

Sungho Hong, PhD

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Education

- PhD in Physics/Theoretical High Energy Physics, University of Pennsylvania, 2004.
- MSc in Physics/Elementary Particle Physics, Korea Advanced Institute of Science and Technology, 1999.
- BSc in Physics, Korea Advanced Institute of Science and Technology, 1995.

Research Experience

Research Fellow (PI), Center for Cognition and Sociality, Institute for Basic Science, 2024—.

- Currently studying the biophysical basis of neural information processing via computational methods and implications in building Artificial Intelligence systems.

Group Leader, Computational Neuroscience Unit, Okinawa Institute of Science and Technology, 2012—2024.

Supervisor: Erik De Schutter.

- Developed computational frameworks to uncover how the cerebellar neurons encode and learn diverse types of information for sensorimotor coordination, with a focus on saccadic eye movements (collaboration with Hans-Peter Thier, U. Tübingen). This work resulted in two publications in *eLife* and *Nat Commun*.
- Developed a large-scale (~ 1 million cells) computational model of the cerebellar cortex with physiological details. Published in *PLOS Comput Biol* and *Front Neuroinform*.
- Studied the cellular mechanisms for encoding circadian rhythms in the suprachiasmatic nucleus (SCN) and choroid plexus (with Toru Takumi, RIKEN BSI). Published in *PNAS* and *Nat Commun*.

Researcher, Computational Neuroscience Unit, Okinawa Institute of Science and Technology, 2007—2012.

Advisor: Erik De Schutter.

- Demonstrated that intrinsic cellular properties determine how neurons transfer information by correlated firing (with Steven Prescott, U. Toronto). Published in *J Neurosci* and *Neuron*.
- Developed a clustering method for analyzing imaging data of the Bmal1 gene expression in the SCN neurons. Published in *J Neurosci*.

Senior Fellow, Physiology and Biophysics Department, University of Washington, 2004–2007. Advisor: Adrienne L. Fairhall.

- Investigated biophysical interpretation of statistical models for neural coding by single neurons and cellular basis for adaptive information processing. Three publications in *Neural Comput* and *PLOS Comput Biol*.

Graduate Student, Department of Physics and Astronomy, University of Pennsylvania, 1999–2004. Advisor:

Matthew J. Strassler & Mirjam Cvetič.

- Developed superstring theory-based methods to analyze hadron-like strongly bound states for solving longstanding puzzles in nuclear physics such as the ρ -meson universality problem. This work resulted in 4 publications in *JHEP*.

Grants

- Principal Investigator, Role of Ion Channel Distributions in Dendritic Information Processing of the Cerebellar Purkinje Cell. JSPS KAKENHI (科研費), Grant no:15K06725 (with Weiliang Chen, OIST), 2015–2017. Amount: ¥4,810,000. Designed the research program and wrote the grant.
- Recipient of the OCNS Travel Award for *60 Years of the Hodgkin-Huxley* (Cambridge, UK), 2012.

Teaching Experience

- Assistant Lecturer, Computational Neuroscience (A310), Okinawa Institute of Science and Technology (Okinawa, Japan), 2014–2023. Taught how to build computer models of neurons and neural networks on the NEURON simulation platform. Materials available at https://github.com/shhong/a310_cns_2023.
- Lecturer, Introduction to Numerical Methods for Ordinary/Partial Differential Equations, Okinawa Course of Computational Neuroscience (Okinawa, Japan), 2016&2023. Gave an introductory lecture on differential equations and numerical methods to students with the biology background.

Service and Outreach

- Academic Editor, *PeerJ*, 2016—.
- Reviewer for the Computational Neuroscience Meeting, 2012—.
- Reviewer for Neuroinformatics, Cell Reports, PLOS Computational Biology, Physical Review Letters, Cerebellum, Neural Computation, and Journal of Physics A, 2004—.
- Military service (mandatory). The 72 Infantry Division, Korean Army, 1995–1996.

