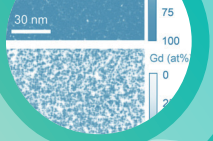

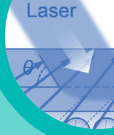

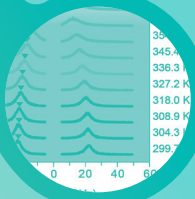

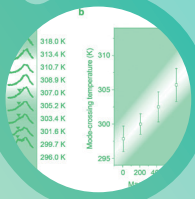

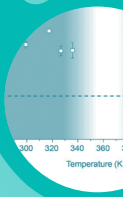

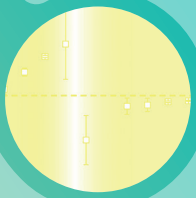

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- Bulletin of the Korean Physical Society
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2021년 2021 KPS Spring Meeting

봄 학술논문발표회 및 제97회 정기총회

2021년 4월 21일(수) ~ 23일(금)

Virtual Conference

KPS 한국물리학회 The Korean Physical Society

A13.02 [11:34 - 11:58]

Bio-inspired deep neural networks for hearing / KIM Sung-Won[1], PARK Sang-hyun[1], KIM Jaehyeon[1], KIM Hyunjae[1], KIM Gibeom[1], PARK Maruchan[1], LIM Woojae[1], LEE Changwon[1], PARK Hyoseok[1], BOICHENKO Nelly[1], YOO Jaeyun[1], LEE Wooseok[1], AHN Kang Hun*[1] ([1]Bio-inspired Artificial Intelligence Lab., Department of Physics, Chungnam National University)

A13.03* [11:58 - 12:10]

Tubulin-based Architectures by Cationic Molecular Switch and 2D Shape-controllable Building Blocks / LEE Juncheol[2], SONG Chaeyeon[2], LEE Jimin[2], MILLER Herbert P.[3], CHO Hasaeam[2], GIM Bopil[2], LI Youli[4], FEINSTEIN Stuart C.[3], WILSON Leslie[3], SAFINYA Cyrus R.[5], KIM Jinjoo[6], KEUM Hyeongseop[6], KIM Yumi[2], KIM Yujin[6], YU Byeongjun[6], LEE Sang Yeop[2], TANAKA Junichi[7], JON Sangyong[6], CHOI Myung Chul*[2] ([1]KAIST, [2]Department of Bio and Brain Engineering, KAIST, [3]Molecular, Cellular and Developmental Biology Department and Neuroscience Research Institute, UCSB, [4]Materials Research Laboratory, UCSB, [5]Materials, Physics, Molecular, Cellular and Developmental Biology Departments, UCSB, [6]Department of Biological Sciences, KAIST, [7]Department of Chemistry, Biology and Marine Science, University of the Ryukyus)

A13.04* [12:10 - 12:22]

Tensile elasticity of a freely jointed chain with reversible hinges / NOH Geunho[1], BENETATOS Panayotis*[1] ([1]Department of Physics, Kyungpook National University)

A13.05 [12:22 - 12:34]

Theoretical analysis of kymographs : influence of time window and resolution / DURANG Xavier[1], PARK Hye Yoon[2], JEON Jae-Hyung*[1] ([1]Department of Physics, POSTECH, [2]Department of Physics & Astronomy, Seoul National University)

A13.06 [12:34 - 12:46]

Dynamical Origin for The Winner-Take-All Competition and Emergence of Sparsely Synchronized Rhythms in The Hippocampal Dentate Gyrus / KIM Sang-Yoon[1], LIM Woochang*[1] ([1]Daegu National University Of Education)

A13.07 [12:46 - 12:58]

Simple model of artificial selection of microbial groups on the group composition / LEE Juhee[1], PARK Hye Jin*[1] ([1]APCTP)

A13.08* [12:58 - 13:10]

Heterogeneous vesicle fusion in the auditory hair cells / YOO Jaeyun[1], AHN Kang Hun*[1] ([1]Bio-inspired Artificial Intelligence Lab., Department of Physics, Chungnam National University)

[A14-A17] No session

Abstract Submission

2021 KPS Spring Meeting April 21-23, 2021 Virtual Conference

Dynamical Origin for The Winner-Take-All Competition and Emergence of Sparsely Synchronized Rhythms in The Hippocampal Dentate Gyrus

학술대회 명 2021 KPS Spring Meeting 접수일 2021-02-18

발표분야 Statistical physics 서브발표분야 Biophysics

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Abstract:

We consider a biological network of the hippocampal dentate gyrus (DG). The DG is a preprocessor for pattern separation which facilitates pattern storage and retrieval in the CA3 area of the hippocampus. The main encoding cells in the DG are the granule cells (GCs) which receive the sensory information from the entorhinal cortex (EC) and send their output to the CA3. The activation degree of GCs is so low (~ 5%). This sparsity has been thought to enhance the pattern separation. We investigate the dynamical origin for the winner-take-all competition which leads to the sparse activation of the GCs. The whole GCs are grouped into clusters. In each GC cluster, there is one inhibitory (I) basket cell (BC) along with excitatory (E) GCs. There are three kinds of external inputs into the GCs; the direct excitatory EC input, the indirect inhibitory EC input, mediated by the HIPP cells, and the excitatory input from the hilar mossy cells (MCs). The firing activities of the GCs are determined via competition between the external E and I inputs. The ratio of the external E to I conductance ($R_{E-I}^{(con)}$) may represents well the degree of such external E-I input competition. It is thus found that GCs become active when their $R_{E-I}^{(con)}$ is larger than a threshold, and then the mean firing rates of the active GCs are strongly correlated with $R_{E-I}^{(con)}$. In each GC cluster, the feedback inhibition of the BC may select the winner GCs. GCs with larger $R_{E-I}^{(con)}$ survive, and they become winners; all the other GCs with smaller $R_{E-I}^{(con)}$ become silent. In this way, winner-take-all occurs via interaction of the excitation of the GCs and the feedback inhibition of the BC in each GC cluster. The hilar MCs play a role of enhancing the activity of the GC-BC loop. Moreover, the feedback inhibition from the BCs also leads to emergence of sparsely synchronized rhythms in the GC-BC loop. Successive synchronized stripes appear with the population frequency f_p (=13 Hz) in the raster plots of spikes in each population of GCs and BCs. Such population rhythm also appears in the population of MCs via interaction with the GCs (i.e., GC-MC loop). The population firing activities are also quantitatively characterized in terms of their occupation degrees, the pacing degrees, and the spiking measures. In addition to population behavior, we study individual firing activity of GCs, BCs, and MCs. Individual GCs exhibit random spike skipping, leading to a multi-peaked inter-spike-interval histogram. In this case, population-averaged mean-firing-rate (MFR) is less than the population frequency f_p, which leads to normal sparse synchronization. On the other hand, both BCs and MCs show intrastripe spiking, in addition to the stochastic spike skipping. Thus, the population-averaged MFR is larger than f_p, which results in abnormal sparse synchronization.

Keywords:

Hippocampal dentate gyrus, Winner-take-all competition, Sparsely synchronized rhythm