

# Louis Kang

Neural Circuits and Computations Unit

RIKEN Center for Brain Science

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<https://louiska.ng>

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## POSITIONS

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**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

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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

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**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

## VISITING POSITION

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

## PUBLICATIONS

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\*equal contribution †corresponding author

8. **Kang L<sup>†</sup>**, 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<sup>†</sup>**, 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<sup>†</sup>**, 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<sup>†</sup>**, 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\*,<sup>†</sup>, 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\*,<sup>†</sup>, **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<sup>†</sup>. 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<sup>†</sup>. Emergence of species in evolutionary “simulated annealing”. *Proc Natl Acad Sci USA* 106, 1869 (2009). doi:10.1073/pnas.0809852106.

## GRANTS, AWARDS, AND HONORS

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**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 <sup>†</sup>talk

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**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<sup>†</sup>*

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

*A geometric attractor mechanism for the self-organization of entorhinal grid modules<sup>†</sup>*

**Interdisciplinary Navigation Symposium (iNAV)**, Mont-Tremblant, Canada 2018

*A geometric attractor mechanism for the self-organization of entorhinal grid modules<sup>†</sup>*

<b>American Physical Society March Meeting</b> , Los Angeles, USA <i>Self-organization of entorhinal grid modules through commensurate lattice relationships<sup>‡</sup></i>	2018
<b>Computational and Systems Neuroscience (Cosyne)</b> , Denver, USA <i>Self-organization of entorhinal grid modules through commensurate lattices</i>	2018
<b>American Physical Society March Meeting</b> , New Orleans, USA <i>Membrane rafts stabilized by chiral liquid crystal correction to bare interfacial tension<sup>‡</sup></i>	2017
<b>Computational and Systems Neuroscience (Cosyne)</b> , Salt Lake City, USA <i>Coupling between attractor networks naturally generates a discrete grid cell hierarchy</i>	2017
<b>Gordon Research Conference &amp; Seminar on Liquid Crystals</b> , Biddeford, USA <i>Roles of entropy and chirality in depletion-induced colloidal membranes<sup>‡</sup></i>	2015
<b>American Chemical Society Colloid &amp; Surface Science Symposium</b> , Philadelphia, USA <i>A theory for depletion-induced colloidal membranes<sup>‡</sup></i>	2014
<b>American Physical Society March Meeting</b> , Denver, USA <i>A theory for depletion-induced colloidal membranes<sup>‡</sup></i>	2014
<b>IAS Program on Frontiers of Soft Matter Physics</b> , Hong Kong <i>A theory for depletion-induced colloidal membranes</i>	2014
<b>American Physical Society March Meeting</b> , Baltimore, USA <i>Mitotic wavefronts mediated by mechanical signaling in early <i>Drosophila</i> embryos<sup>‡</sup></i>	2013
EXTERNAL SEMINARS <hr/>	
<b>University of Tokyo</b> , Japan Yuji Ikegaya Group <i>Replay as wavefronts and theta sequences as bump oscillations in a grid cell attractor network</i>	2019
<b>Ludwig-Maximilians-Universität München</b> , Germany Bernstein Center for Computational Neuroscience Munich <i>Modules (and phase precession and replay) in continuous attractor models of grid cells</i>	2018
<b>University College London</b> , UK Institute for Behavioural Neuroscience <i>Replay arises naturally as a traveling wavefront in an entorhinal attractor network</i>	2018
<b>École Normale Supérieure</b> , Paris, France Group for Neural Theory <i>Self-organization of entorhinal grid modules through commensurate lattice relationships</i>	2017
<b>Institut Curie</b> , Paris, France Pierre Sens Group <i>Chiral twist drives raft formation and organization in membranes composed of rod-like particles</i>	2017
<b>University College London</b> , UK Gatsby Computational Neuroscience Unit <i>Coupling between attractor networks naturally generates a discrete grid cell hierarchy</i>	2016
<b>University of California, Los Angeles</b> , USA Center for Biological Physics <i>Chiral twist drives raft formation and organization in membranes composed of rod-like particles</i>	2016

TEACHING 

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<b>Teaching Assistant</b> University of Pennsylvania	2011–2015
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Modern physics, wave phenomena, electromagnetism, physics laboratory

**Teaching Fellow**

2006–2007

Harvard University

Organic chemistry, linear algebra

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**CLINICAL SERVICE****Medical Volunteer**

2018–present

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 Philadelphia

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**REFERENCES****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

**Tom Lubensky**

*PhD advisor*

University of Pennsylvania

Department of Physics & Astronomy

tom@physics.upenn.edu

**Taro Toyoizumi**

*Research mentor*

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Neural Adaptation and Computation Group

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