Publications

Journal and Peer-reviewed Conference Publications:

1. Kim, M.-Y., Kim, M. J., Lee, C., Lee, J., Kim, S. S., **Hong, S.**, Kim, H. T., Seo, J., Yoon, K.-J., Han, S. (2023) Trametinib activates endogenous neurogenesis and recovers neuropathology in a model of Alzheimer's disease. *Exp. Mol. Med.* *55*, 2177–89.
2. Kim, S., Jeon, J. Ganbat, D., Kim, T., Shin, K., **Hong, S.** and Hong, J. (2023) Alteration of Neural Network and Hippocampal Slice Activation through Exosomes Derived from δ XFAD Nasal Lavage Fluid. *Int J Mol Sci*, *24(18)*, 14064.
3. Myung, J., **Hong, S.**, Schmal, C., Vitel, H., and Wu, M.-Y. (2023) Weak synchronization can alter circadian period length: Implications for aging and disease conditions. *Front. Neurosci.* *17*, 1242800.
4. Markanday, A.*, **Hong, S.***, Inoue, J, De Schutter, E., and Thier, P. (2023). Multidimensional cerebellar computations for flexible kinematic control of movements. *Nat. Commun.* *14*, 2548. (*contributed equally)
5. Medlock, L*, Sekiguchi, K.*, **Hong, S.**, Dura-Bernal, S., Prescott, S. A., and Lytton, W. W. (2022) Multiscale computer model of the spinal dorsal horn reveals changes in network processing associated with chronic pain. *J. Neurosci.* *42* (15), 3133–3149.
6. Lindeman, S.*, **Hong, S.***, Kros, L*, Meijas, J.F., Romano, V., Oostenveld, R., Negrello, M., Bosman, L.W.J, and De Zeeuw, C.I. (2021). Cerebellar Purkinje cells can differentially modulate coherence between sensory and motor cortex depending on region and behavior. *Proc. Nat. Acad. Sci. USA* *118*, e2015292118.
7. Han, D., De Schutter, E., and **Hong, S.** (2020). Lamina-specific neuronal properties promote robust, stable signal propagation in feedforward networks. In Larochele, H., Ranzato, M., Hadsell, R., Balcan, M. F., and Lin, H., eds., *Advances in Neural Information Processing Systems* *33*, 3033–44.
8. Zang, Y., **Hong, S.**, and De Schutter, E. (2020). Firing rate-dependent phase responses of Purkinje cells support transient oscillations. *eLife* *9*, e60692.
9. Wichert, I., Jee, S., De Schutter, E., and **Hong, S.** (2020). Pycabnn: Efficient and extensible software to construct an anatomical basis for a physiologically realistic neural network model. *Front. Neuroinform.* *14*, 31.
10. Myung, J.*, Schmal, C.*, **Hong, S.***, Tsukizawa, Y., Rose, P., Zhang, Y., Holtzman, M. J., De Schutter, E., Herzl, H., Bordyugov, G., and Takumi, T. (2018). The choroid plexus is an important circadian clock component. *Nat. Commun.* *9*, 1062.
11. Sudhakar, S. K.*, **Hong, S.***, Raikov, I., Publio, R., Lang, C., Close, T., Guo, D., Negrello, M., and De Schutter, E. (2017). Spatiotemporal network coding of physiological mossy fiber inputs by the cerebellar granular layer. *PLOS Comput. Biol.* *13*, e1005754.
12. **Hong, S.**, Negrello, M., Junker, M., Smilgin, A., Thier, P., and De Schutter, E. (2016). Multiplexed coding by cerebellar Purkinje neurons. *eLife* *5*, e13810.
13. Huang, S., **Hong, S.**, and De Schutter, E. (2015). Non-linear leak currents affect mammalian neuron physiology. *Front. Cell. Neurosci.* *9*, 432–41.
14. Myung, J., **Hong, S.**, DeWoskin, D., De Schutter, E., Forger, D., and Takumi, T. (2015). GABA-mediated repulsive coupling between circadian clock neurons in the SCN encodes seasonal time. *Proc. Nat. Acad. Sci. USA* *112*, E3920–9.
15. Ratté, S., **Hong, S.**, De Schutter, E., and Prescott, S.A. (2013). Impact of neuronal properties on network coding: Roles of spike initiation dynamics and robust synchrony transfer. *Neuron* *78*, 758–72.

