

# David Cai, 1963-2017

Born in Wenzhou, China

Died in New York



- BS Peking University 1984
- PhD Northwestern University (Physics) 1994
- Postdoc: Los Alamos, NYU
- Faculty appointments: University of North Carolina in Chapel Hill, New York University, Shanghai Jiao Tong University
- Alfred P. Sloan Research Fellow
- Founder and Director, Institute of Natural Sciences, Shanghai Jiao-Tong University

# Generalized integrable discrete nonlinear Schrödinger equation

$$i\dot{\phi}_n = -(\phi_{n+1} + \phi_{n-1}) - [\mu(\phi_{n+1} + \phi_{n-1}) + 2\nu\phi_n]|\phi_n|^2$$

Soliton solution:

$$\phi_n = \frac{\sinh \beta}{\sqrt{\mu}} \operatorname{sech}[\beta(n - ut - x_0)] e^{-i(\omega t - \alpha n + \sigma_0)},$$

$$\omega = -2 \cos \alpha \cosh \beta,$$

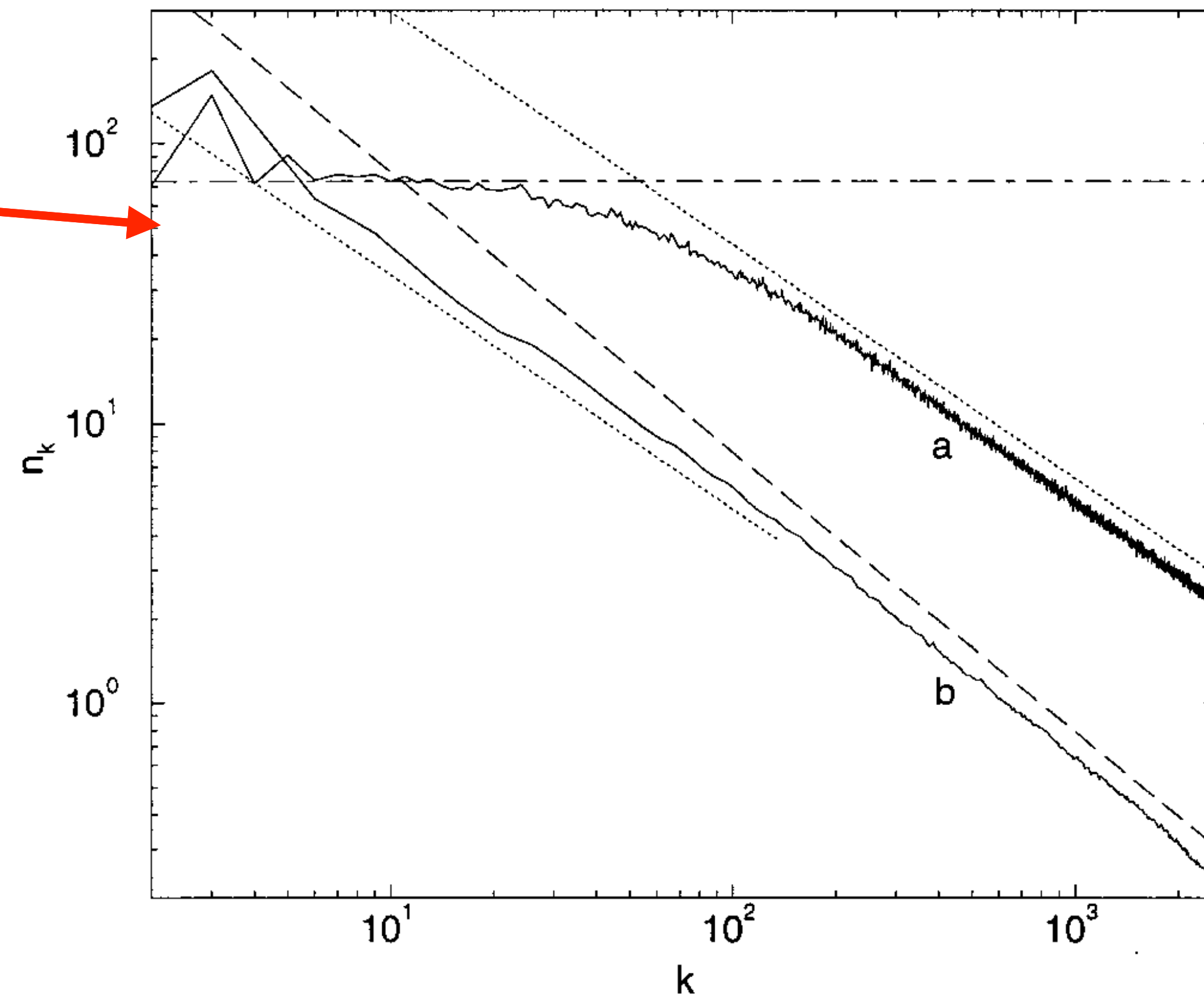
$$u = 2\beta^{-1} \sin \alpha \sinh \beta,$$

