, Philadelphia, USA
Research elective with Vijay Balasubramanian in theoretical neuroscience

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

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

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

Visiting Position

Visiting Scientist Summer 2019

RIKEN Center for Brain Science, Wako, Japan
Host faculty: Taro Toyoizumi

Conference Presentations ‡talk

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, 2014
Philadelphia, USA
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*‡

External Seminars

Simons Collaboration for the Global Brain, online 2020
West Coast Postdoc/Student Meeting
Topological discovery in spatial representation circuits with persistent homology

University of Tokyo, Japan 2019
Yuji Ikegaya Group

Replay as wavefronts and theta sequences as bump oscillations in a grid cell attractor network

Ludwig-Maximilians-Universität München, Germany 2018
Bernstein Center for Computational Neuroscience Munich
Modules (and phase precession and replay) in continuous attractor models of grid cells

University College London, UK 2018
Institute for Behavioural Neuroscience
Replay arises naturally as a traveling wavefront in an entorhinal attractor network

École Normale Supérieure, Paris, France 2017
Group for Neural Theory
Self-organization of entorhinal grid modules through commensurate lattice relationships

Institut Curie, Paris, France 2017
Pierre Sens Group
Chiral twist drives raft formation and organization in membranes composed of rod-like particles

University College London, UK 2016
Gatsby Computational Neuroscience Unit
Coupling between attractor networks naturally generates a discrete grid cell hierarchy

University of California, Los Angeles, USA 2016
Center for Biological Physics
Chiral twist drives raft formation and organization in membranes composed of rod-like particles

Teaching

Teaching Assistant 2011–2015
University of Pennsylvania
Modern physics, wave phenomena, electromagentism, physics laboratory

Teaching Fellow 2006–2007
Harvard University
Organic chemistry, linear algebra

Clinical Service

Medical Volunteer 2018–2020
Project Homeless Connect
Providing medical care at homeless services events in San Francisco

Medical Student Volunteer 2010–2013
United Community Clinics
Provided medical care at a free health clinic in Phladelphia

References

Mike DeWeese
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University of California, Berkeley
Redwood Center for Theoretical Neuroscience
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Tom Lubensky
PhD advisor
University of Pennsylvania
Department of Physics & Astronomy
tom@physics.upenn.edu

Vijay Balasubramanian
Research mentor
University of Pennsylvania
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Taro Toyoizumi
Research mentor
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Neural Adaptation and Computation Group
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