16. **Hong, S.**, Robberechts, Q., and De Schutter, E. (2012). Efficient estimation of Phase Response Curves via Compressive Sensing. *J. Neurophysiol.* *208*, 2069–81.
17. Myung, J., **Hong, S.**, Hatanaka, F., Nakajima, Y., De Schutter, E., and Takumi, T. (2012). Period coding of Bmal1 oscillators in the suprachiasmatic nucleus. *J. Neurosci.* *32*, 8900–18.
18. **Hong, S.**, Ratté, S., Prescott, S. A., and De Schutter, E. (2012). Single neuron firing properties impact correlation-based population coding. *J. Neurosci.* *32*, 1413–28.
19. Anwar, H., **Hong, S.**, and De Schutter, E. (2010). Controlling Ca^{2+} -Activated K^+ channels with models of Ca^{2+} buffering in Purkinje cells. *Cerebellum*, 1–13 (online first).
20. **Hong, S.**, and De Schutter, E. (2008). Purkinje neurons: What is the signal for complex spikes? *Curr. Biol.* *18*, R969–R971.
21. **Hong, S.**, Lundstrom, B.N., and Fairhall, A.L. (2008). Intrinsic gain modulation and adaptive neural coding. *PLOS Comput. Biol.* *4*, e1000119.
22. Lundstrom, B.N., **Hong, S.**, Higgs, M.H., and Fairhall, A.L. (2008). Two computational regimes of a single-compartment neuron separated by a planar boundary in conductance space. *Neural Comput.* *20*, 1239–60.
23. **Hong, S.**, Agüera y Arcas, B., and Fairhall, A.L. (2007). Single neuron computation: from dynamical system to feature detector. *Neural Comput.* *19*, 3133–72.
24. **Hong, S.**, Yoon, S., and Strassler, M.J. (2006). On the couplings of vector mesons in AdS/QCD. *J. High Energy Phys.* *04*, 003.
25. **Hong, S.**, Yoon, S., and Strassler, M.J. (2006). Adjoint Trapping: A new phenomenon at strong 't Hooft coupling. *J. High Energy Phys.* *03*, 012.
26. Erlich, J., **Hong, S.**, and Unsal, M. (2004). Matrix models, monopoles and modified moduli. *J. High Energy Phys.* *09*, 024.
27. **Hong, S.**, Yoon, S., and Strassler, M.J. (2004). Quarkonium from the fifth dimension. *J. High Energy Phys.* *04*, 046.

Preprints online:

1. Kwon, J., Kim, S., Woo, J., De Schutter, E., **Hong, S.***, and Lee, C. J.* (2024). Cerebellar tonic inhibition orchestrates the maturation of information processing and motor coordination. bioRxiv. <https://doi.org/10.1101/2024.05.30.596563>.
2. **Hong, S.**, Yoon, S., and Strassler, M.J. (2004). On the couplings of the rho meson in AdS/QCD. arXiv:hep-ph/0501197. <https://arxiv.org/abs/hep-ph/0501197>.

Other Publications:

Hong, S. (2004). Hadron Form Factors and Interactions: Comparing AdS/CFT and QCD. University of Pennsylvania Thesis (Philadelphia: University of Pennsylvania).

Presentations

Talks in Conferences and Workshops:

1. Hong, S. (2023) Multidimensional cerebellar computations for flexible kinematic control of movements. OIST-RIKEN Brain Symposium (Okinawa, Japan).
2. Hong, S., Markanday, A., Inoue, J., De Schutter, E., and Thier, P. (2022) Multidimensional cerebellar computations for flexible kinematic control of movements. NEURO2022. (Okinawa, Japan).
3. Hong, S., Kwon J., Woo, J., Kim, S., De Schutter, E., and Lee, C.J. (2022) Computational modeling of age-dependent tonic inhibition in the cerebellar granule cells in a network context. The 99th Annual Meeting of the Physiological Society of Japan (Sendai, Japan).
4. Hong, S. (2019). Lamina-specific neuronal properties promote robust, stable signal propagation in feedforward networks. OCNS Workshop: *Neural Multiplexed Coding* (Barcelona, Spain).
5. Hong, S. (2018). Impact of neuronal properties on network coding. NCTS Winter School: *Frontiers of Complex Systems Science* (Taipei, Taiwan).