D. Cai, A.R. Bishop, N. Grønbech-Jensen, Localized states in discrete nonlinear Schrödinger equations, *Physical Review Letters* 72, 591 (1994)

## Wave turbulence: MMT model

$$iq_t = |\partial_x|^\alpha q \pm |\partial_x|^{-\sigma} \left( \left| |\partial_x|^{-\sigma} q \right|^2 |\partial_x|^{-\sigma} q \right)$$

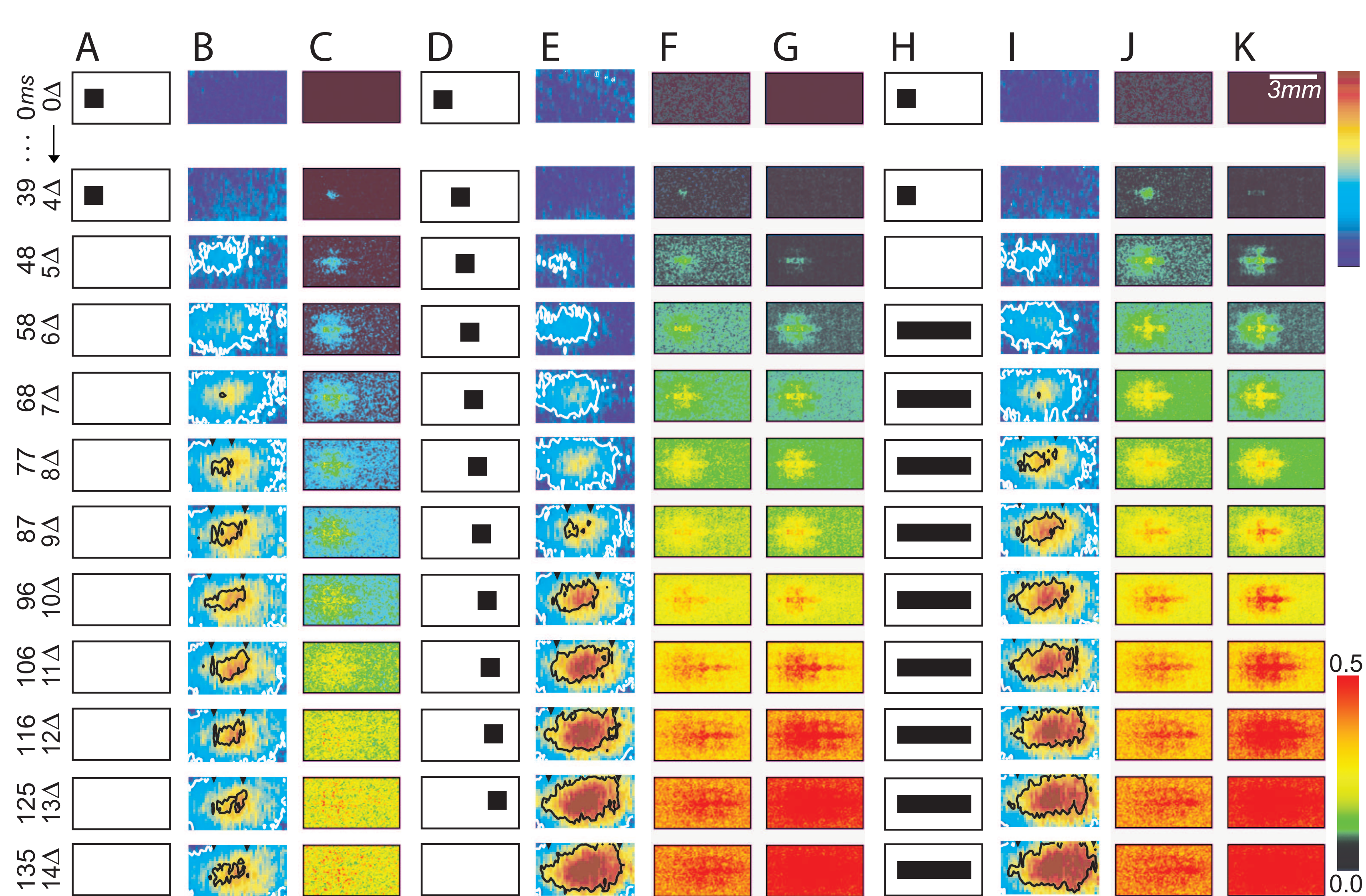
Thermodynamic  
equilibrium



Direct cascade

Inverse cascade

# Theoretical and Computational Neuroscience

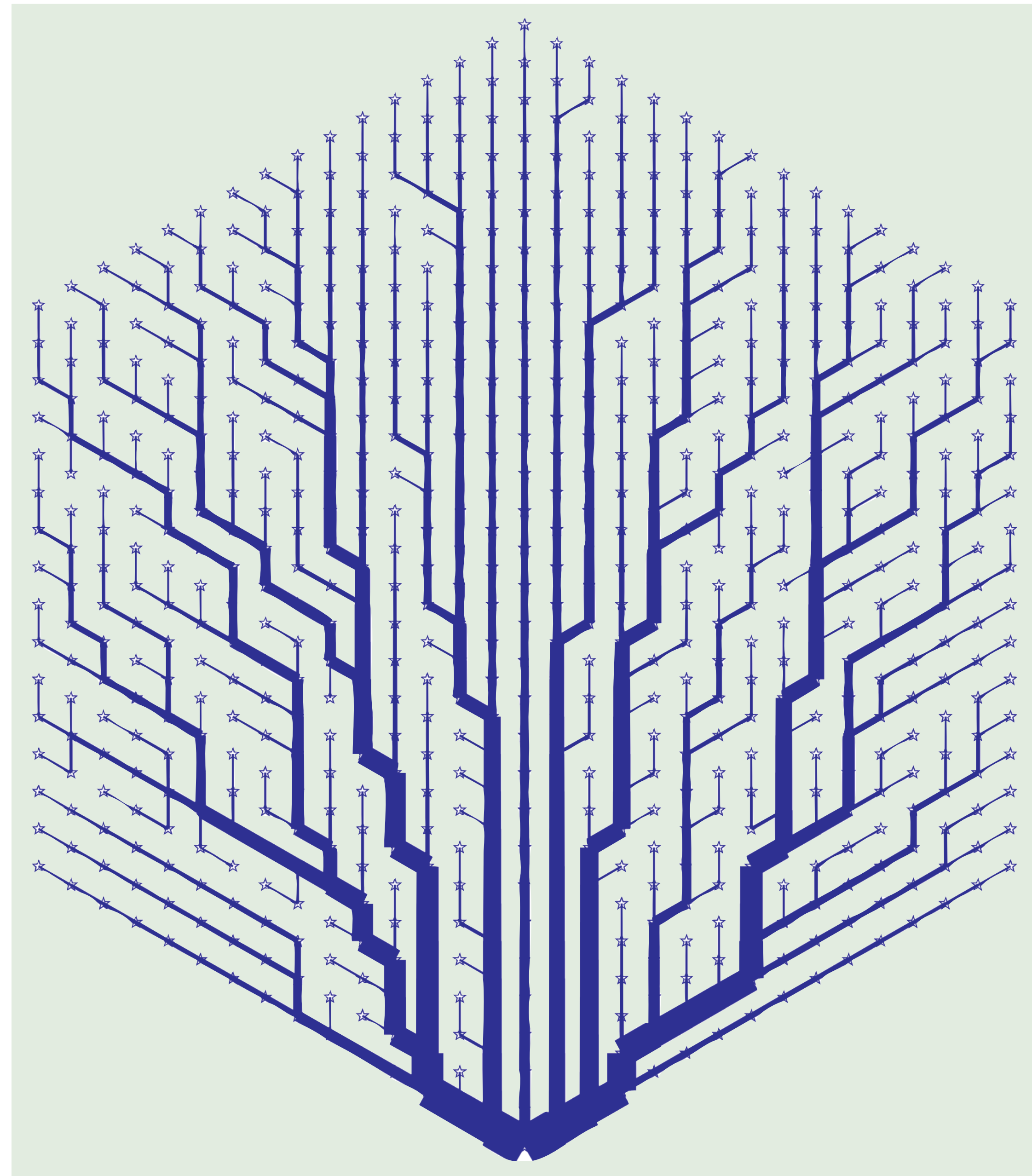


Hikosaka line-motion illusion in V1

A. V. Rangan, D. Cai, and D. W. McLaughlin, Modeling the spatiotemporal cortical activity associated with the line-motion illusion in primary visual cortex, Proc. Natl. Acad. Sci. USA, **102**, no. 52, pp. 18793–18800, 2005.

# Blood Flow Networks

D. Hu and D. Cai, Adaptation and Optimization of Biological Transport Networks,  
*Physical Review Letters* **111**, 138701  
(2013)



# Internal Waves in the Ocean

S.W. Jiang, G. Kovačič, D. Zhou, and D. Cai,  
Modulation-resonance mechanism for  
surface waves in a two-layer fluid system,  
*Journal of Fluid Mechanics* **875**, 807-841 (2019)

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