Physical processes controlling biological neural networks

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The intensive experimental and theoretical research into the nerve signalling, which lasts for more than two hundred and thirty years, has provided many valuable pieces of knowledge but no definite, really satisfying solution. Such an unfavorable state is due to the extraordinary complexity of this phenomenon and enormous technical difficulties encountered by experiments. At present, there are two main competing models of signal transfer in neuron networks: Hodgkin-Huxley electric theory and Heimburg's thermomechanical, soliton theory. Since the major premises of both these approaches are mostly different, their reconciliation is not probable. The talk will first briefly overview our efforts in improvement of our understanding of physical processes, which control information transfer and processing in biological neural networks. We then introduce a scenario of the signal transmission in nerves, intentionally based only on well turned-out physically transparent arguments. We hope it will be useful for the efforts aiming to the improvement of the present models.

[1] J. J. Mareš, P. Hubík, V. Špička: Diffusive propagation of nervous signals and their quantum control. Eur. Phys. J. Spec. Top. 227 (2019) 2329–2347.

[2] J. J. Mareš, V. Špička, P. Hubík: Possible role of extracellular tissue in biological neural networks. Eur. Phys. J. Spec. Top. 230 (2021) 1089–1098.

[3] J. J. Mareš, V. Špička, P. Hubík: On physical processes controlling biological neural networks. Eur. Phys. J. Spec. Top. 232 (2023) 3561-3576.