6. Han, D. and Hong, S. (2017). Heterogeneous layers stabilize propagation of a multiplexed spike signal in a feedforward network. Computational Neuroscience Meeting (CNS) 2017 (Antwerp, Belgium).
7. Hong, S. (2016). Multiplexed coding in the cerebellar cortex. Annual Meeting of Korean Society for Chemical Senses (Ansan, Korea).
8. Hong, S. and Myung, J. (2016) GABA-mediated phase couplings and seasonal time coding in the suprachiasmatic nucleus. Japanese Society for Mathematical Biology Meeting (Fukuoka, Japan).
9. Hong, S. (2015). GABA-mediated phase couplings and seasonal time coding in the suprachiasmatic nucleus. East Asia Joint Symposium on Biomedical Research (Okinawa, Japan).
10. Hong, S. (2015). Multiplexed coding by cerebellar Purkinje cells. OCNS Workshop: *Rate vs. temporal coding schemes: mutually exclusive or cooperatively coexisting?* (Prague, Czech).
11. Hong, S. (2015). Multiplexed coding by cerebellar Purkinje cells. Mini Symposium: *Recent Findings on the Cerebellar Microcircuitry* (Okinawa, Japan).
12. Hong, S. (2014). Exploring microcircuits in the cerebellum via computational modeling. Korean Society for Computational Neuroscience Meeting (Seoul, Korea) (Plenary talk).
13. Sudhakar, S. K., Hong, S., and De Schutter, E. (2014). Patterns in network activity and information processing in a detailed computer model of the cerebellar granular layer, CNS 2014 (Quebec City, Canada).
14. Hong, S. (2012). Adaptive computation of neurons with Hodgkin-Huxley mechanisms. OCNS Conference: *60 Years of the Hodgkin-Huxley* (Cambridge, UK).
15. Hong, S. (2012). Single neuron firing properties impact correlation-based population coding. RIKEN BSI Workshop: *Circuit Function of the Brain* (Wako, Japan).

Invited Talks:

- July 2024, Dept. of Neuroscience, Erasmus MC (Rotterdam, Netherlands).
- Jun 2022, School of Physiology, Pharmacology & Neuroscience, University of Bristol (Bristol, UK)
- Nov 2021, Carey Lab, Champalimaud Center for the Unknown (Lisbon, Portugal)
- Nov 2021, Département de Biologie, École Normale Supérieure (Paris, France)
- Nov 2018, Korea Brain Research Institute (Daegu, Korea).
- Oct 2017, Center for Functional Connectomics, KIST (Seoul, Korea).
- Oct 2017, Dept. of Bio and Brain Engineering, KAIST (Daejeon, Korea).
- Oct 2016, Dept. of Brain and Cognitive Science, DGIST (Daegu, Korea).
- July 2016, Center for Functional Connectomics, KIST (Seoul, Korea).
- Dec 2015, College of Pharmacy, Hanyang University (Ansan, Korea).
- July 2015, Dept. of Neuroscience, Erasmus MC (Rotterdam, Netherlands).
- July 2015, Dept. of Cognitive Neurology, University of Tübingen (Tübingen, Germany).
- Aug 2013, Blue Brain Project, EPFL (Lausanne, Switzerland).
- Aug 2013, Dept. of Neuroscience, Erasmus MC (Rotterdam, Netherlands).
- Oct 2009, Dept. of Physics, Kyoto University (Kyoto, Japan).
- Oct 2009, Graduate School of Biomedical Sciences, Hiroshima University (Hiroshima, Japan).
- Mar 2008, Dept. of Neurobiology, Yale School of Medicine (New Haven, CT).
- Jun 2007, Center for Brain Science, Harvard University (Cambridge, MA).
- Jun 2006, Dept. of Bio and Brain Engineering, KAIST (Daejeon, Korea).
- Oct 2003, Physics Dept., University of Washington (Seattle, WA).